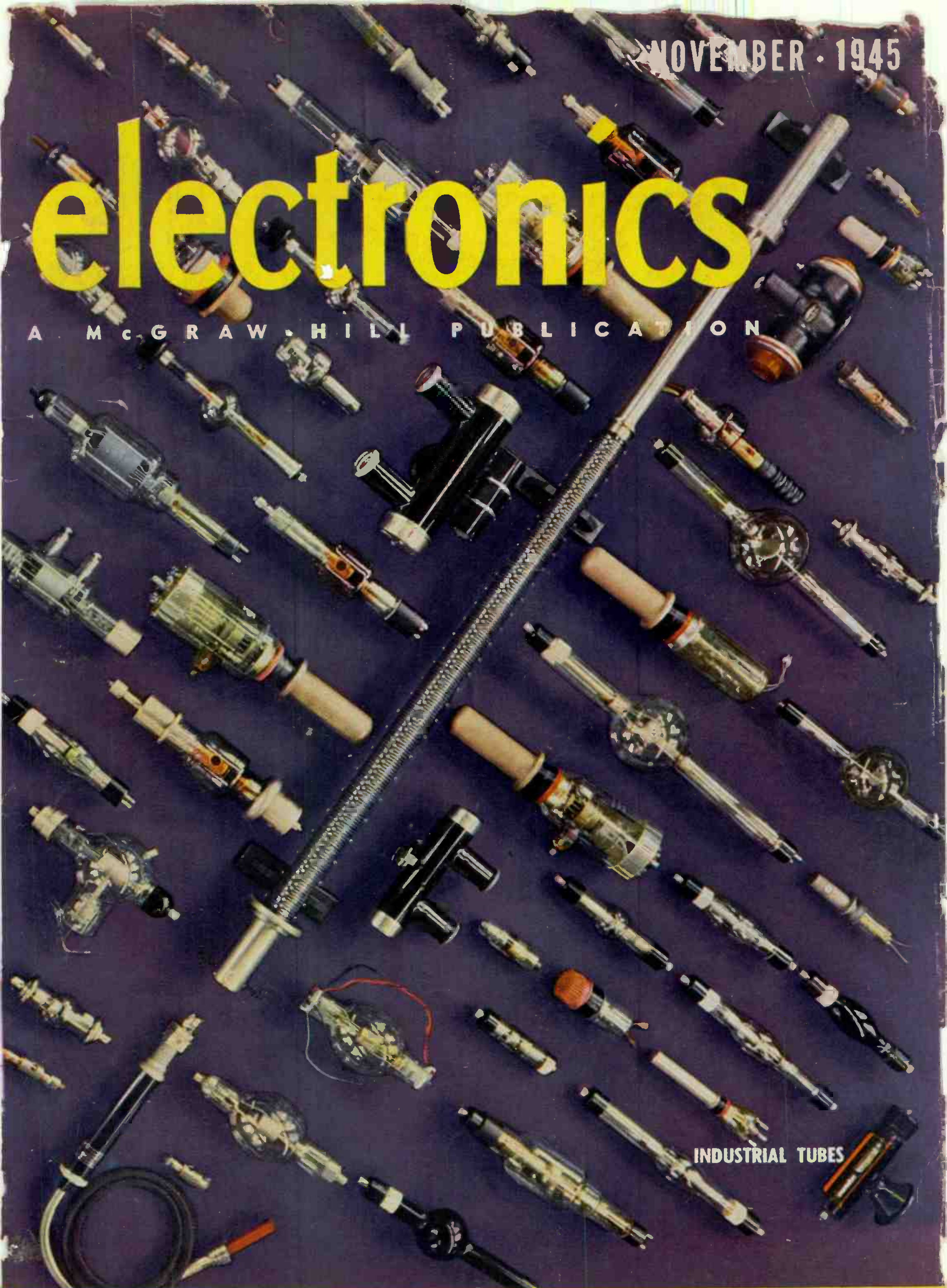
NOVEMBER · 1945

electronics

A McGRAW-HILL PUBLICATION

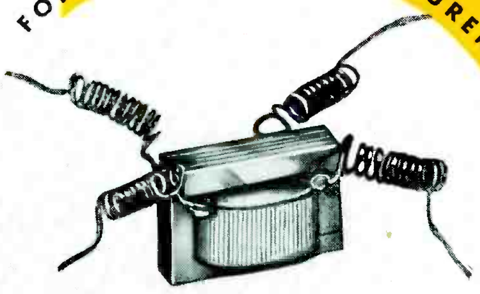


INDUSTRIAL TUBES

ginning
WARTIME ELECTRONIC DEVELOPMENTS ★ DIRECTORY ISSUE

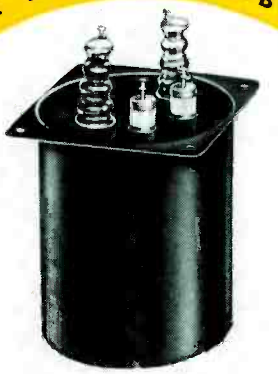
UTC for every transformer application

FOR THE SET MANUFACTURER



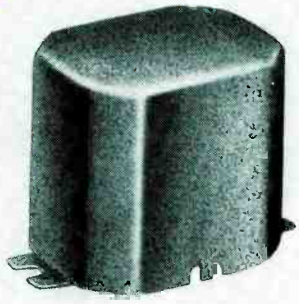
Miniature components to match the new "proximity fuse" miniature tubes. Output and input transformers, and reactors with dimensions 9/16" x 3/4" x 5/8".

FOR THE RESEARCH LABORATORY



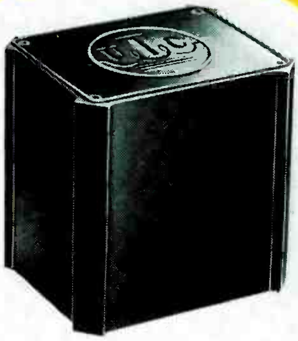
Typical of the special units produced by UTC is this high gain, 100 cycle, matching transformer. Primary impedance 500 ohms, secondary impedance 37,500,000 ohms, shielding suitable for—160 DB signal level.

FOR THE RADIO AMATEUR



UTC Special Series components cover the entire range of amateur and low priced PA requirements . . . attractively cased . . . economically priced.

FOR THE BROADCAST STATION



UTC linear standard transformers are the ultimate in high fidelity design . . . frequency response guaranteed ± 1.5 DB 20 to 20,000 cycles . . . Low wave form distortion . . . Extremely low hum pickup.

ARMY E NAVY ALL PLANTS

United Transformer Corp.

150 VARICK STREET • NEW YORK 13, N. Y.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y., CABLES: "ARLAB" nishes considerable information regarding the general shape of the universal resonance curves. As already stated, the relative gain g_D is the ratio of the gain at the outer roots to the gain at resonance. From the values of g_D given in the table, universal resonance curves may be quite accurately sketched. This information furnishes the ordinates of three points (three roots) through which the curve passes; the slopes of the curve through these points is zero, i.e., the curve is flat through these points.

Changing the factor h, alters the shape of the component curves. When h is increased, the ripple in the resultant curve, and the selectivity of the two stage amplifier are both reduced. When h is decreased, the reverse is true. In general a happy mean between high selectivity and uniform pass band response occurs when h is near unity. Practical values of Q also result when h is near unity.

In columns 3, 4 and 7 will be found data for a constant of the universal resonance curve defined as the product of the fractional frequency deviation and the circuit Q. Thus $\alpha = Q\delta$ where $\delta = \frac{\Delta f}{f_o} = \frac{f - f_o}{f_o}$. The quantity α has a value of zero at resonance. Its value at the critical roots, α_D is an essential design factor from which circuit Q may be derived.

Since the Q of the circuits in the three resonant circuit network may not be the same, there are two values of α_D, namely α_{AD} and α_{BD}. The two resonant circuit network has only value of α_D. These values permit one to readily calculate the Q of the circuits if the desired fractional frequency deviation at the critical roots is known. This frequency deviation is about 80 percent of the frequency deviation at the pass band edges.

The product of the Q and the coefficient of coupling, k, is another design quantity defined as

$$b = k\,Q$$

Values of this universal quantity which are necessary for critical couplings are given in the fifth and seventh columns of Table I.

Experimental Models and Results

A three resonant circuit transformer and a matched two resonant circuit transformer were constructed according to calculated design. The design procedure and calculations are as follows:

1. Preliminary Data and Assumptions
   - Choice of type of curve . . . . $h = 1$
   - Resonant frequency . . . . $f_o = 505$ kc.
   - Frequency deviation of critical roots from resonance . . . . $\Delta f_D = 9.1$ kc.
   - Fractional frequency deviation at critical roots . . . . $\delta_D = \dfrac{\Delta f_D}{f_o} = 0.018$
2. Three Resonant Circuit Calculations (from Table I)
   - Universal constant . . . . $\alpha_D = 1.323$
   - Circuit Q . . . . $Q = \dfrac{\alpha_D}{D} = 73.6$
3. Two Resonant Circuit Calculations
   - Universal constant . . . . $\alpha_D = 1.502$
   - Circuit Q . . . . $Q = \dfrac{\alpha_D}{D} = 83.5$

The experimental three resonant circuit transformer is shown in Fig. 8. The two resonant circuit transformer was almost identical except for omission of one resonant circuit.

The transformers were made with variable mutual inductance coupling in order to provide variable selectivity as well as a means of easily aligning the units.

On the three resonant circuit transformer, the coefficient of coupling between the first two coils was equal to that of the last two coils at all times. The coupling between the first and third coils was kept zero and the intermediate coil was kept

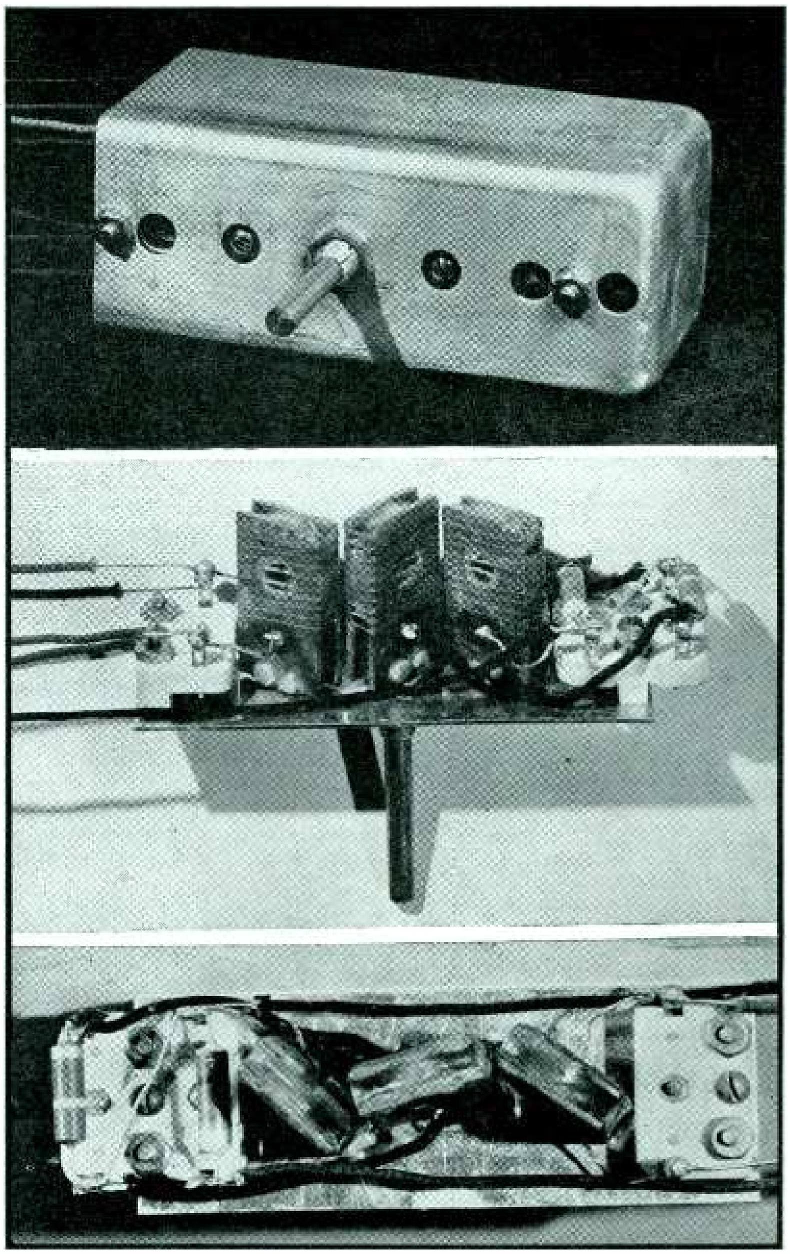


Fig. 8—Interior and exterior views of three resonant circuit transformer: Exterior view (top) with trimmer screws (ends) and shaft for varying coupling of center coil. Interior view (center) showing three coils, with copper wire spiral static shield on each coil, and coupling between center and outer coils only. View looking at transformer coils, end on (bottom)

symmetrical to them at all times.

There are other forms of transformer construction differing somewhat from that of Fig. 8 which provide the same coupling and variations of coupling.**

Capacity coupling on both transformers was eliminated rather uniquely by grounding the outside plates of the trimmer condensers, by arranging the coil leads to prevent coupling, and by placing a static shield around the coils. Capacity coupling is not objectionable unless it disturbs coupling symmetry or prevents zero coupling from being obtained.

The circuits were tuned when the coupling was quite small. The coupling was then increased to give the desired response.

The response curves of the experimental models is shown in Fig. 9.

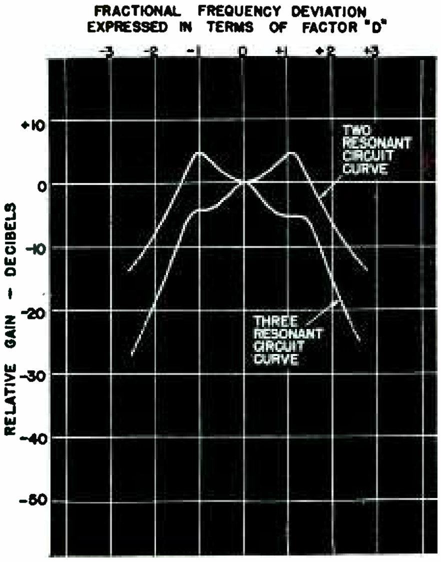


Fig. 9—Experimental resonance curves of critically coupled three resonant circuit, and its complementary matched two resonant circuit network. The overall response may be determined by adding, algebraically, the response of the component networks shown here.

Appendix

The mathematical solutions are not complicated and owe much of their simplicity to the nomenclature chosen. The method used has evolved, with some changes, from a system used by E. S. Purrington.[1] It is desirable, before discussing solutions, to tabulate most of the terms and their definitions.

f = frequency (cps)
$\omega = 2\pi f$
K = coefficient of coupling
$\delta = \dfrac{\Delta f}{f_\circ} = \dfrac{f - f_\circ}{f_\circ} = \dfrac{\omega - \omega_\circ}{\omega_\circ}$ = fractional frequency deviation
C = capacity (farads)
L = inductance (henries)
R = resistance (ohms)
X = reactance (ohms)
$Q = \dfrac{\omega L}{R} = \dfrac{1}{R\omega C} = \dfrac{X}{R}$
$X = QR$
$M = KQR$ = mutual reactance
e = voltage in series with input circuit
e_o = output voltage across reactance
G = absolute gain
$g = \dfrac{G}{G_\circ}$ = relative gain
h = ratio of Q between resonant circuits
l = ratio of reactance between output and resonant circuits
$a = \delta Q$
$b = KQ$
Subscript ($_\circ$) indicates value at resonance
Subscript ($_D$) indicates value at roots
Subscript ($_2$) refers to two resonant circuit problem†
Subscript ($_3$) refers to three resonant circuit problem†

A simplified expression for the impedance of a series resonant circuit, which appear often in solutions to follow, can be deduced from definitions given above.

$$Z = R + j\left(\omega L - \frac{1}{\omega C}\right)$$

$$= R + j\left(\frac{\omega}{\omega_\circ} X_\circ - \frac{\omega_\circ}{\omega} X_\circ\right)$$

We can write approximately,

$$Z = R + j\,2\,\delta\, X_\circ = R\,(1 + j\,2\,\delta Q)$$
$$Z = R\,(1 + j\,2\,a)$$

Solution of the Three Resonant Circuit Problem

A rather convenient solution of the three resonant circuit networks shown in Fig. 2, Fig. 3, and Fig. 4, can be obtained if the coefficient of coupling is assumed to be zero between circuit A and circuit C. A simplified solution has been known[2] but a more generalized solution will be given here.

The subscript ($_3$) will be omitted while discussing only the three resonant circuit problem. Three simultaneous equations describe the voltage components in the respective circuits.

$$e = Z_A I_A \pm j\, M_{AB}\, I_B$$
$$0 = \pm j\, M_{AB} I_A + Z_B I_B \pm j\, M_{BC} I_C$$
$$0 = \pm j\, M_{BC} I_B + Z_C I_C$$

Eliminating I_A and I_B and solving for I_C,

$$I_C = \frac{-\,e\, M_{AB}\, M_{BC}}{Z_A Z_B Z_C + Z_A M_{BC}{}^2 + Z_C\, M_{AB}{}^2}$$

The method of solution assumes symmetry, so let

$Q_A = Q_C,\ Z_C = lZ_A$ then $M_{BC} = \sqrt{l}\, M_{AB}$

Solving for gain

$$G = \frac{e_o}{e} = \frac{I_c X_c}{e} = \sqrt{l}\,\frac{X_A\, M_{AB}{}^2}{Z_A{}^2 Z_B + 2\, Z_A M_{AB}{}^2}$$

Also let $Q_B = hQ_A$ and $\alpha_B = h\alpha_A$ then

$$G = \sqrt{l}\left[\frac{Q_A b^2}{(1 - 4\alpha - 8h\alpha^2 + 2b^2)} + \frac{Q_A b^2}{j\,(4\alpha^2 + 2h\alpha - 8h\alpha^3 + 4b^2\alpha)}\right]$$

$$G = \frac{\sqrt{l}\;\; Q_A b^2}{\sqrt{\begin{array}{l}64\,\alpha^6\,(h^2) + \\ 16\,\alpha_A{}^4\,(1 + 2\,h^2 - 4\,hb^2) + \\ 4\alpha_A{}^2\,(2 + h^2 - 4\,hb^2 + 4\,b^2 + 4\,b^4) + \\ (1 + b^2 + 4\,b^4)\end{array}}}$$

It is interesting to note that in the above expression the gain is proportional to the square root of the ratio of the output to input impedance $\sqrt{l}$ just as it is for ordinary low frequency transformer. Rememberoing α_A is zero at resonance, the relative gain is

$$g = \frac{G}{G_\circ} = \frac{1 + 2\,b^2}{\sqrt{\begin{array}{l}64\,\alpha_A{}^6\,(h^2) + \\ 16\,\alpha_A{}^4\,(1 + 2\,h^2 - 4\,hb^2) \\ 4\alpha_A{}^2\,(2 + h^2 - 4\,hb^2 + 4\,b^2 + \\ 4\,b^4) + (1 + 4\,b^2 + 4\,b^4)\end{array}}}$$

By differentiating relative gain in respect to α_A and equating to zero, it is possible to solve for the roots of the resonance curve.

$$\frac{dg}{d\alpha_A} = 0 = 48\,\alpha_A{}^5\,(h^2) + 8\,\alpha_A{}^3\,(1 + 2\,h^2 - 4\,hb^2) + \alpha_A\,(2 + h^2 - 4\,hb^2 + 4\,b^2 + 4\,b^4)$$

The five roots are

$$\alpha_A = 0$$

$$\alpha_A = \pm\left[\frac{(4\,h)\,b_2 - (1 + 2\,h^2) \pm}{12\,h^2}\;\frac{\sqrt{4\,h^2b^4 - (4\,h)\,(2+h)\,(1+h)b^2 + (1-h^2)^2}}{12\,h^2}\right]^{1/2}$$

Critical coupling occurs when the inner radical becomes zero for which

$$b^2{}_x = \frac{(2 + 3\,h + h^2) + \sqrt{3 + 12\,h + 15\,h^2 + 6h^3}}{2\,h}$$

$$\text{and, } \alpha_{AD}{}^2 = \frac{(4\,h)b^2 - (1 + 2\,h^2)}{12\,h^2}$$

The factor D, by definition, is made equal to unity at the roots in order to have a common abscissa for plotting the response curves.

$$D = \frac{\alpha_A{}^3}{\sqrt{\dfrac{(4\,h)b^2 - (1 + 2\,h^2)}{12\,h^2}}}$$

The relative gain, when the coupling approaches zero as a limit, $b \to 0$, is as follows:

$$\lim_{b \to 0}\; g = \frac{1}{\sqrt{(4h^2\alpha_A{}^2 + 1)\,(4\alpha_A{}^2 + 1)^2}}$$

It is interesting to note that this relative gain is the same as the product of the relative gain of the corresponding circuits used as single resonant circuits. The relative gain of a single resonant circuit may be derived as follows:

$$g_\circ = \frac{1}{1 + j2\alpha} = \frac{1}{\sqrt{4\alpha^2 + 1}}$$

Typical universal resonance curves for single resonant circuits may be plotted from this simple equation.

Solution of the Two Resonant Circuit Problem

Omitting the subscript ($_2$) the voltage components for all common types of coupling are

$$e = Z_A I_A \pm jMI_B$$
$$0 = \pm jMI_A + Z_B I_B$$

(*Continued on page 204*)

** One form of transformer construction described by Crossley and Meinema (U. S. Patent No. 2,104,792) can be made to work equally well if the effects of capacity coupling are not permitted to be detrimental.

(† The subscripts (2) and (3) will ordinarily be omitted. They will be used only where values might conflict.)

TUBES AT WORK

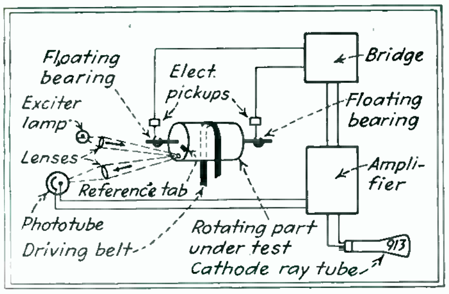


Fig. 1—Block diagram showing principle of operation of electronic balancing machine. Amount and position of unbalance in a rotated part is shown directly on the screen of the cathode-ray tube

Electronic Machine Balances Rotating Parts

A DYNAMIC balancing machine designed by the R. B. Annis Company of Indianapolis determines and indicates the amount and position of unbalance in small rotating parts through a single reading of the trace on the screen of a cathode-ray tube.

The part to be checked is suspended on its own shaft in light-weight, free-floating bearings and is rotated by a driving belt as shown in Fig. 1. A beam of light impinges upon one end of the rotating part and is reflected to a phototube. The light is interrupted once each rotation by a reference tab affixed to the end of the part during the test and from which there is little reflection. Thus a timing pulse rate dependent upon the speed of rotation appears across the output of the phototube and is passed to the cathode-ray tube amplifier.

Voltage proportional to the bearing vibration is generated at each end of the shaft by electrical pickups connected to the cathode-ray tube amplifier through a bridge. Unbalance voltage appearing across the output of the bridge when bearing pressure is unequal is indicated by the height of the cathode-ray tube trace. Position of unbalance is also shown by the trace as the phase relationship between voltage generated by the pickups and voltage generated by the phototube.

The reference tab on the end of the rotated part is set opposite the light spot while the part to be tested is at rest, before the rotating motor is started. The phototube and exciter lamp head are on the same optical axis in a common frame which may be rotated eccentrically around a central pivot by means of a handwheel. A constant correction position may be obtained by turning the handwheel so that zero phase relationship exists between phototube and bridge circuit output voltages. A switch included in the machine permits the operator to determine the extent of unbalance in either of two correction planes.

The largest photograph in Fig. 2 shows the "Dynograph" in use in an industrial plant, with the operator correcting unbalance in a small rotating part under test by adding the weight of solder where it is needed to true up the part. Identifying numerals and letters in the other photographs indicate the location of balancing machine parts, as follows: (1) A-c power switch (3) horizontal gain control (4) vertical gain control (5) left-right unbalance plane selection switch (6) potentiometer dial (7) power cord (10) cable to electrical pickup number one (14) 913 cathode-ray tube (17) driving motor pulley (18) idler slide bar (21) idler pulley (22) fabric drive belt (23) foot switch (24) vibration isolating mount (*H*) calibrated handwheel (*K*) photoelectric optical system (*N*) carriage base for right and left movement (*P*) front vertical guard (*Q*) rear vertical guard and right and left pickup housing (*U*) connector for pickup number two (*Z*) belt bracket.

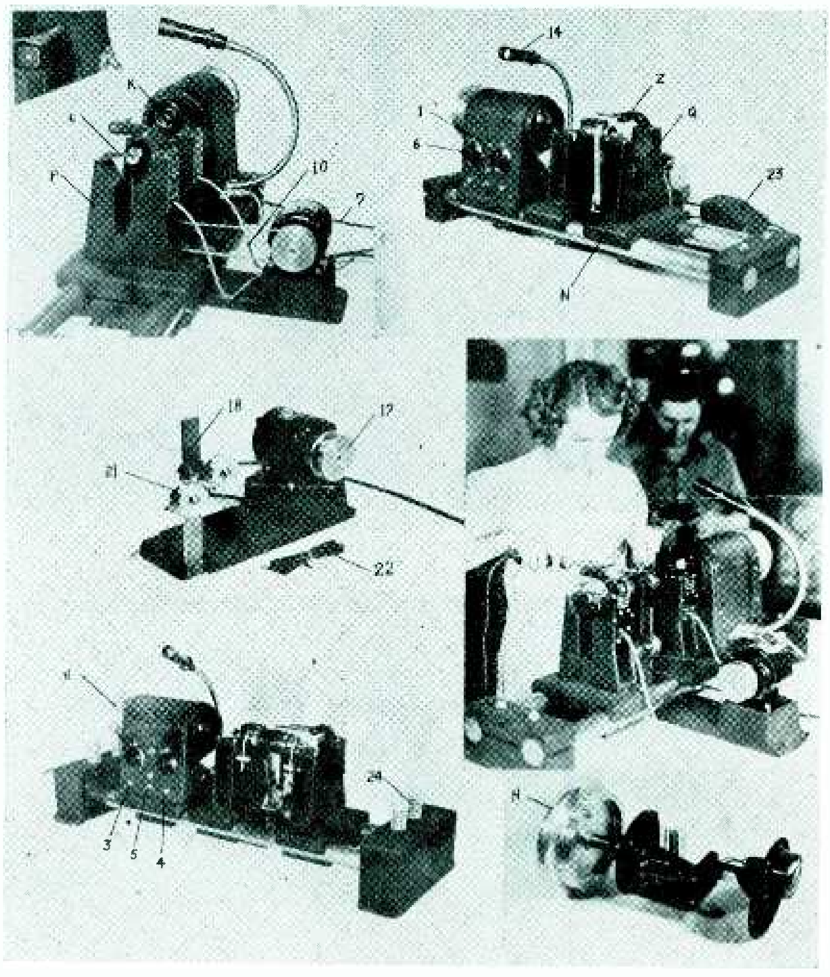
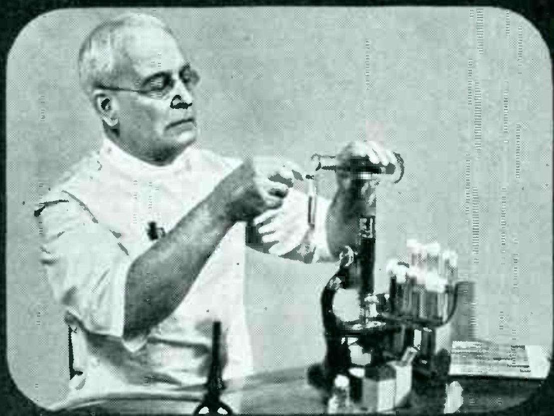


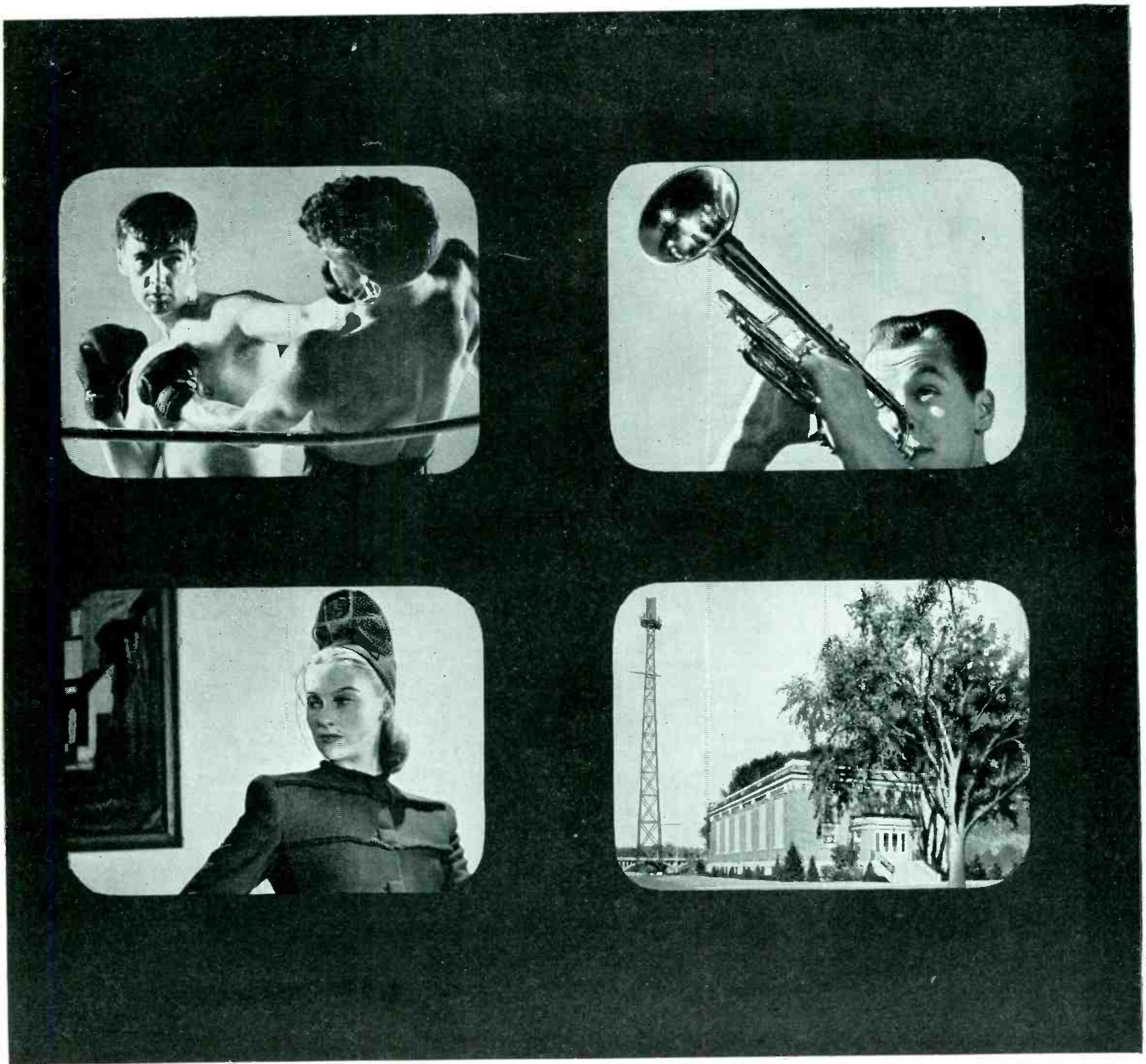
Fig. 2. Photos showing the balancing machine in use and the locations of various component parts. Designating numerals and letters are referred to in the text



We're experimenting so you won't have to

General Electric is operating today one of the world's most complete television stations, WRGB, at Schenectady. There, within the limitations of full-scale war production, G. E. is gaining practical knowledge on which to build a new industry.

For a clear television picture on a fluorescent screen is only the beginning of television. From there on out, problems still loom. What will television offer that movies, theater, concert hall,



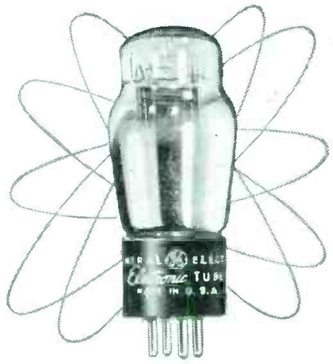
To help you plan for television, visit General Electric's proving-ground station WRGB, shown above

school, and radio cannot offer? Will the television screen make a good teaching platform? Will it further the fine arts, science, industry? What can it offer uniquely to the church?

How, in short, will television best serve the public welfare? How best improve our lives?

General Electric electronic engineers are studying and improving transmission and reception. And studio manager and program staff are urged to give fullest expression to creative talents and ideas. For the General Electric vision is to make television stand on its own feet as a new cultural and entertainment medium.

In the future, when you are planning your television station, General Electric will be ready with a wealth of experience in television programming and techniques. General Electric today is scanning tomorrow. . . . Radio, Television, and Electronics Department, General Electric Company, Schenectady, New York.

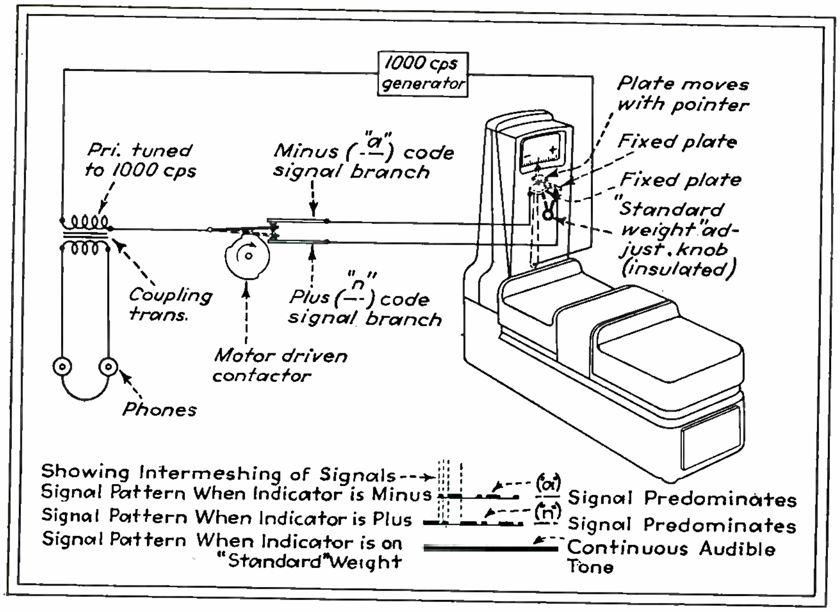


LEADER IN RADIO, TELEVISION, AND ELECTRONIC RESEARCH

GENERAL ELECTRIC

160-A1-6918

TELEVISION



Scale designed to audibly indicate "standard" weight, under-weight and over-weight. A steady tone is heard in the headphones in the first case, the code signal "a" in the second and "n" in the third

Scale Audibly Indicates Selected Standard Weight

A SCALE suggested by a Buffalo blind woman, developed by the Toledo Scale Company and recently demonstrated at the offices of the American Foundation for the Blind transmits a continuous tone to a pair of headphones when the weight of objects placed upon its platform exactly corresponds with any selected standard weight within the range of the scale, sends the code-letter "a" when objects weigh less than the standard and the letter "n" when they weigh more. Obviously invaluable to the blind, the scale should also prove useful to people having normal sight where, for example, an industrial process requires weighing of objects in the dark or where the worker's eyes must simultaneously be used in another operation.

A small, light metal plate is permanently fastened to the pointer of the visual weight indicating device. Two "fixed" plates, insulated from each other and from a knob which permits them to be moved to a position corresponding with the desired standard weight, are positioned in close proximity to the plate fastened on the pointer. The three plates constitute a split-stator capacitor of about 10$\mu\mu$f maximum capacity, with the pointer plate serving as the rotor.

The capacitor is connected in a series circuit containing a simple 1,000 cps General Radio "hummer" type signal generator, the primary of an audio transformer tuned to 1,000 cps and a contact driven by a motor-operated cam. The cam is cut so that two fixed contacts, connected to the fixed plates of the capacitor in a branch circuit arrangement, are opened and closed in a dot-dash-dot sequence.

It will be seen when examining the accompanying diagram that when the capacitor rotor is exactly centered over the slot between the two fixed plates, so that the capacity from the rotor plate is precisely the same to each stator plate, the amplitude of the radio signal flowing in the primary of the audio transformer through each of the contact circuit branches will be equal. When this condition applies, indicating close agreement between the weight of objects on the scale and the standard weight for which the fixed plate adjustment knob is set, a steady tone will appear in the headphones owing to a merging of "a" and "n" code signals generated by the motor driven disc, in the manner indicated by the notation at the bottom of the diagram.

When the weight of measured objects is less than the standard value the scale pointer and its affiliated capacitor rotor plate will be off center in a negative direction and when the weight is more than standard value it will be off center in a positive direction. In the first case the amplitude of the audio signal flowing through the larger capacity in series with the minus or "a" branch circuit will be greater than that flowing through the "n" branch, while in the latter case the amplitude of the signal flowing through the "n" branch will be greater than that flowing through the "a". The predominating code signal heard in the headphones will, therefore, indicate whether objects are under or over standard weight. An operator is thus guided by audio signals, in very much the same manner as is the pilot of an airplane following a typical radio beam.

Single Contact Controls Shaft Rotation Direction

A WIDELY USEFUL circuit developed by Hurley Electronic Controls of Chicago permits the direction of rotation of a shaft driven by two opposed a-c motors to be controlled by the opening and closing of a single make-break contact, one motor being energized when the contact is closed and the other motor operating when the contact is open.

The control contact handles little electrical power so it may be a light, sensitive unit susceptible to operation by a small amount of mechanical force. This, plus the fact that the rapidity with which the shaft rotation direction may be reversed depends almost exclusively upon the characteristics of the associated driving motors, admirably adapts the circuit to automatic control of such things as temperature, pressure, gas and liquid flow. The contact may, for example, be adjusted for operation at some critical value by various kinds of thermometers, bellows and valves. Motion of the controlled shaft as temperature, pressure, gas or liquid flow trends above or below the selected value may then be used to effect whatever external equipment

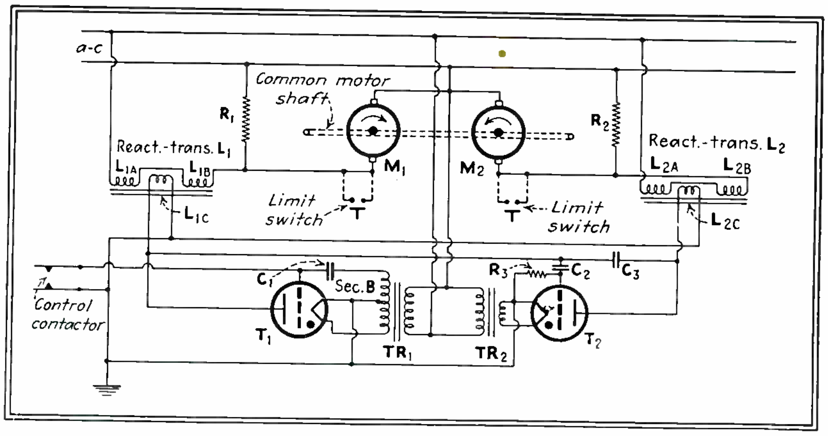
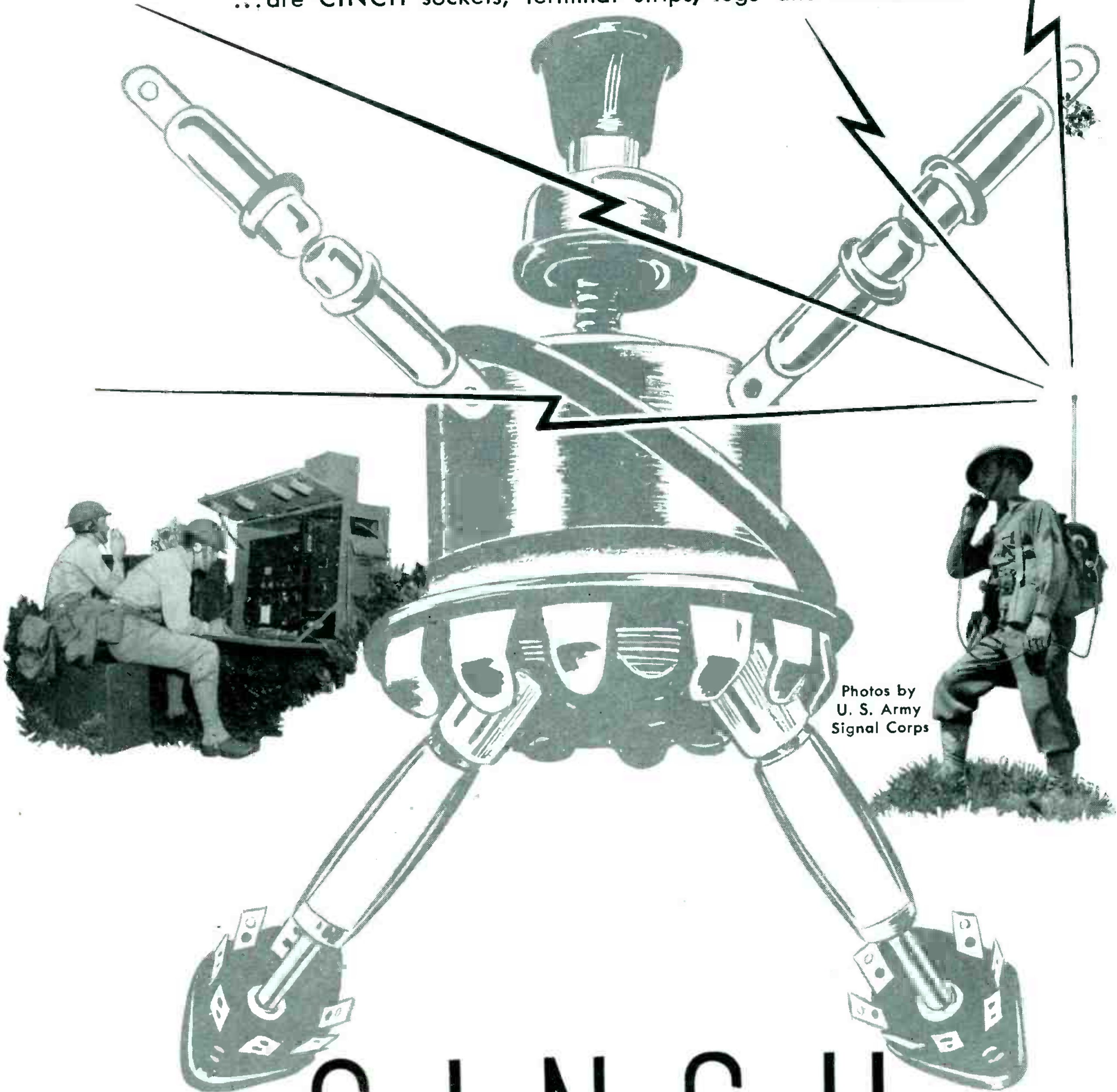


Fig. 1—Schematic of electronic control designed to rotate a shaft in one direction when temperature, pressure, gas or liquid flow falls below a selected critical value and in the other when such factors rise above the critical value. Motors M_1 and M_2 provide the power to operate external corrective equipment

LITTLE . . . BUT THEY REACH . . .

RIGHT UP INTO THE SKY AND SPREAD EVERYWHERE, all the time. In the air . . . on land and sea, "CINCH" parts fit in perfectly in the job to be done. Extensively used . . . serving faithfully in the rapidly extending upward and onward lines . . . are CINCH sockets, terminal strips, lugs and connectors.



Photos by U. S. Army Signal Corps

CINCH

MANUFACTURING CORPORATION · 2335 WEST VAN BUREN STREET · CHICAGO, ILL.

SUBSIDIARY: UNITED-CARR FASTENER CORP., CAMBRIDGE, MASS.

adjustments are necessary to restore desired conditions.

Circuit Operation Principle

A typical control circuit is shown in Fig. 1. Reactor L_1 is designed to limit current-flow from the a-c line through series-connected windings L_{1A} and L_{1B} so that motor M_1 cannot operate unless the reactor core is saturated by d.c. flowing through winding L_{1C}. Reactor L_2, controlling motor M_2, is similarly designed.

Direct current saturating reactor L_1 to operate motor M_1 flows through winding L_{1C} only when thyratron tube T_1 fires and self-rectifies applied a-c anode voltage. Tube T_1 cannot fire unless the control contactor is *closed.* Similarly, d.c. saturating reactor L_2 to operate motor M_2 flows through winding L_{2C} only when thyratron T_2 fires and self-rectifies applied a-c anode voltage. The circuit of T_2 is arranged so that this tube cannot fire while T_1 is operating. Tube T_2 fires only when the control contactor is *open.* Both motors obviously, cannot operate at the same time.

(It should be noted that, in addition to their function as motor current control reactors, L_1 and L_2 also serve as a.c. anode supply voltage transformers for tubes T_1 and T_2. Windings L_{1A} L_{1B}, L_{2A} and L_{2B} constitute the primaries and windings L_{1C} and L_{2C} the secondaries. Anode voltage is supplied by these reactor-transformers, even though there may be insufficient primary current flowing to operate the associated motors, due to the completion of primary loops by resistors R_1 and R_2. These resistors also permit the circuit to function if motor rotation limit switches are included as shown by the dotted lines in the schematic.)

Open Contact Conditions

With the control contactor open, a.c. developed across transformer TR_1 secondary B is rectified in the grid-cathode circuit of tube T_1 and charges capacitor C_1. Because of the phase relationship of this winding and winding L_{1C} of reactor-transformer L_1 this voltage biases the grid of tube T_1 negatively with respect to the cathode and is of sufficient amplitude to cut off this tube despite the presence of a.c. from winding L_{1C} on its anode. No d.c. anode current flows through winding L_{1C}, therefore motor M_1 cannot operate.

The grid of tube T_2 is connected through capacitor C_2 to one leg of winding L_{1C} and through capacitors C_2 and C_3 to one leg of winding L_{2C}. Phase-shift of potential applied across grid-cathode resistor R_3 by L_{1C} is less than that of the grid potential derived from voltage across L_{2C} since only capacitor C_2 is effective in the circuit under the open control contactor conditions outlined. Thus, if the potential across winding L_{1C} is substantially equal to or greater than the potential across

electronics

A McGRAW-HILL PUBLICATION

NOVEMBER • 1945

KEITH HENNEY, *Editor;* **DONALD G. FINK**, *Executive Editor;* W. W. MacDonald, *Managing Editor;* John Markus, *Associate Editor;* Vin Zeluff, *Associate Editor; Assistant Editors*—Frank Haylock, Frank Rockett, J. M. Heron, M. L. Mattey, and J. E. Grolimund; J. A. Myers, *Chicago Editor;* G. T. Montgomery, *Washington Editor;* Harry Phillips, *Art Director*

H. W. MATEER, *Publisher;* J. E. Blackburn, Jr., *Director of Circulation, Electronics;* Wallace B. Blood, *Manager*

DISTRICT MANAGERS, D. H. Miller, H. R. Denmead, Jr., *New York;* R. H. Flynn, *New England;* F. P. Coyle, R. E. Miller, *Philadelphia;* C. D. Wardner, A. F. Tischer, *Chicago;* E. J. Smith, *Cleveland*

McGRAW-HILL PUBLISHING COMPANY, INCORPORATED
JAMES H. McGRAW, Founder and Honorary Chairman

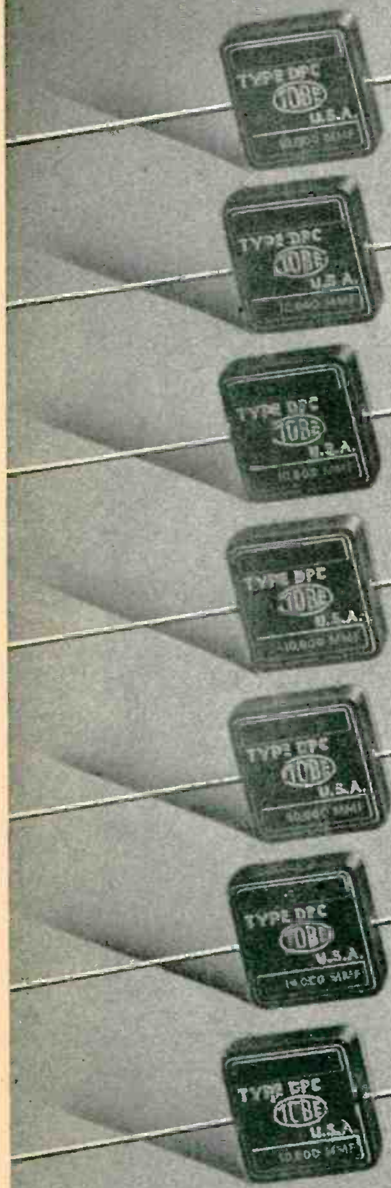
PUBLICATION OFFICE 99-129 North Broadway, Albany, I, N. Y., U. S. A.
EDITORIAL AND EXECUTIVE OFFICES 330 West 42nd St., New York 18, N. Y., U. S. A.

James H. McGraw, Jr., President; Curtis W. McGraw, Senior Vice-President and Treasurer; Howard Ehrlich, Vice-President (for business operations); Willard Chevalier, Vice-President (for editorial operations); Joseph A. Gerardi, Secretary; and J. E. Blackburn, Jr., Director of Circulation.

ELECTRONICS, November, 1945, Vol. 18; No. 11. Published monthly, price 50c a copy. Directory Issue $1.00. Allow at least 10 days for change of address. All communications about subscriptions should be addressed to the Director of Circulation, 330 W. 42nd St., New York 18, N. Y.

Subscription rates—United States and possessions, Mexico, Central and South American countries, $5.00 a year, $8.00 for two years, $10 for three years. Canada (Canadian funds accepted) $5.50 a year, $9.00 for two years, $11.00 for three years. Great Britain and British Possessions, 42 shillings for one year, 84 shillings for three years. All other countries $7.00 for one year, $14.00 for three years. Please indicate position and company connection on all subscription orders. Entered as Second Class matter August 29, 1936, at Post Office, Albany, New York, under the Act of March 3, 1879. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill.; 68 Post Street, San Francisco 4; Aldwych House, Aldwych, London, W.C. 2; Washington, D. C. 4; Philadelphia 2; Cleveland 15; Detroit 26; St. Louis 8; Boston 16; Atlanta 3, Ga.; 821 So. Hope St., Los Angeles 14; 38-9 Oliver Building, Pittsburgh 22.

7 REASONS *why this Capacitor* BELONGS IN YOUR FIRST LINE PRODUCTS



1 LONG LIFE

The superior moisture seal afforded by the molded phenolic case guarantees that these oil-impregnated capacitors will withstand the rigors of sea shipment and tropical service.

2 SMALL SIZE

Conforming to AWS dimension standards, the cases are 13/16" x 13/16" x 19/64" (CN35) and 11/16" x 29/64" x 7/32" (CN20).

3 CLOSE STACKING

The flat, rectangular form permits side-by-side mounting in minimum sub-chassis space.

4 SELF SUPPORTING

Light in weight — and with solid, #18 wire leads — these capacitors are satisfactorily mounted by their connecting leads only.

5 ALL POPULAR RATINGS

Capacitances from 100 to 50,000 mmfd.; Working voltages from 200 to 1600 V.D.C.

6 IMMEDIATE AVAILABILITY

Large-scale production facilities — for winding, oil-impregnating, assembling, molding and testing — assure continuous delivery of these dependable capacitors.

7 LOW COST

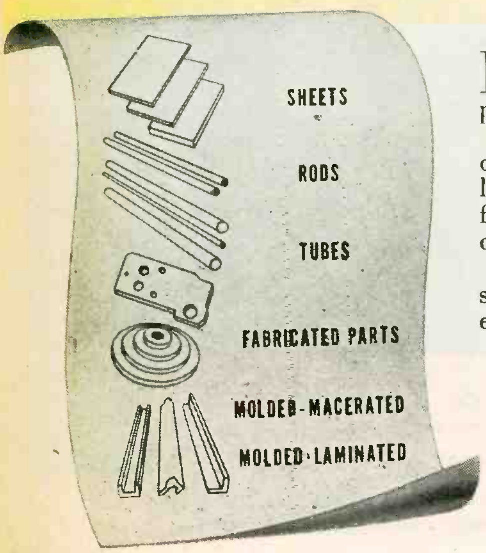
Comparing favorably in cost with the paper tubulars they supersede, these non-inductive capacitors offer more service per penny.

Where failures in bypass and coupling circuits cannot be tolerated, specify and use Tobe Molded Oil-paper Capacitors — Types APC and DPC.

TOBE DEUTSCHMANN CORP. • TOBE • CANTON • MASSACHUSETTS

FIELD OFFICES IN NEW YORK CITY · CHICAGO · DETROIT · GLENDALE, CALIFORNIA

Using Corrosion Resistance, Strength, and Machinability



MOVIE FILM carriers are an excellent example of using plastics where plastics belong.

The film carrier illustrated is only one of many types made from Synthane laminated plastics. Synthane is well-suited for the job because it stoutly resists the corrosive action of developing solutions.

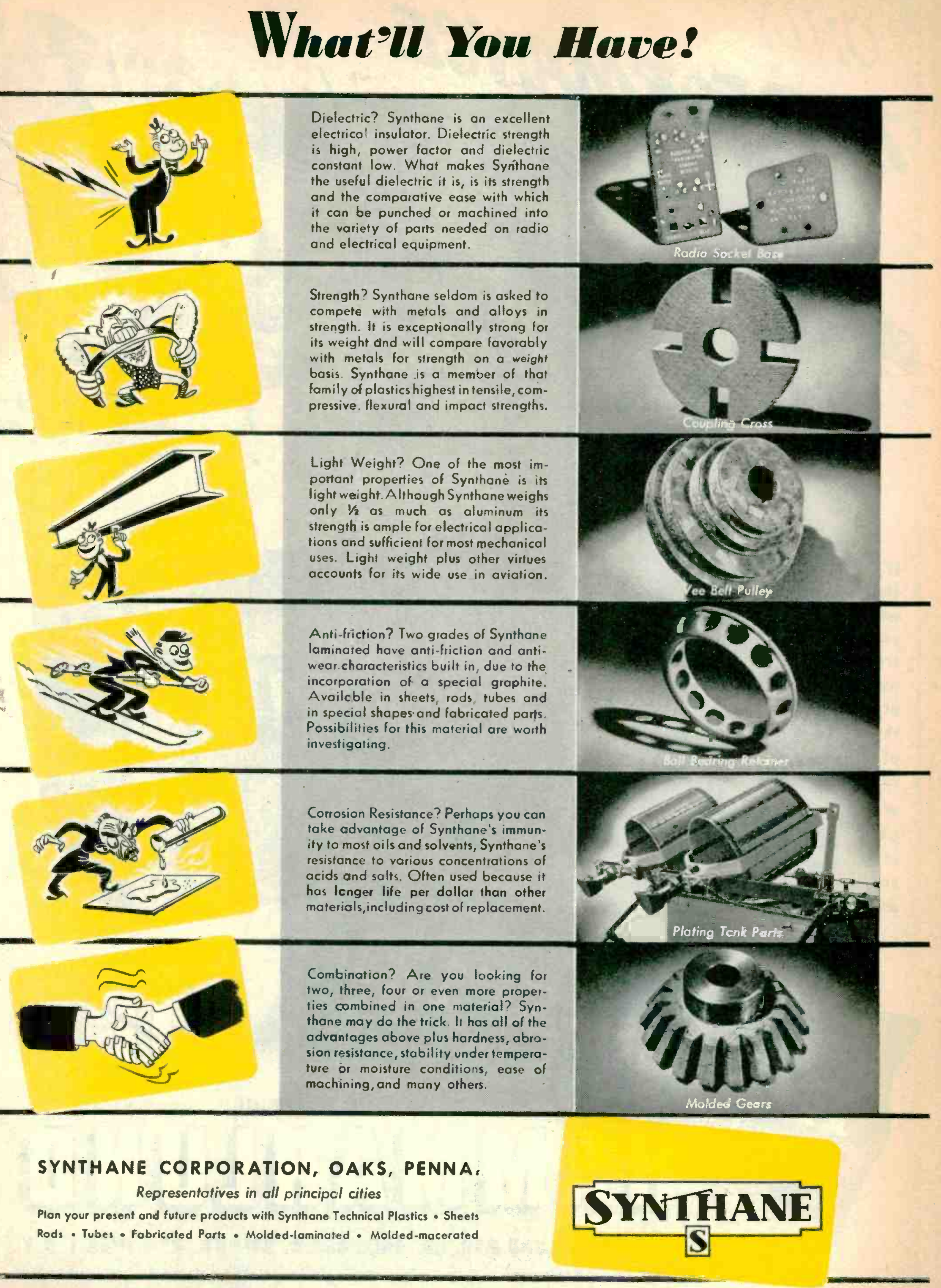
The teeth, though small, must be strong and accurately indexed. They are easily milled from Synthane.

If you have any application for which laminated plastics seems to be indicated, let us know about it—*before* you design, if possible.

Our development engineers want to help you fit the job for plastics and fit the plastics for the job. Design, materials and production should be eyed as one problem if performance and costs are to be satisfactory. Synthane's help includes design, selection of the right material, and fabrication by men who know plastics. Synthane Corporation, Oaks, Pa.

SYNTHANE TECHNICAL PLASTICS • DESIGN • MATERIALS • FABRICATION

SYNTHANE



What'll You Have!
Dielectric? Synthane is an excellent electrical insulator. Dielectric strength is high, power factor and dielectric constant low. What makes Synthane the useful dielectric it is, is its strength and the comparative ease with which it can be punched or machined into the variety of parts needed on radio and electrical equipment.
Radio Socket Base
Strength? Synthane seldom is asked to compete with metals and alloys in strength. It is exceptionally strong for its weight and will compare favorably with metals for strength on a weight basis. Synthane is a member of that family of plastics highest in tensile, compressive, flexural and impact strengths.
Coupling Cross
Light Weight? One of the most important properties of Synthane is its light weight. Although Synthane weighs only ½ as much as aluminum its strength is ample for electrical applications and sufficient for most mechanical uses. Light weight plus other virtues accounts for its wide use in aviation.
Vee Belt Pulley
Anti-friction? Two grades of Synthane laminated have anti-friction and anti-wear characteristics built in, due to the incorporation of a special graphite. Available in sheets, rods, tubes and in special shapes and fabricated parts. Possibilities for this material are worth investigating.
Ball Bearing Retainer
Corrosion Resistance? Perhaps you can take advantage of Synthane's immunity to most oils and solvents, Synthane's resistance to various concentrations of acids and salts. Often used because it has longer life per dollar than other materials, including cost of replacement.
Plating Tank Parts
Combination? Are you looking for two, three, four or even more properties combined in one material? Synthane may do the trick. It has all of the advantages above plus hardness, abrasion resistance, stability under temperature or moisture conditions, ease of machining, and many others.
Molded Gears
SYNTHANE CORPORATION, OAKS, PENNA.
Representatives in all principal cities
Plan your present and future products with Synthane Technical Plastics • Sheets
Rods • Tubes • Fabricated Parts • Molded-laminated • Molded-macerated
SYNTHANE
S

ONLY PERFORMANCE PAYS OFF!

It's no photo finish with the new HQ-129-X. This new professional-type receiver is way out in front when it comes to performance. Every feature of the HQ-129-X is the outgrowth of years of building commercial receivers.

Write for descriptive booklet — place your order with your dealer today to insure early delivery.

HQ-129-X $129*

AMATEUR NET LESS SPEAKER

THE SIGN OF QUALITY

ESTABLISHED 1910

WRITE TODAY FOR BOOKLET!

HAMMARLUND

THE HAMMARLUND MFG. CO., INC., 460 W. 34TH ST., NEW YORK 1, N.Y.

MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

*PRICES SUBJECT TO CHANGE WITHOUT NOTICE

Yes, for you
there could very well be a citation
which would read
"For distinguished service
to the American people . . ."
. . . that is, there could be
if the nation only realized
as well as we,
who have worked with you,
what a splendid job you have done
as a radio engineer
during the emergency

If they only knew
how you overlooked the word *overtime*
and how an *eight-hour day*
lost its meaning
when we most needed
to be informed and entertained.

If they only knew
how you coddled and repaired
the irreplaceable tools
of your trade
so that not even one
valuable broadcasting moment
was lost in wartime.

If they only knew
how the station remained awake
each twenty-four hours
because of your personal effort.

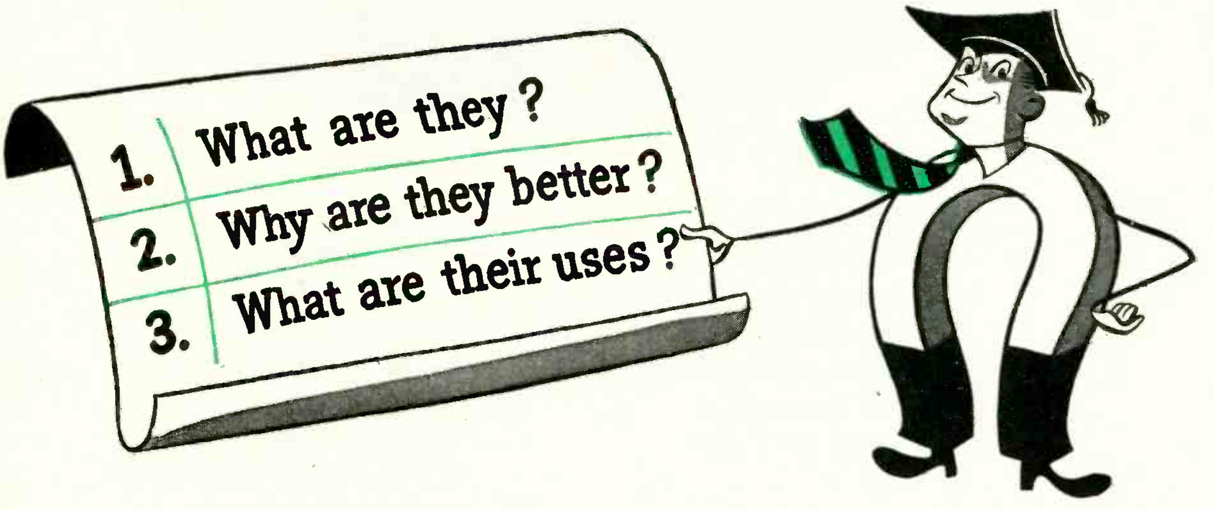
. . . Well, perhaps they don't realize
to whom the thanks belong,
or their tongues don't give voice
to their feelings . . .
but in their homes and hearts
there has been mute appreciation
for the privilege you extended to all,
the privilege that could not
have been forfeited easily,
the privilege that is used so casually,
the privilege of switching on the radio.

AMPEREX ELECTRONIC CORPORATION

25 WASHINGTON STREET • • BROOKLYN 1, N. Y.

A COPY OF THIS ADVERTISEMENT, SUITABLE FOR FRAMING, WILL BE SENT WITHOUT CHARGE UPON REQUEST

The 3 "most-asked" questions about Carbonyl Iron Powders



For wartime uses, design engineers asked these three questions.

In peacetime, as design engineers plan for peacetime equipment, the same questions are asked.

"What are they?"

G.A.F. Carbonyl Iron Powders are obtained by thermal decomposition of iron penta-carbonyl. There are five different grades in production, designated as "L," "C," "E," "TH," and "SF" Powder. Each of these five types of iron powder is obtained by special processing methods and has its special field of application.

The particles making up the powders "E," "TH," and "SF" are spherical with a characteristic structure of concentric shells. The particles of "L" and "C" are made up of homogeneous spheres and agglomerates.

Their weight-average diameter, their total iron contents, and their carbon contents are given in the table at upper right.

"Why are they better?"

Carbonyl Iron Powders are better because of their unique spherical shape, shell structure, particle size distribution, high degree of purity and freedom from stress.

Their stability against magnetic shock, temperature changes, and time (aging) is of the highest order.

Permeabilities range up to 70 with low eddy-current losses. Q values are the highest obtainable because of extremely small eddy-current and hysteresis losses.

Carbonyl Iron Powders are better as electromagnetic material over the entire communication frequency spectrum.

A set of relative Q values for the five powder grades is given in the graph on the other page to show the conventional frequency range for each grade.

"What are their uses?"

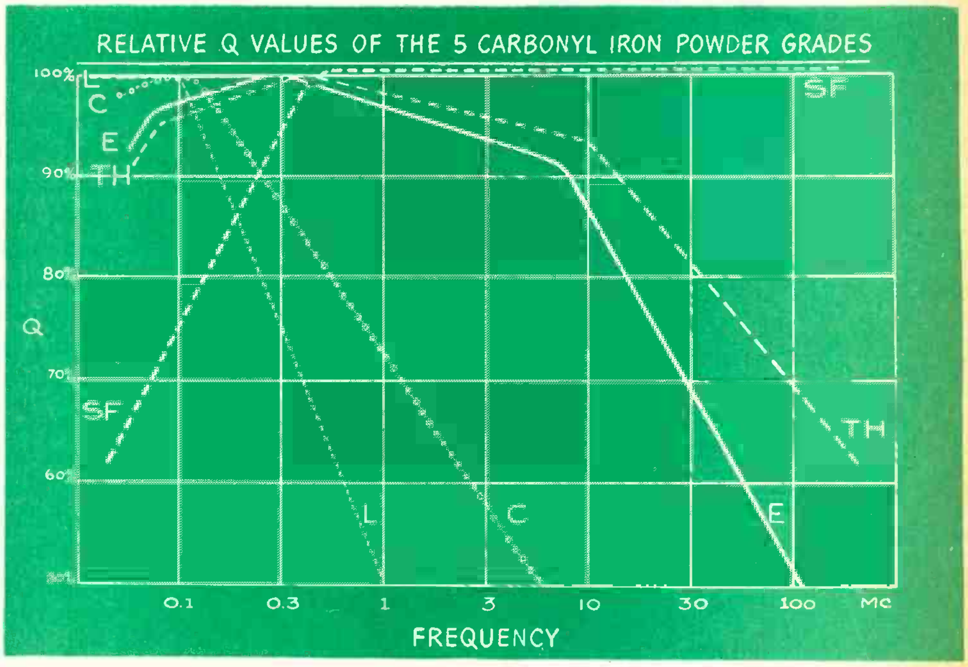
Carbonyl Iron Powders are used for electromagnetic cores and structures for widely different purposes. Five typical applications are shown on the chart at bottom of other page.

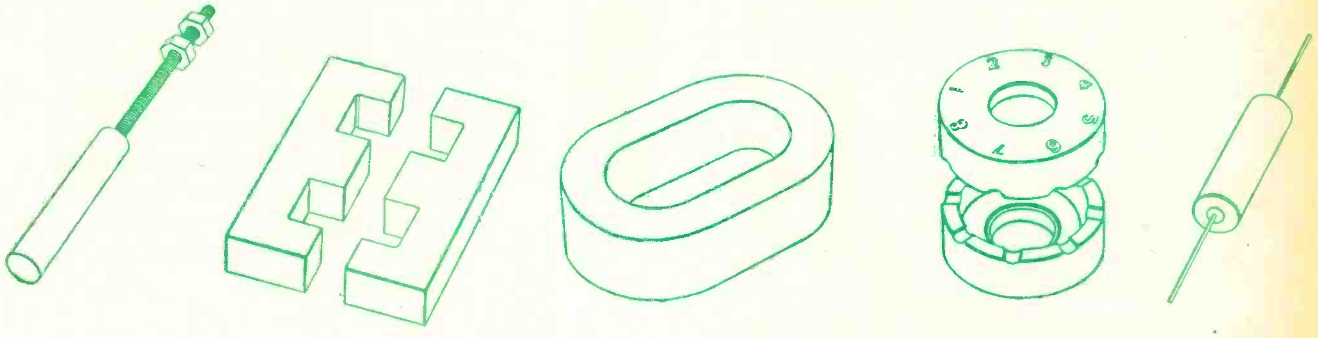
"L" and "C" powders are also used as powder metallurgical material because of their low sintering temperatures, high tensile strengths, and other very desirable qualities. Sintering begins below 500°C and tensile strengths reach 150,000 psi. Compacts can be made having regular pronounced porosity to function as a spongy mass. Compacts can also be made of highest density for excellent magnetic properties.

Further information can be obtained from the Special Products Sales Dept., General Aniline & Film Corporation, 270 Park Avenue, New York 17, N. Y.

Diameters and Chemical Composition of the 5 Carbonyl Iron Powder Grades

Carbonyl Iron Grade	Weight-Average Diameter Microns	Total Fe Content %	Total Carbon Content %
L	20	99.7-99.9	0.005-0.03
C	10	99.5-99.8	0.03 -0.12
E	8	97.9-98.3	0.65 -0.80
TH	5	98.1-98.5	0.5 -0.6
SF	3	98.0-98.3	0.5 -0.6





"L" Type Powder used in cores for permeability tuning.

"C" Type Powder for E-cores in filter coils.

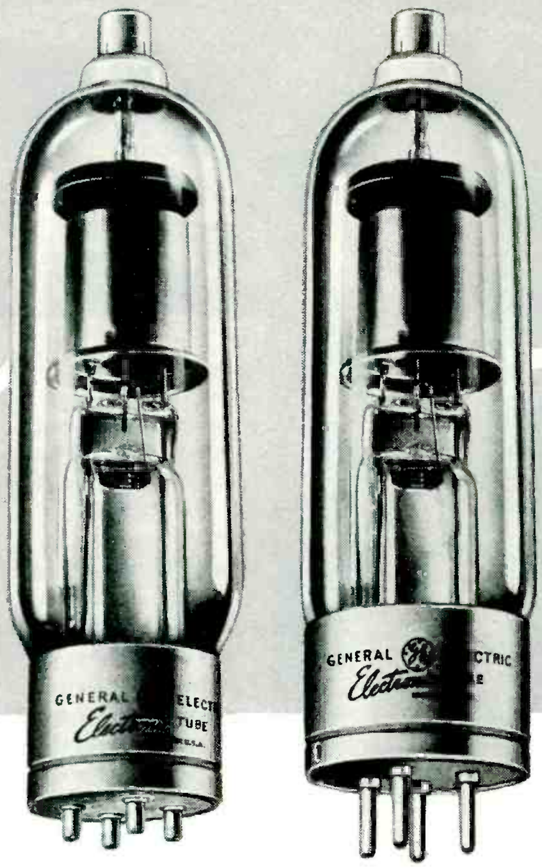
For antenna coils, "E" Type Powder used in cores.

"TH" Type Powder is employed for cup shields in coils.

One use of "SF" Type Powder is in high frequency choke cores (with sealed-in leads).

THIS VERSATILE GE RECTIFIER TUBE

is conveniently supplied in two base types



TYPE GL-872-A/872
Fitted with 4-pin jumbo base. (Ratings same as Type GL-8008.)

TYPE GL-8008
Fitted with heavy-duty base. (Ratings same as Type GL-872-A/872.)

GENERAL ELECTRIC offers you the GL-872-A/872 and GL-8008 (identical in design, but with different bases) as low to medium-power rectifier types with an unusually wide range of applications. Here are some typical uses:

- To rectify plate power for the low and intermediate stages of large transmitters.
- To serve as rectifiers for smaller transmitters, "ham" sets, and police-radio, ship-to-shore, aviation, and other communications equipment.
- To convert power from a-c to d-c for small industrial equipment, such as electrical testing apparatus, diathermy units, fractional hp motors, etc.

Ratings at the right are conservative. The mercury vapor in the tube assures (1) the ability to pass high peak currents, and (2) a low internal voltage drop. These qualities spell long service-life and exceptional efficiency.

Your equipment will use Type GL-872-A/872 or Type GL-8008, depending on your basing requirements. For further data see your nearest G-E office or distributor, or write to *Electronics Department, General Electric Company, Schenectady 5, N. Y.*

G.E.'s new manual of industrial electronic tubes is the most comprehensive book in its field. Over 400 large pages, price $2. Write for complete description.

CHARACTERISTICS

of Types GL-872-A/872 and GL-8008

Half-wave, mercury-vapor rectifier tubes, 2-electrode type, with filamentary cathode. Convection-cooled. Cathode voltage and current are 5 v and 7.5 amp; typical heating time is 30 seconds. Approximate tube voltage drop is 10 v. Maximum anode ratings are: peak inverse voltage 10,000 v, instantaneous current 5 amp, average current 1.25 amp.

Type GL-872-A/872, with 4-pin jumbo base, is adapted to much existing equipment which calls for this type of base. The heavy-duty base of Type GL-8008, giving greater pin-contact area, will be found preferable for newer rectifier installations.

GENERAL ELECTRIC

161-D11-8850

TRANSMITTING, RECEIVING, INDUSTRIAL, SPECIAL PURPOSE TUBES • VACUUM SWITCHES AND CAPACITORS

The New G-E 5-Kw Television Transmitter
The Famous GL-8002-R Transmitting Tube
EVERYTHING
● FM Transmitters
● Television Transmitters
● AM Transmitters
● International Transmitters
● Complete Aural and Visual Equipment for Studios
● Microphones
● Measurement Equipment
● Electronic Tubes
● Studio-to-Transmitter Relay Apparatus
● Micro-Tel Systems
● Intra-Tel Systems
● Power Equipment and Switchgear
● Station Lighting, Heating, Air-Conditioning
The Famous G-E Circular Antenna, 2-bay
The New G-E 1-Kw FM Transmitter
The New G-E 250-Watt FM Transmitter
The New G-E Studio Consolette
STUDIO AND STATION EQUIPMENT • TRANSMITTERS
GENERAL ELECTRIC
160-D8-6914

NEW All-Metal "MIDGET" THYRATRON

SMALL • COMPACT • STURDY • EFFICIENT

For control applications where space and weight must be conserved. Interchangeable with Type GL-2050

Type GL-502-A. $1.50

THE TREND toward compactness in electronic equipment is well met by this capable small thyratron, Type GL-502-A. It fits snugly into panel designs where clearances must be measured in fractions of an inch. If heavy vibration or shocks are apt to be encountered, then the tube's sturdy metal envelope gives added strength and longer life.

• Type GL-502-A is a control and relay tube of great sensitiveness. This is due to the 4-electrode (control-and-shield-grid) construction, with extremely low grid requirements, so that a mere "whisper" of electrical impulse will start the flow of current.

• Positive, accurate, and lightning-fast in its operation, the GL-502-A should be favorably considered for your next temperature, phototube, or other electronic-control circuit—especially so if compactness and light weight are essential. General Electric's new Booklet ETI-8 tells about this remarkable small, low-priced thyratron and what it will do industrially. For your free copy, see your nearest G-E office, or write *Electronics Department, General Electric Company, Schenectady 5, N. Y.*

CHARACTERISTICS

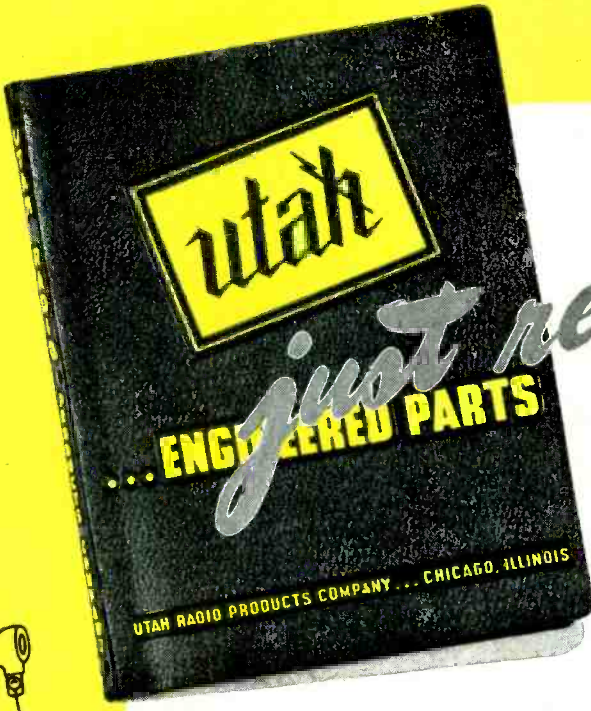
A 4-electrode (control-and-shield-grid) all-metal thyratron tube, with indirectly heated cathode. Typical heating time, 10 seconds. Seated height of tube is $2\frac{1}{16}$", diameter (at base) $1\frac{5}{16}$", net weight approximately 2 oz. Ratings are: cathode voltage 6.3 v, current 0.6 amp; peak anode voltage 1,300 v, peak anode current 500 ma, average 100 ma. The ambient temperature range is unusually wide— −55 to +90C—meaning that the tube retains its efficiency under extremes of heat and cold.

G. E. HAS MADE MORE BASIC ELECTRONIC TUBE DEVELOPMENTS THAN ANY OTHER MANUFACTURER

GENERAL ELECTRIC

162-D16-8850

TRANSMITTING, RECEIVING, INDUSTRIAL, SPECIAL PURPOSE TUBES ★ VACUUM SWITCHES AND CAPACITORS



just released!

50 pages of parts and their technical data

Standard items are "keyed" with jobber part numbers, making it simple and convenient to order from your local distributor.

Included are:

- **POTENTIOMETERS AND RHEOSTATS** in 5 different sizes ranging from 3 to 15 watts. Simple in design, rugged, and dependable.
- **"T" & "L" PAD ATTENUATORS** in 5 different designs for controlling volume in circuits of microphones, loud speakers, phonograph pick-ups, mixers, audio and public address amplifiers.
- **SWITCHES** that are compact in size, simple in design, and of highest quality material are your assurance of dependable service with economical cost. Standard types and circuits.
- **LEAF SPRING STACK ASSEMBLY SWITCHES**—Low-cost, practical, dependable Contact Switch Assemblies for use in coin machines, record changers, electrical medical instruments or wherever simple leaf switches are required—available to meet innumerable different specifications and arrangements.
- **PHONE PLUGS AND JACKS** are available in various styles. Jacks include the famous "Imp" Type, and the Short and Long Frame Types. Phone Plugs supplied in two- and three-conductor types . . . for practically every type of application.

This Utah Catalog, No. U.C.-44, is 50 pages loose-leaf bound, and provides the engineer with complete technical data and blueprint details. Copies available without obligation upon written request on your business letterhead and mention of your position. Write today for your copy!

utah

UTAH RADIO PRODUCTS COMPANY

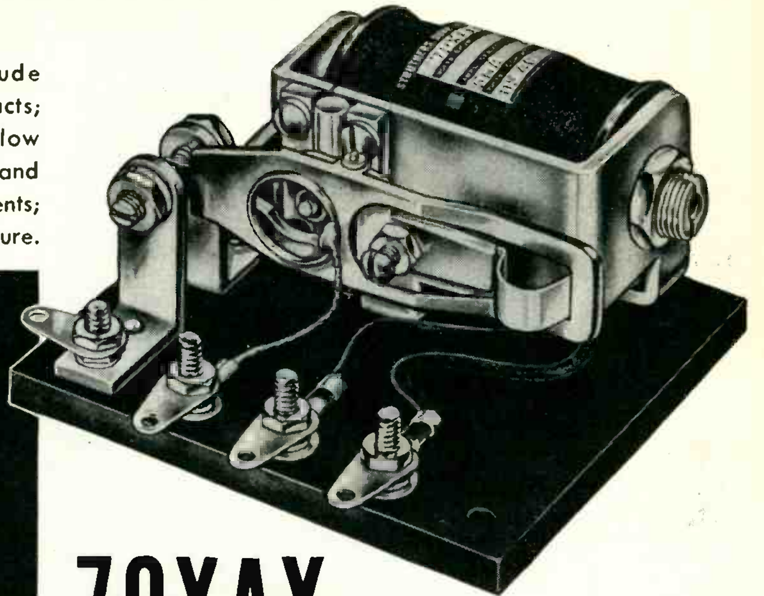
820 NORTH ORLEANS STREET • CHICAGO 10, ILLINOIS

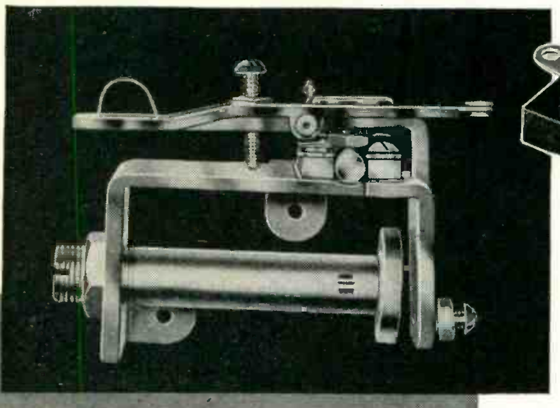
Utah Electronics (Canada) Ltd., 300 Chambly Road, Longueuil, Montreal (23) P. Q. • Ucoa Radio, S. A. Misiones 48, Buenos Aires

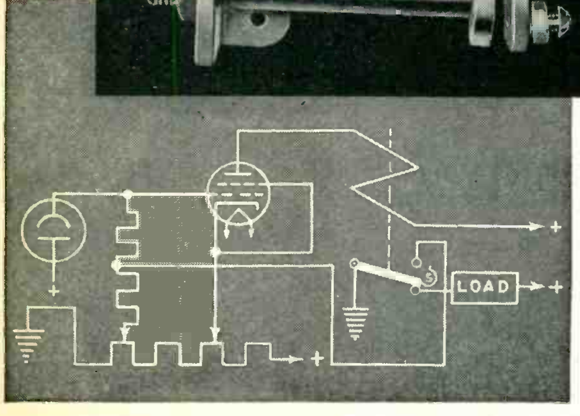
POSITIVE SNAP ACTION

0.02 WATT SENSITIVITY

SIMPLIFIED CONSTRUCTION . . . Features include snap action contacts; high sensitivity; low operating power; statically balanced armature and contact assembly; six easily accessible adjustments; good contact wipe and stable contact pressure.







A typical vacuum tube application. A slight increase in plate current closes the relay, thus increasing negative bias on the amplifier tube so that plate current through the relay coil immediately decreases to a point close to the release value for the relay. Thus, any slight decrease in light falling on the photo cell will reduce plate current sufficiently to return relay contacts to normal position.

79XAX

Struthers-Dunn Type 79XAX snap action d-c operated relay is a positive acting sensitive unit that finds a wide variety of applications in circuits with slowly changing control currents. Erratic operation and varying contact resistance encountered with ordinary sensitive relays are eliminated. Applications for this popular relay cover a broad range of use from vacuum tube circuits, to overcurrent protection, pulsing circuits, and uses where extremely close differential or sensitivity of operation is required.

WRITE for Data Bulletin 79XAX giving full construction details and outlining a variety of suggested uses.

STRUTHERS-DUNN, Inc., 1321 Arch Street, Phila. 7, Pa.

STRUTHERS-DUNN

5,312 RELAY TYPES

DISTRICT ENGINEERING OFFICES: ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DENVER • DETROIT • HARTFORD • INDIANAPOLIS • LOS ANGELES • MINNEAPOLIS • MONTREAL • NEW YORK • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

Again IRVINGTON *leads the way!*

with **Fibron**

EXTRUDED TUBINGS AND TAPE
of low-loss

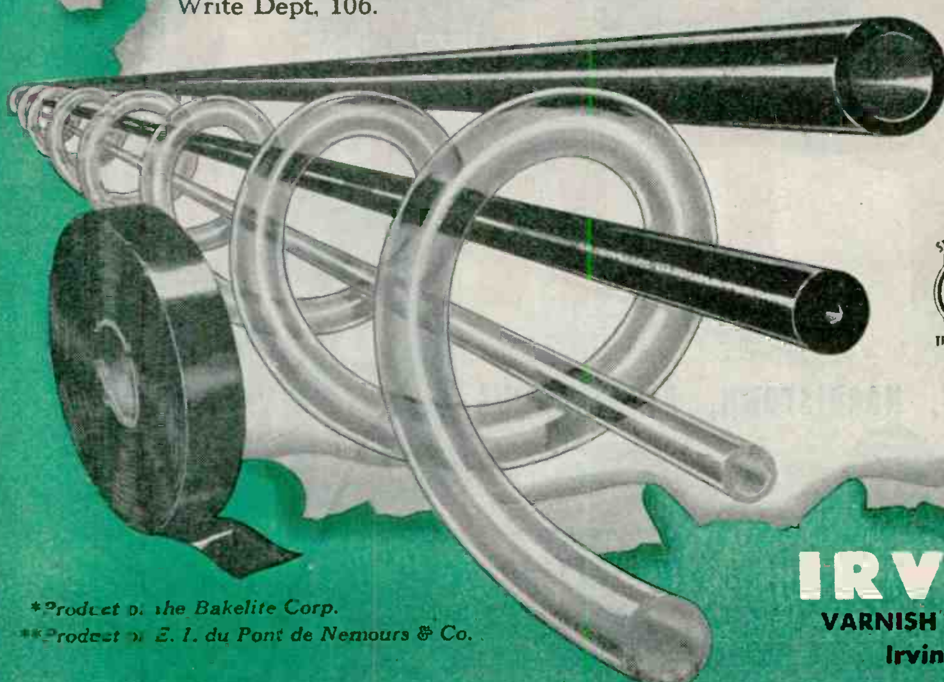
POLYETHYLENE* and POLYTHENE**

Irvington now offers these new thermo-plastic materials, in extruded and calendered tape forms, for use as insulation where high frequencies are involved and applications where exceptional chemical and moisture resistance are required.

For electrical insulation . . . superior low-loss electrical properties, low moisture absorption, and high resistance to ozone, oil, acids and alkalis, make Polyethylene and Polythene ideal for high frequency applications and other special requirements as well.

For chemical applications . . . Both Polyethylene and Polythene are highly resistant to the halogen group including fluorine . . . offer the low density and other properties of paraffin *plus* superior mechanical strength and higher melting point; can be formed and reformed in service as desired.

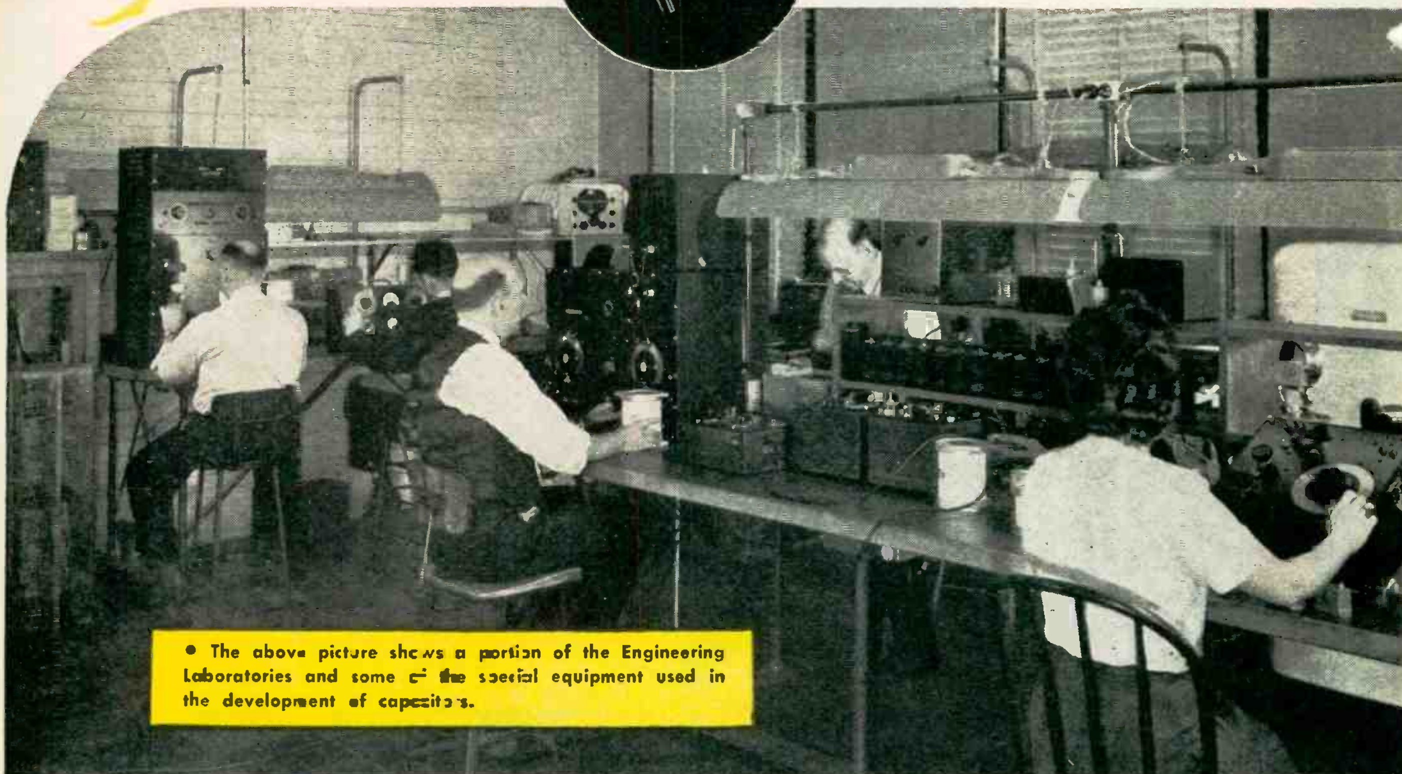
Samples, and complete cooperation on your problems, are freely offered. Write Dept. 106.



STANDARD OF THE WORLD
IRVINGTON INSULATION
TRADE MARK REG. U. S. PAT. OFF.

*Product of the Bakelite Corp.
**Product of E. I. du Pont de Nemours & Co.

IRVINGTON
VARNISH & INSULATOR COMPANY
Irvington 11, New Jersey



• The above picture shows a portion of the Engineering Laboratories and some of the special equipment used in the development of capacitors.

• A portion of the Chemical Laboratories where material control is maintained and other vital research engineering work is done in the development of Sangamo Mica Capacitors.

SANGAMO ELECTRIC

• • • ESTABLISHED 1898 • • • MICA CAPACITORS • • •

HOW EXCELLENCE IS BUILT INTO

Sangamo

MICA CAPACITORS

•

Research AND *Engineering*

Excellence of quality in mica capacitors is, of course, greatly dependent upon the materials used and the manufacturing processes employed in their construction. The best materials and the most precise production methods, however, will not produce a quality product unless the basic design is right. Material selection and control, as well as basic design is a function of engineering and research. Sangamo maintains a competent staff of Electrical and Chemical engineers, whose duty it is to insure that each capacitor is designed and manufactured to best perform the particular duty for which it is intended.

Sangamo Engineers are constantly striving to discover new materials—increase safety factors—improve performance characteristics—all to the end that better units will be available to the many users of Sangamo capacitors. New capacitors for new applications in the ever growing electronic field requires constant attention from our engineering staff.

Sangamo is pardonably proud of its Engineering and Research Laboratories and its staff of engineers. To these facilities and to these engineers belong a large measure of the credit for the excellent quality inherent in Sangamo mica capacitors.

☆

COMPANY SPRINGFIELD ILLINOIS

• • • WATT HOUR METERS • • • TIME SWITCHES • • •


OHMS PER VOLT
20,000 D.C.
1,000 A.C.
CHICAGO ILL. U.S.A.
10 M.A.
100 MIC. A.
R×1
R×100
R×10,000
2.5 V.
10 V.
50 V.
250 V.
1000 V.
POS.
SIMPSON ELECTRIC CO., CHICAGO, ILL.

The most honored instrument of the war

This is not our own appraisal of the Simpson 260. We knew, before the war, that it was a fine instrument but, frankly, we didn't know *how* good it was until war wrote the record. Now the story of the 260 is written into the records of such wartime industrial developments as that of synthetic rubber, and into the vast and secret research and servicing of radar.

Originally designed as a radio serviceman's test unit, the Simpson 260, because of its sensitivity and wide range was found adaptable to general service duties in the entire electronics and electrical fields. Not a warborn instrument, the 260 was given thousands of essential war jobs in the production and servicing of communications equipment. It made a vital contribution to the success of tactical operations.

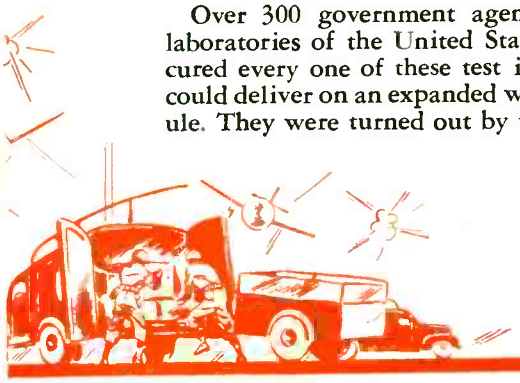
Over 300 government agencies and university laboratories of the United States and Canada procured every one of these test instruments Simpson could deliver on an expanded war production schedule. They were turned out by the thousands. Every branch of the armed services—Army, Navy, Marines, Coast Guard—carried them to the far ends of the earth. They were compelled to perform under conditions often so arduous that testimonials of amazement at their ability to function at all became commonplace as the record grew.

Chosen on its merits, the Simpson 260 became uniquely *the* test instrument of the war.

AVAILABLE NOW TO YOU

Now the Model 260, always the preferred instrument of radio servicemen, is available again to a widened field of peacetime services. We ask you to remember its record as an example of the quality and advanced engineering that goes into all Simpson instruments, as evidence that other new Simpson developments are well worth waiting for. They will be released as soon as Simpson standards for their manufacture are satisfied. They will continue the leadership that has given Simpson a world-wide reputation for "instruments that *stay* accurate" with ideas that *stay* ahead.

SIMPSON ELECTRIC COMPANY
5200-5218 W. KINZIE ST., CHICAGO 44, ILL.



Simpson
INSTRUMENTS THAT STAY ACCURATE

SIMPSON 260, HIGH SENSITIVITY SET TESTER FOR TELEVISION AND RADIO SERVICING
Ranges to 5000 Volts—Both A.C. and D. C. ***20,000 Ohms per Volt D.C.—1000 Ohms per Volt A.C.***

At 20,000 ohms per volt, this instrument is far more sensitive than any other instrument even approaching its price and quality. The practically negligible current consumption assures remarkably accurate full scale voltage readings. Current readings as low as 1 microampere and up to 500 milliamperes are available.

Resistance readings are equally dependable. Tests up to 10 megohms and as low as ½ ohm can be made. With this super sensitive instrument you can measure automatic frequency control diode balancing circuits, grid currents of oscillator tubes and power tube, bias of power detectors, automatic volume control diode currents, rectified radio frequency current, high-mu triode plate voltage and a wide range of unusual conditions which cannot be checked by ordinary servicing instruments. Ranges of Model 260 are shown below.

Price, complete with test leads..................$33.25
Carrying case 4.25

ASK YOUR JOBBER

WATCH FOR NEW SIMPSON DEVELOPMENTS. THEY WILL BE WORTH WAITING FOR!

Volts D.C. (At 20,000 ohms per volt)	Volts A.C. (At 1,000 ohms per volt)	Output	Milliamperes D.C.	Microamperes	Ohms	
2.5	2.5	2.5 V.	10	100	0-1000	(12 ohms center)
10	10	10 V.	100		0-100,000	(1200 ohms center)
50	50	50 V.	500		0-10 Megohms	(120,000 ohms center)
250	250	250 V.				
1000	1000	1000 V.				
5000	5000	5000 V.				

(5 Decibel ranges: —10 to +52 DB)

9 FACTORS in efficient, dependable, long-life RECTIFIER PERFORMANCE

CHATHAM engineers are specialists in rectifier design and production. Their concentration of effort in this field—the large scale production of rectifiers for industry and communication—has naturally culminated in exclusive design advancements and lowered costs.
The CHATHAM rectifiers illustrated are but a few of the many types available. Although production is centered around standard types for complete interchangeability and to comply with industry wide standardization, each CHATHAM type incorporates proven advantages — mechanical and electrical —that improve performance and minimize replacements. Inquiries are invited; no obligation is incurred.

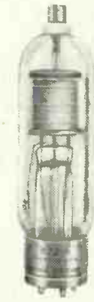
17 Grid Controlled Mercury Vapor Rectifier
Peak inverse voltage 5,000 volts
Peak plate current 2.0 amps
Average plate current .5 amps
Filament voltage 2.5 volts
Filament current 5.0 amps
Condensed mercury temperature 40° C to 80° C

3B28 Half Wave Xenon Rectifier
Peak inverse voltage 10,000 volts
Peak plate current 1.0 amps
Average plate current .250 amps
Filament voltage 2.5 volts
Filament current 5.0 amps
Ambient temperature range −75° C to +90° C

866A Half Wave Mercury Vapor Rectifier
Peak inverse voltage 10,000 volts
Peak plate current 1.0 amps
Average plate current .25 amps
Filament voltage 2.5 volts
Filament current 5.0 amps
Condensed mercury temperature 25° C to 60° C

394A Grid Controlled Argon-Mercury Vapor Rectifier
Peak inverse voltage 1,250 volts
Peak plate current 2.5 amps
Average plate current .64 amps
Filament voltage 2.5 volts
Filament current 3.2 amps
Condensed mercury temperature −40° C to +80° C

4B32 Half Wave Xenon Rectifier
Peak inverse voltage 10,000 volts
Peak plate current 5.0 amps
Average plate current 1.25 amps
Filament voltage 5.0 volts
Filament current 7.5 amps
Ambient temperature range −75° C to +90° C



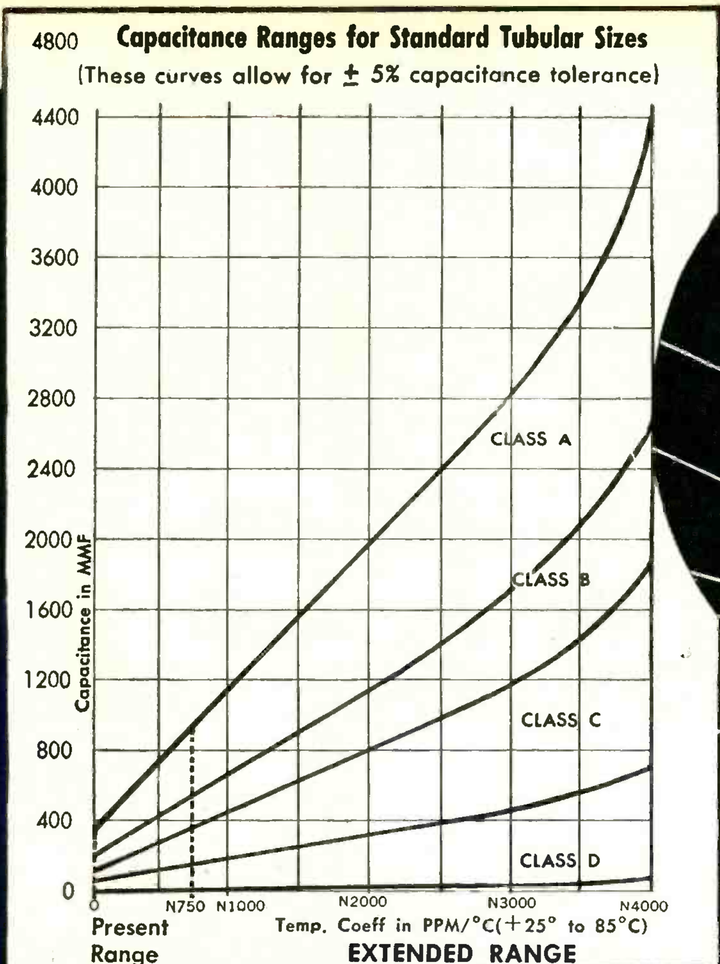
872A Half Wave Mercury Vapor Rectifier
Peak inverse voltage 10,000 volts
Peak plate current 5.0 amps
Average plate current 1.25 amps
Filament voltage 5.0 volts
Filament current 7.5 amps
Condensed mercury temperature 20° C to 60° C

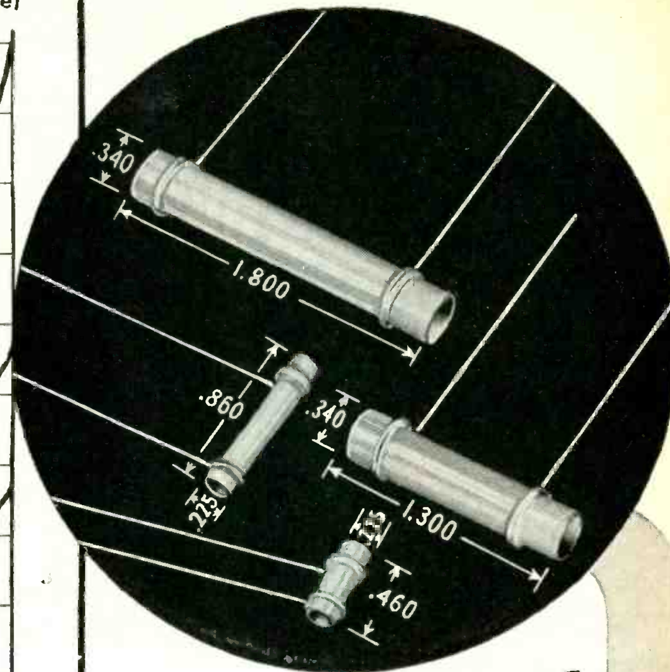
884 Grid Controlled Argon Rectifier and Oscillator
Peak inverse and peak forward voltage 300 volts
Peak plate current 300 Ma
Average plate current 75 Ma
Average plate current (oscillator) 2 Ma
Filament voltage 6.3 volts

4B22 Full Wave Argon Rectifier
Peak inverse voltage 340 volts
Peak plate current 15 amperes
Load current 5.0 amps
Filament voltage 2.5 volts
Filament current 12.0 amps

2050 Grid Controlled Xenon Rectifier
Peak inverse voltage 1,300 volts
Peak plate current 500 Ma
Average plate current 100 Ma
Filament voltage 6.3 volts
Filament current .6 amps

CHATHAM ELECTRONICS
475 WASHINGTON STREET, NEWARK 2, NEW JERSEY





A *New* RANGE OF CONTROLLED TEMPERATURE COMPENSATING CAPACITORS *by* Centralab

Centralab Tubular Ceramic Capacitors can now be supplied in any desired temperature coefficient from P120 to N4000 parts per million per degree Centigrade.

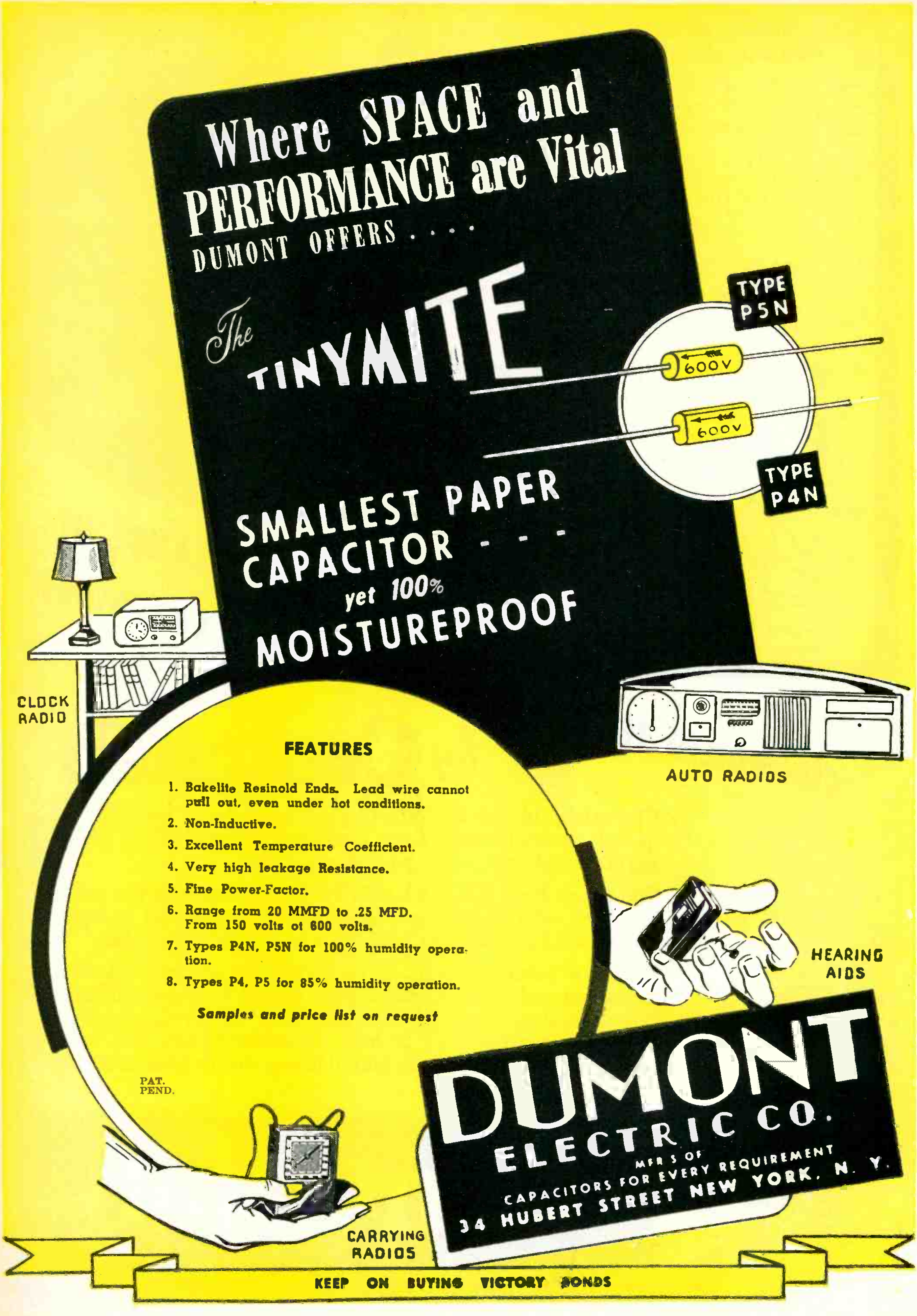
The range from N750 to N4000 P.P.M. is *new*, with the same accuracy of temperature compensation curve and uniform electrical characteristics as the present standard ranges.

The new ceramic bodies have somewhat higher dielectric constants and thus provide higher values of capacitance on the same size tube. They are not to be confused, however, with the so called Hi-K or high dielectric bodies that have still higher dielectric constants but less uniform characteristics.

Producers of:
Variable Resistors — Selector Switches — Ceramic Capacitors, Fixed and Variable — Steatite Insulators — and Button-Type Silver Mica Capacitors.

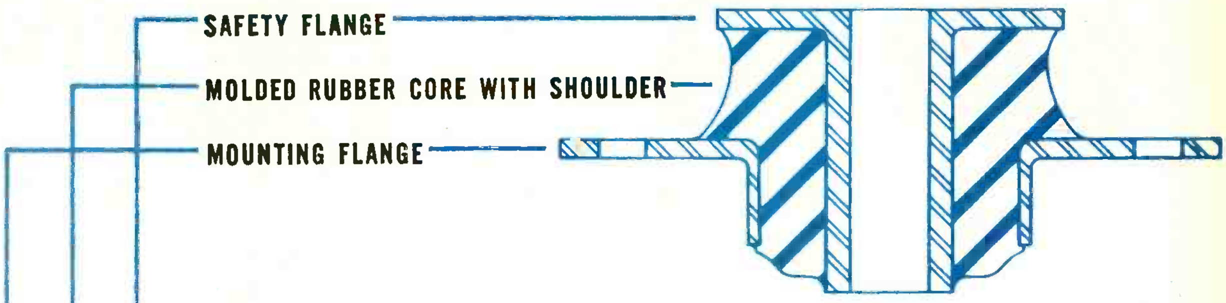
Centralab

***Division of* GLOBE-UNION INC., Milwaukee**


Where SPACE and PERFORMANCE are Vital
DUMONT OFFERS . . . .
The TINYMITE
TYPE P5N
600V
600V
TYPE P4N
SMALLEST PAPER CAPACITOR - - -
yet 100%
MOISTUREPROOF
CLOCK RADIO
AUTO RADIOS
FEATURES
1. Bakelite Resinold Ends. Lead wire cannot pull out, even under hot conditions.
2. Non-Inductive.
3. Excellent Temperature Coefficient.
4. Very high leakage Resistance.
5. Fine Power-Factor.
6. Range from 20 MMFD to .25 MFD. From 150 volts at 600 volts.
7. Types P4N, P5N for 100% humidity operation.
8. Types P4, P5 for 85% humidity operation.
Samples and price list on request
HEARING AIDS
PAT. PEND.
DUMONT ELECTRIC CO.
MFR S OF
CAPACITORS FOR EVERY REQUIREMENT
34 HUBERT STREET NEW YORK, N. Y.
CARRYING RADIOS
KEEP ON BUYING VICTORY BONDS

New!

MB VIBRATION ISOLATORS THAT CONTROL ALL MODES OF MOTION



EQUAL SPRING RATES IN ALL DIRECTIONS is the secret of this unit's efficiency. It's an outstanding feature unique with the MB "ISOMODE."

The shoulder of the molded rubber core is compressed by vertical and rocking motions. Lateral movements produce a similar change in the lower part of the core. Whatever the mounting angle for your installation, you'll find this *non-directional* MB unit efficiently isolating disturbing or destructive vibrations.

MB "ISOMODES" are self-snubbing . . . will take high overloads and shock. They've more than ample rubber, permitting high deflection. And here's another thought: the exclusive "shoulder" design would prevent operational failure even if the rubber-metal bond were to fail! There's dependability *plus*.

MB units come in a range of sizes and spring rates to dovetail with your individual design. They're engineered to give the deflection required for a high degree of vibration isolation . . . and do it with a smaller-size, lighter-weight, stable mounting.

To assure peak isolator performance, MB engineers are prepared to work with you on your new plans for machine suspensions . . . or make a detailed study of your existing mechanisms . . . and submit highly qualified recommendations, and data that'll save you much time and effort. We invite your inquiries.

"ISOLATE ALL MODES FOR POSITIVE VIBRATION CONTROL"*

THE
MB
MANUFACTURING COMPANY, INC.
Vibration Division
1066 State Street, New Haven 11, Conn.

VIBRATION DIVISION

VIBRATION ISOLATOR UNITS AND MOUNTINGS • SPECIAL VIBRATION TEST EQUIPMENT • PRECISION AIRCRAFT ENGINE PARTS

FRANKLIN ANNOUNCES ANOTHER TOWARD BETTER

★★★★★ *FLASH* ★★★★★

EXTRA

IT'S NEW

NOTHING ELSE LIKE IT!

AUTOMATICALLY EMBOSSED ON BACKBOARD TO SPECIFICATION

OPENS UP MANY AVENUES TO BETTER RADIO SET DESIGNING

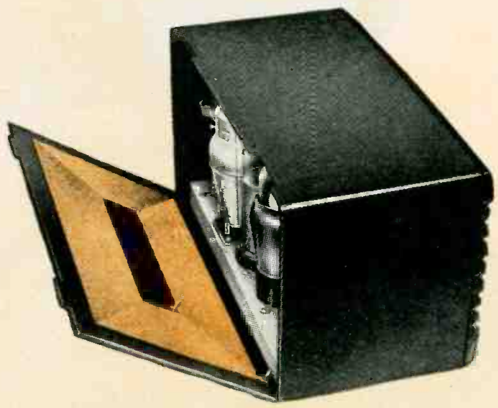
THE AIRLOOP

AIR DIELECTRIC THROUGHOUT ITS ENTIRE LENGTH

A radio engineers' dream come true . . . Flat sheets of copper die-stamped into perfect super-sensitive loops . . . The greatest development in loop antenna design and manufacture since 1920 . . . Being rectangular the Airloop has 27% more effective area . . . Better performance at lower cost . . . No set builder can afford to overlook the significance of the Airloop.

INVESTIGATE • SPECIFY FRANKLIN AIRLOOPS

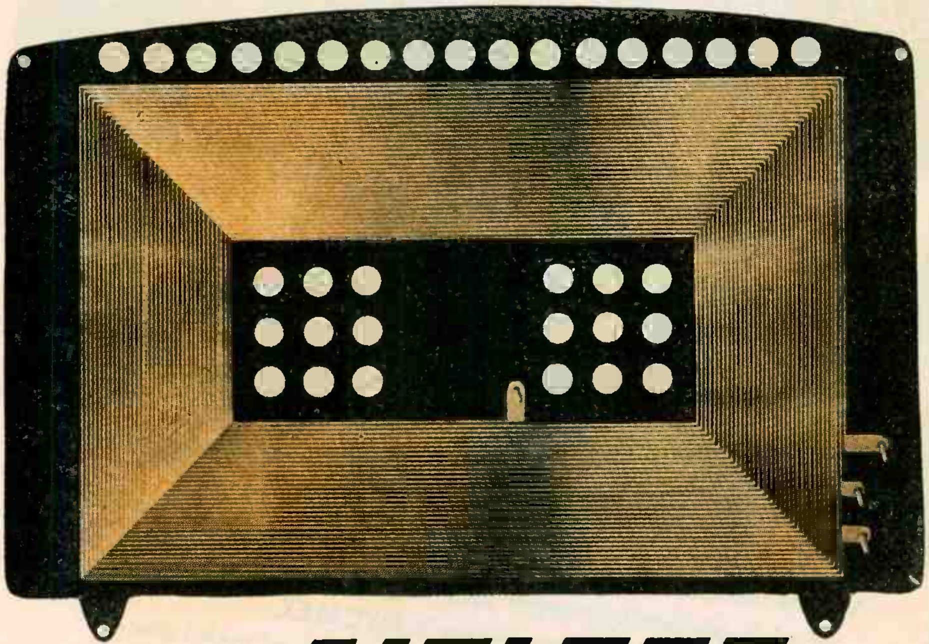
- Optimum sensitivity
- High uniform "Q" over entire band
- Inductance to close tolerance without adjustable turn
- Low distributed capacity
- 27% greater effective loop area
- Electrical and mechanical stability
- Backboard and loop in one
- Lower cost
- Elimination of individual loop adjustment on assembly line
- Maximum space utilization (cabinet depth)



Illustrating the AIRLOOP as installed in a typical table model receiver; note that the AIRLOOP and backboard are one and placed as far away from the chassis as is possible to permit optimum sensitivity, easy access to tubes . . . and no Haywire.

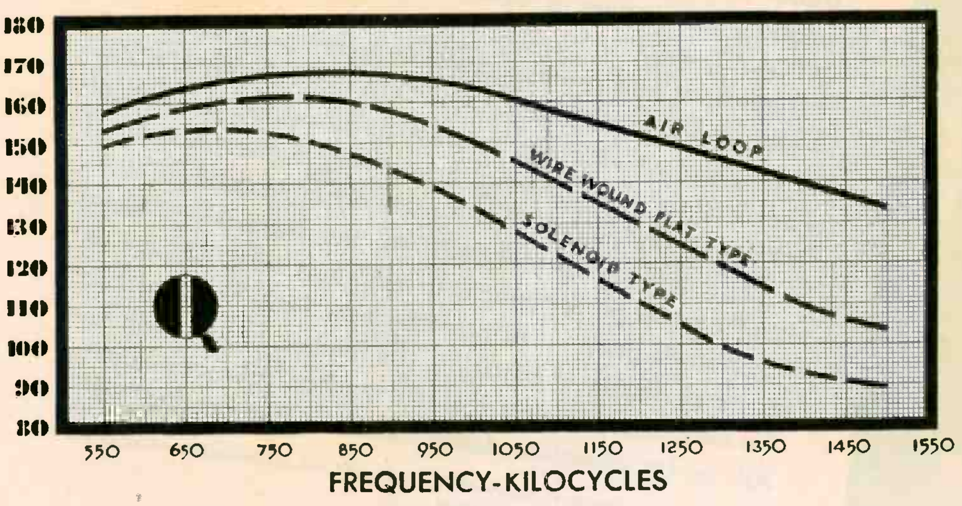
*Patents pending in U.S.A. and Foreign Countries.

SENSATIONAL CONTRIBUTION RADIO RECEPTION!



THE AIRLOOP

Illustrating the preciseness of AIRLOOP manufacture; note that every turn has uniform air dielectric throughout. Die-embossed on automatic machines, each AIRLOOP is identical in every way...and is the backboard as well as the loop.



FEATURING AIRLOOP STABILITY . . .

AIRLOOPS have only 5% reduction in "Q" after being subjected to 100% humidity for 24 hours. Such mechanical stability is unequaled by any wound wire type of loop. Since AIRLOOPS require no wax for treatment against humidity, operation is stable at temperatures much higher than conventional wax treated loops can tolerate (wax usually melts at around 70° C.).

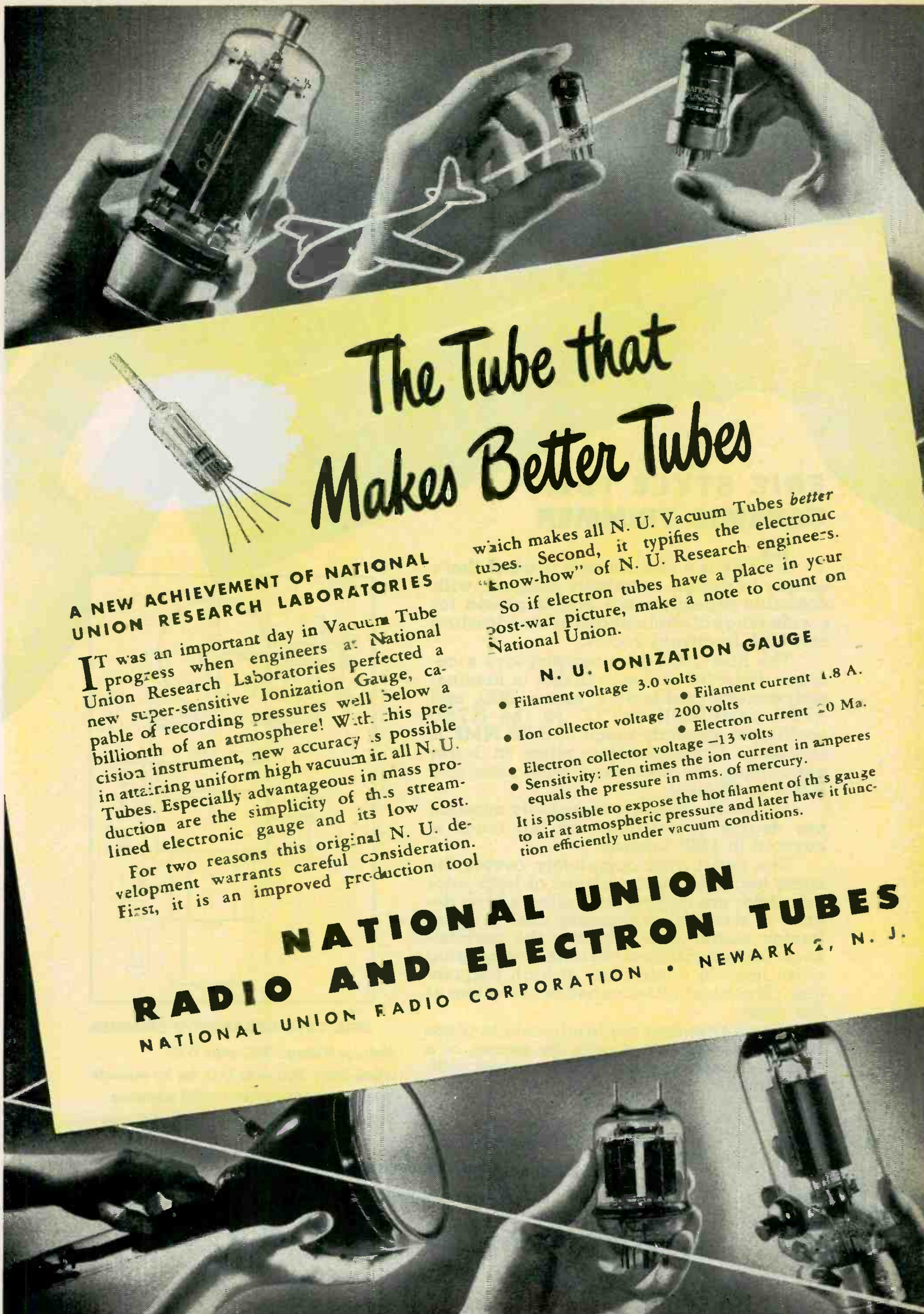
Inductance cannot be changed by rough handling in installation or in changing tubes.

FEATURING AIRLOOP LOW DISTRIBUTED CAPACITY . . .

By actual test, AIRLOOPS have 25% less distributed capacity than conventional loops of equivalent effective area. This means better frequency stability, permits use of smaller gang condenser resulting in lower costs and better performance (sensitivity) at high end of band since low distributed capacity does not lower the "Q" of the AIRLOOP as it does in conventional loops . . . also "Q" is more uniform over the entire band.

Investigate the AIRLOOP and you will specify them for your receivers.

Franklin AIRLOOP corp.
175 VARICK ST., NEW YORK 14, N. Y.


The Tube that
Makes Better Tubes
A NEW ACHIEVEMENT OF NATIONAL UNION RESEARCH LABORATORIES
IT was an important day in Vacuum Tube progress when engineers at National Union Research Laboratories perfected a new super-sensitive Ionization Gauge, capable of recording pressures well below a billionth of an atmosphere! With this precision instrument, new accuracy is possible in attaining uniform high vacuum in all N. U. Tubes. Especially advantageous in mass production are the simplicity of this streamlined electronic gauge and its low cost.
For two reasons this original N. U. development warrants careful consideration. First, it is an improved production tool which makes all N. U. Vacuum Tubes better tubes. Second, it typifies the electronic "know-how" of N. U. Research engineers.
So if electron tubes have a place in your post-war picture, make a note to count on National Union.
N. U. IONIZATION GAUGE
• Filament voltage 3.0 volts
• Filament current 1.8 A.
• Ion collector voltage 200 volts
• Electron current 20 Ma.
• Electron collector voltage −13 volts
• Sensitivity: Ten times the ion current in amperes equals the pressure in mms. of mercury.
It is possible to expose the hot filament of this gauge to air at atmospheric pressure and later have it function efficiently under vacuum conditions.
NATIONAL UNION
RADIO AND ELECTRON TUBES
NATIONAL UNION RADIO CORPORATION • NEWARK 2, N. J.

ERIE STYLE TS1F CERAMIC TRIMMER

HERE is a new ceramic trimmer that's unique in design, extremely compact, with desirable capacity ratios and is priced for a wide range of applications in broadcasting and high frequency bands.

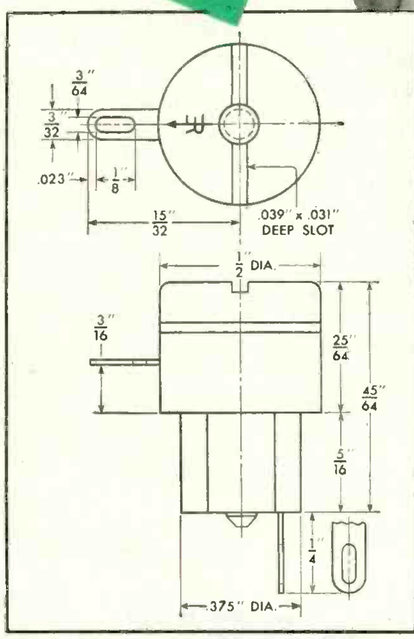
The Erie TS1F trimmer employs a ceramic dielectric and is available in nominal temperature coefficients, zero, −300, and −750 parts/million/°C. In the N750 coefficient, capacity range of 8-50 MMF is available. Corresponding ratios in lower capacities are furnished with zero and N300 coefficient.

Capacity change is essentially constant per degree of rotation, and full range is covered in 180° rotation.

The metal rotor completely covers the stator track. Contact surfaces of both rotor and stator are lapped, providing a high degree of stability, preventing dust or other foreign matter from affecting the performance characteristics of the unit, and keeping noise level to a minimum at high frequencies. Electrical characteristics are given at the right.

These trimmers are firmly held in place in a D hole in the chassis by means of a multiple-tooth spring clip, furnished with the trimmer.

For complete information contact our nearest representative or write us direct.



ERIE TS1F CERAMICON TRIMMER

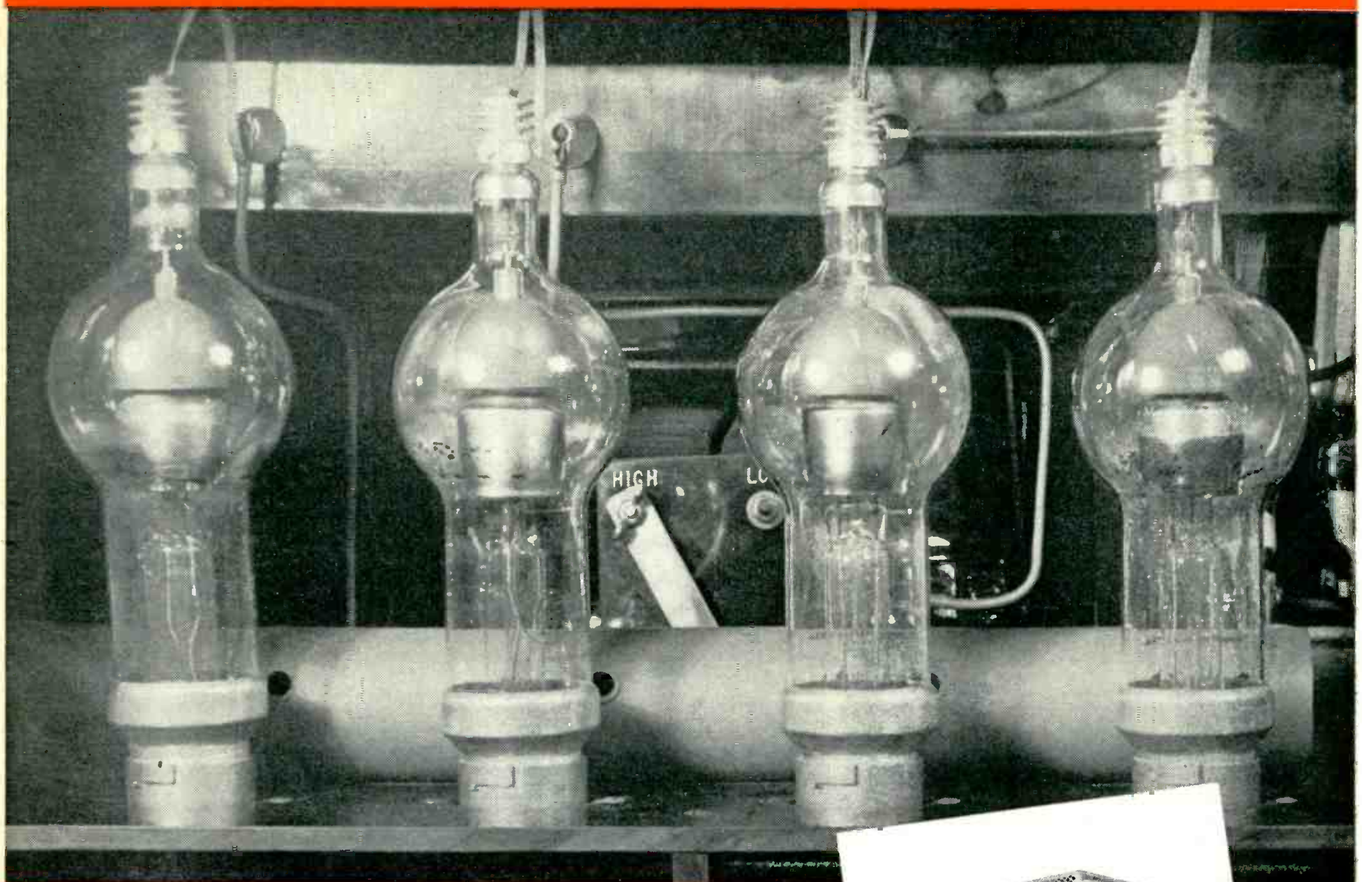
Voltage Rating: 350 volts D.C.
Flash Test: 700 volts D.C. for 15 seconds
Initial Q Factor at 1MC: 500 minimum
Initial Leakage Resistance: 10,000 meg. min.

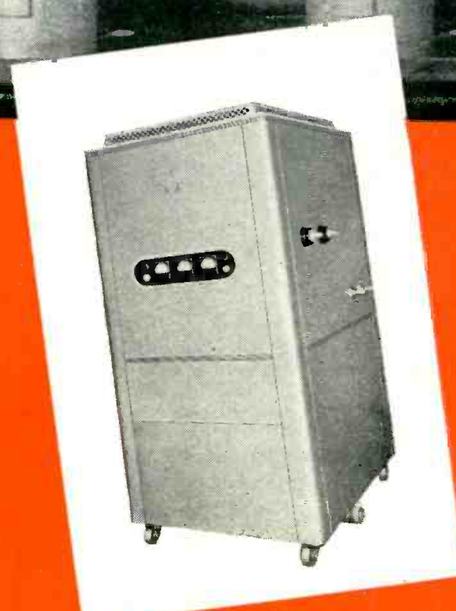
Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND — TORONTO, CANADA.

GENERAL ELECTRONICS "575As"
Give Peak Performance For "THERMONIC"





The four "575A" rectifier tubes shown in the unretouched photograph above are the "heart and soul" of the famous THERMONIC Induction Heating Machine illustrated here. Induction Heating Corp. chose General Electronics' "575As" for their "Thermonic" machines after exhaustive tests had proved their ability to stand up under grueling conditions for thousands of hours. Though standard specifications rate the "575As" at 15,000 volts inverse peak, they are tested at 25,000 volts—thus providing an overload factor in excess of 50% and, at the same time, assuring exceptionally low maintenance cost for the hundreds of "Thermonic" Generators performing so brilliantly in many vital industries.

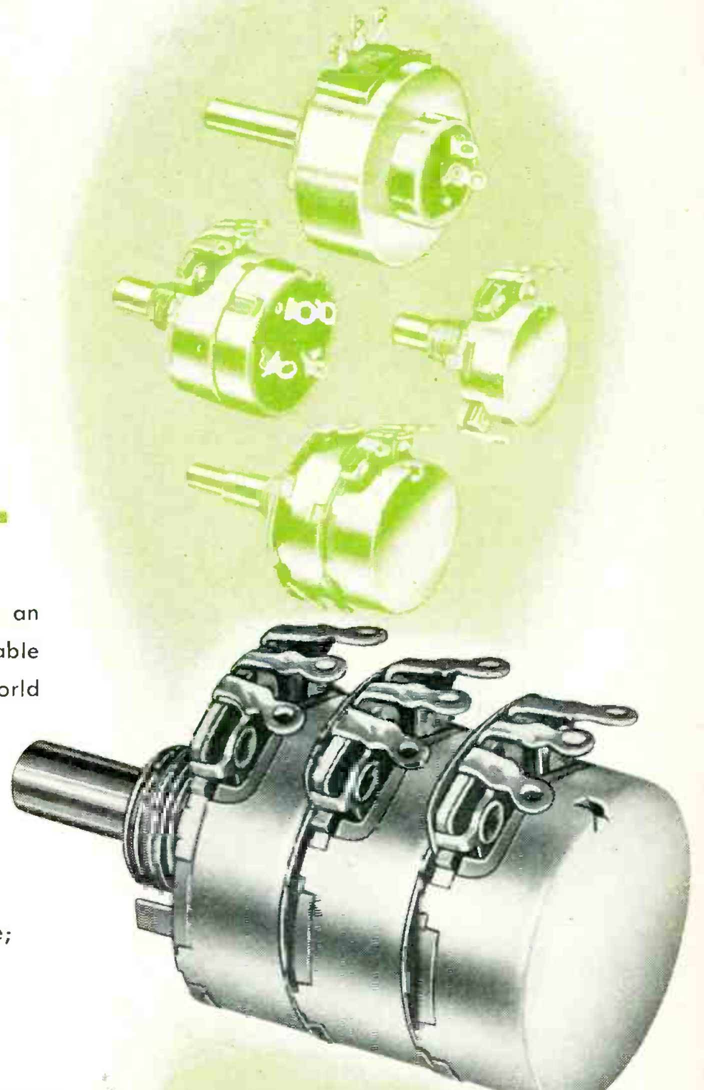
The entire line of General Electronics' tubes has been designed to provide "most hours for your tube dollars." All types are in stock and available for use in peace-time products. General Electronics' engineering and sales staffs are ready to consult with you on your requirements. Write, wire or telephone for complete data!

GENERAL ELECTRONICS INC.

SALES: 1819 BROADWAY, NEW YORK 23, NEW YORK

TELEPHONE: CIRCLE 7-8093

Specialists IN CONTROL



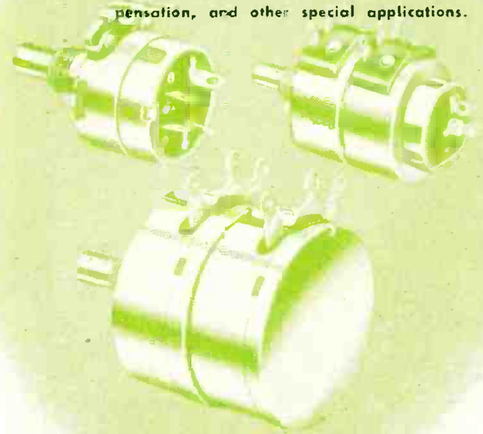
Chicago Telephone Supply Co. has long been known as an outstanding authority and producer in the field of variable resistors. That is why radio manufacturers all over the world prefer to have CTS *specialists in control.*

CTS saves you production delays and operating trouble by these long established practices:

- Delivery when promised;
- Each resistor carefully tested to assure top performance;
- Uniform quality throughout the shipment;
- A variable resistor engineered for the application.

1¾ times actual size

This type 3-35 triple section potentiometer is a good example of CTS skill and precision workmanship. All three sections operate from the same shaft. Used as gain control in impedance matching circuits, as volume control with the two extra sections as tone compensation, and other special applications.



REPRESENTATIVES

R. W. Farris Co.
406 West Thirty-fourth Street
Kansas City 2, Missouri
Phone: Logan 7495

Frank A. Emmet Co.
2837 West Pico Boulevard
Los Angeles 6, California
Phone: Rochester 9111

George A. Coleman
420 Market Street
San Francisco 11, Calif.

BRANCH OFFICES

S. J. Hutchinson, Jr.
401 North Broad Street
Philadelphia 8, Pennsylvania
Phone: Walnut 5389

IN ENGLAND

Chicago Telephone Supply Co.
St. John's Woods
103 Grove End Gardens
London, N. W. 8, England

CANADIAN ASSEMBLY PLANT

C. C. Meredith & Co.
Streetsville, Ontario

IN SOUTH AMERICA

Jose Luis Pontet
Cordoba 1472
Buenos Aires, Argentina
South America

Masculino 2624
Montevideo, Uruguay
South America

Avda. Conselheiro Rodrigues Alves 1057
Villa Mariana
Sao Paulo, Brazil
South America

Walter Th. Kommann Willson
Apartado 1891
Norte 6 No. 17
Caracas, Venezuela
South America

CTS

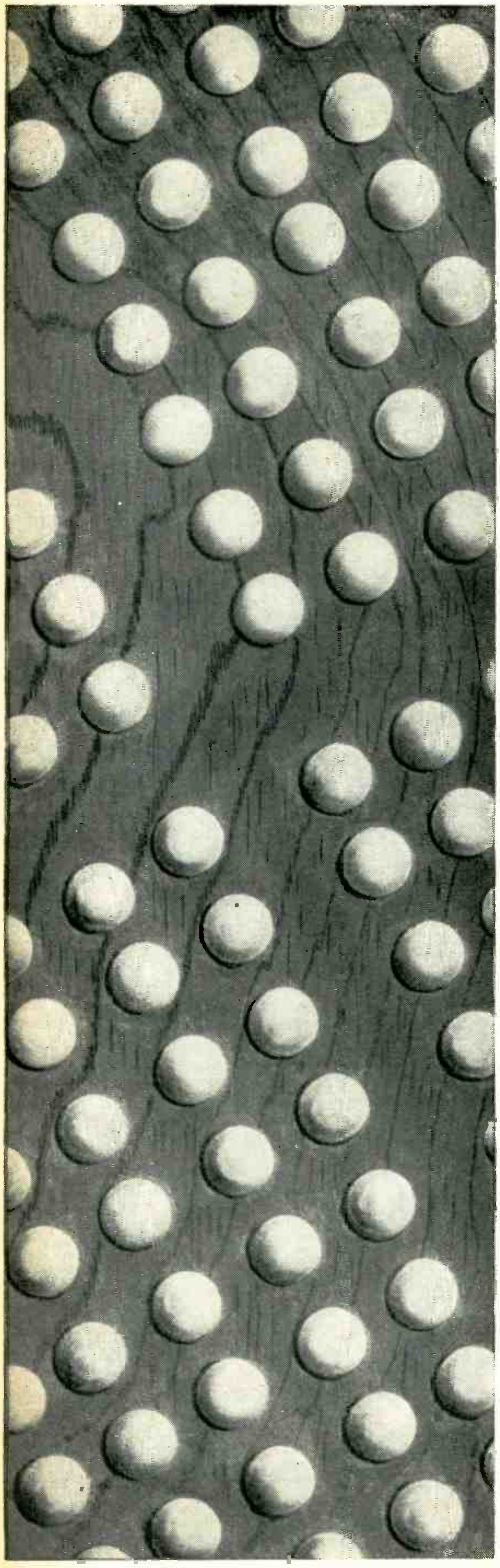
CHICAGO TELEPHONE SUPPLY *Company*

ELKHART ★ INDIANA

VARIABLE RESISTORS • SWITCHES • RINGERS
PLUGS AND JACKS • TELEPHONE GENERATORS

Manufacturers of Quality Electro-Mechanical Components Since 1896

ANOTHER WILCO DEVELOPMENT



Aero No. 50 Alloy ELECTRICAL CONTACTS

Long Service Life in High Frequency Operations

PROPERTIES AND CHARACTERISTICS:—WILCO AERO NO. 50 ALLOY CONTACTS are composed entirely of noble metals, and are especially desirable for higher frequency operations because of their extreme hardness, high melting and boiling points, freedom from contact surface oxidation, low contact resistance and high density. They are therefore extensively used in Tirrell type vibrating voltage regulators, in aircraft, warship and tank voltage regulators, meter-testing devices, dental and medical equipment, thermal cutouts, electric heaters, time switches, and many other severe-service applications.

WILCO AERO No. 50 ALLOY and other Platinum Contacts are available in a variety of shapes, solid rivets, or as parts of screw, blade or other assemblies.

CONSULT OUR ENGINEERING DEPARTMENT—Write our Engineering Department for help in developing the proper application of WILCO materials to your products.

SEND FOR WILCO BLUE BOOK—The Blue Book contains charts, formulae, and full descriptions of *all* Electrical Contacts, including WILCO AERO No. 50 Alloy, and other WILCO products. Send for FREE copy today.

WILCO PRODUCTS INCLUDE:

CONTACTS—
Silver
Platinum
Tungsten
Alloys
Sintered Powder Metal

THERMOSTATIC BIMETAL—
All Temperature ranges, deflection rates and electrical resistivities.

PRECIOUS METAL COLLECTOR RINGS—
For rotating controls

SILVER CLAD STEEL JACKETED WIRE—
Silver on Steel, Copper, Invar or other combinations requested.

ROLLED GOLD PLATE

SPECIAL MATERIALS

WILCO

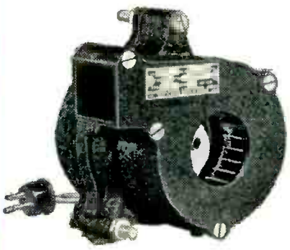
THE H. A. WILSON COMPANY
105 Chestnut Street, Newark 5, N. J.
Branch Offices: Chicago • Detroit • Los Angeles

SPECIALISTS FOR 30 YEARS IN THE MANUFACTURE OF THERMOMETALS
ELECTRICAL CONTACTS • PRECIOUS METAL BIMETALLIC PRODUCTS

New Westinghouse 6-volt input, 250-volt output dynamotor delivers 50 milliamperes. Adaptable for other ratings. Size 3.45 inch frame.

where it's needed · · when it's needed

OTHER WESTINGHOUSE EQUIPMENT FOR COMMUNICATIONS



LIGHTWEIGHT MOTOR BLOWERS

cool electronic equipment or keep temperature constant. Deliver 8 cfm free air at 60 cycles, single-phase and 25 cfm at 400 or 800 cycles, single-phase.

MOTORS

in a wide range of ratings—light in weight, compact, efficient for driving blowers or actuating controls.

This compact dynamotor for police communications equipment rates high on every count . . . for efficiency . . . light weight . . . dependable, long life . . . quiet operation . . . low ripple . . . excellent commutation. It provides the right power output where it's needed—in the way it's needed.

It's efficient as well, in conserving input power—important for low-voltage supply systems—operating, in effect, as a rotating direct-current transformer. Furthermore, its smooth functional design economizes on the small space allotted in a radio transmitter or receiver. Its ruggedness withstands the shock in moving vehicles as well as extreme climatic conditions. It is built to operate 2000 hours without servicing.

For further details on Westinghouse Dynamotors, see your nearest Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-03240

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Communications Equipment

CAPACITOR *Craftsmanship*

● With tiny silvered micas, it's precision: capacitance tolerances of 1%, with temperature coefficients and stability requirements to meet the highest characteristics requirements of JAN-C-S; excellent retrace characteristics; practically no capacitance drift with time; exceptionally high Q. Yes, Aerovox *specializes* in such precision capacitors.

And at the other extreme are giant Type 26 oil-filled capacitors for high-voltage requirements such as in X-ray equipment, high-voltage test and laboratory equipment, and for carrier-current coupling. Again, Aerovox *specializes* in high-voltage oil-impregnated, oil-filled capacitors.

But how, you ask, can one organization really *specialize* in such totally different products? The Aerovox answer:

The huge Aerovox plant is really *several* plants in one. Micas are made in the Mica Department, oils in the Oil Department, electrolytics in the Electrolytic Department, and so on. Each has its OWN engineers, supervisors, trained workers.

Thus you are assured of that *specialized* craftsmanship that insures the best in highly specialized products, along with the convenience, certainty and economy of ONE outstanding source of supply.

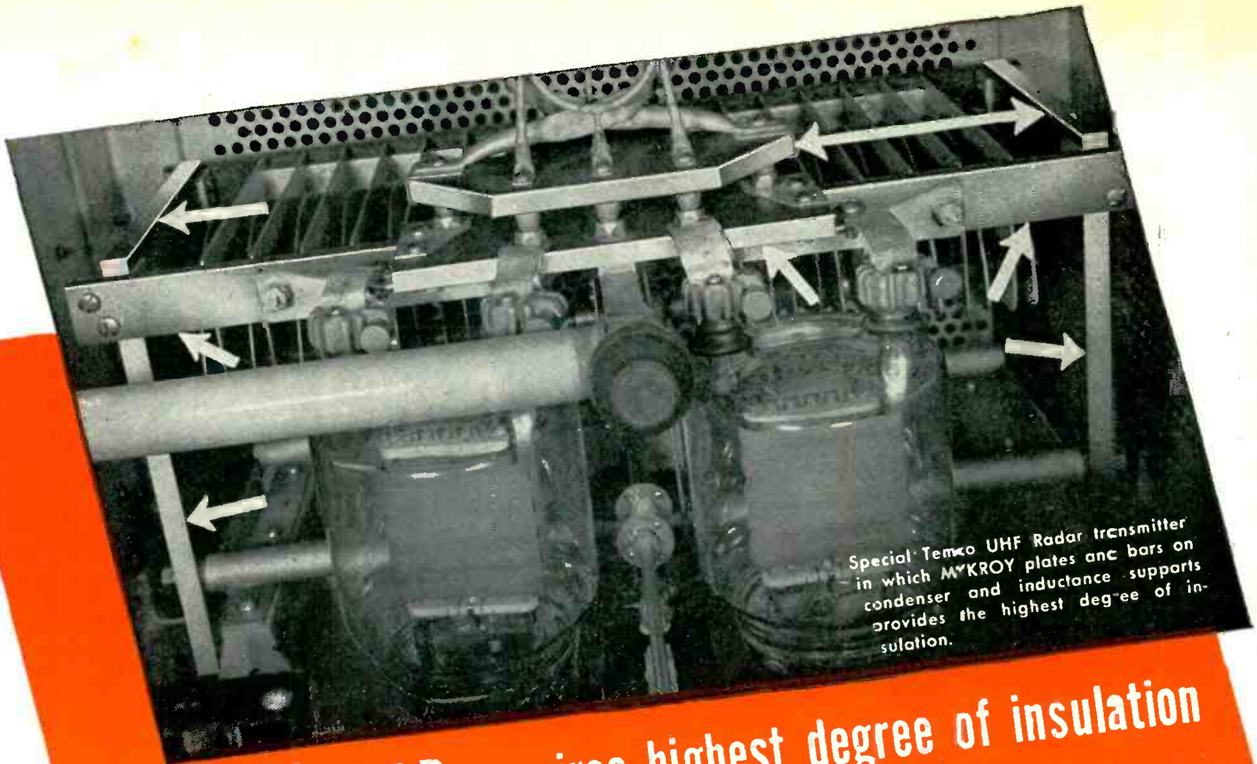
● *Try us on that capacitance problem*

AEROVOX *Capacitors*

INDIVIDUALLY TESTED

AEROVOX CORPORATION, NEW BEDFORD, MASS., U. S. A. • SALES OFFICES IN ALL PRINCIPAL CITIES

Export: 13 E. 40 ST., NEW YORK 16, N. Y. • Cable: 'ARLAB' • In Canada: AEROVOX CANADA LTD., HAMILTON, ONT.



Special Temco UHF Radar transmitter in which MYKROY plates and bars on condenser and inductance supports provides the highest degree of insulation.

Because RADAR requires highest degree of insulation MYKROY is specified at TEMCO

MYKROY

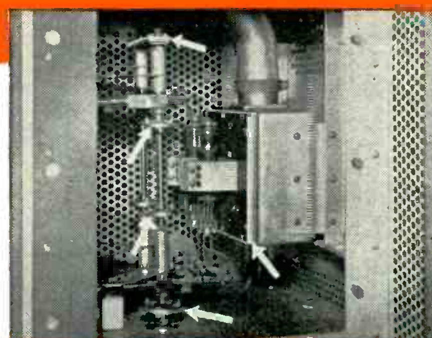
PERFECTED MICA CERAMIC INSULATION

"WHEN insulation of the highest order is specified you can always depend on MYKROY to fill the bill," says Morton B. Kahn, President of Transmitter Equipment Manufacturing Company, designers and builders of advanced Radar equipment, "and insulation requirements for Radar set an all-time high for the industry."

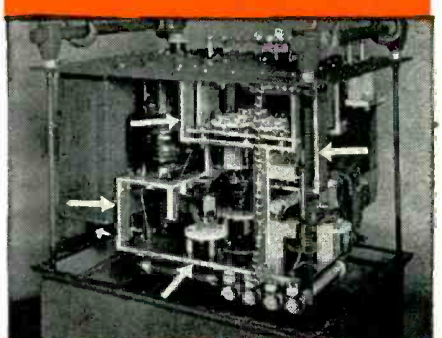
Mr. Kahn's opinion is shared by leading engineers and manufacturers everywhere who have also discovered that MYKROY is one of the best and most usable insulating materials ever developed for general and high frequency applications.

Mykroy is a perfected Glass-Bonded Mica Ceramic made entirely of inorganic ingredients, hence it cannot char or turn to carbon even when exposed to continuous arcs or flashovers. Its electrical characteristics are of the highest order and do not shift under any conditions short of actual destruction of the material itself. Furthermore it will not warp—holds its form permanently—molds to critical dimensions and is impervious to gas, oil and water.

Although MYKROY is a new and superior type of insulation it costs no more than many standard dielectrics of lower electrical and mechanical properties. It will pay you, therefore, to investigate MYKROY now in planning your new products. Write for Bulletins 101-104.



High powered Temco VHF Radar unit operates over wide frequency range utilizing forced air cooled tubes. MYKROY is used at all points requiring maximum insulations.



Temco 350KW Radar Pulse Modulator, all parts of which are completely immersed in oil, operates with a normal plate voltage of approximately 25000 volts. MYKROY is used at all critical high voltage points to assure maximum dependable insulation and particularly because it is impervious to oil.

MADE EXCLUSIVELY BY

ELECTRONIC MECHANICS INC.

70 CLIFTON BLVD., CLIFTON, N. J.

CHICAGO 47; 1917 N. Springfield Ave., Tel. Albany 4310

EXPORT OFFICE: 89 Broad Street, New York 4, New York

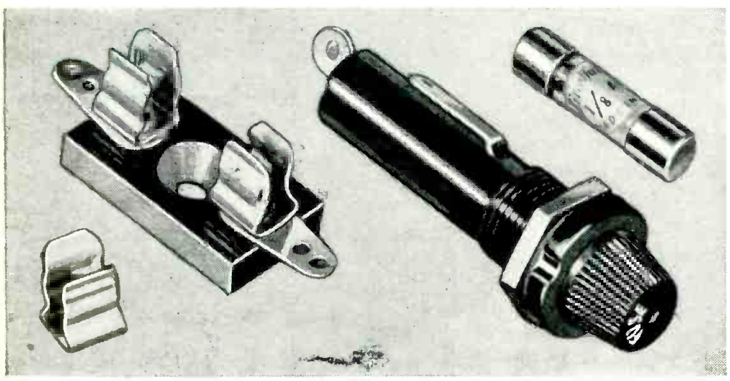
MYKROY IS SUPPLIED IN SHEETS AND RODS — MACHINED OR MOLDED TO SPECIFICATIONS

LF

First in Circuit Protection

LITTELFUSE

FIRST in the development of instrument and aircraft and vacuum fuses under ¼ amp. (3, 4, 5, and 8 AG; 3, 4, and 5 AB). FIRST with Underwriters' Approval on 3 AG and 3 AB fuses. FIRST with Extractor Posts, Breakerettes, Circuit Testers and Neon Indicators, Non-Filament Signal Indicators, Beryllium Copper Fuse Clips, low cost Mercury Switches, and many allied developments for the Armed Services.



Littelfuse products are available through leading electrical distributors. For distributor nearest you or solution to your special circuit protection problems, write to Littelfuse Incorporated, 4757 N. Ravenswood Ave., Chicago 40, Illinois.

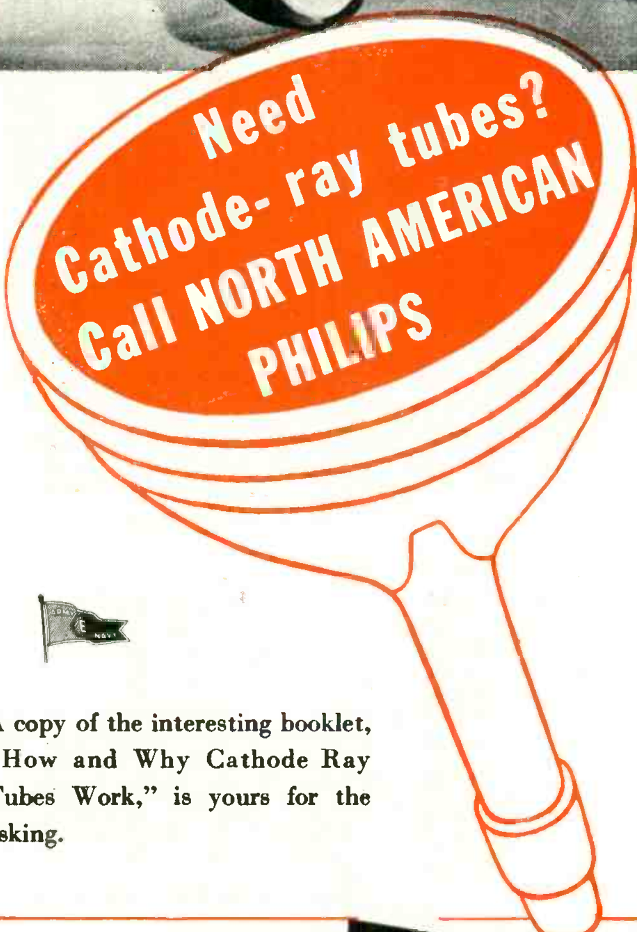
QUALITY IS A CHALLENGE

Quality is a challenge which the weak must decline but which the strong joyfully accept. The acceptance demands courageous planning and resourceful thinking. It demands patient research and unending vigilance against the temptation of profitable inferiority; it demands an unbending desire to serve well and the will to pursue unwaveringly the desired standards of perfection.

The path of quality is the road to victorious accomplishment.

President

LITTELFUSE LF *Incorporated*



NORTH AMERICAN PHILIPS has the ability to supply many sizes and varieties of cathode ray tubes... every one backed with the long life reputation gained by NORELCO tubes now in service.

Because North American Philips is one of the largest specialists in the production of cathode ray tubes, your requirements are in the hands of experts when you specify NORELCO.

And this specialized knowledge goes back to the earliest work in cathode ray tubes, because North American Philips draws on the experience gained by an organization with a background of over fifty years of research and development in the electrical field.

Make North American Philips your headquarters for cathode ray tubes.

A copy of the interesting booklet, "How and Why Cathode Ray Tubes Work," is yours for the asking.

Norelco Electronic Products by **NORTH AMERICAN PHILIPS COMPANY, INC.**

Reg. U. S. Pat. Off.

OTHER PRODUCTS: Quartz Oscillator Plates; Searchray (Industrial X-ray) Apparatus, X-ray Diffraction Apparatus; Medical X-ray Equipment, Tubes and Accessories; Tungsten and Molybdenum Products; Fine Wire; Diamond Dies.

• We invite you to visit our office and showroom when in New York City.

Dept. C-11, 100 East 42nd Street, New York 17, N. Y.
Factories in Dobbs Ferry, N. Y.; Mount Vernon, N. Y. (Metalix Div.); Lewiston, Me. (Elmet Div.)

Microphones Engineered by Electro-Voice

Answer Everyday Sound Problems

Maximum Intelligibility Under Extreme Noise

Hand-Held, close-talking single button carbon *DIFFERENTIAL microphone for all speech transmission in any noisy, windy, wet or extremely hot or cold locations. Cancels out background noise. Articulation is at least 97% under quiet conditions, and 88% under a 115 db noise field.

Model 205-S. List Price........$25

*Patent No. 2,350,010

Higher Articulation with Less Fatigue

Moving coil, hand-held Dynamic microphone for high fidelity speech transmission. Uniform response, free from peaks, in the useful frequencies gives higher articulation, provides more usable power level, and is less fatiguing to the listener. For outdoor or indoor use.

Model 600-D. Dynamic. List. $27.50
Model 210-S. Carbon. List. . $17.50

Poly-Directional with Adjustable Polar Pattern

The versatile high fidelity Cardak is readily adjustable to reduce any combination of reflected sound. Cuts reverberation or random noise pick-up . . . minimizes acoustic feedback. For broadcasting, recording, public address, communications.

Model 725—Cardak I. List....$55
Model 730—Cardak II. List....$75

General-Purpose Dynamic for Voice and Music

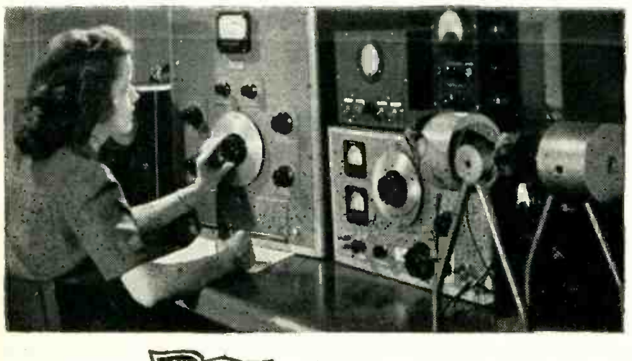
Widely used because of its dependable all-around performance. Excellent frequency response for both indoor and outdoor speech and music pick-up. Rugged, small size, light weight. High output. Suitable for public address, dispatching, paging, recording and remote broadcast.

Model 630-C. List Price........$30

Velocity High Fidelity Bi-Directional Sound Pick-Up

Wide, flat frequency response, bi-directional polar pattern, high fidelity characteristics, wide-angle front pick-up, and pick-up range make it ideal for solo, orchestra, or chorus, for single speaker or groups. For indoor P.A., broadcasting, recording.

Model V-1-C. List Price........$30
Model V-2. List Price........$37.50
Model V-3. List Price..........$50



Corner of E-V "Lab"

One of our Quality-Control units used in testing close-talking microphones. Harmonic distortion, frequency response, positional response (for carbons) level, etc., are carefully analyzed. Calibration is effected by Bell Laboratory standards and our own reciprocity checks.

SEND FOR COMPLETE CATALOG

Gives valuable data on Electro-Voice Microphones for communications, public address, broadcasting and recording. Includes helpful Reference Level Conversion Chart.

Authorized Distributors Everywhere

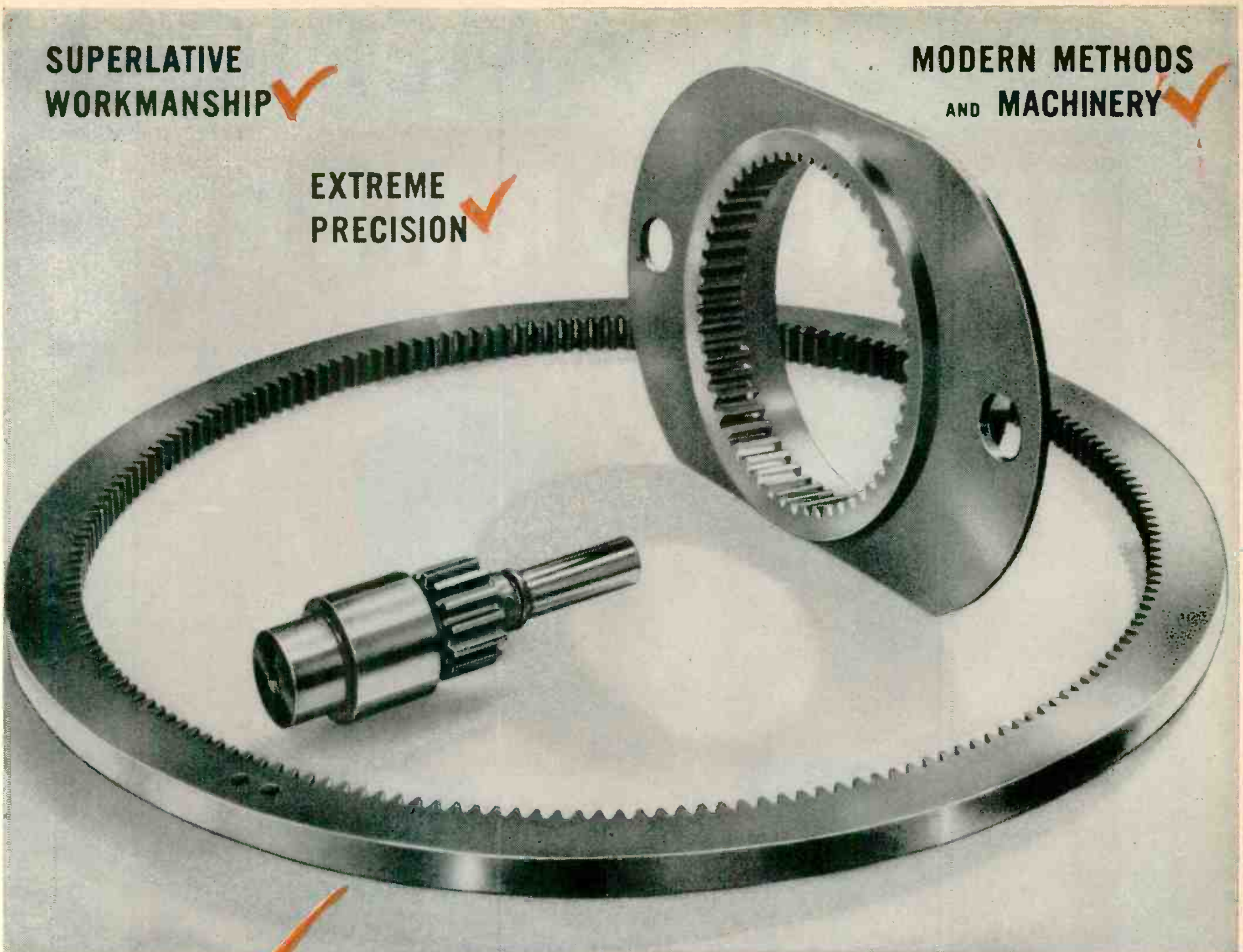
ARMY E NAVY

No finer choice than **Electro-Voice MICROPHONES**

GUARANTEE

The E-V models shown here are guaranteed forever against defects in workmanship and material.

ELECTRO-VOICE, INC., 1239 South Bend Ave., South Bend 24, Indiana ★ Export Division: 13 East 40th St., New York 16, N. Y., U. S. A.—Cables: Arlab



CHECK THESE AND OTHER FEATURES OF GEARS BY

FRACTIONAL HORSEPOWER GEARING
G S

If small gears are involved in your postwar plans, remember *it's a job for G-S!* Here, gears from 12 to 96 d.p. are a highly developed specialty. We've produced them in large quantities for many of America's biggest users for a quarter century, or more. G-S methods and machinery have been raised to a degree of speed and efficiency unapproached in the history of fine small gear manufacture. Discuss your problems with our engineers. Write or wire today. Get suggestions, ideas, and cost estimates. No obligation, of course.

DON'T WAIT! . . PRODUCTION FOR POST-WAR CIVILIAN PRODUCTS IS BEING SCHEDULED NOW!

FRACTIONAL HORSEPOWER 12 TO 96 D.P.

GEAR Specialties

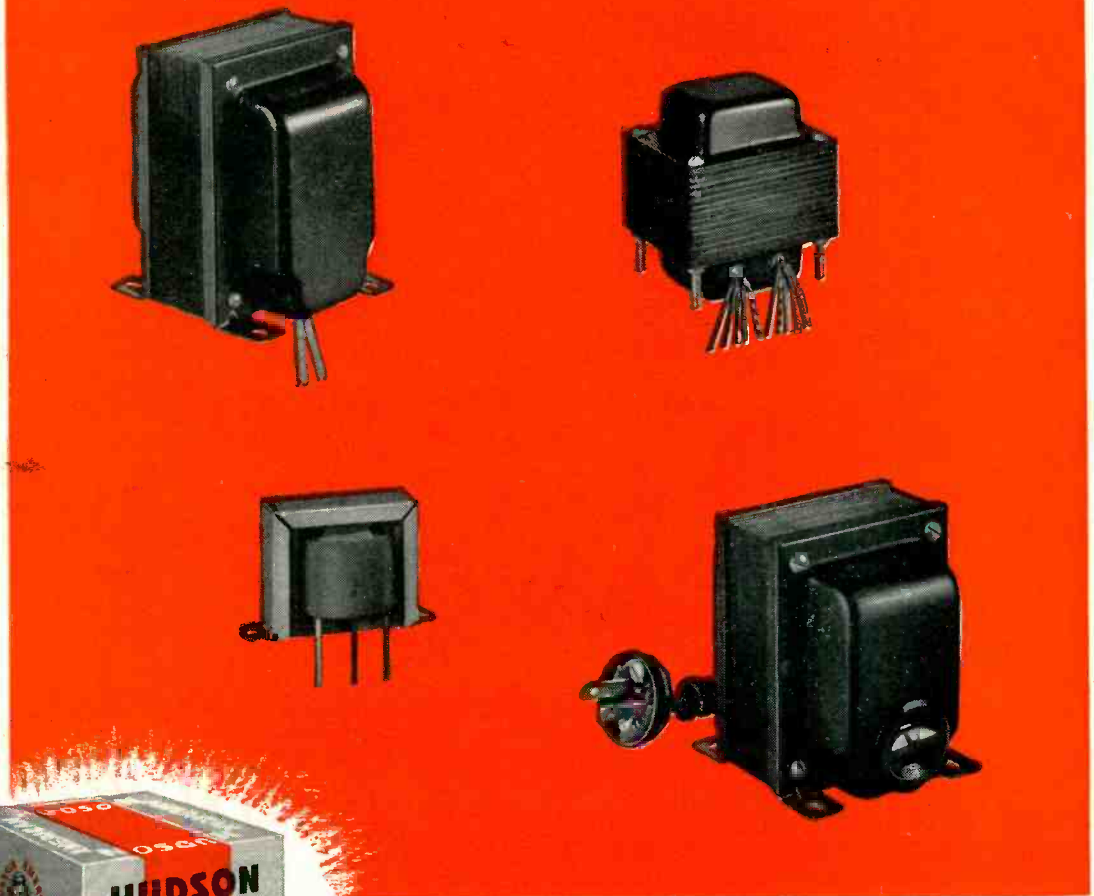
Spurs • Spirals • Helicals • Bevels • Internals • Worm Gearing • Racks • Thread Grinding

2635 WEST MEDILL AVENUE • CHICAGO 47, ILLINOIS

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

HUDSON AMERICAN

TRANSFORMERS



Look for this distinctive package

FOR GENERAL PURPOSE AND REPLACEMENT USE IN RADIO AND ELECTRONIC EQUIPMENT

HUDSON AMERICAN'S engineering experience in designing and manufacturing high quality transformers extends over a period of more than 20 years.

HUDSON AMERICAN'S up-to-date facilities include the most modern coil producing machinery available—vacuum impregnating equipment for wax or varnish and completely automatic production test apparatus. HUDSON AMERICAN Transformers are precisely wound—meticulously assembled—thoroughly impregnated and carefully finished. Continuous inspection and quality control insure maximum uniformity.

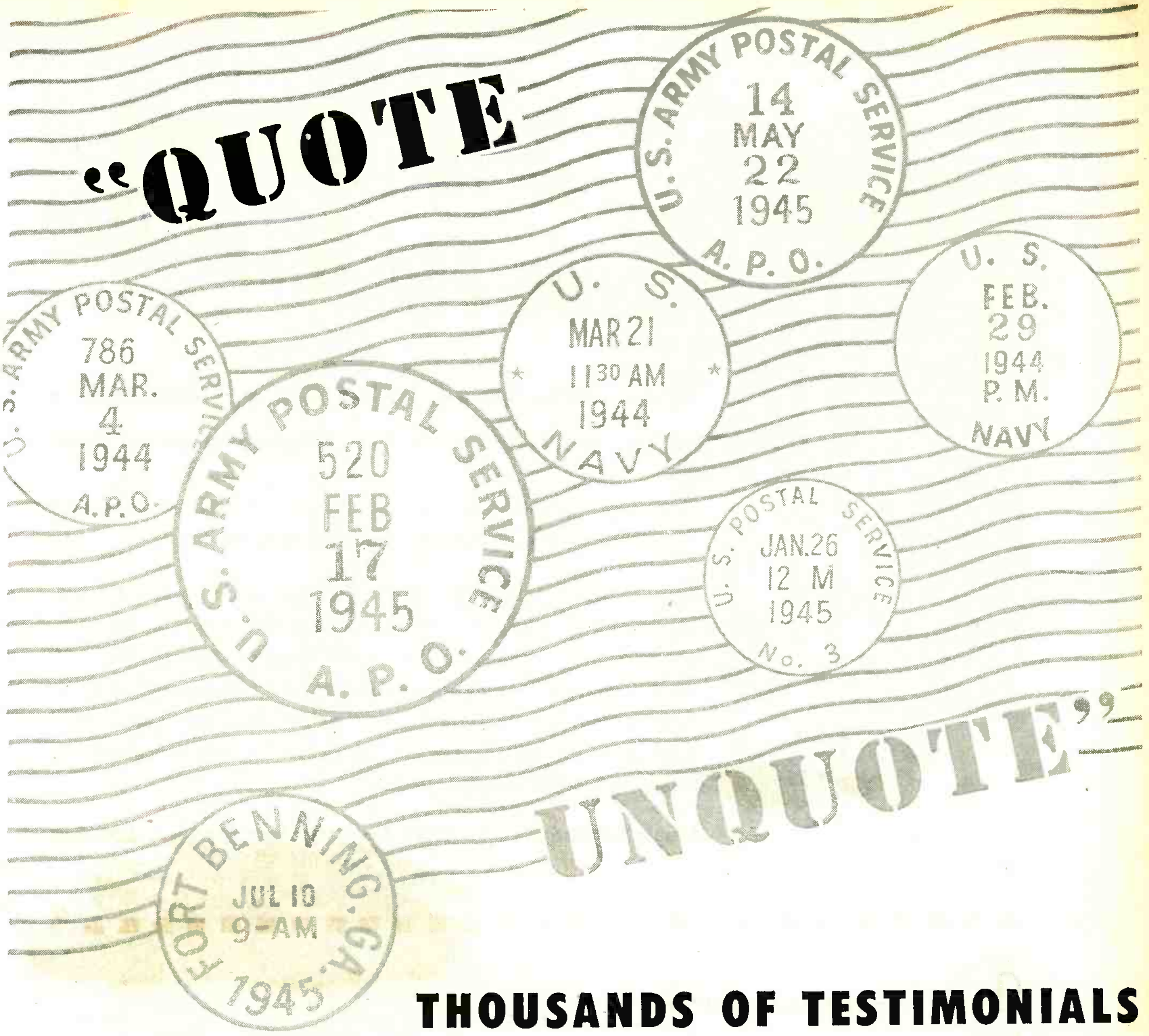
For dependability and economy, specify HUDSON AMERICAN Transformers for *your* radio and electronic requirements. They cost no more than ordinary transformers.

Write for catalog 1045

HUDSON AMERICAN CORPORATION

(A subsidiary of Reeves-Ely Laboratories, Inc.)

25 WEST 43rd STREET, NEW YORK 18, N. Y.



THOUSANDS OF TESTIMONIALS

Thousands of testimonials are in the files at Hallicrafters. They are from members of the armed services all over the world. They tell how Hallicrafters-built communications equipment has performed dependably and brilliantly on all the battle fronts of the world. Many of these letters are signed by licensed amateurs who include their call letters with their signatures. A high percentage of the letters conclude with sentiments like these—we quote: "*If a rig can take it like the HT-9 took it in the Australian jungles, it's the rig for my shack after the war*"... "*When I buy my communications equipment it will be Hallicrafters*"... "*After we have won this war and I can get a ham ticket there will not be the slightest doubt as to the equipment I will use ... it will be Hallicrafters*"... "*Meeting Hallicrafters gear in the service was like seeing someone from home ... I used to have one of your receivers at W7FNJ ... hope to have more after the war*" ... "*being an old ham myself I know what went into the 299 ...*" Thus does the voice of the amateur come pouring into Hallicrafters headquarters, providing information, guidance and further inspiration to Hallicrafters engineers. Amateurs will find in Hallicrafters peacetime output just the equipment they need—refined and developed in the fire of war and continuing to live up to the well earned reputation as "the radio man's radio."

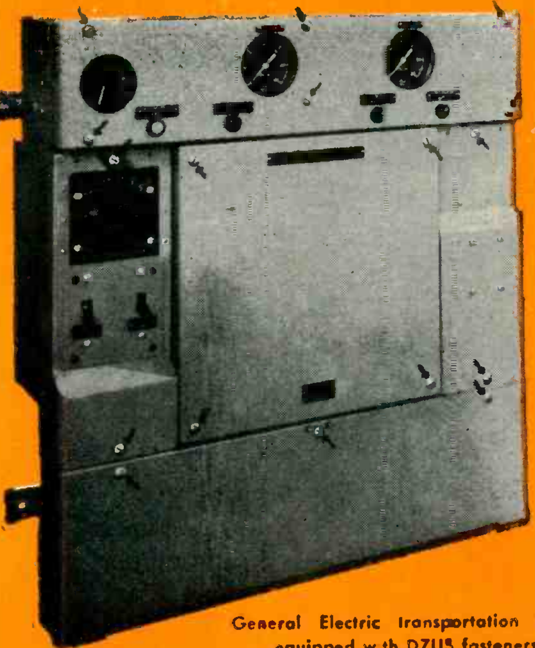
BUY A VICTORY BOND TODAY!

hallicrafters RADIO

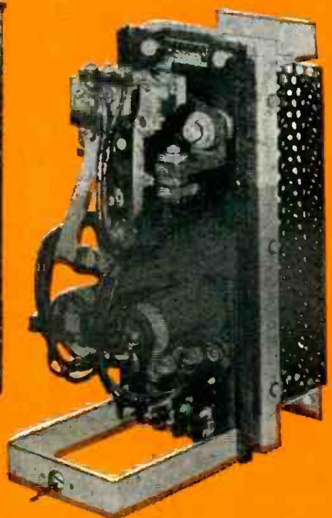
THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U. S. A.

QUICK ACCESS *with* DZUS*

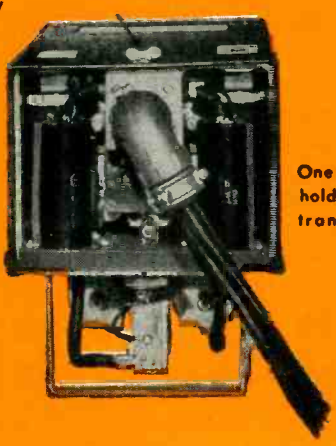
SELF-LOCKING FASTENERS



General Electric transportation panel equipped with DZUS fasteners



General Electric transportation relay cover removed. Note that only one DZUS fastener is necessary



One wing-type fastener holds the cover of this transportation relay unit

Yes, you get quick, positive action with Dzus fasteners on removable covers, panels, access and inspection doors and other hinged or removable parts. Just a quarter turn to open or close. They are rugged and vibration-proof. They may be permanently attached so no parts are lost — or they may be removable. They are easy to install too, and lend themselves to modern mass production methods. In addition its simple, quick operation saves valuable time of mechanics in inspection and maintenance.

If you have a fastening problem on a hinged or removable part, consider the outstanding advantages of Dzus spiral cam fasteners. They are available in various sizes, head styles and materials to meet your requirements. Send for our catalog. It contains detailed directions, specifications and many illustrated applications.

*The word Dzus is the registered trade mark of the Dzus Fastener Co., Inc.

DZUS FASTENER CO., INC.
BABYLON NEW YORK
IN CANADA: RAILWAY AND POWER ENGINEERING CORP., LTD.

Oval head stud

Grommet

Spring

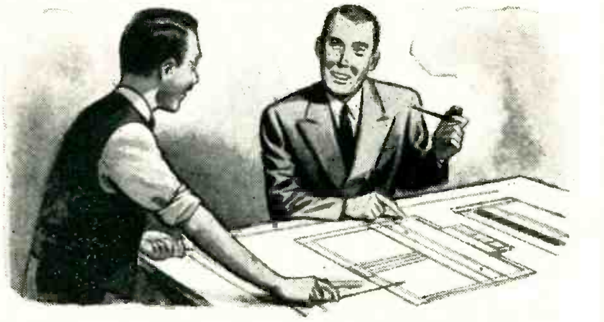
Cut-away view of complete assembly

TUNES OUT TROUBLE

When slotted screws were used by this musical instrument maker, head breakage and driver skids damaged expensive assemblies – required disassembly, costly refinishing, and reassembly. A shift to Phillips Recessed Head Screws ended this trouble, permitted lower assembly costs.

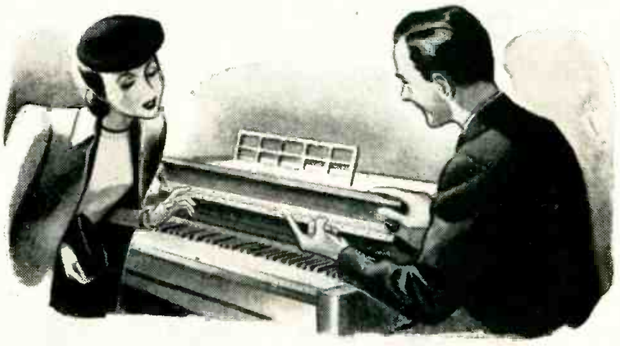
SWING TO SAVINGS

Because the recessed head makes more efficient use of turning power, Phillips Screws can be set up tighter without danger of burring. As a result, fewer Phillips Screws are needed to make the rigid assembly required – a further saving in time and material.



IN TIME WITH TOMORROW

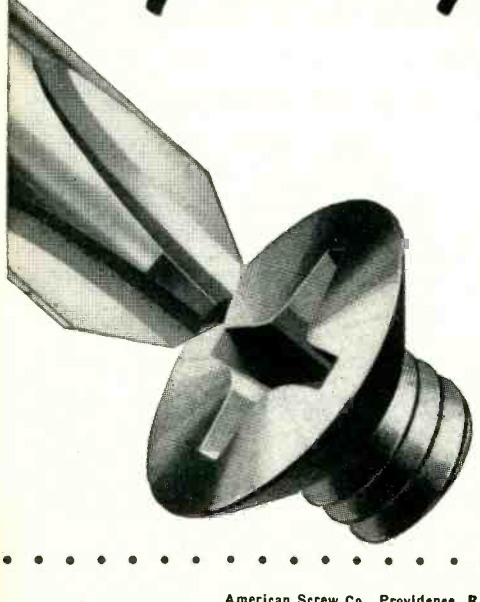
Besides reducing costs and speeding up production, Phillips Screws help designers plan new, simpler methods of achieving strength, rigidity, and improved appearance. Result – a product in step with design trends – and a match for competition in tomorrow's tough markets.



SALES HIT HIGH NOTE

From the sales angle, Phillips Recessed Heads make fastenings a *feature!* No unsightly burrs to cool off prospects! The ornamental pattern of the Phillips Recess blends in harmony with modern design ... helps start cash registers ringing a sweet sales symphony!

It's Phillips ... the engineered recess!



In the Phillips Recess, mechanical principles are so correctly applied that every angle, plane, and dimension contributes fully to screw-driving efficiency.

... It's the exact pitch of the angles that eliminates driver skids.

... It's the engineered design of the 16 planes that makes it easy to apply full turning power – without reaming.

... It's the "just-right" depth of recess that enables Phillips Screw Heads to take heaviest driving pressures.

With such precise engineering, is it any wonder that Phillips Screws speed driving as much as 50% – cut costs correspondingly?

To give workers a chance to do their best, give them faster, easier-driving Phillips Recessed Head Screws. Plan Phillips Screws into your product now.

PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS • MACHINE SCREWS • SELF-TAPPING SCREWS • STOVE BOLTS

Made in all sizes, types and head styles

25 SOURCES

American Screw Co., Providence, R. I.
Atlantic Screw Works, Hartford, Conn.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
General Screw Mfg. Co., Chicago, Ill.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
Manufacturers Screw Products, Chicago, Ill.
Milford Rivet and Machine Co., Milford, Conn.
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N.Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
The Steel Company of Canada Ltd., Hamilton, Canada
Wolverine Bolt Co., Detroit, Mich.

This Amperex tube Type 233, is a copper anode, water-cooled tube nearly four feet in height, designed for use in high power broadcast transmission and in industrial heating applications. Special construction features in this tube give freedom from change in characteristics that might arise from shock and vibration.

Contributing to its sturdy dependability are a number of working parts by Callite, including tungsten filaments, tungsten center and side leads, molybdenum hooks, grid collars and grid rods and other Callite tungsten and molybdenum parts.

Our methods of processing tube components are the result of years of painstaking research and experience. That's why leading manufacturers look to Callite to safeguard the life and performance of their electron tubes.

If you manufacture an electronic or electrical device requiring precision metallurgical components, our engineering department will be glad to cooperate with you. Callite Tungsten Corporation, 544 Thirty-ninth Street, Union City, N. J. Branch Offices: Chicago, Cleveland.

Callite
tube components

CALLITE TUNGSTEN CORPORATION
CT

Hard glass leads, welds, tungsten and molybdenum wire, rod and sheet, formed parts and other components for electron tubes and incandescent lamps.

KARP solves peacetime housing problems

All our extensive sheet metal fabricating facilities are now ready to help you speed production of your peacetime products.

Because our specialty in both peace and war years has been a custom-built service at ready-made economy, we have no reconversion worries or delays. We can serve you immediately—whatever your needs may be in sheet metal cabinets, boxes, enclosures or housings . . . racks, panels, chassis for electrical or mechanical apparatus.

Our vast variety of stock dies is at your service to save your time and money . . . thanks to the fact that our production has never been standardized or restricted to any particular items.

Tell us your needs. Get quotations.

ANY SIZE • ANY FINISH
ANY GAUGE • ANY METAL

ARMY E NAVY

KARP METAL PRODUCTS CO., INC.

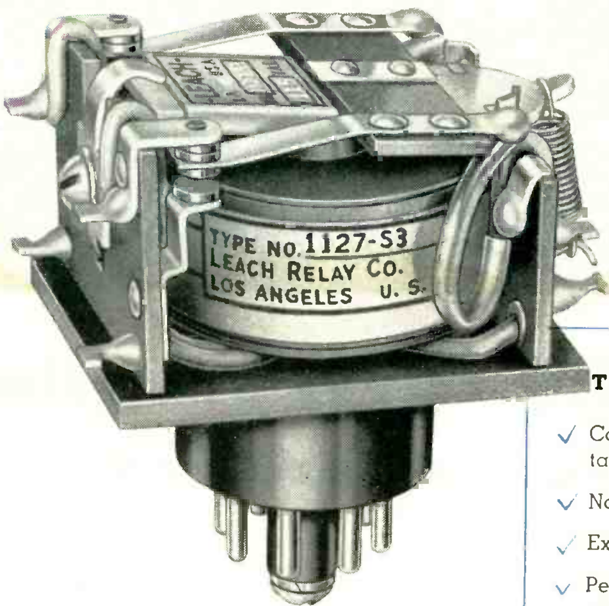
124-30th Street, Brooklyn 32, N. Y.

Custom Craftsmen in Sheet Metal

Relays

BY

LEACH



THE LEACH PLUG-IN RELAY

- ✓ Concealed wiring—all connections on receptacle, behind panel.
- ✓ No soldering required in exchanging relays.
- ✓ Exclusive interchangeable feature.
- ✓ Permits flexibility of circuit combinations and operating voltages, without re-wiring.
- ✓ Designed to fit standard octal socket.

● *All the engineering skill that has created for Leach its reputation as manufacturers of fine relays is at your service. Our Engineering Department will be glad to discuss with you any problems which you may have. Write for literature.*

LEACH RELAY CO.

5915 AVALON BOULEVARD, ★ LOS ANGELES 3, CALIF.

RAYTHEON

IONICALLY HEATED LOW VOLTAGE GAS RECTIFIERS

Readily Available • Smaller Space Requirement • Lower Operating Temperature • Commercial in Cost • Long Life • Quicker Starting

A major deterrent to the further size reduction of radio receivers and other equipment designed for universal operation from a standard 117 volt AC or DC line or internal batteries, has been the size and power dissipation associated with the rectifier tube. The advantages of an ionically heated tube for low voltage applications were recognized early by the Raytheon engineers, who have long pioneered in the field of gas tube development. However, considerable research has produced the OY4 and OY4G which start cold from no more than 95 volts DC. High rectification efficiency is realized from the low internal drop and high peak current ratings. Physically these types have the same dimensions as the familiar OZ4G and OZ4.

Where size is an important factor, use of the OY4G in place of the 117Z6GT, as extensively employed in the three way receivers, will result in a substantial reduction of the space requirements.

Even more important is the differential of approximately eight watts in favor of the OY4 and OY4G because of the ionic heating feature. This saving cuts the input power down by more than 50% for a normal receiver. Consequently, cabinet size can be decreased without danger of excessive heating. Furthermore, the time required for the set to become operative is the same whether on DC, AC or battery — that is, almost instantaneous.

These tubes have been engineered to produce a minimum of the radio frequency disturbances associated with a gaseous discharge. The simple filter circuit indicated below will generally reduce such interference to a negligible value.

If your product does not call for the ionically heated low voltage gas rectifier, there is a Raytheon type designed for your need. And all Raytheon tubes follow the same rigid pattern of advanced engineering with precision manufacture. To get continuing best results, specify Raytheon High-Fidelity Tubes.

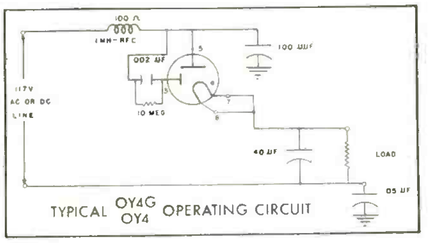
OY4G AND OY4 RATINGS

Half Wave Rectifier—Condenser Input to Filter*

Maximum Inverse Peak Voltage	300 volts
Maximum Peak Current	500 ma
Maximum DC Output Current	75 ma
Minimum DC Output Current	40 ma
Minimum Series Anode Resistance (117V line operation)	50 ohms
Approximate Tube Drop	12 volts
Maximum DC starting Voltage**	95 volts

*Pins 7 and 8 must be connected together. Rapid intermittent operation is undesirable.

**With starter anode network as shown in circuit.



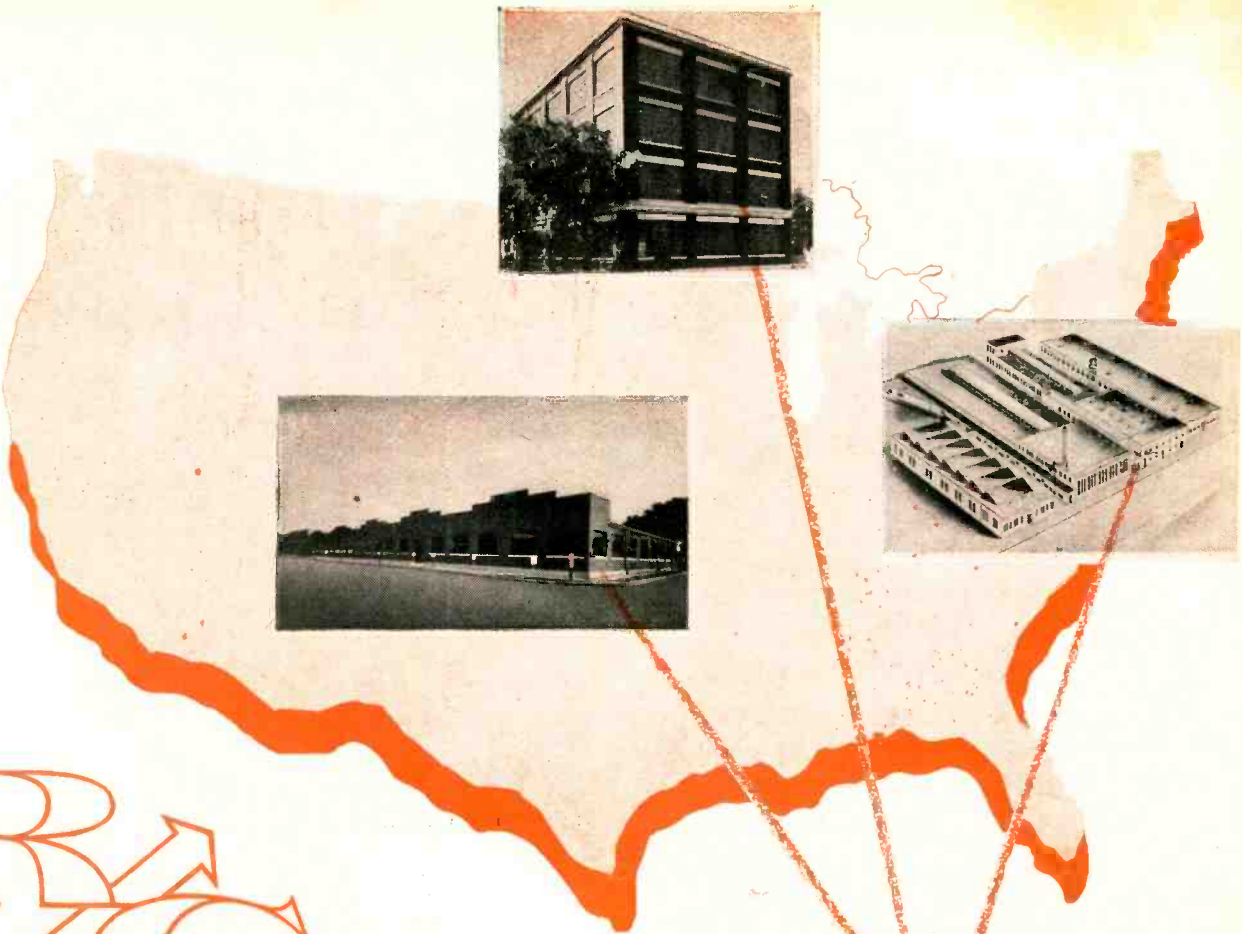
TYPICAL OY4G / OY4 OPERATING CIRCUIT

Radio Receiving Tube Division

NEWTON, MASSACHUSETTS • LOS ANGELES
NEW YORK • CHICAGO • ATLANTA

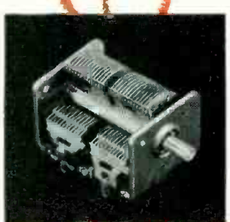
RAYTHEON MANUFACTURING COMPANY

DEVOTED TO RESEARCH AND THE MANUFACTURE OF TUBES AND EQUIPMENT FOR THE NEW ERA OF ELECTRONICS



VARIABLE CAPACITORS

...direct to you...from the plant nearest you



WATSEKA, ILL.

TORONTO

CAMDEN, N. J.

Where is the supplier located? What about shipping costs? How fast deliveries? What about specialized engineering assistance?

R/C has solved problems such as these for its clients by maintaining, in addition to its big Camden, N. J. plant, an affiliate in the Middle West and a subsidiary in Toronto, Canada.

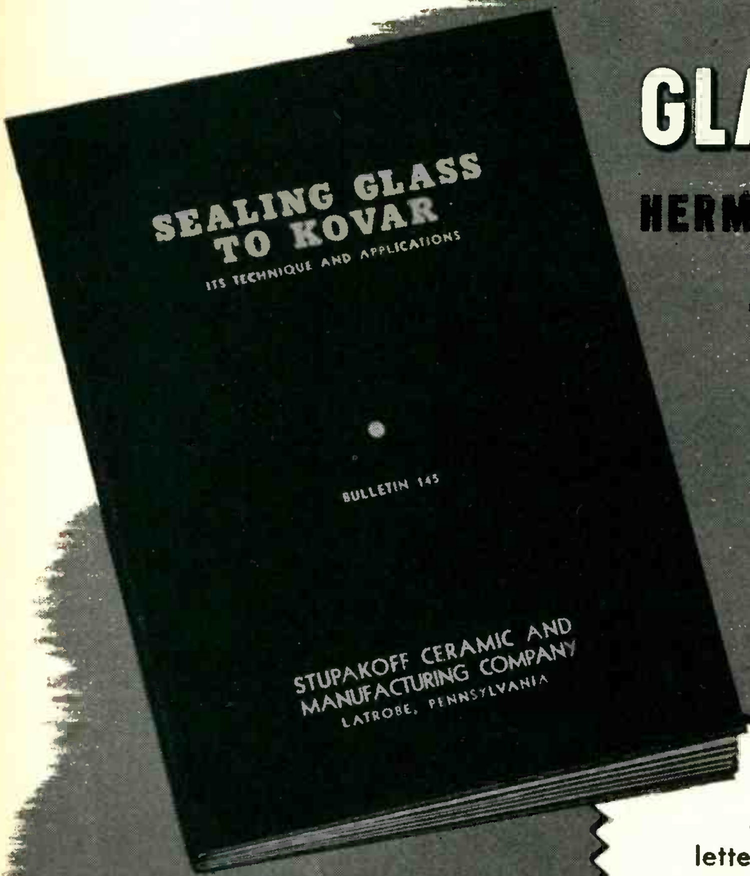
These plants, servicing sales offices from New York to California and Canada assure utmost efficiency from any standpoint you can name.

Service *direct to you*, from *the plant nearest you*, is the aim of Radio Condenser Company—and this is backed by strategically placed sales office service literally at your fingertips.

RADIO CONDENSER CO., Camden, N. J. • Radio Condenser Co., Ltd., Toronto, Canada

RADIO CONDENSER COMPANY

SUPPLIERS TO SET MANUFACTURERS ONLY



GLASS TO METAL

HERMETIC SEALING PROBLEMS ANSWERED FOR YOU!

A request on your company letterhead will bring to you this valuable technical bulletin.

THE latest technical data on Kovar-glass hermetic sealing, representing the results of extensive research and users' experience, are made available in a new publication, Stupakoff Bulletin 145, "Sealing Glass to Kovar."

Kovar-glass seals are used to protect apparatus and its contents from damaging atmospheres, and to maintain vacuum or gas tightness within a container.

For your copy of this timely bulletin on techniques and applications of hermetic sealing, write Stupakoff Ceramic and Manufacturing Company, Latrobe, Pa., distributors and fabricators of Kovar.

RADIO MANUFACTURERS' ASSOCIATION RMA MEMBER

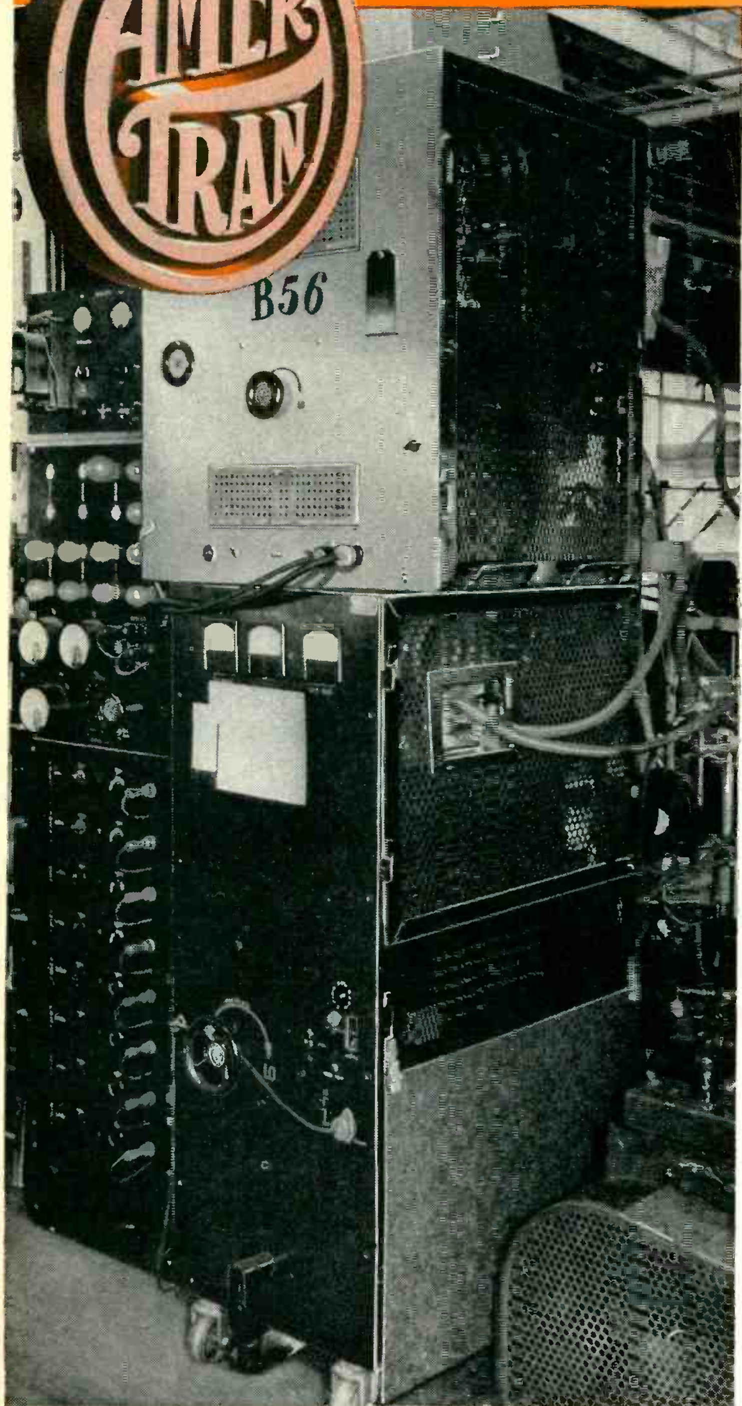
★ BUY VICTORY BONDS ★

ARMY E NAVY "FOR GREAT ACHIEVEMENT"

STUPAKOFF CERAMIC AND MANUFACTURING CO., LATROBE, PA.

Products for the World of Electronics

TRANSTATS ARE THE "TRIGGERS" OF TUNG-SOL'S BOMBARDERS



Shown here are Bombarder (below with black panel) and Induction Heater (above with light panel) at Tung-Sol, Newark, N. J., Plant.

Transtat for 0.3 to 20 KVA.

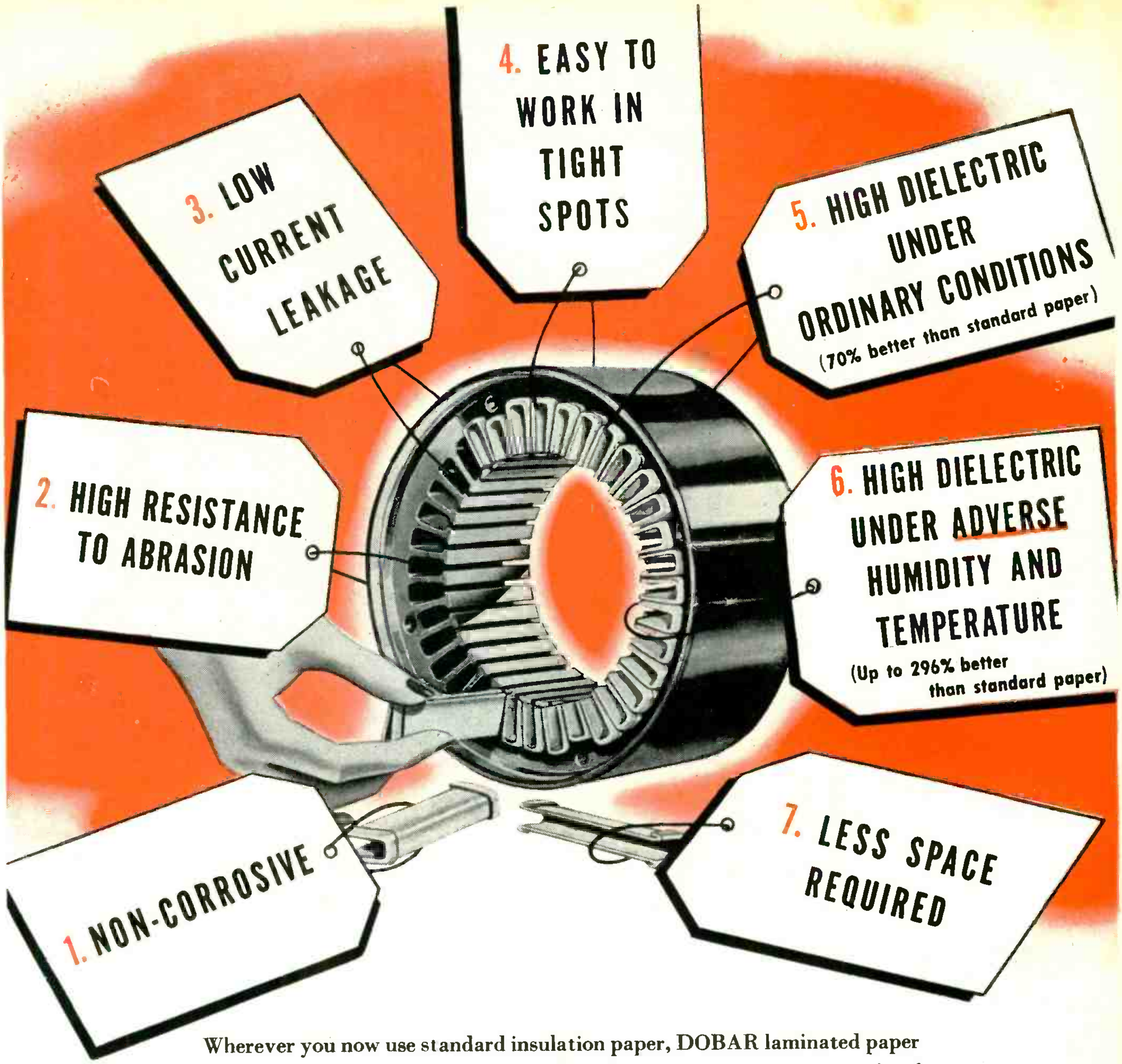
Whenever heavy alternating currents are controlled at the Tung-Sol Lamp Works, Transtats are put on the job. Tung-Sol builds quality into tubes with the help of Transtats used for Life Testing, Aging and Induction Heating.

To provide the unusual ruggedness and close control needed for this work, the Transtat Commutator is ground out of the periphery of the coil—where the wires are flat and parallel. This produces a glass-smooth, broad brush track. It permits a longer, cooler running brush, prevents arcing and jumping and provides practically stepless control. A transformer-type regulator, the Transtat will not distort wave form, interfere with radio reception or disturb power factor. State rating required when writing for bulletin.

AMERICAN TRANSFORMER COMPANY
178 Emmet Street   Newark 5, N. J.

AMERTRAN
REG. U. S. PAT. OFF.
MANUFACTURING SINCE 1901 AT NEWARK, N. J.

Pioneer Manufacturers of Transformers, Reactors and Rectifiers for Electronics and Power Transmission



Wherever you now use standard insulation paper, DOBAR laminated paper offers you seven extra advantages. They all sum up to a greater margin of safety, space-saving and ease of application. Send for samples and check DOBAR'S superior insulation and processing qualities for your products.

DOBAR insulation is a permanent lamination of cellulose acetate film to standard insulation paper. Made by the makers of LEXEL and DOPLEX insulation tapes.

TRADE-MARK

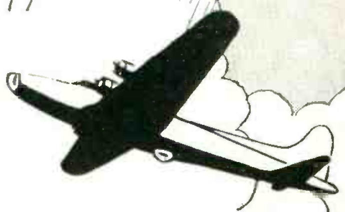
DOBAR *Insulation*

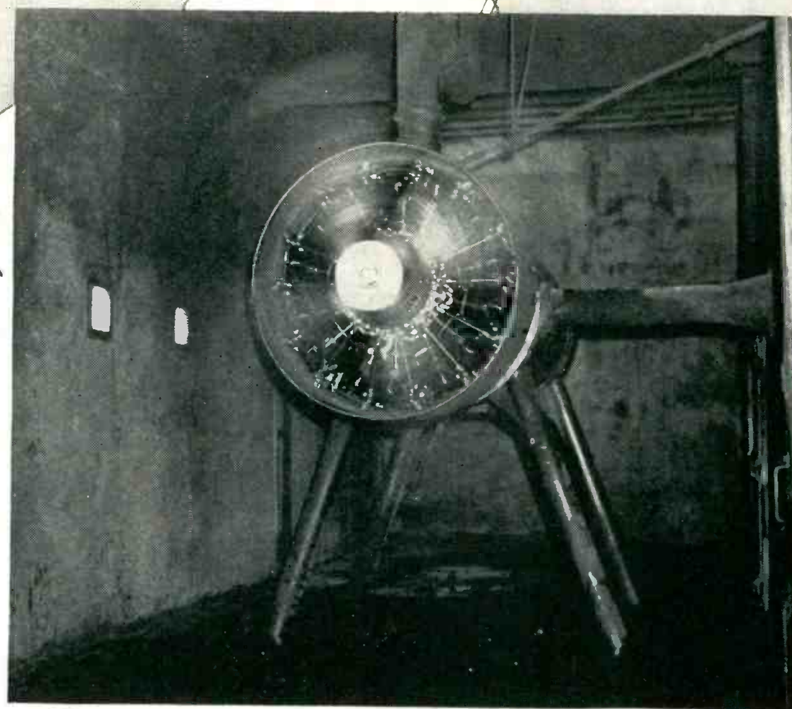
Another insulation product of THE DOBECKMUN COMPANY

Industrial Division . . . . Cleveland 1, Ohio

ARMY E NAVY CLEVELAND PLANT

STILL BETTER AIRCRAFT ENGINES BECAUSE OF WRIGHT AERONAUTICAL'S TEST TECHNIQUE BASED ON . . .





A Wright Cyclone engine running on the test stand. Electrical resistance strain gages affixed to various component parts and wired to the remote oscillographic equipment, serve to indicate stress and load under actual operating conditions.

DuMONT *Oscillography*

➧ *Write for literature.*

➧ What are the stress and load on various component parts during *actual operation!* The answer is vital in the design and development of aircraft engines.

Engineers of Wright Aeronautical Corporation use an electrical resistance gage and Wheatstone Bridge, in combination with the DuMont Type 208 Oscillograph, to secure a quick, accurate, explicit answer. They report:

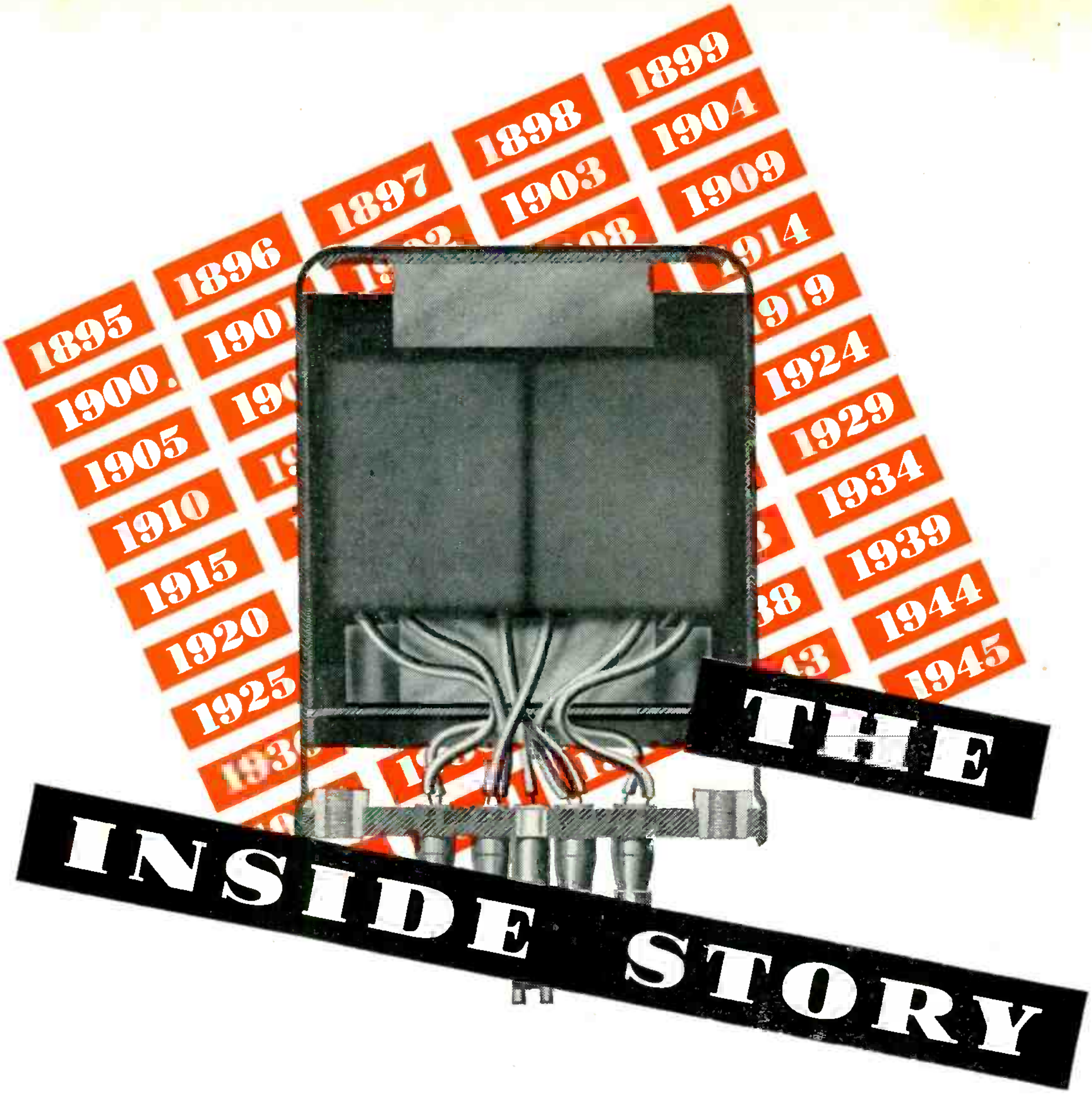
"With this monitoring means, both amplitude and wave form are easily observed. The oscillograph allows immediate observation of sharp changes in amplitude such as occur with relatively undamped resonant phenomena which may be troublesome. Such conditions may thus be recognized quickly and, if necessary, the test procedure adjusted to allow for closer investigation in the critical range.

"Simultaneously, changes in wave form can also be ascertained. Points at which changes in wave form occur may be quickly observed and given closer study. Also, the observer can detect any erratic circuit operation or malfunctioning associated equipment."

This simple technique saves time and money in aircraft engine development. Doubtless other applications of DuMont Oscillography can do a comparable job for you.

DUMONT *Precision Electronics & Television*

ALLEN B. DUMONT LABORATORIES, INC., PASSAIC, NEW JERSEY •



A background of *Performance* – over 50 years – is the *inside story* of the popularity that has brought leadership to *Thordarson* transformers. Performance over the years, after all, is the only true test of product quality.

Consumer acceptance will continue because *Thordarson* research and design engineers are never satisfied just keeping abreast of the times. These men are continually developing many transformer components which are instrumental in the production of new and better performing devices and equipment for the electronics industry.

This same pioneering spirit has been responsible for many new *Thordarson* transformer applications and developments during the war . . . all of which will be available shortly for civilian requirements.

Thordarson's well-tested methods of sales promotion and distribution will continue their joint task of making *Thordarson* Transformers, together with complete information on their applications and use, available to everyone in the field.

Always think of Thordarson for top-notch transformers!

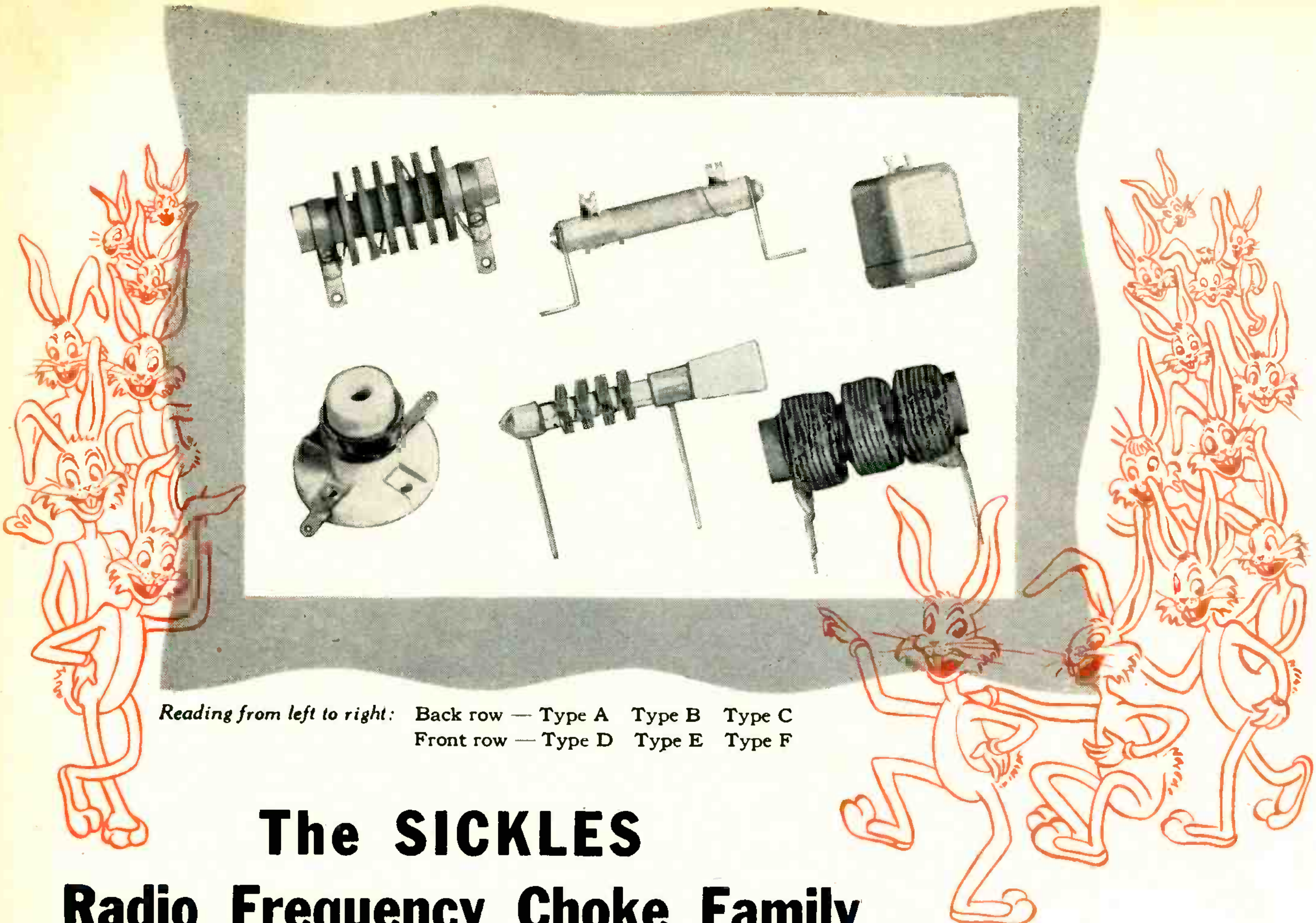
500 WEST HURON ST., CHICAGO, ILL.

ORIGINATORS OF TRU-FIDELITY AMPLIFIERS

THORDARSON

ELECTRIC MANUFACTURING DIVISION

MAGUIRE INDUSTRIES, INCORPORATED



Reading from left to right: Back row — Type A Type B Type C
Front row — Type D Type E Type F

The SICKLES
Radio Frequency Choke Family

It just GROWS and GROWS and GROWS!

There doesn't seem to be any end to the Sickles Radio Frequency Choke Family. For, in addition to producing a wide range of chokes for stock, we manufacture chokes exactly to the customer's specifications. This service, made possible through years of experience, often enables us to assist engineers in their problems.

Only a very few members of the Choke Family are in the family portrait for it would be impossible to cram the hundreds of chokes into one picture. The following is a brief description of those illustrated:

Choke A — Multi-pie type, for current ratings up to 500 M.A.
Choke B — The solenoid type of winding, for ultra-high frequency ranges.
Choke C — Wound on iron cores, has an advantage when size and relatively high efficiency are required.
Choke D — Wound on ceramic cores, this type is designed for general receiver use.
Types E & F — Two of the variations of the "A" type choke. These are used where the current is heavy and a low D.C. resistance winding is required.

There are special high-voltage chokes and there's a whole family of midget chokes. Daily, chokes are made to answer individual design and specification. The family is still growing.

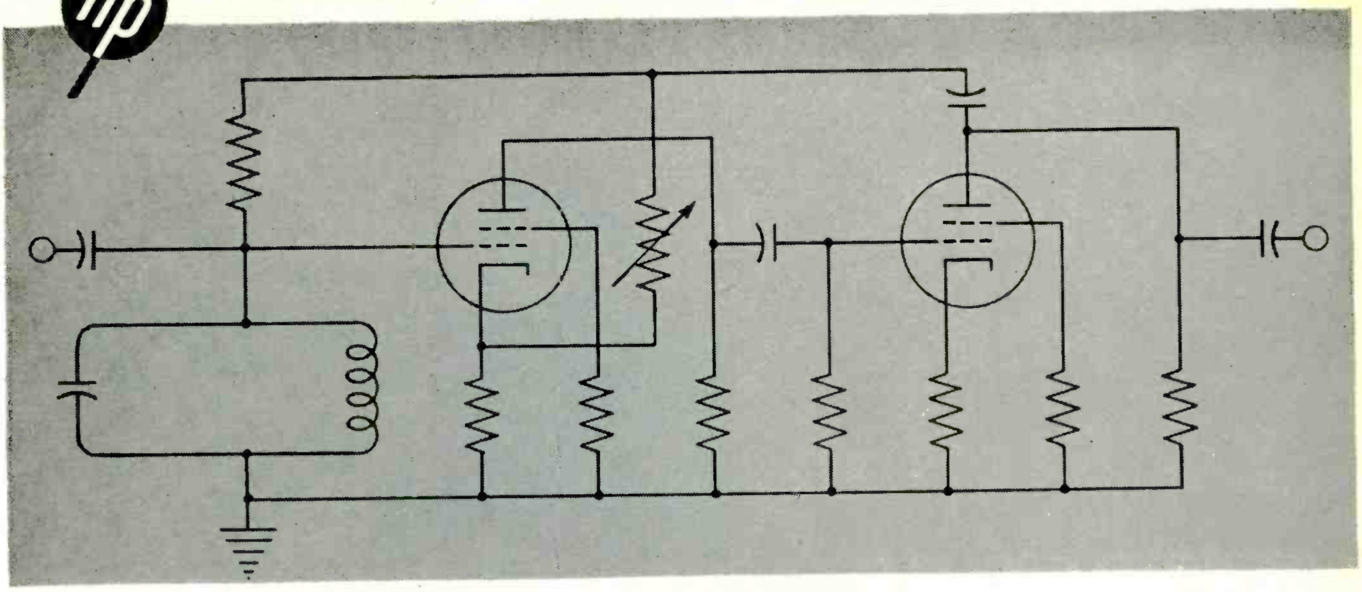
Write today for more complete information on the Sickles Radio Frequency Choke Family.

THE F. W. SICKLES COMPANY, CHICOPEE, MASSACHUSETTS

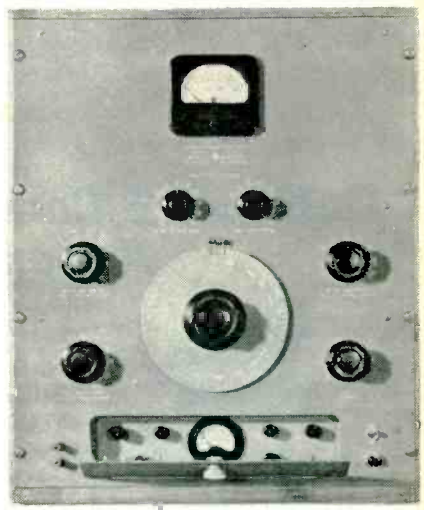
SICKLES

Radio and Electronic Specialties for Today and Tomorrow

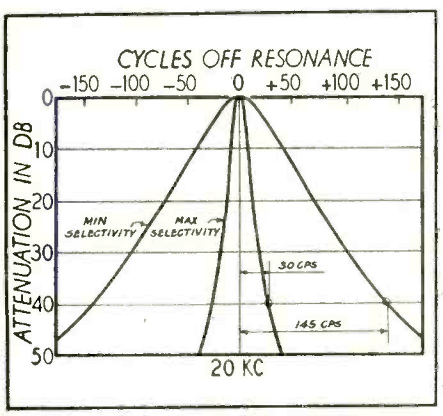
LABORATORY INSTRUMENTS FOR SPEED AND ACCURACY



The High—and Variable "Q" of This Circuit Means Rapid, Accurate Wave Analysis



This -*hp*- Harmonic Wave Analyzer measures the individual components of complex waves with speed and surety, because of the highly efficient composite circuit shown above. The variable selectivity of the amplifier is the factor which makes it especially useful for measurements at higher frequencies. Regeneration is used to give the amplifier a high effective "Q," and a degeneration control provides variable selectivity. The resulting performance of this circuit is shown in accompanying graph.



In practical terms, variable selectivity means no tedious "searching out" of the harmonics to be measured. Yet the fingertip control is easy to manage. This characteristic makes the -*hp*- Harmonic Wave Analyzer useful for many applications where constant selectivity would be unsuitable. Variable selectivity is required in measuring distortion of sound on recorded film, disks and other cases where there may be a small amount of frequency modulation. It is also used in integrating the noise spectrum in acoustic measurements and elsewhere when a wider pass band gives a more representative integration.

The -*hp*- Harmonic Wave Analyzer covers the audio spectrum from 30 to 16,000 cps. There is likewise a wide voltage range; full scale voltmeter readings may be obtained with inputs of .001 to 500 volts. Thus the 300A may be used with equal success with low output recording devices and high power modulating amplifiers. Other features which make it unexcelled for both laboratory and production testing are the linear meter scale, fully protected against overloads, and the built-in calibrating system to standardize voltage measurements. With the stability, accuracy, flexibility and ease of operation of the Harmonic Wave Analyzer, Hewlett-Packard continues to set a new standard. 1119

HEWLETT-PACKARD COMPANY

BOX 1119 • STATION A • PALO ALTO, CALIFORNIA

Audio Frequency Oscillators *Signal Generators* *Vacuum Tube Voltmeters*
Noise and Distortion Analyzers *Wave Analyzers* *Frequency Meters*
Square Wave Generators *Frequency Standards* *Attenuators* *Electronic Tachometers*

These -hp- Representatives Are at Your Service

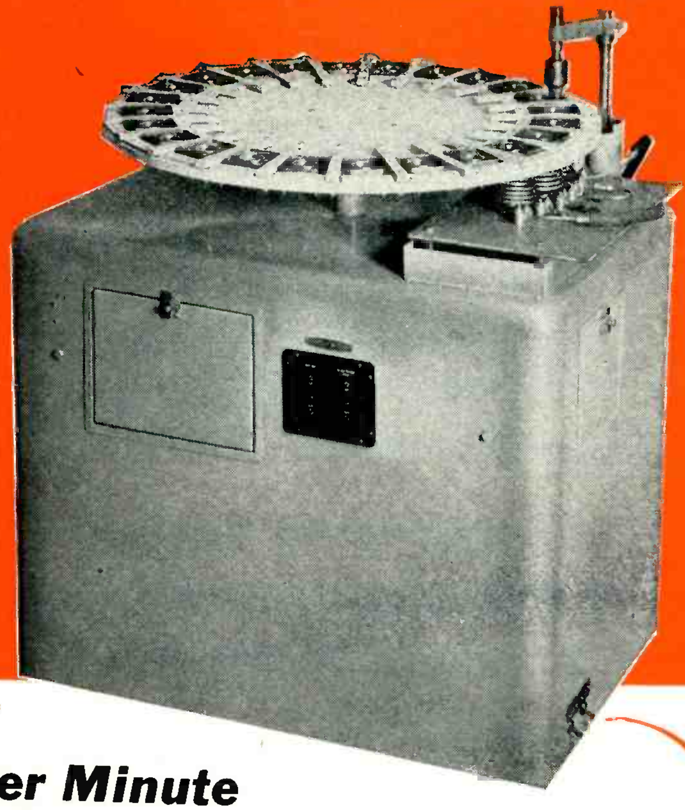
Eastern Representative:
Burlingame Associates, Ltd.
11 Park Place
New York 7, N. Y.—Worth 2-2171

Midwestern Representative:
Alfred Crossley
549 West Randolph Street
Chicago 6, Illinois—State 7444

Western Representative:
Norman B. Neely Enterprises
7422 Melrose Avenue
Hollywood 46, California—Whitney 1147

Canadian Representative:
Atlas Radio Corporation
560 King Street West
Toronto 2, Canada—Wa 4761

ELECTRONIC BRAZING UNIT *with* 24 Station INDEXING Work Carrier



Delivers 5 Complete Assemblies Per Minute

HERE'S a striking example of how Scientific Electric Engineers increased brazing production output by designing a special automatic machine to operate in conjunction with Electronic heating.

A manufacturer of weather-proof control box covers was already using electronic heat to speed up production in the brazing operation involved. But greater production was urgently needed. Each assembly was being inserted and removed from a single heater coil . . . one at a time.

To increase output Scientific Electric engineers designed this compact circular, 24 station indexing work carrier which operates from the 18 KW electronic generator at the left.

The operator merely loads the stations as they come around empty. Heat is applied by three water-cooled induction coils under three of the work positions. The coils are followed by the vertically operating ejecting mechanism and a complete assembly is ejected from the carrier each 12 seconds.

The carrier, which is operated by a small motor can be applied to any of our electronic generators depending upon the heat input requirements of the work to be handled. Normal output of the unit illustrated is at 200 to 600 kc.

Workpiece output up to 20 per minute can be obtained and carriers, custom tailored to your requirements, can be delivered within 30 days. Send us your requirements today.

Scientific Electric Electronic Heaters are made in these power sizes... and a range of frequencies up to 300 Megacycles depending upon power requirements.	3 KW	18 KW
	5 KW	25 KW
	7½ KW	40 KW
	8 KW	60 KW
	10 KW	80 KW
	12½ KW	100 KW
	15 KW	250 KW

Scientific Electric

Division of

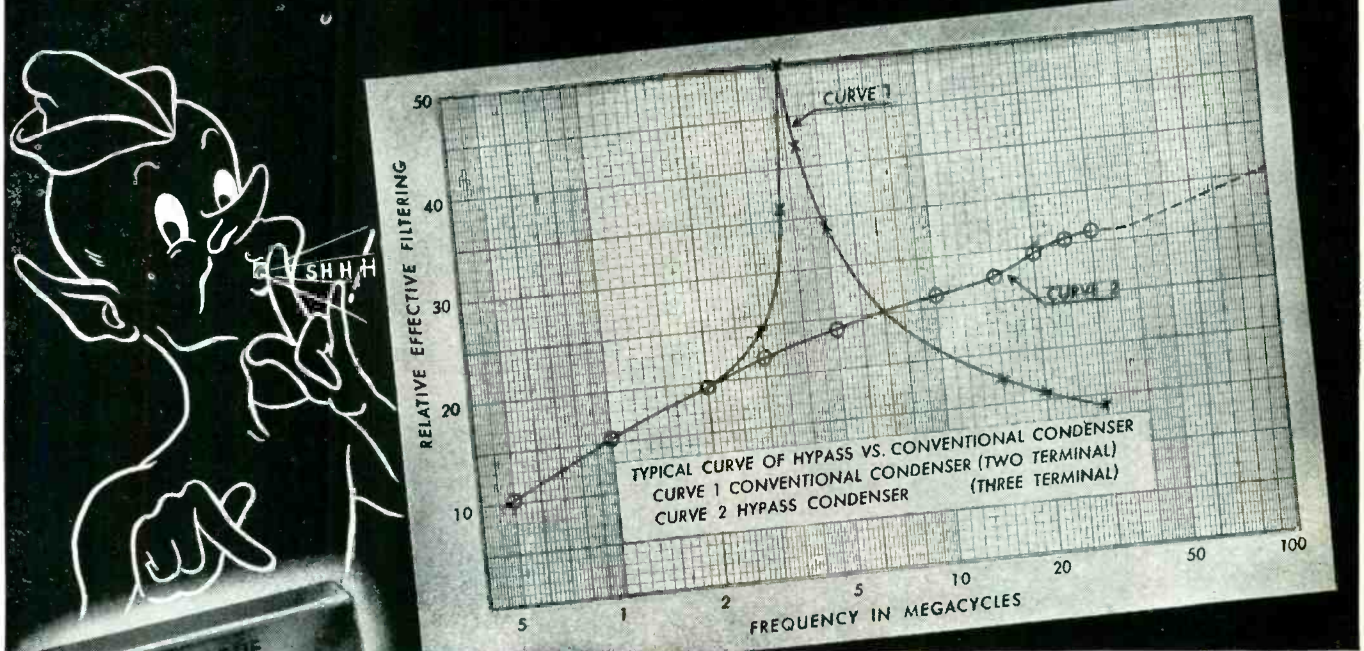
"S" CORRUGATED QUENCHED GAP COMPANY

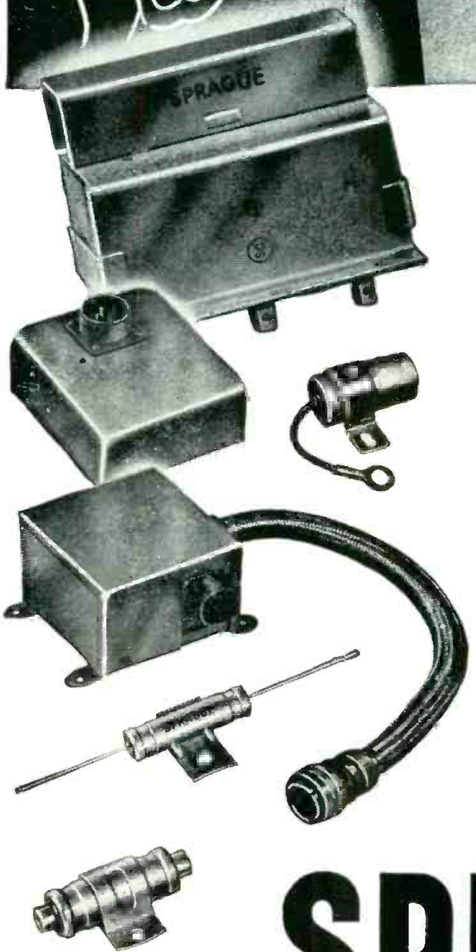
119 MONROE ST. GARFIELD, N. J.

Manufacturers of

Vacuum Tube and Spark Gap Converters Since 1921

RADIO INTERFERENCE ?





SPRAGUE HAS *the Answers!*

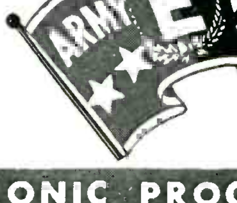
From inexpensive noise suppression capacitors for automotive use, to heavy-duty designs for service on power equipment, and for current ratings from 5 to 200 amperes capacity, Sprague produces modern filter units for practically any need. An unsurpassed background of engineering experience in dealing with all types of radio noise interference problems, is here at your disposal. Write for Sprague Capacitor Catalog 20.

ANTI-RESONANT FREQUENCY PROBLEMS SOLVED

Have you a vibrator "hash" problem that a conventional by-pass capacitor shunted by a mica capacitor only partially solves? Write for details on Sprague *HYPASS Capacitors, the 3-terminal networks that do the job at 100 megacycles or more!

SPRAGUE ELECTRIC COMPANY *Trademark Reg. U. S. Pat. Off.
North Adams, Mass.

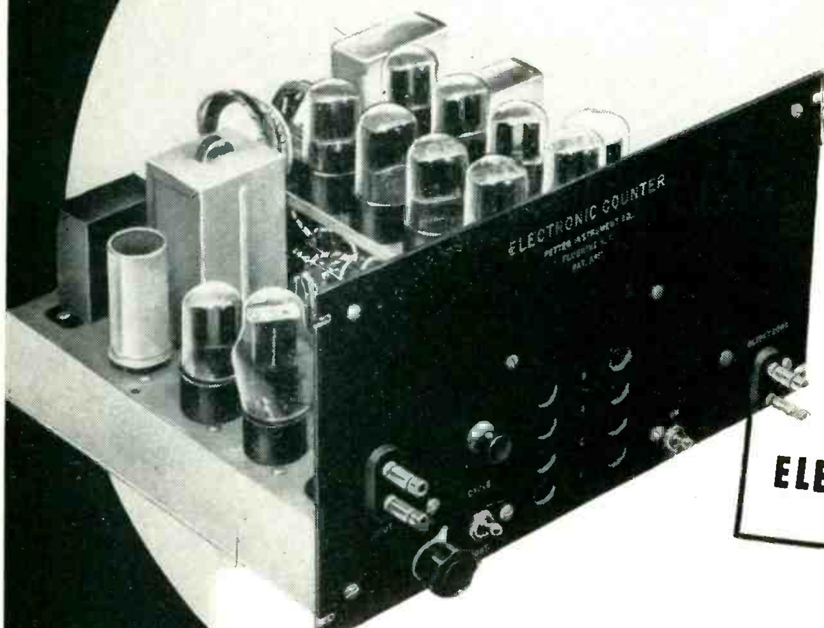
SPRAGUE



5-Times Cited for Distinguished Wartime Service

PIONEERS OF ELECTRIC-ELECTRONIC PROGRESS

A New and Better High Speed Counting Method...



Potter

TWO DECADE ELECTRONIC COUNTER

A versatile, efficient instrument for use as a counter, timer, interval controller, radiation counter, and many other applications

- The Potter Two-Decade Electronic Counter is especially well suited for counting rates exceeding 10 cycles a second, a speed generally too fast for conventional counters.
- For continuous high speed operation, it will readily replace those mechanical counters that cannot stand up under such conditions.
- Another use for this versatile and efficient instrument is counting and calibration of cycles in resistance welding operations.
- It may also be used as an interval timer by connecting it through a switch to a known external frequency; readings are observed in terms of the number of cycles of the known input frequency.
- We can install dial switches on this unit to make it predetermining. It then becomes useful in a number of control applications.

The Potter Two-Decade Electronic Counter operates from a 60 cycle, 105 to 125 volt line, at speeds up to 1000 cycles a second. Each decade divides by 10, giving a scaling factor of 100. A telephone-type relay, whose contacts close once for each 100 input cycles, is connected to output terminals. An electro-magnetic counter may be added to this output to extend the count to as many places as desired. It uses 11 tubes. Delivery now in 60 days. *Additional details will be forwarded promptly.*

Other counter products are – RADIATION COUNTERS which resolve repetition rates of well over 2.5 microseconds; **PREDETERMINED COUNTERS** using several decades for control of industrial processes requiring a rapidly repeated operation to occur after a predetermined number of counts; **COUNTER CHRONOGRAPHS** for measuring projectile velocities to accuracies of one part in 10,000; **INTERVAL GENERATORS** that generate a predetermined time interval from 10 microseconds to 10 seconds in 999,999 steps of 10 microseconds.

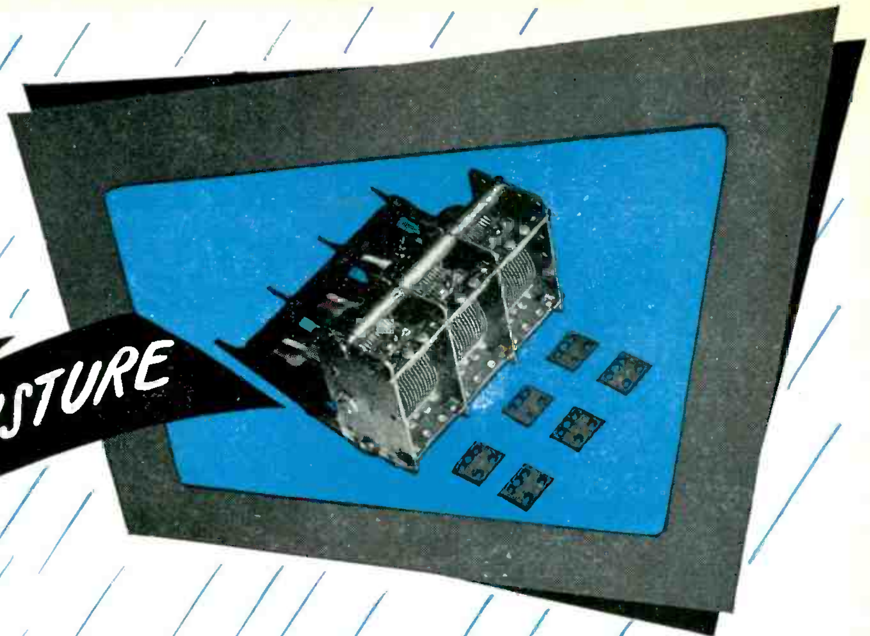
INSTRUMENT Potter COMPANY

ELECTRONIC COUNTER PRODUCTS...

136-56 ROOSEVELT AVENUE FLUSHING, NEW YORK

Resistant to moisture and humidity changes, Phenolite used as stator insulation helps this radio condenser perform uniformly under varying climatic conditions.

RESISTS MOISTURE



Low moisture absorption of PHENOLITE improves performance of your product

In the electrical industries, Phenolite laminated Bakelite finds widespread use because of its extreme resistance to moisture and changing humidities . . . its ability to reduce dimensional changes and variations in electrical properties to a minimum.

This desirable quality accounts for its use where a tough, machinable insulation is demanded. But, because of its rare *combination* of outstanding properties, it is also readily adaptable for many more industrial applications. Light in weight (about one-half that of aluminum), it is exceptionally resilient and high in impact strength . . . is resistant to abrasion . . . possesses good machinability . . . resists heat and moisture . . . and is not affected by solvents and oils.

Find out now some of the many ways this versatile material may serve you profitably in your peacetime plans and products. Write for full information and the assistance of one of our trained engineers.

NATIONAL VULCANIZED FIBRE CO.

Offices in Principal Cities **Wilmington 99, Delaware**

Meet your UNITED CINEPHONE *Field Engineer:*

We are proud of our Manufacturers' Representatives.

They are also competent Electronic Engineers ready to advise and co-operate on the application of Electronics to industry. Present your problem to your nearest representative. It will receive prompt attention.

CALIFORNIA
Signal Electric Company
336 South San Pedro Street
Los Angeles, California
Att.: Mr. W. W. Brunick
Tel.: Michigan 6314

COLORADO
A. J. Nelson Company
Box 2244
Denver, Colorado
(Also covers N. & S. Dakota, Wyoming, Nebraska, Nevada, Utah, Kansas, Arizona & New Mexico)

CONNECTICUT
Industrial Sound & Electronics Corp.
333 Trumbull Street,
Hartford 3, Connecticut
Att.: Mr. A. K. Staunton, President
Tel.: 2-3121
(Also covers Rhode Island and Western Massachusetts)

GEORGIA
Walter V. Gearhart
1067 Stovall Boulevard, N. E.,
Atlanta, Georgia
Tel.: Cherokee 5836
(Also covers Alabama, Florida, No. & So. Carolina, Mississippi & Tennessee)

ILLINOIS
Harry Halinton
612 North Michigan Avenue
Chicago 11, Illinois
Tel.: Sup. 0796
(Also covers Iowa, Minnesota, Wisconsin, Northern Michigan & Lake County, Indiana)

INDIANA
Law Instrument Company
Box 95
Angola, Indiana
Att.: Mr. Ted Law
Tel.: 408-J
All Indiana except Lake County. (Also Southeast Michigan & Northwest Ohio.)

MASSACHUSETTS
Holliday-Hathaway Sales Company
176 Federal Street
Boston, Massachusetts
Tel.: Hancock 9240
(Eastern Mass., and all of Vermont, New Hampshire and Maine)

MICHIGAN
Carman Adams
15476 James Couzens Highway
Detroit, Michigan
Tel.: University 3-9100
Southern Michigan

MISSOURI
Mr. Carl P. Lohr
5579 Pershing Avenue
St. Louis 12, Missouri
Tel.: Rosedale 0150
(Also covers southern Illinois)

NEW YORK
Kahant Associates
11 Park Place
New York, New York
Att.: Mr. E. M. Squire
Tel.: Courtland 7-5326
(Covers eastern New York including the counties of Onondaga & Northern Jersey)

PENNSYLVANIA
James T. Castle
424 First Avenue
Pittsburgh 19, Penna.
Tel.: Court 1957
(Western Penna. and all West Virginia)

Mr. Herbert K. Neuber
1207 Race Street
Philadelphia 7, Penna.
Tel.: Spruce 2125
Eastern Penna. (Also Delaware, Maryland and Southern New Jersey)

TEXAS
Edward F. Aymond Company
3235 McKinney Avenue
Dallas 4, Texas
Tel.: Lakeside 1022
(Also covers Arkansas, Louisiana, Oklahoma and Northern Texas)

Power Equipment Company
Amusu Building
Corpus Christi, Texas
Att.: Mr. K. K. Kalb
Tel.: 1305
(Southeastern Texas)

WASHINGTON
Jas. J. Backer Company
2321 Second Avenue
Seattle 1, Washington
Att.: Mr. Jas. J. Backer
Tel.: Main 8811
(Also covers Idaho, Montana, Oregon, British Columbia and Alaska)

CANADA
Frederick C. Baker Company
229 Yonge Street
Toronto 1, Canada
Tel.: Elgin 4525
(All Canada but British Columbia)

All communications relative to business outside of the United States and Canada should be addressed to our Export Representatives:
ROCKE INTERNATIONAL CORP., 13 East 40th St., New York 16, N. Y.

UNITED CINEPHONE CORPORATION

20 NEW LITCHFIELD STREET, TORRINGTON, CONNECTICUT

Here's the easiest way to get 10 WATTS OUTPUT at 156 Mc!

Build your Xmtr around HK-24G *Gammatrons*

JAN 3C24

Designing transmitters for the 152 to 162 megacycle region can be greatly simplified through the use of HK-24Gs. In the circuit below one of these tubes produces 10 watts at 156 Mc; more than ample to excite a pair of HK-257Bs in a 400 watt final.

These efficient Gammatrons, with low inter-electrode capacities and short plate and grid leads, are the answer for those who are engineering 1.9-meter equipment for railroads, police point-to-point, fire, press or broadcast relays, maritime, geophysical, urban telephone, and experimental use. They are also ideally suited for amateur transmitters on the 144-148 megacycle band, authorized as of November 15.

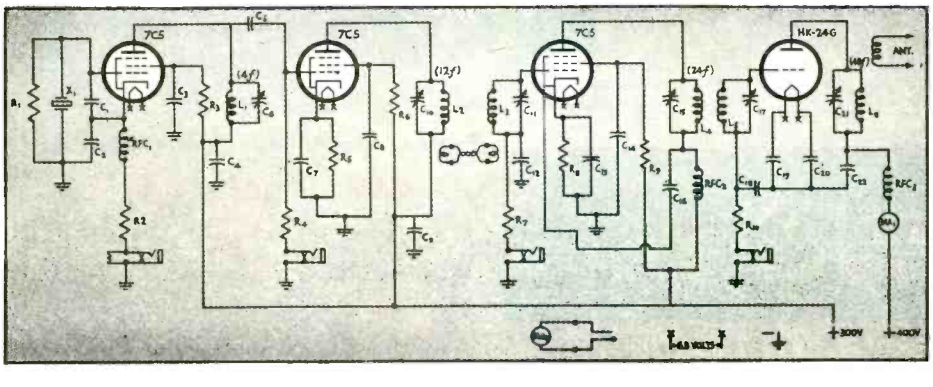
Not only will HK-24Gs do the job, but they will do it at low cost. Made with tantalum elements, without internal insulators, they can withstand heavy overloads and have a long operating life. And they are offered at a new low price made possible by improved production methods.

HK-24Gs are available now in quantity . . . and are one of Heintz and Kaufman's *standardized* types. Maximum plate dissipation 25 watts. Write today for data.

Now

ONLY $6.00

HEINTZ AND KAUFMAN LTD.
SOUTH SAN FRANCISCO - CALIFORNIA
EXPORT AGENTS: M. SIMON & SON CO., INC., 25 WARREN STREET, NEW YORK CITY, N. Y.



COMPONENT PARTS FOR WIRING DIAGRAM

C_1—35 mmfd.
C_2—250 mmfd.
C_3, C_4, C_7, C_8, C_9, C_{12}, C_{13}, C_{14}—.002 mfd.
C_5—50 mmfd.
C_6—APC 100
C_{10}, C_{11}, C_{15}, C_{17}—APC 25 mmfd.
C_{16}, C_{18}, C_{22}—100 mmfd.
C_{19}, C_{20}—250 mmfd.
C_{21}—15 mmfd.
R_1—100,000 ohms, ½ watt
R_2—200 ohms, 1 watt
R_3—10,000 ohms, 1 watt
R_4—250,000 ohms, ½ watt
R_5, R_8—500 ohms, 1 watt
R_6, R_9—20,000 ohms, 1 watt
R_7—100,000 ohms, ½ watt
R_{10}—15,000 ohms, 2 watts
RFC_1—2.5 mh.
RFC_2,
RFC_3—Hf choke, approx. 50 turns No. 32 on ¼" form.
MA_1—0-100 ma.
MA_2—0-25 ma.
X_1—3.5 Mc. crystal
L_1—19 turns No. 22 DCC ⅜" form
L_2—7 turns No. 14 enamel, 3/16" dia. Length ¼" air, link
L_3 coupled to L_2 with one turn.
L_4—6 turns No. 14 enamel, dia. ⅜", length 7/16" air, inductively coupled on same axis.
L_5
L_6—4 turns No. 12 copper, dia. ⅜", length ⅜"

Note: Grid and plate by-passes on driver and doubler final should be returned directly to tube cathode. All jacks are closed circuit jacks.

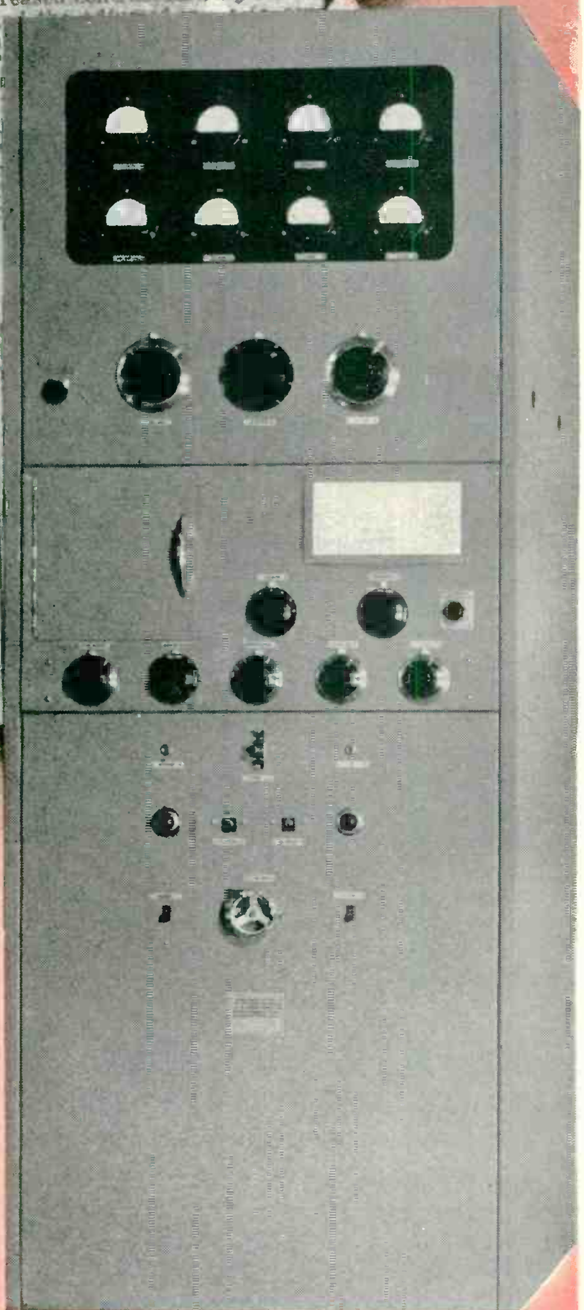
The "FIGHTING 400" by Press Wireless

Press Wireless 400/600 watt radio transmitters, keeping close to the battlefronts in the European and Pacific theatres, carried more than 15,000,000 words of news direct to America during the war.

Installed in U. S. Army trucks which rolled with the troops to victory through Normandy, France, Belgium, Holland and Germany, Press Wireless "Fighting 400's" withstood the rigors of thousands of miles of rough travel and maintained the highest average transatlantic radio transmission speeds ever attained by transmitters of this type.

In the Philippines, another Press Wireless 400, operating as a fixed station, performed with equal brilliance in transpacific duty. The 400's were also used for voice and radiophoto transmission across the oceans.

The dependable operation of these units near the battlefronts and often under adverse conditions reveals the degree of serviceability built into the entire line of Press Wireless communication equipment...now available for commercial installations.



RADIO TRANSMITTER T.4CM1

- 400 watts—radiotelephone
- 600 watts—radiotelegraph
- Continuous Coverage—2,100 to 18,000 kilocycles
- Automatic Carrier Control for remote operation
- "MODUPLEX"*—simultaneous AM and FS modulation
- Flat A-F Response—150 to 10,000 c.p.s.
- High-speed Keying—electronic, frequency shift or relay
- Power Requirements—90/130, 200/240 volts; 40/60 cycles, single phase

*TRADE MARK

Engineering Bulletin Sent on Request

PRESS WIRELESS, INC.

Executive and Sales Office **1475 BROADWAY, NEW YORK 18**

Awarded to our Hicksville, L. I. plant for outstanding achievement in war production.

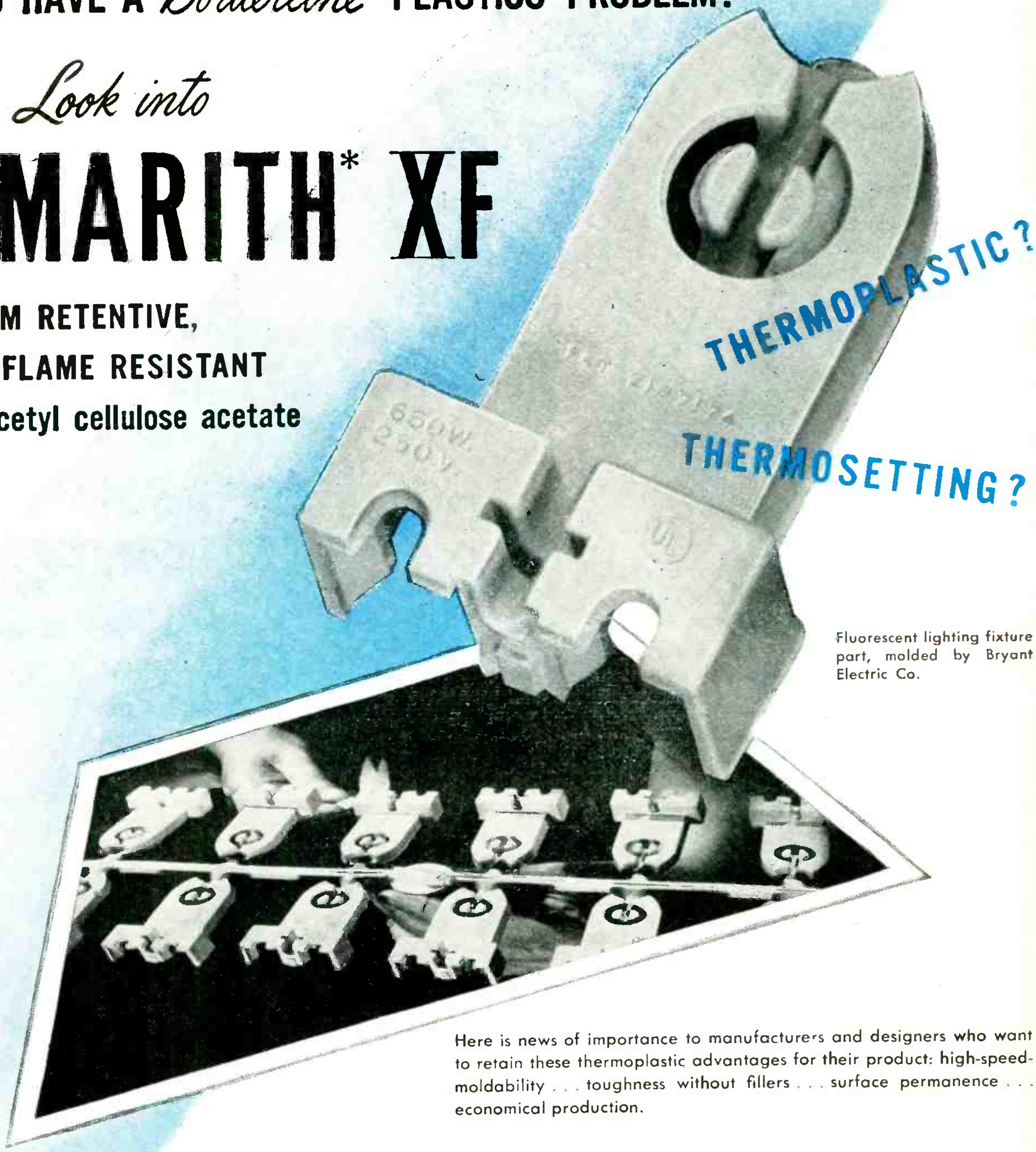
PARIS · BUENOS AIRES · RIO DE JANEIRO · MONTEVIDEO · MANILA · BERNE · SANTIAGO DE CHILE · NEW YORK · SHANGHAI · LOS ANGELES · LONDON · HAVANA

DO YOU HAVE A *"Borderline"* PLASTICS PROBLEM?

Look into

LUMARITH* XF

FORM RETENTIVE,
FLAME RESISTANT
high acetyl cellulose acetate



Fluorescent lighting fixture part, molded by Bryant Electric Co.

Here is news of importance to manufacturers and designers who want to retain these thermoplastic advantages for their product: high-speed moldability . . . toughness without fillers . . . surface permanence . . . economical production.

LUMARITH XF SERIES OF THERMOPLASTIC MOLDING MATERIALS, a new Celanese development, is providing the answer to many "borderline" plastics molding problems. These formulations are rated self-extinguishing when tested according to ASTM method D 635-41T, and show excellent form retention when subjected to heat and humidity. Giving high values for flexural and tensile strength, they offer ⅓ *greater resistance to cold flow* than standard formulations of cellulose acetate.

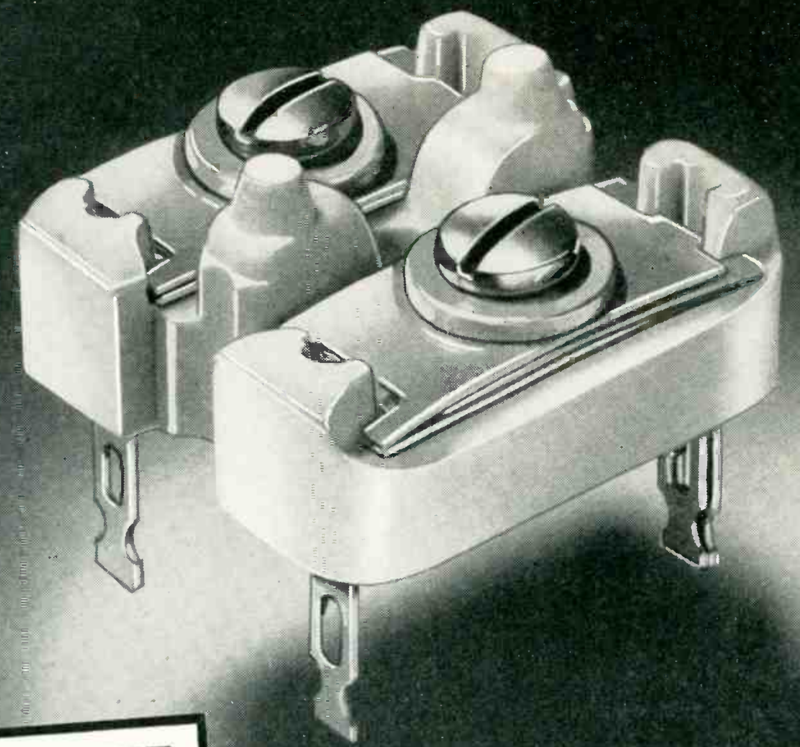
In the short time since its introduction, Lumarith XF has broadened the field of usefulness of the cellulosics tremendously—particularly in the electrical and allied fields where flame resistance and stability under load and heat are of prime importance.

If you are planning a product that you feel could be improved or more economically produced by thermoplastics, get in touch with the Celanese technical service staff for complete data on this new Lumarith plastic. Celanese Plastics Corporation, a *division of Celanese Corporation of America*, 180 Madison Avenue, New York 16, N. Y.

A Celanese Plastic*

*Reg. U. S. Pat. Off.

USE STANDARD PARTS—SAVE TIME AND MONEY



SAVE

For many years
Automatic has manufactured
Coils and Trimmers for manufacturers.

Our mass-production methods
will save you money and headaches.

Order your Coils and Trimmers from
people who "know how".

ARMY E NAVY

AUTOMATIC MANUFACTURING CORPORATION

MASS PRODUCTION COILS & MICA TRIMMER CONDENSERS

900 PASSAIC AVE. EAST NEWARK, N. J.

HERE'S WHY YOU SHOULD BUY A Thermatron ELECTRONIC DIELECTRIC HEATER

THERMATRON electronic heat generators are manufactured by a company which has made important contributions to the science of industrial electronics.

THERMATRON electronic heat generators are available in a size for every application involving non-metallic materials. They are ruggedly built to deliver consistent operation under exacting production standards.

THERMATRON electronic heat generators can help increase your output — lower your production costs — minimize rejects . . . and yet, they need no experienced help to operate them efficiently.

THREE OUTSTANDING Thermatron UNITS:

"The HEATMASTER"

Type K-5 — 5 KW. output. For plastics, sealing and other production purposes.

"The WELDMASTER"

Type K-1 — 1 KW. output. For sealing, laboratory or general purpose uses.

"The HEATMASTER, JR."

Type K-3 — 2½ KW. output. For pre-heating plastics, sealing, laboratory or general purposes.

Thermatron PLUS SERVICES

Field engineers supervise installation of units without additional charge.

THERMATRON engineers assist you on the solution to application problems.

Periodic check-ups are made, and emergency service is available.

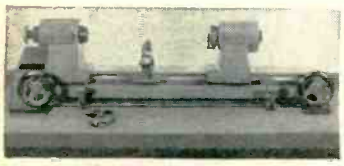
Write for new circulars—"Electronic Heating with the Thermatron"—and—"Electronic Heat-Sealing of Thermoplastics".

RADIO RECEPTOR COMPANY, INC.
251 WEST 19th STREET NEW YORK 11, N. Y.
SINCE 1922 IN RADIO AND ELECTRONICS

The Model K Lathe
Maximum length overall, 113"
Spindle hole diameter, 6⅞"

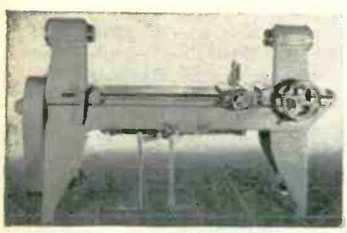
LITTON GLASS WORKING LATHES

Model C
The Vertical Sealing Machine



The Model F Lathe
Maximum length overall, 39"
Spindle hole diameter, 1-5/16"

The Model HS Lathe
Maximum length overall, 63½"
Spindle hole diameter, 2⅝"



The Model EE Lathe
Maximum length overall, 84"
Spindle hole diameter, 3⅞"

Litton Glass Making Lathes were developed for the purpose of bringing precision in glass to the vacuum tube industry, but applications outside of this industry are equally benefited.

Litton glass working equipment has been used by major oil companies in the fusing, shaping and building of glass oil installations. They have also been used in the Chemical, Physical and Metallurgical laboratories of large universities, and in private and industrial and government research organizations. Also by manufacturers of scientific glass apparatus, optical equipment, precision instruments, glassware and thermal containers.

Ranges of work vary from .020 to 35. inches in diameter.

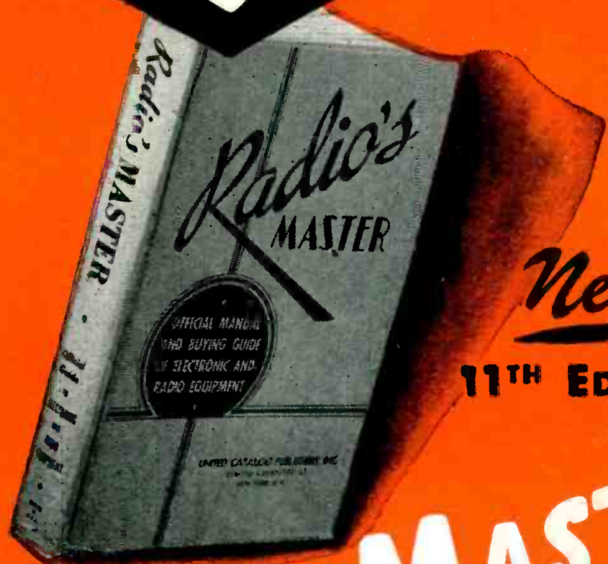
Wherever glass precision and production are important Litton equipment should be used. Send for catalog.

Litton

ENGINEERING LABORATORIES

REDWOOD CITY, CALIFORNIA, U. S. A.

FREE to Engineers & Purchasing Agents



New 11TH EDITION

RADIO'S MASTER

OFFICIAL SOURCE BOOK, COMPILED IN COOPERATION WITH MANUFACTURER'S GROUP

This valuable, 800 page source book, containing practically all the data you'll ever need on parts and equipment, sells regularly for $4.50.

It is available ***FREE*** of charge (and without obligation) to Engineers and Purchasing Agents connected with industrial organizations, laboratories, schools, government agencies, etc.

Jobbers all over the country now have limited quantities of RADIO'S MASTER for FREE distribution to authorized Engineers and Purchasing Agents.

Write us promptly on your business stationery and we will send you a list of the JOBBERS in your area who have RADIO'S MASTER available for you.

RADIO'S MASTER TELLS YOU:

What the product does, its specifications, comparable and competing items . . . Thousands of illustrations . . . Data covers 90% of all products in the industry, each item indexed and cross indexed.

Who makes it. Directory of manufacturers alphabetically listed, with page numbers for instant reference.

How much Prices on thousands of items, all clearly catalogued for easy buying.

Where you can get it. Your nearest sources that can supply your radio and electronic requirements. Saves time . . . Eliminates bulky files.

Write now for your copy

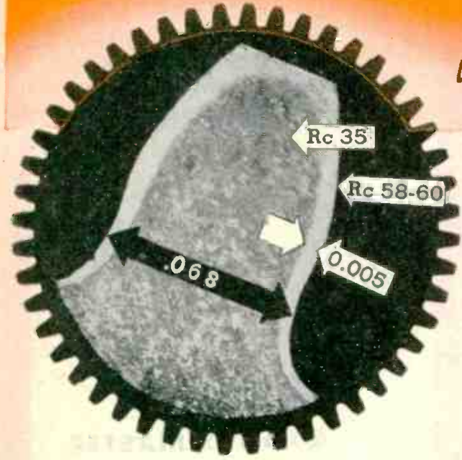
YOU'LL FIND IT *FASTER* IN RADIO'S MASTER

UNITED CATALOG PUBLISHERS INC.
106 Lafayette St. • New York 13, N. Y.

They're All Talking About It!

A New Thin Case Contour Hardening Job . . .

with MEGATHERM*



Thin case contour hardening of gear teeth with controlled depth of hardness has been made possible by the use of MEGATHERM induction heat.

The hardened surface completely follows the tooth and root contour of the gear with the core still in its original state, as shown plainly by this microphotograph. This 0.005 case was applied to gears of 24 D. P. —51 teeth—2.125 P. D.—2.208 O. D. and S.A.E. 4140 steel in 1/4 of 1 second with a 25 KW MEGATHERM—5 megacycle energy doing the job.

These long wearing contour hardened gears become an automatic production item with MEGATHERM.

Write *today* on your company letterhead for data on MEGATHERM.

Federal Telephone and Radio Corporation

*REG. U. S. PAT. OFF.

AN IT&T ASSOCIATE

Newark 1, N. J.

JENSEN RADIO MANUFACTURING COMPANY • 6607 SOUTH LARAMIE AVENUE, CHICAGO 38, ILLINOIS

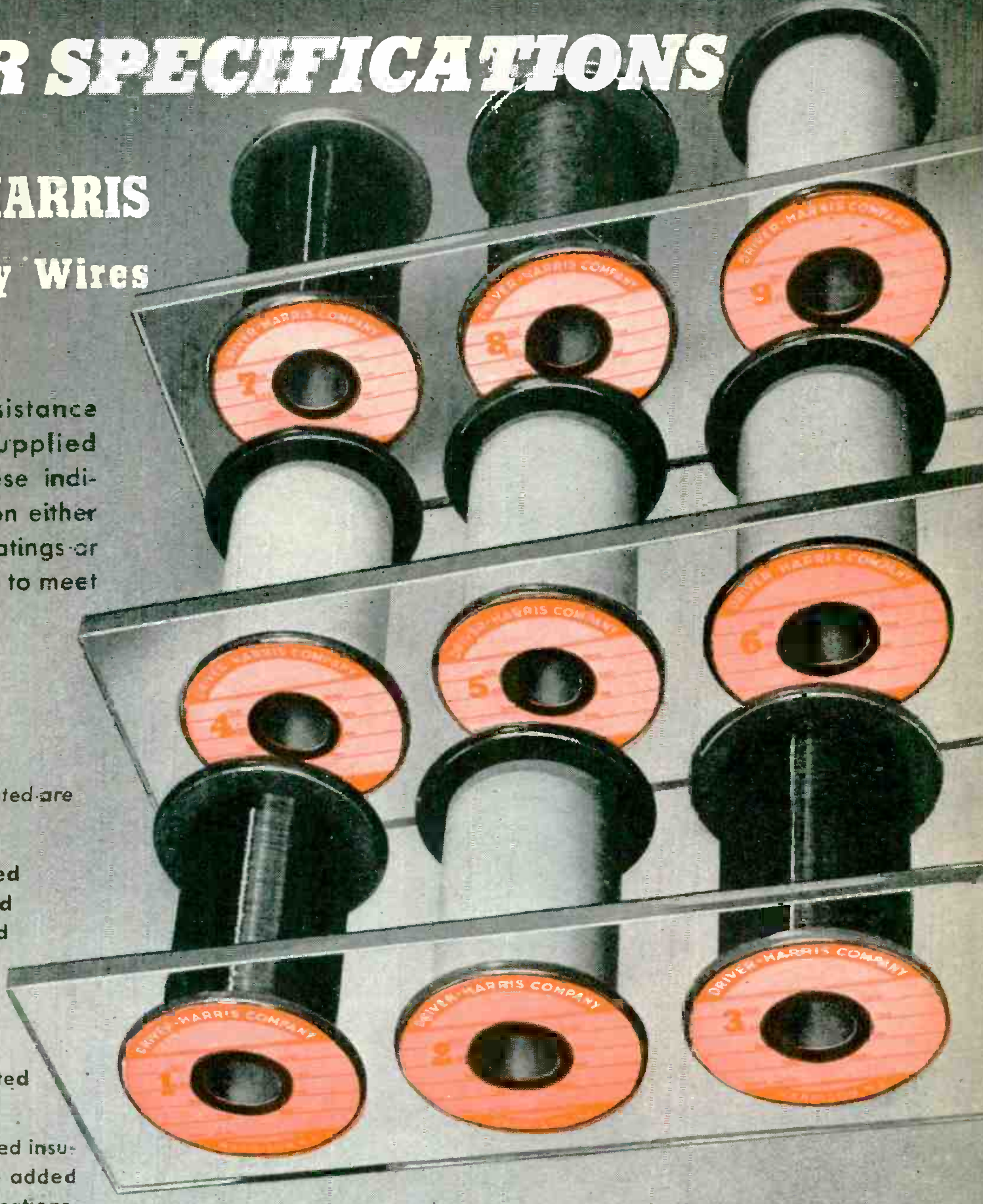
IN CANADA—COPPER WIRE PRODUCTS, LTD., 137 RONCESVALLES AVENUE, TORONTO

INSULATED

TO YOUR SPECIFICATIONS

ALL DRIVER-HARRIS

Resistance Alloy Wires



All Driver-Harris resistance alloy wires can be supplied to you with any of these individual types of insulation either in single or multiple coatings or in various combinations to meet special requirements.

The spools of D-H wire illustrated are insulated as follows:

1—Formvar Enamel Coated
2—Double Cotton Covered
3—Double Enamel Coated
4—Double Glass Coated
5—Single Silk Covered
6—Double Silk Covered
7—Enamel Coated
8—Resin Over Glass Coated
9—Single Cotton Covered

Additional technically advanced insulations now in research will be added to this list. Send us your specifications.

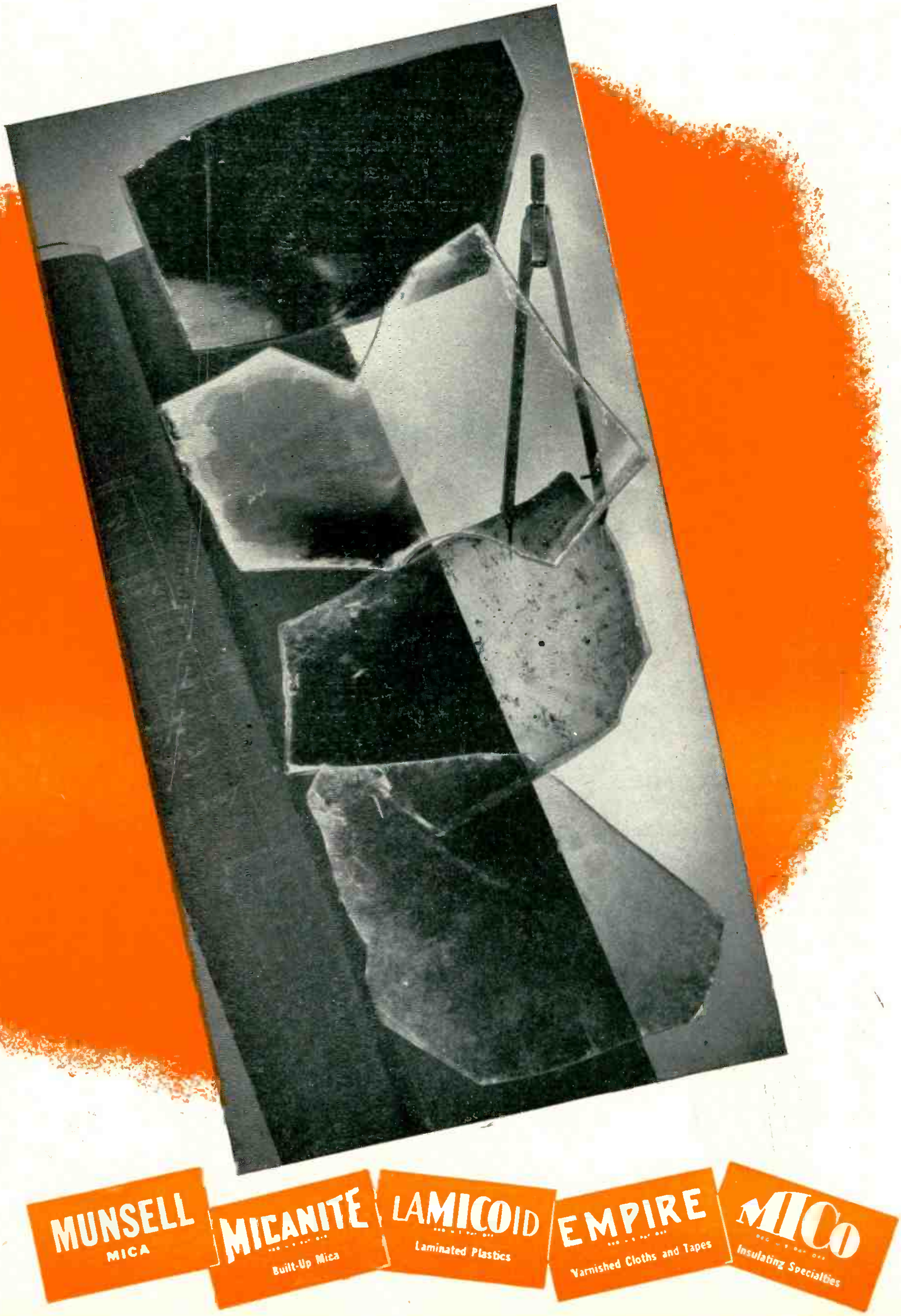
Famous for NICHROME*

Driver-Harris
COMPANY
HARRISON, N. J.

Branches: Chicago • Detroit • Cleveland
Los Angeles • San Francisco • Seattle

*Trade Mark Reg. U. S. Pat. Off.

What's *New* about



Mica Insulation?

Actually, there's nothing new about mica as a raw material. It possesses *all* the best qualities required of electrical insulation. And we use the same six grades of raw mica that we used over 50 years ago.

But there are many new things that we do with mica that make it an economical insulation to use over a wider range of applications. After mica is classified, split, built-up, and combined with other modern materials, new physical and electrical standards are provided. It is because of the improved standards that rotors and stators insulated with the Fiberglas* and mica, for example, can now withstand temperatures in excess of 250°C.

The proper selection of insulating materials including pure and built-up mica, laminated plastics, varnished fabrics and paper, insulating varnishes and compounds, is one of the most important considerations in the design and manufacture and performance of electric and electronic equipment.

Because Mica Insulator Company produces a complete line of insulation materials, you can obtain unbiased recommendations that will help solve your insulation problems.

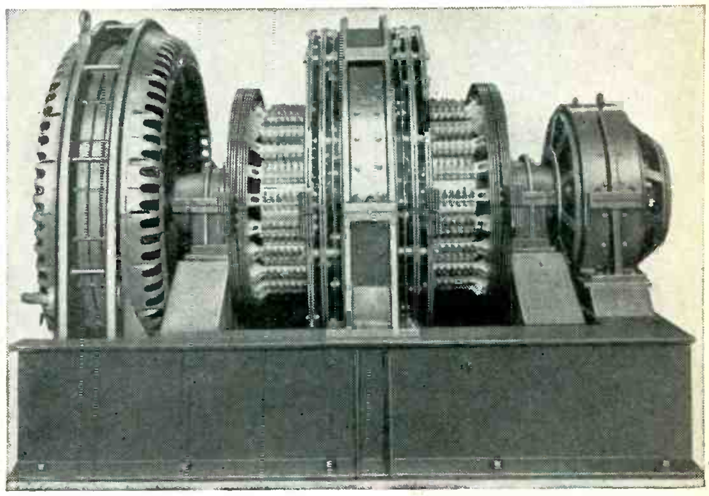
SALES OFFICES:

BOSTON • CINCINNATI • CHICAGO • CLEVELAND
DETROIT • HOUSTON • LOS ANGELES
NEW YORK • SAN FRANCISCO • SEATTLE

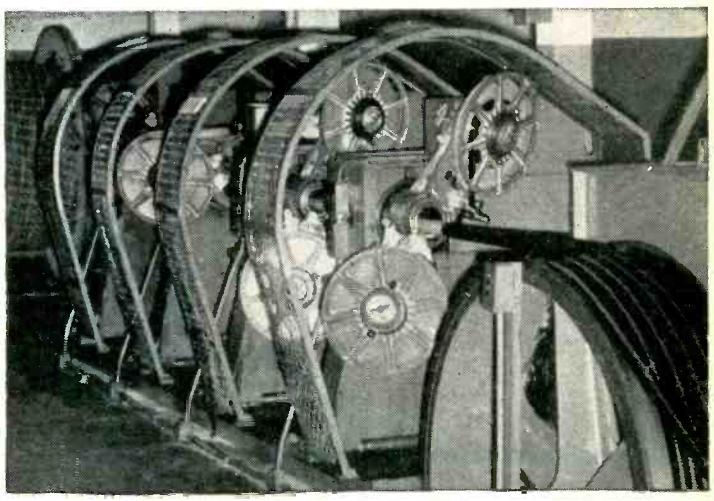
FACTORY:

SCHENECTADY, NEW YORK

*Reg. Trade-Mark Owens-Corning Fiberglas Corp.



Motor-generating set made by Hanson-Van Winkle Munning Co., utilizes Mica in the commutators, Micanite V-rings, Empire cloth and tape, for dependable insulation. The twin-commutator generator is rated 20,000 amperes, 9 volts.

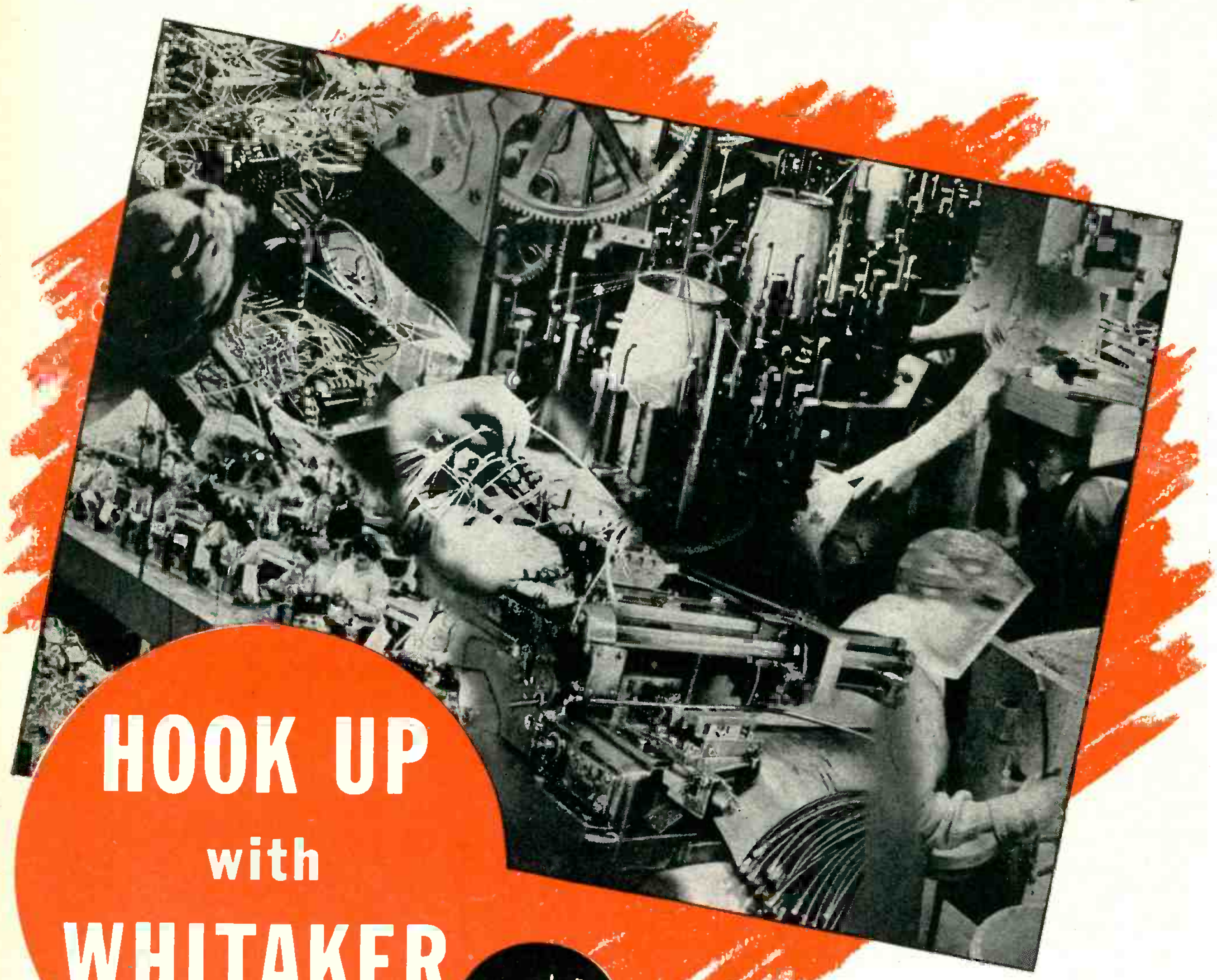


Cable wrapping machine in the plant of Collyer Insulated Wire Co., Inc., utilizes Empire straight-cut cable tape in the manufacture of their heavy-duty cable.

MICA *Insulator* COMPANY

200 VARICK STREET, NEW YORK 14, N. Y.

Does Your Product Require Electrical Wiring?



HOOK UP
with
WHITAKER

Whitaker Can Wire It

If your product requires electrical wiring—you'll find Whitaker to be a dependable source for WIRING HARNESSES . . . BONDING JUMPERS . . . CABLE ASSEMBLIES . . . CABLES or TERMINALS.

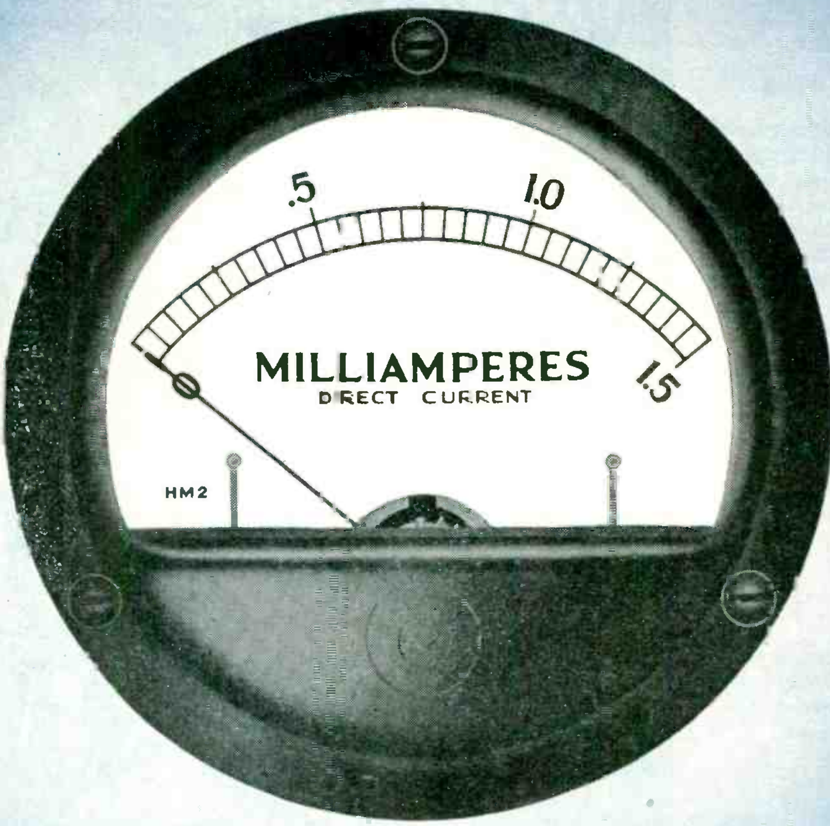
We are wiring *specialists* — and you have everything to gain by utilizing the full benefits of our 25 years of experience, our ample engineering and production facilities, trained manpower, exacting inspection, and the economies resulting from our use of modern methods, and special equipment . . . In addition to an engineered wiring service, Whitaker also offers a quality line of standard cable products. We cordially invite you to write us.

WHITAKER CABLE CORPORATION

General Offices: 1307 Burlington Avenue, Kansas City 16, Missouri
Factories: Kansas City, Mo. • St. Joseph, Mo. • Philadelphia • Oakland

Now Available

FOR ALL CIVILIAN USE...



...... AT NO MORE COST THAN STANDARD UNSEALED INSTRUMENTS

Marion Glass-to-Metal Truly Hermetically Sealed 2½" and 3½" Electrical Indicating Instruments

IMPROVED PRODUCT • APPEARANCE • PERFORMANCE • SALABILITY

Write for our 12-page brochure

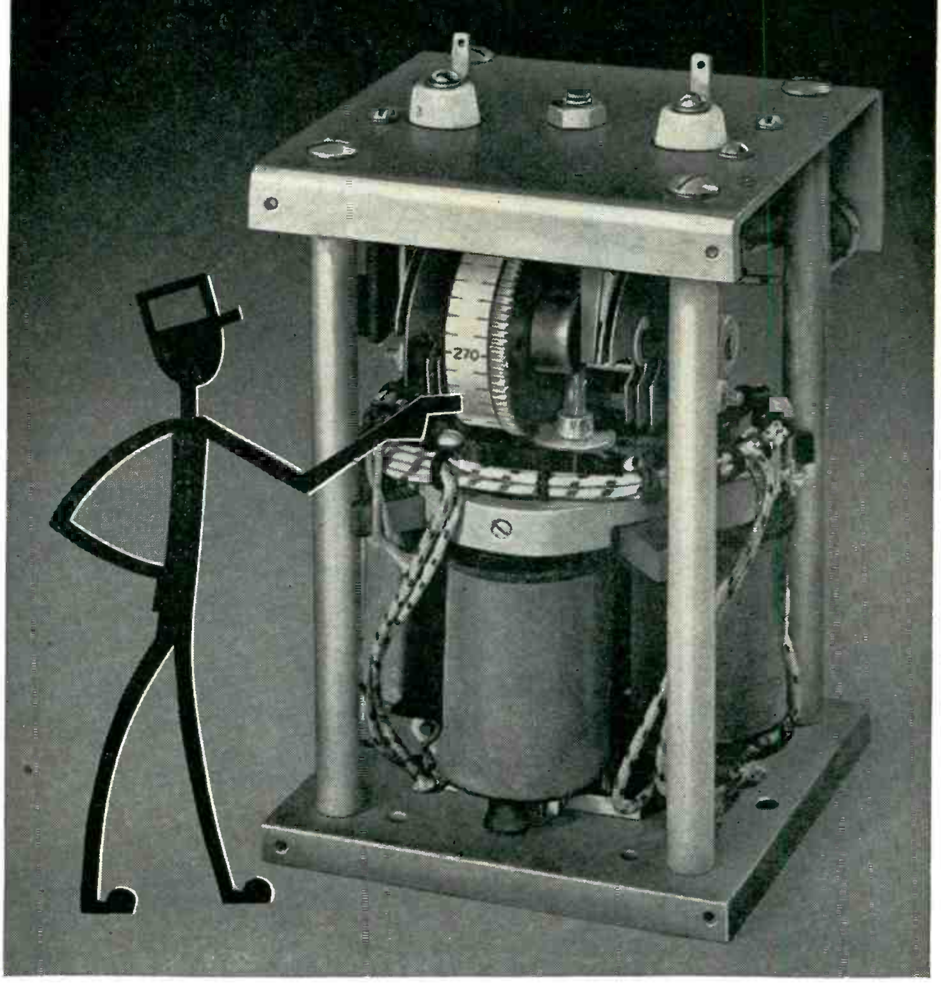
MARION ELECTRICAL INSTRUMENT CO.

MANCHESTER, NEW HAMPSHIRE

EXPORT DIVISION • 458 BROADWAY • NEW YORK 13, N. Y., U. S. A. • CABLES: MORHANEX

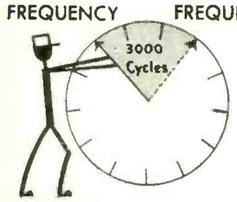
Western Electric

FM Frequency Watchman provides split-second control

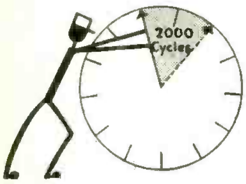


Let him show you what we mean!

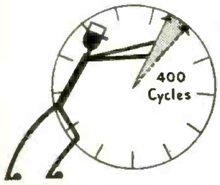
With the *Frequency Watchman* on guard, stability of the Western Electric *Synchronized* FM transmitter is governed by the stability of the low frequency crystal, which varies less than *25 cycles per million* for an ambient temperature range from 40° to 130° F. To demonstrate this split-second control, let's take an extreme case with a far greater deviation than would occur when the transmitter is on the air.



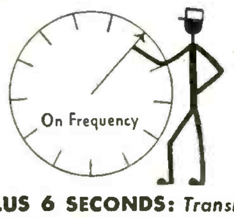
ZERO HOUR: *Starting up after a shutdown, transmitter may be 3000 cycles above or below assigned frequency.* **Frequency Watchman** *goes to work.*



ZERO PLUS 6/10 OF A SECOND: ***The Watchman****—in the fraction of a second—has reduced deviation to 2000 cycles.*



ZERO PLUS 3 SECONDS: Frequency Watchman *has now brought actual frequency to within 400 cycles of assigned frequency.*



ZERO PLUS 6 SECONDS: *Transmitter is on its assigned frequency and the* **Watchman** *will hold it there.*

TUCKED away inside every Western Electric FM transmitter is the *Frequency Watchman*, a super sentry who maintains continuous and accurate control of the transmitter's mean carrier frequency. Comes the slightest frequency deviation and he corrects it quietly and efficiently. He works so fast that even in the extreme case shown at the left, the correction is made in a few seconds. He is always on the alert, helping to make Western Electric FM transmitters the easiest to control and operate. He is another reason why more stations will choose *Synchronzied* FM.

For the full story, send for your copy of the illustrated booklet, "The Frequency Watchman." Just drop a line to Graybar Electric Co., 420 Lexington Avenue, New York 17, N. Y.

Buy all the Victory Bonds you can —and keep them!

When an unusual problem in capacitors arises, engineers think first of C-D. A case in point is this giant mica tank capacitor for a transoceanic transmitter. It is now in use and combines space-saving design with the capacity of much larger units.

No matter what kind of capacitor you require, C-D can design and build it for you. Discuss your capacitor requirements with our engineers. They will welcome the opportunity to help. Cornell-Dubilier Electric Corporation, South Plainfield, N. J.

FROM THE LARGEST TO THE SMALLEST — WE MAKE THEM ALL

Other plants at:
New Bedford, Brookline, Worcester, Mass. and Providence, R. I.

CORNELL-DUBILIER
First in Quality **CAPACITORS**
MICA • DYKANOL • PAPER • ELECTROLYTICS

THE GERMAN ECONOMIC PEACE
HARD, SOFT...or WORKABLE?

IT is not surprising that difficulties are being encountered in spelling out the detailed terms of the German economic settlement.

The problem is exceedingly complex. The German economy is more or less inextricably bound up with the economy of continental Europe. Before the war that area—excluding the United Kingdom, Ireland and Russia—accounted for approximately one-fourth of the world's production, and for more than thirty-five per cent of world import and export trade. Germany's production constituted almost one-third of the output of continental Europe. It is obvious that the decisions we make now concerning the future German economy will exert profound influence not only upon the economy of Europe but also upon that of the world. It is clearly not practicable to plan for an expanding world economy unless provision is made for Europe generally to share in the development.

Despite the magnitude and complexity of the problems involved, it is crucial that we and our Allies come to swift and decisive agreement. Such agreement is important both to world economic reconstruction, and as a demonstration that those who won the war can reach accord on the terms of world economic rehabilitation.

We shall accomplish little if we continue to debate in terms of *adjectives*. Yet most of the public discussion to date has centered around whether or not the economic settlement with Germany should be *hard* or *soft*. To make progress we must focus instead upon *objectives*. A good program is one that will promote our objectives—a bad program is one that will not.

What Are We Trying To Accomplish?

Upon the economic objectives of the German peace settlement there is little fundamental debate. This is demonstrated by reference to a number of documents of recent release—the United States Directive to General Eisenhower of April 1945, the Report of the Tripartite Conference at Berlin of July, the Report of the American Advisors to the Office of Military Government of September. The latter document stresses fundamental difficulties in developing a practical program for carrying out the objectives of the other two, but it does not question their formulation of aims.

What are the objectives that we are seeking to forward:

1. The disarmament of Germany.

2. The elimination of German industries devoted primarily to armament production.

3. The assessment of reparations to compensate those nations which have suffered losses from German aggression through direct war destruction and through the German policy of confiscating industrial equipment to her own use.

How Far Are We Agreed on Procedure?

There is also a wide measure of agreement upon detailed procedure for carrying out these objectives. No one, of course, questions the policy of confiscating German arms. Equally, there is agreement that German industry devoted directly to the production of war equipment should be confiscated or destroyed, and that control measures should be instituted and sustained to prevent her from reconstituting such industries in the future. Since it is not practicable to prevent aircraft production and shipbuilding from being diverted to military use, these industries are included in the armament category. And similar reasoning generally extends the list of prohibited industries to ball bearings and abrasives.

There is an additional category of German production which all of the Allied powers agree should be uprooted and permanently barred. It embraces all economic activity which prewar Germany cultivated on an uneconomic basis through subsidy and other protection for the prime purpose of developing a self-sustaining economy to support aggressive war.

The major elements in this category are not difficult to define. A great German industry for the synthetic production of gasoline and other oil products from coal never operated upon an economic basis. The cost of such fuel products to prewar Germany averaged almost four times what it would have cost her to buy petroleum products in the world market. It is doubtful whether these plants could be operated postwar at a cost much below three times the world market price for competing petroleum products.

A similar situation applies to German synthetic rubber production. In an attempt to free herself at least partially from dependence upon supply lines, she produced synthetic rubber at a cost at least double the world market purchase price. Similarly, she protected or otherwise subsidized a considerable agricultural production, particularly in grains, for which her lands were so ill suited that Germans had to pay for German-grown wheat from three to four times the world market price.

These are merely outstanding examples. The maintenance of such activities in Germany constituted a drain upon the German economy rather than an advantage other than that of preserving a self-sufficiency necessary for war. Hence their elimination is clearly indicated, and generally subscribed to, though the job of defining a complete list is far from easy.

What Is The Area of Dispute?

Unfortunately, this total catalogue of agreed-upon measures is not sufficient to provide either adequate security against a resurgence of German militarism or satisfactory restitution to her European neighbors for Germany's ruthless destruction of their industrial plant and equipment. To serve these two ends it is necessary to cut down the margin of German dominance in heavy industry—in steel, in electric power, in machine tools, and other industrial equipment. Unless such steps are taken, Germany will emerge from the war with sufficient industrial power to provide a continuing and perhaps uncontrollable military threat; and we should be perpetuating a dominance that was developed, as a matter of German strategy, far beyond the requirements of her civilian domestic markets or the export potentials of normal trade.

German steel capacity was built to a wartime peak of twenty-four million tons a year. Before the war she had accumulated a store of machine tools greater than that of the United States, and her present stock of some four or five million tons of such tools is second only to ours. There is little debate over the necessity and justice of cutting down the margin of German dominance in heavy industry, particularly since it was built to its current levels through aggressive economic warfare to serve as an instrument of actual warfare. It is recognized, too, that in this sector of the German economy will be found the most useful reparations in kind for the countries damaged by German aggression.

The question is how much heavy industry and electric power equipment should be taken from Germany and transferred to others. The Russians, having experienced colossal war damage, are demanding very severe assessments. They talk of reducing postwar German steel capacity to three million tons annually.

The United States inclines to assessments in this field of less extreme dimension—we have suggested leaving in Germany an annual steel capacity of from seven to ten million tons. We naturally are concerned lest action be taken that will cause a complete breakdown of the German economy. If this should happen while we maintain occupational forces there, we should feel responsible for seeing that the Germans within our jurisdiction are provided with at least the means for subsistence. Furthermore, both we and the British know that in the long run our peoples will not support control measures over Germany which go beyond our concepts of reasonable fairness consistent with security requirements.

It is no part of our intention, as has been suggested by some, to provide for a German economy that will serve as a buffer against Russian expansion. We know, however, that our weakest course would be to commit ourselves now to continuing control measures which our people would later repudiate as falling outside democratic concepts of justice. On this issue we cannot, and should not, compromise.

How Can We Resolve Our Differences?

The best chance for resolving the differences which have appeared between the Russian position on the one hand and the American and the British position on the other lies in making a sharper distinction than has appeared in current discussion between long-term and short-term control decisions. All of us are agreed upon the policy of wiping out German military production and that part of German economic activity which has been run at economic loss to provide for a national self-sufficiency useful only for war purposes. But we are unwilling to enter into long-term commitments for holding down those parts of the German economy that do not constitute a war threat. That would unduly penalize future generations of Germans and drag down the whole economy of continental Europe.

It should be possible to reach agreement that measures for cutting down German heavy industries and power-generating facilities are immediate measures, and that no attempt will be made to sustain such controls over an extended period. If part of the German establishment in these fields is transferred to countries whose manufacturing resources have been damaged by German aggression, it can serve the purpose of effecting a reasonable balance without destroying utterly incentives for a new generation of Germans to improve by peaceful methods their status in a peacetime world.

Such a program is consistent with the concept of building a healthy and balanced European economy in which general economic interdependence provides one of the essential safeguards against a resurgence of German militarism. We must still face the problem of agreeing upon how far the non-armament segments of German industry can be cut back at the present juncture without leading to disastrous breakdown with its resultant chaos. Such definition, though formidably difficult, should not be beyond the capacities of the nations whose combined might brought victory, and who have the strongest of incentives for devising a lasting peace.

The key to agreement lies in each of us doing his best to understand the position of the other. Russia must recognize that we cannot get our people to subscribe to the permanent repression of a European economy which would deny to millions of people any hope of normal economic betterment. We should try to understand Russia's conviction that she is entitled immediately to reimburse herself for her war losses by drawing upon the German industrial establishment that still exists. It will help to resolve our differences if we separate in our thinking steps that require permanent controls from those which are merely temporary expedients.

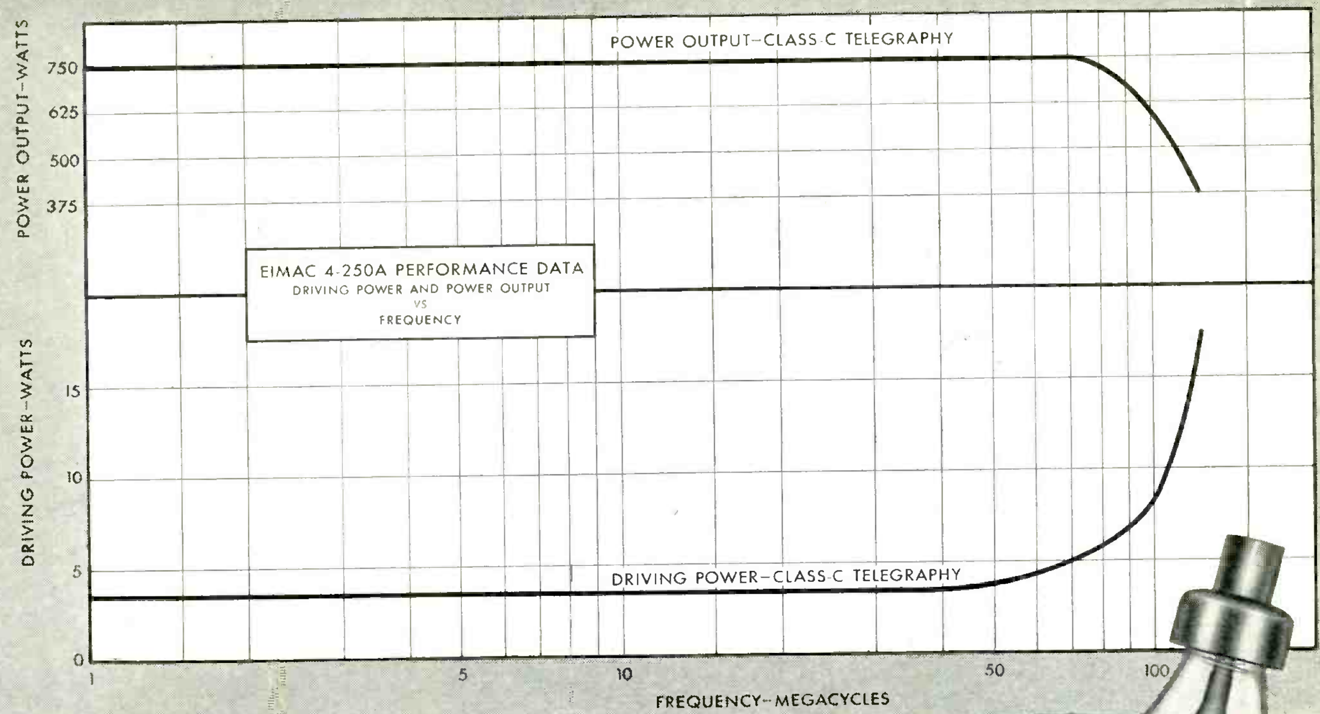
Neither of us will be forwarding our ultimate and common objectives if we impose controls that blight the development of so large and important a segment of the world as continental Europe. In such a blight lies the germ of a Third World War.

James H. McGraw, Jr.

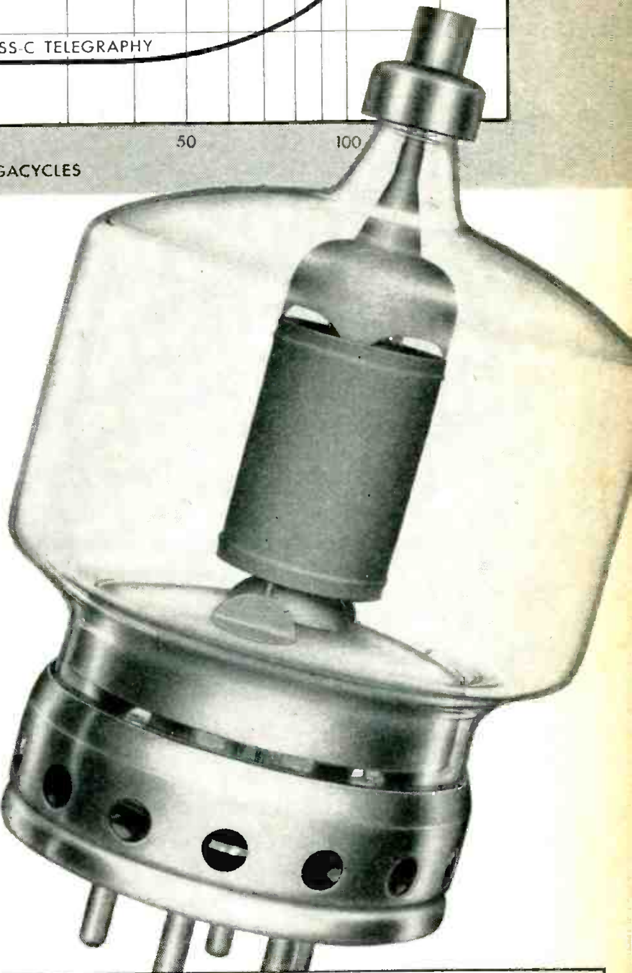
President, McGraw-Hill Publishing Co., Inc.

THIS IS THE 41ST OF A SERIES

THE COUNTERSIGN OF DEPENDABILITY IN ANY ELECTRONIC EQUIPMENT



NEW EIMAC 4-250A TETRODE



Heading a parade of sensational new tubes now in production, the Eimac 4-250A Tetrode—introduced several months ago—is already in great demand. It may pay to check these performance characteristics against your own requirements.

As can be seen by the chart above, the new Eimac 4-250A Tetrode will deliver 750 watts output at frequencies up to 70 Mc. with a driving power of only 5 watts. At frequencies up to 40 Mc. an output of 750 watts may be obtained with a driving power of 3.5 watts.

The grid-plate capacitance of 0.12 $\mu\mu$fd. is extremely low, allowing operation at high frequencies without neutralization. Use of Eimac "X" process control grid reduces both primary and secondary emission which provides utmost stability.

You are invited to supplement the information given here with a technical bulletin on Eimac 4-250A Power Tetrode. It contains an elaboration of the tube's characteristics and constant current curves. Send your name and address and a copy will go to you by return mail.

The Lid's Coming Off...
Watch your favorite trade journals for announcements of other new Eimac tubes to be released this year.

CAUTION! Check serial numbers on Eimac tubes before you buy. Be sure you're getting newest types. Look for latest serial numbers.

FOLLOW THE LEADERS TO

Eimac TUBES

EITEL-McCULLOUGH, INC., 1086 San Mateo Avenue, San Bruno, Calif.
Plants located at: San Bruno, California and Salt Lake City, Utah
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco 11, Calif., U.S.A.

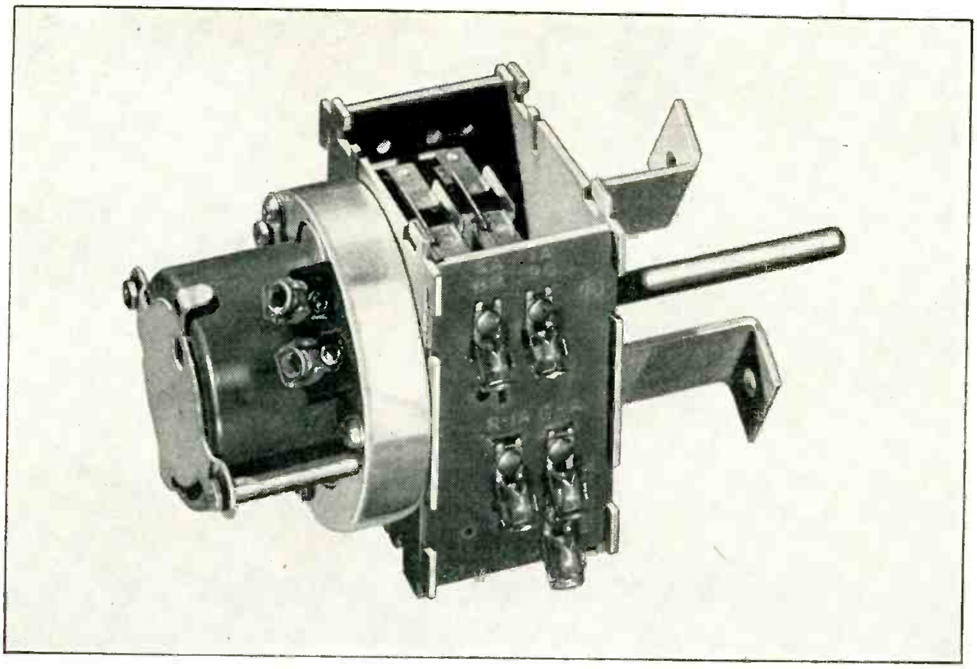
TYPE 4-250A—POWER TETRODE

ELECTRICAL CHARACTERISTICS

Filament: Thoriated Tungsten	
Voltage	5.0 volts
Current	14.5 amperes
Plate Dissipation (Maximum)	250 watts
Direct Interelectrode Capacitances (Average)	
Grid-Plate	0.12 $\mu\mu$fd.
Input	12.7 $\mu\mu$fd.
Output	4.5 $\mu\mu$fd.
Transconductance (i_B = 80 ma., E_B = 3000 v., E_{C2} = 500 v.)	4000 μmhos

1086

Brains of Your Postwar Product— a Mallory Interval Time Switch



HERE'S a precision part—developed by Mallory for controlling automatic home laundry equipment, washing machines and dryers—that seems almost human.

Controlled by a Mallory Interval Time Switch, a piece of electrical or electronic equipment performs a pre-determined sequence of operations automatically. Simply set a dial, and the machine's "thinking" is done for it by the Mallory switch.

Construction of the time switch is typical of the *precision workmanship* for which Mallory is noted. The small sturdy motor is sealed in oil—requires no lubrication. Precision springs assure smooth mechanical operation, and contacts of a special Mallory alloy have uniformly low electrical resistance. The entire switch is ruggedly built for dependability and long life.

Manufacturers of industrial, electrical and electronic equipment . . . seeking greater operating efficiency and output . . . will find many uses for the Mallory Interval Time Switch, as have makers of household appliances. The postwar trend to automatic operation is evident.

Now is the time to discover how *you* can incorporate the "brains" of this switch in your postwar products—for the greater efficiency that assures greater sales appeal. Consult Mallory while your designs are being planned.

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

P. R. MALLORY & CO. Inc

MALLORY

Industrial and Electronic Switches

CROSS TALK

►**TALK** . . . In the October issue of *The American Magazine*, Paul A. Porter, Chairman of the FCC, has an article entitled "Radio Must Grow Up." In it Mr. Porter comments on the growing displeasure of the listening public about the increasing blatancy and poor taste of commercial announcements.

Because of Mr. Porter's position, his interest in and awareness of this attitude on the part of the public is most encouraging. And because he mentions an incident occurring in the mountains of New Hampshire, a locality with which we are familiar, a report on the radio situation there may not be amiss.

In Mr. Porter's incident a famous scientist and his friends listened to an afternoon symphony with great enjoyment only to have the music suddenly followed by a "squalling, dissonant, nasty singing commercial." The scientist promptly threw out of the house the products advertised by the commercial and vowed that no more of the stuff would be permitted to enter. Scientists, of course, are few and are probably not representative of the people. On the other hand, the people are not dumb. Once you get away from the cities, people become folks and you can get close to them. You can find out, for example, how they feel about things. In the mountains of New Hampshire people listen to the radio but shut their ears to the plugs. When asked what they think of the commercials, they invariably say, "Aren't they awful!"

So far as radio service is concerned, this part of New England is poorly served. Field strengths are not great enough to override static and man-made noise. At dusk the best of the daytime stations are badly garbled and soon disappear in a rush of distant stations, few of which deliver good service because of fading and general interference. WQXR, the old standby for New York people who believe that radio means music, comes in well at first but birdies and whistles finally get it down. At 8:55 WABC comes in long enough to bring in comment-free news, thanks to Quink and Johns Manville. As a matter of fact WABC is the best CBS station heard. The radio problem is solved, however, by the Yankee Network f-m station on top of Mt. Washington. Its signals are clear and steady, free from noise and fading. It, however, carries Mutual programs, and since Mutual seems to have gone whole hog for talk programs there isn't much from Mt. Washington for New England people who believe that radio means music.

New Englanders are no better and no worse off than the rest of the country when it comes right down to programs. There simply is too much talk, not alone advertising talk but all kinds of talk—program talk, news comment talk, program notes talk, drama talk. People here really want music and music is one of the things that the broadcasters seem to be eliminating from their programs. They even hire a good musician like Oscar Levant and make him crack jokes!

It is just a hunch, but if the broadcasters did not dilute their programs with so much other corny chatter the bad taste of the advertising blah would be evident even to the men who prepare it.

►**PAPER** . . . With the removal of the restrictions on paper, ELECTRONICS' first move was to add to its circulation list the names of more than 5000 engineers who have been patiently waiting, some for many months, to get their first copies. The next step was to improve the paper stock from 31-pound to 40-pound paper; in January the page size will return to its old dimensions of $8\frac{3}{4} \times 11\frac{5}{8}$ inches; and in the early months of 1946 the paper will be improved again to 45 or 50-pound full coated stock.

Not content with these improvements, the editors have determined to bring to the readers a rapid and full report of wartime developments hitherto restricted. This issue, for example, contains a considerable amount of material which was unmentionable a bare month ago.

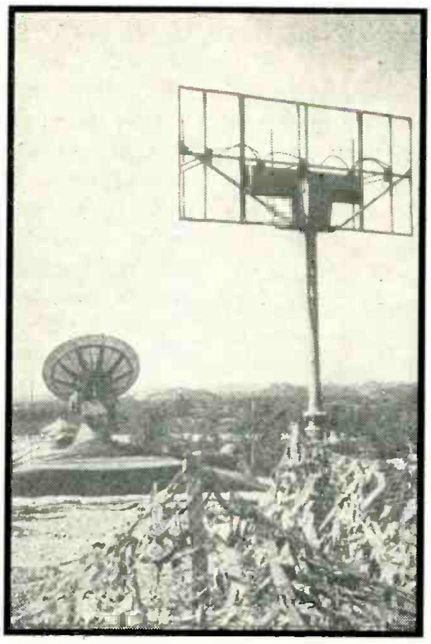
And by the way, there are more editorial pages in this issue than have ever appeared between the covers of ELECTRONICS. As the months go by the readers will have ample evidence that so far as this magazine is concerned, the war is indeed over.

Report on WARTIME ELECTRONIC DEVELOPMENTS

On the following pages, and continuing in succeeding months, ELECTRONICS presents a series of articles describing electronic systems, equipment and components developed during the war, information on which the future course of the industry largely depends

IN THE FOLLOWING PAGES, and in issues to follow, ELECTRONICS undertakes its share of a huge project: to acquaint industry with the accomplishments of the war period in its field.

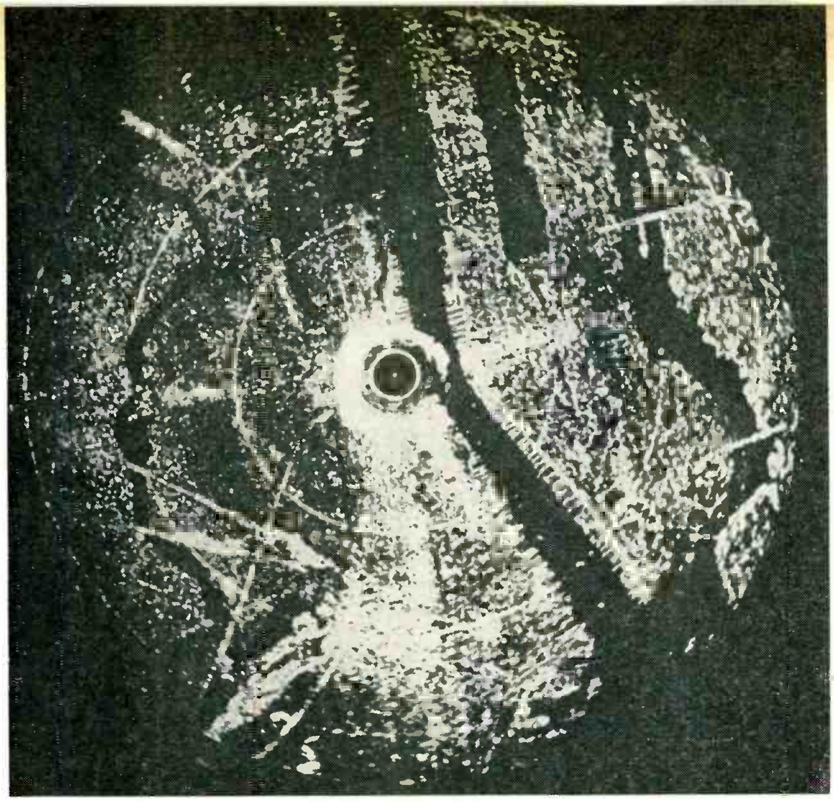
For more than four years technical workers, backed by almost unlimited resources, have researched, designed, developed, and produced all manner of electronic gear behind closed doors. Information on this vast effort has been interchanged only where the value of exchanging ideas clearly outweighed the threat to military security, and then only between groups working in similar equipment. The radar specialists knew little if anything of the plans to use television in military operations despite the close relationship between the two arts. Even more remote was the group developing the variable time (VT) fuze, a c-w radar carried in a bomb or howitzer shell. Off in still another corner were the "straight-communication" boys who did wonders to supply what the Army and Navy needed above all, reliable radio contact between combat units and commands. And among the most hush-hush were the "rcm" (radar and radio countermeasures) workers whose business it was to fox and outfox the enemy in his use of radio and radar.



SCR-584 radar and RC-184 identification equipment of Battery B, 5th Antiaircraft Battalion. The radar (left, dug in) is the 10-cm 300 kw job which licked the buzz-bombs. RC-184 (antenna, right) transmits pulses on a lower frequency to friendly aircraft which retransmit a coded reply. By this means the buzz bombs were separated from Allied fighters chasing them, and in the end, 80 percent of the V-1's were shot down by radar control

So it is that many technical workers have been in possession of a small part of a particular field, but barred by security or lack of time from other parts of the electronic art. Material available for publication has been scanty (but not entirely so as the accompanying bibliography shows) and of theoretical nature, especially on the topics of greatest technical interest. Even now many restrictions apply, but present indications are that soon all wraps will be removed from most systems, equipment and components developed for use in the war.

That a good start has already been made will be evident from the following 26 pages, all of which were assembled within six weeks of the end of hostilities. The articles cover a wide range. Radar assumes a central position, as indeed it must in view of the prodigious effort expended on it. But interest is by no means confined to radar. The paper on the AN/PRS-1 mine detector describes a remarkable device which saved untold lives, albeit by a technical principle which is even now very imperfectly understood. The Loran navigation system, one of the great American contributions, is well known in fact if not in name to listeners who have tuned through the 160-meter ham band since 1942. The ground-controlled approach system for bringing aircraft safely down through fog has a bright future. The VT fuze, whose vacuum tubes can stand the shock of being thrown from a gun with an acceleration of 20,000



The radar equipment which produced this PPI picture of Manhattan Island and nearby New Jersey (looking north) was still under development at the war's end. The resolution of the individual docks along the Hudson River, bridges, islands, ships, and even railroad tracks (diagonal lines lower left) is made possible by the use of a wavelength shorter than 3 cm

times gravity, is pure Jules Verne.

For those who like their radar concentrated, the table under "Radar Specifications" is prescribed. Somewhat more dilute, and perhaps more generally informative, is the description of the SCR-584, the most versatile radar to be designed by any of the warring powers and the first S-band radar (10-cm wavelength) to be described. The GCA system also employs radar. All these will be found in this issue.

This is merely a start. It would be imprudent in a competitive world to list detailed plans for future issues. But assurances of early declassification of equipment by Air Force and Navy, following the noteworthy step already taken by the Signal Corps, leave no doubt as the general trend: airborne and shipborne radars to match the ground radars here tabulated; shf communication by pulses and otherwise; television systems reduced to the airborne, and even the bombborne, stage; tubes for creating more power at higher frequencies than, perhaps, anyone can use for a non-military purpose; test equipment covering every phase of uhf and shf technology; simple control circuits for pilotless aircraft.

In short, after the famine, the feast. It is the plan of the editors to continue the ELECTRONICS War Report for as many months as their readers find it interesting. Material is available, from among the radar and radio equipment already declassified, to fill extra columns for many months. The editorial task is one of selecting the more important contributions and presenting them lucidly. Suggestions from readers concerning suitable material will be gratefully received and carefully considered.

ARTICLES ALREADY PUBLISHED

by electronics

THE LORAN SYSTEM .. Part I

Pulsed transmissions on 1700-2000 kc provide precise over-water navigation for ships and aircraft at distances up to 1500 miles from shore-based stations at night, or 750 miles by day. Operating principles of the most important long-range navigation system to come out of the War

LORAN (from Long Range Navigation) is a system of radio navigation which permits the navigator of a ship or an aircraft to determine his position with an accuracy not worse than 15 miles at a distance of 1500 miles from shore. It is one of a family of systems, known as "hyperbolic navigation systems", which measure the relative time of arrival of two or more radio signals sent synchronously from known points.

Loran operates in the region from 1700 to 2000 kc, and employs high-power pulses of approximately 50 microseconds duration.

History of the Development

The Loran development is based on a proposal of Dr. Alfred L. Loomis, of the National Defense Research Committee, who in 1940 devised a hyperbolic method of position finding and suggested that the Radiation Laboratory, then being formed at M.I.T., undertake to develop the system. Prior to this, Robert J. Dippy of the Telecommunications Research Establishment in England had devised independently substantially the same system, which was christened the "Gee" system and developed to the point of operational use in 1942. In that year an exchange of information between Radiation Laboratory and T.R.E. revealed that the two groups were working on the same system, but with different aims.

The Gee system was intended for the guidance of high-flying bomber aircraft over Germany, at maximum distances of 200 to 300 miles, and employed line-of-sight frequencies in the region from 40 to 80 mc. The Radiation Lab group was working on a system, later christened Loran, which would serve equally well for aircraft at high altitudes or naval ships on the surface and which would have a range greater than 500 miles, for the defense of American shores. The frequency adopted for Loran in the winter of 1941-42 was 1950 kc, just inside the then recently vacated 160-meter amateur band. After the interchange of information, the two projects were coordinated and thereafter the two systems, Gee for short ranges at high altitudes and Loran for long ranges at any altitude, were exploited independently by the two groups.

In 1942, the first Loran stations were put in operation along the Atlantic coast from Delaware to Greenland by the Radiation Laboratory and later turned over, for routine operation, to the Coast Guard. In that same year shipborne navigating equipment was manufactured in small quantity and later appeared in several improved models in sufficient quantity to equip the entire fleet. By 1943 production was in full swing on the AN/APN-4 airborne navigating (receiver-indicator) equipment, and in 1944 a new version, the AN/APN-9, made its appearance. These receivers were based on the original Radiation Laboratory design, as was the ground station equipment (transmitters, pulse timers, and synchronizing equipment). Ground installations were made at Allied bases over the entire globe, from The Bay of Bengal in the west to the Mediterranean on the east, and

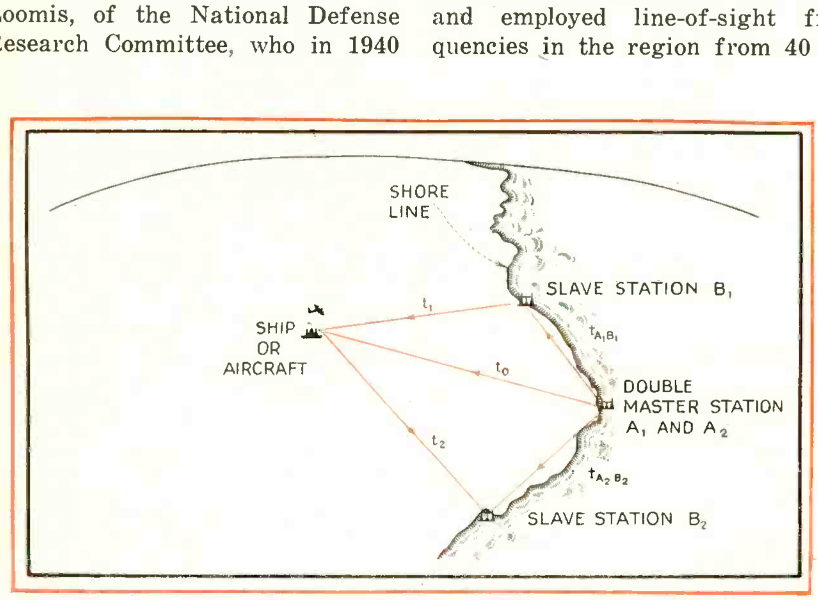
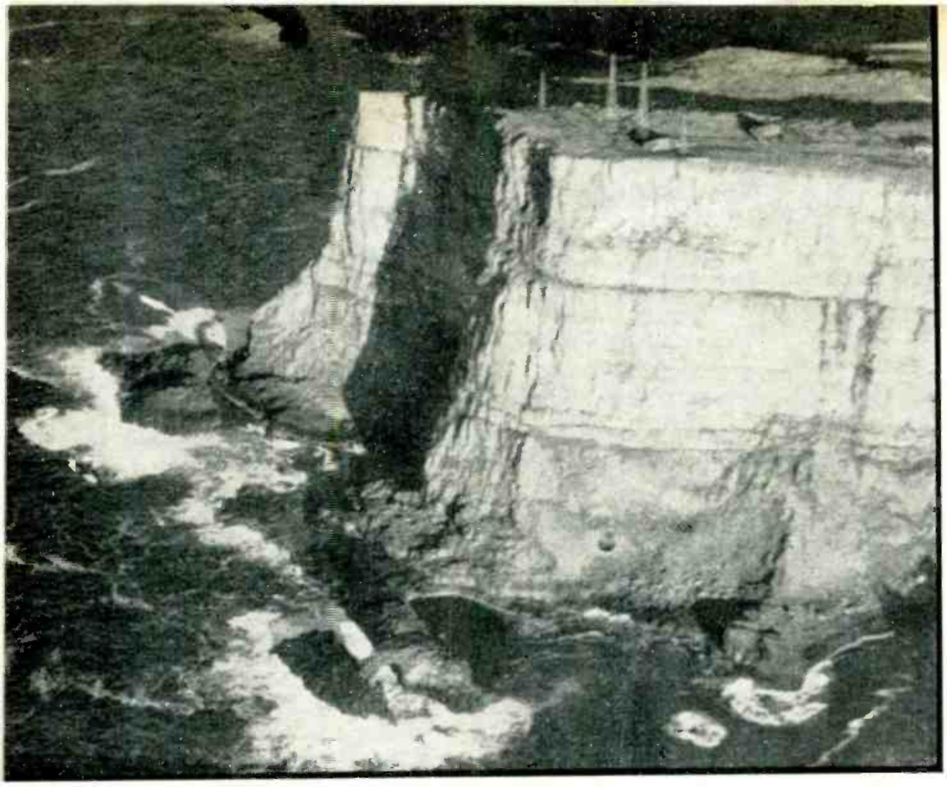


FIG. 1—Basic layout of the Loran system. Master and slave stations transmit synchronized pulses, and the difference in their times of arrival determines the position of the ship or aircraft



Loran stations have been installed in many remote places, like this one (note towers) on top of a cliff in the Faeroes Islands

electronics WAR REPORT

manned by personnel of the Coast Guard, Army Air Forces, Canadian Navy, British Navy, and Royal Air Force.

Credit for the development of the Loran system and all its components, as well as the study of radio wave propagation on which it is based, goes to the Loran Division of the Radiation Laboratory, a group* of approximately 50 engineers, physicists and technicians which served under the direction in successive years of Melville Eastham, Donald G. Fink, J. C. Street and J. A. Pierce. Credit for the effective use of the system by the fleets and air forces of the Allies goes to thousands of individuals in the Armed Forces who put into effect plans formulated by Major General H. M. McClelland of the U. S. Army Air Forces, Rear Admiral Joseph Redman of the U. S. Navy, and Air Vice Marshal Sir Victor Tait of the Royal Air Force.

The principle of hyperbolic navigation, as exemplified in the Loran system, is illustrated in Fig. 1. Four pulse-transmitting stations are located along a shoreline adjacent to the ocean area over which navigation is desired. Two of these stations (A_1 and A_2 in the figure) are, for economy's sake, at one point which is known as the "double master" station. This station sends out pulses broadcast in all directions, at a highly precise rate. Two sets of pulses are transmitted. One set, transmitted by station A_1, operates at a rate of, say, 25 pulses per second. The other set, corresponding to station A_2, operates at a slightly different rate, say 25.0627 pulses per second. The difference in the rates permits the two sets of pulses to be distinguished when they arrive at the ship or aircraft.

Consider first a pulse broadcast by station A_1. This pulse travels to the associated "slave station" B_1, where it is received. After a predetermined delay, B_1 sends out an identical pulse which is timed at the rate of the pulse received from station A_1. Hence stations A_1 and B_1 send out identical pulses at the same rate (in this case 25 per second), but the pulses from station B_1 are emitted later than those from A_1 by the time t_{A1B1} (the time of travel from A_1 to B_1) plus the delay δ within station B_1. The two sets of pulses from A_1 and B_1 are transmitted to the receiver on the ship or aircraft. The pulses from B_1 arrive after an additional delay t_1 and those from A_1 after an additional delay t_0.

At the receiver the two pulses are displayed on a cathode-ray oscilloscope and the *difference* in their

WAR and POSTWAR

DEVELOPED by the Radiation Laboratory at M.I.T. in 1941-42, Loran has since served as the principal long-range navigation service of the Allied fleets and air forces.

The system currently provides precise navigational coordinates covering one quarter of the earth's surface. Representing a wartime investment of over 100 million dollars, it will continue to be operated for the use of commercial marine and air services. The British government in an unprecedented step has recently recommended that Loran be standardized internationally, in preference to other British and German systems, as the primary radio aid to transoceanic air navigation.

This article, the first of a series, describes the operating principles of the system, its basic specifications and methods of use. Following articles will describe the airborne and shipborne navigating equipment as well as the ground stations which provide the service

* Among the staff members of the Loran Division who contributed to the development and installation of the equipment are Elizabeth Cooper, David Davidson, Melville Eastham, D. G. Fink, Gordon Gregory, John Halford, D. E. Kerr, R. B. Lawrance, A. A. MacKenzie, Glenn Musselman, J. A. Pierce, J. K. Phelan, A. J. Pote, B. W. Sitterly, J. A. Stratton, W. L. Tierney, Joseph Waldschmit, J. C. Williams, and R. H. Woodward. Among the military contributors were Major J. M. Hertzberg, AAF; Commander A. S. Van Dyck, USNR; Commander J. R. Foster, RCNR; Lt. Commander Fletcher Watson, Hydrographic Office; and Captain L. M. Harding, USCG.

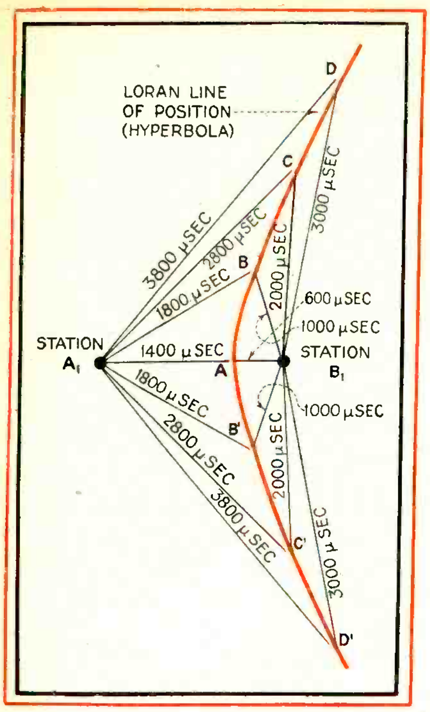


FIG. 2—Derivation of a hyperbolic Loran line (shown in red) from points of equal time difference

times of arrival is very precisely measured (to an accuracy of the order of one microsecond). The time difference so measured is equal to

$$T_{G1} = (t_{A1B1} + \delta_1 + t_1) - t_o \quad (1)$$

The quantity in brackets represents the time required for the master pulse to be relayed to the receiver via station B_1 and t_o represents the time for the master pulse to arrive directly from A_1. Using the measured value of time difference, the navigator consults a Loran chart and finds on it a line (or interpolates between lines where necessary) associated with station pair A_1B_1 and marked with the corresponding value of time difference. The ship or aircraft is located on this line.

By an exactly similar procedure, the navigator then measures the time difference between the other pair of pulses, originating in stations A_2 and B_2 and sent out at 25.0627 pulses per second. The time difference is

$$T_{G2} = (t_{A2B2} + \delta_2 + t_2) - t_o \quad (2)$$

Using this value of time difference, the navigator consults the same chart and finds (or interpolates) another line, associated with the station pair A_2B_2. The intersection of this line with the line found previously is the position of the aircraft or ship. Thus by two measurements of time difference on synchronized pulses arriving from two pairs of stations, the navigator finds his position.

If the time difference is measured precisely, the accuracy of position finding is correspondingly precise. When the time differences are measured accurately to one microsecond it is possible to determine the position to within a few tenths of a mile in the most favorable regions of the area covered, and the error in navigation is in no case worse than one percent of the mean distance of the ship or aircraft from the stations. Thus if the navigator is roughly 500 miles from shore, he can determine his position within 5 miles, and in certain areas (at this distance) he may even determine it within a mile or less. Moreover, as the navigator approaches shore and the need for precise navigation increases, the accuracy of position finding increases in proportion to the need, approaching a limiting accuracy which is well within one mile.

The relation between the time difference and the corresponding position line on a Loran chart can be seen from Fig. 2. Suppose that the navigator is at point A, between the two stations A_1 and B_1, and suppose that t_o is 600 microseconds and t_1 is 1400 microseconds. Then the time difference between the two paths $t_1 - t_o$ is 800 microseconds. Likewise, if the navigator is at point B, both times are longer (1000 and 1800 respectively) but their difference remains the same, 800 microseconds. Similarly, at points C, D, B', C', and D' the same time difference appears. The locus of these points and of all intermediate points displaying the same time difference (shown as a red line in the Figure) is theoretically a hyperbola. However, when the locus is plotted on the surface of the earth, the term hyperbola does not strictly apply and the term used is a Loran line of position, or simply "Loran line".

It will be noted that in discussing Fig. 2 we refer to the time difference $t_1 - t_o$, whereas the time difference actually measured is that given by Eq. (1). But in Eq. (1) the quantities t_{A1B1} and δ_1 are constants for any particular pair of stations, so the time difference actually measured is $t_1 - t_o$ plus a constant. The constant is computed and taken into account in labelling the lines on the chart, and need not be considered by the navigator.

The Loran line shown in Fig. 2 is one of a family of lines, since for each value of measured time difference there is a corresponding hyperbolic locus. Such a family is shown in Fig. 3. Here the lines have been labelled with the actual values of time difference, given by Eq. (1), when the value of the slave station delay δ is 1000 microseconds. In the case shown, the value of time difference increases continuously from a low value of 1000 microseconds on the degenerate hyperbola (baseline extension) passing through the slave station B_1 to a high value of 5000 microseconds on the corresponding line passing through the master station A_1. It will be noted that each line has a separate value of time difference, and there is no ambiguity. This follows from the time difference defined by Eq. (1). If the signals were emitted simultaneously from master and slave stations, lines at equal distance to the left and right of the center line would have the same value of time difference and an ambiguity would exist. It will be noted also that the lines shown are separated by intervals of 400 microseconds. For every line shown, the system can distinguish 400 intermediate lines.

The family of lines in Fig. 3 nevertheless illustrates a fundamental shortcoming of all hyper-

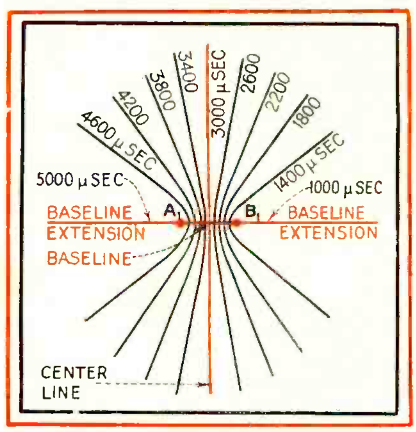


FIG. 3—Family of Loran lines. The navigator selects the line corresponding to the measured time difference, interpolating where necessary

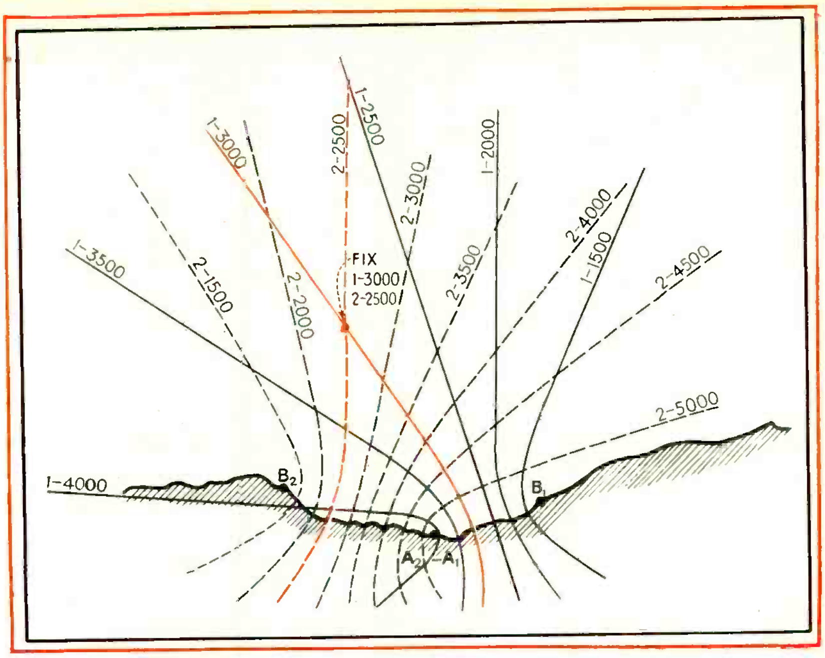


FIG. 4—Two families of lines, from two pairs of stations, overlap to form a system of Loran coordinates. The lines determine the fix (shown in red). Between adjacent lines, 500 additional lines can be resolved by the system

bolic navigation systems: the accuracy of determining the position is not constant over the coverage area. The lines are most closely spaced (and the accuracy of position correspondingly highest) along the baseline connecting the two stations. As the navigator departs from the baseline, the lines diverge. Hence the accuracy of navigation decreases with increasing distance from the stations, as already stated. Moreover, the divergence of the lines increases as the navigator departs from the center line and approaches the baseline extensions. Along the baseline extensions themselves, the accuracy of the system is poor. To assure navigation of acceptable accuracy over the desired area it is necessary to select the locations of the stations with care, so that the areas of primary interest fall within the central portion of the family of lines.

Figure 4 represents a typical arrangement of a double master station and two slave stations and shows the overlapping families of Loran lines. The position fix shown corresponds to a time difference of 3000 microseconds from station pair A_1B_1, and 2500 microseconds from station pair A_2B_2. This figure illustrates another factor influencing the accuracy of the fix, the angle at which the two lines intersect (crossing angle). In the vicinity of the master station, the crossing angle is close to 90 degrees, the optimum case. At greater distances the angle decreases and longitudinal accuracy, i.e., along the lines, is thereby reduced. However, the combined effect of all the losses of accuracy is expressed in the rule-of-thumb previously stated; the accuracy is not worse than one percent of the mean distance from the stations, and the accuracy improves as the navigator approaches the center line or the baselines, or both.

A quantitative index of accuracy is given in Fig. 5. Each line of Loran line is indicated as a zone, at the center of which is the indicated line of position and the edges of which represent the limits of uncertainty in measuring the time difference. When two such zones are crossed to find the position fix, the intersection of the zones forms a quadrilateral, shown shaded in the figure. The indicated position is the point shown in the center of the quadrilateral, but the position is uncertain over the shaded area. The maximum diagonal of the quadrilateral is a measure of the error in fixing the position. The maximum possible error is one half of this dimension.

Another way of expressing the accuracy of the system is to state the angle corresponding to the uncertainty in a line of position. This angle is directly comparable with the angular accuracy of a loop-type direction finder. In the family of lines shown (Fig. 3) there are 3200 separately distinguishable lines between the limiting parabolas, which subtend an angle, at the center of the baselines, of about 110 degrees. Hence the average angular separation between resolvable lines is about 0.03 degree, compared with one to five degrees which is the normal accuracy of a loop-type direction finder.

Distance of Coverage

After the accuracy of the system has been established, the important remaining question is the maximum distance at which the signals can be received with sufficient accuracy for the intended use.

The attenuation of 2000-kc radio signals propagated with horizontal polarization via the ground wave over sea water is approximately 10 db per 100 miles. The standard Loran pulse is fed to the antenna with a peak power level of from 75 to 100 kw, and the standard Loran transmitting antenna has a power efficiency of at least 75 percent. Under these conditions the

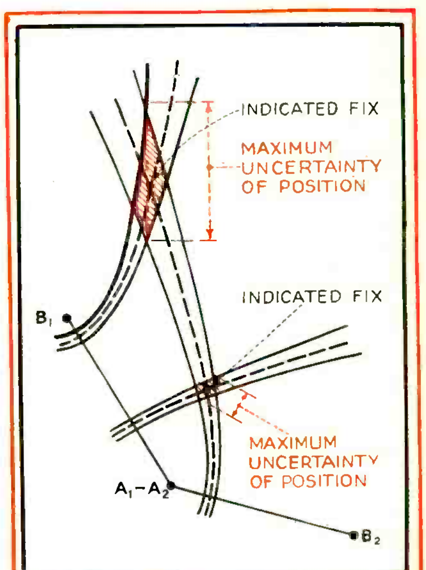


FIG. 5—Any discrepancy in measuring the time differences spreads the Loran line into a "zone." Two zones, crossed, form a quadrilateral (shown in red) within which the position lies

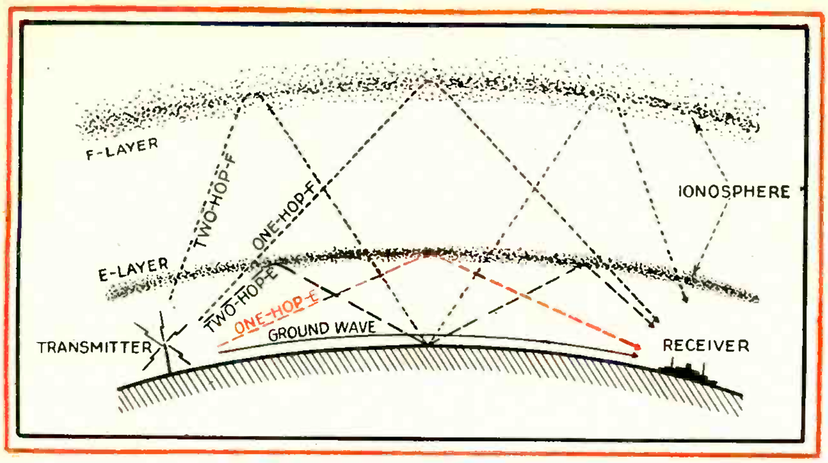


FIG. 6—Propagation of Loran signals at night via the sky wave. The "one-hop-E" reflection possesses sufficient constancy of transmission to replace the ground wave and thus extend the night-time range of the system

signal falls to a level of about 2 microvolts per meter at a distance of 750 statute miles, and this is about the minimum level on which the receiver can operate in the absence of atmospherics. At night the external noise level (originating outside the receiver) increases and the maximum useful range via the ground wave is reduced to about 500 statute miles. In exceptional circumstances, noise may reduce the range to smaller values, and precipitation static encountered in aircraft may obliterate the signals even within a few miles of the station. But for 95 percent of the time, the reliable range using the ground wave is 750 miles by day, 500 miles by night.

Early in the development of the system, Melville Eastham suggested that the sky wave signal might be employed at night to extend the range and this thesis was first proved by a series of several thousand observations made by J. A. Pierce at Bermuda early in 1942. Since the pulses employed in the system are short, the several signals reflected from the ionosphere are discernible separately, and it was possible to investigate the constancy of transmission of signals reflected from the several ionospheric layers. The early investigations showed that a singly-reflected signal from the E-layer of the ionosphere was transmitted with remarkable constancy. The E-layer signals displayed some fading and variations in shape, but were sufficiently stable to allow the time difference to be measured to an accuracy of the order of five microseconds. The same investigation showed conclusively that reflections from the F-layers of the ionosphere were much less stable, not only in the time of transmission but also in the constancy of pulse shape.

This discovery of an hitherto unsuspected property of sky wave transmission made it possible, at night, to double the range of the system by employing singly-reflected E-layer signals. The height of the E-layer is about 60 miles, so a wave leaving the earth tangentially is refracted back to another point of tangency at a distance of about 1600 statute miles. At distances beyond this only doubly or multiply-reflected E-layer signals can be received and these are generally so weak, or so inconstant in transmission, that they were not believed to have utility in a system intended for use by the Armed services. Accordingly the limit was set at 1500 miles, and the Loran charts and tabulations of time difference were prepared to cover this range from the stations.

The mechanism of the propagation of the sky-wave is shown in Fig. 6. The "one-hop-E" signal is the sky wave signal used. It will be noted that this signal takes an additional length of time to travel from transmitter to receiver, relative to the ground wave. This "sky wave delay" must be taken into account in using the system. Specifically, a sky wave correction of a specified number of microseconds is computed for each portion of the chart and this correction added to or subtracted from the observed reading of time difference before entering the chart to find the Loran line. Figure 7 gives the average values of the singlehop E-layer sky wave delay in microseconds (as measured over the winter of 1942-43) for various distances between transmitter and receiver. The appropriate values of delay are added to the ground wave transmission times t_1 and t_2 (see Fig. 1) in computing the sky wave time difference. The difference between the sky wave time difference and the ground wave time difference (the latter being given by Eq. (1)) at the given point is the sky wave correction which is applied as previously stated.

Sky wave transmission is generally available at 2000 kc only at night, although at distances beyond 500 miles the sky wave signals are often seen on Loran oscilloscopes in the early morning and late afternoon hours. Where military operations are scheduled for the night hours (for example night-bombing missions), the sky wave may be relied upon not only for reception at the ship or aircraft but also for synchronizing the pairs of stations. When sky waves are so employed for synchronization, the system is known as SS Loran ("SS" for skywave synchronization). Since the sky waves are propagated over land with almost negligible attenua-

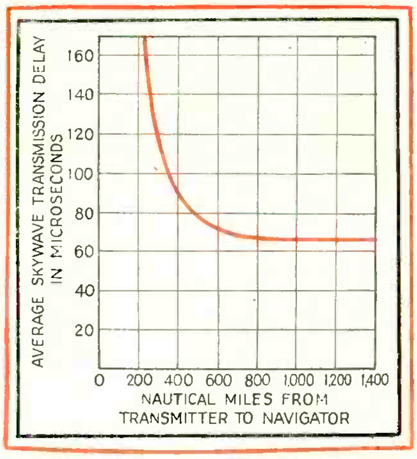


FIG. 7—The additional time of transmission of the "one-hop-E" sky wave, relative to the ground wave, over various distances. This delay is applied as a correction when using sky-wave signals with ground-wave charts

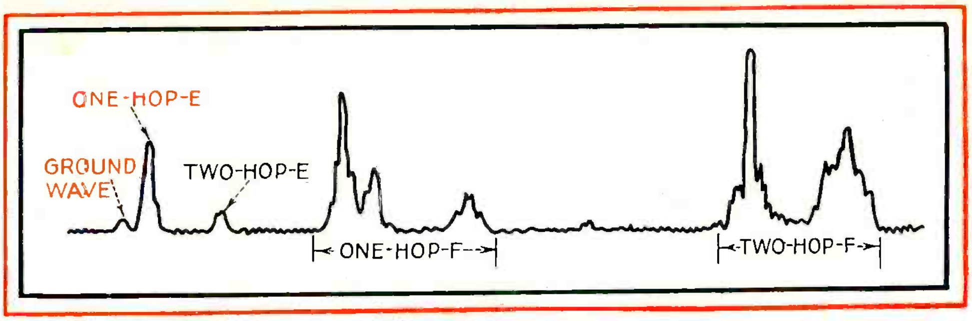


FIG. 8—Typical ground-wave and sky-wave pulse sequence as observed on the Loran oscilloscope. Signals to the right of the one-hop-E are disregarded by the navigator

tion, it is possible to set up an SS system for navigation over land areas. The first such system was set up over Germany, using stations in Africa (later Italy) and Scotland. It provided accurate coverage over the entire region of occupied Europe from the summer of 1944 to the end of the war. This system was used by the British night bomber force, and was sufficiently accurate to permit blind bombing over Berlin.

Figure 8 shows a typical sequence of pulses as they are observed on the cathode-ray trace of the Loran indicator. It is evident that the navigator must identify the proper pulse before measuring the time difference, and this constitutes a problem in the application of sky waves. When within range of the ground wave, the first pulse to appear is the ground wave, which is generally considerably weaker (because of the higher attenuation) than the following sky waves. The next after the ground wave pulse is the one-hop-E pulse, since it arrives by the next shortest path. If the navigator is just beyond the range of the ground wave the first pulse seen is the one-hop-E, and this pulse must be matched with the corresponding pulse from the other station of the pair. Experience in operation has proved that a navigator soon becomes accustomed to the sequence of pulses shown and is generally able to distinguish the ground wave from the sky waves and the one-hop-E wave from the other sky waves.

How the Time Difference is Measured

Figure 9 shows the method by which the navigator measures the time difference. The cathode-ray indicator displays two horizontal traces which are formed, in succession with invisible retrace lines, as shown. The traces are formed under the control of a quartz-crystal oscillator which is adjusted to exact synchronism with the incoming pulses, say those from station pair A_1B_1. In the case we have cited (Fig. 1) the pulse rate for A_1B_1 is 25 pulses per second, so the time from the beginning of the top trace through the entire pattern and back to the beginning of the top trace is exactly 1/25th second, and each trace is approximately 1/50th of a second long. The pulses, being synchronous with the traces, appear as stationary vertical lines, as shown in the Figure.

Auxiliary "pedestals," created by circuits within the indicator, are used as index marks. By adjustment of the crystal-control circuit, the pulses are moved until one pulse falls on the top pedestal. The bottom pedestal, controlled by an adjustable delay circuit, is then moved under the bottom pulse. The relative positions of the two pedestals are then adjusted, by a series of expanded sweeps, (details of which will appear later in this series) until they are oriented with the incoming pulses to an accuracy of one microsecond. The time delay between the formation of the pedestals is then measured by calibration pulses derived from the crystal control. This is the value of time difference associated with stations A_1B_1. A similar measurement is performed on the pulses from station pair A_2B_2 by adjusting the cathode-ray deflection circuits to be synchronous with the rate for that pair, namely 25.0627 pulses per second.

In all, 14 pulse rates are available in the indicator, eight rates being slight variations of 25 pulses per second, and the remaining six being variations of 33⅓ pulses per second. In addition, three radio frequencies, 1750, 1850, and 1950 kc, are available (1900 kc was also used in the SS system) so a wide choice exists in the selection of pairs of stations. Theoretically 14 x 3 = 42 pairs of stations can be accommodated in any one interference area (about a 2000-mile radius) and the whole group can be duplicated in another non-adjacent area. In this manner it is possible to provide widespread coverage without requiring any more than 300 kc of ether space. In post-war applications, only 1850 and 1950 kc will be used, according to the Loran band proposed for international standardization at the Rio de Janeiro conference last month.
—D.G.F.

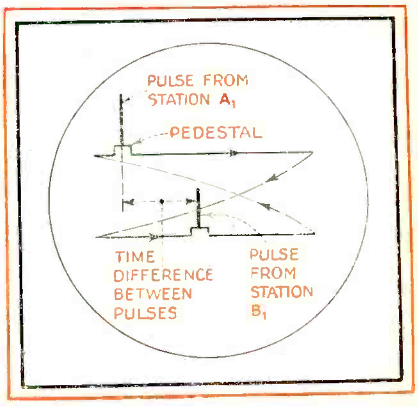


FIG. 9—Basic Loran oscilloscope pattern. By orienting the pulses with the pedestals, and measuring the time between pedestals, the time difference is determined. Expanded sweeps are required to obtain one-microsecond accuracy

Non-Metallic

Disturbances to ground during planting of plastic or other non-metallic mines change the dielectric constant enough to actuate detector set AN/PRS-1, also highly effective for metallic mines. Complete technical details and suggested peacetime industrial applications are given

By T. E. STEWART

Applied Electronic Branch
The Engineer Board
Fort Belvoir, Virginia

Detector set in operation. Operator is using headphones, as required in locations where ambient noise level is high or silence requirements prohibit use of the loudspeaker-type resonator

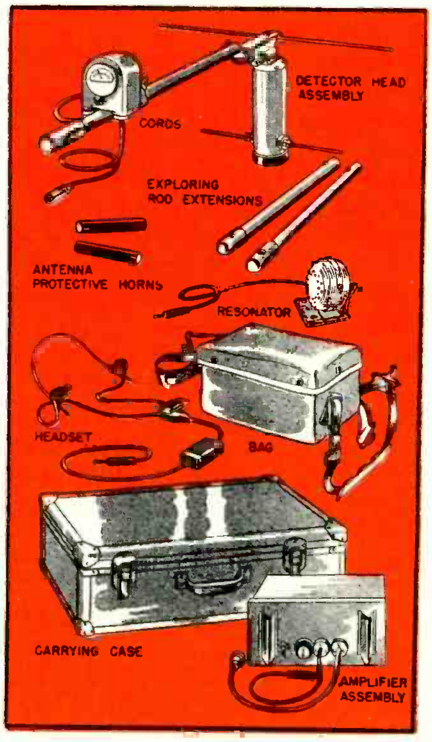


FIG. 1—Main components of detector set AN/PRS-1

During 1942, German forces began to use anti-tank mines that were completely non-metallic in construction. The incidence of these mines became so great that an urgent requirement was established for a detector of non-metallic mines. This problem had been anticipated and development of appropriate non-metallic detecting equipment had been under way as a phase of the overall mine detection problem.

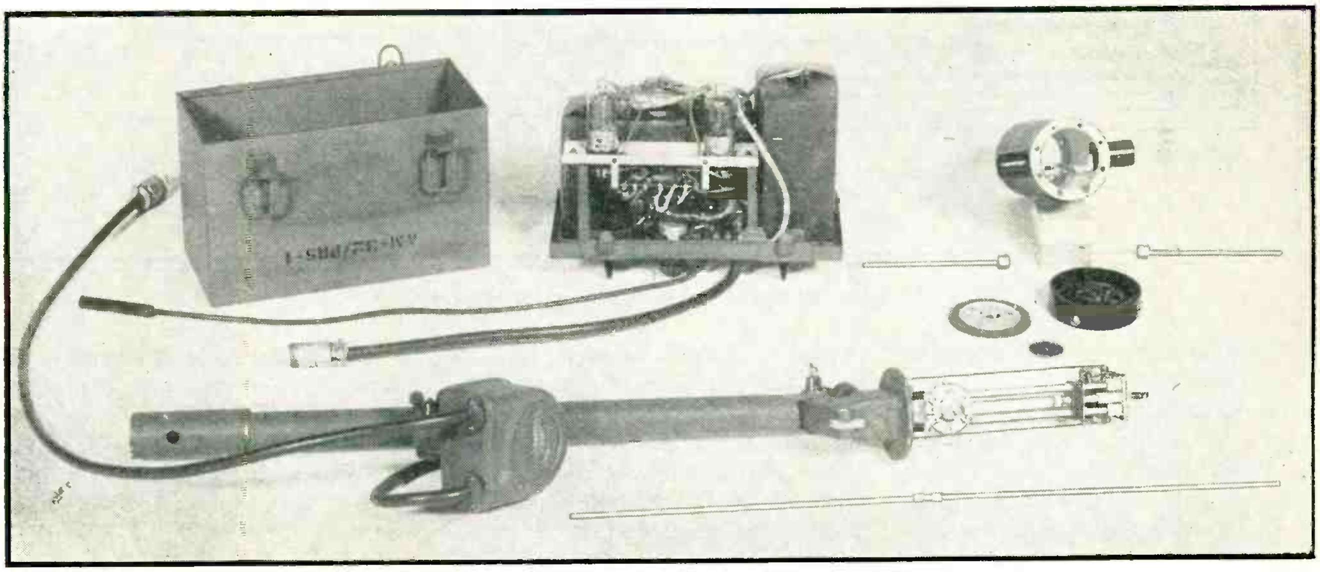
The resultant new detector set AN/PRS-1 reacts to both non-metallic and metallic mines. The device consists primarily of a 300-megacycle oscillator and its associated antenna system. Buried objects, such as non-metallic and metallic anti-tank mines, are indicated by both aural and visual means, the same adjustment of the detector being used to detect either or both types of mines. Aural indications of mines are provided by a 1000-cycle audio resonator or a standard headset. Visual indicating means are provided by a 0 to 150-microampere meter mounted on the detector exploring rod. The detector set is carried and operated by one man.

The detector is generally capable of indicating the presence of the standard American non-metallic or metallic anti-tank mines at depths of 0 to 5 inches, depending upon the conditions of the soil in which the mines are buried. In general, water-saturated soils limit the depth of detection to fractions of an inch for both types of mines, depending on the depth of surface water. Extremely dry soils of high resistivity completely mask the presence of the non-metallic mines but allow detection of the metallic mines in the normal manner. Soils of intermediate characteristics allow normal operation.

Detector set AN/PRS-1 responds to changes in the average dielectric characteristics of the soil over which it is being operated. Because of the frequency of the generated signal (300 mc) non-uniformities in the ground generally must be at least 5 inches long, 2 inches wide, and 1 inch deep before detector response is obtained. Indications then will be derived from objects such as boulders, tree roots, and voids (air pockets). The visual and aural indications obtained from such discontinuities may be similar to those produced by a non-metallic or metallic mine, depending upon the dimensions of the non-uniformity and the depth at which it occurs. A trained operator can learn to recognize the characteristics of the signals produced by many of these discontinuities and treat them properly.

The main components of detector set AN/PRS-1 are illustrated in Fig. 1.

Mine DETECTOR



Set disassembled to show construction. A 6-volt filament battery and 90-volt B battery supply power for the three tubes. Total weight is only 23 lb

Main Components

The detector head assembly includes the detector head with antenna and reflector, and the meter and meter housing. These units are attached to the lower section of the exploring rod and are adjustable. The antenna and reflector are removable, and a control located at the bottom of the detector head furnishes a means of tuning and loading the oscillator. The detector head assembly is connected to the amplifier assembly by a cord equipped with a five-connector male plug.

The antenna protective horns are constructed of a low-loss thermoplastic tubing. These horns fit over bosses mounted on the detector head case and are used to cover the transmitting antennas, protecting them from high weeds, brush, and rain.

The exploring rod extension is an aluminum tube designed for attachment to the detector head assembly rod by means of a ball-detent joint. Two extensions are supplied to afford an optimum exploring range.

The amplifier assembly consists of the audio oscillator, the amplifier, and two short cords. One cord, which terminates in a five-connector female plug, is used to connect the amplifier to the detector head assembly. The other cord terminates in a phone jack for connection to the headset or resonator. Located on the bottom of the amplifier housing are the volume control and on-off switch. Two base legs are provided on the bottom of the amplifier to protect the controls. Space for the batteries is provided within the amplifier housing. The controls, cords, and amplifier housing are of immersion-proof construction.

Electronic Circuits

The complete circuit is given in Fig. 2. The ultrahigh-frequency oscillator mounted in the detector head is of the resonant line type, operating at a frequency of approximately 300 mc. A 50-$\mu\mu$f capacitor, used as a resonant line shunt, is made externally adjustable by means of the tuning knob at the bottom of the detector head assembly. An antenna coupling loop is mounted in the detector head case, providing coupling from the oscillator to the antenna system. The coupling loop is shunted by a resistor chosen to maintain the antenna impedance at the value required for operation.

The radiating dipoles are provided with tapped bosses to fit the studs on the detector head case at which the antenna coupling loop terminates. Provision is made on the detector head assembly to mount a reflecting dipole to increase the signal in the ground over which the detector is being operated. A 3,200-ohm grid resistor is connected in series with the detecting meter to ground. The variations in grid current registered on the detecting meter during operation are used as the visual indicating means. The variations in direct voltage across the grid resistor during operation are applied through a 15,000-ohm resistor to the grid of the output tube of the a-f amplifier to provide variations in audible signal output.

The amplifier assembly contains

electronics WAR REPORT

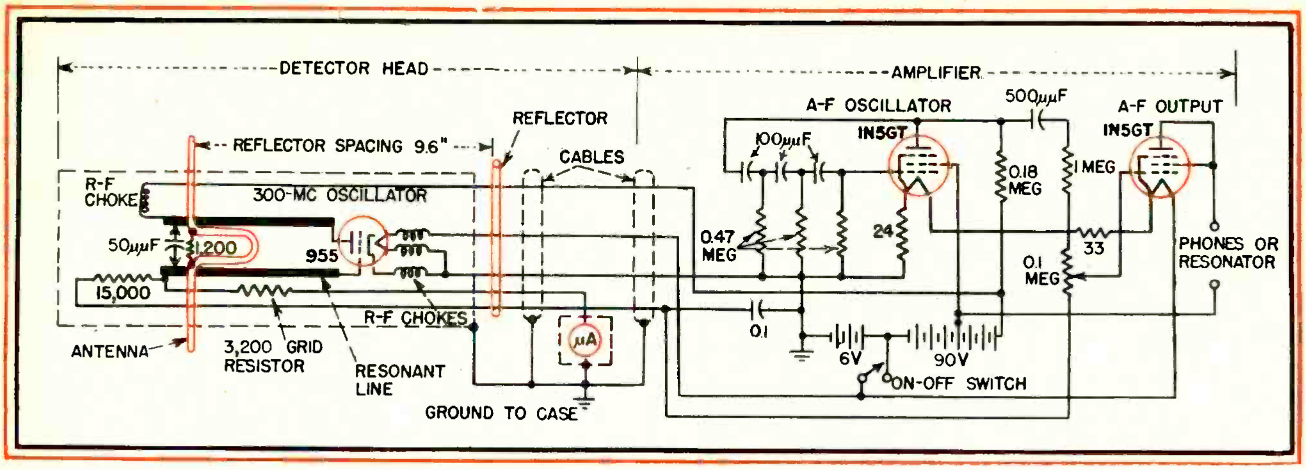


FIG. 2—Complete schematic circuit diagram of detector set AN/PRS-1

a two-tube a-f oscillator- amplifier. The oscillator is of the *RC* type using an untapered phase shift network. A redesign of this amplifier-oscillator combination calls for a tapered phase shift network to be used, in order that oscillation difficulties with low-gain 1N5GT tubes be reduced. The amplifier tube filaments are connected in series with 24 and 33-ohm resistors across a 6-volt filament supply to provide bias for the phase-shift oscillator and reduce the number of batteries required in the detector. A potentiometer is provided in the amplifier to adjust the audio signal initially to the desired level.

Theory of Operation

In Fig. 3A the oscillator is shown coupled to a dipole antenna over homogeneous earth. Radio-frequency current flows from the oscillator to the antenna and along the antenna. A portion of the current flows through space from one side of the antenna to the other as capacitance current. Another portion of the current flows from the right-hand side of the antenna to the earth as capacitance current, through the earth as capacitance and conduction current, and from the earth to the left-hand side of the antenna as capacitance current.

At the operating frequency of the detector (300 mc) the current flow through the earth is equivalent to capacitive current flow through a poor dielectric. If the dielectric constant of a discontinuity in the ground is less than that of the surrounding medium, as in Fig. 3B, an increased amount of current will flow through the surrounding medium, causing an increase in antenna resistance and reactance. If the dielectric constant of the discontinuity is greater than that of the surrounding medium the inverse effect occurs.

Over normal ground the resistance to capacitive flow does not change appreciably when the height of the antenna above ground varies between 2 and 5 inches. However, the presence of a non-metallic mine does measurably change reactance in this region. The change in reactance in the presence of a mine tends to be negative. If the oscillator is tuned to a frequency higher than that of the antenna, the presence of a non-metallic mine brings the antenna into resonance with the oscillator, thus loading the oscillator heavily and decreasing the amount of grid current flow. If the oscillator is tuned to a frequency lower than that of the antenna this change in reactance tends further to reduce the oscillator loading, with no appreciable resultant effect on the oscillator grid current. The presence of metallic mines buried at operational depths in normal ground tends to decrease antenna loading, causing a decrease in oscillator loading and a consequent increase in grid current flow. In the case of metallic mines this increase in grid current is usually by a factor of 2.

Adjustment Procedure

The parameters of the high-frequency oscillator and antenna loading loop are so chosen that the operating frequency of the oscillator is higher than the resonant frequency of the antenna. The coupling loop is shunted by a resistor (of selected high-frequency characteristics) and is retained in a fixed position with respect to the oscillator lines. The oscillator frequency is adjusted, by means of the resonant line shunt capacitor, from the high-frequency side of resonance of the antenna system towards resonance. This is accomplished by manipulation of the tuning knob at the bottom of the detector head assembly.

Proper adjustment is obtained when approximately 80 microamperes of grid current flows in the oscillator circuit when the detector head is held approximately 3 inches above the ground. The presence of a non-metallic mine then causes the grid current to drop to that value established by the contact potential of the tube (usually 10 or 15 microamperes). The presence of a metallic mine unloads the oscillator, causing a substantial rise in grid current (usually in excess of 150 microamperes).

The decrease in grid current causes a drop in the d-c potential across the grid resistor, which is coupled to the amplifier output tube control grid. The decrease in control grid voltage on the a-f output tube in the amplifier causes an increase in the audio signal output. The inverse effect occurs when the oscillator grid current increases. The audible signal is initially adjusted to a satisfactory level, the presence of a non-metallic mine causing the signal to increase in amplitude, and a metallic mine causing the signal to cut off.

During the development of this detector it was determined that the incremental variations obtained from the grid current flowing in the high-frequency oscillator tube were more usable and greater than those changes occurring in the plate circuit. The normal grid current drawn by the type 955 tube oscillating in the unloaded condition is in the order of 5 milliamperes, at 300 mc. As previously indicated, the grid current flowing during operation is in the order of 80 microamperes. High efficiency must be obtained from the oscillator to maintain regeneration under the severe loading conditions imposed upon it.

Technical Considerations

The characteristics of the oscillator tube under the operating condition determine to a great extent the successful operation of the oscillator as a mine detector. For this reason, a great many type 955 tubes do not allow operation of the oscillator under the loading conditions required. It was found necessary to select the tubes used in the high-frequency circuit during production. The choice of the 955 tube for use in the detector circuit was based upon the availability of this type, its high-frequency characteristics, and its measurable grid current under the operating conditions required. The use of this tube required that a substantial filament and plate battery supply be used in the detector in order that a reasonable operating time be obtained between battery changes.

Operation

Detector set AN/PRS-1 is carried and operated by one man. The total weight is 23 pounds, the amplifier weighing 15 pounds and the exploring rod assembly 8 pounds. The operator initially mounts the two tapped dipoles and the reflector on the detector head assembly. The proper cable connections are made to the amplifier and headset or resonator. The choice of resonator or headset is left to the operator. In general, the resonator is more comfortable to the operator than the headset, its use being determined by the necessity for quiet operation or the level of ambient noise.

The detector is turned on by means of the switch mounted on the amplifier. Approximately 30 seconds is required for the 955 tube to reach cathode operating temperature. With the detector head held well above the ground, the tuning knob at the bottom of the detector head assembly is turned clockwise to the extent of its travel so that the oscillator is operating at its highest frequency. The tuning knob is then turned counter-clockwise until the detector meter reads approximately one-half full scale (approximately 80 microamperes). The detector head is then presented to the ground and the tuning knob is turned counter-clockwise until

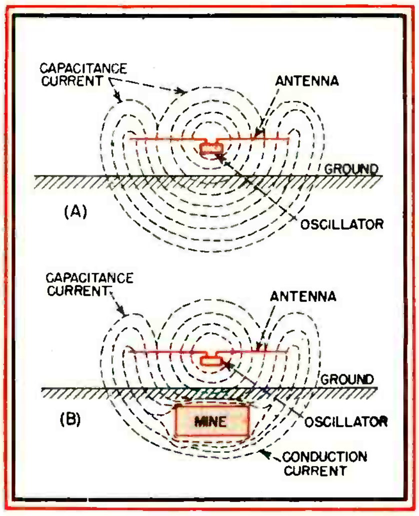


FIG. 3—Manner in which buried metallic or non-metallic mine affects 300-mc r-f conduction currents through earth. These in turn react on capacitance currents that pass through space and change the grid current of the r-f oscillator

no deflection of the meter occurs until the detector head is within 8 inches of the ground. The knob is adjusted until the detector meter reads half-full scale at a height of approximately 3 inches from the ground. The detector oscillator is then operating under the condition necessary for the detection of both non-metallic and metallic mines.

The potentiometer on the amplifier case is adjusted, with the detector head held in the operating position, until a nominal audio signal is heard. The detector operator then moves the detector head from side to side, advancing approximately 1 foot per sweep. For proper operation the height of the detector head above ground is maintained between two and five inches. Over normal soils and with mines buried at operational depths, metallic mines increase the meter reading and decrease the audio signal, and non-metallic mines decrease the meter reading and increase the audio signal.

Future Use

Detector set AN/PRS-1 or modifications of this detector may be used to detect the presence of non-metallic masses buried at shallow depths in the ground. Modifications could be used to detect the presence of metallic masses of finite dimensions in non-metallic objects, while discriminating against objects of smaller size.

The presence of voids or discontinuities in plastic objects could be determined by a modification of this detector. When the device is adjusted off resonance it is capable of detecting the presence of personnel or vehicles in motion at ranges up to 100 feet. Such an application might be valuable in plant protection or machine safety installations where space limitations or arrangement preclude the use of a separate source and receiver combination, or where ambient noise or light prevent the use of audio or photoelectric systems.

Acknowledgments

Initial research and development work on detector set AN/PRS-1 was carried out by the Radio Corporation of America, RCA Victor Division, Indianapolis, Indiana, and the RCA Laboratories, Princeton, New Jersey. Because of the difficulties arising during initial production and testing of the first models of the detector set, additional developmental work was carried out at the Engineer Board. The work was directed and coordinated by the War Department, The Office, Chief of Engineers, Engineer Board, Fort Belvoir, Virginia and the National Defense Research Committee. The Engineer Board is directed by Brigadier General John W. N. Schulz, President, with Colonel W. J. Matteson as Executive Officer.

The SCR-584 Radar
---Part I---

The most versatile of the ground-based radars, SCR-584 stopped the buzz bombs by guiding antiaircraft batteries automatically to an accuracy of 0.06 degree. Technical features include conical scanning, 300-kw pulses at 10-cm wavelength, and range-timing accuracy to 0.01 microsecond

HIGH on the list of the electronic achievements of the war is the SCR-584 radar. A microwave set developed primarily for accurate fire control of 90-mm anti-aircraft batteries, the 584 served this basic purpose from Anzio to the end of the war. It also served as an early-warning radar against approaching enemy aircraft, as a ground control for low-flying fighter aircraft in the advance across France, and detected the motion of enemy transportation along roads and the flight of enemy shells and mortars in the Italian campaign. Technically, also, SCR-584 merits a high place. It is among the most powerful of the portable radars, and is outstanding in the accuracy of its indications. In short, this radar is one of the most highly-engineered electronic devices in existence.

The need for a radar to control the fire of anti-aircraft guns was felt before the war, and the SCR-268 (ELECTRONICS, September 1945, page 100) was applied to this use in the early days. But greater accuracy, obtainable only by the use of shorter wavelengths, was required. The military needs were presented to the Radiation Laboratory at M.I.T. by the Coast Artillery Corps (then the parent body of the Anti-aircraft Command) in January, 1941. By April, the prototype equipment had been erected on the roof of Building 6 at M.I.T. and was successfully tracking aircraft the following month. Since the need for portability was evident, the equipment was then transferred by the Radiation Lab group to a truck, known as XT-1, and demonstrated in November of the same year.* After coordination at the Signal Corps Laboratories, the XT-1 was given its service test by the Coast Artillery at Fort Monroe in February 1942. This test having been passed successfully, manufacturers were called in to bid on production and a year later, in May 1943, the first production model of SCR-584 was delivered to Camp Davis. Its first active service was at the Anzio beachhead in February 1944. In all, no fewer than 1,710 SCR 584 radars

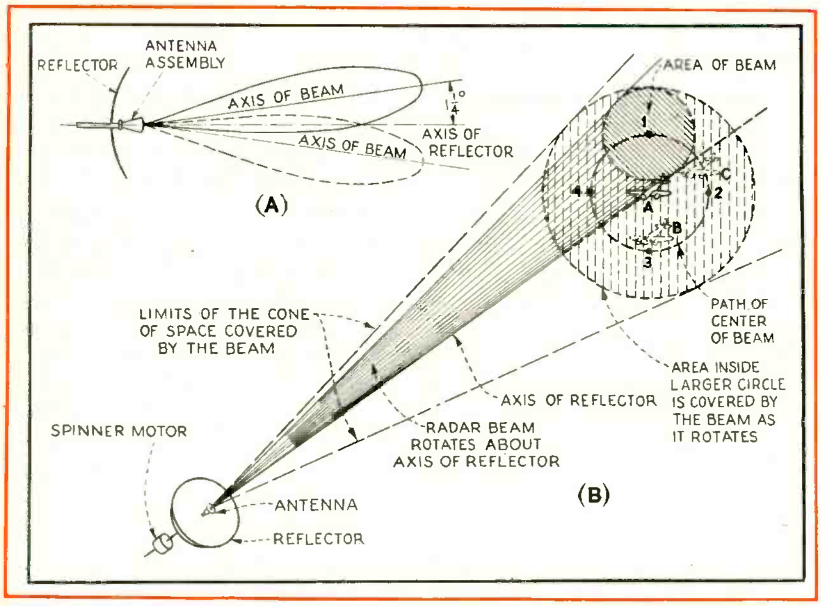
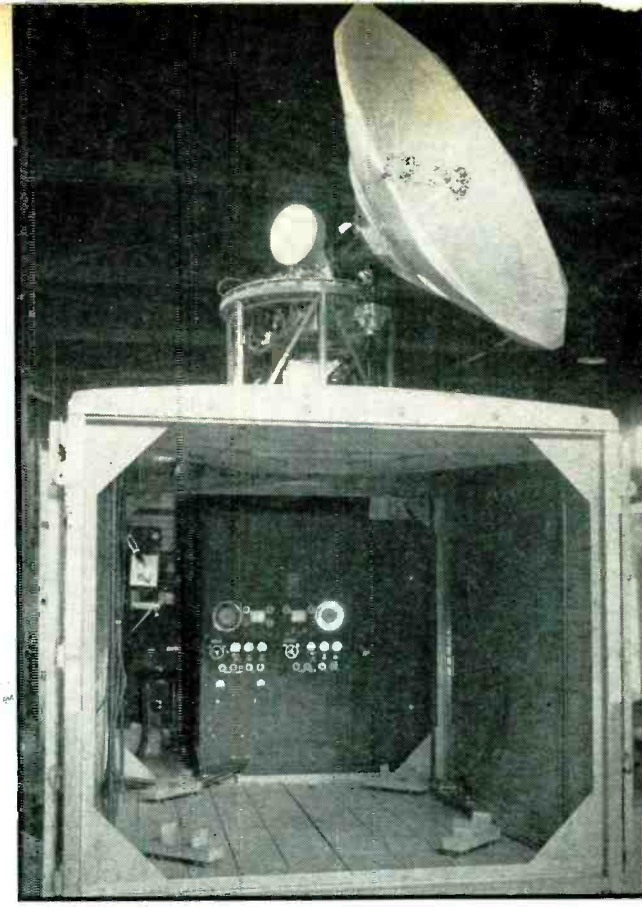


FIG. 1—(A)—Conical scanning is obtained by rotating an offset beam about the axis of the reflector. (B)—The effect of conical scanning is to create a sinusoidal error signal when the target lies off the axis of the reflector

*Among the personnel at the Radiation Laboratory and in military organizations who contributed to the design and production of the SCR-584 are: H. B. Abajian, Col. W. S. Bowen, B. Chance, L. L. Davenport, H. D. Doolittle, I. A. Getting, Sidney Godet, A. Grass, D. T. Griggs, G. B. Harris, C. E. Ingalls, Col. J. E. McGraw, L. N. Ridenour, C. W. Sherwin, Lt. Col. J. A. Slattery, L. J. Sullivan, A. H. Warner, and the late Lt. Col. Paul Watson.

Production model SCR-584 in operation at 68th CA (AA) Bn (C Battery) in the Nettuna Area, Italy, for antiaircraft gunfire control, camouflaged against detection and sandbagged for protection



The original model, developed and built in the Radiation Laboratory in 1941 and known as XT-1. This was the first radar capable of following a target automatically without human aid

were delivered, at an average cost (including spare parts) of approximately $100,000 each.

Basic Specifications

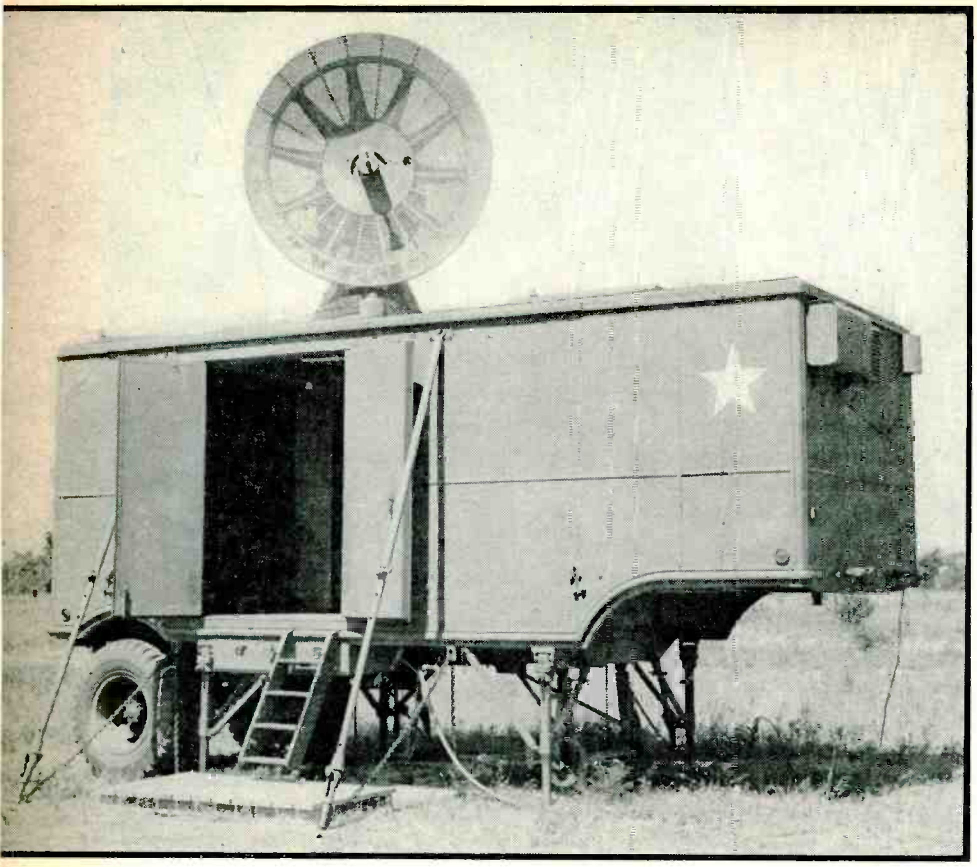
The specifications of the SCR-584 are listed in the accompanying table, the significance of the data being discussed in other pages of this issue. By the use of 300-kw pulses of 10-cm radiation, transmitted from a 6-foot paraboloidal reflector, the SCR-584 is designed to track (i.e., follow continuously) individual aircraft out to 18 nautical miles, and detect them at 40 miles. Actually it can track aircraft at 50 miles if required. While tracking, the target position is indicated within plus or minus 25 yards in range, and 0.06 degrees in azimuth and elevation. The range indication, while looking at a stationary target, may be reset to an accuracy of 2 yards, which represents a timing accuracy of about 0.01 microsecond. The key to this outstanding performance lies in the use of conical scanning for angular determination of the target position and a quartz-crystal oscillator for timing the echoes. The use of a short pulse (0.8 microsecond long) and an expanded cathode-ray sweep permits the echo pulses to be measured precisely.

Two forms of scanning (the motion of the radiated beam through space) are employed: helical scanning and conical scanning. In helical scanning, employed for searching for aircraft before they come within range of the guns, the paraboloid is swung in a circle at a rate of 6 rpm. Simultaneously the reflector is tilted in the vertical angle (elevation) at a rate of about 4 degrees per turn. A point on the beam thus traces out a helical path, from about 10 degrees below the horizontal to the zenith, over any 20° sector. Since the beam itself is 4 degrees wide (7 degrees when the conical scanning is in operation) all points of space are passed over by the beam during each full helical scan. If an aircraft target is within range, the radar will surely detect it.

SPECIFICATIONS

Wavelength	10-11 cm
Frequency	2,700-2,900 mc
Reflector	6-foot paraboloid
Pulse Power	300 kw
Pulse width	0.8 microsecond
Pulse rate	1,707 pps
Receiver bandwidth	1.7 mc
Receiver noise figure	15 db
Beam width	4 degrees (not spinning)
Beam width	7 degrees (spinning)
Search scan	6 rpm helical
Track scan	1,400 rpm conical
Azimuth range	360 degrees
Elevation range	-10 to $+89$ degrees
Maximum range, search	40 miles
Maximum range, track	18 miles
Minimum range	500-1,000 yards
Range accuracy	± 2 yd (dynamic)
Range accuracy	± 2 yd (static)
Angular accuracy	± 1 mil $= 0.06$ degree

electronics WAR REPORT



Overall view of the SCR-584. The paraboloid can be lowered into the trailer during transportation

Once the target is detected and is within range of the guns the radar function is shifted from search to track. In tracking, the axis of the antenna points automatically and continuously at the target, while the radar transmits range and angular data to the associated gunfire computer. This automatic function is accomplished by the use of conical scanning, illustrated in Fig. 1A. The radiation is off-set electrically from the focus of the reflector and the dipole radiator is rotated about the focus by an auxiliary motor at a rate of 1400 rpm. The offset causes the axis of the radiated beam to depart from the axis of the paraboloid by about 1.25 degrees, and as it rotates, the beam traces out a cone as shown.

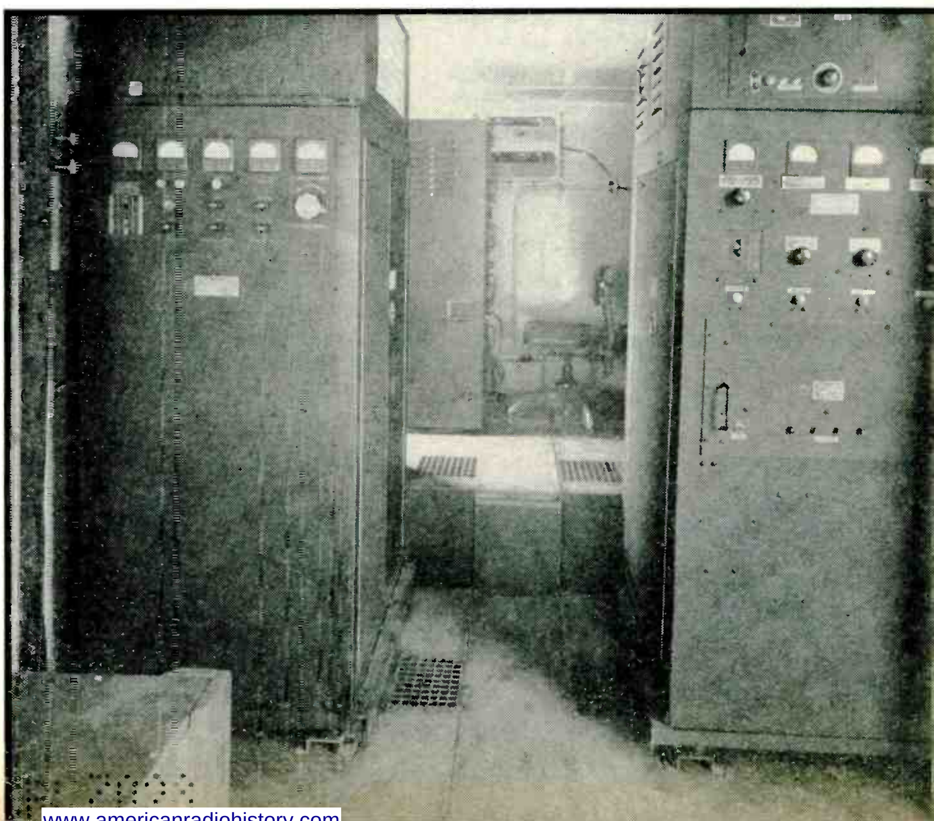
When the target lies on the axis of this cone (at point A in Fig. 1B) the signal intercepted has a constant value throughout the rotation. Consequently the reflected pulses are of constant amplitude, except for changes due to fading, polarization effects, etc. But if the target is off this axis, say at point B, the signal intercepted is a maximum at position 3, a minimum at position 1 and has intermediate values at positions 2 and 4. The variation in the intercepted and reflected signal is approximately sinusoidal, with a frequency equal to the rotation rate. Finally, if the target is at position C, the same sinusoidal variation occurs, but is shifted 90° in phase relative to that of position B. When the target has some intermediate position between B and C, the phase angle has a corresponding intermediate value.

The reflected pulses are thus modulated in amplitude. The amplitude of the modulation increases as the target departs from the axis of the cone, and the phase angle indicates the direction of the departure. By translation of these quantities into appropriate motor controls the antenna is directed so as to keep the target centered on the axis of the cone. So sensitive is this control that a departure from the cone axis of a few hundredths of a degree is immediately perceived and corrected. Moreover, the hunting of the radiator while following the target position is restricted to a probable error of one mil, or 0.06 degree.

General Operating Principles

The components of the SCR-584 are shown in the block diagram in Fig. 2. The operation starts in the timing unit, which contains a crys-

Looking forward in the trailer, the 22-kilovolt rectifier is at the left, and the modulator (including magnetron transmitter) at the right. These two units develop pulses of 300-kw peak power at a rate of 1707 per second



tal oscillator and four frequency-dividing multivibrator stages which produce the basic pulse rate of 1,707 pulses per second. Several waveforms are generated in the timing unit to initiate the transmitter pulses and to synchronize the receiving and indicating systems with them. Narrow trigger pulses are fed to the transmitting system which comprises a driver, modulator, and r-f generator (cavity magnetron). R-f pulses of 0.8 μsec width, 3,000-mc frequency, and 300 kw peak power are generated every 586 microseconds in the transmitting system and applied through the co-axial transmission line to the antenna. On their way to the radiator, the pulses pass an enclosed low-pressure spark gap known as the transmit-receive switch (T/R box). This gap breaks down during each pulse and short-circuits the transmission line to the receiver, thus preventing the transmitter pulses from burning out the crystal mixer of the receiver.

The pulses continue to the radiator, passing concentrically through the shaft of the spinner motor which rotates the antenna to produce the conical scan. After reflection from the target the pulses are received by the same antenna and return along the same transmission line. The transmitter is then inactive and its impedance is different from that of the transmission line. Consequently, little of the received signal is absorbed by the transmitter. The T/R spark gap has by then ceased conduction, so the transmission line conducts the signal to the receiver. Here it is converted in a silicon-crystal mixer to an intermediate frequency of 30 mc, amplified, detected, and amplified again as a video control signal. Pulses are fed to the receiver from the timing unit to bias the i-f amplifier during the transmission of the pulse, as additional protection against overload.

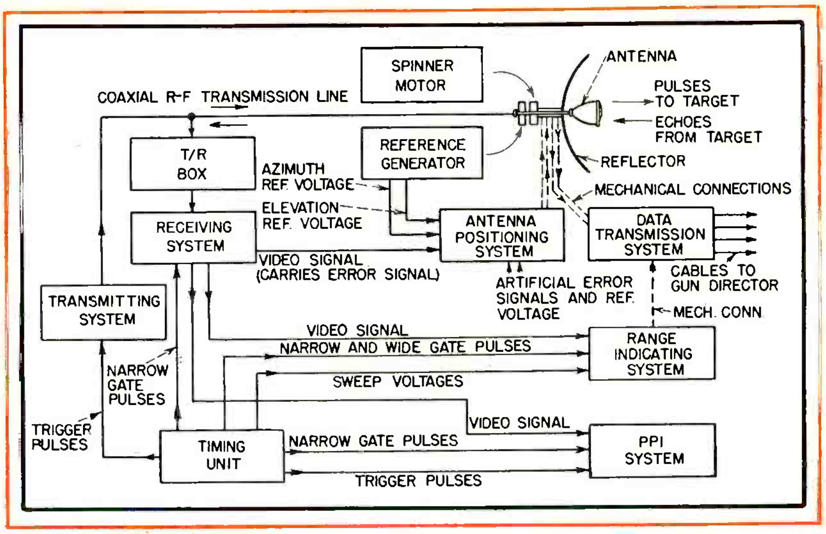
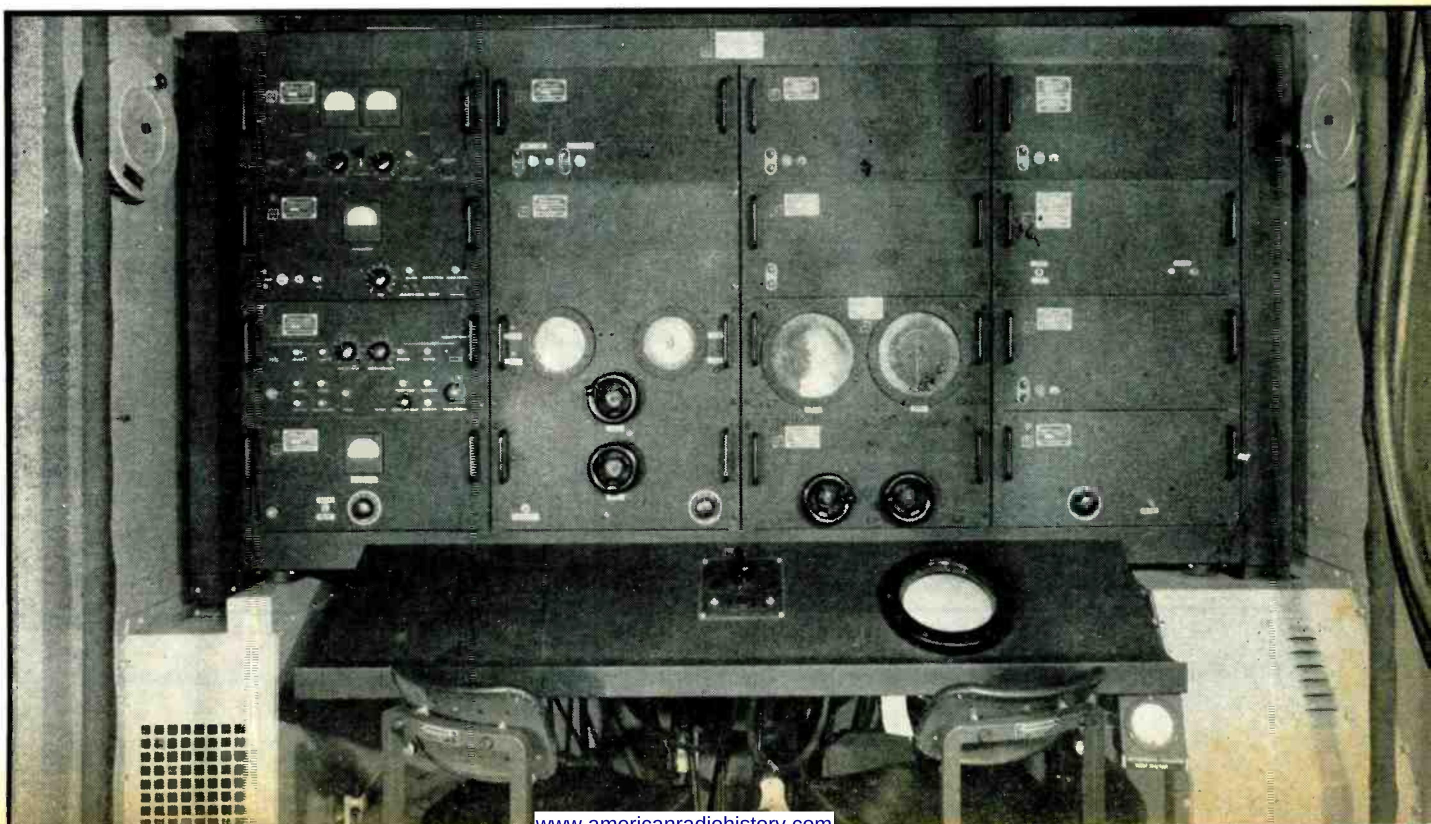


FIG. 2—Block diagram of the SCR-584. Details of the transmitting system are included in this article; other elements are in articles to follow

The video output of the receiver is fed to three units. The first is the antenna positioning system which compares the error signal (the amplitude modulation envelope of the received pulses) in phase and amplitude with reference voltages derived from a reference generator mounted on the spinner shaft. This comparison develops two control voltages, one proportional to the azimuth component of the error



The SCR-584 units. The two oscilloscopes at left of center are the type J indicators used in measuring the distance to the target. The dials at the right indicate the azimuth and elevation angles at which the antenna is pointing. The inclined screen is a PPI indicator which shows simultaneously the positions of all aircraft targets out to 40 miles signal, the other proportional to the elevation component. These control voltages operate an amplidyne control system which orients the antenna so that the error signal is a minimum. Manual positioning is also possible through the use of an artificial error signal, produced within the equipment and controlled by knobs set by the operator to the desired values of azimuth and elevation.

Another output from the receiver is fed to the range indicating system. This system contains two 3-inch oscilloscopes used as type J indicators. The sweep pattern is circular. The echo signal is displayed as a radial pulse on the trace. One scope covers a range of 2000 yards for fine indication of the range, and the other covers 32,000 yards for coarse indication. The circular sweep is provided by sweep voltages derived from the timing unit.

The range indicating system is used primarily as an adjunct to automatic operation. The operator adjusts the tracking handwheel so as to keep the echo pulse on the calibration hairline. The range unit includes a mechanical aided-tracking device which maintains a given rate of change of range to keep up with the target, while the operator feeds in occasional corrections to the rate. A mechanical connection from the range handwheel to the data transmission system introduces the range coordinate, and similar connections from the antenna introduce the azimuth and elevation coordinates. The data transmission system computes the height of the target, and passes all the information to the gun computer.

The remaining component shown is the plan position indicator (PPI) system. This is an indicator used primarily during the search phase of the radar operation. The cathode-ray beam in the PPI is deflected radially, starting from the center of the screen at the instant the transmitted pulse leaves the radar and continuing outward at a constant rate. The sweep rotates synchronously with the antenna as it scans in azimuth. When an echo is received from a target, the c-r beam is brightened and a spot appears on the trace representing the target. The distance of the spot from the center of the tube indicates the slant range of the target and the direction of the trace indicates the azimuth angle to the target. The PPI thus presents a map of the area surrounding the radar, with all targets within range shown in their relative positions, in plan view. The deflection currents are generated within the PPI system, and are synchronized by trigger pulses from the timer unit.

The Transmitting System

The transmitting system block diagram is shown in Fig. 3, and simplified schematics of the driver and modulator are shown in Fig. 4 and 5. The driver unit is controlled by a short, sharp trigger pulse of 15 volts amplitude derived from the timer unit (as indicated later in this series of articles). These pulses drive a one-shot (biased) multivibrator (6SN7GT tube) which generates a negative rectangular pulse of two microseconds duration. This is fed to a 6L6G inverter stage which reverses the polarity and applies the pulse, in positive polarity, to the first driver stage (type 3E29).

The first driver is coupled by a pulse transformer (capable of passing short pulses) which reverses the polarity, feeding positive pulses to the second driver stage. The negative pulse appearing in the output of the second driver stage (two type 3E29) is fed back to the grid of the first driver through a low-pass filter network which serves as an artificial transmission line. The constants of this line are so chosen that the pulse requires exactly 0.8 microsecond to pass through the line. Consequently 0.8 microsecond after the pulse is applied in positive polarity to the first driver, a large negative pulse is fed

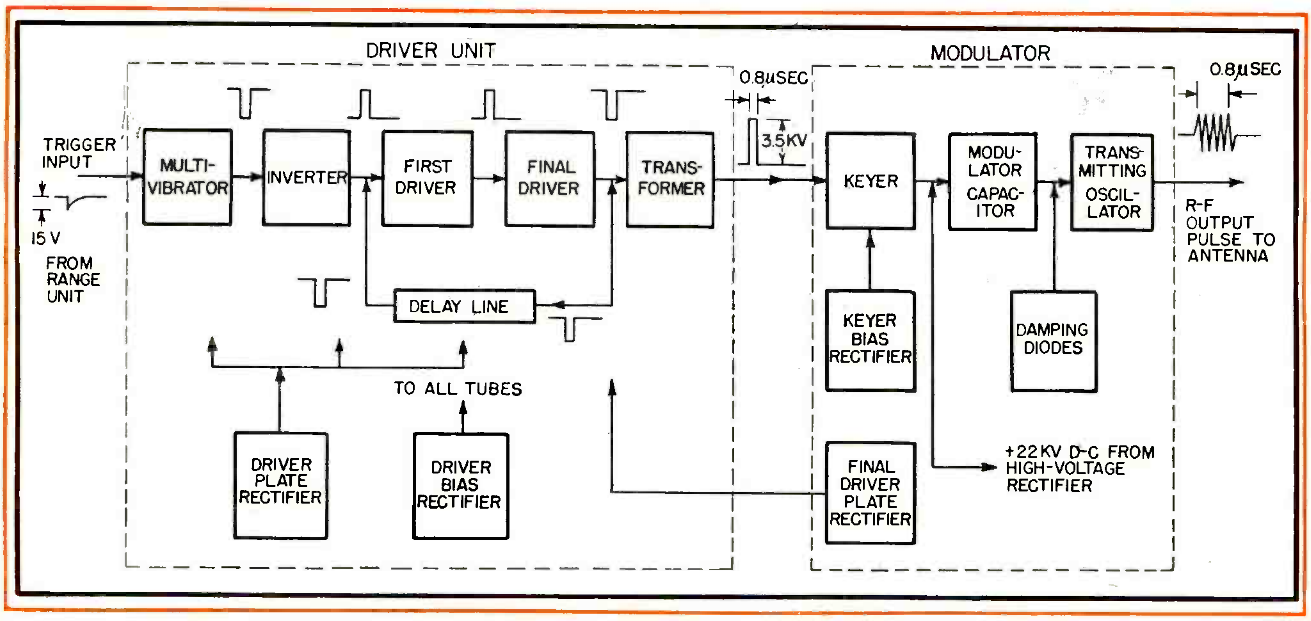


FIG. 3—Block diagram of the transmitting system. Acting under the control of the timing unit, these circuits create r-f pulses of the required length, power and rate

back to it, thus cutting off the first driver and forming the trailing edge of the pulse. The resulting pulse appears across the output pulse transformer, with an amplitude of 3,500 volts, positive against ground.

The output of the driver is fed to the grids of the modulator or keyer tubes, two type 6C21 tubes in parallel, shown in Fig. 5. The grids are biased to −1400 volts and thus remain cut off between pulses.

When the driver pulse appears, it drives the grids of the modulator tubes into the positive region, and the modulator tubes pass a current of about 20 amperes, discharging the modulator capacitor (previously charged to 22 kilovolts) through the magnetron. This sudden passage of current excites the magnetron into oscillation at the desired frequency (in the band from 2,700 to 2,900 mc).

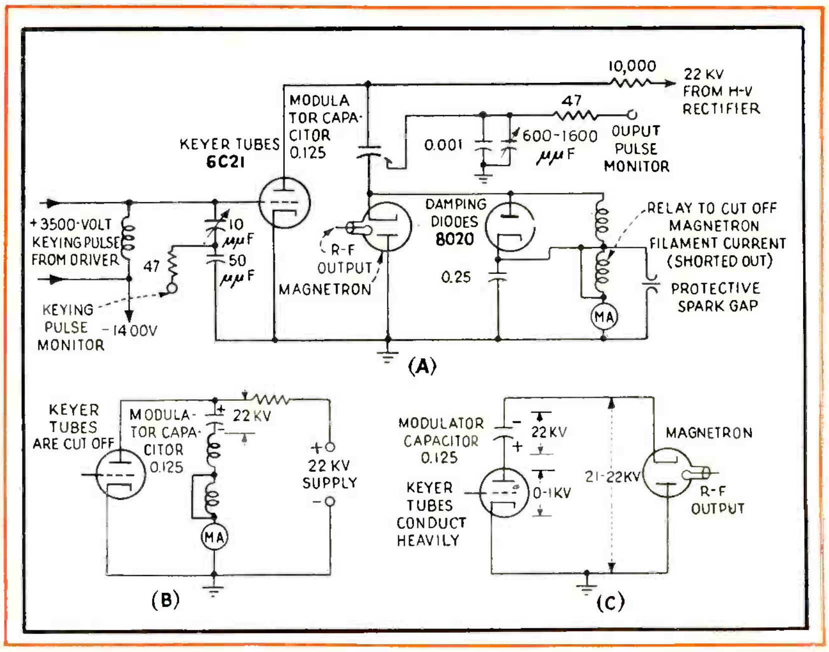


FIG. 5—(A)—Simplified schematic of the modulator and r-f generator. (B)—Equivalent circuit between pulses, while modulator capacitor is charging. (C)—Equivalent circuit during discharge through magnetron

At the conclusion of the driver pulse, the modulator tubes suddenly become nonconducting and the discharge through the magnetron is stopped. There is a tendency for the circuit to continue to oscillate, due to resonance between the stray capacitance of the magnetron and wiring with the inductance which completes the capacitor charging circuit to ground. To damp this resonant circuit, three diodes (type 8020) are provided which conduct the positive halves of the oscillations and thus rapidly absorb the stored energy.

Figure 5 shows the two equivalent circuits of the modulator. At the lower left is the condition between pulses, with the modulator tubes cut off, and the modulator capacitor charging from the power supply at a slow rate through the inductance. At the lower right is the condition during each pulse, in which the capacitor is discharged through the magnetron. The inductance, which cannot pass a sudden change in current, prevents the power supply from being short-circuited during the pulse, while allowing the capacitor to be charged at a slow rate between pulses.

The r-f transmission system, radiator, spinner mechanisms, and receiver will be described in the second article of this series.—D.G.F.

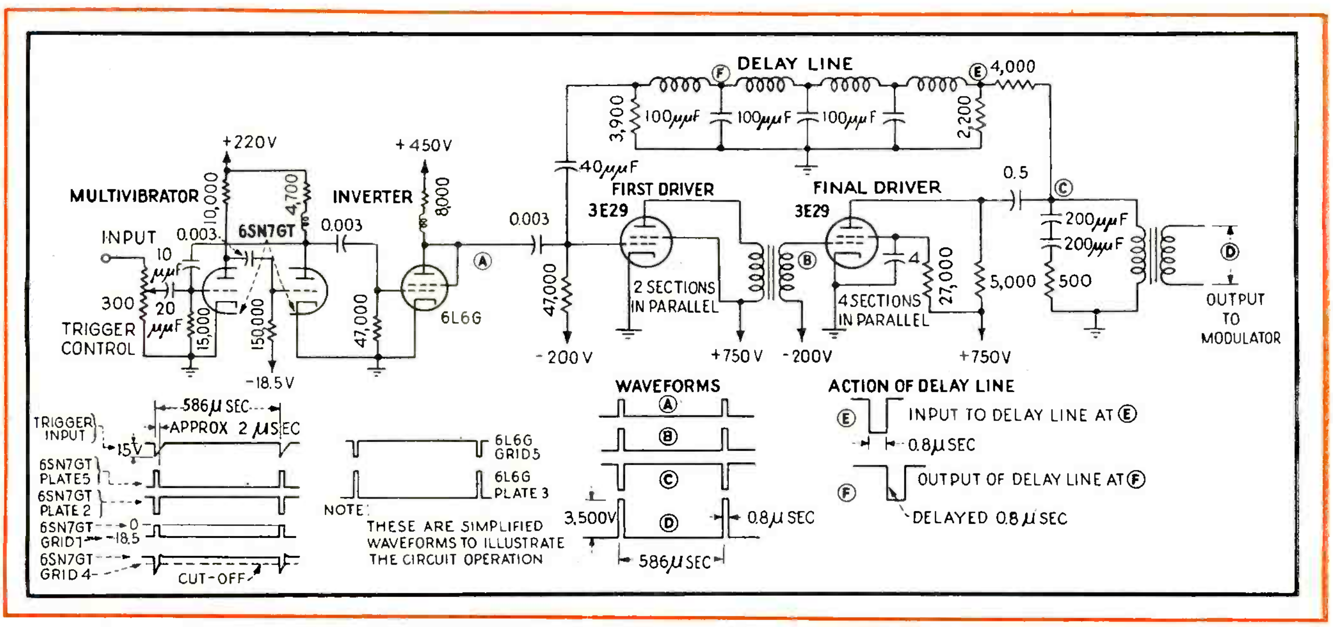


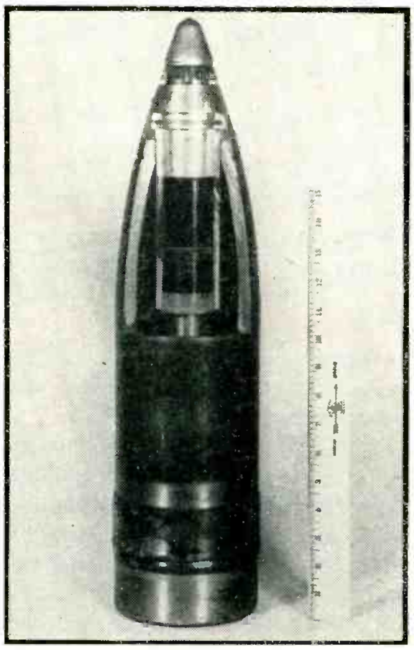
FIG. 4—Simplified schematic of the driver unit, which creates 0.8-microsecond pulses of 3500-volt amplitude for driving the modulator tubes

Proximity Fuze

Transmitter-receiver in nose develops a ripple signal which is used to explode projectile as it approaches target. Compact, midget construction makes possible assembly of electronic circuit and power supply in rockets, bombs and shells

THE ELECTRONICALLY OPERATED fuze to be described causes a projectile to burst in the vicinity of its target and therefore is called a proximity or influence fuze. Under the conditions for which it was designed, a near miss is as effective as a direct hit.

The fuze, designated as a VT fuze, includes a high-frequency oscillator that excites an antenna. Depending on the strategic application of the projectile, the antenna is either the projectile itself and a small insulated metal cap, or a short, balanced dipole mounted on the nose. If radiation from this antenna is reflected back to it by a target, the apparent impedance of the antenna is changed. This change in oscillator loading is detected and fed into an electric control circuit which ignites an electrical detonator to initiate the explosion.



(Right) Navy VT fuze for an AA shell includes a Lucite-insulated nose assembly, the electronic control circuit, a special electrolytic battery, and a triple safety assembly which arms the fuze after it has passed beyond the influence range of the gun and detonates the shell when it returns to the ground if the fuze is a dud

(Below) Radio-influence fuze for a bomb includes dipole antenna and wind-driven generator

Operation

The antenna impedance as seen by the electronic fuze during flight varies in space as illustrated in Fig. 1. (The frequency at which this impedance varies, and hence the frequency that must be detected and used, depends upon the relative velocity between projectile and target.) The change in antenna impedance up to the optimum point for detonation of the projectile is a small fraction of the total impedance. Thus a circuit is required that is sensitive to loading, yet stable in operation.

If antenna impedance in free space is Z_0, and the apparent impedance in the presence of reflected waves is Z, and if the projectile is approaching the target along a path as shown in Fig. 1, the relative velocity of projectile to target is $V = V_0 \sin \theta$ where V_0 is the velocity of the projectile in a coordinate system for which the target is at rest, then

$$Z = Z_0 + A\epsilon^{j\left(\frac{4\pi\, V_0 \sin\Theta}{\lambda} + \phi\right)}$$

where A and ϕ are functions of the reflectivity of the target and radiation pattern of the fuze antenna.

Initial accelerations of antiaircraft projectiles, 20,000 g, and centrifugal forces produced by rotation at 475 rpm, necessitated development of rugged tubes and circuit components. The initial acceleration and acquired centrifugal force are used to break a vial of electrolyte and diffuse it throughout the specially developed battery used for power in fuzes for this class of missile. By this method the fuzes are held inactive until the instant of gun firing, and deterioration of batteries is prevented.

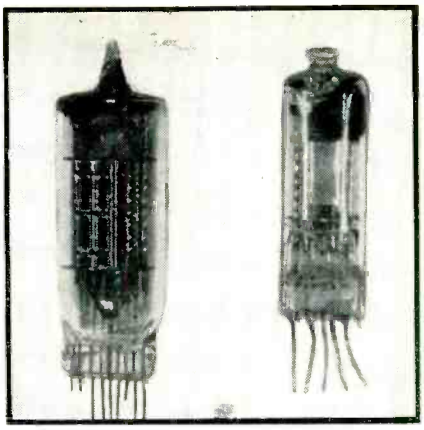
Bombs and rockets are launched at high altitudes after being carried aloft and cooling to as low as − 60 C, thus batteries are unreliable for power in this type of missile. Miniature, high-speed, wind-driven generators were developed. The use of these generators also simplified safety measures because, unless the missiles are in motion, there is no power.

Vibrations from the missile and generator required tubes that were free from microphonics.

Strategic Uses

Success of airplanes against surface ships in the early stages of the war indicated a need for more effective weapons. Radar provides advance warning and gun direction against aircraft, but the necessity of accurately measuring target

electronics WAR REPORT



Typical tubes used in VT fuzes are similar to hearing-aid tubes. Types include triode, pentode and thyratron

range and setting time fuzes limited effectiveness of fire. A fuze was needed that would increase effectiveness of attack on airborne targets by shells from ship or ground AA or by rockets from fighter aircraft, and on ground targets by howitzer shells or bombs.

When a VT-fuzed projectile is used against an airplane, the fuze detonates the shell when its fragmentation will embrace the target as shown in Fig. 2, even if its path would not result in a direct hit as is necessary for contact-fuze detonated missiles, or if range has been inaccurately determined in the case of time fuzes.

When a VT-fuzed bomb, artillery or mortar shell is used against partially shielded personnel and light equipment, its effectiveness is greatly increased through its ability to shower high velocity fragments into the fox hole or revetment.

Against Jap kamikaze bombers, Nazi buzz bombs, and in the Battle of the Bulge, the proximity fuze was highly praised by tactical personnel. In such Pacific Island operations as Iwo Jima and Okinawa the fuze was used by us during attack to disrupt enemy gun operation through bombing and later during defense to shoot down enemy aircraft by VT-fuzed AA.

Development

The National Defense Research Committee centered research on influence fuzes for the Army and Navy at Carnegie Institution of Washington in mid 1940. The project was soon divided into two parts.

Development of fuzes for nonrotating projectiles such as rockets, bombs, and mortars was conducted through the Bureau of Standards under NDRC and Army Ordnance; fuzes for rotating projectiles including field artillery and antiaircraft projectiles were developed through Carnegie Institution and Johns Hopkins University, this portion of the project being transferred to the OSRD and later to the Navy Bureau of Ordnance.

Special tubes and components were developed in cooperation with numerous manufacturers. One-third of the electronic industry in the United States was involved. Manufacturing capacity for tubes, capacitors, and resistors was tremendously increased. Cost of the project approached a billion dollars; over 20 million expendable fuzes were produced, and upward of 100,000 individuals were directly involved in development and production.

As a new weapon the VT fuze combined increased destructiveness and surprise. On the home front the project was shrouded in secrecy, the industries working in cooperation with war agencies not even receiving well-merited E awards so that talk about the fuze would be held to a minimum. Armed guards accompanied all fuze shipments.

In battle the proximity fuze was used at first in areas where duds could not land in enemy territory. In this way the maximum element of surprise was obtained. Its development rates as one of the best kept of war secrets, and is a monument to scientific and engineering skill, industrial productivity, and official coordination.

British scientists were working on influence fuzes for rockets and bombs in 1939. Later, their efforts were combined with ours. German scientists, although they had begun research on proximity fuzes in the early 1930's, did not develop usable models because of lack of coordination and duplicity of effort.

Material and assistance for the preparation of this article were generously supplied by H. Diamond, Dr. R. D. Huntoon, Dr. C. Brunetti, Dr. J. A. Hynek, and Mrs. D. Schulte. Col. C. H. M. Roberts read the first draft and made valuable suggestions as to the proper nomenclature.—F.R.

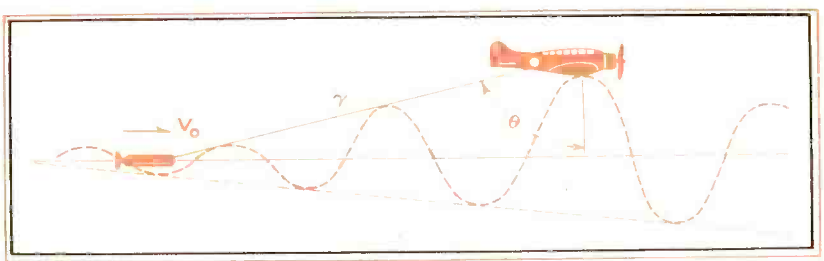


FIG. 1—*(left)* Interference pattern established at moving projectile antenna by Doppler effect varies as target is approached, resulting in fluctuation in antenna impedance as shown by dotted curve

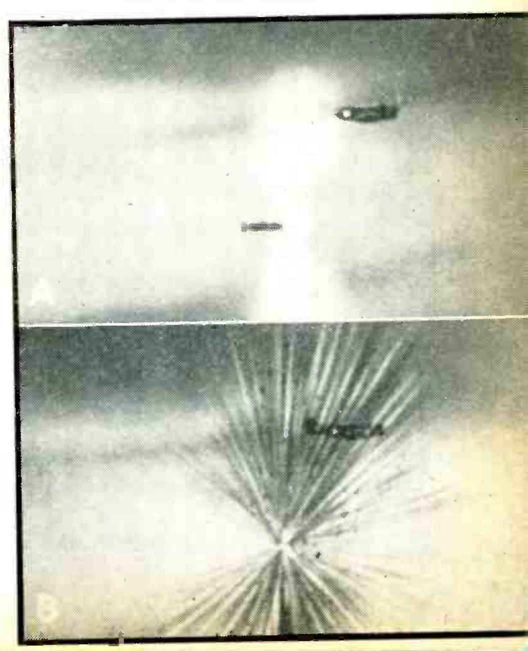
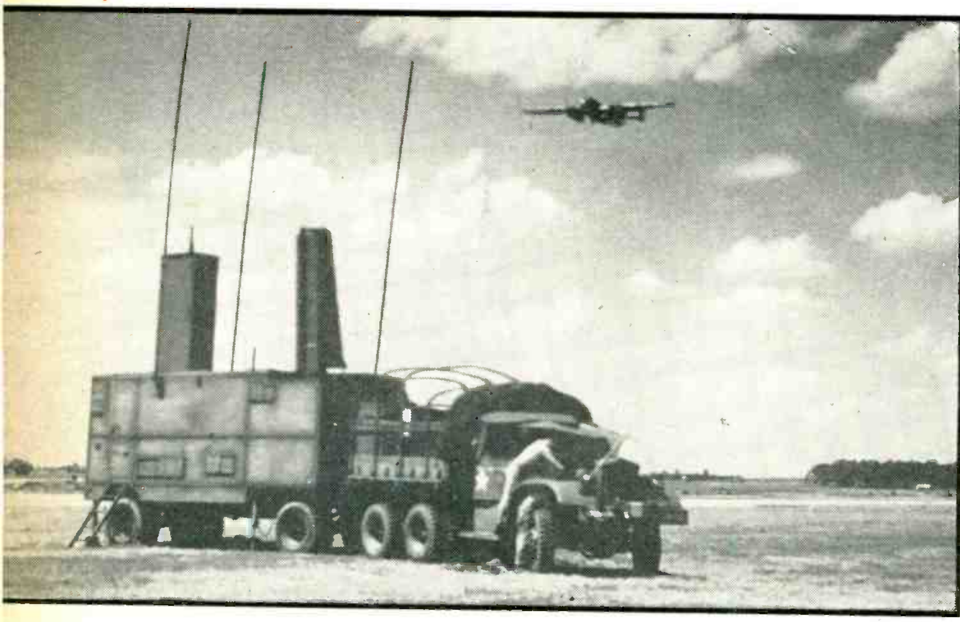


FIG. 2—*(below)* (A) Although this rocket will not directly hit the airplane, its radiation field, shown in white, does. (B) The shell is detonated within damaging distance of the target

Ground-Controlled



GCA equipment ready for use at an Army Airways Communications System airfield. The radar antennas are atop the trailer, along with conventional whip antennas for radio communication with incoming aircraft

By CAPTAIN C. W. WATSON

Radar Officer
Headquarters, Army Airways Communications System

ONE of the last radar developments of the war may turn out to be the most important for peacetime aviation. Aircraft arrivals and departures may soon be scheduled to and from airports without regard to the weather, an accomplishment made possible by an Army-Navy electronic device that has been used since early this year to land aircraft during weather conditions nearing zero ceiling and visibility. The radar system which makes closed-in airports a thing of the past is known as Ground Controlled Approach (GCA), and is the result of four years of experimentation and testing.

Early History of GCA

A group of scientists assembled by the National Defense Research Council at the Radiation Laboratories, Cambridge, Massachusetts, conceived the idea of using radar for blind landings of aircraft in 1941 and the process of development was begun. The first model, known as Mark I, was finished in 1943, after being assembled from existing airborne radar sets then available. The unit was flight tested in the U. S. and in the British Isles, where it convinced those engaged in the development that it was operationally sound.

Although it demonstrated the potentialities of GCA, the Mark I version was not quite what the Radiation Laboratory scientists wanted. The succeeding model, Mark II, included many refinements. It was, however, outmoded before production was thoroughly underway and the result was the emergence of the Mark III model which is the GCA in use today.

Justification for the development of an electronic device of this type was not long appearing. Rushed to the European and Pacific theaters early this year, it quickly demonstrated that planes could be brought down through zero-zero weather safely and efficiently. Operated by personnel of the Army Airways Communications System for the U. S. Army Air Forces, GCA made regular flight schedules possible around the clock when our airfields were completely closed in by fog. At Iwo Jima alone, in the final phases of the war against the Japanese, it saved scores of superforts and nightfighters returning from missions at a time when Maple airfield on Iwo Jima was invisible at a distance of one hundred feet.

Two Radars Are Used

GCA is a completely self-contained mobile radio set having two ground radar systems together with the necessary communications facilities. One of the radar systems, known as the search system, operates on a shf band and is designed to aid in or control the homing, holding, stacking and traffic pattern operations of aircraft out to approximately 30 miles.

The second system, a precision system, operates on a higher shf band and controls the aircraft during its actual let-down along a predetermined glide path. The unique characteristic of this type of radar-controlled approach is that no special equipment is required in the aircraft other than ordinary air-ground communications equipment.

Search Radar Characteristics

The search radar system provides the GCA operators with information on the azimuth bearing and range of aircraft from the airfield at distances up to 30 miles and at altitudes up to 4,000 feet. To ac-

Approach for Aircraft

In GCA, two microwave radar systems at an airfield reveal the exact position of an incoming aircraft with respect to the landing glide path, permitting the ground operator to radio precise flight instructions to a pilot coming in through zero-zero fog. Possibilities for around-the-clock traffic control and landing at commercial airfields are promising

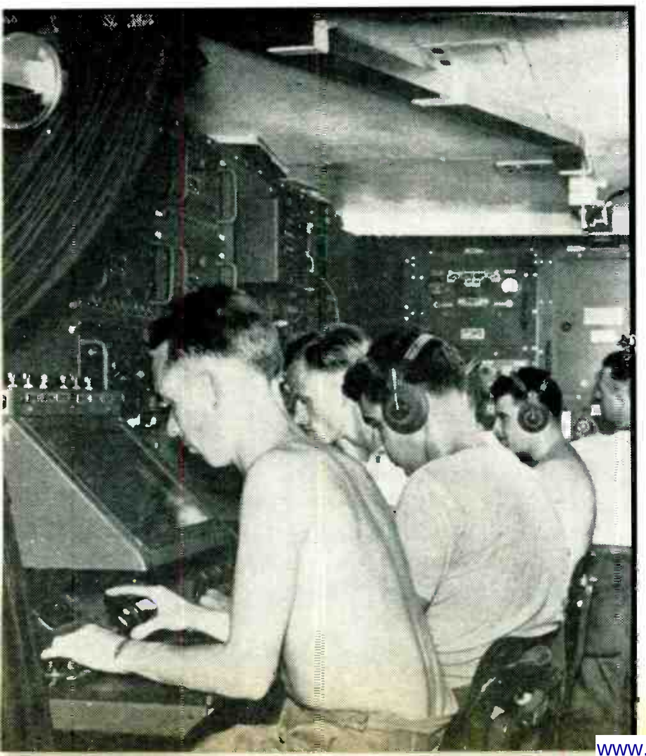
complish this purpose, the search antenna used with the search radar system is designed with a number of horizontal dipoles in a vertical linear array. Such an arrangement gives coverage as in Fig. 1A.

The search antenna system examines the space around the GCA set by an actual rotation of the antenna and its reflector, the rotation of the visually displayed indicator sweep being synchronized with the antenna. The antenna beam is approximately six degrees wide in azimuth. (Its relation to the plan-position indicator from which the operator obtains his display of information is shown in Fig. 1B and 1C.) The narrow beam width needed is obtained by placing a parabolic reflector behind the antenna array to focus the beam.

Since the speed of antenna rotation is very slow in comparison to the time that it takes a pulse of energy to travel from the antenna to an object (186,000 miles per second) and be reflected, the energy gets back before the antenna has moved appreciably. The transmitting antenna can thus be used also as a receiving antenna simply by connecting the antenna as a radiator for the period of pulse radiation, then switching the antenna to the receiver input and leaving it thus connected until the energy pulse has had sufficient time to travel out 30 miles (161 microseconds) and back (another 161 microseconds). The cycle is then repeated. Energy pulses are of 0.5 microsecond duration and occur at the rate of 2,000 per second, so that there are 500 microseconds between pulses. This is sufficient time for a pulse to travel out 30 miles and back; specifically, the pulse consumes 322 microseconds of the 500 microseconds made available.

Magnetron Generates SHF Power

The transmitter is built around the cavity magnetron oscillator tube. This tube provides enough power output, at the frequencies required, so that sufficient energy is available for indications at the receiver after the pulse of energy has traveled 30 miles, has been partially reflected from an object, and the reflection returned to the re-



Inside the trailer, these men watch the PPI search pattern and the expanded precision indicator patterns on cathode-ray tube screens, and adjust control knobs that transfer position indications to the radio operator

All position indications go to one man, who brings an aircraft in to a safe landing through fog by voice instructions alone. Experience has shown that pilots respond even faster to voice instructions from the ground than to instruments they might be watching ceiver. This performance may not appear remarkable until one realizes that radiated energy decreases inversely as the distance squared, which means that at 30 miles there is only 1/900th of the power available at one mile. Also, objects vary in reflection qualities, and no object reflects back more than minute portions of the total energy received. This small amount of energy is then subject to the same decrease in strength on its return path as on its radiation.

The requirements for pulse power output and receiver sensitivity are far beyond any provided in commercial designs of radio receivers and transmitters made to date. The magnetron, however, provides r-f oscillations modulated by a pulse of approximately 10 to 15 kilovolts and 0.5 microsecond in duration, and by beaming this energy to the 6 degrees mentioned previously, enough energy is reflected from an object to provide the concentration desired.

Plan-Position Indicator

By means of a transmit-receive switch the antenna is alternately connected to the receiver and transmitter at a switching rate of 2,000 times per second. The echo pulses received by the antenna are fed through amplifying stages and displayed on the plan-position indicator. This is a high-persistence cathode-ray tube that displays at its center the transmitted pulse, and has an illuminated line from the center of the tube to its outer edge to display the azimuth of search while the receiver is switched into the antenna circuit. The line rotates with the tube center as its hub, but it is actually a stream of electrons which starts at the tube center, runs out to the edge, and then returns to repeat the same procedure at the rate of 2,000 times a second. This fact, plus the persistence of the tube face, make the radial line appear continuous. Echoes show as brightened blobs of light.

The heart of the complete search system is the synchronizer which furnishes the modulator, transmitter, receiver, and indicators with starting and stopping signals.

Traffic Control

Operators of the search system merely watch for targets on the indicator and, by using the air-ground communications equipment provided, vector the aircraft to the range and bearing desired. This type of information is necessary for efficient control of aircraft approaching a field for a landing under instrument conditions.

By means of the GCA search system, aircraft can be held at a given point and stacked in altitude prior to landing. It serves to line up the aircraft in azimuth with the precision radar system where the actual let-down of the aircraft is begun.

Precision Radar System

The precision radar system is designed to provide operators with accurate information on azimuth headings, altitude, and range up to 10 miles. For the more precise close-in work a two-mile indication is also provided. The area of coverage by the precision antennas is 20 degrees wide in azimuth (15 degrees to the left of a line from the set parallel to the runway and 5 degrees to the right) and 7 degrees high in elevation (6 degrees above the ground level and 1 degree below). The coverage areas are shown in Fig. 1D and 1E.

Antennas for Precision Scanning

Two separate antenna systems are used in precision scanning. One, the elevation antenna, sweeps an area 3 degrees wide in azimuth and 7 degrees in elevation; the other, the azimuth antenna, sweeps an area 1.5 degrees in elevation and 20 degrees wide in azimuth. Actual beam dimensions for the azimuth antenna are 1.5 degrees in height and 0.6 degree in width. The sweeping of the 20-degree azimuth area is accomplished electrically by proper time phasing of the energy feeding the dipoles in the horizontal array. The beam dimensions for the elevation antenna are 3 degrees in width and 0.4 degree in height. The sweeping of the 7-degree elevation area is also accomplished electrically, by proper phasing of the energy feeding the dipoles in the vertical array.

The cross-hatched rectangular area shown in Fig. 1D is the area covered by both antennas as their beams are swept in elevation and azimuth. The proper time phasing of the energy feeding the dipoles for both the horizontal and vertical array is made possible by squeezing and expanding the waveguide transmission line which feeds the antennas. Both antennas are equipped with reflectors that focus the radiation of pulse energy.

Antenna Switching Sequence

As in the search system, the precision transmitting antennas are also used for receiving the reflected energy. The elevation and azimuth antennas alternately are switched from receive to transmit, the switching rate being high in comparison to the squeezing of the waveguide which carries the beam through the sweep sector. Thus, the cycle can be explained as follows:

(1) *Elevation antenna energized.* The waveguide is squeezed by means of a cam which lifts the elevation beam from minus 1 degree to plus 6 degrees. At this point, the elevation antenna becomes deenergized through the action of an r-f switch and the cam leaves the elevation beam in its raised position.

(2) *Azimuth antenna energized.* The waveguide feeding this antenna is also squeezed by a cam arrangement, which sweeps the azimuth beam from plus 15 degrees (left) to minus 5 degrees (right). The azimuth antenna then is deenergized and the cam leaves the azimuth antenna in its extreme right position.

(3) *Elevation antenna deenergized.* The elevation wave guide is expanded to lower the elevation beam to minus 1 degree, where the antenna is deenergized and left until the next cycle.

(4) *Azimuth antenna deenergized.* The azimuth wave guide is expanded to reverse the sweep of the beam (minus 5 degrees to plus

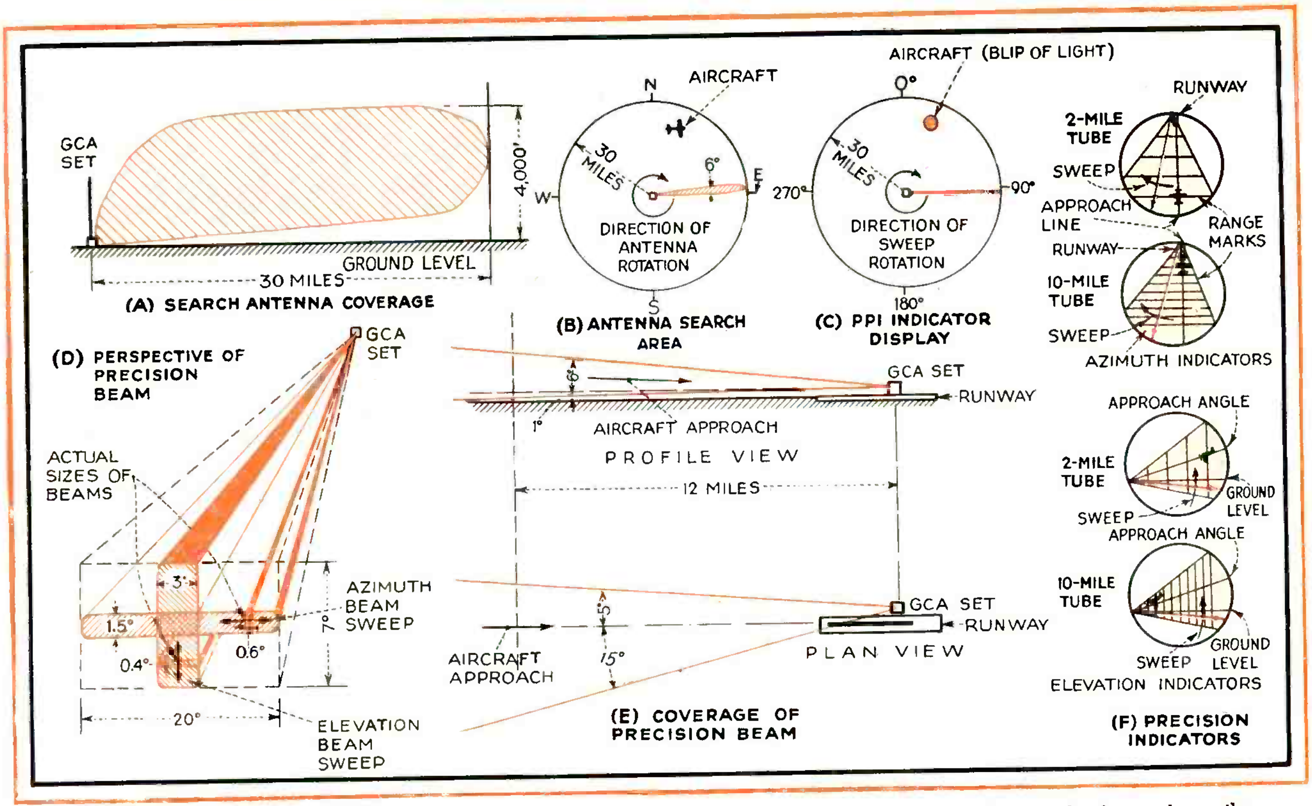


FIG. 1—Characteristics of microwave beams used in GCA, and types of patterns obtained on the scopes. The PPI indicator display shows positions of all aircraft within 30 miles, while the precision indicator displays show the relation of the aircraft to the correct landing path in both horizontal (azimuth) and vertical (elevation) directions

15 degrees), where the antenna is deenergized and left until the next cycle.

Shifting of Precision Beams

By using the above process, the system requires only one magnetron tube, which is pulsed at a much higher rate than it takes to complete a half of the above cycle. To achieve accurate resolution of signals this magnetron oscillates in the shf band. Together with the beam width obtained, it provides an accuracy of approximately five feet within one mile range. In this manner, the area of the elevation beam (3 degrees wide and 7 degrees high) and the azimuth beam (1.5 degrees high and 20 degrees wide) is receiving a high concentration of radar pulses. The elevation beam can be shifted in azimuth to locate aircraft and the azimuth beam moved in elevation to locate any aircraft within the area 7 degrees high by 20 degrees wide. This shifting is done mechanically by servo-mechanisms connecting the antennas and the indicators so that the operators may direct the beam sweeps to the proper point of contact.

Indicator Displays

Since the major components of the search and precision system are identical in function, the only major difference to be explained is the method of display of information on the cathode-ray tubes. Both azimuth and elevation information is provided on the indicators, together with ranges.

A main feature of this development is the expanded partial-indication display used. Each tube has the sweep center not in the middle but on the outer extremity of the tube face, with the sector (20 degrees wide on the azimuth tube and 7 degrees high on the elevation tube) expanded across the tube. The sweep applied to the indicators is synchronized with the sweeping of the precision antennas. Upon completion of the sweep cycle of the antennas the proper indicator sweep line is blanked out electrically until the cycle is reversed and starts again. The coverage area provided on the indicators is illustrated in Fig. 1F.

By means of tracking cursors following the aircraft blip, electrical meters record the azimuth error in degrees and the elevation deviation in feet with respect to the correct approach line and angle. This information is then relayed over the communication system to the pilot and the proper corrections made in heading and rate of descent.

Summary

The search and precision radar systems, the air-ground communications facilities, and the selective intercommunications system between operators enable the GCA controller to give positive, accurate data on an aircraft's range and bearing from the airfield. In addition, the pilot is given altitude, range, and bearing information in the last ten miles of the approach which enables him to bring the aircraft to a point where a visual landing can be made.

The Army and Navy in less than one year of operation of this electronic system have saved many planes that would otherwise have been ditched. GCA will no doubt be improved by further research and development. It promises to eliminate that ultimate danger to flying, inability to land at the airport of destination.

Radar Specifications

The significance of new technical terms and constants, used to specify the performance of a radar, is outlined and illustrated by an extensive tabulation of Signal Corps equipment employing carrier frequencies from 110 to 10,000 mc

NOW THAT TECHNICAL DETAILS of radar equipment are being released, engineers not previously familiar with the art find themselves confronted with a bewildering array of new terms and constants, knowledge of which is essential in estimating and comparing the virtues of different equipments. It is the purpose of this survey to explain these new technical specifications.

Basically, radar specifications relate to the performance of the gear, that is, the maximum distance at which a given target may be detected, and the accuracy and continuity with which its position may be specified. The maximum distance is determined primarily by the pulse specifications and receiver sensitivity. The accuracy of position is determined by the angular width of the radiated beam and the precision of timing of the radar echo. The continuity of following the target depends on the number of contacts per minute between radiated beam and target. Each of these relationships is discussed in the following paragraphs.

Pulse Specifications

Among the constants which determine the maximum distance at which a radar can detect a target are the pulse specifications, that is, the carrier frequency, peak power, and duration (width) of the transmitted pulses. These quantities are contained in the radar equation, which specifies the maximum range of detection in terms of equipment constants. This equation has already been derived in these pages[1], to which the reader is referred for a detailed statement of underlying principles. The form of the equation pertinent to this discussion is

$$r_{\max} = \sqrt[4]{\frac{P_t A^2 \rho d}{nkT\, 4\, \pi \lambda^2}} \text{ meters} \qquad (1)$$

Here $r_{\max}$ is the maximum distance, in free space, at which a target of area ρ square meters can be seen. The pulse specifications are the peak power P_t in watts, the pulse width d in seconds, and the operating wavelength λ in meters. The other factors of interest are the area A in square meters of the reflector which forms the radiated beam, and the noise figure of the receiver n, expressed as a ratio relative to the minimum theoretical noise, $kt\Delta f$, where Δf is the bandwidth of the receiver in cps. The constants kT are equal, at room temperature, to 4×10^{-21} watts per cycle of bandwidth. Using Eq. 1 it is possible to predict the range performance of a radar if the pulse specifications, as well as the reflector area and receiver noise figure, are known. The maximum range depends, of course, on the area of the target ρ. For a medium bomber this figure is approximately 50 square meters.

Two other aspects of the pulse are of interest. First, the pulse width represents the time during which the receiver cannot receive echoes because it is blocked by the transmitter. Consequently echoes from nearby targets, arriving while the transmitted pulse is still leaving the radiator, cannot be perceived. The pulse width thus sets a lower limit to the minimum range of detection. Other factors, particularly recovery of the receiver circuits, may prolong the inactive time beyond this lower limit.

At the other end of the scale, the pulse rate determines the maximum detection range. This follows since the interval between pulses, during which echoes may be perceived, is the inverse of the pulse rate. Thus the lower the pulse rate, the longer the interval and the greater the distance at which targets may be perceived, within the limits of the transmitter power and receiver sensitivity. If a high pulse rate is used, distant targets may still be perceived, but the echoes may arrive not in the first interval between pulses but in some later interval. In this event an ambiguity exists, since one cannot be certain whether the echo interval is that shown on the indicator, or longer by some multiple of the pulse interval. In general, radars intended for long-distance detection employ low pulse rates.

Radiator Specifications

The precision of detecting the position of the target in azimuth (horizontal angle) and elevation (vertical angle) rests fundamentally on the size of the radiated beam. The larger the reflector and the shorter the wavelength, the narrower the beam and the higher the angular precision. The angular width of the beam is

$$b = \frac{\lambda}{\sqrt{4\, A/\pi}} \text{ radians} \qquad (2)$$

where A is the area of the reflector

in square meters and λ is the operating wavelength in meters.

It is evident that the beam width is intimately tied up with the factors A and λ which have previously appeared in the equation for maximum range. This is true because as the beam becomes smaller, the energy density in the beam increases for a given transmitter power, and hence the range increases. This effect is often stated in terms of the radiator gain, that is, the ratio of the energy density actually present along the axis of the beam to the energy density which would be produced by the same power feeding an isotropic (broadcast) radiator. The equation for gain is

$$G_0 = \frac{4\pi A}{\lambda^2} = \pi^2/b^2 \quad (3)$$

where A, λ and b are as previously defined.

In most cases it is possible to determine the angle to the target to a small fraction (say $\frac{1}{5}$ to 1/10) of the beam width. When conical scanning (described in the article on the SCR-584, beginning on page 104 of this issue), the angular accuracy can be refined to a few hundredths of the beam width.

The accuracy of timing the radar echoes, which determines the precision of the range coordinate, depends on many factors in the timer and indicator design, so it is generally stated as an overall performance figure. Outstanding in this respect is the performance of the SCR-545 and SCR-584, both of which can determine range accurately to plus or minus 15 yards. This is equivalent to a timing accuracy of the order of 0.06 microsecond. This high performance is required in a radar intended to control gun-fire, since it permits the fuze of the shell to be set to cause it to explode at the target. In early warning radars, and those used to control searchlights, such precision is not required. Thus the SCR-270 early warning radar has an accuracy of 8000 yards, and the AN/TPL-1 searchlight set an accuracy of 200 yards.

Scanning Specifications

Continuity in following the target depends on the scanning constants of the radar, that is, the rates at which the radiated beam is moved in space in searching for and following the target. Two aspects of scanning are of interest:

electronics WAR REPORT

the number of pulses radiated while the beam moves over the target, and the number of contacts per minute between beam and target.

The first aspect is simply analyzed. Consider a beam of angular width b radians, scanning at an angular rate of r beam widths per second. Then the beam moves through an angle equal to its own width in b/r seconds. In that time at least one, and preferably five or more pulses, must be radiated. If less than one pulse is radiated in that time, a point in space may be moved over without a pulse hitting it, and a target at that point will remain undetected. If five or more pulses are radiated in that time, several pulses will hit the target and the effect of the echo, integrated on the cathode-ray screen, will be sufficient to cause full screen brilliance. It follows that the pulses must be radiated at a rate of $5r/b$ per second, or at a higher rate, if each point in the scanned space is to receive sufficient pulses to cause a clearly discernible echo. In equation form

$$f_r \geq 5r/b \quad (4)$$

It is evident that the higher the rate of scanning and the narrower the beam width, the higher must be the pulse rate. As a numerical example, consider the wide-beam slow-scanning SCR-270 early warning radar, which has a beam width of 28 degrees in azimuth and scans in azimuth at 1 rpm or 360/60 = 6 degrees per second. The 28-degree beam thus moves through its own width in about five seconds. The pulse rate is 621 per second, so in five seconds some 3100 pulses are radiated, and each point in the scanned space receives this large number of pulses.

In contrast, consider the AN/MPG-1, a narrow beam, rapid-scanning set. This radar scans in azimuth at a rate of 160° per second with a beam width in azimuth of 0.6 degrees. The scanning thus occurs at a rate of about 0.004 seconds per beam width. The pulse rate while tracking is 4098 per second, so $0.004 \times 4098 = 16$ pulses are radiated while the beam passes through its own width. This number is in excess of the minimum value (five pulses) previously stated. When the lower pulse rate (used for searching) of 1024 pulses per second is used, only four pulses are radiated and this is somewhat below at the lower limit.

The other aspect of scanning is frequent contact between beam and target. When a target is detected and attention can be restricted to it alone, it is possible to suspend the search and concentrate on the particular target in question. But in early warning activities it is necessary to maintain a watch on several targets simultaneously, and to anticipate the appearance of new targets at all times. In such cases search cannot be suspended, and continuity of following the target then depends on frequently recurring contacts with the target. The SCR-270 scans the horizon at one rpm, and the target information is thus renewed once every minute. The persistence of the cathode-ray screen is employed to store the information over the one-minute interval so the motion of the target can be followed from one scan to the next. But if the target is close,

MORE TO COME

The specifications presented here are those of ground-based sets employed for the most part by the Army Ground Forces for detection of marine and aircraft targets and gunfire control.

Airborne and shipborne radars have not yet been declassified. Similar information on them will be presented as soon as it is available

or moving fast, it cannot be followed from one scan to the next if a minute of time intervenes. For following nearby fast-moving targets, the beam must rotate at a faster rate. The SCR-584 used for antiaircraft fire, scans the horizon at six rpm, making contact with the target six times as often as the SCR-270. The AN/MPG-1 scans a 10-degree sector in 0.0625 second, giving substantially continuous coverage.

When it is necessary to use a narrow beam (for precision) and to search in elevation as well as in azimuth for targets, the simple circular scan just described must be expanded into a helical scan. In helical scanning the beam rotates horizontally, as previously described, but superimposed on the horizontal motion is a vertical tilt at a slow rate, which causes a point on the radar beam to describe a helix. The angular distance between the turns of the helix is less than the beam width, so that all points in space are covered during the scan. The same requirement governs the pulse rate as in circular scanning, namely at least five pulses must be radiated while the beam rotates through its own width. When helical scanning is employed, the contacts with the target are cut down by approximately the number of turns in the helix, relative to those made in circular scanning at the same azimuth rate. If continuous contact with the target is required under those conditions, the azimuth scanning rate must be increased, to cover many turns of the helix in a brief time. The limit in the azimuth rate is generally set by the strength of the scanning mount, which may jam or shatter due to unbalance stresses if rotated at too high a speed.

Indicator Types

The tabulation lists the types of indicators used. Type A refers to a presentation very similar to that of a test oscilloscope, in which the c-r spot moves horizontally at constant speed, measuring the echo interval, and is deflected vertically by the transmitted pulse and the

TECHNICAL SPECIFICATIONS OF REPRESENTATIVE

Type Number	SCR-268	SCR-516	SCR-270	AN/TPS-3	SCR-545
Primary Function	Searchlight and gun control (mobile)	Early warning against aircraft (mobile)	Early warning against aircraft (mobile)	Light weight for search and tracking (mobile)	Search (s) and track (t) for AA fire-control (mobile)
Size, Weight	Two trailers; 28,850 lb	Same as SCR-268	3 trucks and trailer; 81,400 lb	Air-transportable; 1340 lb	2 trucks and trailer; 71,460 lb
Carrier Frequency (mc)	195-215	205	110	600	205 (s) 3000 (t)
Wavelength (λ) (cm)	140-154	146	270	50	146 (s) 10 (t)
Peak Power (P_t) (kw)	50-75	100	100-300	200	200 (s) 350 (t)
Pulse Width (d) (microseconds)	5-9	5-8	10-30	1.5	1
Pulse Rate (f_r) (pps)	4098	1366	621	200	480
Radiator Type, Size, Gain (G_o)	Three mattresses; 100	Same as SCR-268	4x9 mattress; 140	10-ft paraboloid; 220	4x4 mattress (s) 60; 57-in. parab. (t) 1300
Types of Scan	Manual track in azimuth and elev.	Manual search	Circular search	Circular search	Helical search, conical track
Beam Width (b) (degrees)	12 az., 9 el.	12 az., 9 el.	28 az., 10 el.	12.5 az., 11.5 el.	25 (s), 5 (t)
Horizontal Scanning Rate (rpm)	Manual	Manual	1	6	5
Receiver Noise (n) (db above $kt\Delta f$)	14	14	12	11	7 (s), 22 (t)
Receiver Bandwidth (Δf) (mc)	1.5	1.5	1.5	1.8	1.25 (s), 5 (t)
Indicators	3 type-A	3 type-A	1 type-A	1 type-A, 1 type-PPI	3 type-A
Maximum Range (r_{max}) on Bombers at 10,000 Feet (miles)	23	68	80-120	100	34 (s), 16 (t)
Minimum Range (yd)	3000	3000	10,000	10,000	1100 (s), 500 (t)
Range Accuracy (yd)	200	500	8000	4000	150 (s), 15 (t)
Angular Accuracy (degrees)	1.1	3	4	2	6 (s), 0.17 (t)

echo. The time between the two is a measure of the range. Type J is similar, except that the trace is circular, about the periphery of the tube, rather than linear. Type PPI has been described elsewhere in this and previous issues; it produces a map-like indication by radial deflection from the center of the tube, the deflection keeping step with the azimuth rotation of the radiated beam. Type B presents range information vertically and azimuth information horizontally, in rectangular coordinates, and is thus a distorted portion of a PPI picture. Tube sizes vary from 3-inch (SCR-584 J-scopes) to 12-inch (SCR-270 PPI). Most A-scopes are five-inch tubes and PPI's are typically about seven inches in diameter.

The sets described here cover the gamut of radio frequency from 110 mc to 10,000 mc (270 centimeters to 3 centimeters wavelength). The peak power employed varies from 50 to 350 kw. These are typical figures, although higher powers have been used in early-warning sets employed by the Air Forces and the Navy. In general, the beam widths, pulse rates and scanning rates will be found consistent with the requirements previously stated. Moreover, the maximum ranges quoted are generally consistent with the radar equation, when the indicated constants are substituted. One major difference should be stated, however. Some of the maximum ranges given are those which occur when the radar beam is partly reflected from the surface (sea or ground) and partly transmitted directly to the target. Constructive interference of the two waves may, in ideal circumstances, double the maximum range predicted by the radar equation. Destructive interference, under the same circumstances, may similarly reduce the maximum range to zero miles. Hence a wide variety of possible maximum ranges exists, depending on the conditions of measurement. The radar equation gives an index to average performance.—D.G.F.

Reference

(1) Fink, D. G., The Radar Equation, Electronics, p 92, Apr. 1945.

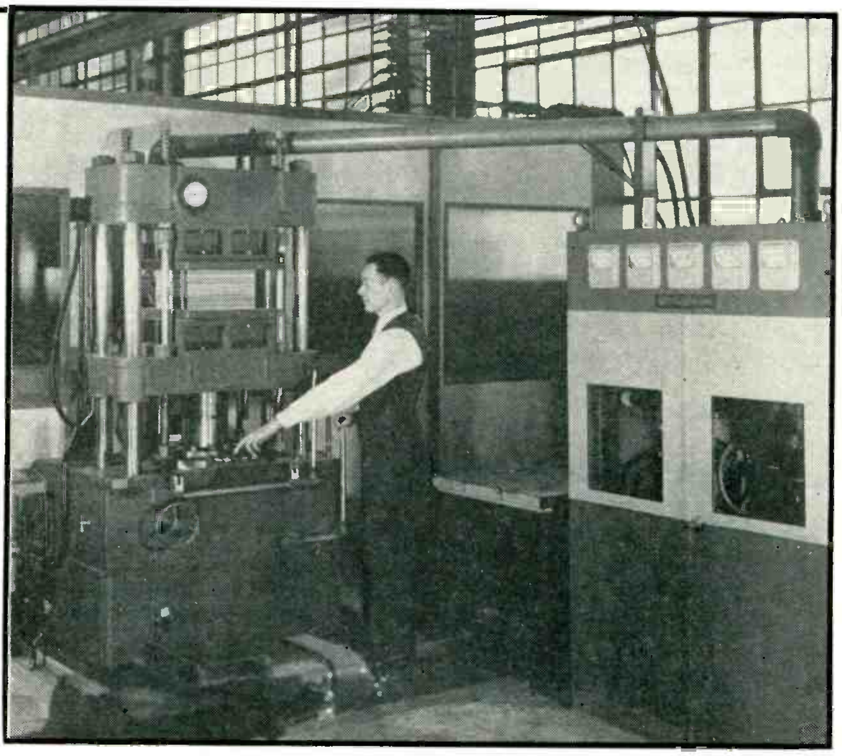
U. S. SIGNAL CORPS RADARS

SCR-547	SCR-582/682	SCR-584/784	AN/TPL-1	AN/MPG-1	Type Number
Range finder for AA fire-control (mobile)	Coastal search for ships and planes (fixed)	Search (s) and automatic track (t) for AA fire-control (mobile)	Light weight searchlight control (mobile)	Seacoast fire-control against marine targets (mobile)	Primary Function
2 trucks and trailer; 49,487 lb	3359 lb (582); 13,640 lb (682)	Trailer, 20,000 lb (584); 12,000 lb (784)	Trailer; 4205 lb	Trailer; 28,000 lb	Size, Weight
2720-2890	2800	2700-2900	2700-2900	10,000	Carrier Frequency (mc)
10	10.7	10-11	10-11	3	Wavelength (λ) (cm)
80	30 (582) 225 (682)	300	200	60	Peak Power (P_t) (kw)
0.5	1	0.8	1	1 (s) 0.25 (t)	Pulse Width (d) (microseconds)
4098	500 (582) 420 (682)	1707	400	1024 (s) 4098 (t)	Pulse Rate (f_r) (pps)
2 57-inch parab.; 5000	4-ft paraboloid; 800-900	6-ft paraboloid; offset dipole; 1200	4-ft paraboloid; 860	Schwarzchild rapid-scanner; 12,000	Radiator Type, Size, Gain (G_o)
Range only, optical tracking	Circular search	Helical search, conical track	Helical search, conical track	Circular search; also 10° sector; track	Types of Scan
3.8	6	4 (7 when spinning)	10	0.6 az., 3 el.	Beam Width (b) (degrees)
Manual	10-20	6	7.25	160°/sec	Horizontal Scanning Rate (rpm)
—	18 (582), 14 (682)	15	18.5	17	Receiver Noise (n) (db above $kt\Delta f$)
6	1.5 (582), 2 (682)	1.7	1.8	10	Receiver Bandwidth (Δf) (mc)
1 type-A	1 type-A, 1 type-PPI	2 type-J, 1 type-PPI	3 type-A, 1 type-PPI	2 type-B, 1 type-PPI	Indicators
12	45 (582), 140 (682)	34 (s), 18 (t)	34	28 (battleship)	Maximum Range (r_{max}) on Bombers at 10,000 Feet (miles)
300	1000 (582), 500 (682)	500	500	—	Minimum Range (yd)
25	2 per cent	15	200	—	Range Accuracy (yd)
—	2	1 (s), 0.06 (t)	1 (s), 0.5 (t)	—	Angular Accuracy (degrees)

Dielectric HEATING

By DOUGLAS VENABLE

Industrial Electronics Division
Westinghouse Electric Corp.
Baltimore, Md.



The r-f generator at the right supplies heat energy for bonding plywood in the press, a typical application of dielectric-heating equipment

DIELECTRIC HEATING is today opening many new fields in industry, and speeding up many old processes. Materials such as rayon, wood, foods, and plastics are being dried; plastics and rubber are being cured; wood and plastics are being bonded one to another and to metals. Greater production rates have been attained in the molding or forming of plastic preforms. Even some cooking of foods is being done.

To best make use of high-frequency power for industrial heating applications, it is necessary that the manufacturer and producer of dielectric materials, who may use or contemplate using high-frequency power, have an understanding of the fundamentals of dielectric heating.

Molecular Dipoles

If one were to examine, by some microscopic means, the molecules of a dielectric which are immersed in an electrodynamic field, he might well appreciate the generation of heat within the dielectric. At some time when the electric field is zero, a molecule might be seen to have its center of postive charges and its center of negative charges coincident, or he may see these centers displaced a given distance relative one center to the other. This latter molecule is called a permanent molecular dipole.

The orientation of the permanent molecular dipole would necessarily be a function of the properties of the molecule of the dielectric as well as the history of the molecule. The individual positive and negative charges are being held in place by very appreciable forces so that their resultant centers are coincident or permanently displaced (assuming zero external electric field), even though the electrons of the molecule are very active. As the electric field changes, these centers of positive and negative charges might be seen to be displaced relative one to another forming induced dipoles whose axes are parallel to the electric field.

Power Density

The permanent dipoles will be influenced by a torque tending to rotate them until their axes are parallel to the electric field. An added displacement may also take place between the electrical centers of the permanent dipoles. In so displacing the centers and/or causing a rotation of permanent dipoles, work is done, for work is simply defined as the overcoming of resistance through distance.

Since power is the time rate of doing work, the power absorbed by a dielectric from an electrodynamic field in which the dielectric is immersed is some function of the time rate of change of the electric field. Thus, the energy absorbed per unit time may be considered a function of frequency. Heat power generated within a dielectric because of hysteresis may be thought of as the time rate of energy required to produce molecular deformation and rotation.

It may be shown for practical purposes that

$$P_v = 1.4 f E_1^2 e'' \text{ watts per cu in.} \quad (1)$$

where f = Frequency in megacycles

E_1 = Voltage gradient in kilovolts rms per inch

e'' = Loss factor = product of dielectric constant e' and power factor

This equation indicates that the power density is directly proportional to the frequency, f. Assuming the loss factor, e'', and voltage gradient, E_1, to remain constant, it

FUNDAMENTALS

To utilize industrial dielectric heating efficiently, the basic theory of the technique must be considered. Power requirements, thermal losses, characteristics of the load, and types of networks for matching the load to the oscillator are discussed

is clear that the heat energy generated in a dielectric increases as the frequency increases. For a constant frequency and loss factor, e'', the heat generated in the dielectric is proportional to the square of the voltage gradient, E_1.

The loss factor, e'', is made up of two factors, the dielectric constant and the dielectric power factor. Both of these may vary with a change in frequency, with moisture content, temperature and pressure. Therefore, during a heating process, the heat generated may not be uniform with time because of changing properties. Any change in the loss factor will involve a change in the impedance of the load and therefore a voltage and current change.

A careful study of the problem should be made at the particular installation. Thus, consideration can be made of the initial conditions such as (1) the particular set-up that will be used in order to account for stray and mutual reactances, (2) the load properties, moisture content and initial temperature, and (3) humidity which often limits the desired electrode voltage. Equation 1 is sufficiently accurate for making estimations and is used here for that purpose.

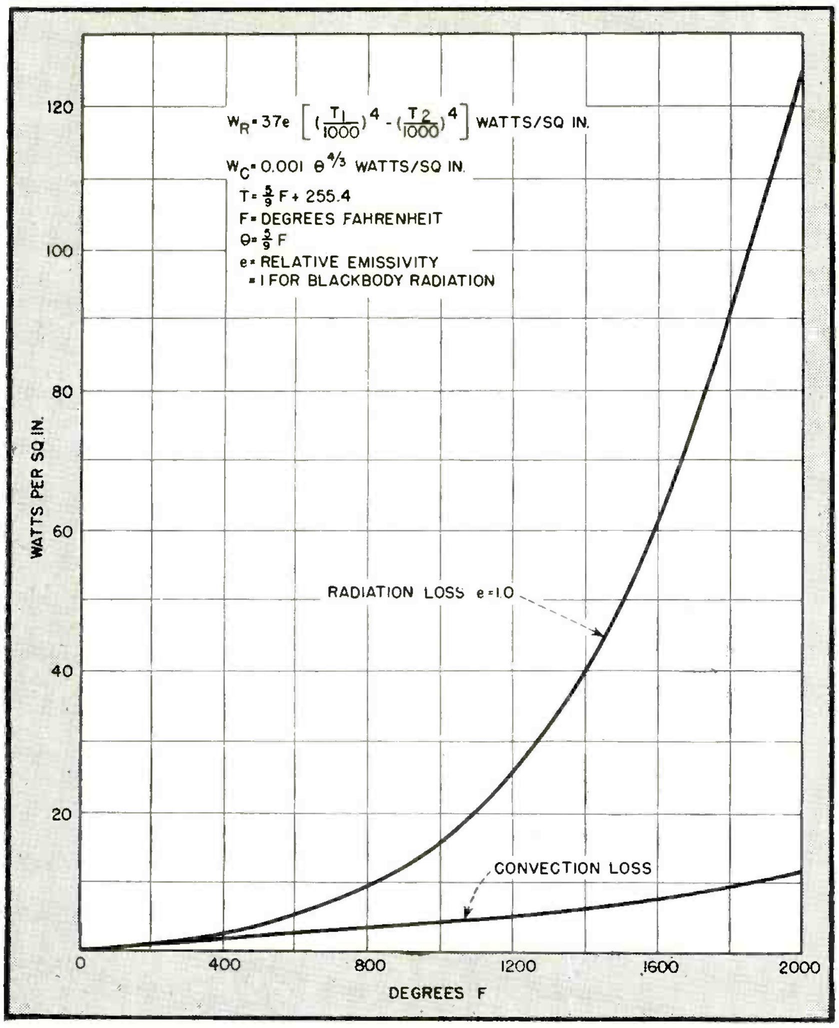


FIG. 1—Curves showing radiation and convection loss from surface in free air that were plotted at 75 degrees Fahrenheit

Determining Losses

The thermal power requirements may be specified by the general heat equation (neglecting thermal losses)

$$P = 17.6\ mc\ \Delta T \text{ watts} \quad (2)$$

where m = lb of material heated per minute
c = Specific heat
ΔT = Temperature rise F

In some dielectric heating work, thermal losses such as convection, radiation, and conduction should be considered. The conduction loss is rather complicated, especially in the use of presses, and should be considered as an individual problem. The convection and radiation losses may be considered more general. The curve of Fig. 1 indicates approximately the radiation losses for surfaces whose relative emissivity is unity. The radiated power is proportional to the relative emissivity of the surface; therefore, blackbody radiation (unity relative emissivity) times the relative emissivity of the surface will indicate the radiated losses. Tables of the relative emissivity of various surfaces may be found in handbooks.

The curves of Fig. 1 indicate the

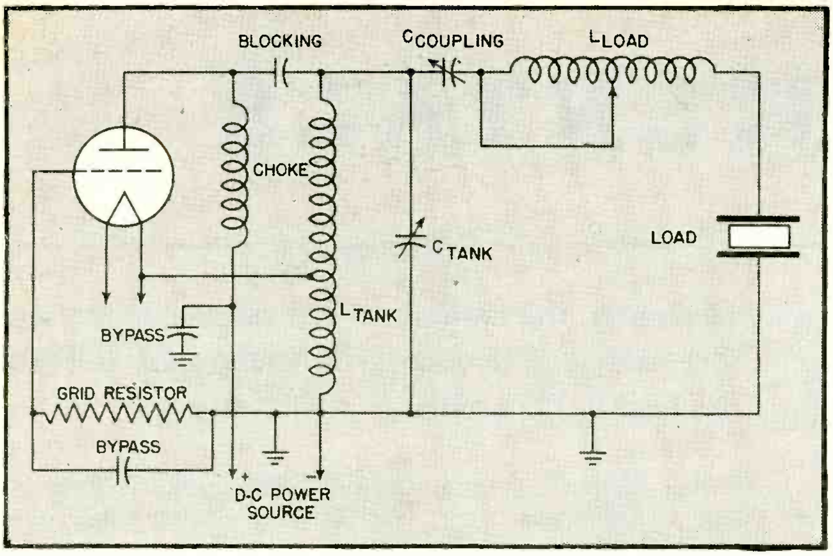


FIG. 2—Basic circuit of 2-kw oscillator for dielectric heating

radiation losses of a blackbody and convection losses for a particular temperature assuming the ambient, T_2, is 75 F. To give the true radiation loss, the blackbody radiation should be multiplied by the relative emissivity of the surface. By use of these curves or by substituting the temperature values into the equations, the losses may be determined.

For accurate determination of radiation and convection losses, these curves should be integrated over the temperature range of the load-heating cycle. Graphical integration is sufficiently accurate for most purposes. Over very short distances, the curves may be assumed to be straight lines and an average made of the sum of the initial and final radiation and convection losses.

The power density P_v used in this discussion is the required total thermal power P per cubic inch of material heated. The total thermal power includes thermal losses as well as the power required to heat the load as desired.

Three application problems are considered here. The first is the determination of the available power density for a given frequency, voltage gradient, and loss factor. This may be determined from Eq. 1.

Typical Conditions

In the second case, the frequency is fixed and the desired power density and loss factor are predetermined. The required voltage gradient E_1 in kv per inch is

$$E_1 = \left(\frac{0.7P_v}{fe''}\right)^{0.5} \qquad (3)$$

Assume that a fixed-frequency oscillator is to be applied to a load. The material specifies the loss factor e'', at a frequency f. To generate the desired power in the load for a given frequency, power density, and loss factor, the required voltage gradient may be determined from Eq. 3.

The third case will be governed by the fact that the required power density P_v and loss factor e'' are predetermined. A practical electrode voltage is assumed, being based on available voltage and electrode assembly. Then the required frequency in mc may be determined by

$$f = \frac{0.7P_v}{E_1^2e''} \qquad (4)$$

Equation 4 determines the required frequency for an estimated maximum electrode voltage. If E_1 is a maximum, the frequency f may be increased, thus requiring a decrease in E_1.

Causes of Nonuniform Heating

Generally, a frequency range of from 2 to 200 megacycles is used in dielectric heating processes. In selecting frequency, consideration must be made for the allowable voltage gradient the dielectric media will withstand at various frequencies as well as creepage along the surface of the dielectric between electrodes. Once the voltage gradient has been chosen, the desired power density and the dielectric properties of the material specify the required frequency.

Another matter of importance to consider relative to the frequency choice is the geometry of the load. The electrodes act as open-circuited electric lines. If these lines are long comparable to the wavelength, appreciable voltage nonuniformity will result, which means a nonuniformity in voltage gradient. Since the heating is proportional to the square of the voltage gradient, care must be taken to provide means of assuring approximately uniform voltage gradient in the dielectric from one point to another. If, from the point of line connection on the electrode to any other point on the electrode, there is a distance greater than one-sixteenth wavelength, appreciable voltage difference will result which will cause

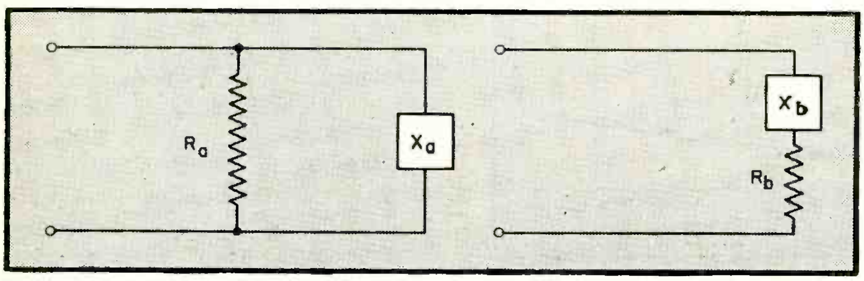


FIG. 3—Single-element network

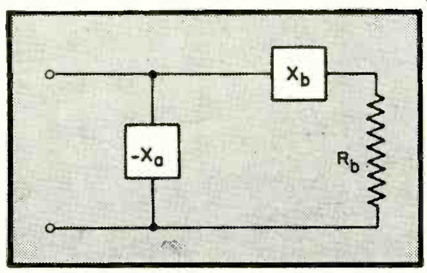
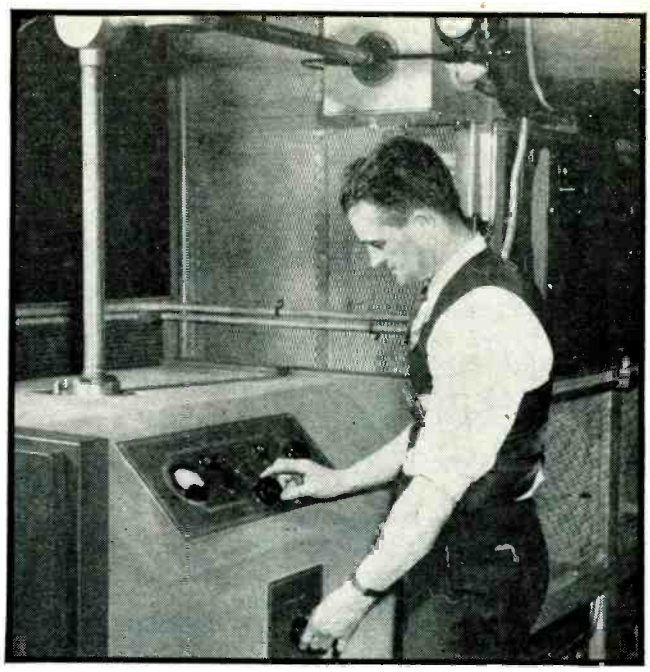


FIG. 4—Two-element L network

Thermosetting resin preforms are preheated in a 2-kw 30-mc generator prior to injection molding



In this installation, a standard 10-kw 5-mc electronic generator is used to dry nonconducting material

nonuniform heating of the load, where the wavelength in feet along the electrode is

$$\lambda = \frac{984}{f\sqrt{e'}} \qquad (5)$$

where f = Frequency in megacycles
e' = dielectric constant of the material heated

If electrode length is such that appreciable nonuniform heating results, arrangements should be made to feed the electrode at more than one point. Possibly networks will be needed to supply power properly to various points on the electrodes.

Load Characteristics

Most dielectric heating is done with the load material between two parallel electrodes. It is necessary to know the reactance of this load. The reactance in ohms is

$$X = \frac{1}{\omega C} \qquad (6)$$

where $\omega = 2\pi f$
f = frequency in cps

$$C = 0.224\,\frac{A}{d}\,e' \times 10^{-12}\ \text{farads}$$

A = Area of one electrode in sq in.
d = Distance between electrodes in inches

To represent a capacitor with losses, a perfect capacitor may be visualized with either a resistor in series or a resistor in parallel with it. Thus, losses in a capacitor may be thought of as being generated in the resistance. The effective series resistance may be represented by

$$R_1 = |X|\ (\text{power factor}) \qquad (7)$$

and the equivalent shunt resistance by

$$R_2 = \frac{|X|}{\text{power factor}} \qquad (8)$$

The series resistance representation will be used throughout the rest of this discussion and unless otherwise indicated R_1 will be represented by simply R_b.

Equations 6 and 7, if properly applied, determine the load characteristics. The load impedance is, in vector form,

$$Z = R_b + jX \qquad (9)$$

Today, high-frequency power is almost universally produced by vacuum-tube self-excited oscillators. These generators produce power fairly efficiently at frequencies from 2 to 200 megacycles. There are now available vacuum-tube generators capable of producing from 1 to 25 kilowatts up to 50 megacycles. Powers up to 100 kw are available at frequencies up to 20 mc and powers up to 175 kw may be obtained for frequencies up to 10 mc. The very-high-frequency generators are as yet limited to a few hundred watts. Figure 2 illustrates the circuit of a typical standard 2-kw 30-mc industrial r-f generator.

Impedance Matching

For these r-f generators there is an optimum load impedance for a required power output. If the impedance of the load happened to load the oscillator properly, no matching network would be needed. In practically all cases, however, some kind of network is needed to convert the voltage and current available at the tank coil into the voltage and current needed through the resistance of the load to cause the correct amount of heat to be generated in the work. In some

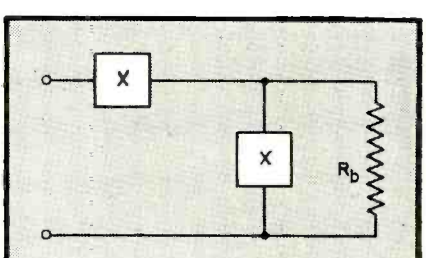


FIG. 5—Network with reactive load

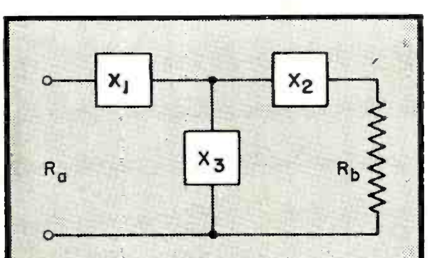


FIG. 6—Three-element T network

cases the work is located close to the tank circuit; in others, it may be a considerable distance away. When the distance from the oscillator to the work is more than about one-eighth wavelength, a nonresonant transmission line is generally employed, necessitating two coupling networks, one at each end.

In general, there are three types of network that may be used, one, two, or three element. The configuration may be either T or π. Each element of the network offers control over one characteristic of the network.

A single-element network can be used to match the resistance of the load to the oscillator provided the reactive component is not important. If the input of the network is connected directly across the tank circuit of the oscillator, a reactive component reflected from the load will shift the frequency slightly. This is usually unimportant. The action of this network is merely to provide a series impedance which may be used to control the current passing through the resistive component of the load. Usually the largest part of this impedance is the reactance of the load. One great advantage of this type of network is that changes in dielectric properties of the load cause relatively minor changes in loading.

Effect of Reactance

The shunt resistance that must be reflected back across the tank coil can be found from the relation $R_a = E_t^2/P$, where E_t is the available rms voltage and P the power in watts. R_a is the resistance in ohms to be reflected across the tank coil.

Referring to Fig. 3, the two impedances are equal at the terminals if

$$R_a = \frac{R_b^2 + X_b^2}{R_b} \tag{10}$$

$$X_a = \frac{R_b^2 + X_b^2}{X_b} \tag{11}$$

Assume it is required to match a load of R_b ohms to a generator which is properly loaded by R_a ohms. Re-arranging Eq. 10,

$$X_b = \pm \sqrt{R_a R_b - R_b^2} \tag{12}$$

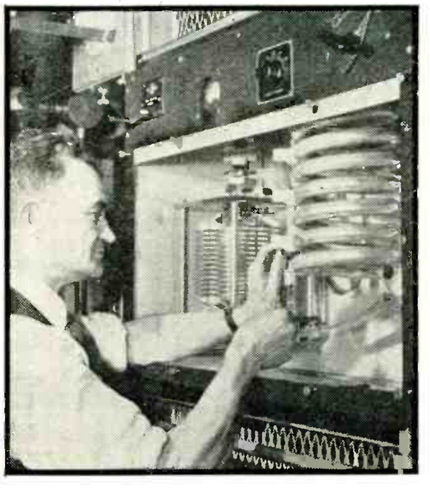
It will be noticed that if R_b is greater than R_a, then X_b will be an imaginary number, an impossible condition, therefore this network may not be used.

X_b is the total series reactance including the reactance of the load, and may be either inductive or capacitive. In dielectric heating, the reactance of the load is always capacitive so it is advisable to make the total reactance capacitive. In this way the stored energy in the load circuit is kept to a minimum and the oscillator is more stable.

The reactance reflected across the tank can be found from the relation

$$X_a = \pm R_a \sqrt{\frac{R_b}{R_a - R_b}} \tag{13}$$

In this equation, the sign of X_a



A coupling network which enables power to be removed from the material without shutting down the generator

will be the same as the sign X_b in Eq. 12.

If it is necessary to have the input impedance of the network purely resistive, the input may simply be shunted with a reactance of X_a, but of opposite sign. This configuration gives a two-element network commonly known as an L network, as shown in Fig. 4.

In both networks shown thus far, R_a must be greater than R_b. There are cases, however, where R_b is greater than R_a. The circuit shown in Fig. 5 cannot be used because the load has a reactive component. It is necessary therefore to use a T network as indicated in Fig. 6.

Since this T network has three elements, three characteristics may be varied. These three characteristics are resistance, reactance, and phase shift. In dielectric heating, phase shift is usually of no concern, so that arbitrarily a value of one element of the network may be picked. Then the remaining two elements may be calculated for correct resistance and reactance, the resulting phase shift being neglected.

The load has a series reactance; let this reactance be termed X_2 and calculate X_1 and X_3 from the relations

$$-R_a R_b = X_1 X_2 + X_1 X_3 + X_2 X_3 \tag{14}$$

and

$$\frac{R_a}{R_b} = \frac{X_1 + X_3}{X_2 + X_3} \tag{15}$$

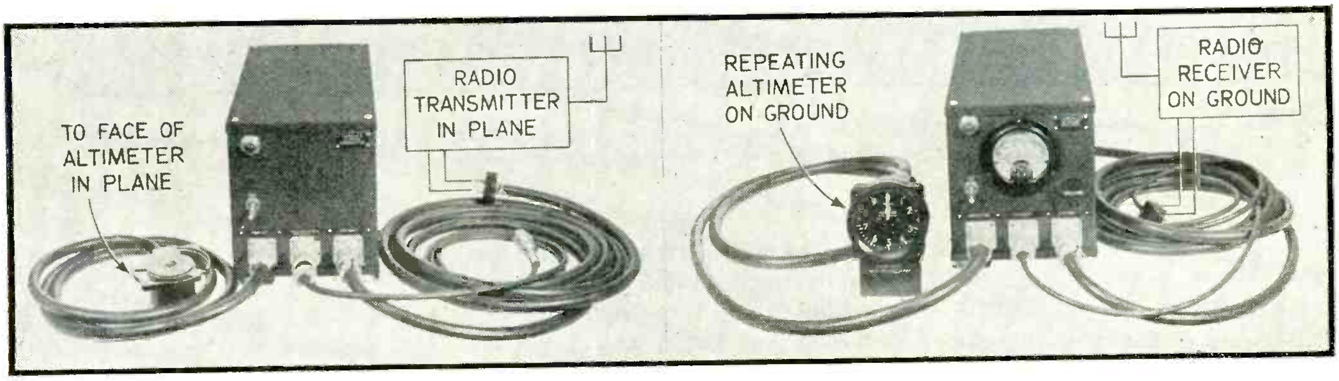
In considering thermal losses one must bear in mind that there are thermal conduction losses. These constitute the absorption of energy by material in contact with the hot load. In the case of dielectric heating, the contacting electrodes will absorb energy. The rate of absorption depends upon the temperature differential, the geometry of the absorber and the load and its thermal properties. If in production the dielectric heating electrodes are used almost continuously, they will absorb sufficient energy to raise their temperature to about that of the final load temperature. Then conduction losses equal the radiation and convection losses from the electrodes. Radiation and convection losses will also occur at the sides of the dielectric load.

Bibliography

(1) Whitehead, Lectures on Dielectric Theory and Insulation, McGraw-Hill, N. Y. 1928.
(2) Hund, A., "Phenomena in High Frequency Systems," McGraw-Hill Book Co., New York, 1936.
(3) Glasgow, R. S., "Principles of Radio Engineering," McGraw-Hill Book Co., New York, 1936.
(4) Everitt, W. L., "Communication Engineering," 2nd Ed., McGraw-Hill Book Co., New York, 1937.
(5) Eastman, A. V., "Fundamentals of Vacuum Tubes," McGraw-Hill Book Co., New York, 1937.
(6) Terman, F. E., "Radio Engineers' Handbook," McGraw-Hill Book Co., New York, 1943.
(7) Harnwell, G. P., "Principles of Electricity and Electromagnetism," McGraw-Hill Book Co., N. Y. 1938.
(8) Smythe, W. R., "Static and Dynamic Electricity," McGraw-Hill Book Co., 1939.
(9) Zemansky, M. W., "Heat and Thermodynamics," McGraw-Hill Book Co., New York, 1937.
(10) Hund, Hochfrequenzmesstechnik," Julius Springer, Berlin, 1929.
(11) Espe and Knoll, "Workstoffkunde Der Hochvakuumtechnik," Julius Springer, Berlin, 1936.
(12) Ingersoll and Zobel, "An introduction To the Mathematical Theory of Heat Conduction," Ginn and Co., New York, 1913.
(13) Carslaw, "Introduction to the Mathematical Theory of the Conduction of Heat in Solids," MacMillan and Co., London, 1921.
(14) Smith, P. H., L-type Impedance Transforming circuits, ELECTRONICS, 15, No. 3, Mar. 1942.

Plane-to-Ground RADIO TELEMETERING

Electronic system utilizing phase angle as transmission means for radio link permits reading altimeter and other instruments from ground during flight-testing or in radio-controlled aircraft. Mounting of small magnet on pointer is only alteration to instrument



Left: Pickup chassis used in plane, with pickup and connecting cable, battery cable, and output cable going to transmitter. Right: Chassis used on ground, showing repeating altimeter and connecting cable, input cable going to receiver output, and battery cable

By DAVID W. MOORE, JR.

Engineer,
Fairchild Camera and Instrument Corp.
New York, N. Y.

In many instrumentation systems it is desirable or necessary to have an indication of the measured value at some distance from the point of measurement. This is particularly true in aircraft flight testing, or in the flying of radio-controlled aircraft. In installations of this type it is frequently advantageous for reasons of safety to remove all personnel from the aircraft being tested or flown by radio control systems. It then becomes necessary to have a means for reading the flight instruments, particularly, at some remote point. For this, radio is the only practical communication link.

Quite a number of systems have been and are being developed to serve this purpose. These range from telemetering devices producing a graphical indication of the phenomenon being studied, to systems which faithfully reproduce a dial indication similar or equal to that which would be seen by the pilot if he were present in the plane. Systems of the latter type are particularly desirable in flying radio-controlled aircraft, since they preclude any necessity of having to train an experienced pilot to become familiar with new instruments.

This article describes a telemetering system which permits reading a standard aircraft instrument with very slight modification to the instrument itself, transmitting this reading to any desired remote position or positions, and reproducing faithfully the initial indication on a dial equivalent to that of the aircraft instrument.

All possible means for transmitting intelligence were studied for application to a particular installation which required the transmission of the indication of a standard sensitive altimeter. As a continuous indication was required, all of the step-by-step impulse systems were eliminated. It was also deemed undesirable to employ any amplitude comparison arrangements over a radio link which might seriously affect amplitude values. After much consideration it was decided to use electrical phase angle as the transmission means.

Phase-shifting Pickup

An instrument indication pickup was designed which coupled magnetically to the sweep pointer of the sensitive altimeter, and which shifted the phase of its input signal degree for degree with the motion of the sweep pointer. In other words, for a 90-degree shift in the position of this pointer, the electrical phase angle of the output signal of the pickup would shift 90 electrical degrees with reference to the input signal.

The pickup was designed to mount directly on the sensitive altimeter, as shown in the accompanying photographs. No alterations were necessary to the altimeter other than the mounting of a small permanent magnet on the hub of the sweep pointer. This magnet enabled the use of magnetic coupling to the position pickup and the maintaining of the pressure seal of the instrument.

The position-receiving instru-

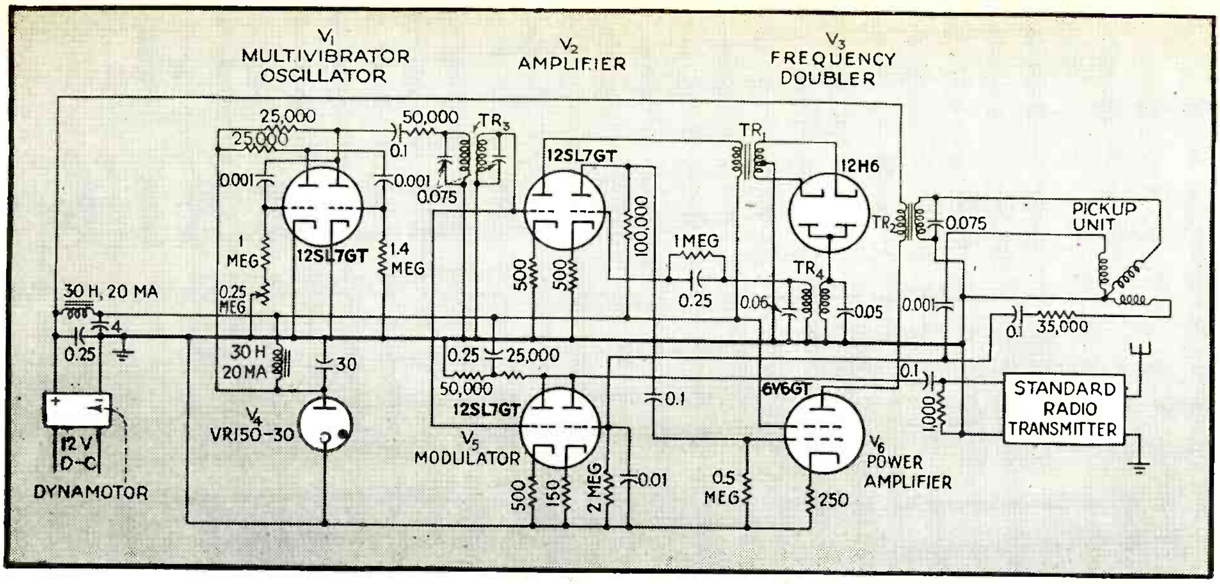


FIG. 1—Schematic diagram of chassis used in plane to convert output of pickup unit into signals that can be handled by one of the plane's standard radio transmitters

ment was an electrical phase-angle meter with its output connected to a pointer system similar to that in the original altimeter. The similarity of this component to an actual altimeter is apparent from the photographs.

Schematic diagrams of the electronic components of the position transmitting and receiving systems are given in Fig. 1 and 2. The operation of the transmitter will be taken up first.

Transmitter Circuit

To transmit intelligence by electrical phase angle, it is necessary to transmit a reference signal to be used as a time or phase standard, as well as the intelligence signal. The comparison signal and the intelligence signal are transmitted as two separate audio frequencies on one radio-frequency carrier.

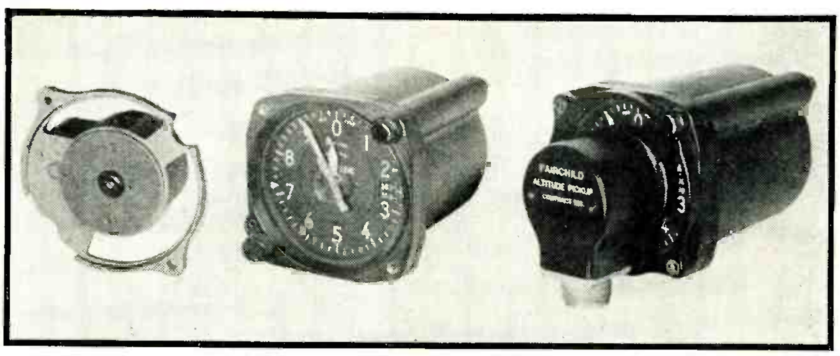
Referring to the pickup chassis diagram in Fig. 1, V_1 is a double triode (12SL7GT) acting as a 250-cps multivibrator oscillator. The 250-cycle wave passes through tuned transformer TR_3 to one half of V_2 (12SL7GT) acting as an amplifier for the frequency-doubling circuit including V_3 (12H6), and to one half of V_5 which acts as a modulator for the radio transmission system. Tube V_3 rectifies the 250-cycle signal, producing a strong second harmonic component which is selected by tuned transformer TR_4 which is tuned to 500 cycles. This second harmonic signal is then fed into the second half of V_2 which amplifies it and feeds it into power amplifier V_6. This power amplifier energizes the phase-shifting pickup whose output is fed to modulator V_5 and combined with the original 250-cycle signal which is used as the reference signal. The phase angle between the input of the phase-shifting pickup and its output is a function of the position of the altimeter sweep hand.

The output of the modulator tube is fed into a standard radio transmission system capable of being modulated by 250 and 500 cycles and having a small fixed phase shift between the two signals. For testing, a frequency-modulation radio transmitting and receiving system was used.

Repeater Circuit for Receiver

The repeater chassis diagram in Fig. 2 shows that the output from the radio receiver energizes two filter systems starting with the first halves of V_1 and V_2 (both 12SL-7GT). The output from the first half of V_1 is filtered by TR_1, which passes only the 500-cycle component to the second half of V_1 for energizing the zero-setting phase-shifting device that excites power amplifier V_5 (6V6GT). In turn, V_5 feeds into phase one of the two-phase drag-cup motor driving the phase meter indicator.

The first half of V_2 is connected to TR_2, which passes only the 250-cycle reference component of the received signal. This 250-cycle component is amplified by the sec-



Left to right: Pickup unit that attaches to face of instrument on plane; altimeter on plane, with small permanent magnet attached to its pointer; altimeter with pickup

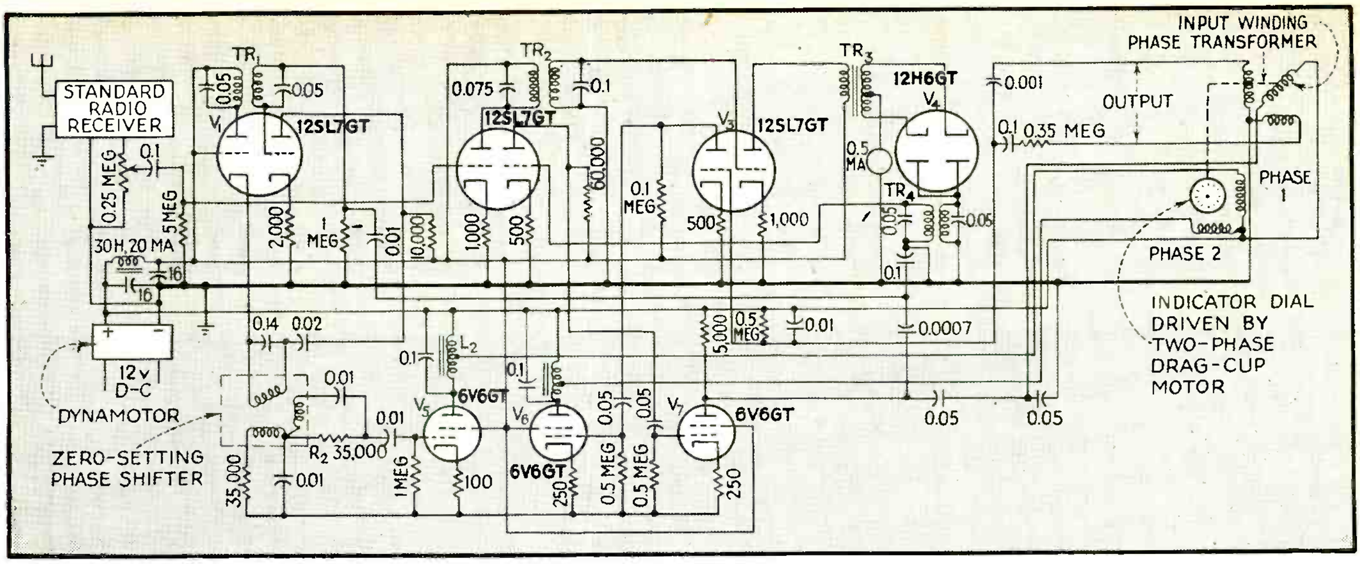


FIG. 2—Schematic diagram of chassis used on ground to convert output signals of receiver into currents suitable for driving an indicator that repeats accurately the readings of the instrument on the plane

ond half of V_3 and then fed through TR_3 for rectification by V_4, producing a strong second harmonic component which is selected by TR_4, producing a reference signal of the same frequency as the intelligence signal and therefore easily compared with it by a phase angle meter. This 500-cycle component is amplified by V_2 and V_7 and fed into a phase transformer driven by the two-phase drag-cup motor. The output of this phase transformer is amplified again by amplifiers V_5 and V_6, which in turn excite phase two of the two-phase meter indicator.

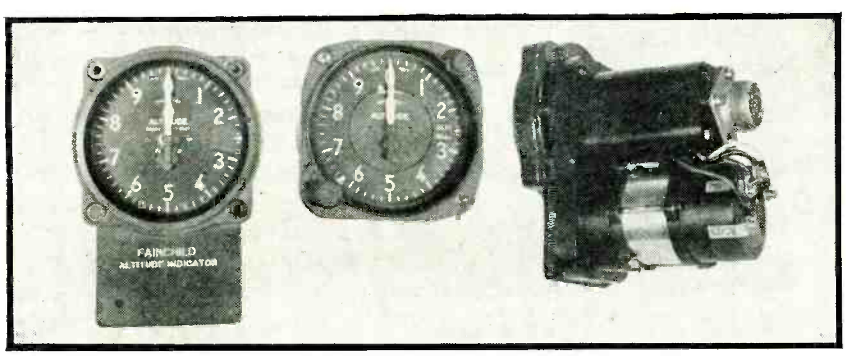
The two-phase motor will develop torque when there is any phase angle difference between the currents in phase one and phase two of the motor. Phase one is, as mentioned heretofore, excited by the amplified 500-cycle component of the received signal. Phase two is excited by the comparison signal, doubled in frequency and shifted in phase by the phase transformer in the motor-driven phase angle meter. The phase transformer position for zero phase angle between the currents in phase one and phase two of the motor is then a function of the difference in phase between the intelligence and the comparison signal in the received wave, which is in turn a function of the altimeter reading. The phase transformer operates the indicating pointer directly. Any discrepancy between the position of this phase transformer and the sensitive altimeter shaft which might be due to electrical phase shifts in the radio transmission equipment and in the transmitting and receiving electronic units is compensated at the time of installation by adjusting the zero-setting phase shifter. This adjustment only has to be made once for each installation.

Performance and Applications

Complete flight tests were made of this equipment by the Aircraft Radio Laboratory at Wright Field, Dayton, Ohio. The position-transmitting equipment was mounted in an AT7 aircraft and favorable results were obtained within the range of the radio equipment. It was noted that when the aircraft was flown out of the range of the radio equipment, the phase meter indicator maintained the indication at the point of losing radio contact, taking up the correct reading instantaneously again upon reestablishment of the radio contact.

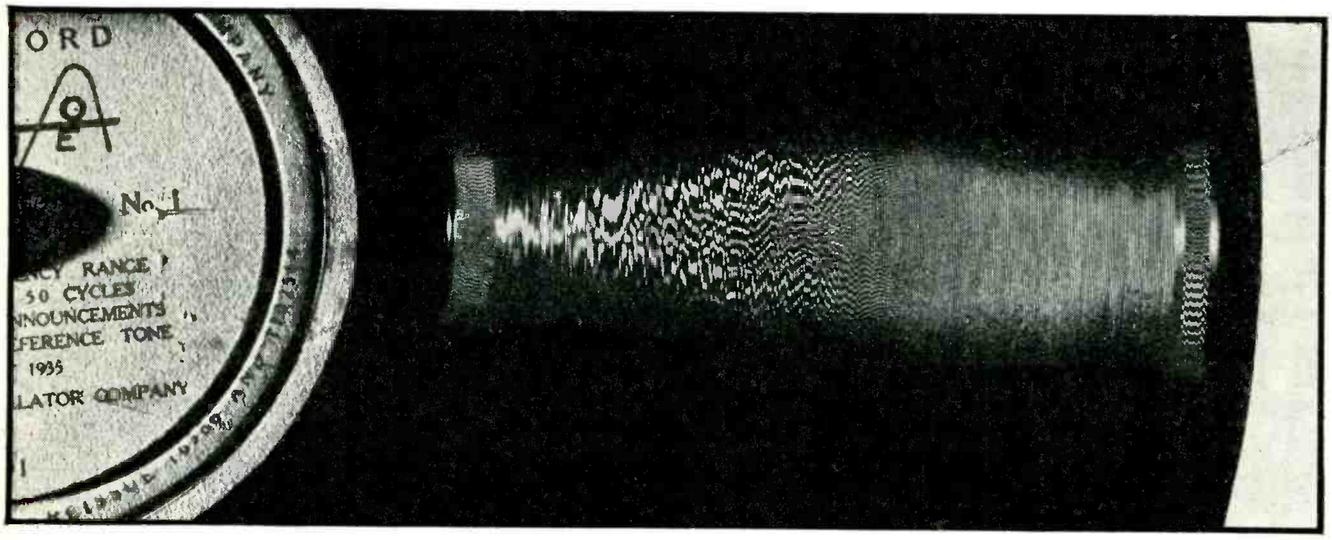
A system of this type is also applicable to multichannel instrument transmission on one radio carrier. For this use one comparison signal is employed with a multiplicity of intelligence waves, permitting a compact and accurate system for transmitting the entire flight group of instruments.

For industrial telemetering, the radio link may be eliminated, providing accurate and flexible multichannel or single-channel telemetering adaptable to carrier current or wire service.



Front and rear views of repeater used on ground, with standard altimeter (center) shown for comparison

Crystal Pickup Compensation Circuits



Light pattern on test record indicates frequency-response characteristic

From consideration of recording practice, record properties, pickup frequency characteristics, and listener acceptance, the appropriate corrective network for connecting crystal pickup to amplifier input to give desired overall frequency response is determined

IN THE DESIGN of phonograph equipment, quality performance is not automatically assured by choosing better-grade components for the playback mechanism. The circuit connecting the pickup to the amplifier plays an important part in the satisfaction which the user obtains from the instrument. A clear understanding of the latest trends in recording characteristics is essential to the selection of this circuit. In this article general consideration is given to the frequency response of phonograph playback equipment, with particular attention to the design of circuits for connecting piezoelectric pickups to playback amplifiers.

Recording Characteristics

To reproduce a record in the manner intended by the recording director, the characteristic of the playback system should match the characteristic of the recording system. Recording characteristics are specified in terms of the lateral or hill-and-dale amplitude and velocity of the modulated record groove.

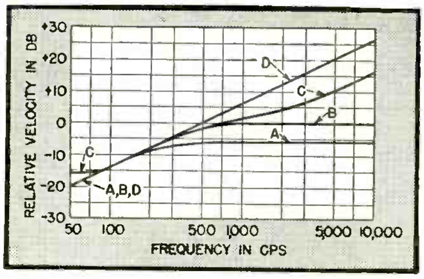


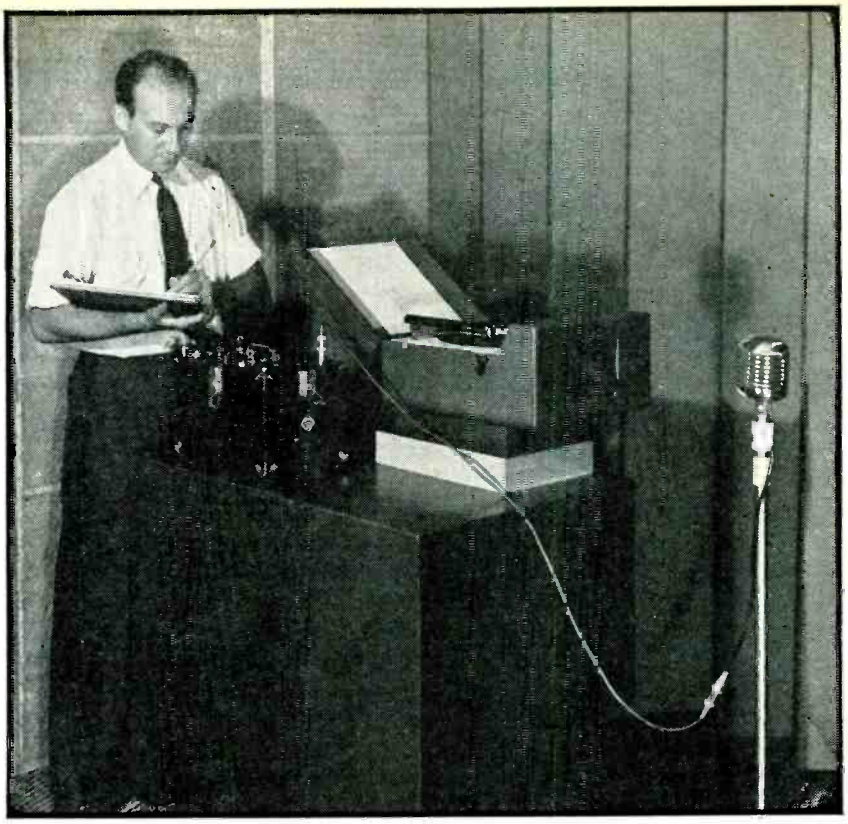
FIG. 1—Theoretical recording characteristics for (A) 250-cps turnover, (B) 500-cps turnover, (C) N.A.B. lateral recording, and (D) constant-amplitude recording

Peak velocity of groove modulation, which is a function of signal frequency is commonly known as the modulation velocity. If modulation velocity is to remain constant, amplitude must decrease with the frequency.

Recording characteristic of a system is defined by the velocity-frequency or amplitude-frequency curve obtained by cutting a disk with a sinusoidal voltage of constant amplitude and varying frequency applied to the input terminals of the recording amplifier. In this manner a test record is obtained which can be used for calibrating playback systems.

Shortly after the introduction of electrical recording, cutting heads and recording circuits were adjusted in such a manner that a constant velocity characteristic was obtained at frequencies above 250 cps, and a constant amplitude characteristic was obtained below this frequency (known as the turnover point). This recording characteristic is shown by curve A in Fig. 1. Maximum modulation velocity above the turnover point was limited—by the ability of the relatively heavy pickup needle chucks to turn the

By B. B. BAUER
Chief Engineer, Shure Brothers
Chicago, Ill.



Overall frequency characteristic of a portable record player is measured by means of a calibrated microphone and sound level meter

corners of the modulated groove at high frequency—to approximately 2.5 inches per second. The modulation amplitude below the turnover point was limited by the pitch of the grooves to approximately 0.002 inches. Disks recorded with this characteristic gave satisfactory tonal balance with equipment available at the time.

Extension of the frequency range by lightening the moving system of phonograph pickups, together with the development of wide-range loudspeakers for home use, led to the increase of the high-frequency modulation velocity to peaks of 5 to 7 inches per second. This resulted in a substantial improvement of the signal-to-noise ratio. Because of groove spacing limitations, maximum low-frequency modulation remained unchanged and the turnover point was shifted upward to 500 cps in home records. Such a recording characteristic is shown by curve B in Fig. 1. Because the surface-noise energy is contained principally above 1000 cps, this recording characteristic provides an improvement of signal to surface-noise ratio over the 250-cps turnover point characteristic of approximately 6 db.

High-Frequency Pre-Emphasis

To diminish the audibility of surface noise in transcriptions, it became common practice to accentuate the high-frequency characteristic in the cutting-head amplifier, and conversely, to attenuate the high-frequency response of the pickup. An example of such a recording characteristic is the orthoacoustic characteristic employed by the National Broadcasting Company, which provided for a 16-db rise at 10,000 cps. In 1942 the National Association of Broadcasters[1] recommended as standard the characteristic shown by curve C in Fig. 1, which corresponds closely to this

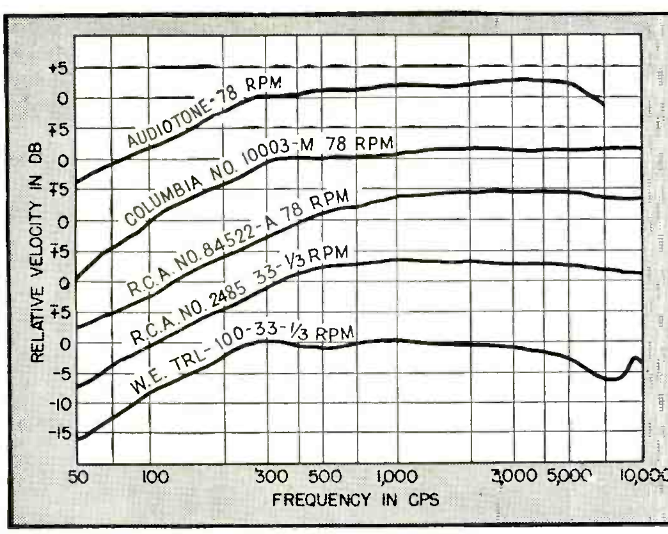


FIG. 2—Measured velocity-frequency characteristic of several test records

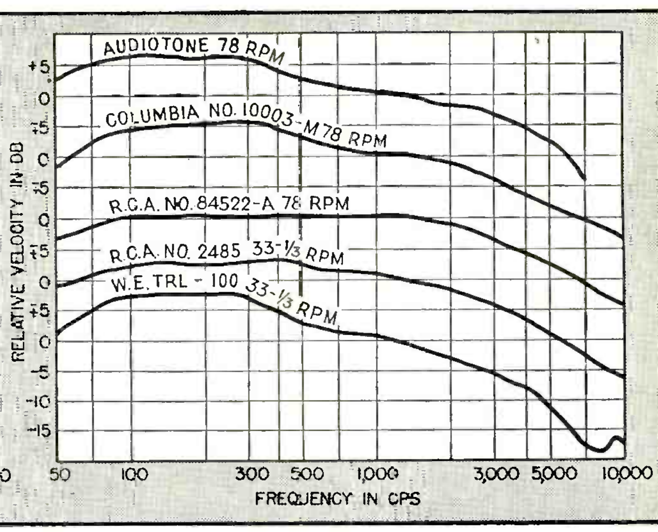


FIG. 3—Playback characteristics of test records in terms of N.A.B. response

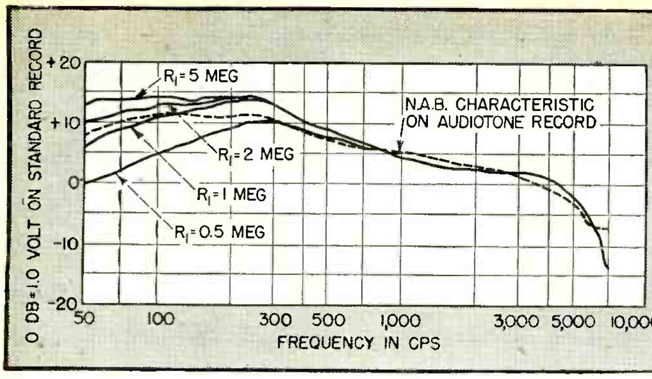


FIG. 4—Terminating resistance affects the low-frequency response of crystal pickups and therefore can be used to adjust overall response

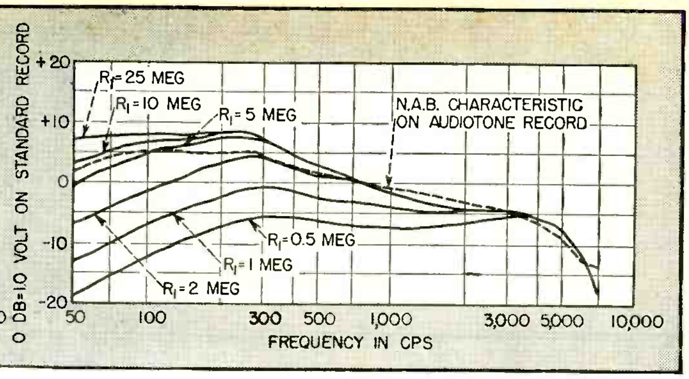


FIG. 5—By choosing terminating resistance used with PN type cartridge, N.A.B. characteristic can be approached. Five megohms gives best match

orthoacoustic characteristic.

In addition to high-frequency pre-emphasis, the recommended standard indicates a low-frequency pre-emphasis. When compensated in the appropriate manner, low-frequency pre-emphasis, tends to diminish effects of turntable rumble and line frequency hum.

If the recorded amplitude is kept at a low value, it is possible to employ a constant-amplitude recording characteristic shown by curve D in Fig. 1. Such a characteristic has a number of advantages, among them that of efficiently utilizing the available record surface and of providing a high signal-to-noise ratio. This characteristic has not been extensively applied.[2]

Characteristics of Shellac Pressings

The manufacturer of home records is confronted with a number of factors which have a bearing upon response-frequency characteristics. Home records are employed in an extremely wide variety of record players with different characteristics, in coin-operated machines, and in broadcast work. Such factors as needle tracking, recorded level, and surface noise, all of which are interdependent with response characteristics, are given different weight by various manufacturers and users. One finds, as a result, a difference between response-frequency characteristics of records manufactured under various brand names. Because of these differences in recording characteristics, a single playback response cannot meet all requirements and a compromise must be sought. It is to be expected that standardization work may be done in the future to remedy this situation.

Many recent recordings exhibit a good tonal balance when played back with a pickup adjusted to conform to the N.A.B. Standard. Other records provide a better balance when reproduced with a pickup which is flat on a velocity basis beyond the 500-cycle turnover point. However, surface-noise considerations in shellac-type home records dictate a reduction of high-frequency response of the playback roughly in accordance with the N.A.B. Standards. For reasons which are stated later, attenuation greater than prescribed by N.A.B. Standards is often desirable beyond 4,000 to 5,000 cps. There is little doubt that useful frequency content in commercial records beyond 8,000 cps is negligible.

Playback Tests

Test records provide convenient and precise means for testing and adjusting the response of playback systems. The test record need not be recorded with the exact characteristic which is desired for the playback system, as long as its characteristic is known. Most test records are recorded with a constant amplitude characteristic up to the turnover point, and a constant velocity characteristic above the turnover point.

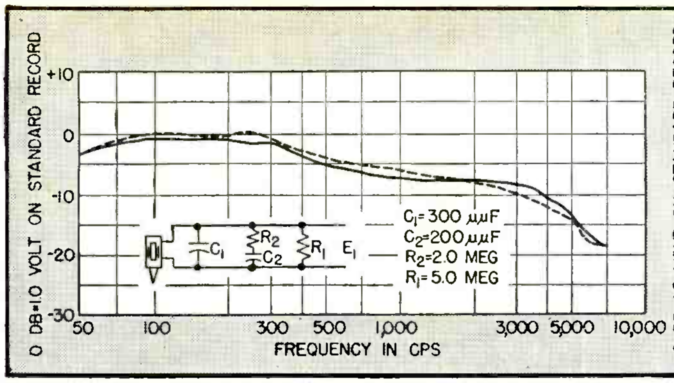
Among American-made lateral test records are Audiotone No. 78-1 (250 cps turnover), Columbia Frequency Record No. 10003-M (300 cps turnover), and R.C.A. Frequency Record No. 84522 (500 cps turnover). These are 78-rpm records intended for use with home record players. For broadcast test work R.C.A. Orthoacoustic No. 2485 (500 cps turnover) and Western Electric Test Record TRL-100 (250 cps turnover) 33⅓ rpm records are available.

Frequency characteristics of test records are sometimes supplied by the manufacturers, but they can also be obtained by measurement of the width of reflected light pattern[3], or by measurement with a phonograph pickup which is known to be substantially flat and to have low needle-point impedance.

Velocity-frequency characteristics of the above test records, as measured in the Shure Laboratory, are shown in Fig. 2.

Procedure for obtaining the playback characteristic of a test record in terms of a given recording curve is to subtract the desired recording characteristic from the frequency characteristic of the given test record. The resultant curve is the overall characteristic which will be exhibited by the playback mechanism when reproducing the test record with the playback adjusted to match the desired recording characteristic. This subtraction has been performed for the first five test records mentioned above in terms of the N.A.B. Standard. The resulting curves are shown in Fig. 3.

Precise adjustment of the playback characteristic requires measurement of the acoustical output of the loudspeaker when the pickup is playing the test record. In practice, when suitable acoustical measurement facilities are not available the pickup output voltage is measured across the amplifier volume control; the characteristic of the



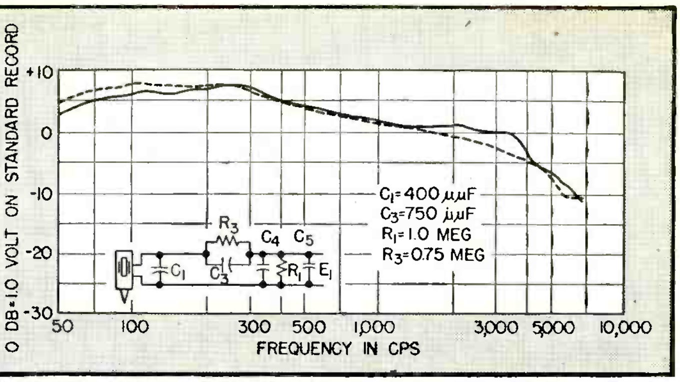


FIG. 6—Solid line is response of PN pickup cartridge with compensating network; dash line is Audiotone record response adjusted to N.A.B. Standard

FIG. 7—Similar curves to those of Fig. 6 but for crystal pickup. Both the curves of Fig. 8 and this figure are for response with bent-shank aluminum needle

amplifier and the loudspeaker is then added to these readings to obtain the overall characteristic.

Crystal Pickup Characteristics

Two types of piezoelectric crystals are employed in phonograph pickups, the x-cut rochelle salt type and a new crystal developed by the Brush Development Company known as the PN type. Rochelle salt crystal pickups are characterized by high output voltage and high internal capacitance. PN crystal pickups have acoustical characteristics similar to the crystal pickups, with the added advantage of withstanding extremely high ambient temperatures without deterioration. On the other hand, PN crystal pickups have a low internal capacitance which requires careful design of the input circuit for optimum operation.

From the electrical standpoint, a piezoelectric pickup can be represented as a zero-impedance generator connected in series with a capacitance which is numerically equal to the capacitance of the crystal. This capacitance is approximately 1000$\mu\mu$f in the case of rochelle salt pickups, and is approximately 100 $\mu\mu$f in the case of PN pickups. The addition of a capacitive cable to the pickup terminals results, therefore, in a loss of output voltage without change in frequency characteristic. The loss in output can be calculated by considering pickup capacitance C_0 and cable capacitance C_1 as forming a capacitive voltage divider. The loss due to cable, in decibels, is 20 log $(1 + (C_1/C_0))$, indicating the desirability of connecting the pickup to the amplifier with a cable having the lowest possible capacitance.

Phonograph pickups are generally connected to potentiometer-type volume controls. Because the internal impedance of the pickup is capacitive (and therefore increases at low frequencies), the addition of the volume control across the pickup causes a drop in output at low frequency. The added loss due to the shunting effect of the volume control resistance, in decibels, equals 20 log $[1 + (1/\omega CR_1)^2]^{1/2}$ where C is the sum of the capacitance of pickup and cable $(C_0 + C_1)$ in microfarads, and R_1 is the volume control resistance in megohms.

Input-Circuit Loading

To illustrate the point, Fig. 4 shows the characteristic on an Audiotone record of a Shure P-87 rochelle salt pickup cartridge connected across resistances of 0.25 megohms to 5.0 megohms. In dotted line is shown the playback characteristic which should be attained on an Audiotone record in order to match the N.A.B. Standard Characteristic. (This is obtained from Fig. 3.) It is seen that with this particular rochelle salt pickup, a 1.0 megohm volume control provides the best fit to the N.A.B. characteristic.

Figure 5 shows the characteristic of a PN-87 type pickup cartridge connected across resistances of 1.0 megohms to 10 megohms. In this instance, a 5-megohm termination resistance provides the most satisfactory performance. (It should be noted that the 100-$\mu\mu$f capacitance of the vtvm leads has doubled the effective generator capacitance.) Where such high termination resistance is not desirable, it is permissible to connect a 0.0008-microfarad capacitor across the PN pickup. This expedient results in a 15-db drop in the output voltage, but good performance can then be obtained with a 1.0 megohm termination resistance or potentiometer volume control.

Pickup input circuits of the simple potentiometer type do not, in general, provide completely satisfactory performance, but they can be employed in low-cost sets.

Low-Frequency Compensation

One of the earliest circuits employed for low-frequency compensation in piezoelectric pickups is shown in Fig. 6. The pickup is shunted by a series combination of capacitor C_2 and resistor R_2. At low frequency, R_2 is less than the capacitance of C_2, and therefore R_2 can be neglected. C_0, C_1, and C_2 form a capacitive voltage divider which reduces the low-frequency response evenly without frequency discrimination. At higher frequency, $X_C < R$, and the effects of the capacitor become gradually less important. In the design of this circuit, C_2 can be calculated from loss = 20 log $[1 + (C_2/C)]$ db, where C is the sum of the capacitances of pickup and cable, $(C_0 + C_1)$, based upon the desired low-frequency loss R_2 is adjusted to equal X_{C2} at the frequency above which compensation is no longer desired.

Because of changes of capacitance of x-cut rochelle salt crystals with temperature, low-frequency compensation can vary several decibles over the temperature range of 76° to 90° F; however, if PN crystals are used this is not encountered. On the other hand, this circuit has the advantage of not being adversely affected by cable capacitance between the parallel branch and the volume control.

Figure 6 shows the Audiotone record response of a Shure PN-87 pickup cartridge connected to a network having the indicated circuit components. Response of this circuit matches well the playback characteristic of the Audiotone record adjusted to the N.A.B. Standard Characteristic.

Another low-frequency compensating circuit, introduced by the writer several years ago for use with rochelle salt crystal pickups, is shown in Fig. 7. It consists of a parallel combination of a capacitor C_3 and a resistor R_3 connected in series between pickup and volume control. This circuit presents a high impedance to the crystal at low frequency and therefore diminishes the effects of capacitance-temperature variations. In computing this circuit, R_3 and R_1 are treated as a voltage divider at low frequency. X_{C3} is then made equal to R_3 at the frequency above which compensation is no longer desired. Stray capacitance C_4 and C_5 should be kept to a minimum to avoid a shunting effect upon R_1 at high frequency.

By the way of example, Fig. 7 shows the response-frequency characteristic of a Shure P-87 pickup employing a version of this circuit in which the network elements have the indicated values. By comparison with the N.A.B. Standard shown in broken line, it is seen that the two are in substantial agreement.

High-Frequency Compensation

Because the recording characteristic varies from one record to another, it is not feasible to specify with precision what response is apt to produce the most faithful reproduction. As has been pointed out, records appear to produce best fidelity when the response above 1,000 cps is flat on a constant velocity basis. Some of the newer recordings provide excellent results when played with a pickup adjusted in accordance with the N.A.B. Standards. For maximum flexibility, it appears best to have a pickup with an inherent high-frequency response somewhat higher than that required by the N.A.B. Standards. This response can be lowered, if necessary, by means of a conventional tone control circuit incorporated in later stages of the amplifier.

TABLE I—PREFERRED HIGH-FREQUENCY CUT-OFF

	Cut-off Frequency	Non-tech. Listeners	Technical Listeners
	3,000 cps	71%	13%
	5,000 cps	21%	58%
above	5,000 cps	8%	29%

The high-frequency range most acceptable to the listener is determined, to a large extent, by surface noise. The surface noise energy content for various recording materials is shown in Fig. 8[4]. Surface noise energy is distributed over practically all of the audible range on the basis of approximately equal energy content per cycle. Therefore, the effects of surface noise can be eliminated most easily by removing the higher end of the frequency spectrum, which contains the most surface noise energy per octave in the range where the ear is most sensitive to low level sounds.

Listener Tests

Distortion is another factor which has an important bearing upon the optimum high-frequency cut-off of the pickup. The origin of this distortion is (a) the relatively large radius of needle tip required to track properly in conventional record groove[5], (b) distortion inherent in the process of duplicating commercial records, and (c) distortion which takes place in playback equipment. Distortion due to these causes can attain values as high as 15 to 20 percent on a direct measurement basis (not including intermodulation effects). Removal of response at high frequency is instrumental in reducing the annoyance caused by this type of distortion.

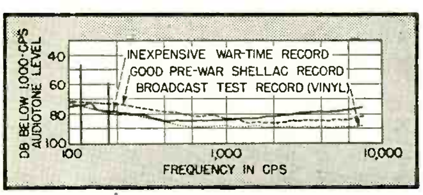


FIG. 8—Energy level per cycle of noise for various types of record material

The author has conducted a number of tests to determine the preference of listeners to high-frequency cut-off in the reproduction of home records. The tests were given to 100 non-technical listeners, and to over 100 radio engineers.[6] While a description of these tests is outside the scope of this article, the results given in Table I, although not conclusive, indicate that in the reproduction of home records, response above 5 kc exaggerates the effects of surface noise and distortion out of proportion to the improvement in fidelity. High-frequency cut-off can be obtained through the use of specially designed needles, or it can be obtained electrically with conventional low-pass filters.

The situation is, of course, totally different in the reproduction of broadcast-type transcriptions produced on low surface noise material and carefully processed to keep the sources of distortion to a minimum.

The author is grateful to the following persons for helpful discussion and for information regarding response characteristics: J. Dickert of Decca Records, Inc.; W. R. Dresser of the Audio-Tone Oscillator Company; H. S. Knowles of the Jensen Radio Corp.; V. J. Liebler of Columbia Recording Corporation; R. A. Miller of Bell Telephone Laboratories; A. A. Pulley and H. I. Reiskind of the Radio Corporation of America.

REFERENCES

(1) Technical Standards and Good Engineering Practices for Electrical Transcription and Recordings for Radio Broadcasting, National Association of Broadcasters, Washington, D. C., Mar. 1942.

(2) Williams, A. L., Further Improvements in Light-Weight Record Reproducers and Theoretical Considerations Entering into Their Design, *Journal of the Society of Motion Picture Engineering*, Aug. 1939, p 203–222.

(3) Buchmann, G., and Meyer, E., A New Optical Method of Measurement for Phonograph Recordings, *E. W. T.*, 7, p 147, 1930.

(4) The method of obtaining this information and other factors affecting fidelity of phonograph reproduction were described by the author in a paper presented before the Chicago Section of the I.R.E. on Dec. 15, 1944.

(5) Pierce, J. A., and Hunt, F. V., On Distortion in Sound Reproduction from Phonograph Records, *Journal of the Acoustical Society of America*, 10, p 14, 1938.

(6) Method of administering preference tests and the results obtained were described in a paper presented by the author before the Acoustical Society of America on May 12, 1945.

Electronic WATTMETER

Substitution of a cathode follower for a transformer and use of a push-pull parabolic rectifier provide a sensitive, wide-range electronic wattmeter that is useful to higher frequencies and loads the circuit less than electrodynamic types

By L. R. MALLING
Seattle, Wash.

AN ELECTRONIC WATTMETER was patented in 1926 by Eugene Peterson[1], and although a few years later Turner and MacNamara described a phase-shifting bridge adaption of this original circuit, little real use has been made of the principle.

Difficulties of measuring true power have led the electronic engineer to rely on the substitution of resistive components for reactive loads and the estimation of power from the measured current or voltage. However, continued expansion of electronics into the field of industrial engineering, use of high-frequency heating and the increasingly high frequencies used, for example, in airplane power systems, well justify an investigation into the properties and design requirements of the vacuum-tube wattmeter.

This article will discuss the limitations of the conventional a-c power wattmeter and will show how present-day circuit techniques and modern vacuum tubes may be applied to construction which will overcome the difficulties of the early design and make the vacuum-tube wattmeter a permanent and useful tool of the electronic engineer.

Advantages of Electronic Wattmeter

Average power in an electrical circuit is given by the product of $EI\cos\theta$ where E and I are rms values and θ is the phase angle between current and voltage. Average power may be measured by the power circuit engineer with an electrodynamometer, an instrument depending for its action on the average torque produced between two coils in which currents flow proportional to the applied voltage and current. It can be seen that the inductance of the coils will produce increasingly large errors as the frequency is increased and that the power absorbed by such an instrument limits the sensitivity. In addition, many electronic circuits will be seriously disturbed by the introduction of such an instrument.

Power can be measured by electronic voltmeters and ammeters in conjunction with electronic phase meters provided only single-frequency, sinusoidal voltages and currents are involved. Also slide-back wattmeters can be used where tubes can only be relied upon over a small portion of their characteristic.

Vacuum-tube wattmeters may be made independent of frequency over wide ranges and, while still retaining the advantages of high-power measurements by the use of shunts and multipliers, can also read powers of the order of fractions of a microwatt by the use of suitable amplifiers. The disturbing effect of placing the electronic wattmeter in a given circuit may be reduced

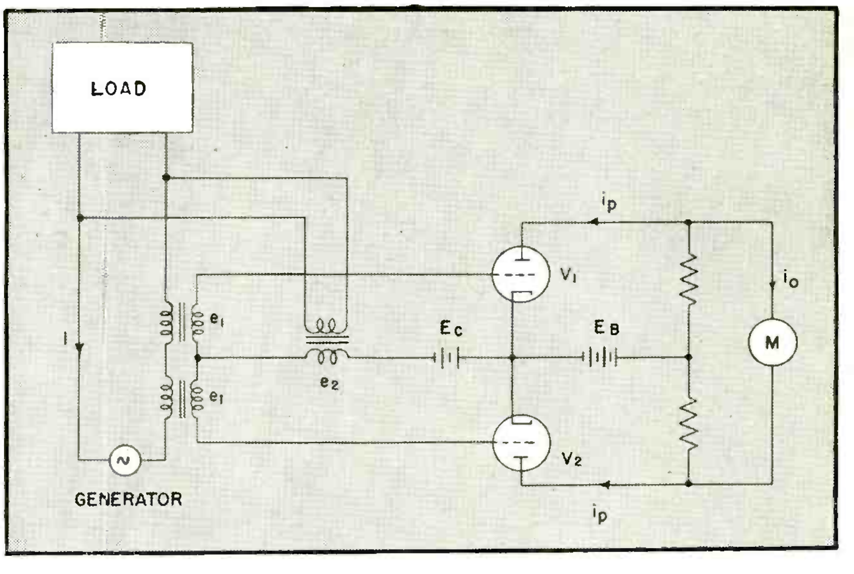


FIG. 1—Original electronic wattmeter circuit of Peterson, using transformers to compare the phase angle between potential and current

to the level that is presently recognized for other electronic test equipment. Accuracy of reading at low power factors becomes less of a limitation and the use of square-law rectifier tube characteristics makes the electronic instrument almost completely free of waveform errors.

Early Design and Theory

Figure 1 shows the original circuit described by Peterson, which operates on the principle of the balanced modulator. Voltage and current components of the load are applied to the tubes V_1 and V_2 and the difference in their plate current is registered on meter M. The voltages applied to the grids add in one case and subtract in the other so that the change in plate current in tube V_1 is

$$i_p = a_1 (e_1 + e_2) + a_2 (e_1 + e_2)^2 \qquad (1)$$

and in tube V_2 is

$$i'_p = a_1 (e_1 - e_2) + a_2 (e_1 - e_2)^2 \qquad (2)$$

The difference or meter current is

$$i_0 = i_p - i'_p = 2\, a_1 e_2 + 4\, a_2 e_1 e_2 \qquad (3)$$

If $e_2 = E_1 \cos \omega t$ and $e_1 = E_2 \cos (\omega t - \theta)$

$$\begin{aligned} i_0 &= 2\, a_1\, E_1 \cos \omega t + 4\, a_2\, E_1 E_2 \cos \omega t \times \cos (\omega t - \theta) \\ &= 2\, a_1\, E_1 \cos \omega t + 2\, a_2\, E_1 E_2 \times [\cos (2\, \omega t - \theta) + \cos \theta] \\ &= 2\, a_1\, E_1 \cos \omega t + 2\, a_2\, E_1 E_2 \times \cos (2\, \omega t - \theta) + 2\, a_2\, E_1 E_2 \cos \theta \end{aligned} \qquad (4)$$

and neglecting the frequency terms whose average value equals zero, the meter or d-c current is

$$i_{d\text{-}c} = 2\, a_2\, E_1 E_2 \cos \theta \qquad (5)$$

It can thus be seen that the electronic instrument will register true power.

The manner in which the voltage and current components add or subtract for out-of-phase load conditions may be illustrated by taking the case for a 90-degree phase difference or zero power factor. Let

$$e_1 = \sin A \text{ and } e_2 = \sin (A - 90)$$

$$\begin{aligned} \text{then } e_1 + e_2 &= \sin A + \sin (A - 90) \\ &= 2 \sin (A - 45) \cos 45 \\ &= 1.4 \sin (A - 45) \end{aligned} \qquad (6)$$

$$\begin{aligned} e_1 - e_2 &= \sin A - \sin (A - 90) \\ &= 2 \cos (A - 45) \sin 45 \\ &= 1.4 \cos (A - 45) \end{aligned} \qquad (7)$$

It can be seen that two new components are introduced and that these are of equal amplitude, separated by 90 degrees representing sine and cosine functions. These give equal changes in the d-c plate current of V_1 and V_2 and thus there will be no deflection of the meter needle. Figure 2 shows graphically the sum and difference components for in-phase and out-of-phase components.

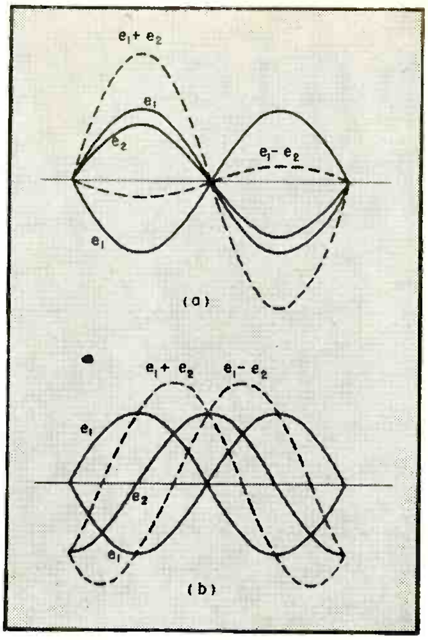


FIG. 2—Response of wattmeter reading to power factor is illustrated by (a) the addition of in-phase current and potential waves giving a large resultant meter current, and (b) the addition of out-of-phase components giving a zero resultant meter current

New Circuit

A modernized version of the Peterson wattmeter circuit is shown in Fig. 3. The load is supplied with power from the generator G through transformer T, in the secondary of which is placed a small resistor R_1 for obtaining a small voltage component proportional to current. A component proportional to voltage is fed to tube V_6, a phase inverter which supplies push-pull voltages to tubes V_3 and V_4.

Tubes V_3, V_4 and V_5 constitute a

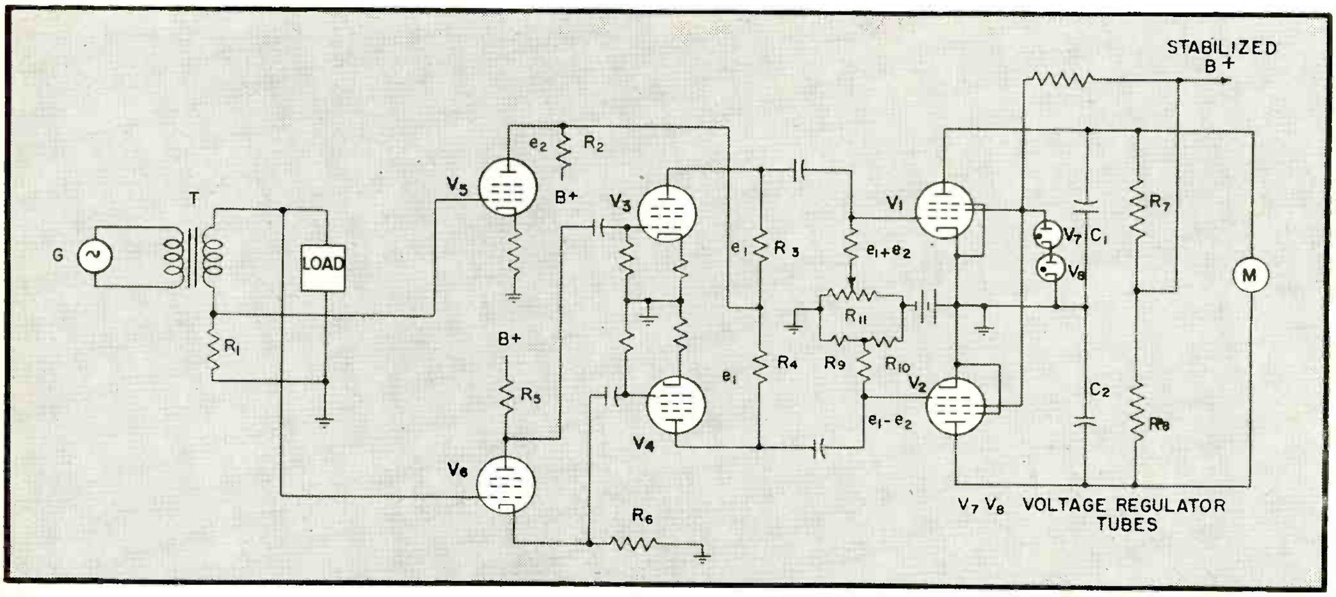


FIG. 3—Modernized electronic wattmeter makes use of cathode follower to shift phase of the potential component, and balanced modulator to combine current and potential for rectification by the parabolic rectifiers which feed the indicating meter

mixer circuit which, by virtue of the particular plate connections employed and the relat^ive phases of the plate curr... produces sum and differe... at the grids of pentode rectifiers V_1 and V_2 pro... to voltages at the input ...its of the mixer tubes.

This arrangement avoids the current and voltage transformers of Peterson, gives greater frequency range, and is readily adapted to single-ended circuit measurements. The advantages of using pentode rectifier tubes are brought out in the following paragraphs.

Parabolic Tube Characteristics

Considerable care is required in the selection and operating conditions of the tubes V_1 and V_2. For true parabolic operation the first derivative of the plate-current, grid-voltage curve should be a straight line. Thus the linearity of the transconductance versus grid-voltage curve should be used as a criterion of parabolic rectification characteristics.

The tube transconductance is given by $g_m = \partial i_p/\partial e_g$ so that $\partial^2 i_p/\partial e_g^2$ or $\partial g_m/\partial e_g$ should be linear to meet the above requirements. Typical curves of grid voltage versus transconductance for a typical screen-grid tube are given in Fig. 4.

It can be readily shown[2] that the steady or d-c value of the incremental plate current Δi_p of a parabolic plate rectifier due to the application of a superimposed a-c grid voltage ΔE_g is given by

$$\Delta i_p = \frac{1}{4}\frac{\partial g_m}{\partial e_g}(\Delta E_g)^2 \qquad (8)$$

where ΔE_g is the peak value of the applied a-c voltage. Equation (8) shows that the slope of the transconductance curve should be steep and that the linear portion should extend over the widest possible grid range for greatest change of plate current. High-conductance power tubes are thus indicated as suitable for parabolic rectifier applications and will give the greatest change of plate current.

The importance of Eq. (8) will be realized when power factor is taken into consideration. Assuming equal inputs to the rectifier tubes only one tenth the meter reading for unity power factor loads will be obtained for 0.1 power factor loads. While it would seem possible to increase meter sensitivity indefinitely to cover low power factor measurements, tube microphonics and d-c stability limitations militate against this alternative.

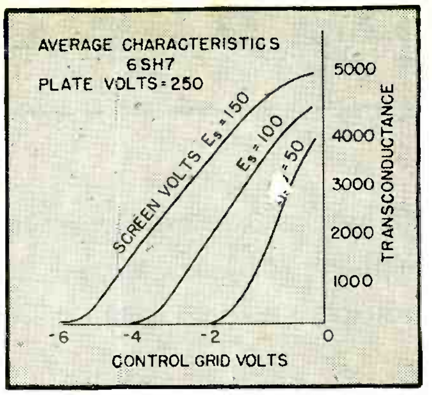


FIG. 4—Transconductance vs grid voltage for various values of screen voltage of a typical screen-grid tube

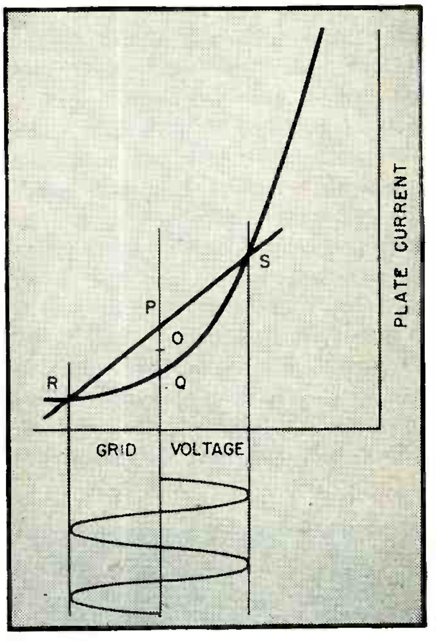


FIG. 5—Graphic method of determining the d-c change in plate current due to applied a-c grid potential

Incremental plate current may also be determined graphically. A straight line RS is drawn on the i_p/e_g characteristic, connecting the positive and negative peaks of the applied voltage on the parabolic working curve as in Fig. 5. A perpendicular PQ is then dropped to the working point Q of the curve. One half of the distance PQ, or OQ, is the incremental or d-c change in plate current for the given a-c wave applied.

Design Considerations

It is apparent that V_1 and V_2 should be matched both statically and parabolically. Feedback methods to stabilize these characteristics are difficult to apply and become complex due to the fact that the input and output components are totally different in character: that is, the input is an alternating current and the output is a d-c component produced by the non-linear characteristics of the tubes.

One good method of tube selection is to first choose tubes having similar but not necessarily identical static characteristics. By applying a small a-c voltage the tubes can then be selected for parabolic or rectification characteristics by noting d-c plate current changes.

Use of high-transconductance rectifier tubes with large grid swings gives considerable d-c plate and screen current variations. Voltage-stabilized sources thus become essential in order to preserve the linearity of the meter readings. The advantage of using pentode rectifiers is that plate current is substantially independent of plate voltage.

It would seem that unlimited sensitivity might be obtained by using high values of plate resistance R_7 and R_8 and a sensitive meter. However, the rectifier circuit and meter may be considered as a d-c amplifier and so to avoid microphonics and other circuit instabilities the overall d-c gain should be kept low. The bias arrangement shown in Fig. 3 enables residual unbalanced components to be eliminated from the meter circuit. Meter shunts can be used to extend the effective working range and to protect the instrument during the warm-up period provided care is taken not to use inputs that exceed the linear transconductance range of the rectifier tubes.

References

(1) Peterson, Eugene, U. S. Patent 1,586,533.
(2) Chaffee, E. L., "Theory of Thermionic Vacuum Tubes", McGraw-Hill Book Company, New York City, Chapter XX.

INDUSTRIAL X-RAY

Survey of tubes used today in plants for microradiography with low-voltag. eryllium-window types, x-ray diffraction with types having targets lower in atomic number than the material to be examined, and industrial radiography at 50,000 to 2,000,000 peak volts

INDUSTRIAL x-ray tubes have greatly increased in number and variety within the present war period. In fact, they have received from this war as great an impetus as that which marked medical x-ray tube development after World War I.

Although the first industrial x-ray installation in this country was completed in 1922, there was a long period when such tubes, in effect, took a back seat with respect to the developments in the field of medical applications. During this slow development period when the value of x-ray was being proven for industrial use, tubes designed solely for medical applications were commonly used. Aside from a few limitations, these tubes adequately met the industrial requirements of this period.

Within recent years the great increase in applications has brought about a demand for tubes designed specifically for industry. As a result, today there is available a complete range of industrial x-ray units employing tubes from the very low-voltage type to the super-voltage tubes of one and two-million volt capacity. A brief description of the various designs of tubes, divided primarily as to operating voltage and application, follows.

Low-Voltage Tubes for Microradiography

With the advent of beryllium-window, permanently-evacuated x-ray tubes,[1] developed primarily for diffraction, low-voltage radiography became a practical tool. This field covers radiography of thin sections that can be magnified to produce a microradiograph, and radiography of thin spot-weld structures such as airplane aluminum wing sections viewed directly or at low magnification.

Microradiographs can be successfully magnified to 200 to 400 diameters. The limiting factor, of course, is the film emulsion itself. Ordinary radiographic films are too grainy and only suitable for low magnifications up to 15 to 20 diameters. The first successful emulsion usable for this work was the Lippman emulsion, which essentially was a non-grain material. Within recent years the Eastman Kodak Co. has developed Type UO film and plate suitable for magnification up to 50 diameters. The type 548-0 emulsion can be used with magnifications well over 200. Figure 1 is a microradiograph enlarged 250 diameters of high-temperature cast iron alloy. Lighter areas are of higher x-ray density.

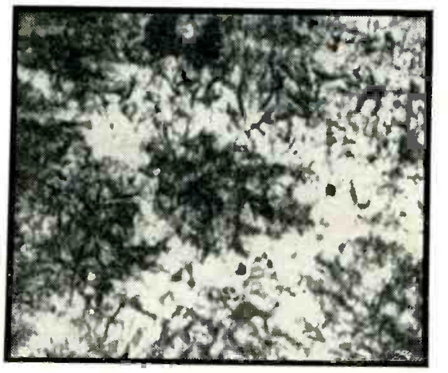


FIG. 1—Microradiograph, enlarged 250 times, of high-temperature cast iron alloy. The lighter areas are of higher x-ray density

There are basically two different methods used in interpreting microradiographs. The most common method[2] is simply to use the differences in absorption of the various arrangements of crystals or elements in the thin section as exaggerated by long-wavelength x-rays. The second method[3] is based on characteristic absorption discontinuities of the various elements which compose the substance being radiographed.

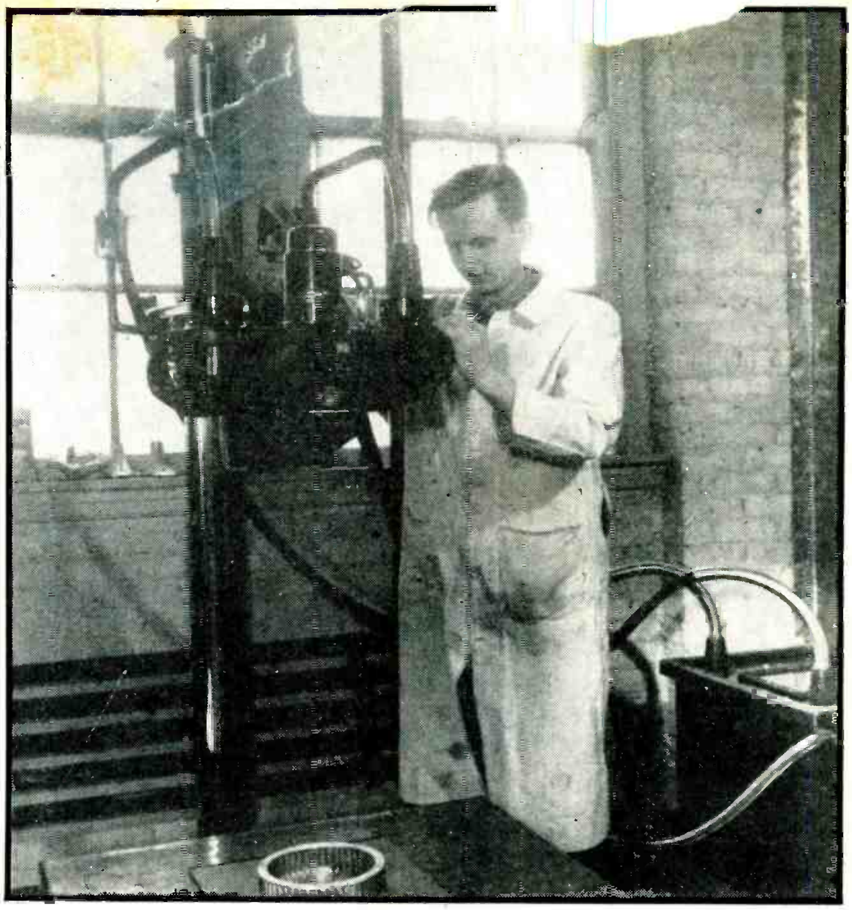
Interpretation of Microradiographs

In the first method a tungsten target usually is desired because it gives the maximum intensity of radiation. For a given x-ray tube current the efficiency of total radiation produced is a linear function of the atomic number. Copper or other low-atomic-number targets are usable for this work, but the exposures required are about 2½ times as long as those for tungsten.

In the second method, characteristic radiation is required which makes possible the accentuation of the contrast to bring out small inclusions that might not otherwise be discernible. Going even farther, by proper selection of the target material with respect to the critical absorption coefficient of the suspected element the method can be used to determine an unknown. The target selection for this technique should be two or three atomic numbers higher in the periodic chart than the unknown being sought. This calls for considerable compromise and can become a real headache for the x-ray tube designer who is required to provide the necessary numerous target materials. For example, this method has been proposed to identify and locate the iodine secreted in a goiter. Iodine, having atomic number 53 with a critical absorption coefficient of 0.37344 angstrom units calls for lanthanum, 57, or cerium, 58, for a target. Since neither can be used in modern permanently

TUBES

By Z. J. ATLEE
Chief, ... Engineering Dept.
General ... X-ray Corporation
...go, Illinois



Radiographing an aluminum casting with x-ray tube head employing the 140-kvp tube shown in Fig. 2D. Connections to the high-voltage transformer at the right are made with shockproof cable

evacuated tubes, a compromise would have to be made by going up to the first possible practical target above iodine in atomic number. This would be tantalum, 73.

Recently another technique made possible by these low-voltage tubes has been developed[4, 5]. This is chemical analysis by x-ray absorption using a comparative method. A phototube of the secondary electron multiplier type, a sensitive x-ray fluorescent screen to produce light of a wavelength to affect the phototube, and the low-voltage x-ray source are the essential parts of this system. The cell of unknown material can have a wide variety of shapes and include substances in all forms, as gases, liquids, or solids.

Figure 2A illustrates a beryllium-window tube for this class of work. It has a large-diameter beryllium window to give adequate coverage, and it can be operated at voltages from as low as one or two kvp (kilovolts peak) up to a maximum of 50 kvp oil-immersed. When oil-immersed the mounting is made in such a manner that there is no oil absorption, the beryllium being exposed directly to air.

Targets for X-ray Diffraction

Tubes for x-ray diffraction are essentially in the low-voltage classification described above and, as explained, preceded them in development. Here characteristic radiation is the sole interest. The total white radiation produced is a nuisance and many different mechanisms are employed to eliminate it. The operating voltage required ranges from 20 to 70 kilovolts, with most work done in the range of 25 to 42 kvp. The essential requirement in voltage is that it be above the minimum exact value that excites the characteristic radiation and not high enough to give so much white radiation that the characteristic lines are covered up.

Different wavelengths of radiation are required to provide suitable measuring sticks[6, 7] for the infinite variety of materials being studied by x-ray diffraction. This has meant a demand for targets of different atomic numbers, ranging from tungsten with an atomic number of 74 down to chromium with an atomic number of 24. This diversity has meant considerable work for the x-ray tube designer in that targets of metals such as cobalt, chromium, etc, have not been easily fabricated into the necessary target shapes and purity.

Chromium target tubes are being made today by electroplating onto the copper anode. Such electroplated targets also have the advantage of higher rating over a solid block type of target, being thin layers on the high-conductivity copper backing. Purity of metal in the target is important because impurities will give their characteristic radiation lines in the spectrum and thus confuse the interpretation of the diffraction pattern. It is possible for an impurity of as little as one part in ten thousand to give a line strong enough to result in misinterpretation under certain conditions. If it were not for the difficulty of making samples into targets for such an x-ray tube, this method could be used for chemical analysis. As a method, of course, it could not compete with spectroscopy either from a standpoint of sensitivity or convenience.

Beryllium-Window Tubes for Diffraction

An accepted type of tube for diffraction is of a two-port construction with beryllium windows as shown in Fig. 2B. This tube is made as a standard production item in seven different targets—tungsten, molybdenum, copper, nickel, cobalt, iron, and chromium. In addition, for special orders it has been supplied in silver, columbium, zirconium, germanium, manganese, and titanium. Vanadium has been requested and is definitely a desirable target material for some specific applications. Unfortunately, as yet the metal has resisted all attempts to make it into a successful target. Success with titanium has been very poor and only one or two experimental tubes have been made to date.

The demand is for long-wavelength radiations. The only way to accomplish this is with lower atomic number targets, and the question is just how far it is possible to go. With sealed-off types of tubes probably the lowest atomic number material in a commercial tube will be titanium, atomic number 22. Scandium, atomic number 21, is a rare earth unavailable as a target material except possibly for a research project.

Recent attempts to make a calcium (atomic number 20) target tube show that it will not be possible in a sealed-off commercial type of tube. An experimenter working with a demountable tube on continuous exhaust equipment could probably utilize it as a target. Below atomic number 20, the choice becomes slim indeed. Silicon, atomic number 14, would be the first possible choice. Its characteristic K alpha radiation is 7.111 angstroms, which would be absorbed completely in a beryllium window only a few mils thick. For such long wavelengths the target, specimen, and diffraction camera will all have to be housed in the same vacuum.

Recently x-ray diffraction has been greatly enhanced by the successful development of a Geiger-counter type of continuous recording spectrometer.[8] It can be predicted that this type of unit will branch out into several different forms requiring specific tube designs to meet the equipment design.

Radiographic Low-Voltage Tubes

X-ray tubes for industrial radiography at voltages from 50 to 150 kvp have not received too much special attention from the designer. In general, tubes used in medical roentgenography and therapy have been employed with little modification. This has been particularly true for voltages up to 100 kvp which is today the maximum for medical roentgenography. Every tube manufacturer has a dozen or more types of tubes suitable for the application. Small self-contained, self-rectified units are available in many forms. In general they are all that is required for low-voltage industrial radiography.

Figure 2C shows a small self-rectified tube with 85 kvp top kilovoltage rating and 15 to 25 ma current rating, with a 1.7-mm line focus. This tube meets all of the present requirements for voltages of this order. Higher-current diagnostic tubes have never been used industrially since there has been no need to make fractional-second exposures. In the medical field, motion of the patient has required split-second speed in the radiograph to arrest motion—the same reason high-speed exposures are required in photography. This has brought about high-current tubes with small focal spots, as ideally accomplished in the rotating-anode tubes which are now in widespread use by the roentgenologist.

Rotating-Anode Tubes

Rotating-anode tubes are not used industrially today. It is very unlikely that any use will be found for the present type of rotating-anode tube other than in medical work. Incorporation of rotating anodes in high-voltage x-ray tubes to provide for small focal spots is a possibility, but at present it does not seem to go beyond being just that.

In the diffraction field, rotating-anode types of tubes may some day be a reality because small focal spot loadings are limited even with circulating coolant, particularly with targets of low melting point and poor conductivity. Diffraction tubes require continuous loadings, making the present form of medical rotating anode of no particular value. The tube will probably have to be operated on the vacuum pump and have a relatively tight vacuum bushing to be able to bring circulating coolant to the anode. A tube of this type was made quite some years ago by Mueller in England.[9] Rcently a rotating-anode diffraction tube has [illegible] described by McArthur [illegible] of Leeds, England.[10] [illegible]ry-oil liquid seal is described, [illegible]ted to Astbury, operating at the [illegible]elatively low speed of 620 rpm.

Recently a rota[illegible]anode seal has been made with a [illegible]al-oil sealing surface that has operated satisfactorily at 3000 rpm.

Tubes for 100 to 150 Kilovolts

Above 100 kilovolts, the present ceiling for medical roentgenography, we begin to arrive at operating requirements in industry that made necessary the design of tubes specifically for industrial use. However, up until recent years the range of voltage from 100 to 150 kv has been handled industrially by the medical superficial therapy class of tube. Tubes in this range have been essentially of low-voltage design, with sufficient increase in dimensions to operate 50 kv higher. Essentially continuous loadings are required at low currents of five to 10 ma. In general, these tubes are made in shockproof casings with high-voltage cables to the generator as used for low-voltage tubes. The casing and tube are cooled by tap water, oil cooler, or fans. One of the tubes used in a shockproof casing for 140-kv industrial equipment is shown in Fig. 2D. A similar design of equipment has been made for voltages as high as 220 kvp, but this is the maximum because of the cables.

High-Voltage Tubes

Above 150 kilovolts we enter the higher-voltage range which is usually thought to start at 200 kilovolts. As pointed out in the beginning, this is the start of the deep-therapy range for which a well-developed commercial line of tubes has been available for many years. These tubes met the industrial requirements in all but one very important consideration—that of focal spot size. In therapy work a beam of radiation bathes the patient just as it would for ultraviolet treatment, so the source of medical

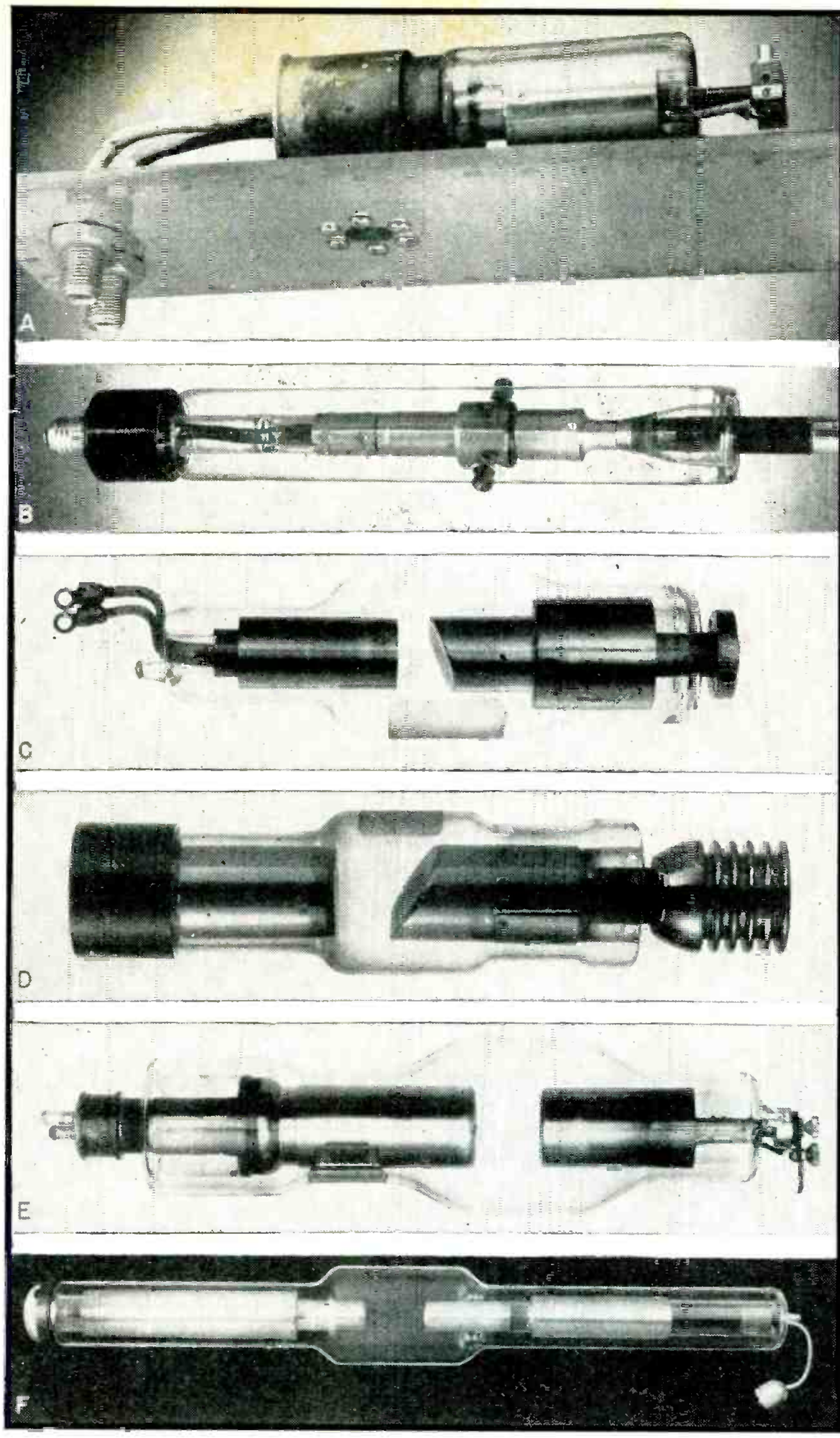


FIG. 2—Examples of modern industrial x-ray tubes. (A) Tungsten-target diffraction tube with ¾-inch beryllium window; (B) Two-port beryllium-window diffraction tube, in which the ports resemble black buttons fused into the glass envelope; (C) Small self-rectified tube for 85-kvp operation; (D) X-ray tube used in 140-kvp oil-immersed head; (E) Self-rectified hooded-anode line-focus tube for 250-kvp operation; (F) X-ray tube used in 400-kvp unit for self-rectified operation now made only with line focus but with five types of fittings

radiation need not be small. For shadow-pictures, ports and cones which limit the radiation to the area being treated are not required.

Of course, for industrial radiography it is desirable to approach a point source as far as practical, to get the desired detail.

The therapy tubes with large round or elliptical focal spots 10 to 20 mm in diameter were used in the early days of industrial radiography and were at best only a poor compromise. By working at long distances, of course, they did give satisfactory radiographs. Gradually the size of therapy-tube focal spots was brought down to 8 to 10 mm diameter to help in radiography.

It has been only within the last five years that line focus tubes with 5-mm projected focal spots and 20-degree targets have been made available for exclusive use in industrial radiography. Some sacrifice in the therapy tube life was made by attempting to reduce the focal spot size so that they are now made in the former 20-mm size of spot. Figure 2E shows the modern self-rectified 250-kilovolt tube with oil circulation and hooded anode construction. This same tube is made with two different focal spots, 20-mm round focus for therapy with 250 kvp and 15 ma continuous rating, and 5-mm line focus with 250 kvp and 10 ma intermittent-duty rating compatible with the radiographic exposure times needed.

400-Kilovolt Tube

Above 250 kvp various models of tubes have been made for 300 kilovolts and higher because of the industrial demand for radiographing greater thickness of steel.[11] These models were made obsolete by the successful development of a 400-kilovolt tube[12] for such use that has had a very wonderful record in medical therapy and industrial radiography since 1935. At first it was energized from various forms of generators to give a constant or unipotential voltage. The tube was housed in a separate oil tank or an air drum, or in some cases in the same cumbersome tank with the high-voltage generator and kenotrons. In 1939 it was redesigned to operate self-rectified, making possible a practical single-package high-voltage x-ray unit.

At first this tube was made only with round focus for both medical and industrial applications. As the industrial demand exceeded the medical it was redesigned in line focus and is today made only in line focus for all applications. This is possible because the rating has been limited to 5.0 ma at 400 kvp for all types of generators. Today this one tube is supplied with five different types of fittings to operate in the obsolete type of generators as well as the self-contained, self-rectified unit of present manufacture. This tube, as shown in Fig. 2F, was for a number of years, and until the advent of the present million-volt tube, the largest and highest-voltage permanently-evacuated x-ray tube made.

No commercial permanently-evacuated x-ray tubes have as yet been made for voltages between 400 and the now well established million-volt type of tube. Before and throughout the period when the 400 kvp tube was the highest voltage type available, various therapy installations were made for voltages from 600 to 1000 kvp and higher, with demountable tubes operated on the exhaust system continuously.[13] It is significant that none of these installations was made for industrial radiography. The reason is quite apparent when you consider their size and lack of mobility.

The first million-volt industrial installation was made using the type of unit developed in the General Electric Research Laboratory for medical therapy[14] but with the pumping equipment mounted on the tank to give some small degree of mobility. It operated successfully until the development of the present unit incorporating the sealed-off type of tube. As a matter of fact, the physical dimensions of the demountable tube were made so closely approaching the present sealed-off type that it had little to offer in ruggedness over the present tube.

Million-Volt X-ray Tubes

The tube for million-volt industrial radiography is an eleven-section tube operated self-rectified inside a 180-cycle resonant transformer, with freon gas as the dielectric.[15] Nearly fifty of these tubes are in operation daily in industrial installations, and they are making important contributions to the war effort. Only one unit of this type is in use medically, at Walter Reed Hospital in Washington, D. C.

The SMS-1000 tube (abbreviation of Sealed-off Multi-section 1000 kvp) has a round focal spot of three different values depending on the operating current. For best possible radiographic detail where a great distance cannot be employed, the focal spot is focused to a small spot about 5.0 mm in diameter by the focusing coil and the current rating is limited to 0.1 ma. An intermediate current rating of 1.0 ma is given with a focal spot about 7.0 mm in diameter. Full rating of 3.0 ma at 1000 kvp is given with the focal spot about 10 mm in diameter.

Two-Million-Volt Tube

With million-volt x-rays 8 inches is the maximum thickness of rolled steel plate that can be radiographed with a two-hour exposure. The war has brought about a demand for radiography of steel even thicker than this with shorter exposure times. In 1944 a two-million-volt tube and unit were developed[16] along the lines of the million-volt equipment illustrated. Figure 3 gives the physical size comparison of the two tubes. The two-million-volt tube is nearly nine feet long which probably is the maximum length that such a tube will ever reach. Possibly three- or four-million-volt tubes will be built along similar lines, but they will not be any picnic for the x-ray tube builder. The present two-million-volt tube in the horizontal position, supported by the anode, deflects more than $\frac{1}{8}$ inch at the cathode end. Special carrying trays had to be made to carry the tube around the factory during construction.

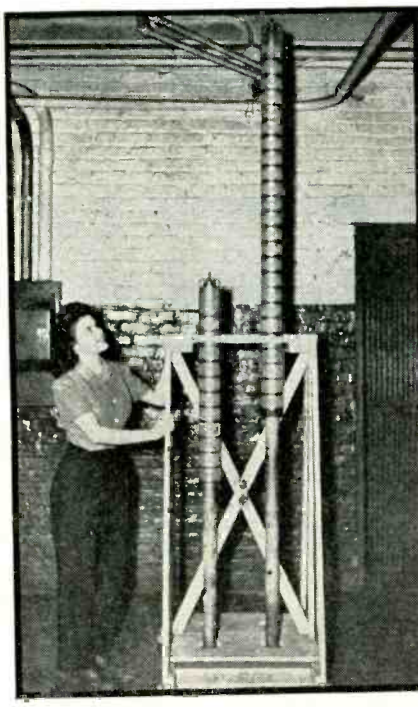


FIG. 3—Comparison of 1,000,000 (left) and 2,000,000 (right) kvp industrial x-ray tubes

There is speculation as to what the next step above voltages of three or four-million will be either for industrial or medical applications. It is certain that it will not be with tubes of the design described above. The induction electron accelerator[17], now popularly referred to as the betatron, may be the answer. Successful operation has been reported with such devices at from 20 to 100 megavolts, but as yet radiographic results have not been reported.

REFERENCES

(1) Brackney, H. W., and Atlee, Z. J., Beryllium Windows for Permanently Evacuated X-Ray Tubes, *Review of Scientific Instruments*, **14**, No. 3, p. 59–63, Mar. 1943.

(2) Ball, Leslie, X-Ray Micrography as a Tool for Foundry Control, presented at 48th Annual Meeting of American Foundrymen's Association, Buffalo, New York, Apr. 25, 1944.

(3) Maddigan, S. E., The Technique of Micro Radiography, *Journal of Applied Physics*, **15**, No. 1, p. 43–54, Jan. 1944.

(4) Smith, H. M., X-Ray Inspection with Phosphors and Photoelectric Tubes, *General Electric Review*, **48**, No. 3, Mar. 1945.

(5) Liebhafsky, H. A., and Winslow, E. H., Chemical Analysis by X-Ray Absorption, *General Electric Review*, **48**, No. 4, Apr. 1945.

(6) Atlee, Z. J., Diffraction of X-Rays, *Radio-Electronic Engineering*, June 1944.

(7) X-Ray Tubes and Apparatus, *British Journal of Scientific Instruments*, 22, No. 4, p. 66–70. Report of the meeting of the x-ray analysis group of the Institute of Physics held at University of Leeds, Nov. 25, 1944.

(8) Friedman, H., Geiger Counter Spectrometer for Industrial Research, ELECTRONICS, p. 132–137, Apr. 1945.

(9) Mueller and Clay, *Proc. Roy. Soc.* **46**, p. 703, 1934—*Proc. Roy. Soc.* A117, p. 30, 1927.

(10) McArthur, Ian, A Rotating Anode X-Ray Generator, *Electronic Engineering* (British), Dec. 1944, p. 272, Jan. 1945, p. 317.

(11) Carpenter, O. R., High-Voltage X-Ray in the Boiler Shop, Symposium on Radiography, A.S.T.M. Pub., 1943.

(12) Gross, M. J., Characteristics of Roentgen Ray Equipment at Voltages in Excess of 200,000, *The American Journal of Roentgenology and Radium Therapy*, **XXXVI**, No. 4, Oct. 1936.

(13) Coolidge, W. D., Dempster, L. E., and Tanis, H. E., Jr., High Voltage Cathode Ray and X-Ray Tubes and Their Operation, *Physics*, **4**, Oct. 1931.

(14) Charlton, E. E., Westendorp, W. F., Dempster, L. E., and Hotaling, G., A New Million Volt X-Ray Outfit, *Journal of Applied Physics*, **10**, No. 6, June 1939.

(15) Charlton, E. E., and Westendorp, W. F., A Portable Million Volt X-Ray Outfit for Industrial Laboratories, *General Electric Review*, **44**, No. 12, p. 652–661.

(16) Charlton, E. E., and Westendorp, W. F., Mobile Industrial X-Ray Unit, ELECTRONICS, Dec. 1944.

(17) Kerst, D. W., The Acceleration of Electrons by Magnetic Induction, *The Physical Review*, **60**, No. 1, July 1941.

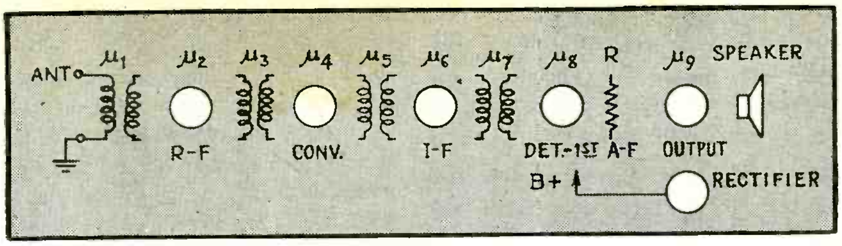


FIG. 1—Simplified diagram of six-tube receiver used as example in illustrating procedure for setting sensitivity control limits for production-line tests

Sensitivity Limits in RADIO MANUFACTURING

Statistical procedure for determining economical sensitivity limits of receivers coming off a production line, and use of a preselected average set of tubes to determine if rejection of a receiver is due to circuit trouble or to an unfortunate combination of tubes

By A. S. BLATTERMAN

Manufacturing Methods Division
RCA Victor Co. Limited
Montreal, Canada

EVEN with the most careful control in manufacture the performance of finished radio receivers of a given design will vary. The performance can be described in terms of various operating characteristics such as the selectivity, sensitivity, maximum power output, avc action, and distortion (using the terms in a very general sense). These characteristics are not independent of one another, nor are they all of the same importance.

The present discussion directs attention to the sensitivity alone, defining it in terms of microvolts input to give a stated output (in watts or in volts). The sensitivity will vary from one receiver to another, and the question arises as to how much variation should be expected or allowed. This question can be answered through straightforward statistical analysis.

Suppose we consider a more or less conventional six-tube receiver as indicated in Fig. 1. Here there are at least eleven variable factors in the circuit which will affect the overall sensitivity—the nine gain factors μ_1, μ_2, μ_3, . . . μ_9 of the coupling circuits and tubes, the coupling resistor R, and the B supply voltage.

In the course of manufacture and assembly of receivers, suppose that each of the above eleven factors varies ± 10 percent. The total overall gain of the receiver (its sensitivity) might then, if we happen to get all low-value factors together first and all high-values factors next, vary in the ratio of $(1.1/0.9)^{11}$ and give a range of over 9 to 1 in sensitivity.

Standard Deviation Unit

It will now be shown that the principle just used, taking all the possible maximum and minimum limits for determining the limits of a complete assembly of parts, is not economically justified. It will also be shown how proper economic limits may be specified.

If the gain factor (the mutual conductance g_m) of a large number of supposedly identical vacuum tubes is measured, it will be found that there is a certain distribution of high, low, and intermediate values. Under commonly existing, controlled conditions of manufacture, the distribution will follow the normal or Gaussian law typified by the curve of Fig. 2. About 68 percent of all values of g_m will be within ± 1 standard deviation s from the average value, about 95 percent within ± 2 standard deviations $2s$, and 99.73 percent within ± 3 standard deviations $3s$ from the average.

The standard deviation s is a statistical measure of dispersion and by formula is the square root of the average of the squared differences from the arithmetic mean

$$s = \sqrt{\frac{(X_1-\overline{X})^2 + (X_2-\overline{X})^2 + \dots (X_n-\overline{X})^2}{n}} \qquad (1)$$

where n is the n[illegible]mber of observations and $\overline{X}$ i[illegible]e arithmetic mean of the n o[illegible]tions. The same sort of thi[illegible]happen for such other cir[illegible]its as coils, resistors [illegible]ors if measurements [illegible]Q, R, or C.

[illegible]robabilities

[illegible]he vacuum tubes, s[illegible]erage mutual con-[illegible]of a certain kind of [illegible]cified as 1,000 micromhos. If a lot of say 100 of these tubes is measured, it will be found that the average value is very closely 1,000 micromhos. The standard deviation s, when calculated, may be 10 micromhos. This means then that if we pick out tubes at random from a large lot we can be quite sure of not getting more than about 15 in 10,000 tubes having g_m greater than $1{,}000 + 3s = 1030$ micromhos, and no more than 15 in 10,000 with g_m less than 970 micromhos.

With this low probability of picking a tube having either extremely high or extremely low gain, the chances of ever getting a combination of say 5 such tubes into one receiver, all having highest gain or all having lowest gain in a given combination, is exceedingly remote indeed. The fallacy of setting performance limits of the assembled receiver on the basis of separately adding maximum and minimum limits of component parts is therefore obvious. One would expect almost all receivers to give performance very far within the extreme limits that such a calculation shows.

Suppose that coils, transformers, resistors, voltages, etc are held substantially constant so that receiver sensitivity is only affected by the tubes, and suppose there are n stages of these producing average stage gains of $\mu_1, \mu_2, \mu_3, \ldots \mu_n$ decibels with standard deviations of gain from each of the average values of $s_1, s_2, s_3, \ldots s_n$ decibels. Then for the combination of n tubes the value of average overall gain is

$$\bar{\mu} = \bar{\mu}_1 + \bar{\mu}_2 + \bar{\mu}_3 \ldots\ldots\ldots\ldots + \bar{\mu}_n \text{ db} \quad (2)$$

and the standard deviation of this overall gain is

$$s_\mu = \sqrt{s_1^2 + s_2^2 + s_3^2 + \ldots\ldots\ldots s_n^2} \text{ db} \quad (3)$$

The limits, then, of overall gain $\bar{\mu}$ between which we may expect to find all receivers except about 3 in 1000 are $\bar{\mu} + 3s_\mu$ and $\bar{\mu} - 3s_\mu$.

Equations for Equal Stage Gains

As a simple special case to illustrate the point of the discussion let us suppose that the individual stage gains (average) are all the same (μ_1) and that each has the same standard deviation s_1. Then Eq. (3) becomes $s_\mu = s_1\sqrt{n}$, and 99.73 percent of all receivers will show gains between the limit values $n\,\bar{\mu}_1 + 3s_1\sqrt{n}$, and $n\,\bar{u}_1 - 3s_1\sqrt{n}$.

Had we followed the plan described earlier of finding these limits from the $3s$ limits of each stage, the overall limit values would obviously have been $n\,\bar{\mu}_1 + 3s_1n$ and $n\,\bar{\mu}_1 - 3s_1n$, which is a variation from overall average gain $\sqrt{n}$ times as great. The extreme case where all tubes are on the low side or all on the high side may of course happen, but the point is that the probability of it happening is extremely small. The situation is shown in Fig. 3 for four stages ($n = 4$).

Practical Application

An important practical question that arises is, "In the quantity production of radio receivers of a given type, what high and low limits shall be established for sensitivity such that within these limits we can be sure that variations in sensitivity are due solely to normal variations in tubes?" The procedure is as follows:

(1) Select a receiver of the type to be dealt with which is known to be normal (although perhaps not exactly average) in regard to its component parts, wiring, etc., and allow it to come up to operating temperature with a random lot of proper type tubes in the sockets.

(2) Take successive readings of sensitivity (μv input for standard output) for say 100 different tubes inserted in socket No. 1. These, for example, could be 100 different type 6K7 r-f amplifier tubes taken at random from stock.

(3) Calculate the average sensitivity $\bar{X}_1$ (μv) of the 100 readings and the standard deviation s_1 in μv.

(4) Insert in socket No. 1 a tube which produces this average value of sensitivity, and leave it there.

(5) Take successive readings of overall sensitivity for 100 different tubes of the required type, inserted one after the other in socket No. 2. Again calculate average value of sensitivity $\bar{X}_2$ of these 100 readings and the new standard deviation s_2.

(6) Insert in socket No. 2 a tube which gives this average overall receiver sensitivity, and leave it there.

(7) Repeat for each successive socket until all sockets are equipped with average tubes.

(8) Measure sensitivity $\bar{X}_n$ (microvolts) of the receiver with the tubes in the sockets which have thus been selected as being average tubes.

(9) Calculate the expected standard deviation in sensitivity s_t of the receiver with randomly chosen tubes in production from

$$s_t = \bar{X}_n\sqrt{(s_1/\bar{X}_1)^2 + (s_2/\bar{X}_2)^2 + \ldots\ldots (s_n/\bar{X}_n)^2}$$

(10) Set sensitivity limits for normal tube variations at $\bar{X}_n + 3s_t$ and $X_n - 3s_t$ μv.

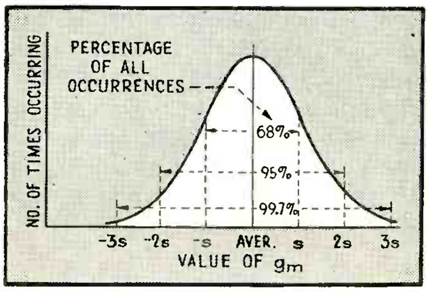


FIG. 2—Variations in mutual conductance values of supposedly identical tubes follow the normal or Gaussian distribution curve shown here

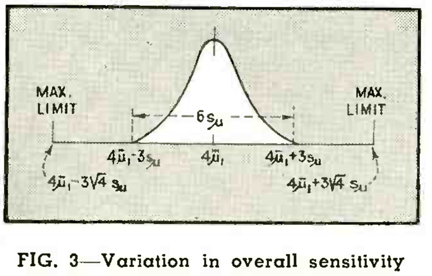


FIG. 3—Variation in overall sensitivity of four stages having equal gain. The maximum limit is twice the probable limit for four stages

Six-Tube Set As Example

Suppose that sensitivity limits are required for a six-tube set with the following tube complement: (1) r-f amplifier; (2) converter; (3) i-f amplifier; (4) detector—first audio; (5) output; (6) rectifier.

As the first step in the procedure, sensitivity is measured in microvolts at the antenna and ground input terminals, using 100 tubes in each socket in turn. The complete data and calculations (hypothetical) for the r-f amplifier stage are given at A in Table I. Similar measurements are then made and tabu-

TABLE I. DETERMINATION OF CONTROL LIMITS FOR SIX-TUBE SUPERHETERODYNE RECEIVER

(A) DATA FOR R-F STAGE (r-f tube changed 100 times—other tubes fixed)

X in μv	f freq. of occurrence	fX	$(X-\overline{X})$	$(X-\overline{X})^2$	$f(X-\overline{X})^2$
9.9	2	19.8	−0.4	0.16	0.32
10.0	4	40.0	−0.3	0.09	0.36
10.1	7	70.7	−0.2	0.04	0.28
10.2	20	200.4	−0.1	0.01	0.20
10.3	34	350.2	0	0	0
10.4	19	197.6	0.1	0.01	0.19
10.5	8	84.0	0.2	0.04	0.32
10.6	3	31.8	0.3	0.09	0.27
10.7	2	21.4	0.4	0.16	0.32
10.8	1	10.8	0.5	0.25	0.25
Total	100	1026.7			2.51

Av. $\overline{X}_1 = 1026.7/100 = 10.3$, and standard deviation $s_1 = \sqrt{2.51/100} = 0.159$

(B) AVERAGE VALUE OF MICROVOLTS INPUT $\overline{X}_1$ AND STANDARD DEVIATION s_n FOR STANDARD OUTPUT

Tube Disposition	No. 1 varied; 2, 3, 4, 5, 6 fixed	No. 2 varied; No. 1 at average	No. 3 varied; 1, 2 average	No. 4 varied; 1, 2, 3 average	No. 5 varied; 1, 2, 3, 4 average	No. 6 varied; others average
Averages $\overline{X}_{1,2,3,\ldots n}$	10.3	18.5	14.6	16.0	12.1	14.3
Std. Dev. $s_{1,2,3\ldots n}$	0.159	0.304	0.180	0.215	0.120	0.106

(C) COMPUTATION OF CONTROL LIMITS FOR INPUT TERMINALS

Average overall sensitivity $\overline{X}_n = 14.3$ microvolts (measured with average tubes)

$$\text{Overall standard deviation } s_t = 14.3\sqrt{\left(\frac{0.159}{10.3}\right)^2+\left(\frac{0.304}{18.5}\right)^2+\left(\frac{0.180}{14.6}\right)^2+\left(\frac{0.215}{16.0}\right)^2+\left(\frac{0.120}{12.1}\right)^2+\left(\frac{0.106}{14.3}\right)^2} = 0.45\mu v$$

Control limits on this receiver: $\overline{X}_n \pm 3s_t = 14.3 + 1.35 = 15.7\ \mu v$ and $14.3 - 1.35 = 12.9\ \mu v$

lated for the other five stages, the results summarized as at B in Table I, and the control limits computed as at C.

The data in Table I also provides another check. It is common practice to measure the sensitivity at the control grid of the converter tube. We have, from the data, the standard deviations for the groups of 5 tubes (r-f tube eliminated): $s_2 = 0.304\ \mu v$; $s_3 = 0.180\ \mu v$; $s_4 = 0.215\ \mu v$; $s_5 = 0.120\ \mu v$; $s_6 = 0.106\ \mu v$. Suppose the sensitivity at the converter grid with average tubes is 170 microvolts. This gives for the combination

$$s_0 = 170\sqrt{\left(\frac{0.304}{18.5}\right)^2+\left(\frac{0.180}{14.6}\right)^2+\left(\frac{0.215}{16.0}\right)^2+\left(\frac{0.120}{12.1}\right)^2+\left(\frac{0.106}{14.3}\right)^2} = 4.67\ \mu v$$

Therefore the sensitivity limits at the converter grid to be taken as acceptable and due to normal tube variations in this particular receiver are $170 + 3s_0 = 184.0\ \mu v$ and $170 - 3s_0 = 156.0\ \mu v$.

Sensitivity Deviations Not Due to Normal Tube Variations

We can go farther now and establish economic sensitivity limits where the variations are due to the combined effect of normal variations in coils, capacitors, resistors, wiring, etc. The procedure is as follows:

Using a set of average tubes determined as such by the measurements and calculations previously described, measure the sensitivity of say 100 different receivers each of which is known to have normally controlled components. Since the same tubes are used in each of the sets, variations in sensitivity between the sets will be due solely to variations in the sets themselves.

Calculate the average sensitivity $\overline{X}_s$ in microvolts for the lot of sets used and the standard deviation S_s of the sets in microvolts. If in production average tubes are used, the acceptable limits in sensitivity for set variations alone will be $\overline{X}_s + 3S_s$ and $\overline{X}_s - 3S_s$. If, on the other hand, tubes are taken at random, the limits in sensitivity covering normal expected variations of both tubes and sets will be

$$\overline{X}_s \pm 3\,\overline{X}_s\sqrt{(s_1/\overline{X}_1)^2 + (s_2/\overline{X}_2)^2 + \ldots\ldots (s_n/\overline{X}_n)^2 + (S_s/\overline{X}_s)^2}$$

Having established sensitivity limits as described, a production receiver showing sensitivity beyond these limits must be immediately suspected as containing abnormal components or wiring or abnormal tubes. Insertion of a set of average tubes removes the possibility of abnormal tubes and if the sensitivity then exceeds $\overline{X}_s \pm 3S_s$ microvolts, the set must be suspected of abnormality in itself.

Trouble Shooting

Sensitivity values as measured on 100 receivers coming from production, each using the set of average tubes measured in the first example, are $\overline{X}_s = 13.5\ \mu v$ and $S_s = 0.50\ \mu v$. Limits on sensitivity exclusive of tubes are $13.5 \pm 3 \times 0.5 = 12.0$ to $15.0\ \mu v$. Limits including both normal tube and set variations are

$$13.5 + 3 \times 13.5\sqrt{\left(\frac{0.159}{10.3}\right)^2+\left(\frac{0.304}{18.5}\right)^2+\left(\frac{0.180}{14.6}\right)^2+\left(\frac{0.215}{16.0}\right)^2+\left(\frac{0.130}{12.1}\right)^2+\left(\frac{0.106}{14.3}\right)^2+\left(\frac{0.50}{13.5}\right)^2}$$
$$= 15.7 \text{ to } 11.3\ \mu v$$

Limits including tube variations only (see previous example) are

$$13.5 \pm 3 \times \frac{13.5}{14.3} \times 0.45 = 14.8 \text{ to } 12.2\ \mu v$$

Suppose now that a receiver comes through production with random tubes and shows a sensitivity of 16.0 μv. This is beyond the upper limit of 15.7 μv. Upon the insertion of a set of average tubes (selected as previously described), the sensitivity is 14.2 μv. This is within the 12.0–15.0 μv limit for receiver variations alone. We conclude that there was trouble with the original set of tubes.

WOOFER-TWEETER

Design and construction of a crossover network for feeding a low-frequency horn and a high-frequency horn from a single amplifier, using low-cost components yet giving a response flat within 2 db from 30 to 10,000 cps, with crossover at 400 cps

By PAUL W. KLIPSCH
Hope, Arkansas

IN some experimental work involving two speakers, a crossover network was evolved which gives very flat overall performance over a wide frequency range but which involves low-cost components. The crossover network itself follows ordinary design and may be altered to conform to derived m, x-termination, or other configuration. The use of non-high-fidelity components to give high-fidelity performance is the point of novelty. Since many questions have been asked about the network it was felt that a description of the whole circuit, including the design steps, would be of interest.

The Circuit

Figure 1A shows the circuit as actually set up. Each output transformer is required to work over only a narrow frequency range so that inexpensive components are used in place of high-fidelity units. Placing the network reactances in the high-impedance part of the circuit results in small capacitor values of much lower cost than the, say, 100-microfarad capacitors which would be required if placed in the 8 to 16-ohm part of the circuit.

Design of Network

The transformer requirements are dependent upon the design of the network, so their consideration will be dealt with as part of the design.

Figure 1B shows the basis of the design, a ½-section low-pass portion to allocate the low-frequency output to the appropriate load, and a 1½-section high-pass portion to feed the high-frequency load. The choice of the number of sections is based on the fact that a steep cutoff for the low-pass portion is not necessary as most low-frequency loudspeakers will cut off somewhere near the crossover frequency. The high-frequency speakers, when fed power at frequencies below their acoustic cutoff, are very apt to radiate harmonics of the received power,[1] and since harmonics constitute one form of distortion, this is to be avoided. Thus a steeper cutoff is provided in the high-pass filter by the choice of 1½ sections. Ideally, the ½-section low-pass portion would produce 12 db loss per octave above cutoff, and the 1½-section high-pass portion would give 30 db loss per octave below cutoff; practically, the loss is somewhat less due to the fact that the reactive elements will not exhibit zero power factor.

Design Equations

The numerical design follows conventional practice.[2] The impedance level was chosen as 5000 ohms, the nominal load for a pair of type 2A3 tubes operated self bias. The class A triode was chosen because of its inherently low distortion; with pentode or beam tubes it is imperative that feedback be employed to minimize distortion within the amplifier as well as to produce a low equivalent generator impedance to prevent distortion from being produced by the speakers. The cutoff frequency f was chosen as 400 cycles. The half-section low-pass portion requires elements

$$L_k = \frac{5000}{\pi f} = 4.0 \text{ henrys}$$

$$C_k = \frac{1}{5000\pi f} = 0.16 \text{ microfarad}$$

The isolated half-section causes a nominal loss of 12 db per octave, with the intercept of the zero loss line and the asymptote of 12 db per octave slope occurring at 1.41 times the nominal cutoff frequency. This intercept may be moved down to the cutoff frequency by doubling L, C, or the LC product.

In a conventional half-section, the capacitance would be $\frac{1}{2}C_k$. This was doubled, to make $C_1 = C_k$ so as to give 3 db loss at the nominal cutoff frequency and the desired slope beyond cutoff. Hence, in the figures C_1 is twice the computed value, so that in Fig. 1B $L_1 = \frac{1}{2}L_k = 2.0$ henrys, $C_1 = C_k = 0.16$ microfarad, and in Fig. 1A $L_1 = \frac{1}{2}L_k = 2.0$ henrys reckoned with the 2 windings connected series aiding and $2C_1 = 0.32$, two of which in series gives the equivalent $C_1 = 0.16$. This arbitrary change does not appear to have caused any undue variation in the input impedance.

The high-pass portion is calculated from

$$L_k = 5000/4\pi f = 1.0 \text{ henry}$$
$$C_k = 1/(5000 \times 4\pi f) = 0.040\ \mu f$$

The configuration calls for architrave capacitors of $2C_k = 0.080$ and pillar inductances of $L_k = 1$ for the full-section and $2C_k$ and $2L_k$ for the following half-section. Thus $C_2 = C_k$. The inductance $L_2 = L_k = 1.0$, and T_2 has a primary inductance $L_T = 2L_2 = 2.0$.

Construction Details

The inductance L_1 should be wound with the windings closely coupled to enforce balance; it has been found satisfactory to put one winding on top of the other. Both

CROSSOVER NETWORK

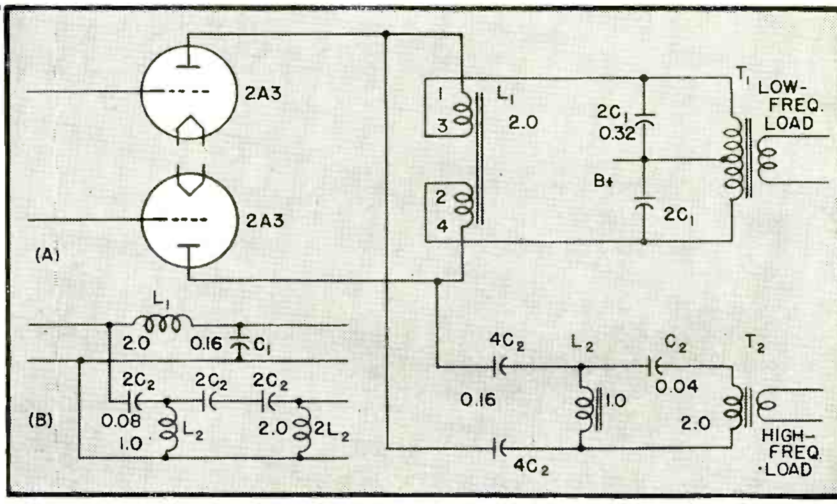


FIG. 1—Actual circuit of crossover network (A), and elementary circuit (B) used for design purposes

L_1 and L_2 should have adequate iron and copper to permit opening up a large air gap to hold the inductances reasonably constant at all levels of a-c voltage under which they will be required to operate. The matching transformer T_2 can be any readily available transformer of proper ratio which will give the required 2 henrys inductance when the air gap is opened up sufficiently to hold the inductance nearly constant over all levels of excitation.

Transformer T_1 should have a high primary inductance, of the order of 50 to 100 henrys to keep the exciting current low at the lowest frequencies to be transmitted, but its leakage inductance need not be held as low as demanded by expensive high-fidelity equipment; the leakage inductance as measured at the primary can be as high as one henry. Transformer T_2 must have a low leakage, preferable less than 0.05 henry to hold the loss at 10 kc to less than 3 db. It may be a low-cost unit, however, since its primary inductance need be only 2 henrys after opening the air gap—say 10 henrys before adding the air gap. Transformers T_1 and T_2 should have the proper turns ratios to match the 5000-ohm filters to the respective loads.

Collecting and tabulating the constants for Fig. 1A gives

Impedance level .... 5000 ohms
Crossover frequency .... 400 cycles
Inductance L_1 ..... 2.0 henrys (series aiding)
Inductance T_1 .... 50 henrys minimum
Inductance L_2 ..... 1.0 henry (with air gap)
Inductance T_2 .... 2.0 henrys (with air gap)
Capacitance C_1 ...... 0.16 microfarad
or $2C_1$ .... 0.32 microfarad
Capacitance C_2 ...... 0.04 microfarad
or $4C_2$ .... 0.16 microfarad
Leakage ind. of T_1. not over 1.0 henry
Leakage ind. of T_2. not over 0.05 henry

Conversion of the constants given for other impedance levels and/or other crossover frequencies is well known and will not be discussed.

The fact that a pair of 2A3 or 6A5G tubes exhibits a plate impedance of only 2000 ohms when the load impedance and the surge impedance of the filters are 5000 ohms raises the question of reflections. The mismatch is not great enough to cause serious reflection from a theoretical standpoint. A measured performance curve shows each output to be flat in its transmission range and to fall off smoothly in its attenuation range. The mismatch is necessary for proper loading of the output tubes and if this is a necessary evil from the filter standpoint it is of sufficient unimportance in the present application to be disregarded. It should be remembered that speaker voice-coil impedance is itself highly variable.

Performance

This crossover network has been in experimental use with a speaker combination comprising a low-frequency horn[3] operating between 40 and 400 cycles and a high-frequency horn operating from 400 cycles up. Two types of low-frequency horns and three types of high-frequency horns, all of different acoustic length, have been tried in various combinations. The output appears smooth throughout the transmission range including that in the immediate vicinity of crossover. Phase relations at this point seem to have little or no bearing on performance. Even complete 180-degree reversal of one speaker (in any of the several combinations) makes no difference in performance. Thus phase shifts in the described crossover network or in the speakers themselves may be neglected. Of course, if two identical speakers are used on one channel, they should be properly phased to prevent peculiar radiation patterns.

An obvious advantage of this crossover network is the fact that low-cost components may be used to give the same high-fidelity performance as more expensive equipment. The experimental model was constructed at less cost than that of a single high-fidelity matching transformer, and the performance is such that the combined power output is flat within 2 db from less than 30 cycles to over 10,000 cycles.

The design presented here may be considered the result of developing a pilot model. It is felt that the arrangement will be found advantageous for quantity production in connection with multiple speakers applied to home radios or for more specialized uses.

REFERENCES

(1) Klipsch, P. W., A Note on Acoustic Horns, *Proc. I.R.E.*, 33, No. 7, p. 447–449, July 1945.

(2) Terman, F. E., "Radio Engineers' Handbook," McGraw-Hill Book Company, New York, 1943, p. 228–229.

(3) Klipsch, P. W., A Low Frequency Horn of Small Dimensions, *Jour. Acous. Soc. Am.*, 13, No. 2, p. 137–144, Oct. 1941. Improved Low Frequency Horn, *Jour. Acous. Soc. Am.*, 14, No. 3, p. 179–182, Jan. 1943.

Manufacture of SILVERED MICA

Discussion of mica quality factors, and details of new manufacturing techniques developed to conserve existing stocks of mica and at the same time improve tolerances and quality standards of finished units

By ALAN T. CHAPMAN

Engineer
Western Electric Co.
Kearny, N. J.

Although in peacetime there is a steady demand for mica capacitors required for radio sets and communications equipment, this demand was increased manyfold in wartime. The intrinsic properties of high stability, low-power factor or high Q high dielectric strength, low temperature coefficient and compactness possessed by mica capacitors make them practically indispensable in the design of electronic and communications equipment.

To increase the output of capacitors it might be assumed that the mica capacitor industry had but one current major problem, namely the one of increasing plant facilities and procuring additional manpower. However, there have been other problems of equal difficulty, such as critical shortages of mica and tinfoil, which have frequently compelled the mica capacitor manufacturer to produce on a day-to-day basis. Also, improvements in design and manufacturing methods were necessary to meet the exacting requirements under wartime operating conditions.

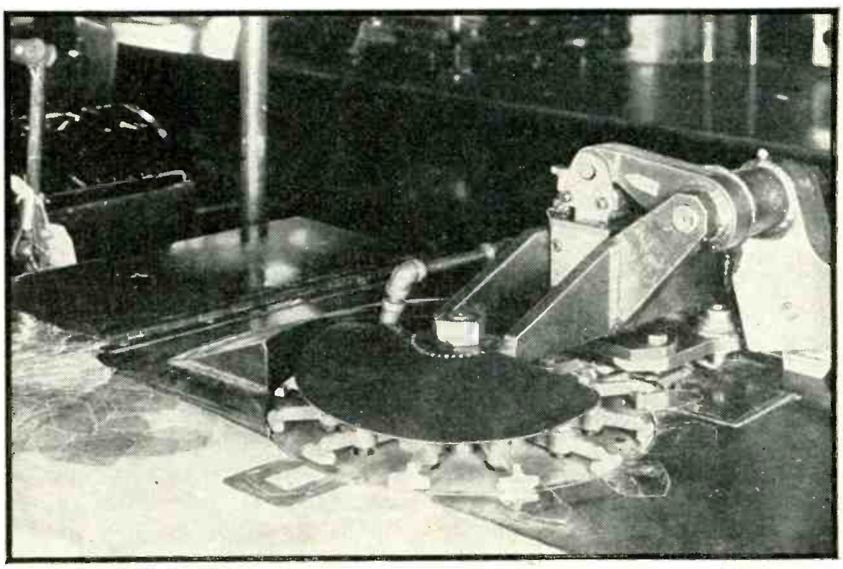
It is the purpose of this article to point out briefly the results of the Western Electric Company's efforts to surmount these difficulties, with the thought that part of the information presented may be helpful to other readers. It is appreciated that some of the results presented here were arrived at by other companies also.

Mica Procurement and Processing

In normal times mica was purchased in the form of cut or uncut film 0.001 to 0.003 inch thick from concerns which imported the material from India. Because the supply of India mica to the United States became sharply reduced due to transportation difficulties, it was necessary for the War Production Board to issue Conservation Order M-101 in March 1942 to allocate the material properly and, furthermore, to develop domestic resources and to encourage the exploitation of mica deposits in Brazil and Canada.

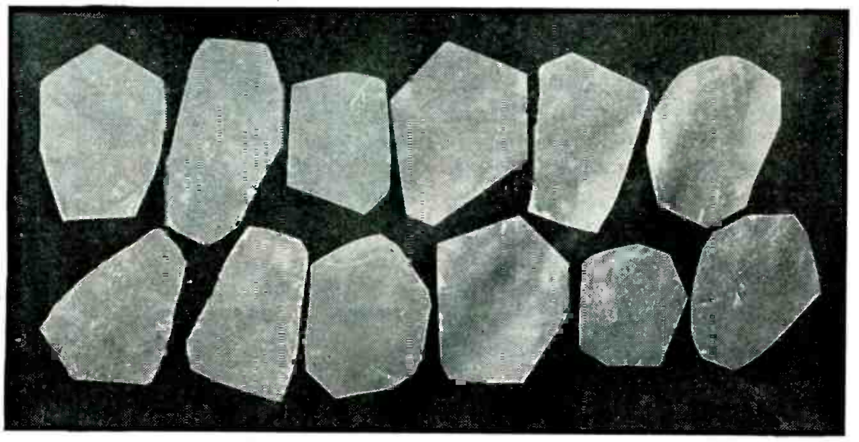
Studies were pushed ahead to evaluate not only the mica from Brazil and Canada but also to examine samples from Guatemala, Peru, New Mexico, South Dakota, and Connecticut, as well as samples from the better known domestic sources in North Carolina, Georgia and New Hampshire. Good-quality mica capacitors were produced from a large number of the samples, but unfortunately the supply of many of the new sources could not be assured and the variability in the mica qualities was such that standard manufacturing routes could not be maintained.

A more thorough evaluation of the domestic micas was undertaken and completed through the joint efforts of the War Production Board, the National Research Council, Bell Telephone Labora-



Dial-feed mica punching machine, having mechanical fingers that hold the mica accurately in position and bring it close to the punch and die

CAPACITORS



Quality B mica, showing maximum allowable air inclusions

tories and eight participating capacitor manufacturers. The results indicate the possible application of many grades of micas that were heretofore considered unsuitable for capacitor use.

Mica Conservation Program

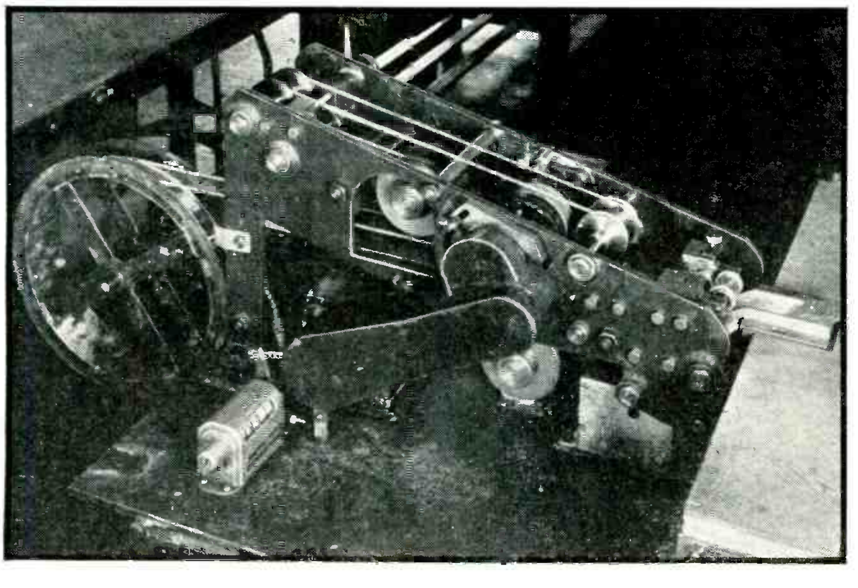
In addition to pursuing an active program for replacing mica capacitors with paper, ceramic, polystyrene and other capacitors, several changes were initiated in order to conserve strategic mica.

First, a new mica specification was written in agreement with the mica processors to define accurately the material required. The specification describes three empirical qualities, namely A, B and C, which are ample for normal manufacturing purposes. Quality B, which corresponds to the best second-quality film in shipments received from the joint British-American Mica Mission during 1944, has replaced better than 90 percent of the fair-stained India mica formerly used by the Western Electric Company.

Second, extra sorting for size was instituted so that an uncut film only slightly larger than the finished part would be used. Although this extra handling effort is costly, the resultant saving in mica makes it justifiable because the cost of the mica increases sharply with the larger sizes due to the limited supply. As a further conservation measure, the use of remnants after punching for making smaller parts was considerably increased even though it resulted in higher labor costs.

Third, a dial-feed mica punching machine was developed. The important feature of this machine is that the mica can be held by mechanical fingers very close to the punch and die, and the template in front of the operator permits accurate location of the part. Experience indicates that the yield of good parts per hour exceeds that obtained by punch press operation even with mica which has been previously sorted to be only slightly larger than the template. Incidentally, the extra cost of sorting is, to a large extent, offset by the increased productivity of these machines.

Fourth, the operator training program was revamped to meet conditions resulting from the higher rate of labor turnover being experienced and to assure the more painstaking handling of mica through all processes, with emphasis being placed on its strategic nature.



Mica masking machine, used to arrange laminations in a continuous strip ready for spraying with silver

Silver Coating

Over 80 percent of the mica used by the Western Electric Company is coated with a thin film of silver on each side. The purpose of the silver film is to obtain the excellent capacitance stability which results from the intimate contact between the conducting film and the mica. A further advantage is the ease with which precise capacitance adjustments can be made by scraping off small portions of the silver coating. The use of silver-coated mica was introduced to improve stability and to facilitate the manufacture of potted telephone-type mica capacitors which generally are made to limits of ±0.25 percent.

In applying the silver coating, the mica is first suitably masked, then sprayed with a commercial silver solution and fired in a conveyor furnace at a temperature below 1100°F. The masking is accomplished on special machines which apply tape to mask the side margins of a mica lamination. The end margins are masked by overlapping the laminations as they are fed into the machine. The masked strips are racked, sprayed, and then fired in the furnace.

Stacking and Adjusting

The operation of stacking mica capacitors requires the alternate interleaving of mica and foil, and is a real challenge to the time and motion economist. The design of the workplace, with the supply of mica, foil, and terminals immediately adjacent to the recessed nest into which the parts are laid, is important. Needless to say, all types of capacitors cannot be advantageously assembled in a single type of workplace, and no two manufacturers appear to use identical methods. A complete description of the different methods is beyond the scope of this article; however, a brief resumé of the method used for assembling the majority of the silvered mica capacitors at the Western Electric Company may be of interest.

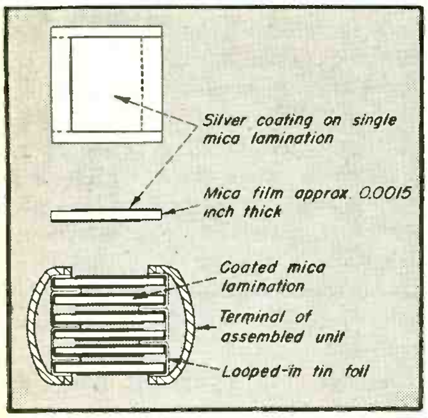


FIG. 1—Assembly of laminations

Silvered mica laminations are assembled with foil looped-in to make electrical contact between the silvered coatings and the terminals, as illustrated in Fig. 1. Lead foil from 0.0005 to 0.001 inch thick, with a tin content of less than 10 percent is used. The purpose of looping-in the foil is to permit a continuous electrical connection between the stack and a precise capacitance meter during assembly. This arrangement, together with the adjusting operation described later, assures that the capacitor will be within limits in spite of relatively wide variations in the thickness of the mica. Consequently, it is practicable to apply terminals and to test for dielectric strength at the assembly position. The need for assembling surplus capacitors to take care of fall-outs in subsequent tests is largely eliminated.

After stacking, the capacitor units are dried at atmospheric pressure for about 1½ hours at 300°F, a relatively short time which has proven to be practicable because all assembly operations are performed in an air-conditioned space where the relative humidity is maintained under 40 percent at 75°F. The dried units are adjusted within final capacitance limits by scraping off small portions of silver coating from the top lamination. Normally, the adjusting limits are about half of the final limits in order to compensate for variables in the potting or molding operation.

Final Assembly

The capacitor assembly may be completed in numerous ways, i.e., potted in metal containers, molded cases, or hermetically-sealed cans or molded directly in thermosetting or thermoplastic materials. The molding and potting techniques are well established and depend on the design of the capacitor and the volume of production.

The method used for molding capacitors may be of interest. Four to twenty cavity molds are mounted on inverted Hannifin pneumatic presses. The molds with few cavities are loaded by hand and those with eight or more cavities by means of loading boards. The knockout is pneumatically operated and controlled by a foot-pedal. The mold is first loaded with preforms, which are made from low-loss mineral-filled thermosetting material, then with the capacitor unit, and finally with a preform on top.

Layout for assembling silvered mica capacitors with looped-in foil, with provisions for checking capacitance continuously during assembly

The loaded mold is pushed to the rear position and the pressure on the unit is applied slowly, 1 inch per minute or less, until a pressure of approximately two tons per square inch is reached. The small units are cured at 300° ± 10°F for approximately two minutes and the large units from three to four minutes, a time which undercures the molding material. The capacitors are then stamped with code and capacitance markings, and given a final stabilization bake for one hour at 250°F. The undercuring, followed by a final baking, not only saves valuable press time, but minimizes capacitance shifts.

Final inspection is performed on precision electrical testing equipment which is located in an air-conditioned room. Since most of the mica capacitors produced by this method are required to have a capacitance precision of better than ±1 percent, the testing equipment is very carefully designed, calibrated, and maintained.

Requirements and Problems

Prior to the war, mica capacitors were designed for operation under the temperature and humidity conditions encountered in indoor locations in the United States. These normally range from 60° to 120°F and with maximum humidity of 95 percent prevailing for short summer periods. The service conditions for military equipment involve much more difficult operating conditions, namely, temperatures ranging from $-50°$ to $+185°F$ and humidities up to 100 percent prevailing in many cases over most of the year. Yet the designers of airborne and ground communication and electronic equipment demand the same high degree of performance over this greater temperature range and under these more damaging humidity conditions.

New capacitor designs for ground signal equipment, which normally uses low frequencies and relatively large capacitance units, required potting in hermetically-sealed containers. New designs for radio equipment, which uses the smaller molded units, required the introduction of new processes for stabilization over the wide temperature range and new materials for sealing the terminals in order to protect units from humidity.

A typical manufacturing and design problem was the change required to assure conformance with a severe humidity requirement placed on molded capacitors which were used on special military equipment. It was necessary at the start to check 100 percent of the molded mica capacitors. Subsequently, experiments proved that Neoprene cement applied to the leads greatly improved the yield of capacitors and reduced the inspection costs. Further investigation showed that solutions of Vinylite VMCH and XYNC were even more effective in sealing the units against humidity and were easy to apply.

Manufacturing experience has shown that relatively poor stability and high values of temperature coefficient will result with the best quality of mica unless proper precautions are taken in the assembly, processing and molding of the units. Manufacturing methods were worked out to assure high stability with temperature and time for molded mica capacitors covering capacitances up to 20,000 $\mu\mu f$. Some of these are made to a capacitance tolerance of $\pm$ (0.5 percent + $1\mu\mu f$), have a temperature coefficient of less than 15 parts per million per degree Fahrenheit over the temperature range of $-50°$ to $+185°F$, and retrace to within 0.05 percent of the initial capacitance after repeated thermal cycling over this range. Such capacitors are being made because critical electronic equipment will not operate precisely without them.

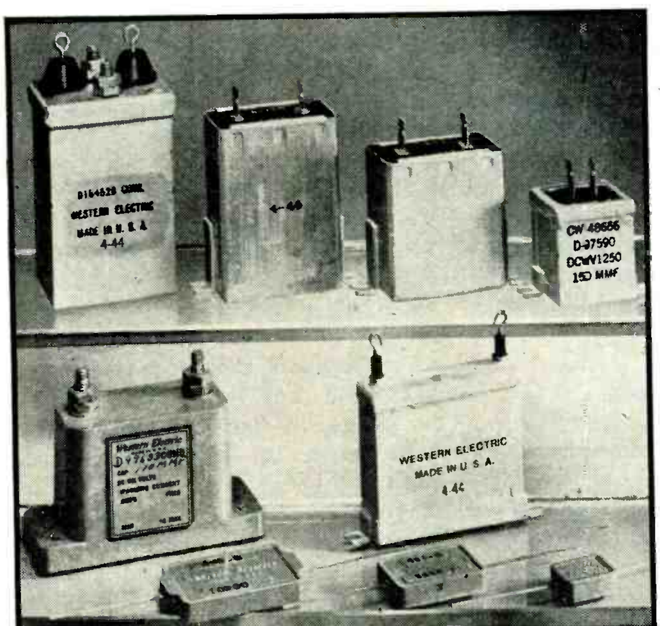
Use of Mica Substitutes

In view of some of the problems and processes discussed above, a brief statement concerning the use of paper and other types of capacitors as alternates may be in order. The development and application of small molded, mineral-oil filled capacitors has been accomplished to a considerable extent. Designs have been devised and are in production that are both mechanically and electrically interchangeable with the mica types.

As has been well publicized, many synthetic micas have been developed and have helped insofar as they could replace mica in capacitors for special applications. However, to date none of the available alternative dielectric materials compare favorably in all characteristics with mica—even with the lower grades of mica that remain practically untouched.

Continued effort to make certain that the lower grades of mica are used wherever the requirements permit, and that the available stocks are processed with the great care this precious material deserves, will go far toward assuring an adequate supply of mica capacitors.

The improvements in the processes and facilities for manufacturing mica capacitors reported above are to a large extent based upon the unified efforts of the engineering staffs of the Western Electric Company and Bell Telephone Laboratories, which the author gratefully acknowledges.



Representative examples of the nine types of molded and potted mica capacitors now being made by Western Electric

Adjusting finished silvered mica capacitors to exact capacitance value by scraping silver from the top lamination

ARTIFICIAL

By SIDNEY WALD
*Advanced Development Engineer
RCA Victor Division
Radio Corporation of America
Camden, N. J.*

ARTIFICIAL ANTENNAS are necessary for testing variable-frequency radio equipment under conditions closely approximating those encountered in service. It is impractical to use an actual antenna in laboratory tests because radiated energy must be kept at a minimum, and it is usually inconvenient to precisely duplicate an antenna which is used in a special application such as on aircraft.

Although artificial antennas are used for both transmitters and receivers, the complexity of the antenna matching problem is not the same for both classes of equipment. This difference arises mainly because most receiver antenna circuits are untuned while transmitter output circuits, to deliver maximum power to the radiator, must be closely adjusted at each frequency. Because of the greater relative importance of the latter problem, this paper will concern itself with transmitting rather than receiving antennas.

Need for a greatly improved artificial antenna for transmitters became apparent during the author's experience in the design and testing of aircraft communication transmitters in the medium to high-frequency band. Types of dummy load in wide use for this purpose, while perfectly satisfactory for use at a single frequency, resulted in much loss of time and were excessively bulky when applied to equipment having a frequency range of one to ten megacycles. To speed up variable-frequency tests, which at times had to be performed under reduced atmospheric pressure to simulate high-altitude flight conditions, a fixed network was designed which matched the actual antenna both for resistance and reactance at all frequencies.

TABLE I—MINIMUM REQUIRED DATA FOR ARTIFICIAL ANTENNA DESIGN

(1) Reactance and resistance at the lower frequency limit.

(2) Quarter-wavelength frequency and resistance.

(3) Resistance at some critical frequency between upper frequency limit and quarter-wavelength frequency.

(4) Resistance at the upper frequency limit.

(5) Half-wavelength frequency. (If this frequency is not known, it can be assumed to be approximately 1.67 times the quarter-wavelength frequency. This constant is empirical and was selected as an average during a study of many fixed, single-wire antennas.)

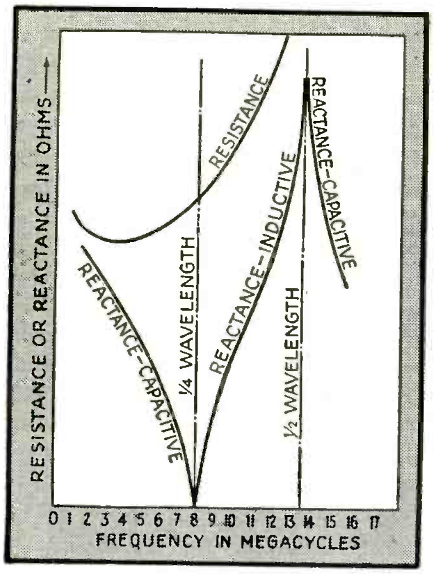


FIG. 1—Typical impedance variation of an antenna of fixed length when the frequency is varied, showing reactance variation as a tangent function of frequency

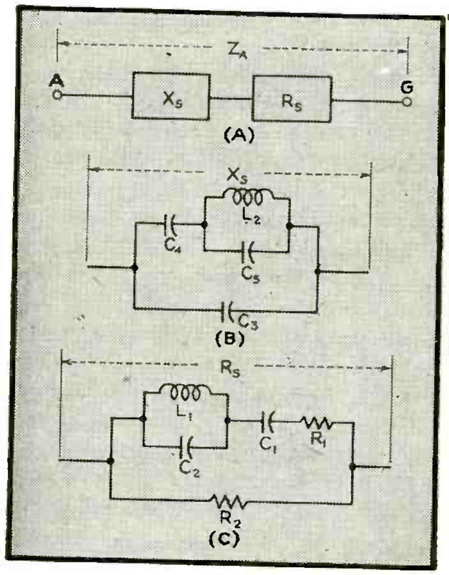


FIG. 2—(A) Antenna impedance can be represented by variable series reactance and resistance. (B) The reactance component and (C) the resistance component can be simulated by lumped constants

Basis for Design

While theoretical considerations in this paper are general, this discussion is limited to a band from approximately one to twenty mc. The antenna for which an equivalent circuit is desired is the single-conductor type operating against a ground. The configuration of the wire may be horizontal, vertical, straight, or folded V. The quarter-wave resonant frequency of such a radiator usually lies between 5 and 10 mc. The characteristics of the antenna which must be known are given in Table I. A typical impedance characteristic is shown in Fig. 1.

To properly evaluate various requirements of a good dummy antenna, it is necessary to understand the way in which the impedance of an actual antenna varies with frequency. The equivalent circuit of an antenna is that of a series reactance X_s and series resistance R_s as shown in Fig. 2A. These two components of impedance change with frequency. The variations of X_s and R_s with frequency given in Fig. 1 apply to all types of antennas where size and geometry remain fixed, while the frequency is changed. To simulate such an antenna at a given frequency it is only necessary to connect the pro-

ANTENNA

Design of a two-terminal, lumped-constant network that simulates, within a specified frequency band, the impedance variations of a single-wire antenna. The resulting artificial antenna can be used for tuning transmitters and for power measurements

per values of resistance and either inductive or capacitive reactance in series.

If I_A is the current flowing in the artificial antenna circuit, the power output of the transmitter would be $P = I_A^2 R_S$. If the values of X_S and R_S are correctly chosen, P will be true power output of the transmitter into the actual antenna at the same frequency.

Single Series Circuits

Using fixed R-C and L-C combinations to simulate the antenna is accurate and simple, but lacks flexibility where a continuous frequency band must be covered. The circuit consists of either a fixed capacitor or coil in series with a nonreactive resistor. The constants of the inductor or capacitor and resistor are calculated from the given antenna reactance, radiation resistance, and frequency.

The fixed resistance is made equal to the antenna resistance. The series capacitance is $C_s = 1/2\pi f X_A$ where X_A is negative. For positive values of X_A the antenna is inductive and $L_s = X_A/2\pi f$.

To provide an arrangement that is easier to work with when the frequency is frequently changed, the reactive and resistive components are made adjustable as, for example, a variable capacitor in series with a carbon compression resistor. When the antenna is inductive, a variable inductor is substituted for the capacitor. To further increase the versatility of the artifical antenna, both an inductor and a capacitor can be included in the series circuit, and a switch provided to short the unwanted element.

Although these adjustable circuits are theoretically sound, they seldom are satisfactory over a wide frequency range. In addition to their stray capacitance to ground, adjustable inductors have a high distributed capacitance. This may give rise to spurious resonances. Variable capacitors of high maximum capacitance must be extremely large to withstand the high r-f potentials.

Not only are there practical electrical difficulties, but there are the operational disadvantages which require the manipulation of two controls for each change in output frequency. An error in setting of either the reactor or resistor results in unreliable measurements and a loss of time in rechecking results.

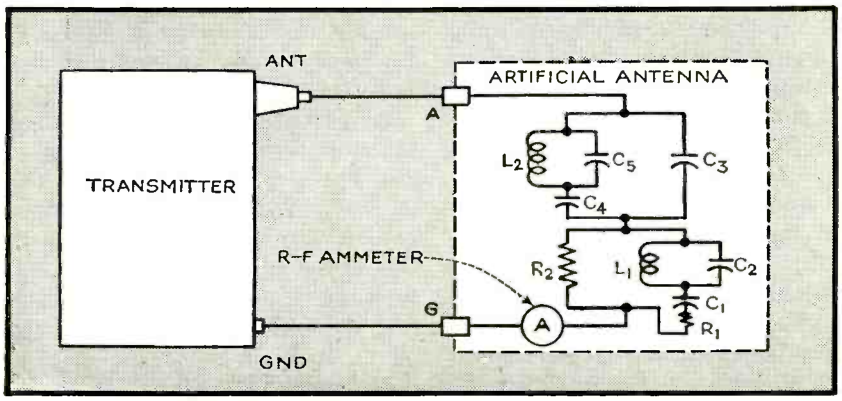
Composite Series Circuits

In contrast to the foregoing circuits that utilize variable components, the proposed artificial antenna is composed of fixed elements. When these elements are properly chosen, the reactance and resistance seen at the terminals of the network (Fig. 2A) will match those of the actual antenna at every frequency within the assumed limits.

It is the plan of this paper to treat each portion separately and finally to show how they are connected in series to form the desired circuit. The portion marked X_S will automatically duplicate the series reactance of the given antenna, while R_S will produce the resistance variation with frequency. Although in practice it is not possible to isolate resistance and reactance completely, it is assumed that the equivalent series resistance of the reactance section is low enough to be negligible and the equivalent series reactance of the resistance section can be disregarded in comparison with that contributed by the reactive circuit.

Network Equations

A combination of reactances which can have an equivalent series reactance variation with frequency similar to that shown in Fig. 1 is represented in Fig. 2B. The cor-



An r-f ammeter can be included in the artificial antenna for power measurements. Stray capacitances must be held to a minimum

TABLE II—REACTANCE NETWORK DESIGN EQUATIONS

Units are in farads, henrys, cycles, and ohms.

(1) Assume a value for C_3

(2) $$C_S = \frac{(\omega_2^2 - \omega_1^2)\,(-X_1\,\omega_1\,C_3 - 1) - X_1C_3\,\omega_1\,(\omega_3^2 - \omega_2^2)}{X_1\,(\omega_1\,\omega_3^2 - \omega_1^3)}$$

where $C_S = C_4C_5/(C_4 + C_5)$
ω_1 — angular velocity at lower limit
ω_2 — quarter-wavelength angular velocity
ω_3 — half-wavelength angular velocity
X_1 — antenna reactance at ω_1 (proper sign must be used for X_1 when substituting into equation)

(3) $C_4 = C_S\,(\omega_3/\omega_2)^2 - C_3\,(\omega_2\,L\,\omega_3)^2/\omega_2^2$

(4) $C_5 = C_SC_4/(C_4 - C_S)$

(5) $L_2 = 1/\omega_2^2\,(C_4 + C_5)$

Note: (A) If ω_3 is unspecified it can be assumed to be 1.67 ω_2, as stated in Table 1 (5); (B) The Q of L_2 should be as high as possible, at least 300; (C) Distributed capacitance of L_2 should be subtracted from the calculated value of C_5 to determine the physical value for C_5.

(6) To check accuracy of computed components, plot X_S vs angular velocity from the following equation, and compare this curve with the given antenna reactance curve

$$X_s = \frac{\omega^2L_2\,(C_4 + C_5) - 1}{\omega C_3\,[1 - \omega^2L_2\,(C_4 + C_5)] - \omega C_4\,(\omega^2L_2C_5 - 1)}$$

responding frequency characteristic is shown in Fig. 3A.

The problem is to select values of C_3, C_4, C_5, and L_2 to yield a reactance variation which duplicates that of any given antenna. While C_3 is theoretically unnecessary to obtain the simulated curve, in practice it was found that the stray capacitance from the antenna terminal to ground introduced a large error in reactance at the low-frequency end of the band. Using a controlled value of C_3 eliminates the effect of this unavoidable capacitance. Thus some value is selected for C_3 greater than the supposed stray capacitance to ground and if the final capacitance to ground is smaller than the assumed value, a trimmer capacitor can be inserted to make up the difference. A practical value for C_3 is about 10 $\mu\mu$f.

Design equations for this reactance network are derived in Appendix I and summarized in Table II.

In a similar manner, the network of Fig. 2C provides the required resistance variation. Design equations for this network are derived in Appendix II and summarized in Table III. The quantities referred to in this table are made clear by Table I and Fig. 3B.

Example of Network Design

Pertinent data concerning the reactive characteristics of an antenna is: Lower limit frequency = 2 mc, reactance at lower limit frequency = $-j$ 930, quarter-wave frequency = 9.3 mc, and half-wave frequency = 15.5 mc.

From this data, values for substitution into Table II are: $\omega_1 = 2\pi\ (2 \times 10^6)$, $\omega_2 = 2\pi\ (9.3 \times 10^6)$, $\omega_3 = 2\pi\ (15.5 \times 10^6)$, $X_1 = -930$, and let $C_3 = 10 \times 10^{-12}$. Solving for the reactive network components, we obtain $C_S = 20.3\ \mu\mu$f, $C_4 = 69.9\ \mu\mu$f, $C_5 = 28.7\ \mu\mu$f, and $L_2 = 2.96\ \mu$h.

If these values are substituted into the equation for X_S and reactance plotted against frequency, the upper curve of Fig. 4 is obtained. Checking the value of X_s against actual antenna reactance at any frequency shows that the error at any point is well within the limits of engineering accuracy. In this

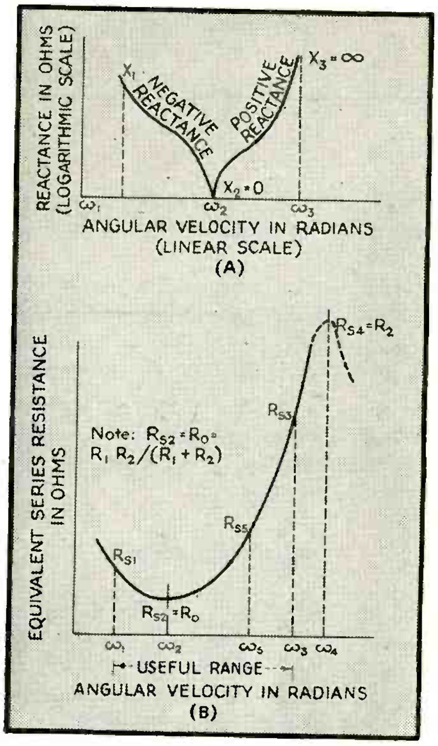


FIG. 3—Critical frequencies and their associated reactances (A) and resistances (B) of the antenna to be simulated are used to obtain values for the artificial antenna elements

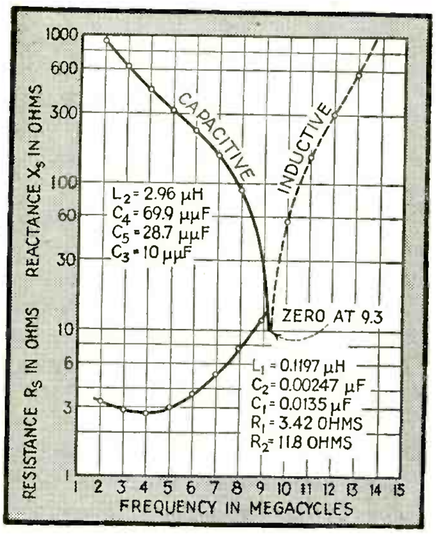


FIG. 4—An artificial antenna built from the design equations was tested and had these reactive and resistive characacteristics; compare with Fig. 1

particular example, the reactance error at any frequency is less than two percent.

To complete the sample calculations, the significant resistance values of the given antenna with reference to Fig. 3B are: $R_{S1} = 3.2$ ohms, $f_1 = 2$ mc or $\omega_1 = 2\pi (2 \times 10^6)$, $R_o = 2.7$ ohms, $f_2 = 4$ mc or $\omega_2 = 2\pi (4 \times 10^6)$, $R_{S5} = 6$ ohms, $f_5 = 7.5$ mc or $\omega_5 = 2\pi (7.5 \times 10^6)$, $R_{S3} = 11.5$ ohms, and $f_3 = 9$ mc or $\omega_3 = 2\pi (9 \times 10^6)$.

Substitution of the preceding constants into the equations of Table III gives $R_2 = 11.8$ ohms, $f_4 = 9.275$ mc, $C_1 = 0.0135$ μf, $L_1 = 0.1197$ μh, $C_2 = .00247$ μf, and $R_1 = 3.42$ ohms.

If these values are substituted in the equation for R_S and the resultant values plotted against frequency, the lower curve of Fig. 4 is obtained.

The actual artificial antenna is the series combination of the resistive and reactive networks.

Reactance Error due to Resistance Network

Lumping the reactive elements of the resistance network of Fig. 2C into a single reactance X_1, we find that the reactance of the resistance network is

$$X_S = X_1 R_2^2 / [(R_1 + R_2)^2 + X_1^2] \quad (1)$$

To find the greatest value that X_S can ever reach, differentiate Eq. (1) with respect to X_1

$$\frac{d(X_S)}{dX_1} = \frac{[(R_1 + R_2)^2 + X_1^2]\,R_2^2 - (X_1 R_2^2) 2 X_1}{[(R_1 + R_2)^2 + X_1^2]^2}$$

Setting the numerator equal to zero, and solving for X_1

$$X_1 = R_1 + R_2 \quad (2)$$

Substituting Eq. (2) into Eq. (1)

$$X_{S\max} = R_2^2 / 2\,(R_1 + R_2) \quad (3)$$

In a typical case where $R_2 = 11.8$ ohms and $R_1 = 3.42$ ohms, the maximum value of X_S is 4.56 ohms inductive. Substituting Eq. (2) in Eq. (10) from Appendix II gives

$$R_S = \frac{R_2 (R_2 + 2R_1)}{2\,(R_1 + R_2)} \quad (4)$$

Using the same numerical values for R_1 and R_2, $R_S = 7.2$ ohms.

Referring to the antenna resistance curve of Fig. 4B, we see that $R_S = 7.2$ ohms at a frequency of 7.9 mc. At this frequency the antenna reactance is $-j100$ ohms. Thus, in the given example, the maximum error introduced by the reactance of the resistance variation circuit occurs at 7.9 mc and has a value of $X_{S\max}/X_A = 4.56/100 = 4.56$ percent.

Antenna Operation

The simulative network discussed in this paper is, strictly speaking, only an approximation of the antenna which it is intended to replace. At any frequency the simulated reactance and resistance will differ from the actual values by a finite amount. The magnitude of these discrepancies will vary depending on the antenna, but in general it will be found that the reactance curve can be made to match within two percent, while the resistance may deviate as much as ten percent from the true value.

Effect of mismatch on the tuning of the transmitter output circuits may for all practical purposes be neglected. However, the setting of the coupling control, being sensitive to the resistive component of the antenna impedance, will differ slightly at some points from its position when working into an actual antenna.

The network may be used for measuring power output if a radio-frequency ammeter is connected in series with the circuit. The power output is $P = I_A^2 R_S$ where P is power output in watts, I_A is amperes rms, and R_S is equivalent series resistance of entire network. The value of R_S at each frequency should be determined by measurement on either a Q meter or a suitable r-f bridge, between terminals

TABLE III—RESISTANCE NETWORK DESIGN EQUATIONS

Units in farads, henrys, cycles, and ohms.

(1) Solve for R_2 from the following equation, using given values from the antenna to be duplicated

$$\pm N [A (R_2 - R_{S5})]^{1/2} \mp M [F (R_2 - R_{S1})]^{1/2} = (N - M) [R_2 - R_{S3}]^{1/2}$$

$$\text{where } A = \frac{(R_{S3} - R_O)/(R_{S5} - R_O)}{\left[\frac{\omega_5}{\omega_3}\left(\frac{\omega_2^2 - \omega_3^2}{\omega_2^2 - \omega_5^2}\right)\right]^2}$$

$$F = \frac{(R_{S3} - R_O)/(R_{S1} - R_O)}{\left[\frac{\omega_1}{\omega_3}\left(\frac{\omega_2^2 - \omega_3^2}{\omega_2^2 - \omega_1^2}\right)\right]^2}$$

$$M = \omega_5^2 - \omega_3^2$$

$$N = \omega_1^2 - \omega_3^2$$

(2) Having found R_2, solve for ω_4 from

$$\omega_4 = [(\pm \omega_5^2 B - \omega_3^2)/(B - 1)]^{1/2}$$

$$\text{where } B = \left[\frac{R_2 - R_{S3}}{A\,(R_2 - R_{S5})}\right]^{1/2}$$

(3) $$C_1 = \left(\frac{\omega_2^2 - \omega_5^2}{\omega_5^2 - \omega_4^2}\right)\left(\frac{\omega_4^2}{\omega_2^2\,\omega_5 R}\right)$$

$$\text{where } R = \frac{R_2^2}{R_2 - R_O}\left[\frac{R_{S5} - R_O}{R_2 - R_{S5}}\right]^{1/2}$$

(4) $L_1 = (\omega_4^2 - \omega_2^2)/\omega_4^2 \omega_2^2 C_1$

(5) $C_2 = 1/\omega_4^2 L_1$

(6) $R_1 = R_O R_2/(R_2 - R_O)$

(7) To check accuracy of the calculated components, plot R_S vs angular velocity from the following equation and compare this curve with the given antenna resistance curve

$$R_S = \frac{(R_1 R_2)(R_1 + R_2) + R_2 X_B^2}{(R_1 + R_2)^2 + X_B^2}$$

$$\text{where } X_B = (-1/2\pi f C_1) + \frac{2\pi f L_1}{1 + (4\pi^2 f^2 L_1 C_2)}$$

A and G.

To get reliable indications of antenna current, the stray capacitance of the input terminal and of C_1 to ground must be reduced to as low a value as possible. Careful arrangement of the elements of the network, together with a short input lead, will increase the accuracy of power output measurements.

There are several precautions to be taken in connection with the design, construction, and use of the artificial antenna described here. The various components of the network must be carefully chosen to give satisfactory service. This caution is particularly applicable to capacitor C_1 which may be subjected to extremely high r-f potential, even with low-power transmitters. For example, at two megacycles, a transmitter which produces 20 watts in an antenna resistance of three ohms causes a current of 2.57 amperes rms to flow. Using the value of C_1 in our typical case, 69.9 $\mu\mu f$, the current in C_1 would be 2.25 amperes. The peak voltage across C_1 with 100-percent modulation is $2 \times 1.4 \times 1140 \times 2.25 = 7{,}160$ volts.

In conclusion, while the antenna network presented here falls considerably short of perfection, it does have a substantial field of usefulness from an engineering point of view. The effort consumed by its design and construction is small indeed when one considers the amount of time which can be saved in the development and testing of multi-frequency transmitters.

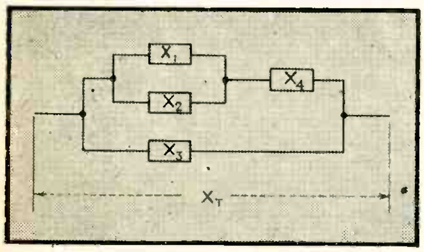


FIG. 5—Assumed circuit from which reactive network is developed

Appendix I Simulation of Reactance Curve

Neglect the resistance in the circuit. The reactive portion of the simulated antenna can be represented by Fig. 5. The total circuit reactance is

$$X_T = \frac{X_1 X_2 X_3 + X_3 X_4 (X_1 + X_2)}{X_1 X_2 + X_4 (X_1 + X_2) + X_3 (X_1 + X_2)} \quad (5)$$

let $X_1 = + \omega L_2$
$X_2 = -1/\omega C_5$
$X_3 = -1/\omega C_3$
$X_4 = -1/\omega C_4$

Substituting these values into Eq. (5) gives

$$X_T = \frac{\omega^2 L_2 (C_4 + C_5) - 1}{\omega C_3 [1 - \omega^2 L_2 (C_4 + C_5)] - \omega C_4 (\omega^2 L_2 C_5 - 1)} \quad (6)$$

when $\omega = \omega_2$, $X_T = 0$

$$\omega_2^2 L_2 (C_4 + C_5) - 1 = 0 \quad (7)$$

when $\omega = \omega_3$, $X_T =$ infinity

$$C_3 [1 - \omega_3^2 L_2 (C_4 + C_5)] - C_4 (\omega_3^2 L_2 C_5 - 1) = 0 \quad (8)$$

when $\omega = \omega_1$, $X_T = X_1$

$$X_1 = \frac{\omega_1^2 L_2 (C_4 + C_5) - 1}{\omega_1 C_3 [1 - \omega_1^2 L_2 (C_4 + C_5)] - \omega_1 C_4 (\omega_1^2 L_2 C_5 - 1} \quad (9)$$

Equations (7), (8), and (9) are now solved simultaneously for unknowns C_4, C_5, and L_2, giving the equations of Table II.

Appendix II Simulation of Resistance Curve

In the network of Fig. 6A the equivalent series resistance, R_S, as shown at Fig. 6B is a function of the branch reactance X_1 which in turn is some function of frequency; thus

$$R_S = \frac{(R_1 R_2)(R_1 + R_2) + R_2 X_1^2}{(R_1 + R_2)^2 + X_1^2} \quad (10)$$

This circuit is satisfactory for our purpose because the equivalent series reactance X_S can at all times be made small compared to either the total series resistance or the total series reactance. This total series reactance includes the reactance developed in Appendix I. We are primarily concerned with the duplication of a resistance variation. The magnitude and importance of X_S is considered elsewhere.

The minimum value of R_S in Eq. (10) occurs when $X_1 = 0$ and $R_S = R_0 = R_1 R_2/(R_1 + R_2)$. If Eq. (10) is solved for X_1 we obtain

$$X_1 = \pm \left[\frac{(R_1 R_2)(R_1 + R_2) - R_S (R_1 + R_2)^2}{R_S - R_2}\right]^{1/2} \quad (11)$$

From the condition for a minimum value of R_S, $R_1 = R_0 R_2/(R_2 - R_0)$, which, substituted into Eq. (11), gives

$$X_1 = \left(\frac{R_2^2}{R_2 - R_0}\right)\left[\frac{R_0 - R_S}{R_S - R_2}\right]^{1/2} \quad (12)$$

Now if in Fig. 6A, X_1 assumes the configuration of Fig. 6C.

$$X_1 = \frac{1 - \omega^2 L_1 (C_1 + C_2)}{\omega C_1 (\omega^2 L_1 C_2 - 1)}$$

Substituting this value of X_1 into Eq. (12) yields

$$\frac{1 - \omega^2 L_1 (C_1 + C_2)}{\omega C_1 (\omega^2 L_1 C_2 - 1)} = \frac{R_2^2}{R_2 - R_0}\left[\frac{R_0 - R_s}{R_s - R_2}\right]^{1/2} \quad (13)$$

If ω_4 is the angular frequency at which the $L_1 C_2$ loop is in parallel resonance, that is: $L_1 C_2 = 1/\omega_4^2$, and similarily, if ω_2 is the angular frequency at which the circuit of Fig. 6C is in series resonance so that $L_1 (C_1 + C_2) = 1/\omega_2^2$, Eq. (13) can be written in terms of resonant and antiresonant angular velocities.

There are three unknowns in this resultant equation, namely, R_2, ω_4, and C_1. If three conditions are known, a corresponding number of simultaneous equations can be set up. The most convenient boundary conditions are the two limit frequencies and one intermediate frequency, and the corresponding antenna resistances. Using these values to solve this equation gives the design equations of Table III.

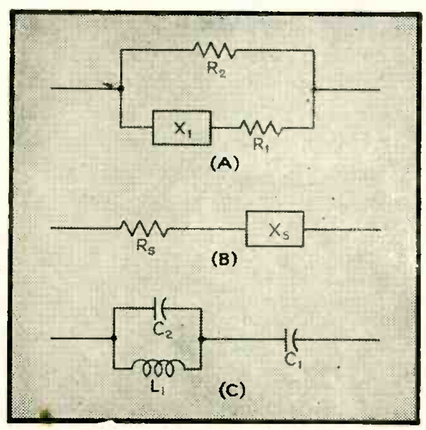
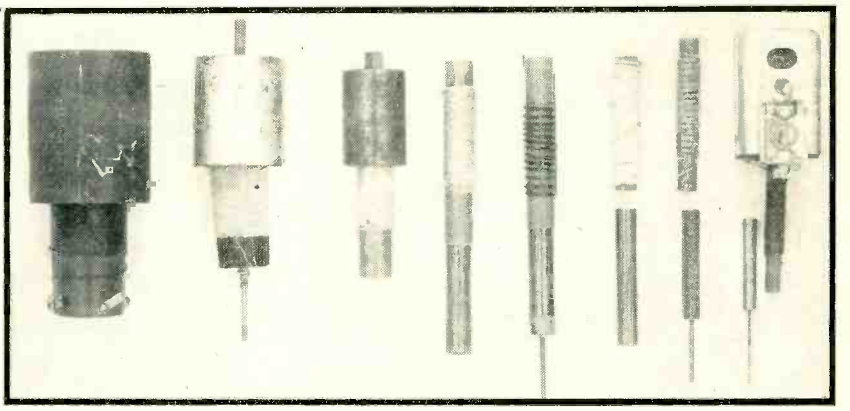


FIG. 6—Circuit from which resistive network is developed: (A) the assumed circuit, (B) the equivalent series circuit, and (C) the final design

Permeability Tuning

Survey of applications for movable pulverized iron cores in postwar a-m, f-m, and television receivers, and analysis of factors to be considered in designing permeability tuners

By W. J. POLYDOROFF
Consulting Engineer
Chicago, Illinois



Evolution of permeability tuners. Left to right: Early pot tuner; British tuner with tapered coil; small, high-Q pot-type tuner; five versions of the modern tuners described in this article

WITH manpower, raw materials, and plant capacity now available for producing home and auto radio receivers, the following facts about permeability tuning constitute a timely aid in the design of postwar sets.

Judging from pre-war acceptance of systems of tuning in which inductance was varied instead of capacitance in tuned circuits, permeability tuning will be found in the majority of the auto sets and in a good share of home radios. The advantages are economy, compactness, light weight, stability, and absence of microphonics. In addition, in a series-resonant antenna circuit the use of permeability tuning compensates the customary lack of selectivity at the high-frequency end of the tuning range because it is possible to secure a substantially constant Q. In r-f amplifiers it is advantageous to employ circuits in which the ratio of L to R is a constant so that the amplification is maintained constant with uniform selectivity. In oscillator circuits, stability is gained by use of high Q and again permeability tuning has something to offer.

Superheterodyne Applications

Superheterodynes have been built with one or two stages of preselection. A two-gang tuner (preselector and oscillator) offers an attractive mechanical design since it is possible to arrange the two cores with continuous mechanical coupling so that both cores move and maintain tracking. At the same time the indicator may be actuated by mechanical coupling to the cores. When the police band is included, the preselector permeability tuner should provide an inductance variation of about 10 to 1 while the oscillator variation is of the order of 5 to 1. Tracking is accomplished by using two similar cores, having larger-diameter tubing for the oscillator, or by two similar forms and a smaller-diameter core for the oscillator. In addition, the oscillator coil may be wound with a progressive pitch which further improves the tracking.

If the public were deprived of the questionable entertainment of listening to police reports, then the inductance ranges for preselector and oscillator become 7.8 to 1 and 3.9 to 1 respectively, corresponding to the requirements for auto receivers.

While a few auto sets have been made with two-gang tuners, the low pickup of the auto antenna necessitates an additional r-f stage so that image-frequency problems and cross-modulation interference practically disappear. It must be borne in mind, however, that trf circuits require interstage shielding and shielding of a permeability-tuned inductor with open core reduces the inductance variation. Hence, it is necessary to start with a variation of inductance higher than 10 to 1 to arrive at the necessary 7.8 to 1 inside the shield.

In the construction of permeability tuners thin-walled tubing is used for coils, the practical wall thickness being approximately fifteen thousandths of an inch. The core usually fits inside the tube, with clearance of not over 0.002 inch, in order to realize the desired inductance variation. In the simplest case a single layer of enameled wire is wound over the tubing to an inductance of 80 to 100 microhenrys. Such a winding usually has a Q of 30 to 50 at 1,500 kc. With 6/42 wire and a ¼-inch diameter core it is possible to approach maximum Q of 100. When higher Q is desired the progressive universal winding is employed, using something like 10/42 or 20/44 Litz.

Analysis of Typical Tuners

Table I gives the characteristics of four sizes of permeability tuners which have either been in use before the war or appeared later. Types 1 and 2 were used before the war. Type 2 should be preferred in every case as it gives better performance, longer spread of frequencies on account of larger stroke, and better mechanical strength of the core itself. It also permits use of thicker-wall tubing. The difference in the cost of the two cores is negligible as compared with other components. It is only in the case of the oscillator coil that type 1 can be used without material difference in performance.

Type 3 represents a core that was used in a commercial loop receiver in which a preselector circuit including a low-impedance loop was tuned by this core. It is believed that with improved techniques of pressing, this core may be reduced in length to $1\frac{1}{2}$ inches and still maintain the same coverage. Fairly high Q is obtainable with this tuner when 20-strand Litz is employed.

In a large console it is possible to provide adequate spacing for a highly efficient tunable loop, but in a small receiver the loop is usually jammed against the chassis, with loss-producing metal in the field of the loop. In small sets the efficiency of a tunable loop may therefore be reduced by 6 db because of chassis losses.

A loop stage tuned by an iron-core inductor is shown in Fig. 1A. The loop is at the grounded end of the circuit, in series with a variable inductance. In addition to its simplicity this circuit possesses a low initial capacitance of the order of 2 to 3 $\mu\mu$f. The value of the inductance of a loop in series with a tuning inductance is determined from a simple formula

$$L_a = \frac{L_o\,[\mu_{eff} - (f_{max}^2/f_{min}^2)]}{(f_{max}^2/f_{min}^2) - 1}$$

where f_{max} and f_{min} are the desired limits of frequency, L_a is the inductance of the loop aerial, L_o is the minimum inductance of the tuner, and μ_{eff} is the total inductance variation of the tuner. The μ_{eff} of a usual iron-core tuner is 10, so that $L_a = 0.32 L_o$ or roughly one-third of the minimum inductance for the broadcast range.

With $L_o = 300$ the value of L_a is 100 and the value of total capacitance becomes 24 $\mu\mu$f, which can be realized with a 10 to 20-$\mu\mu$f adjustable trimmer. In this case a loop in series with the inductor covers the entire broadcast range, with a loss of 3 db as compared with capacitor tuning.

Since a loop and its tuning inductor are interdependent, in the design of loop receivers the tuners and loops must be considered together for their frequency coverage and for oscillator tracking.

It is now possible to increase μ_{eff} to 16 and even 18, by the employment of closed-type binocular structure. Then a loop of 200 μh can be employed with $L_o = 200$ μh so that larger frequency coverage and full sensitivity are realized.

TABLE I. CHARACTERISTICS OF PERMEABILITY TUNERS

Type	Core			Coil				Winding	Q of Coil & Core	Application
	Diam.	Length	L/D	Diam.	Length	L/D	μ_{eff}			
1	0.198	1.375	7	0.225	1.2	5.4	10	Single layer enameled	30–70	Preselector coils for broadcast range
2	0.256	1.5	6	0.275	1.25	4.5	10	Single layer Litz	50–90	
								Prog. universal Litz 6/42	75–100	
3	0.312	1.875	6	0.35	1.625	4.5	11	Prog. univ.	100–125	
4	0.375	1.5	4	0.415	1.250	3.04	4	Single layer enameled	125–175	Short-wave 6–18 mc
				0.430	1.375	3.2	8.5	Prog. univ. Litz 20/44	125–150	Broadcast band high-Q coil

Short-Wave Applications

The large size of tuning core, $\frac{3}{8}$-inch diameter by $1\frac{1}{2}$ inches long, may employ high-grade iron powder suitable for short-wave reception. With finer subdivision of iron the effective permeability is reduced and it is impractical to attempt to cover the short-wave range from 6 to 18 mc with a single tuner. Several pre-war models used spread-band tuning in which cores covered partial frequency bands including the majority of international broadcast stations.

With the public demanding continuous tuning, a new core has been designed to cover the short-wave band in two steps: 6 to 11 mc, and 10 to 18 mc. Such distribution of short-wave stations somewhat approaches a band-spread dial yet offers continuous tuning throughout the whole range of frequencies. In practice this can be accomplished by one tuning unit with a choice of two values of fixed capacitors.

Figure 1B shows such an antenna circuit, with approximate values of inductance and capacitance. The coil is wound in the usual manner and can be made with No. 24 or 26 wire on a thin-walled tube. If, however, the frequency coverage is to be increased, say by 5 percent, two coil windings can be laid on the same tube side by side, with the windings wound closer together and preferably in reverse directions as shown in Fig. 1C. To obtain maximum effective permeability at higher frequencies the turns must be laid close together. By paralleling two or more sections of higher inductance we may get the total value of the inductor down to a desired value. The arrangement shown in Fig. 1C possesses higher Q since the adjacent turns are at the same potential, and therefore electrostatic losses are reduced. In certain vhf applications up to four sections wound in this manner were successfully employed, with the result that the effective frequency coverage was noticeably increased.

Figure 2 shows the manner in which Q varies with frequency for several of the permeability tuners covered in Table I. In general, Q decreases as frequency goes up.

Core-Molding Techniques

With existing core materials it is possible to employ permeability tuning at much higher frequencies, such as those for f-m and television. Smaller grain size should be employed to keep eddy current losses down, which in turn decreases the practical density of the core material and increases the number of gaps in the magnetic circuit. Both tend to reduce the permeability and consequently the permeability drops to a value of about 4 in the region of 100 mc, as contrasted to 30 for broadcast-band applications. Using the same geometrical dimensions of core and coil we may expect an inductance variation in broadcast receivers of the order of 10 to 1, in short-wave receivers of the order of 4 to 1, and less than 2 to 1 in the vhf bands.

In the production of long cores special techniques of pressing and molding have been developed. With pressure applied to the ends of the core a considerable friction develops in the mold, so that very high pressures are used to produce cores of desired density. Since the original powder mixture contains little plastic ingredients, the pressure is not readily transmitted toward the center of the core, resulting in decreased density and permeability in the middle region of the core. Worst of all, this degree and location of soft spot is never the same in two identically prepared cores. The result is that when two similar cores are moved into the coil, the gradient of inductance variation changes from one core to another, making it difficult to track two circuits together.

Several core makers have resorted to a double selection method in which the cores are matched fully in the coil, and also matched at the middle position. Thus it is possible to obtain uniform tracking in a selected family of cores, but the problem of replacements and interchangeability is complicated as the manufacturer is forced to maintain a stock of different families with several sub-families in each for replacement.

When excessive pressure is applied to both ends during molding, it becomes quite a problem to extract the core after it is pressed. One manufacturer employs split molds as a successful but slow method of extracting the cores.

Not long ago a core manufacturer introduced long cores which were strong and uniform throughout their length, both of these qualities being obtained by side pressing. This type of pressing uses a longitudinal mold cavity and both top and bottom plungers are rounded. The core compresses very easily since the depth of compression amounts to the diameter of the core. It is difficult to produce perfectly round cores by this method, but after the cores are completed they can be ground in centerless grinders to a cylindrical shape.

Initial and Effective Permeability

For any given powder the initial permeability is a function of the density to which the mixture has been pressed. The initial permeability can only be realized in a toroidal coil and approached in a closed pot type. In open-type cylinder cores, the effective permeability is only a fraction of the full permeability and depends on the ratio of length to diameter and on the permeability of the material. The longer the cylinder is, the higher will be the effective permeability for variable inductors. The higher the permeability of the material, the higher is the effective permeability up to a certain value.

For further increase in the effective permeability two cores and coils may be employed in a binocular pair, or an elongated sleeve of the same material may be added on the outside of the coil.

Orientation of Core Particles

Additional increase in permeability may be obtained by using flat or flattened particles laid and compressed with their flat faces parallel. The pressure in this case is applied transversely to the flat faces, so that cylindrical cores have to be pressed lengthwise. By careful selection of flat particles having high permeability and careful alignment in the mold, it has been possible to produce permeability tuners of relatively short stroke, such as 1½-inch length for a ⅜-inch diameter core, with correspondingly shortened coil. If proper Litz and universal windings are used, high-Q permeability tuners may be made for the broadcast and police frequency range. A directional permeability, similar to laminated cores, is observed and obviously should be applied in the direction of the magnetic axis of the coil.

Other Considerations

Permeability tuning has been successfully applied to low-power transmitter circuits, using cores up to 2 inches in diameter and weights up to 2 pounds.

Higher-power applications, above 50 watts, have not yet been successfully solved, mainly because of the heat unavoidably generated in the core. This difficulty is further aggravated by the fact that the usual core materials are poor heat conductors and the organic materials employed for binding the core disintegrate under heat.

In cores for high-power applications it is essential to eliminate organic materials or entirely eliminate the binder and rely on sintering after compression to produce a quasi-laminated structure.

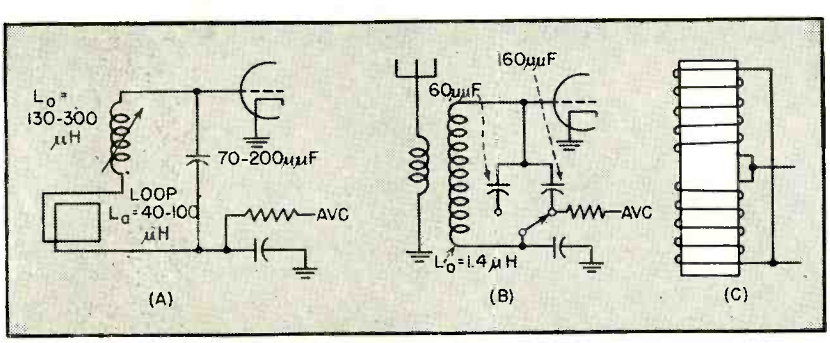


FIG. 1—Loop stage tuned by iron-core inductor (A), use of two fixed capacitors to provide coverage of a short-wave band in two steps with a pulverized iron core (B), and method of winding coil to obtain higher Q along with increased frequency coverage (C)

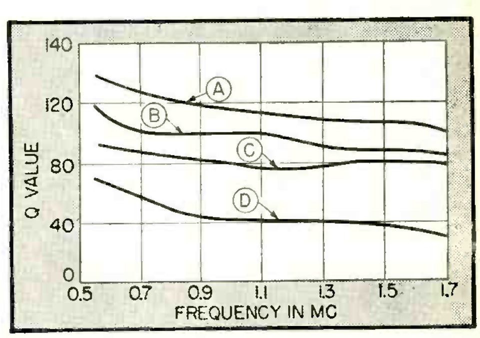


FIG. 2—Variation of Q with frequency for (A) 0.375-inch diam. core 10/44 Litz, (B) 0.256-in. core 6/42 Litz, (C) 0.198-in. core 6/44 Litz, and 0.198-in. core single layer enameled

RESISTANCE at

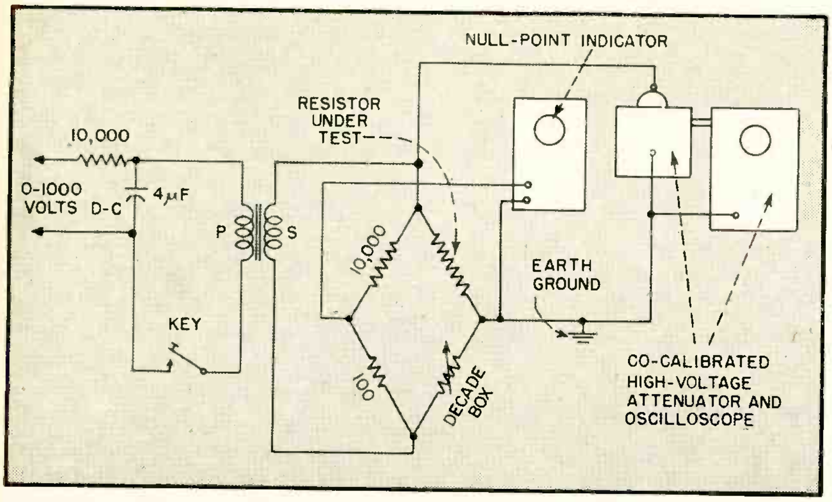


FIG. 1—Circuit for measuring the resistance of a suppressor subjected to high impulse voltage. One oscilloscope is employed as an indicator of the balance point of the bridge and the other for measurement of the peak voltage applied to the sample

COMPOSITION-TYPE resistors are ordinarily possessed of a voltage coefficient characterized by decreasing resistance as the voltage applied to the element increases. The rate of resistance drop with increasing voltage is dependent upon physical characteristics of the resistor such as, for example, the ingredients comprising the mix and the physical size in relation to the resistance value.

Problem of High Voltage

The suppression effectiveness of a resistor element applied to a high-tension ignition circuit is a function not necessarily of the resistance at low voltages, such as would normally be used in an ohmmeter circuit, but of the resistance at the instant of spark-plug discharge when the full high voltage of the system is impressed momentarily across the suppressor. The general range of ignition voltages is considered to be approximately from 5,000 volts to 12,000 volts, with the majority of motor vehicles normally operating near the lower limit

The measurement at low voltage of any given resistor sample is a relatively simple matter. A number of adequate methods are available and generally applicable for the condition under which the applied voltage does not greatly exceed the rated voltage of the sample, or under which the measurement can be made quickly enough so that appreciable heating of the sample does not occur. However, it is evident that commonly employed methods cannot be used where measurements are to be made with applied voltages of 5,000 to 12,000 volts and where the resistor element is a composition carbon suppressor rated at 10,000 ohms and ½ watt.

High voltages may be applied to the resistor element in question only momentarily if a serious heating effect is to be avoided. Thus a pulse of the desired peak value must be generated. As well as being of extremely short duration, it is desirable that the pulse be relatively free of higher harmonics and consequently approximately sinusoidal in wave form, yet capable of being reproduced accurately and repeatedly.

Generation of Pulse

Essentially, the procedure for generating voltage pulses of the desired characteristics is to discharge a capacitor through the primary winding of a suitable step-up transformer. The resulting voltage wave appearing across the secondary winding is actually a rapidly damped wave train of relatively short duration. The initial half-cycle will, with the use of proper circuit elements, reach a peak value of several thousand volts and be eminently satisfactory for the purpose of high-voltage resistance measurements.

One specific circuit is shown in Fig. 1. In this, the pulse is generated by closing the key, thereby discharging a 4-μf capacitor through the primary of a 3-kva, 60-cycle power transformer. A pulse of approximately 12,000 volts peak is developed across the loaded transformer secondary when the capacitor is charged to the full 1,000 volts just prior to discharge. The transformer windings consist of a 110-volt primary and a 3000-volt secondary.

The d-c power supply may be any source that is variable over the range from zero to approximately 1,000 volts and capable of withstanding a current drain sufficient to charge a 4-μf capacitor to 1,000 volts through a 10,000-ohm resistor once every second.

Resistance Measuring Circuit

The measurement is accomplished by use of the Wheatstone bridge circuit, one arm of which is the resistor sample under test. The high-voltage pulse is impressed across the entire bridge, and a balance is obtained by adjusting the variable arm. The null, or balance point, is indicated by the trace on an oscilloscope connected across the bridge at points diagonally opposite the high-voltage pulse connections.

A measure of the peak voltage of the pulses impressed across the test sample is obtained from the height of the trace on the screen of a second oscilloscope, calibrated in conjunction with a high-voltage attenuator.

With reference again to the diagram of Fig. 1, the two fixed arms

MEASUREMENT High Impulse Voltages

Commonly used methods of measuring resistance cannot predict the effect of voltage coefficient on resistors subjected to high impulse voltages. The decreased resistance caused by impulses such as ignition voltages can be determined by the technique described

By SCOTT L. SHIVE

Radio Engineer
Signal Corps Ground Signal Agency
Detroit Signal Laboratory
Detroit, Mich.

of the bridge circuit are 10,000 ohms and 100 ohms respectively. These are wire wound resistors which have zero voltage coefficient. The variable arm consists of a decade box, also of wirewound elements, whose setting at balance is exactly 1/100 of the test sample resistance. The null-point indicating oscilloscope used here is a 3 inch R.C.A. Model 155-A, while the pulse measuring system is composed of a DuMont oscilloscope, type No. 208, and a specially co-calibrated Rowe Research Laboratory high-voltage attenuator, type No. CA-211.

Operating Procedure and Precautions

After connecting the resistor sample into the bridge circuit, the output of the d-c supply is adjusted until the desired pulse voltage, as indicated on the pulse-measuring scope, is applied across the test sample. During this and the subsequent procedure, the pulses should be produced at a rate not exceeding one per second in order to avoid appreciable heating of the sample and in order that the capacitor may become completely charged between discharges, thus assuring identical amplitudes for successive pulses.

With the desired pulse voltage obtained, the decade box used as the variable arm of the bridge is adjusted to produce balance. For the particular fixed arm resistance values used herein, the resistance of the unknown test sample at the selected voltage is then 100 times the decade-box setting.

The bridge circuit is considered balanced for the setting at which the overall height of the trace on the null-point indicating oscilloscope is either zero or minimum. The height will be zero or nearly so when the test sample has little or no voltage coefficient, but for resistors with any appreciable degree of nonlinearity, the overall height of the trace cannot be reduced to zero and the null point becomes somewhat more difficult to detect.

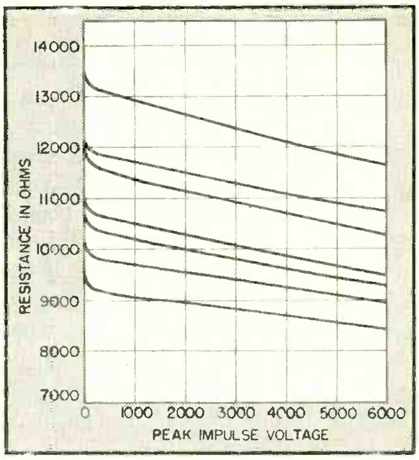


FIG. 2—Typical curves of resistance as a function of high impulse voltages, for samples of composition-type resistors. The nominal rating of the resistors is 10,000 ohms, one watt

Indicator Trace

The effect of voltage coefficient or nonlinearity is to introduce a third harmonic into the current wave in the side of the bridge circuit containing the sample. This harmonic, depending in amplitude upon the degree of the nonlinearity, appears in the voltage wave across the terminals of the null-point indicator and cannot be balanced out. Hence the balance point in this case is taken to be that at which the fundamental of the first half-cycle of the pulse wave train is balanced out, and nothing but harmonics remain in the oscilloscope trace. The fundamental is identified by a long tail extending well above or below the zero line and rapidly decreasing, as balance is approached from the high side, until finally at balance it disappears into the traces of the harmonics.

It will generally be found most satisfactory to operate the null-indicating oscilloscope with a horizontal sweep of approximately ¼ inch and from 200 to 300 cps.

The fixed arms of the bridge may be composed of inductive wirewound resistors. The inductance so introduced has only a negligible effect on the accuracy of measurement at the frequency of the pulse wave. A 10,000 ohm wirewound resistor, with zero-voltage coefficient when measured at 10,000 volts, reads within 0.5 percent of its resistance at 6 volts d-c.

Typical Results

Figure 2 shows typical curves of resistance plotted against high impulse voltage obtained for representative samples of composition carbon-type suppressors nominally rated 10,000 ohms at one watt. The curves are seen to be relatively straight lines, from approximately 1,000 volts on up, with a constant negative slope. Thus for these samples, the resistance drop at high impulse voltages is approximately directly proportional to the peak value of voltage.

MULTIPLE

By JOSEPH F. MANILDI

Chief Research Engineer
G. M. Giannini & Co., Inc.
Pasadena, California

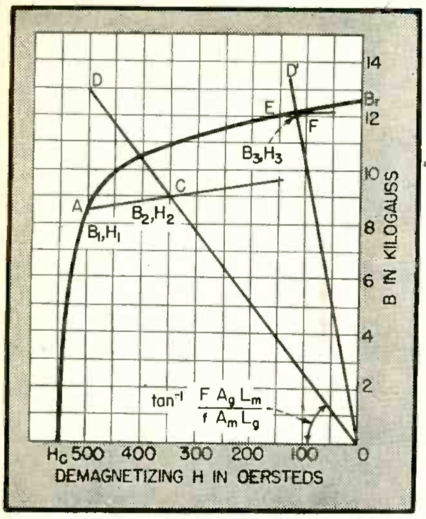


FIG. 1—Demagnetizing curve, Alnico V

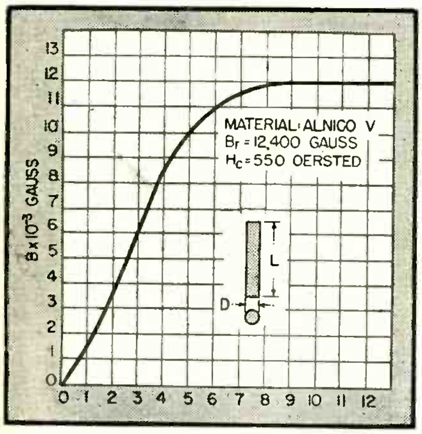


FIG. 2—Field intensity in a permanent magnet as a function of aspect ratio L/D (horizontal scale) for Alniço V

USE of parallel magnetic circuits rather than conventional single-magnet or series magnetic circuits results in many cases in a more efficient utilization of the magnetic material. By using parallel magnetic circuits, desired field strengths may be obtained in meters with less magnetic material, resulting in systems weighing less and occupying less space. This makes the method particularly useful in design of aircraft instruments, where space and weight limitations are important.

The method of design is particularly suited to cases where the magnetic circuit is subjected to open-circuit conditions or strong demagnetizing influences during its history, and it is necessary to make the magnetic system very stable. Considerable advantage is also obtained, however, in circuits which are not subjected to very severe demagnetizing influences.

The problem of efficiently designing a magnetic circuit has been thoroughly explored by present-day designers. Usually, however, design considerations are based upon a magnetic circuit in which the magnetomotive force is supplied by one or more magnets in series. Experimental data and analysis point to the fact that by using parallel magnetic circuits, a given field in an air gap may be obtained with considerably less magnetic material.

The fundamental problem is as follows: a given magnetic field is desired in an air gap of given area and length. What magnet design must be adopted to give a stable field of the stated value, using a minimum amount of magnetic material?

Underhill discusses the problem thoroughly[1] and gives design equations for a single series circuit. The problem of greatest interest is one where the magnets have been subjected to open-circuited conditions at one time or another. The design must be taken from this standpoint if a stable field is desired.

In the event that the magnetic circuit is not subjected to the demagnetizing influence of the air gap, the basic principles developed in the following analysis still continue to hold, and advantage is obtained in the use of parallel magnets. The advantages are more apparent in the case where the magnets are subjected to the equivalent of open-circuit conditions, however, and the analysis will be approached from that standpoint. We shall reiterate here the conditions which determine the design of a single series magnetic circuit, then show how it is modified by use of multiple circuits.

Resumé for Single Magnet

Referring to Fig. 1 which is the demagnetization portion of the *B-H* curve for a given material, when a bar or U magnet is magnetized to saturation then subjected to open-circuit conditions, its state is represented by point A on the curve, where the magnetic field and coercive force have the values B_1 and

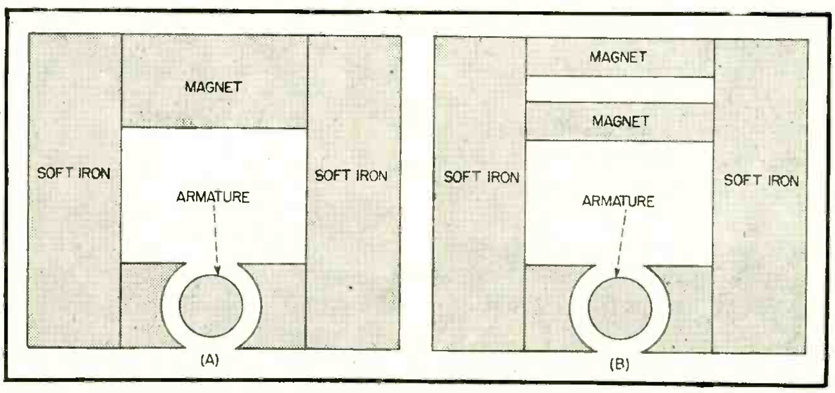


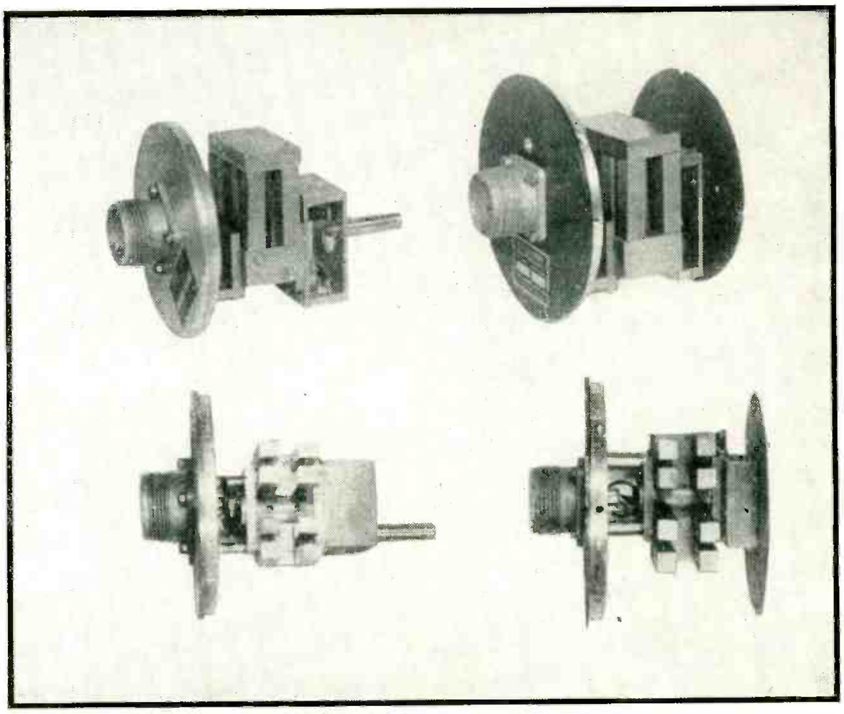
FIG. 3—Complete magnetic circuits employing a single series magnet (A) and four magnets in parallel (B; two magnets are behind those shown)

MAGNETIC CIRCUITS

Small permanent magnets in parallel use less magnet material to produce a given field strength in an air gap, hence offer weight and space advantages in aircraft and other meters or synchros. Design equations and graphs give minimum magnet spacing

H_1 respectively. This point is determined by the L/D ratio of the magnet, where L = length of magnet, and D = effective diameter = $2\sqrt{\text{area}/\pi}$.

Figure 2 shows the relationship between L/D and B from which the point A may be determined for Alnico V (see Appendix A). When the magnet is placed in its magnetic circuit, complete with soft iron bridges, armature, and air gap, the state of the magnet is represented by point C in Fig. 1, which is the intersection of the minor hysteresis loop AC and the air-gap line OD. The minor hysteresis loop is determined from the fact that its slope is approximately parallel to the tangent to the B-H curve at the point B_r. The air-gap line is determined from the fact that its negative slope is equal[1] to FA_gL_m/fA_ml_g, where F and f are leakage factors depending on the configuration of the circuit, A_g is gap area, l_g is gap length, A_m is magnet cross-sectional area, and l_m is magnet length.



Transmitter (left) and receiver (right) of a remote indicating impulse system employing parallel magnetic circuits to reduce weight as required for an aircraft application. Lower views have magnetic bridge removed to show arrangement of magnets more clearly

For a given magnet the necessary quantities are all known, and the point C may be determined either graphically or analytically. Thus, the value of B in the magnet is known, and the value of B in the air gap may be obtained from the relationship

$$B_g = A_m B_m / FA_g \quad (1)$$

where B_g is the field in the gap and B_m is the field in the magnet given by the point C = B_2.

We can now show that if the magnet employed has an L/D less than about eight, a considerably higher field may be obtained in the air gap by using a multiple magnetic circuit. For specific illustration, let us assume that the magnetic circuit is the one shown in Fig. 3A, that the area of the magnet is A_m, that the L/D ratio is 4, and that the dimensions of the elements are such that the air-gap line is OD in Fig. 1. We see from Fig. 2 that L/D = 4 is represented by point A on the magnetization curve. Hence, after insertion into the circuit the point C represents the state of the magnet, and the field in the gap is given by Eq. (1).

Four Magnets in Parallel

Now instead of the one magnet shown, let us use four magnets, as shown in Fig. 3B, each of which is the same length as the first, but whose cross-sectional areas are each one-fourth the original area. The diameters are now one-half the original diameter and L/D = 8. The total magnet area is unchanged, and total magnet volume is unchanged. We now place these magnets in close proximity in the magnetic circuit and proceed to calculate the new gap field.

We shall assume at this point that the proximity of the four magnets does not affect the relationship between B_m and L/D for each magnet. This assumption will be discussed in detail later. The open-circuit field is now given by point E on the curve. If we assume the leakage constants to be essentially unchanged, then the air-gap line for a single magnet has four times the slope, the air-gap line is OD′, and the field in the magnet when the magnetic circuit is complete is given by the point F, where the field in the magnet is B_3. The field in the air gap due to one magnet is now given by Eq. (1) and is equal to

$$B_g' = A_m' B_3/FA_g = A_m B_3/4 FA_g \qquad (2)$$

where $A_m' = A_m/4$, the new cross-sectional area, and the field in the gap due to four magnets is parallel is given by

$$B_g'' = 4 B_g' = A_m B_3/FA_g \qquad (3)$$

The field with the single magnet is equal to

$$B_g = A_m B_2/FA_g \qquad (4)$$

Since $B_3 = 12{,}000$ gauss and $B_2 = 9{,}000$ gauss approximately, we see that the field in the gap has been increased by a factor of 1.33.

Advantages of Parallel Magnets

From the above analysis we see that if a single series circuit utilizes a magnet having $L/D<8$, the field in the gap may be increased with the same amount of material by using parallel magnets having an $L/D \geqq 8$. The value 8 is chosen since it is at the knee of the curve of Fig. 2.

It may readily be seen that if the most efficient[1] series magnet for a particular design has an $L/D<8$, a larger field may be obtained by using parallel magnets having an $L/D \geqq 8$. This amounts to saying that the given field may be obtained, using parallel magnets, with less magnetic material than by using a single series circuit.

Design will be simplified by the fact that the open-circuit point will always be the point E. Furthermore, if it is desired to obtain a large field and the space is limited insofar as permissible length of magnet is concerned, many small magnets, all having an $L/D \geqq 8$, may be as effectively used as a longer magnet having the same mass of magnetic material.

The primary limitation on the effective use of parallel magnetic circuits arises from the fact that the parallelled magnets may not be brought too close to one another, since the adjacent magnets will tend to demagnetize each other.

The degree of proximity which may be imposed on a parallel magnet configuration, in order that maximum field may be obtained, can be determined by simple experiment and calculation.

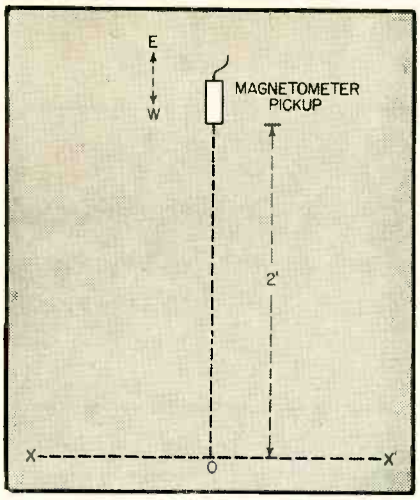


FIG. 4—Test arrangement for determining demagnetization of a permanent magnet as a result of another magnet placed in close proximity

Measurements

Test equipment consisted of a magnetometer, which was used to measure the flux from the test magnets. The test magnets consisted of 6 Alnico V magnets each 1 inch long and of square cross-section ¼ inch on each side. The magnetometer was adjusted to a sensitivity of 10 milligauss for a full-scale reading (30 divisions).

The magnetometer pickup was placed about two feet from the magnets to be tested, as shown in Fig. 4. The magnetometer measured field intensity, which is proportional to pole strength times length of magnet. Since the magnets were parallel to one another, the length of magnet was always 1 inch, and the indication was proportional to pole strength, which is in turn proportional to total flux emanating from the magnets.

TABLE I. Comparison of Strengths of Grouped Magnets With Predicted Strength of Equivalent Solid Magnets

No. of Magnets in Group	Total Pole Strength	Equivalent L/D	Predicted Strength of Solid Magnet
1	7.0	3.3	7.0
2	10.0	2.4	9.0
3	13.0	1.91	11.0
4	14.5	1.65	12.5
5	15.5	1.47	13.5
6	16.5	1.35	14.5

The distance between the magnetometer pickup and the magnet is sufficiently large so that moving the magnet three or four inches on either side along the line XX′ of position O has no effect on the reading of the magnetometer. This is essential to make an accurate determination of the proximity effect.

The six magnets were first individually magnetized and the pole strength of each was measured. Since the zero position of the magnetometer changed over a period of time because of extraneous fields in the region of the magnetometer, a reading was taken first with the south pole nearer the magnetometer, then with the north pole nearer the magnetometer. The total flux was taken as proportional to the average of the two readings.

The strengths of the individual magnets proved to be about the same, and equal to about seven units.

The magnets were then placed intimately side by side, like poles adjacent. First, two magnets were placed together and their combined strength measured, then a third magnet was added and the combined strength measured. This was continued until all six had been grouped. The results are shown in Fig. 5, along with the geometry of grouping. The demagnetizing effect is particularly noticeable. For one magnet the strength is 7, but for six magnets the strength is only 16.5, instead of 42 which would occur if no demagnetizing took place.

The magnets were then separated and individual strengths again measured. Each magnet now had only about half its original strength, indicating permanent demagnetization took place during grouping.

Proximity Effects

In order to determine how closely magnets can be grouped before the demagnetizing effect becomes noticeable, two magnets were placed along line XX' in Fig. 4 after having been freshly magnetized. They were placed 6 inches apart and 3 inches on each side of point O after their individual strengths had been determined. Readings of their combined strength as a function of their separation was taken. This data is plotted in Fig. 6.

It is to be noted that as the magnets are moved together, the combined strengths are about equal to the sum of the individual strengths until a separation of about ½ inch is attained, when the strength drops off. Data was taken first as the separation was decreased, then as it was increased again. The permanent demagnetizing effect is noticeable.

In order to obtain a quantitative measure of the extent of demagnetization when several magnets are grouped intimately, we must compare the strength of the group with the strength of a single magnet having the same length and cross-sectional area and shape. We may do this by use of Fig. 2, which shows the relationship between flux density and L/D ratio for Alnico V.

Using this curve and the strength of a single magnet, we may predict the strength of any magnet in the same material. Table I tabulates the experimental values plotted in Fig. 5 along with the predicted strength of solid magnets having the same length and cross-sectional area. Slightly greater strengths are obtained from the grouped magnets than from the solid magnet, but the difference is small. The curve for equivalent single magnet strengths is also plotted in Fig. 5.

Minimum Separation Distance

For the magnets tested, the smallest separation without serious demagnetizing effect is ½ inch center to center. This holds only for two magnets. The results may be approximately extended to groups of more than two magnets by considering that the limitation on the spacing arises from the field produced at the pole of one magnet by all the other magnets. Since the effect of all other poles is inversely proportional to the square of the distance from the pole under consideration, the pole under consideration will be subjected to the same demagnetizing influence from a group of magnets as from a single other magnet, assuming all magnets similar, if

$$\frac{1}{d_1^2} - \frac{1}{d_2^2} = \sum_i \left(\frac{1}{d_{1i}^2} - \frac{1}{d_{2i}^2} \right) \qquad (5)$$

where d_1 = distance of pole from the like pole in the two-magnet configuration

d_2 = distance of pole from the unlike pole in the two-magnet configuration

d_{1i} = distance of pole from like pole of the ith magnet of the multiple-magnet configuration

d_{2i} = distance of pole from unlike pole of the ith magnet of multiple-pole configuration

Thus, if the safe distances d_1 and d_2 are determined by test as outlined above for two magnets, the results can be used for determining safe spacings for any number of similar magnets in the group by use of Eq. (5). The summation must be performed on every magnet, of course, and the condition is that in each individual summation the right-hand side of Eq. (5) must be less than or equal to the left-hand side.

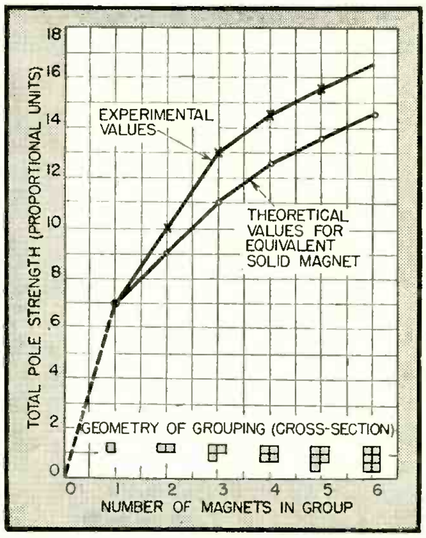


FIG. 5—Combined pole strength of magnets grouped in intimate contact

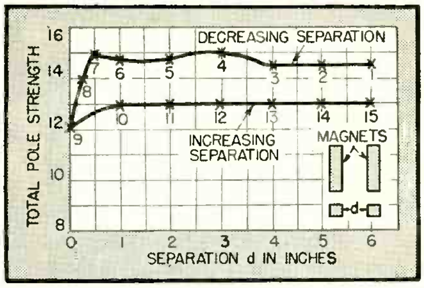


FIG. 6—Combined pole strength of two magnets as a function of their separation. Individual strengths of magnets are equal to 7.5 Plotted points are numbered in the order in which measurements were made

Conclusions

On the basis of the analytical and experimental evidence presented above, it appears that parallel magnetic circuits can be effectively used in instruments operating by virtue of a magnetic field in a gap.

In each individual instance, care must be taken that the individual parallel magnets shall not be placed too close to one another in the parallel circuit. However, the critical spacing distance is not very large in ordinary instances, and this feature does not present an undesirable limitation.

In particular, advantage can be taken of the above design principles in instruments where the L/D ratio for the magnet in the single-magnet circuit is less than 8. The net result of such design is the obtaining of the desired field with less magnetic material and a field which is more stable to demagnetizing influence.

Appendix A. Determination of Relationship Between B and L/D for Single Open-circuited Bar Magnet

We shall use an approximate parabolic equation for the demagnetizing portion of the hysteresis curve for Alnico V[1]

$$B = \frac{B_r (H_c - H)}{H_c - aH} \qquad (6)$$

where B_r is residual flux density, H_c is coercive force, and a is a constant related to the magnet material. An empirical equation relating the ratio of B to H for a permanent bar magnet[1] then is

$$\frac{B}{H} = (1.89 - a) \left(\frac{L}{D} + a \right)^{1.82} \qquad (7)$$

We now obtain a relationship between B and L/D

$$\frac{B(B_r - aB)}{H_c (B_r - B)} = (1.89 - a) \left(\frac{L}{D} + a \right)^{1.82} \qquad (8)$$

Equation (7) and hence Eq. (8) is invalid for $L/D < 1$, but this need not concern us since we know from physical considerations that when $L/D = 0$, $B = 0$. Using B_r = 12,400 gauss and H_c = 550 oersteds,

$$a = 2 \sqrt{\frac{B_r H_c}{B_o H_o}} - \frac{B_r H_c}{B_o B_o} = 1.51$$

where B_o and H_o are coordinates of the maximum-energy point. The curve shown in Fig. 2 is obtained from Eq. (8).

REFERENCE

(1) Underhill, Earl M., Designing Stabilized Permanent Magnets, ELECTRONICS, Jan. 1944, p. 118.

Resistance-Capacitance FILTER CHART

Values of R and C for both low-pass and high-pass filters are given in terms of the amount of rejection desired at any given frequency from 1 millicycle to 1,000 megacycles. Chart also gives the reactance of a capacitor at any frequency

By ERNEST FRANK

Sperry Gyroscope Co.
Garden City, N. Y.

RESISTANCE-CAPACITANCE filters are frequently used when a sharp cutoff characteristic is not required and, in the low-pass case, when the voltage drop across the series resistor can be tolerated. Applications of the low-pass R-C filter include decoupling from a common power supply for a multistage vacuum-tube amplifier, smoothing filters for power supplies when a large voltage drop across the filter is not objectionable, and inexpensive hash filters to attenuate high-frequency disturbances on electrical leads. High-pass R-C filters are often used as interstage coupling networks.

The circuits of Fig. 1 show the R-C low-pass and high-pass filter connected to an a-c generator. The generator resistance is assumed to be negligible compared with R, and d-c voltages are omitted for the purposes of an a-c analysis. R and C form a voltage divider, and the complex output voltage is given by

$$\text{Low-pass: } E_o = \frac{-jX_cE_i}{R - jX_c} \qquad (1a)$$

$$\text{High-pass: } E_o = \frac{RE_i}{R - jX_c} \qquad (1b)$$

The magnitude of the ratio of E_i to E_o is

$$\text{Low-pass: } \left|\frac{E_i}{E_o}\right| = \sqrt{1 + \left(\frac{R}{X_c}\right)^2} \qquad (2a)$$

$$\text{High-pass: } \left|\frac{E_i}{E_o}\right| = \sqrt{1 + \left(\frac{X_c}{R}\right)^2} \qquad (2b)$$

Solving the above equations for the generator frequency f gives

$$\text{Low-pass: } f = \frac{1}{2\pi RC}\sqrt{\left|\frac{E_i}{E_o}\right|^2 - 1} \qquad (3a)$$

$$\text{High-pass: } f = \frac{1}{2\pi RC}\,\frac{1}{\sqrt{\left|\frac{E_i}{E_o}\right|^2 - 1}} \qquad (3b)$$

When the reactance of C is equal to R, the ratio $|E_i/E_o|$ is equal to $\sqrt{2}$. This condition occurs at a frequency f_3 that is equal to $1/2\pi RC$ and corresponds to the frequency at which the output voltage is 3 db down from the input voltage, ignoring impedance levels (db $= 20 \log_{10} |E_o/E_i|$). Therefore

$$\text{Low-pass: } f = f_3\sqrt{\left|\frac{E_i}{E_o}\right|^2 - 1} \qquad (4a)$$

$$\text{High-pass: } f = f_3\,\frac{1}{\sqrt{\left|\frac{E_i}{E_o}\right|^2 - 1}} \qquad (4b)$$

In low-pass applications the ratio $|E_i/E_o|$ is often selected to be 10 or greater. Therefore, Eq. (4a) becomes

$$f \simeq f_3\left|\frac{E_i}{E_o}\right| \quad ; \quad \left|\frac{E_i}{E_o}\right| \geqq 10 \qquad (5)$$

because $|E_i/E_o|^2 \gg 1$. The value of f is given to an accuracy of about 1 percent by Eq. (5) when $|E_i/E_o| = 10$. When $|E_i/E_o| = 100$, f is given to an accuracy of about 0.1 percent. The error resulting from the use of Eq. (5) is in the pessimistic direction since the true value of f, obtained from Eq. (4a), is always smaller than the value of f given by Eq. (5).

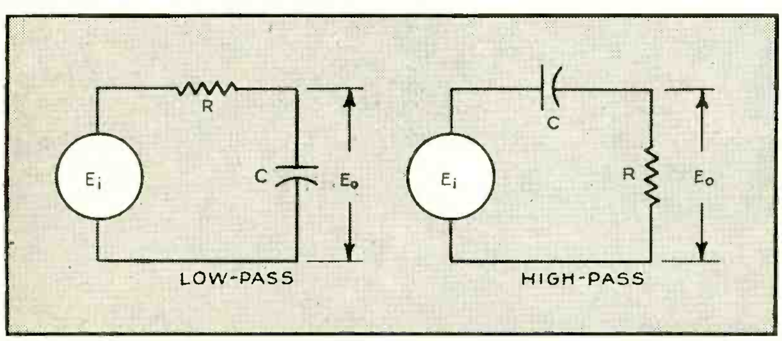


FIG. 1—Low- and high-pass R-C filters shown connected to a-c generator

Use of Chart

In high-pass applications, the value of f_3 is usually of primary interest, and is given by $f_3 = 1/2\pi RC$. The chart in Fig. 2 enables f_3 to be read directly in one operation for a given value of R and C in either the low-pass or high-pass case. When a value of $|E_i/E_o|$ equal to or greater than 10 is desired in the low-pass case, the value of f_3 determined from the chart can be multiplied by $|E_i/E_o|$. The chart can also be used to determine the reactance of a capacitor at any frequency. The following examples illustrate the use of the chart.

Example 1

A plate decoupling R-C filter must attenuate frequencies above 50 cps by a voltage ratio of 10:1. The value of R cannot exceed 4,000 ohms to avoid an excessive loss in d-c voltage. What value of C is required? From Eq. (5), $f_3 = 50/10 = 5$ cps. From the chart, draw a

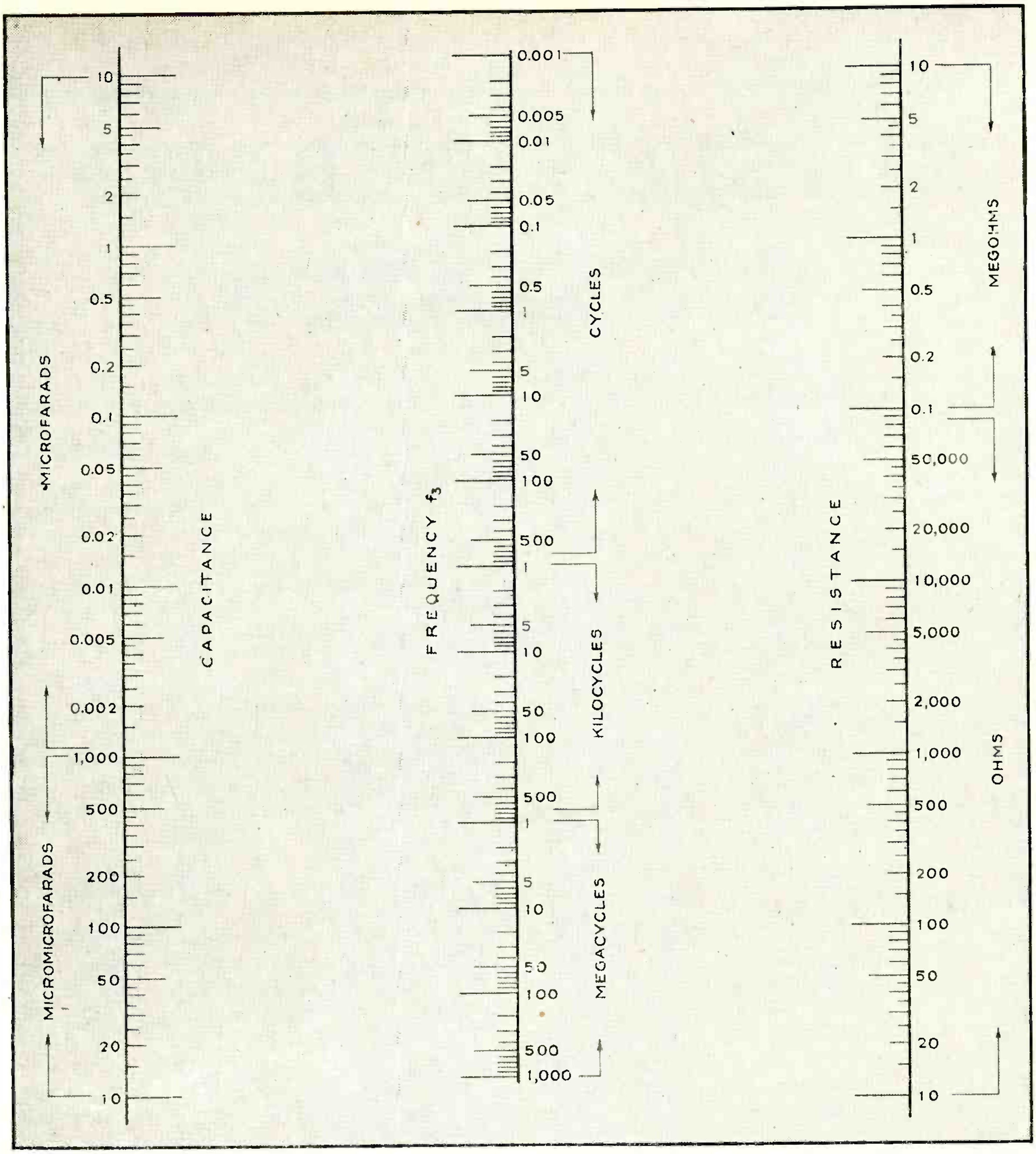


FIG. 2—Resistance-capacitance filter chart based on the relation $f_3 = 1/2\pi RC$, where f_3 is the frequency at which the filter provides an attenuation of 3 db. To find the reactance of a capacitor, place ruler on known capacitance and frequency values and read the reactance value on the resistance scale

line through $f_3 = 5$ cps and $R = 4{,}000$ ohms. Read $C = 8\mu$f.

Example 2

The low-frequency end of the 3-db pass-band of a resistance-capacitance coupled amplifier must be 100 cps. A 0.01-μf coupling capacitor is available. What value of output resistance must be used? Draw a line through $C = 0.01$ μf and $f_3 = 100$ cps. Read $R = 0.16$ meg.

Example 3

What is the reactance of a 0.002-μf capacitor at 1 megacycle? Draw a line through $C = 0.002$ and $f_3 = 1$ mc, and determine $R = 80$ ohms.

Construction of Chart

The chart covers a wide range at the sacrifice of accuracy in readability. If greater accuracy is desired, it is simple to construct a chart which covers a limited range.

1. Use two sheets of log paper, one of which has twice as many cycles as the other; for instance, two-cycle and four-cycle paper. Each complete scale must be the same total length.

2. On opposite edges of the two-cycle paper, write down the resistance and capacitance values including the desired range.

3. Cut a strip of the four-cycle paper and prepare to paste it equidistant from, and parallel to, the R and C scales, in an inverted sense.

4. Compute f_3 for one value of R and C included on the scales.

5. Match the four-cycle frequency scale to the line joining these values of R and C and paste the scale in place.

6. Label the frequency scale, using the computed value of f_3 as a guide to the major scale values.

SINGLE-SIDEBAND GENERATOR

Balancing out the undesired sideband in a vacuum-tube circuit eliminates need for highly selective filters in power-line carrier systems for telemetering or voice communication

By M. A. HONNELL

Associate Professor of Electrical Engineering Georgia School of Technology Atlanta, Georgia

A COMPARISON of a-m, f-m, and single-sideband systems for power-line carrier transmission appeared recently in the literature.[1] To the writer's knowledge, most single-sideband systems require the use of highly selective filters and, in some cases, require a double modulation process to separate the sidebands sufficiently for effective filtering.

Basic Theory

There is another approach to the problem of generating single-sideband signals which appears not to have been exploited. This system makes the use of highly selective filters unnecessary, because the undesired sideband is balanced out in a vacuum-tube circuit.

An examination of the equations for amplitude-modulated signals in Table I reveals some interesting possibilities.[2] Let us consider the following pair of equations for an amplitude-modulated signal

$$\sin A\ (1 + m \cos B) =$$
$$\sin A + \frac{m}{2} \sin (A - B) + \frac{m}{2} \sin (A + B) \quad (1)$$
$$\cos A\ (1 + m \sin B) =$$
$$\cos A - \frac{m}{2} \sin (A - B) + \frac{m}{2} \sin (A + B) \quad (2)$$

where

$A = 2\pi f_c t$
$B = 2\pi f_s t$
m = modulation factor

If the amplitude-modulated signals are generated in a balanced modulator[3], the carriers are readily eliminated, and the resulting signals at the output of the balanced modulators are of the form

$$G \sin (A + B) + G \sin (A - B) \quad (3)$$
$$G \sin (A + B) - G \sin (A - B) \quad (4)$$

where G is the modulator conversion gain.

It is apparent that if these signals are added, the resultant is the upper sideband, while if they are subtracted the resultant is the lower sideband.

The Practical System

The block diagram of a system constructed to generate a single sideband using this technique is shown in Fig. 1. An examination of Eq. (1) and (2) and Fig. 1 reveals that the carrier as well as the signal frequencies must be shifted 90 degrees in order to obtain the desired phase relations. This is readily achieved in the case of the fixed carrier frequency

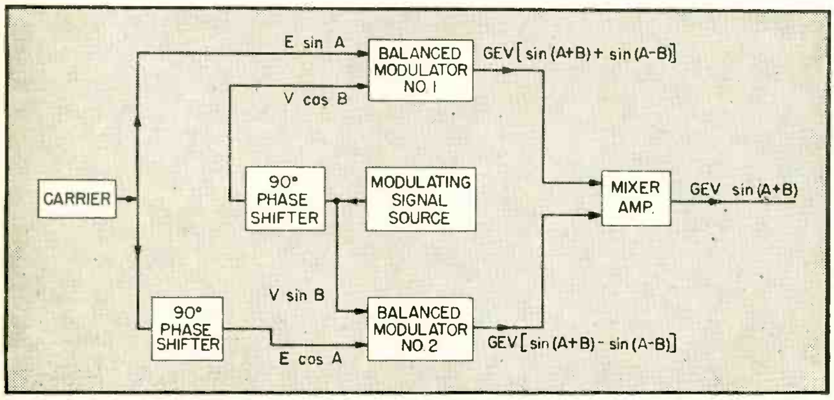


FIG. 1—Block diagram of single-sideband generator using two balanced modulators. The mixer is a linear amplifier

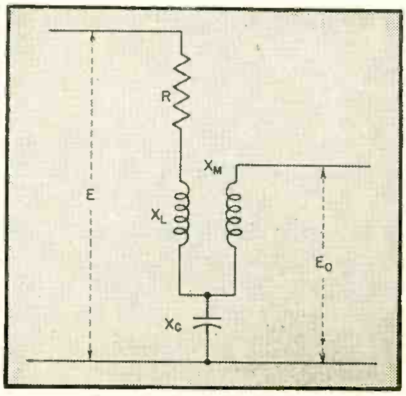


FIG. 2—Schematic circuit diagram of the 90-degree phase shifter

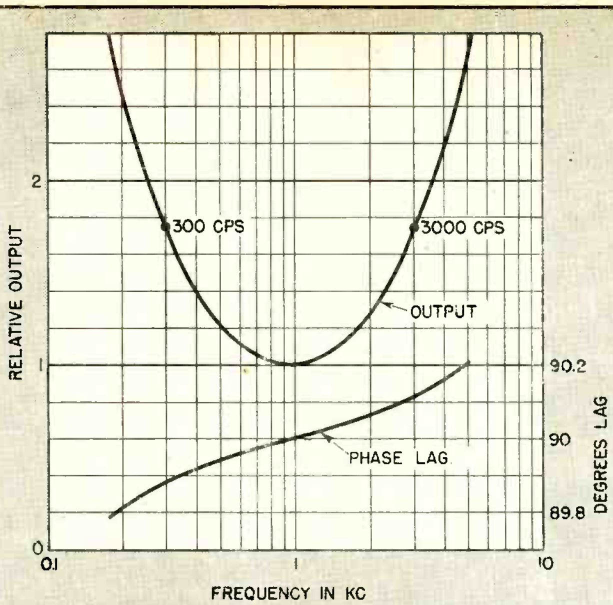


FIG. 3—Calculated amplitude and phase response of phase shifter with $R = 100{,}000$ ohms, $C = 2.34$ microfarads, and $L = M = 0.012$ henry

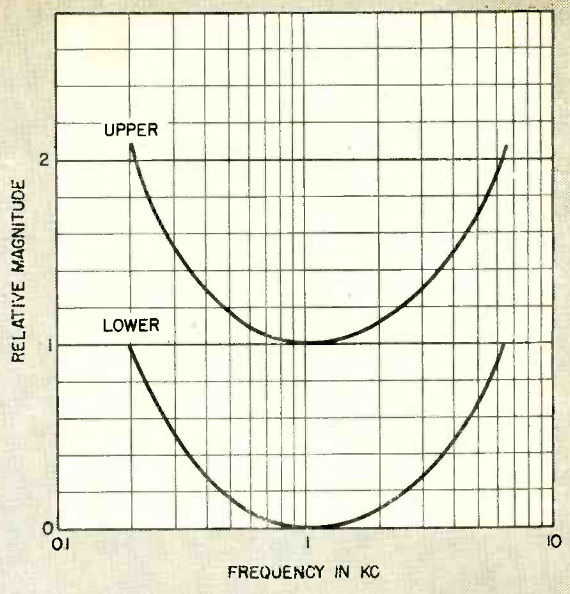


FIG. 4—Measured relative magnitudes of upper and lower sidebands, plotted as a function of the modulating frequency of the system

through the use of a simple phase shifter.[4] If the modulating signals are one or more fixed telemetering frequencies, the required 90-degree phase shifts for these frequencies may be obtained by using a phase shifter of the resistor-capacitor type.

90-Degree Phase Shifter

The problem of shifting a band of telephonic voice frequencies of from 300 to 3,000 cycles is inherently more difficult. It is necessary, in the ideal case, to shift this band of frequencies 90 degrees and at the same time leave the relative magnitudes unchanged. The necessary sine-cosine relationship can be obtained electronically by using an additional pair of modulators and a simple filter.

A passive network which gives a reasonable approach to this problem is shown in Fig. 2, while its amplitude and phase response characteristics are shown in Fig. 3. The amplitude response of this phase shifter is

$$\frac{E_o}{E} = \frac{X_C + X_M}{\sqrt{R^2 + (X_L - X_C)^2}} \tag{5}$$

When R is much greater than $(X_L - X_C)$, this becomes very closely

$$E_o/E = (X_C + X_M)/R \tag{6}$$

The phase response of the network is

$$\phi = -90° - \tan^{-1}(X_L - X_C)/R \tag{7}$$

Referring to Fig. 3, it is seen that the amplitude response varies through a range of 1.75/1 over the frequency band of 300 to 3,000 cps. While this variation is undesirable in an ideal system, it is compensated in part through the use of an output tuned circuit resonated to the mid-frequency of the desired sideband. In addition, this response characteristic partially corrects for the frequency discrimination due to the usual microphones, receivers and speech-band repeat coils.

System Performance

The single-sideband generator outlined in Fig. 1 and using the phase shifter of Fig. 2 was constructed to check the possibilities of the proposed system. A carrier frequency of 8,000 cps was chosen in order that all frequencies through the second harmonic of the carrier would fall within the range of a standard harmonic wave analyzer.

Balanced square-law modulators were used, and since the experimental system contained no filters or tuned circuits, it was necessary to make the carrier amplitude much greater than the signal amplitude so that the residue of the signal would be negligibly small at the output of the modulators.[5] Although the second harmonic of the carrier at the output of each balanced mod-

TABLE I. EQUATIONS OF AMPLITUDE-MODULATED WAVES

$$\sin A\,(1 \pm m \sin B) = \sin A \pm \frac{m}{2}\cos(A - B) \mp \frac{m}{2}\cos(A + B$$

$$\sin A\,(1 \pm m \cos B) = \sin A \pm \frac{m}{2}\sin(A - B) \pm \frac{m}{2}\sin(A + B)$$

$$\cos A\,(1 \pm m \sin B) = \cos A \mp \frac{m}{2}\sin(A - B) \pm \frac{m}{2}\sin(A + B)$$

$$\cos A\,(1 \pm m \cos B) = \cos A \pm \frac{m}{2}\cos(A - B) \pm \frac{m}{2}\cos(A + B)$$

where $A = 2\pi f_c t$
$B = 2\pi f_s t$
f_c = carrier frequency
f_s = modulating signal frequency

ulator is quite large, it is cancelled when the outputs of the two modulators are combined in the mixer amplifier.

Figure 4 shows the measured magnitudes of upper and lower sidebands, plotted as a function of the modulating frequency and normalized about the 1,000-cps value of the upper sideband. These experimental values check very closely with the expected magnitudes on the basis of the calculated response of the phase shifter as shown in Fig. 3.

Referring to Fig. 4, it is to be noted that for an 8,000-cps carrier the 1,000-cps point on the upper-sideband curve represents a sideband frequency of 9,000 cps, whereas the corresponding point on the lower-sideband curve represents a frequency of 7,000 cps. A parallel-resonant circuit or a simple double-tuned coupled circuit tuned to 9,000 cps and placed in the output of the mixer amplifier of Fig. 1 will flatten the upper-sideband curve and will discriminate against the lower-sideband frequencies.

Figure 5 shows the measured upper- to lower-sideband ratios plotted in decibels as a function of the modulating frequency. It is to be noted that this ratio exceeds 10 db from 300 to 3,000 cps. The data for the plotted curves was obtained on the single-sideband generator shown in Fig. 6, containing no filters or tuned circuits and practically no shielding. The results represent, therefore, the most pessimistic of operating conditions. For carrier transmission or for radio transmission, simple tuned circuits would be employed in the amplifiers following the mixer amplifier, with a resultant improvement in discrimination against the undesired sideband.

If it is desired to pass the lower sideband and to balance out the upper sideband, this is accomplished by reversing the polarity of either the carrier or the signal voltage fed to one of the modulators. This result may also be achieved by reversing the polarity of the output voltage of one of the modulators. Measured characteristics for this case are similar to Fig. 4 and 5.

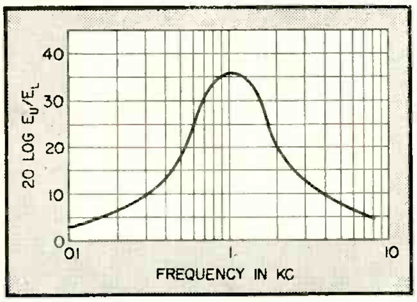


FIG. 5—Measured upper to lower sideband ratios in db

The characteristics of this particular system do not represent the optimum performance that can be obtained from a single-sideband generator of this type. In the opinion of the writer, this generator has the advantage of simplicity over the usual single-sideband systems. The complete success of the system lies in the design of a wide-band 90-degree phase shifter. However, it is to be remembered that a simple 90-degree phase shifter suffices if the modulating signals are fixed telemetering frequencies.

REFERENCES

(1) Cheek, R. C., Power-Line Carrier Modulation Systems, *Westinghouse Engineer*, p. 41–45, Mar. 1945.
(2) Laport, E. A., Characteristics of Amplitude-Modulated Waves, *RCA Review*, p. 26–38, Apr. 1937.
(3) Terman, F. E., "Radio Engineers' Handbook," *McGraw-Hill Book Co., Inc.*, 1943, p. 551–553.
(4) M. I. T. EE Staff, "Applied Electronics," *John Wiley & Sons, Inc.*, 1943, p. 316–319.
(5) Roberts, W. W., Speech Scrambling Methods, ELECTRONICS, p. 108–111 and 270–278, Oct. 1943.

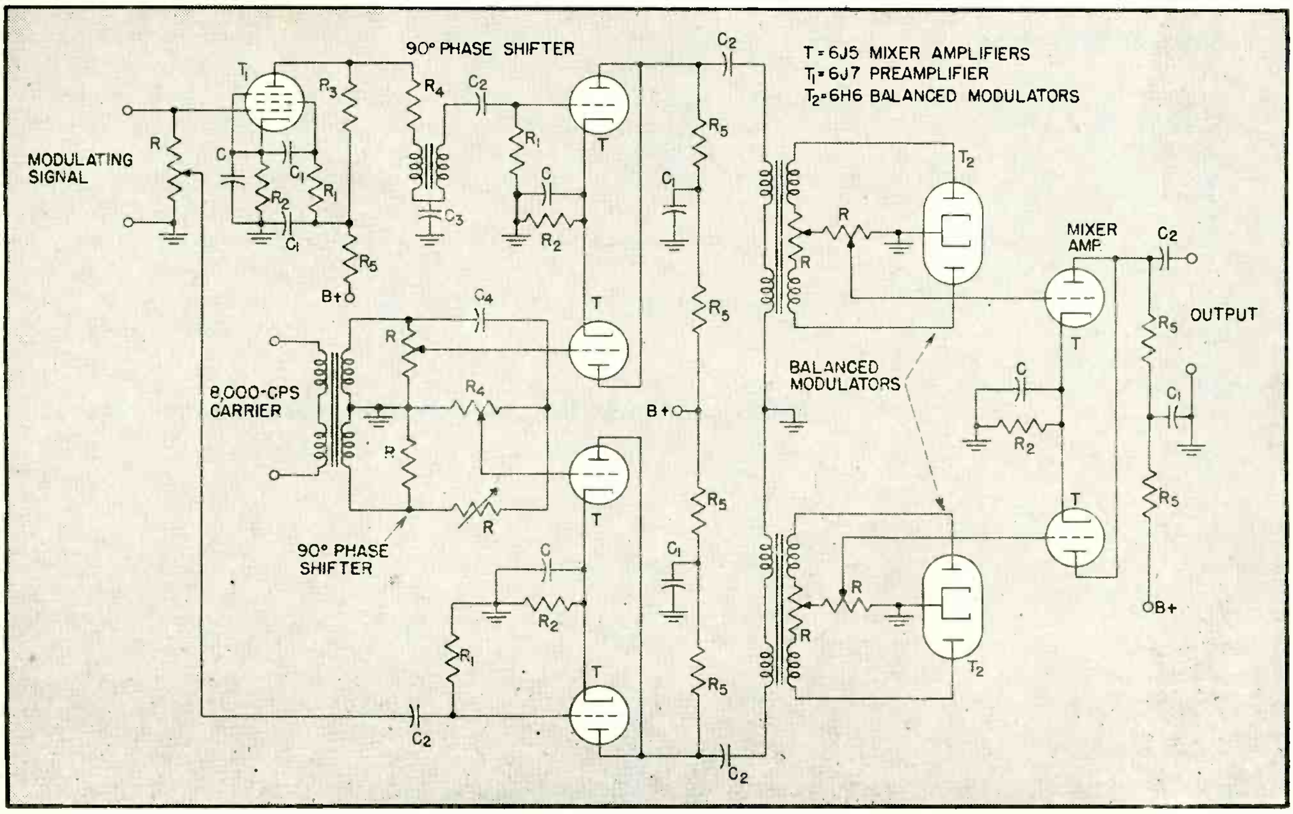
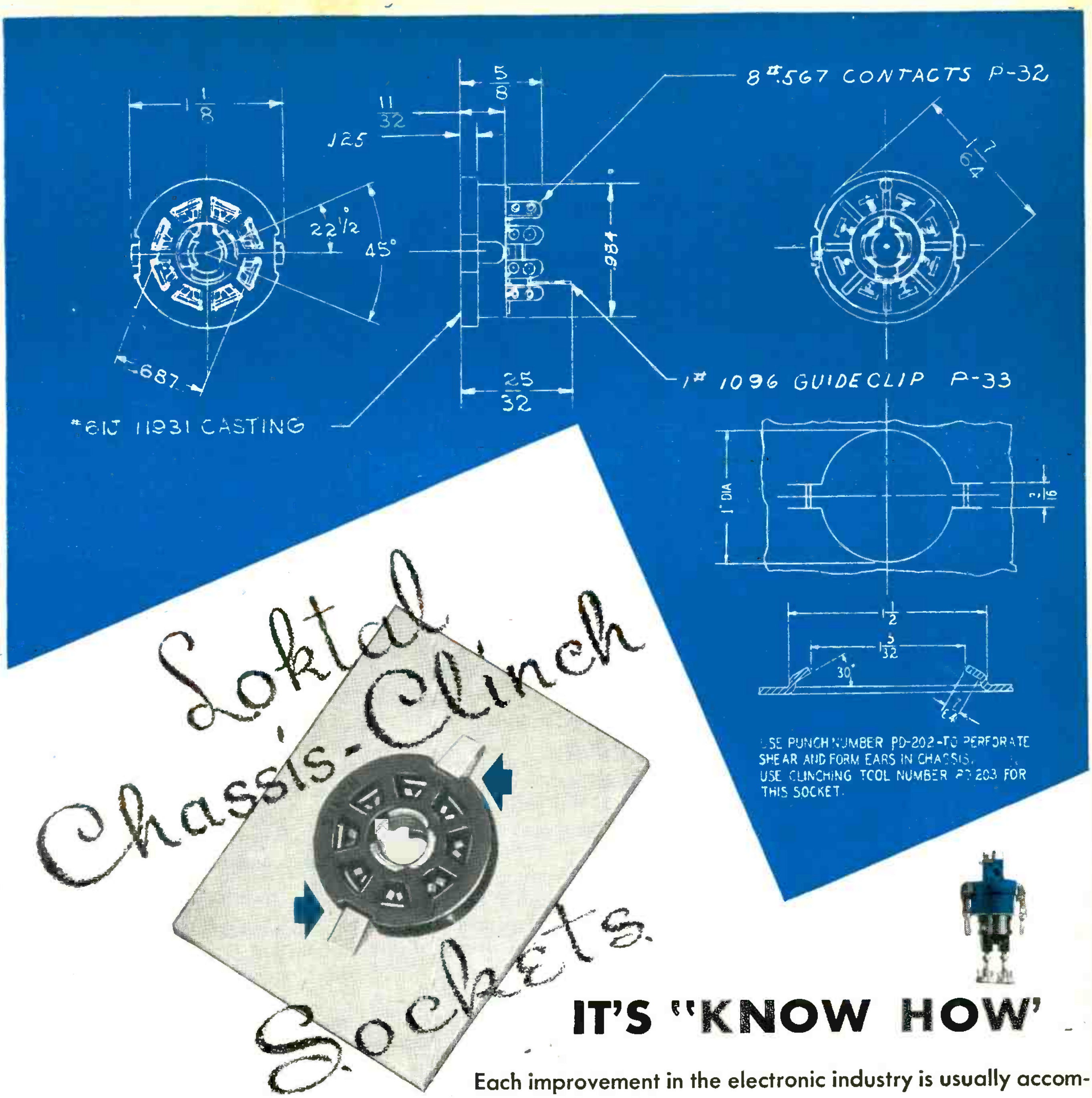


FIG. 6—Circuit of experimental single-sideband generator

Loktal Chassis-Clinch Sockets



IT'S "KNOW HOW"

Each improvement in the electronic industry is usually accompanied by changes in tube design and performance—hence the requirement of new tube sockets. So for nearly a quarter of a century CINCH has pioneered in socket development, our latest being the Loktal Chassis Clinch Socket. It's small, compact and space saving; and its complete dimensional details are here illustrated. Samples, tools and the application services of our field engineers are available on request.

CINCH MANUFACTURING CORPORATION

2335 West Van Buren St., Chicago 12, Illinois

Subsidiary of United-Carr Fastener Corp., Cambridge, Mass.

****The NEW CINCH Catalog, 140 pages describing metal parts and metal plastic assemblies***

Winding UNIVERSAL COILS

Short-cut procedures for winding sample universal coils quickly to exact self-inductance, spacing coils to exact mutual inductance, and taking out a center tap accurately

By A. W. SIMON

Director of Research
Edwin I. Guthman & Co., Inc.
Chicago, Illinois

In winding a universal coil to a given value of inductance, the usual procedure is to wind or unwind turns, more or less by guess, until the desired inductance has been attained. A somewhat similar procedure is followed in adjusting the spacing between two coils to produce a desired mutual inductance or coefficient of coupling, and in taking out a center tap. However, in all these cases it is possible to set up procedures which will lead directly and rapidly to the desired result.

Winding to Exact Inductance

In winding a universal coil quickly and accurately to a desired value of inductance L, a trial coil is first wound with an arbitrary number of turns T_1 and the resulting inductance L_1 is measured. A new coil is then wound with the number of turns T calculated according to the formula

$$T = T_1 \sqrt{L/L_1} \qquad (1)$$

and measured. If this coil is not correct, the number of turns is again corrected by means of Eq. (1). Even though the initial number of turns is far from correct, it is not necessary usually to wind more than a few coils before the desired inductance is obtained exactly.

Another procedure involves changing the number of turns by half the fractional part (or percentage) by which the inductance deviates from the desired value. For example, if the inductance is 10 percent high, the number of turns is decreased by 5 percent.

Spacing to Exact Mutual Inductance

Two parallel coaxial coils, each previously adjusted to the correct self-inductance, are wound with an arbitrary spacing D_1 between centers, and the resulting mutual inductance M_1 is measured. A new pair is then wound with the spacing between centers calculated according to the formula:

$$D = D_1 \sqrt{M_1/M} \qquad (2)$$

where M is the desired mutual inductance. If this pair is not correct, the spacing between centers is again corrected by means of Eq. (2). The alternative procedure involves changing the spacing by half the fractional part (or percentage) by which the mutual inductance deviates from the desired value.

The same process can be used to adjust the spacing between centers of two parallel coaxial coils in order to produce a desired coefficient of coupling k. The formula is:

$$D = D_1 \sqrt{k_1/k} \qquad (3)$$

It is more convenient to work with the coefficient of coupling since the coils need not be adjusted exactly to the correct self-inductance. For constant spacing, k for parallel coaxial universal coils varies only slowly with turns (with self-inductance).

In winding an i-f transformer the process of adjusting the self-inductance (turns) and the coefficient of coupling (spacing) can be carried on simultaneously.

In order to facilitate the spacing adjustment, winding machines should be equipped with a micrometer adjustment between the winding arms, so that the spacing can be changed accurately by the calculated amount.

Universal coils, widely used in modern radio receivers, are wound so that as the dowel or form rotates, the wire is guided back and forth by a shuttle that displaces the wire in linear proportion to the angle of rotation from the point of maximum left or right displacement. Details of how to calculate the various factors entering into the winding of these coils were given by the author in ELECTRONICS, Oct. 1936, p. 22.

Locating a Center Tap

A tap is taken out at an arbitrary number of turns T_1 and the resulting inductance $L_{1\text{-}2}$ from start to tap, and $L_{2\text{-}3}$ from tap to finish, is measured. A new coil is then wound with a tap taken out at a number of turns T given by the formula:

$$T = T_1 \sqrt{(L_{1\text{-}2} + L_{2\text{-}3})/2L_{1\text{-}2}} \qquad (4)$$

If the new coil is not correct, the location of the tap is again corrected by application of Eq. (4).

The formulas given can be applied profitably not only to the winding of sample coils in the laboratory, but also to the continuous control of coils in production. For production a table or chart can be prepared for each coil being run, giving the number of turns to be added or subtracted as a function of the measured inductance, or the distance in thousandths by which the winding arms must be separated as a function of the measured mutual inductance or coupling coefficient.

Spectroscopy and Photomicrography Control the Composition and Structure of MALLORY CONTACTS

SPECTROSCOPIC analysis, accurate to 0.001%, tells exactly the chemical composition of Mallory contact materials. Tungsten, Elkonite*, Elkonium*, silver, platinum and combinations of these metals are checked for correct grain size by Mallory photomicrographs. X-ray examination determines whether contacts and backings are firmly bonded. Life tests check the durability in service of Mallory Contacts and Contact Assemblies.

Such rigorous testing and inspection of both materials and finished products assure peak performance and unvarying quality. You can count on the millionth contact from Mallory to be just as good as the first.

Mallory metallurgists have developed many special contact materials with excellent electrical and mechanical properties. Using these materials, Mallory contact engineers have created more than 5000 designs for individual contacts and contact assemblies. Thus Mallory has become Contact Headquarters—with the most complete research, engineering and production facilities in the industry.

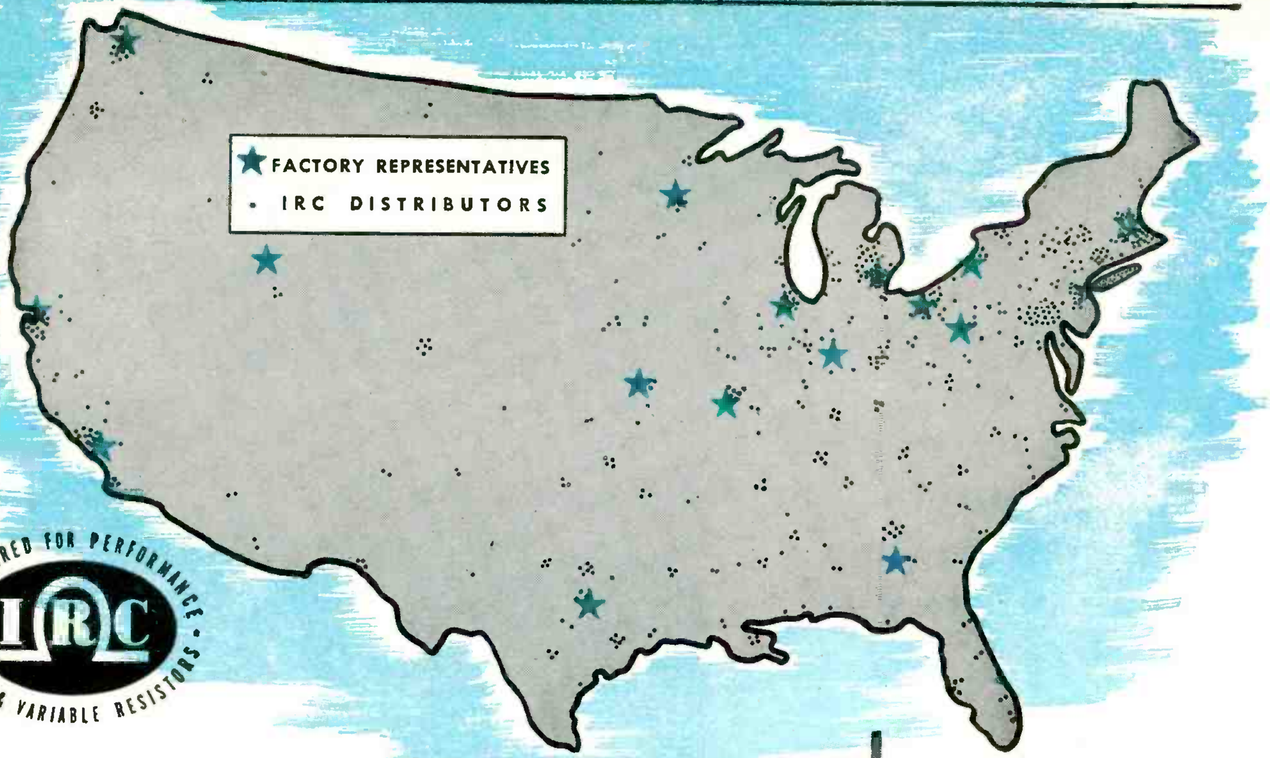
Consult Mallory on your contact problems while your electrical or electronic equipment is being designed—still in blueprints. You can often save engineering time and production costs by obtaining complete contact assemblies from Mallory. Write today for the Mallory Contact Catalog. The New Mallory Contact Data Book will be sent gratis to engineers when requested on company letterhead. Available to students, libraries and schools at $2.50 per copy, postage paid.

ARMY E NAVY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

**Reg. U. S. Pat. Off. for electric contacting elements.*

IRC "SET-UP" for SERVICE



PREFERRED FOR PERFORMANCE • IRC • FIXED & VARIABLE RESISTORS

IRC RESISTORS ARE "ON LOCATION"

Everywhere!

From coast to coast and border to border you'll find IRC "specialists" ready to help you with your resistor problems. These alert and capable organizations are ready to assist you in determining the precise resistors for your specific applications. IRC can render this unbiased technical service because it is the largest exclusive producer of resistance devices, making more types of resistors in more shapes, for more applications than any other manufacturer in the world.

Because of volume production combined with specialized engineering skill, orders in any quantity can be filled promptly. Your inquiries will be given immediate and efficient attention. Names and addresses of your nearest IRC Distributors will be furnished on request.

INTERNATIONAL RESISTANCE CO.

DEPT. 1-K

401 NORTH BROAD STREET • PHILADELPHIA 8, PA.

IRC REPRESENTATIVES

ATLANTA
Hollingsworth & Still, 407 Norris Bldg.

BOSTON
Ray Perron 131 Clarendon St.

BUFFALO
Harry B. Segar Ellicott Square Bldg.

CHICAGO
S. B. Darmstader
308 W. Washington St.

CLEVELAND
Fred Bell 1400 W. 25th St.

DALLAS
George E. Anderson Santa Fe Bldg.

DETROIT
Koehler-Pasmore
8316 Woodward Ave.

INDIANAPOLIS
Vernon C. Macnabb, 915 Riverla Dr.

KANSAS CITY, MO.
C. W. Reid 1825 McGee Avenue

LOGAN, UTAH
Ronald G. Bowen 83 E. First St.

LOS ANGELES
Dave N. Marshank
672 S. Lafayette Park Place

NEW YORK
International Resistance Co.
A. H. Hardwick 165 Broadway

PITTSBURGH
George O. Tanner 508 Grant St.

SAN FRANCISCO
James P. Hermans 1278 Mission St.

SEATTLE
Dave M. Lee 2626 Second Ave.

ST. LOUIS
Norman W. Kathrinus 1218 Olive St.

ST. PAUL
J. U. McCarthy 1725 Hillcrest Ave.

The electronics BUYERS' GUIDE

First Postwar Directory of ELECTRONIC *and* ALLIED PRODUCTS

In the preparation of this year's Directory every possible effort has been made to include the names and product listings of all manufacturers (new or old) of electronic components or complete equipment, as well as those whose products have any application in the electronic field.

This listing includes all postwar products, as far as the companies themselves could accurately determine. The directory therefore should prove extremely useful as a valuable source of information to design engineers and buyers for all products that will be available in the coming year.

More than 3,000 companies and their complete product lines in electronic fields are listed, arranged and indexed in a simple, easy-to-read manner. Wherever possible, manufacturers' lines have been broken down to show various types produced.

PUBLISHED 1945 *by* ELECTRONICS

A McGraw-Hill Publication

330 W. 42nd St., New York 18

Adapters

TEST ADAPTERS

Adrem Co., 143 Newberry St., Boston 16, Mass.
Alden Products Co., 117 North Main St., Brockton 64, Mass.
American Radio Hardware Co., Inc., 152 MacQuesten Pkway South, Mt. Vernon, N. Y.
Dayton Acme Co., 930 York St., Cincinnati, Ohio
General Electric Co., Schenectady 5, New York
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
J. F. D. Mfg. Co., 4111 Ft. Hamilton Pkwy., Brooklyn, N. Y.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Lewyt Corp., 60 Broadway, Brooklyn, N. Y.
McDanel Refractory Porcelain Co., 510 Ninth Ave., Beaver Falls, Pa.
Radio City Products Co., 127 W. 26th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Readrite Meter Works, College Ave., Bluffton, Ohio
Stedman, Robert L., Oyster Bay, N. Y.
Stokes Rubber Co., Jos., Taylor & Webster Sts., Trenton, N. J.
Triplett Electrical Instrument Corp., 286 Harmon Rd., Bluffton, Ohio
Wood Electric Co., Inc., C. D. 826 Broadway, New York 3, N. Y.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio

Aircraft Relays

see Relays, Sensitive Control

Aluminum

see Metals

Ammeters

see Meters

Amplifiers

AUDIO FREQUENCY AMPLIFIERS

Air Associates, Inc., 5827 W. Century Blvd., Los Angeles 45, Calif.
Airdesign & Fabrication Inc., 241 Fairfield Ave., Upper Darby, Pa.
Aireon Manufacturing Corp., Fairfax & Funston Rds., Kansas City 15, Kans.
Altec Lansing Corp., 1680 North Vine St., Los Angeles 28, Calif.
American Communications Corp., 306 Broadway, New York, N. Y.
American Radio Co., 611 W. Garfield Ave., Glendale, Calif.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Arrow Radio Co., 900 W. Jackson Blvd., Chicago, Ill.
Audio Tone Oscillator Co., 237 John St., Bridgeport 3, Conn.
Aviometer Corp., 370 W. 35th St., New York 1, N. Y.
Baldwin Locomotive Works, Eddystone, Pa.
Ballantine Laboratories, Inc., Boonton, N. J.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Bogen Co., David, 663 Broadway, New York 12, N. Y.
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Carrillitone Mfg. Co., 30 N. Penn St., York, Pa.
Chicago Sound Systems Co., 2124 S. Michigan Ave., Chicago, Ill.
Chicago Transformer Div., Essex Wire Corp., 3501 West Addison St., Chicago 18, Ill.
Cincinnati Time Recorder Co., 1733 Central Ave., Cincinnati, Ohio
Collins Radio Co., 855 35th St., N.E., Cedar Rapids, Iowa
Commercial Research Labs. Inc., 20 Bartlett Ave., Detroit, Mich.
Communication Equipment & Engrg. Co., 504 N. Parkside Ave., Chicago, Ill.
Communications Equipment Corp., 134 W. Colorado St., Pasadena 1, Calif.
Consolidated Engineering Corp., 595 E. Colorado St., Pasadena 1, Calif.
DeMornay-Budd, Inc., 475 Grand Concourse, New York, N. Y.
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Eastern Amplifier Corp., 794 E. 140 St., Bronx 54, New York
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Eckstein Radio & Television Co., 914 La Salle Ave., Minneapolis 2, Minn.
Electro Engineering & Mfg. Co., 627 W. Alexandrine Ave., Detroit, Mich.
Electronic Corp. of America, 45 West 18th Street, New York 11, N. Y.
Electronic Supply Co., 207 Main St., Worcester, Mass.
Electronic Transformer Co., 207 West 25th St., New York, N. Y.
Erwood Co., 223 W. Erie St., Chicago, Ill.
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
Fairchild Camera & Instrument Corp., 475 Tenth Ave., New York 18, N. Y.
Farrand Optical Co., Inc., Bronx Blvd., 238th St., New York 66, N. Y.
Federal Instrument Co., 3931 47th St., Long Island City 4, N. Y.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.
Foote Pierson & Co., Inc., 75 Hudson St., Newark 4, N. J.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
General Electric Co., Schenectady 5, New York
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Gibbs & Co., Thomas B., Div. of Borg Corp., George W., 814 Michigan St., Delavan, Wisc.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Neb.
Gray Mfg. Co., 16-30 Arbor St., Hartford, Conn.
Guided Radio Corp., 161 Sixth Ave., New York 13, N. Y.
Harvey Radio Labs., Inc., 447 Concord Ave., Cambridge, Mass.
Harvey-Wells Electronics, Inc., North St., Southbridge, Mass.
Hatry & Young, 203 Ann St., Hartford, Conn.
Hearing Aid Labs., 1404 Franklin St., Michigan City, Ind.
Henney Motor Co., Gentlemen Prod. Div., Freeport, Ill.
Herbach & Rademan Co., Mfg. Div., 517 Ludlow St., Philadelphia 6, Pa.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
Howard Radio Co., 1735 Belmont Ave., Chicago 13, Ill.
Hudson American Corp., 25 West 43rd St., New York, N. Y.
Industrial Sound Products Co., 3597 Mission St., San Francisco, Calif.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Knickerbocker Development Co., 116 Little St., Belleville 9, N. J.
Langevin Co., Inc., 37 W. 65th St., New York, N. Y.
Lincrophone Co., 1661 Howard Ave., Utica, N. Y.
Madison Electrical Products Corp., Madison, New Jersey
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Meck Industries, John, Liberty St., Plymouth, Ind.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Meissner Mfg. Div., Maguire Industries, Inc., Mt. Carmel, Ill.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Miller Corp., Wm., 362 W. Colorado St., Pasadena, Calif.
Minerva Corp. of America, 238 William St., New York 7, N. Y.
National Co., 61 Sherman St., Malden 48, Mass.
National Electronic Mfg. Corp., 22-78 Steinway Street, Long Island City 5, N. Y.
National Scientific Products Co., 5013 N. Kedzie Ave., Chicago 25, Ill.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles 18, Calif.
Northern Communications Mfg. Co., 210 East 40th St., New York, N. Y.
Operadio Mfg. Co., St. Charles, Ill.
Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.
Paraphone Hearing Aid, Inc., 2056 E. 4th St., Cleveland 15, Ohio
Powers Electronic & Communication Co., New Street, Glen Cove, L. I., N. Y.
Press Wireless Inc., Hicksville, L. I., N. Y.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Radell Corp., 6323 Guilford Ave., Indianapolis, Ind.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Craftsmen, 1341 South Michigan Ave., Chicago 5, Ill.
Radio Laboratories, Inc., 2701 California Ave., Seattle 6, Wash.
Radio Mfg. Engineers, Inc., 304 First Ave., Peoria, Ill.
Radolek Co., 601 W. Randolph St., Chicago 6, Ill.
Rauland Corp., 4245 N. Knox Ave., Chicago 41, Ill.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Record-O-Vox, Inc., 721 N. Martel Ave., Hollywood 46, Calif.
Red Arrow Electric Corp., 100 Coit St., Irvington, N. J.
Rehtron Corp., 4313 Lincoln Ave., Chicago 18, Ill.
Rek-O-Kut Co., 173 Lafayette St., New York 13, N. Y.
Remler Company, Ltd., 2101 Bryant St., San Francisco 10, Calif.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles 34, Calif.
Rosen & Co., Raymond, 32nd & Walnut Sts., Philadelphia 4, Pa.
Rowe Radio Research Laboratory, 2422 N. Pulaski Rd., Chicago 39, Ill.
SOS Cinema Supply Co., 449 W. 42nd St., New York 18, N. Y.
Sanborn Co., 39 Osborne St., Cambridge 39, Mass.
Schulmerich Electronics Co., Sellersville, Pa.
Schuttig & Co., 9th & Kearney Sts., N. E., Washington 17, D. C.
Setchell Carlson, Inc., 2233 University Ave., St. Paul 4, Minn.
Sherron Electronics Co., 1201 Flushing Ave., Brooklyn 6, N. Y.
Simpson Mfg. Co., Inc., Mark, 188 W. Fourth St., New York, N. Y.
Sonora Radio & Television Corp., 2626 W. Washington St., Chicago 23, Ill.
Sorensen & Co., 375 Fairfield Ave., Stamford, Conn.
Sound Equipment Corp. of California, 3903 San Fernando Road, Glendale 4, Calif.
Springfield Sound Co., Electronics Division, 12 Cass St., Springfield, Mass.
Stark Sound Engrg. Corp., P. O. 493, Fort Wayne 1, Ind.
Talking Devices Co., 4447 W. Irving Park Rd., Chicago, Ill.
Taybern Equipment Co., 120 Greenwich St., New York 6, N. Y.
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.
Technical Devices Corp., Beaufort & Eagle Rock Aves., Roseland, N. J.
Technical Radio Co., 275 Ninth St., San Francisco, Calif.
Televiso Products, Inc., 6533 N. Olmsted Ave., Chicago, Ill.
Templetone Radio Mfg. Corp., New London, Conn.
Thordarson Electric Mfg. Div., Maguire Industries, Inc., 500 W. Huron St., Chicago 10, Ill.
Transmitter Equipment Mfg. Co., Inc., 345 Hudson St., New York, N. Y.
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.
United States Television Mfg. Corp., 106 Seventh Ave., New York, N. Y.
Valco Mfg. Co., 4700 W. Walton St., Chicago 51, Ill.
Walsh Engineering Co., 34 DeHart Place, Elizabeth, N. J.

ELECTRONIC and ALLIED PRODUCTS

Warwick Mfg. Corp., 4640 W. Harrison St., Chicago, Ill.
Waters Conley Co., 501 First St., N.W., Rochester, Minn.
Waugh Labs., Div. of Waugh Equipment Co., 420 Lexington Ave., New York 17, N. Y.
Webster Electric Co., 1900 Clark St., Racine, Wis.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Western Sound & Electric Labs, 3512 West St. Paul Ave., Milwaukee, Wis.
Westinghouse Electric Corp., East Pittsburgh, Pa.
White Research, 899 Boylston St., Boston, Mass.
Wilcox Electric Co., 1400 Chestnut Street, Kansas City, Mo.
Worner Electronic Devices, 609 West Lake St., Chicago 6, Ill.
Wurlitzer Mfg. Co., Rudolph, North Tonawanda, N. Y.

Analyzers

CIRCUIT ANALYZERS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Clough-Brengle Co., 5501 N. Broadway, Chicago 22, Ill.
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electric Heat Control Co., 9123 Inman Ave., Cleveland 5, Ohio
Electrical Facilities, Inc., 4224 Holden St., Oakland 8, Calif.
Espey Mfg. Co. Inc., 35 West 46th St., New York 19, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Electronics Mfg. Co., 2225 So. Hoover St., Los Angeles 7, Calif.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Cal.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
H-W Mfg. Co., 3124 Larga Ave., Los Angeles, Cal.
Jackson Electrical Instrument Co., 18 S. Patterson Blvd., Dayton 1, Ohio
J-B-T Instruments, Inc., 441 Chapel St., New Haven 8, Conn.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Madison Electrical Products Corp., Madison, N. J.
Philco Corp., Tioga & C Sts., Philadelphia, 34, Pa.
Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y.
Radio City Products Co., 127 W. 26th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Readrite Meter Works, College Ave., Bluffton, Ohio
Roller-Smith, Bethlehem, Pa.
Scientific Service Laboratories, 2225 So. Hoover St., Los Angeles 7, Calif.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Sound Equipment Corp. of California, 3903 San Fernando Road, Glendale 4, Calif.
Supreme Instruments Corp., Greenwood, Miss.
Televiso Products, Inc., 6533 N. Olmsted Ave., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 913 W. Van Buren St., Chicago 7, Ill.
Westinghouse Electric Corp., East Pittsburg, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

COLOR ANALYZERS

Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y.
Coleman Electric Co., 318 Madison St., Maywood, Ill.
Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
General Electric Co., Schenectady 5, N. Y.
Photovolt Corp., 95 Madison Ave., New York 16, N. Y.
Pho-Tron Instrument Co., 5713 Euclid Ave., Cleveland, Ohio
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Saxl Instrument Co., 38-40 James St., East Providence 14, R. I.
Technical Products Co., 158 Madison Ave. at Third St., Memphis, Tenn.
White Research, 899 Boylston St., Boston, Mass.

HARMONIC ANALYZERS

Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Freed Transformer Co., 72 Spring St., New York 12, N. Y.
Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Cal.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Mico Instrument Co., 80 Trowbridge St., Cambridge 38, Mass.
Philharmonic Radio Corp., 528 East 72nd St., New York 21, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
White Research, 899 Boylston St., Boston, Mass.

NOISE ANALYZERS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Ferris Instrument Co., 110-112 Cornelia St., Boonton, N. J.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Measurements Corp., Boonton, N. J.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Sprague Electric Co., 189 Beaver St., North Adams, Mass.
Televiso Products, Inc., 6533 N. Olmsted Ave., Chicago, Ill.
Waugh Labs., Div. of Waugh Equipment Co., 420 Lexington Ave., New York 17, N. Y.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.

SURFACE ANALYZERS & COMPARATORS

Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Continental Machines, Inc., 1301 Washington Ave. S., Minneapolis 4, Minn.
General Electric Co., Schenectady 5, N. Y.
Physicists Research Co., 343 S. Main St., Ann Arbor, Mich.
Saxl Instrument Co., 38-40 James St., East Providence 14, R. I.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.

TRANSMISSION ANALYZERS

Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Calif.
Daven Co., 191 Central Ave., Newark 4, N. J.

Anodes

CARBON ANODES

Becker Bros. Carbon Co., 3450 S. 52nd Ave., Cicero, Ill.
Dixon Crucible Co., Joseph, Monmouth St., Jersey City, N. J.
General Electric Co., Schenectady 5, N. Y.
Helwig Co., 2544 North 30th St., Milwaukee 10, Wisc.
National Carbon Co., Inc., 30 East 42nd St., New York 17, N. Y.
Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio
Speer Carbon Co., St. Marys, Pa.
Stackpole Carbon Co., St. Marys, Pa.

METAL ANODES

American Brass Co., Waterbury 88, Conn.
Art Wire & Stamping Co., 227 High St., Newark 2, N. J.
Belmont Smelting & Refining Works, Inc., 330 Belmont Ave., Brooklyn 7, N. Y.
Bishop & Co. Platinum Works, J., 12 Channing Ave., Malvern, Pa.
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Division Lead Co., 836 W. Kinzie St., Chicago 22, Ill.
DuPont de Nemours & Co., Inc., E. I., Wilmington 98, Del.
Fansteel Metallurgical Corp., 2200 Sheridan Rd., North Chicago, Ill.
General Electric Co., Schenectady 5, N. Y.
Goldsmith Bros. Smelting & Refining Co., 58 E. Washington St., Chicago, Ill.
Handy & Harman, 82 Fulton St., New York, N. Y.
Haydu Bros., Mt. Bethel Rd., Plainfield, N. J.
National Lead Co., 111 Broadway, New York 6, N. Y.
Radio Corp. of America, Tube Div., RCA, Harrison, N. J.
Revere Copper & Brass Inc., 230 Park Ave., New York 17, N. Y.
Rice's Sons, Inc., Bernard, 325 Fifth Ave., New York, N. Y.
Scovill Mfg. Co., 99 Mill St., Waterbury 91, Conn.
Superior Tube Co., Norristown, Pa.
Swedish Iron & Steel Corp., 17 Battery Place, New York, N. Y.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Antenna Mounts

Shur-Antenna-Mount, Inc., Seacliffe, Long Island, N. Y.

Antennas

RECEIVING ANTENNAS

Aireon Manufacturing Corp., Fairfax & Funston Rds., Kansas City 15, Kans.
Airplane & Marine Instruments Inc., Clearfield, Pa.
American Radio Hardware Co., Inc., 152 MacQuesten Pkway S., Mt. Vernon, N. Y.
Amy, Aceves & King, Inc., 11 W. 42nd St., New York 18, N. Y.
Andrea Radio Corp., 43-20 34th St., Long Island City, N. Y.
Andrew Co., 363 East 75th St., Chicago 19, Ill.
Bassett, Inc., Rex, 500 S.E. Second St., Ft. Lauderdale, Fla.
Birnbach Radio Co., Inc., 145 Hudson St., New York, N. Y.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Burton-Rogers Co., 857 Boylston St., Boston 16, Mass.
Cardy-Lundmark Co., 1801 West Byron St., Chicago 13, Ill.
Columbia Wire & Supply Co., 4106 N. Pulaski Road, Chicago 41, Ill.
Communications Co., Inc., 300 Greco Ave., Coral Gables 34, Fla.
Communications Equipment Corp., 134 West Colorado St., Pasadena 1, Calif.
Concord Radio Corp., 901 W. Jackson Blvd., Chicago, Ill.
Cornish Wire Co., 15 Park Row, New York, N. Y.
DeMornay-Budd, Inc., 475 Grand Concourse, New York, N. Y.
Du Mont Labs., Inc., Allen B., 2 Main Ave., Passaic, N. J.
Farnsworth Television & Radio Corp., 3702 Pontiac St., Fort Wayne, Ind.
Fisher Research Laboratory, 1961 University Ave., Palo Alto, Calif.
Fishwick Radio Co., 430 Colorado Bldg., Washington, D. C.
Fleron & Son, Inc., M. M., 113 N. Broad St., Trenton, N. J.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago 51, Ill.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
General Electric Co., Schenectady 5, N. Y.
Harco Steel Construction Co., 1180 E. Broad St., Elizabeth 4, N. J.

Harvey-Wells Electronics, Inc., North St., Southbridge, Mass.
Heath Co., Benton Harbor, Mich.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Jefferson-Travis Radio Mfg. Corp., 245 East 23rd St., New York 10, N. Y.
Johnson Co., E. F., Waseca, Minn.
Kings Electronics Co., 372 Classon Ave., Brooklyn 5, N. Y.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Lavoie Laboratories, Morganville, N. J.
Lear, Inc., Piqua, Ohio.
Lenoxite Div., Lenox Inc., 65 Prince St., Trenton, N. J.
Link, Fred M., 125 W. 17th St., New York, N. Y.
Magnavox Co., The, 2131 Bueter Road, Fort Wayne 4, Ind.
Mec-Rad Div., Black Industries, 1440 E. 222nd St., Cleveland 17, Ohio (H. F. Components)
National Electronic Mfg. Corp., 22-78 Steinway St., Long Island City 5, N. Y.
National Mineral Co., 2628 N. Pulaski Rd., Chicago 39, Ill.
Philco Corp., Tioga & C Sts., Philadelphia 34, Pa.
Philson Mfg. Co., Inc., 156 Chambers St., New York, N. Y.
Plymold Corp., Lawrence, Mass.
Premax Products Div., Chisholm-Ryder Co., College & Highland Aves., Niagara Falls 2, N. Y.
Radex Corp. of America, 1322 Elston Ave., Chicago, Ill.
Radiart Corp., 3571 W. 62nd St., Cleveland 2, Ohio
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
S-W Inductor Co., 1056 N. Wood St., Chicago, Ill.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Schuttig & Co., 9th & Kearney Sts., N. E., Washington 17, D. C.
Skydyne Inc., River Road, Port Jervis, N. Y.
Small Motors, Inc., 1322 Elston Ave., Chicago 22, Ill.
Snyder Mfg. Co., 22nd & Ontario Sts., Philadelphia 40, Pa.
Stromberg-Carlson Co., 100 Carlson Rd., Rochester, N. Y.
Superior Tube Co., Norristown, Pa.
Technical Appliance Corp., 516 W. 34th St., New York 1, N. Y.
Telephonics Corp., 350 West 31st St., New York 1, N. Y.
Telicon Corp., 851 Madison Ave., New York, N. Y.
Trebor Radio Co., Pasadena, Calif.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
United States Television Mfg. Corp., 106 Seventh Ave., New York, N. Y.
Vendo Co., 1907 Grand Ave., Kansas City, 8, Mo.
Ward Products Corp., 1523 E. 45th St., Cleveland 3, Ohio
Whisk Laboratories, 87 Maiden Lane, New York 7, N. Y.
Winters & Crampton Corp., 150 Wilson Ave., Grandville, Mich.
Workshop Associates, 66 Needham St., Newton Highlands, Gardner, Mass.

TRANSMITTING ANTENNAS

Aero Communications, Inc., 231 Main St., Hempstead, Long Island, N. Y.
Aireon Manufacturing Corp., Fairfax & Funston Rds., Kansas City 15, Kans.
Airplane & Marine Instruments, Inc., Clearfield, Pa.
American Bridge Co., Frick Bldg., Pittsburgh, Pa.
Andrew Co., 363 E. 75th St., Chicago 19, Ill.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bassett, Inc., Rex, 500 S. E. Second St., Ft. Lauderdale, Fla.
Birnbach Radio Co. Inc., 145 Hudson St., New York, N. Y.
Blaw-Knox Co., Farmers Bank Bldg., Pittsburgh, Pa.
Brach Mfg. Corp., 55 Dickerson St., Newark, N. J.
Collins Radio Co., 855-35th St., N.E., Cedar Rapids, Iowa
Communication Products Co., Inc., 346 Bergen Ave., Jersey City 5, N. J.
Communications Co. Inc., 300 Greco Ave., Coral Gables 34, Fla.
Communications Equipment Corp., 134 West Colorado St., Pasadena 1, Calif.
DeMornay-Budd, Inc., 475 Grand Concourse, New York, N. Y.
Erco Radio Laboratories, Inc., Fenimore Avenue, Hempstead, N. Y.
Farnsworth Television & Radio Corp., 3702 Pontiac St., Fort Wayne, Ind.
Fisher Research Laboratory, 1961 University Ave., Palo Alto, Calif.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
General Electric Co., Schenectady 5, N. Y.
Grady Instrument Co., 11 Bailey Ave., Watertown 72, Mass.
Harco Steel Construction Co., Inc., 1180 E. Broad St., Elizabeth 4, N. J.
Hoke Vertical Radiator Co., 135 S. Market St., Petersburg, Va.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Isolantite, Inc., 343 Cortlandt St., Belleville 9, N. J.
Jefferson, Inc., Ray, 40 E. Merrick Rd., Freeport, L. I., N. Y.
Jefferson-Travis Radio Mfg. Corp., 245 East 23rd St., New York 10, N. Y.
Johnson Co., E. F., Waseca, Minn.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.
Kings Electronics Co., 372 Classon Ave., Brooklyn 5, N. Y.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Lavoie Laboratories, Morganville, N. J.
Lear, Inc., Piqua, Ohio
Lehigh Structural Steel Co., 17 Battery Pl., New York 4, N. Y.
Lenoxite Div., Lenox Inc., 65 Prince St., Trenton, N. J.
Lingo & Son, John E., 28th St. & Buren Ave., Camden, N. J.
Link, Fred M., 125 W. 17th St., New York, N. Y.
Mec-Rad Div., Black Industries, 1440 E. 222nd St., Cleveland 17, Ohio (H. F. Components)
National Electronic Mfg. Corp., 22-78 Steinway St., Long Island City, N. Y.
National Mineral Co., 2628 N. Pulaski Rd., Chicago 39, Ill.
Plymold Corp., Lawrence, Mass.
Premax Products Div., Chisholm Ryder Co., College & Highland Ave., Niagara Falls 2, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Engineering Labs., Inc., 35-54 36th St., Long Island City, N. Y.
Radio Receptor Co., 251 W. 19th St., New York 11, N. Y.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Richardson-Allen Corp., 15 W. 20th St., New York 11, N. Y.
Schuttig & Co., 9th & Kearney Sts., N. E., Washington 17, D. C.
Skydyne Inc., River Road, Port Jervis, N. Y.
Snyder Mfg. Co., 22nd & Ontario Sts., Philadelphia 40, Pa.
Superior Tube Co., Norristown, Pa.
Technical Radio Co., 275 Ninth St., San Francisco, Calif.
Truscon Steel Co., Youngstown, Ohio
United States Television Mfg. Corp., 106 Seventh Ave., New York, N. Y.
Vendo Co., 1907 Grand Ave., Kansas City 8, Mo.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wincharger Corp., 7th & Division Sts., Sioux City, Iowa
Winters & Crampton Corp., 150 Wilson Ave., Grandville, Michigan
Workshop Associates, 66 Needham St., Newton Highlands, Gardner, Mass.

Attenuators

see Controls

Ballasts

see Tubes

Batteries

DRY BATTERIES

Acme Battery Corp., 59 Pearl St., Brooklyn, N. Y.
Bond Electric Corp., Div. of Olin Industries, Inc., New Haven 4, Conn.
Bright Star Battery Co., 200 Crooks Ave., Clifton, N. J.
Burgess Battery Co., Foot of Exchange St., Freeport, Ill.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
General Dry Batteries, Inc., 13000 Athens Ave., Cleveland, Ohio
Marathon Battery Co., Wausau, Wisc.
National Carbon Co., Inc., 30 East 42nd St., New York 17, N. Y.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
Olin Industries, East Alton, Ill.
Philco Corp., (Battery Division), Philadelphia 34, Pa.
Radio Corp. of America, Tube Div., RCA, Harrison, N. J.
Ray-O-Vac Co., Madison, Wis.
Southern Battery Co., Appomattox, Va.
Transelectric Mfg. Co., Oxford, Pa.
United States Electric Mfg. Corp., 222 W. 14th St., New York, N. Y.
Western Cable Battery Co., Inc., 395 Sibley St., St. Paul, Minn.

STORAGE BATTERIES

American Battery Co., 17 E. Jefferson St., Chicago, Ill.
Am-plus Storage Battery Co., 425 W. Superior St., Chicago, Ill.
Auto-Lite Battery Corp., P. O. Box 931, Toledo, Ohio
Automatic Electrical Devices Co., 324 E. Third St., Cincinnati 2, Ohio
Bowers Battery & Spark Plug Co., Reading, Pa.
Centralab Div. of Globe Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc.
Edison Storage Battery Div., Thomas A. Edison, Inc., Main St. at Lakeside Ave., West Orange, N. J.
Electric Auto-Lite Co., Toledo 1, Ohio
Electric Storage Battery Co., Allegheny Ave. & 19th St., Philadelphia 32, Pa.
General Lead Batteries Co., 196 West Railway Ave., Paterson, N. J.
General Storage Battery Co., 2005 Locust St., St. Louis, Mo.
Gould Storage Battery Corp., 35 Neoga St., Depew, N. Y.
Ideal Commutator Dresser Co., 1291 Park Ave., Sycamore, Ill.
K. W. Battery Co., 3705 N. Lincoln Ave., Chicago 13, Ill.
Koehler Mfg. Co., Marlboro, Mass.
Monark Battery Co., Inc., 1240 N. Homan Ave., Chicago, Ill.
National Battery Co., First National Bank Bldg., St. Paul, Minn.
Perrine Quality Products Corp., 55 Rumford Ave., Waltham 54, Mass.
Philco Corp., (Storage Battery Division), Philadelphia 34, Pa.
Prest-O-Lite Battery Co., Inc., 4500 W. 16th St., Box 1655, Indianapolis, Ind.
Solar Corp., 944 W. Bruce St., Milwaukee 4, Wis.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Universal Battery Co., 3410 S. La Salle St., Chicago, Ill.
Western Cable Battery Co., Inc., 395 Sibley St., St. Paul, Minn.
Willard Storage Battery Co., 246 E. 131st St., Cleveland 1, Ohio

Bearings, Miniature

Ace Mfg. Corp., 1255 E. Erie Ave., Philadelphia, Pa.
Bird & Co., Waltham, Mass.
Bound Brook Oil-less Bearing Co., Bound Brook, N. J.
General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
Graphite Metallizing Corp., 1055 Nepperham Ave., Yonkers 3, N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Miniature Precision Bearings, Keene, N. H.
Moraine Products Div., General Motors Corp., Dayton, Ohio
United States Graphite Co., 1621 Holland Ave., Saginaw, Mich.

ELECTRONIC and ALLIED PRODUCTS

Bellows

Chicago Metal Hose Corp., 1309 S. Third Ave., Maywood, Ill.
Clifford Mfg. Co., 564 E. First, Boston, Mass.
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Fulton Sylphon Co., Knoxville, Tenn.
Giannini & Co., Inc., G. M., 161 E. California St., Pasadena, Calif.

Blanks, Recording

see Discs

Blowers, Small

Chelsea Products, Inc., 1206 Grove St., Irvington, N. J.
Delco Appliance Division, General Motors Corp., Rochester, N. Y.
Dynamic Air Engineering, Inc., 1619 So. Alameda St., Los Angeles 11, Calif.
Eastern Air Devices, Inc., 585 Dean St., Brooklyn 17, N. Y.
Eastern Engineering Co., 45 Fox St., New Haven 13, Conn.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Haydu Bros., Mt. Bethel Rd., Plainfield, N. J.
Heinze Electric Corp., Lowell, Mass.
Ideal Commutator Dresser Co., 1291 Park Ave., Sycamore, Ill.
Ilg Electric Ventilating Co., 2850 N. Crawford Ave., Chicago 41, Ill.
L-R Manufacturing Co., 65 New Litchfield St., Torrington, Conn.
Leiman Bros., 203 Christie St., Newark 5, N. J.
Redmond Co. Inc., Monroe St., Owosso, Mich.
Small Motors, Inc., 1322 Elston Ave., Chicago, Ill.
Smith Mfg. Co., F. A., P. O. Box 509, Rochester 2, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Blue, and Black-White Printing Machinery

Bruning Co. Inc., Charles, 4700 Montrose Ave., Chicago 41, Ill.
Ozalid Products Div., General Aniline & Film Corp., 770 Ansco Rd., Johnson City, N. Y.
Paragon Revolute Corp., 97 South Ave., Rochester 4, N. Y.
Pease Company, C. F., 2601 W. Irving Park Rd., Chicago 18, Ill.
Peck & Harvey, 4327 Addison St., Chicago, Ill.
Photo Reproducing Equipment Co., Chatham, N. J.
Shaw Blue Print Machine Co., Inc., 12 East Park St., Newark 2, N. J.
Wickes Brothers, 515 N. Washington Ave., Saginaw, Mich.

Bolts, Expansion

Ackerman-Johnson Co., 625 W. Jackson Blvd., Chicago, Ill.
American Expansion Bolt & Mfg. Co., 909 N. Spaulding St., Chicago, Ill.
Anchor Products Co., 175 Fifth Ave., New York, N. Y.
Apex Bolt Products Co., 1301 Carroll Ave., Chicago, Ill.
Arro Expansion Bolt Co., 740 W. Center St., Marion, Ohio
Bayonne Bolt Corp., 32 W. Second St., Bayonne, N. J.
Bethlehem Steel Co., 701 E. Third St., Bethlehem, Pa.
Chicago Expansion Bolt Co., 2240 W. Ogden Ave., Chicago 12, Ill.
Church Expansion Bolt Co., Isaac, 1 Fourth St., East Norwalk, Conn.
Croessant Machine Works, 39 Moss St., Reading, Pa.
Diamond Expansion Bolt Co., Garwood, N. J.
Green, Inc., R. H., Dayton 1, Ohio
Line Material Co., 800 N. Eighth St., Milwaukee, Wisc.
National Lead Co., 111 Broadway, New York 6, N. Y.
Ohio Brass Co., Mansfield, Ohio
Oliver Iron & Steel Corp., S. Tenth & Muriel Sts., Pittsburgh 3, Pa.
Paine Co., 2961 Carroll Ave., Chicago 12, Ill.
Palatine Industrial Co., 111 Fifth Ave., New York 3, N. Y.
Phillips Drill Co., 1537 Cortland St., Chicago, Ill.
Rawlplug Co., 98 Lafayette St., New York, N. Y.
Seyler Mfg. Co., Butler Plank Rd., Pittsburgh, Pa.
Star Expansion Bolt Co., 147 Cedar St., New York 6, N. Y.
Steel City Electric Co., 1207 Columbus Ave., Pittsburgh 12, Pa.
Sterling Bolt Co., 209 W. Jackson Blvd., Chicago 6, Ill.
Steward & Romaine Mfg. Co., 124 N. Sixth St., Philadelphia, Pa.
United Screw & Bolt Corp., 2513 W. Cullerton St., Chicago, Ill.
U. S. Expansion Bolt Co., York, Pa.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Bombarders

Ecco High Frequency Electric Corp., 7020 Hudson Blvd., North Bergen, N. J.
Lepel High Frequency Laboratories, 39 West 60th St., New York, N. Y.
Radio Corp. of America, Tube Div., RCA., Harrison, N. J.
S-W Inductor Co., 1056 N. Wood St., Chicago, Ill.
Scientific Electric Div. of "S" Corrugated Quenched Gap Co., 119 Monroe St., Garfield, N. J.
Sherron Electronics Co., 1201 Flushing Ave., Brooklyn 6, N. Y.

Breakers

CIRCUIT BREAKERS (for electronic applications)

Allis Chalmers Mfg. Co., Milwaukee 1, Wisc.
Connecticut Telephone & Electric Div. of Great American Industries, Inc., 70 Brittania St., Meriden, Conn.
Federal Electric Products Co., Inc., 50 Paris St., Newark, N. J.
General Electric Co., Schenectady 5, N. Y.
Heinemann Circuit Breaker Co., 97 Plum St., Trenton 2, N. J.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Littelfuse, Inc., 4755 Ravenswood Ave., Chicago, Ill.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Roller-Smith, Bethlehem, Pa.
Smith Mfg. Co., F. A., P. O. Box 509, Rochester 2, N. Y.
Spencer Thermostat Co., Attleboro, Mass.
Square D Co., 6060 Rivard St., Detroit 11, Mich.
Trumbull Electric Mfg. Co., Plainville, Conn.
Westinghouse Electric Corp., East Pittsburgh, Pa.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.

Bridges

ELECTRICAL MEASUREMENT BRIDGES

see Analyzers
also Testers

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Associated Research, Inc., 231 S. Green St., Chicago 7, Ill.
Baldwin Locomotive Works, Eddystone, Pa.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Central Scientific Co., 1700 Irving Park Blvd., Chicago 13, Ill.
Clough-Brengle Co., 5501 N. Broadway, Chicago 22, Ill.
Communication Measurements Laboratory, 120 Greenwich St., New York, N. Y.
Connecticut Telephone & Electric Div. of Great American Industries, Inc., 70 Brittania St., Meriden, Conn.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electric Heat Control Co., 9123 Inman Ave., Cleveland 5, Ohio
Electronic Supply Co., 207 Main St., Worcester, Mass.
Federal Instrument Co., 3931 47th Ave., Long Island City 4, N. Y.
Foxboro Co., Foxboro, Mass.
Freed Transformer Co., 72 Spring St., New York 12, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Electronics Mfg. Co., 2225 So. Hoover St., Los Angeles 7, Calif.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Gray Instrument Co., 64½ W. Johnston St., Philadelphia, Pa.
Grenby Mfg. Co., Plainville, Conn.
H-W Mfg. Co., 3124 Larga Ave., Los Angeles, Calif.
Hatry & Young, 203 Ann St., Hartford, Conn.
Herbach & Rademan Co., Mfg. Div., 517 Ludlow St., Philadelphia, Pa.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Industrial Instruments, Inc., 156 Culver Ave., Jersey City 5, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Marion Electrical Instrument Co., Manchester, N. H.
Portable Products Corp., C. J., Tagliabue Div., 550 Park Ave., Brooklyn 5, N. Y.
Radio City Products Co., Inc., 127 West 26th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Richardson-Allen Corp., 15 West 20th St., New York, N. Y.
Roller-Smith, Bethlehem, Pa.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Standard Instruments Corp., 568 Prospect Ave., New York 55, N. Y.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.
Thwing-Albert Instrument Co., Penn St. & Pulaski Ave., Philadelphia 44, Pa.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
Waugh Labs., Div. of Waugh Equipment Co., 420 Lexington Ave., New York 17, N. Y.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
White Research, 899 Boylston St., Boston, Mass.
Winslow Co., 9 Liberty St., Newark 5, N. J.

Broadcast Monitors

see Monitors, Broadcast

Brushes, Carbon & Graphite

Becker Brothers Carbon Co., 3450 S. 52nd Ave., Chicago, Ill.
Calebaugh Self-Lubricating Carbon Co., Inc., 2245 E. Ontario St., Philadelphia, Pa.
Carbon Engineering Corp., Slinger, Wis.
Carbone Corp., Myrtle Ave., Boonton, N. J.
Dixon Crucible Co., Joseph, Monmouth St., Jersey City, N. J.
Electro-Nite Carbon Co., 1133 E. Columbia Ave., Philadelphia, Pa.
General Electric Co., Schenectady 5, N. Y.
Graphite Metallizing Corp., 1055 Nepperhan Ave., Yonkers 3, N. Y.

Helwig Co., 2544 North 30th St., Milwaukee 10, Wisc.
Henrite Products Corp., Ironton, Ohio
Keystone Carbon Co., Inc., 1935 State St., St. Marys, Pa.
LeValley-Vitae Carbon Brush Co., Rombout Ave., Beacon, N. Y.
Morganite Brush Co., 33-02 48th Ave., Long Island City, N. Y.
National Carbon Co., 30 East 42nd St., New York 17, N. Y.
Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio
Pittsburgh Carbon Brush Co., 811 Fulton St., Pittsburgh 12, Pa.
Pure Carbon Co., St. Marys, Pa.
St. Mary's Carbon Co., St. Marys, Pa.
Seager Carbon Co., 68 Barclay St., New York 7, N. Y.
Snarr & Co., Geo. W., 110 S. Ninth St., St. Louis 2, Mo.
Southern Carbon Brush Co., P. O. Box 2021, 109 N. 11th St., Birmingham 1, Ala.
Speer Carbon Co., Lincoln Ave., St. Marys, Pa.
Stackpole Carbon Co., St. Marys, Pa.
Superior Carbon Products, Inc., 9112 George Ave., Cleveland, Ohio.
Tungsten Contact Mfg. Co., North Bergen, N. J.
United States Graphite Co., 1621 Holland Ave., Saginaw, Mich.

Cabinets

CABINETS, CHASSIS AND PANELS

Altec Lansing Corp., 1680 N. Vine St., Los Angeles 28, Calif.
Aluminum Goods Mfg. Co., Manitowoc, Wis.
American Communications Corp., 306 Broadway, New York, N. Y.
American Insulator Corp., New Freedom, Pa.
American Radio Hardware Co., Inc., 152 MacQuesten Pkway S., Mt. Vernon, N. Y.
Ansonia Clock Co., Inc., 103 Lafayette St., New York 13, N. Y.
Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Austin Co., O., 42 Greene St., New York, N. Y.
Baer Co., N. S., 9 Montgomery St., Hillside, N. J.
Bakelite Corp., 30 East 42nd St., New York 17, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Caswell-Runyon Co., Huntington, Ind.
Churchill Cabinet Co., 2119 Churchill Ave., Chicago 22, Ill.
Cole Steel Equipment Co., 349 Broadway, New York 13, N. Y.
Collins Radio Co., 855-35th St. N. E., Cedar Rapids, Iowa.
Columbia Metal Box Co., 260 E. 143rd St., New York, N. Y.
Continental-Diamond Fibre Co., 16 Chapel St., Newark, Del.
Corry-Jamestown Mfg. Corp., Corry, Pa.
Creative Plastics Corp., 963 Kent Ave., Brooklyn, N. Y.
Croname, Inc., 3701 Ravenswood Ave., Chicago, Ill.
Dahlstrom Metallic Door Co., Buffalo St., Jamestown, N. Y.
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Edwards, Inc., T. J., 121 Beach St., Boston 5, Mass.
Electric Auto-Lite Co., Toledo 1, Ohio
Electrical Insulation Co., Inc., 12 Vestry St., New York, N. Y.
Electronic Supply Co., 207 Main St., Worcester, Mass.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Erie Art Metal Co., 1602 East 18th St., Erie, Pa.
Erie Can Co., 816 W. Erie St., Chicago, 22, Ill.
Etched Products Corp., 39-01 Queens Blvd., Long Island City, N. Y.
Falstrom Co., 7 Falstrom Court, Passaic, N. J.
Federal Electric Products Co., Inc., 50 Paris St., Newark, N. J.
Franklin Fibre-Lamitex Corp., 12th & French St., Wilmington, Del.
Garod Radio Corp., 70 Washington St., Brooklyn, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Schenectady 5, N. Y.
Goat Metal Stampings Inc., 314 Dean St., Brooklyn, N. Y.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Grammes & Sons, Inc., L. F., 389 Union St., Allentown 2, Pa.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Calif.
Hawley Products Co., St. Charles, Ill.
Hoffman Radio Corp., 3430 South Hill St., Los Angeles 7, Calif.
Hopp Press, Inc., 460 West 34th St., New York, N. Y.
Hudson American Corp., 25 West 43rd St., New York, N. Y.
Industrial Sound Products Co., 3597 Mission St., San Francisco, Calif.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Jefferson Travis Radio Mfg. Corp., 245 East 23rd St., New York 10, N. Y.
Johnson Co., E. F., Waseca, Minn.
Karp Metal Products Co., 129 Thirtieth St., Brooklyn, N. Y.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Lewyt Corp., 60 Broadway, Brooklyn, N. Y.
Lindsay & Lindsay, 222 W. Adams St., Chicago 6, Ill.
Market Forge Co., Everett, Mass.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Metallic Arts Co., 243 Broadway, Cambridge, Mass.
Mica Insulator Co., 797 Broadway, Schenectady 1, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden 48, Mass.
National Vulcanized Fibre Co., Maryland Ave., Wilmington, Del.
New England Etching & Plating Co., 25 Spring St., Holyoke, Mass.
Olesen Illuminating Co., Ltd., Otto K., 1560 Vine St., Hollywood 28, Calif.
Olympic Tool & Mfg. Co., 37 Chambers St., New York 7, N. Y.
Par Metal Products Corp., 32-62 49th St., Long Island City, N. Y.
Penn Fibre & Specialty Co., 2030 E. Westmoreland St., Philadelphia 34, Pa.
Plastic Fabricators Co., 440 Sansome St., San Francisco 11, Calif.
Plastic Manufacturers, Inc., Stamford, Conn.
Porter Metal Products, 121 Ingraham St., Brooklyn 6, N. Y.
Premier Metal Etching Co., 21-03 44th Ave., Long Island City, N. Y.
Radiad Service, 720 West Schubert Ave., Chicago 14, Ill.
Remler Co., 2101 Bryant St., San Francisco 10, Calif.
Richardson Co., Melrose Park, Ill.
Santay Corporation, 351 North Crawford, Chicago 24, Ill.
Scientific Radio Products Co., 738 W. Broadway, Council Bluffs, Iowa.
Scovill Mfg. Co., 99 Mill St., Waterbury 91, Conn.
Screenmakers, 64 Fulton St., New York, 1, N. Y.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn 6, N. Y.
Signal Engineering & Mfg. Co., 154 West 14th St., New York, N. Y.
Silk Screen Supplies, Inc., 33 Lafayette Ave., Brooklyn, N. Y.
Simpson Mfg. Co., Mark, 188 West Fourth St., New York, N. Y.
Skydyne Inc., River Road, Port Jervis, New York
Sonora Radio & Television Corp., 2626 W. Washington St., Chicago 28, Ill.
Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N. Y.
Stamford Metal Specialty Co., 428 Broadway, New York 13, N. Y.
Standard Electric Time Co., 89 Logan St., Springfield, Mass.
Standard Products Co., 505 Boulevard Bldg., Detroit 2, Mich.
Stokes Rubber Co., Jos., Taylor & Webster Sts., Trenton, N. J.
Syracuse Ornamental Co., 581 So. Clinton St., Syracuse, N. Y.
Templetone Radio Mfg. Corp., New London, Conn.
Tingstol Corp., 1461 W. Grand Ave., Chicago, Ill.
Tork Clock Co., 1 Grove St., Mt. Vernon, N. Y.
Trebor Radio Co., Pasadena, Calif.
Tri-United Plastics Corp., 390 Nye Ave., Irvington, N. J.
Union Aircraft Products Corp., 380 Second Ave., New York, N. Y.
Victory Manufacturing Co., 1722 W. Arcade Pl., Chicago 12, Ill.
Wallace Mfg. Co., Wm. T., Chili & Madison Aves., Peru, Indiana
Waters Conley Co., 501 First St., N. W., Rochester, Minn.
Watterson Radio Mfg. Co., P. O. Box 54, Dallas 1, Texas
Wells-Gardner & Co., 2701 N. Kildare Ave., Chicago, Ill.
Wilcox Electric Co., 1400 Chestnut St., Kansas City, Mo.
Wilcox Gay Corp., Charlotte, Michigan
Willor Mfg. Co., 794 East 140th St., New York 54, N. Y.
Winters & Crampton Corp., 150 Wilson Ave., Grandville, Michigan
Wurlitzer Mfg. Co., Rudolph, North Tonawanda, N. Y.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio

Cable

see also Wire

COAXIAL CABLE

Aircraft Products Co., 3502 E. Pontiac St., Fort Wayne, Ind.
American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.
American Steel & Wire Co., Rockefeller Bldg., Cleveland 13, Ohio
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y.
Andrew Co., 363 East 75th St., Chicago 19 Ill.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago 44, Ill.
Boston Insulated Wire & Cable Co., 6[illegible] Bay St. (Dorchester), Boston, Mass.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Columbia Electronics, Inc., 185 East 122nd St., New York 35, N. Y.
Communication Products Co., Inc., 34 Bergen Ave., Jersey City 5, N. J.
Doolittle Radio, Inc., 7421 S. Loomi[illegible] Blvd., Chicago, Ill.
Eby, Inc., Hugh H., 18 W. Chelton Ave Philadelphia 13, Pa.
Federal Telephone & Radio Corp., 591 Broad St., Newark, N. J.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Insulated Wire Corp., 53 Park Pl., New York, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Isolantite, Inc., 343 Cortlandt St., Belleville 9, N. J.
Johnson Co., E. F., Waseca, Minn.
Link, Fred M., 125 W. 17th St., New York, N. Y.
Northern Communications Mfg. Co., 210 East 40th St., New York, N. Y.
Okonite Co., Canal St., Passaic, N. J.
Precision Tube Co., 3828 Terrace St., Philadelphia 28, Pa.
Sherron Electronics Co., 1201 Flushing Ave., Brooklyn 6, N. Y. (test equipment)
Simplex Wire & Cable Co., 79 Sidney St., Cambridge 39, Mass.
Small Motors, Inc., 1322 Elston Ave., Chicago 22, Ill.
Sperry Gyroscope Co., Manhattan Bridge Plaza, Brooklyn 1, N. Y.
Uniform Tubes, Shurs Lane & Lauriston St., Roxborough, Philadelphia, Pa.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Whitney-Blake Co., Dixwell Ave., New Haven, Conn.
Whittaker-Cable Corp., North Kansas City, Mo.
Wood Electric Co., Inc., C. D., 826 Broadway, New York, N. Y.

ELECTRONIC and ALLIED PRODUCTS

Capacitors

FIXED CAPACITORS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass. (Electrolytic, Mica, Oil, Paper)
Aircraft-Marine Products, Inc., 1523 N. Fourth St., Harrisburg, Pa.
American Condenser Co., 4410 Ravenswood Ave., Chicago, Ill. (Electrolytic, Paper)
Atlas Condenser Products Co., 548 Westchester Ave., Bronx, N. Y. (Electrolytic, Paper)
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill. (Paper)
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa. (Air, Oil)
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio (Air)
Capacitron Co., 849 No. Kedzie Ave., Chicago 51, Ill.
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Centralab Div., Globe Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis. (Ceramic, Mica)
Condenser Corp. of America, 1000 Hamilton Blvd., South Plainfield, N. J. (Electrolytic, Mica, Oil, Paper)
Condenser Products Co., 1375 N. Branch St., Chicago, Ill. (Electrolytic, Oil, Paper)
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio (Paper)
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J. (Electrolytic, Mica, Oil-filled, Motor-starting, Paper, Air, X-Ray, etc.)
Cosmic Radio Corp., 699 E. 135th St., New York, N. Y.
Crowley & Co., Inc., Henry L., 1 Central Ave., West Orange, N. J.
Deutschmann Corp., Tobe, Canton, Mass. (Paper, Mica, Electrolytic, Oil, Ceramic, Air, etc.)
Dumont Electric Co., 34 Hubert St., New York, N. Y. (Electrolytic, Mica, Oil, Paper)
Ecco High Frequency Electric Corp., 7020 Hudson Blvd., North Bergen, N. J.
Eitel-McCullough, Inc., San Bruno, Calif. (Vacuum)
Electrical Reactance Corp., Franklinville, N. Y.
Electro-Motive Mfg. Co., S. Park & John Sts., Willimantic, Conn. (Mica)
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Erie Resistor Corp., 644 W. 12th St., Erie Pa. (Ceramic)
Fast & Co., John E., 3101 N. Pulaski Rd., Chicago 41, Ill.
General Electric Co., Schenectady 5, N. Y. (Air Trimmer, Oil, Paper, Vacuum, Radio-Frequency blocking & by-pass, High-Frequency Power or Plate)
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. (Air, Mica, Paper)
Girard-Hopkins, 1000 40th Ave., Oakland 1, Calif. (Oil, Paper)
Glenn Roberts Co., 3100 East Tenth St., Oakland 1, Calif.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Neb. (Oil, Paper)
H. R. S. Products, 5707 W. Lake St., Chicago, Ill.
Illinois Condenser Co., 1160 N. Howe St., Chicago, Ill. (Electrolytic, Oil, Paper)
Industrial Condenser Corp., 3243 North California Ave., Chicago 18, Ill. (Ceramic, Electrolytic, Mica, Oil, Paper)
Industrial & Commercial Electronics, Belmont, Calif.
Jennings Radio Mfg. Co., 1098 E. William St., San Jose 12, Calif. (Vacuum)
Johnson Co., E. F., Waseca, Minn. (Air, Oil)
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill. (Oil & Wax filled, Paper, Oil, Impregnated & Wax Impregnated)
Lapp Insulator Co., 31 Gilbert St., Le Roy, N. Y. (Ceramic)
Magnavox Co., 2131 Bueter Rd., Fort Wayne 4, Ind. (Electrolytic)
Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind. (Electrolytic, Paper)
Micamold Radio Corp., 1087 Flushing Ave., Brooklyn 6, N. Y. (Ceramic, Electrolytic, Mica, Oil, Paper)
Muter Co., 1255 S. Michigan Ave., Chicago, Ill. (Ceramic)
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
Noma Electric Corp., 55 West 13th St., New York 11, N. Y. (Mica)
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Polymet Condenser Co., 699 East 135th St., New York, N. Y.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill. (Oil, Paper)
Radio Corp. of America, RCA Victor Div., Camden, N. J. (Mica, Oil, Paper)
Rothenstein, Albert, 135 Liberty St., New York, N. Y.
Sangamo Electric Co., Springfield, Ill. (Mica, Ceramic, Paper)
Scientific Electric Div. of "S" Corrugated Quenched Gap Co., 111 Monroe St., Garfield, N. J.
Sickles Co., F. W., 165 Front St., Chicopee, Mass. (Mica, Silver, Mica)
Solar Mfg. Corp., 285 Madison Ave., New York 17, N. Y. (Ceramic, Electrolytic, Mica, Oil, Paper)
Sprague Electric Co., 189 Beaver St., North Adams, Mass. (Electrolytic, Mica, Oil, Paper)
Stackpole Carbon Co., St. Marys, Pa.
Teleradio Engineering Corp., 99 Wall St., New York 5, N. Y. (Mica)
Tungsten Contact Mfg. Co., North Bergen, N. J.
Western Electric Co. Inc., 120 Broadway, New York 5, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa. (Oil, Paper)
Winters & Crampton Corp., 150 Wilson Ave., Grandville, Michigan

COMPRESSED GAS CAPACITORS

Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Johnson Co., E. F., Waseca, Minn.
Lapp Insulator Co., 31 Gilbert St., Le Roy, N. Y.

VARIABLE RECEIVER TUNING CAPACITORS

American Steel Package Co., Squire Ave., Defiance, Ohio
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Federal Mfg. & Engrg. Corp., 199-217 Steuben St., Brooklyn 5, N. Y.
Foote Pierson & Co. Inc., 75 Hudson St., Newark 4, N. J.
General Electric Co., Schenectady 5, N. Y.
General Instrument Corp., 829 Newark Ave., Elizabeth 3, N. J.
Halstead Traffic Communications Corp., 155 East 44th St., New York, N. Y.
Hammarlund Mfg. Co., Inc., 460 W. 34 St., New York 1, N. Y.
Hoffman Radio Corp., 3430 S. Hill St., Los Angeles 7, Calif.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Johnson Co. E. F., Waseca, Minn.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.
Meissner Mfg. Div., Maguire Industries, Inc., Mt. Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., Inc., 61 Sherman St., Malden, 48, Mass.
Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Radio Condenser Co., Camden, N. J.
Standard Coil Products Co., 2329 N. Pulaski Rd., Chicago 18, Ill.
Winters & Crampton Corp., 150 Wilson Ave., Grandville, Mich.

VARIABLE TRANSMITTER TUNING CAPACITORS

Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Collins Radio Co., 855-35th St., N. E., Cedar Rapids, Iowa
Federal Manufacturing & Engrg. Corp., 199-217 Steuben St., Brooklyn 5, N. Y.
Foote Pierson & Co. Inc., 75 Hudson St., Newark 4, N. J.
General Electric Co., Schenectady 5, N. Y.
General Instrument Corp., 829 Newark Ave., Elizabeth 3, N. J.
Hammarlund Mfg. Co., Inc., 460 W. 34th St., New York 1, N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Jennings Radio Mfg. Co., 1098 E. William St., San Jose 12, Calif.
Johnson Co., E. F., Waseca, Minn.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.
Lapp Insulator Co., 31 Gilbert St., LeRoy, N. Y.
Litton Engineering Labs., P. O. Box 749, Redwood City, Calif.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., Inc., 61 Sherman St., Malden 48, Mass.
Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.
Standard Coil Products Co., 2329 N. Pulaski Rd., Chicago 18, Ill.
Wilcox Electric Co., 1400 Chestnut St., Kansas City, Mo.
Winters & Crampton Corp., 150 Wilson Ave., Grandville, Mich.

VARIABLE TRIMMER CAPACITORS

American Steel Package Co., Squire Ave., Defiance, Ohio
Automatic Mfg. Co., 900 Passaic Ave., East Newark, N. J.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Centralab Div., Globe Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.
Comar Electric Co., 3150 N. Washtenaw Ave., Chicago 28, Ill.
D X Crystal Co., 1200 N. Claremont Ave., Chicago 22, Ill.
Electro Motive Mfg. Co., Willimantic, Conn.
Erie Resistor Corp., 644 W. 12th St., Erie, Pa.
Foote Pierson & Co. Inc., 75 Hudson St., Newark 4, N. J.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Guthman, Inc., E. I., 15 S. Throop St., Chicago, Ill.
Hammarlund Mfg. Co., Inc., 460 W. 34 St., New York 1, N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Meissner Mfg. Div., Maguire Industries, Inc., Mt. Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Co., Inc., 61 Sherman St., Malden, 48, Mass.
Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Sickles Co., F. W., 165 Front St., Chicopee, Mass.
Standard Coil Products Co., 2329 N. Pulaski Rd., Chicago 18, Ill.
Teleradio Engineering Corp., 99 Wall St., New York 5, N. Y.

Cells

PHOTO-ELECTRIC CELLS

see Tubes (Phototubes & Cells)

Cements

RADIO CEMENTS

Alden Products Co., 117 North Main St., Brockton 64, Mass.

Ambroid Co., 805 Franklin St., Boston 10, Mass.
American Products Mfg. Co., 8127 Oleander St., New Orleans, La.
Bakelite Corp., 30 E. 42nd St., New York 17, N. Y.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Crowley & Co., Inc., Henry L., 1 Central Ave., West Orange, N. J.
D X Crystal Co., 1200 N. Claremont Ave., Chicago 22, Ill.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Bridgeport, Conn.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Haynes Laboratories, Inc., C. W., 61 Chandler St., Springfield, Mass.
Howe & French, Inc., 99 Broad St., Boston 10, Mass.
Linicky & Co., Leslie L., 29 E. Madison St., Chicago, Ill.
Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J.
Paisley Products, Inc., 1770 Canalport Ave., Chicago 16, Ill.
Plax Corp., 133 Walnut St., Hartford 5, Conn.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Cal.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Westinghouse Electric Corp., East Pittsburg, Pa.
Zapon Div. Atlas Powder Co., Ludlow St., Stamford, Conn.
Zophar Mills, Inc., 112 26th St., Brooklyn 32, N. Y.

Ceramics

see Insulation

Chambers, Test

HUMIDITY, PRESSURE, TEMPERATURE

American Instrument Co., 8030 Georgia Ave., Silver Springs, Md.
Bowser, Inc., Mobile Refrigeration Div., 38-32 54th St., Woodside, Long Island, N. Y.
Deepfreeze Division, Motor Products Corp., 2301 Davis St., N. Chicago, Ill.
Distillation Products, Inc., 755 Ridge Rd. W., Rochester, N. Y.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Industrial Filter & Pump Mfg. Co., 1621-25 W. Carroll Ave., Chicago, Ill.
Kold-Hold Mfg. Co., 446 North Grand Ave., Lansing, Mich.
Northern Laboratories Ltd., 3-01—27th Ave., Long Island City, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Revco Inc., Deerfield, Mich.
Sparkes Mfg. Co., Ltd., 318 Jefferson St., Newark, N. J.
Technical Products Co., 158 Madison at Third St., Memphis, Tenn.
Tenney Engineering, Inc., 24-28 Avenue B, Newark, N. J.
Thwing Albert Instrument Co., Penn St. & Pulaski Ave., Philadelphia 44, Pa.
Waugh Labs., Div. of Waugh Equipment Co., 420 Lexington Ave., New York 17, N. Y.
Young Bros. Co., 6500 Mack Ave., Detroit, Mich.

Changers

AUTOMATIC RECORD CHANGERS

Admiral Corp., 3800 W. Cortland St., Chicago 47, Ill.
Andrea Radio Corp., 43-20 34th St., Long Island City, N. Y.
Chicago Sound Systems Co., 2124 S. Michigan Avenue, Chicago, Ill.
Eastern Electronics Corp., 41 Chestnut St., New Haven 11, Conn.
Farnsworth Television & Radio Corp., 3702 Pontiac St., Fort Wayne, Ind.
Galvin Mfg. Corp., 4545 W. Augusta Blvd., Chicago 51, Ill.
Garod Radio Corp., 70 Washington St., Brooklyn, N. Y.
Garrard Sales Corp., 401 Broadway, New York 13, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Industries Co., Taylor & Olive Sts., Elyria, Ohio
General Instrument Corp., 829 Newark Ave., Elizabeth 3, N. J.
International Detrola Corp., Beard at Chatfield, Detroit, Mich.
Magnavox Co., The, 2131 Bueter Road, Fort Wayne 4, Ind.
Maguire Industries, Inc., Electronics Dept., Bridgeport, Conn.
Milwaukee Stamping Co., 824 S. 72nd St., Milwaukee, Wisc.
National Diecasting Co., 3601 W. Touhy St., Newark, N. J.
Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.
Philco Corp., Tioga & C Sts., Philadelphia 3, Pa.
Precise Development Parts, 28 N. Loomis St., Chicago, Ill.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Record-O-Vox, Inc., 721 N. Martel Ave., Hollywood 46, Calif.
Seeburg Corp., J. P., 1510 N. Dayton St., Chicago, Ill.
Sparkes Mfg. Co., 318 Jefferson St., Newark, N. J.
Talking Devices Co., 4447 W. Irving Park Rd., Chicago, Ill.
Trav-Ler Karenola Radio & Television Corp., 1028 W. Van Buren St., Chicago, Ill.
Webster Chicago Corp., Electronics Div., 3825 Armitage Ave., Chicago 47, Ill.
Wilcox Gay Corp., Charlotte, Mich.
Wurlitzer Mfg. Co., Rudolph, North Tonawanda, N. Y.

Changers, Frequency

see Vibrators

Chassis

see Cabinets

Chokes

POWER and AUDIO CHOKES

Advance Transformer Co., 14 N. May St., Chicago, Ill.
Airdesign & Fabrication, Inc., 241 Fairfield Ave., Upper Darby, Pa.
Altec Lansing Corp., 1680 N. Vine St., Los Angeles 28, Calif.
American Communications Corp., 306 Broadway, New York, N. Y.
American Transformer Co., 178 Emmett St., Newark, N. J.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Aray Mfg. & Supply Co., Inc., 3107 Pine St., St. Louis 3, Mo.
Audio Development Co., 2833-13th Ave S., Minneapolis 7, Minn.
Automatic Winding Co., 900 Passaic Ave., E. Newark, N. J.
Best Mfg. Co., Inc., 1200 Grove St., Irvington 1, N. J.
Chicago Transformer Div., Essex Wire Corp., 3501 W. Addison St., Chicago 18, Ill.
Coto-Coil Company, Inc., 65 Pavilion Ave., Providence, R. I.
Davis & Co., Inc., Dean W., Kentland, Ind.
Dinion Coil Co., Inc., 1 North St., Caledonia, N. Y.
Dongan Electric Mfg. Co., 2987 Franklin Street, Detroit, Mich.
DX Crystal Co., 1200 N. Claremont Ave., Chicago, Ill.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electricoil Transformer Co., 421 Canal St., New York 13, N. Y.
Electronic Engineering Co., 3223 West Armitage Ave., Chicago, Ill.
Electronic Transformer Co., 207 W. 25th St., New York, N. Y.
Electronic Winding Co., 5031 Broadway, Chicago 40, Ill.
Essex Electronics, 1060 Broad St., Newark, 2, N. J.
Federal Instrument Co., 3931-47th Ave., Long Island City 4, N. Y.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.
•Foster Co., A. P., 719 Wyoming Ave., Lockland 15, Ohio
Franklin Transformer, 65 22nd Ave. N.E., Minneapolis 13, Minn.
Freed Transformer Co., 72 Spring St., New York 12, N. Y.
Gardner Electric Mfg. Co., 4227 Hollis St., Emeryville 8, Calif.
General Electric Co., Schenectady 5, N. Y.
General Transformer Corp., 1250 W. Van Buren St., Chicago 7, Ill.
Glenn Roberts Co., 3100 East Tenth St., Oakland 1, Calif.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Neb.
Gramer Co., 2734 N. Pulaski Rd., Chicago, 39, Ill.
Guided Radio Corp., 161 Sixth Ave., New York 13, N. Y.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Calif.
Halldorson Co., The, 4500 Ravenswood Ave., Chicago 28, Ill.
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
Hercules Electric & Mfg. Co., Inc., 2500 Atlantic Ave., Brooklyn 7, N. Y.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles 36, Cal.
Hudson American Corp., 25 W. 43rd St., New York, N. Y.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Insuline Corp. of America, 36-20 35th Ave., Long Island City, N. Y.
International Transformer Co., 396 Broadway, New York, N. Y.
Jefferson Electric Co., Bellwood, Ill.
Kenyon Transformer Co., 840 Barry St., New York 59, N. Y.
Langevin Co., Inc., 37 W. 65th St., New York, N. Y.
Lectrohm, Inc., 5125 W. 25th St., Cicero, 50, Ill.
Madison Electrical Products Corp., Madison, N. J.
Magnetic Windings Co., Div. Essex Wire Corp., 416 South 16th St., Easton, Pa.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Merit Coil & Transformer Corp., 4427 N. Clark St., Chicago 40, Ill.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Co., Inc., 61 Sherman St., Malden 48, Mass.
New York Transformer Co., 26 Waverly Place, New York 3, N. Y.
Northern Communications Mfg. Co., 210 East 40th St., New York, N. Y.
Peerless Electrical Products Co., 6920 McKinley Ave., Los Angeles 1, Calif.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radionic Controls, 3758 Belmont Ave., Chicago 18, Ill.
Radionic Transformer Co., 411 S. Sangamon St., Chicago, Ill.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Red Arrow Electric Corp., 100 Coit St., Irvington, N. J.
Rola Co., Inc., 2530 Superior Ave., Cleveland, Ohio
S-W Inductor Co., 1056 N. Wood St., Chicago, Ill.
Smith Mfg. Co., Nathan R., 105 Pasadena Ave., South Pasadena, Calif.
Sorensen & Co., 375 Fairfield Ave., Stamford, Conn.
Standard Transformer Corp., 1500 N. Halstead St., Chicago, Ill.
Super Electric Products Corp., 1057 Summit Ave., Jersey City, N. J.
Telex Products Co., Telex Park, Minneapolis 1, Minn.
Thermador Elec. Mfg. Co., 5119 S. Riverside Drive, Los Angeles 22, Calif.
Thordarson Electric Mfg. Div., Maguire Industries, Inc., 500 W. Huron St., Chicago 10, Ill.
Transformer Products, Inc., 143 W. 51 St., New York, N. Y.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Walsh Engineering Co., 34 DeHart Place, Elizabeth, N. J.
Westinghouse Electric Corp., East Pittsburgh, Pa.

ELECTRONIC and ALLIED PRODUCTS

Wheeler Insulated Wire Co., Inc., 378 Washington Ave., Bridgeport, Conn.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio

R. F. and I. F. CHOKES

Aladdin Radio Industries, Inc., 501 W. 35th St., Chicago 16, Ill.
Albion Coil Co., Albion, Ill.
Automatic Winding Co., 900 Passaic Ave., E. Newark, N. J.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Best Mfg. Co. Inc., 1200 Grove St., Irvington, N. J.
Bridgeport Mfg. Co., Bridgeport, Ill.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Burnett Radio Lab., Wm. W. L., 4814 Idaho St., San Diego, Calif.
Control Corp., 600 Stinson Blvd., Minneapolis, Minn.
Coto-Coil Company Inc., 65 Pavilion Ave., Providence, R. I.
DX Crystal Co., 1200 N. Claremont Ave., Chicago 22, Ill.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electricoil Transformer Co., 421 Canal St., New York 13, N. Y.
Electronic Products Mfg. Co., 7300 Huron River Drive, Dexter, Michigan
Electronic Winding Co., 5031 Broadway Chicago 40, Ill.
Erwood Co., 223 W. Erie St., Chicago, Ill.
Essex Electronics, 1060 Broad St., Newark 2, N. J.
Fast & Co., John E., 3101 N. Pulaski Road, Chicago 41, Ill.
Federal Instrument Co., 3931 47th Ave., Long Island City 4, N. Y.
Ferranti Electric Inc., 30 Rockefeller Plaza, New York 20, N. Y.
Gardner Electric Mfg. Co., 4227 Hollis St., Emeryville 8, Calif.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
General Winding Co., 420 West 45th St., New York, N. Y.
Gold Shield Products, 25 W. Broadway, New York 7, N. Y.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Guthman & Co., E. I., 15 S. Throop St., Chicago, Ill.
Hammarlund Mfg. Co., Inc., 460 W. 34th St., New York 1, N. Y.
Hercules Electric & Mfg. Co., Inc., 2500 Atlantic Ave., Brooklyn 7, N. Y.
Hudson American Corp., 25 W. 43rd St., New York, N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Lectrohm, Inc., 5125 W. 25th St., Cicero, 50, Ill.
Lenoxite Div., Lenox Inc., 65 Prince St., Trenton 5, N. J.
Madison Electrical Products Corp., Madison, N. J.
Meissner Mfg. Div., Maguire Industries Inc., Mt. Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
Muter Company, 1255 S. Michigan Ave., Chicago, Ill.
National Co., Inc., 61 Sherman St., Malden 48, Mass.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago 44, Ill.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radionic Transformer Co., 411 S. Sangamon St., Chicago, Ill.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
S-W Inductor Co., 1056 N. Wood St., Chicago, Ill.
Sickles Co., F. W., 165 Front St., Chicopee, Mass.
Small Motors, Inc., 1322 Elston Ave., Chicago 22, Ill.
Sonora Radio & Television Corp., 2626 W. Washington St., Chicago 28, Ill.
Sound Equipment Corp., of California, 3903 San Fernando Road, Glendale 4, Calif.
Standard Coil Products Co., 2329 N. Pulaski Rd., Chicago 18, Ill.
Stanwyck Winding Co., 102 S. Lander St., Newburgh, N. Y.
Super Electric Products Corp., 1057 Summit Ave., Jersey City, N. J.
Teleradio Engineering Corp., 99 Wall St., New York 5, N. Y.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio

Clips & Clamps

TEST & TUBE CLIPS AND CLAMPS

Aircraft-Marine Prods. Inc., 1523 North Fourth St., Harrisburg, Pa.
Alden Products Co., 117 North Main St., Brockton 64, Mass.
American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.
American Radio Hardware Co., Inc., 152 MacQuesten Pkway. S., Mt. Vernon, N. Y.
Birnbach Radio Co. Inc., 145 Hudson St., New York, N. Y.
Birtcher Corp., 5087 Huntington Drive, Los Angeles 32, Calif.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Dante Electric Mfg. Co., Bantam, Conn.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Jones, Howard B., 2460 W. George St., Chicago 18, Ill.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Morse Co., Frank W., 301 Congress St., Boston 10, Mass.
Mueller Electric Co., 1583 E. 31st St., Cleveland 14, Ohio
National Co., Inc., 61 Sherman St., Malden 48, Mass.
Penn-Union Electric Corp., 315 State St., Erie, Pa.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Reliable Spring & Wire Forms Co., 3167 Fulton Road, Cleveland 9, Ohio
Standard Electric Time Co., 89 Logan St., Springfield, Mass.
Thompson Corp., Geo. S., 5240 Huntington Drive, Los Angeles 32, Calif.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
Wood Electric Co., Inc., C. D., 826 Broadway, New York 3, N. Y.
Zierick Mfg. Corp., 385 Gerard Ave., New York, N. Y.

Coils

POWER and A. F. COILS and WINDINGS

Advance Transformer Co., 14 N. May St., Chicago, Ill.
Airdesign & Fabrication, Inc., 241 Fairfield Ave., Upper Darby, Pa.
Aladdin Radio Industries, Inc., 501 West 35th St., Chicago 16, Ill.
Altec Lansing Corp., 1680 N. Vine St., Los Angeles 28, Calif.
American Transformer Co., 178 Emmett St., Newark, N. J.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y.
Automatic Mfg. Corp., 900 Passaic Ave., E. Newark, N. J.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Best Mfg. Co., Inc., 1200 Grove St., Irvington 1, N. J.
Bittermann Electric Co., 50 Henry St., Brooklyn, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Communication Parts, 1101 N. Paulina St., Chicago 22, Ill.
Coto-Coil Company, Inc., 65 Pavilion Ave., Providence, R. I.
Control Corp., 600 Stinson Blvd., Minneapolis, Minn.
Dano Electric Co., 93 Main St., Winsted, Conn.
Davis & Co., Dean W., Kentland, Ind.
Dinion Coil Co., Inc., 1 North St., Caledonia, N. Y.
DX Crystal Co., 1200 N. Claremont Ave., Chicago 22, Ill.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electric Heat Control Co., 9123 Inman Ave., Cleveland 5, Ohio
Electrical Specialty Co., 2304 Washington St., Boston, Mass.
Electricoil Transformer Co., 421 Canal St., New York 13, N. Y.
Electronic Transformer Co., 207 West 25th St., New York, N. Y.
Electronic Winding Co., 5031 Broadway, Chicago 40, Ill.
Essex Electronics, 1060 Broad St., Newark 2, N. J.
Federal Instrument Co., 3931-47th Ave., Long Island City 4, N. Y.
Ferranti Electric Inc., 30 Rockefeller Plaza, New York 20, N. Y.
Foster Co., A. P., 719 Wyoming Ave., Lockland 15, Ohio
Freed Transformer Co., 72 Spring St., New York 12, N. Y.
Gardner Electric Mfg. Co., 4227 Hollis St., Emeryville 8, Calif.
General Electric Co., Schenectady 5, N. Y.
General Winding Co., 420 West 45th St., New York, N. Y.
Giannini & Co., Inc., G. M., 161 E. California St., Pasadena, Calif.
Glenn Roberts Co., 3100 East Tenth St., Oakland 1, Calif.
Gramer Co., 2734 N. Pulaski Rd., Chicago, 39, Ill.
Hadley Co., Robert M., 711 East 61st St., Los Angeles, Calif.
Halldorson Company, The, 4500 Ravenswood Ave., Chicago 28, Ill.
Hercules Electric & Mfg. Co., Inc., 2500 Atlantic Avenue, Brooklyn 7, N. Y.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles 36, Calif.
Hudson American Corp., 25 West 43rd St., New York, N. Y.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Instrument Resistors Co., Little Falls, N. J.
International Transformer Co., 396 Broadway, New York, N. Y.
Johnson Co., E. F., Waseca, Minn.
Langevin Co., Inc., 37 W. 65th St., New York, N. Y.
Lawton Products Co., Inc., 624 Madison Ave., New York 22, N. Y.
Magnetic Windings Co., Div. of Essex Wire Corp., 416 South 16th St., Easton, Pa.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Merit Coil & Transformer Corp., 4427 N. Clark St., Chicago 40, Ill.
National Co., Inc., 61 Sherman St., Malden 48, Mass.
National Mineral Co., 2628 N. Pulaski Rd., Chicago 39, Ill.
New York Transformer Co., 26 Waverly Place, New York 3, N. Y.
Northelfer Winding Labs., 111 Albermarle Ave., Trenton, N. J.
Northern Communications Mfg. Co., 210 East 40th St., New York, N. Y.
Peerless Electrical Products Co., 6920 McKinley Ave., Los Angeles 1, Calif.
Philco Co., Tioga & C Sts., Philadelphia 34, Pa.
Presto Electric Co., 4511 New York Ave., Union City, N. J.
Printloid, Inc., 95 Mercer St., New York, 12, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radionic Controls, 3758 Belmont Ave., Chicago 18, Ill.
Radionic Transformer Co., 411 S. Sangamon St., Chicago, Ill.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Rola Co., Inc., 2530 Superior Ave., Cleveland, Ohio
S-W Inductor Co., 1056 N. Wood St., Chicago, Ill.
Sandman Electric Motor Co., 164 Oliver St., Boston 10, Mass.
Scientific Radio Products Co., 738 W. Broadway, Council Bluffs, Iowa
Small Motors, Inc., 1322 Elston Ave., Chicago 22, Ill.
Smith Mfg. Co., Nathan R., 105 Pasadena Ave., South Pasadena, Calif.
Sorensen & Co., 375 Fairfield Ave., Stamford, Conn.
Standard Coil Products Co., 2329 N. Pulaski Rd., Chicago 18, Ill.

Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Super Electric Products Corp., 1057 Summit Ave., Jersey City, N. J.
Teleradio Engineering Corp., 99 Wall St., New York 5, N. Y.
Thordarson Electric Mfg. Div., Maguire Industries, Inc., 500 W. Huron St., Chicago 10, Ill.
Transformer Products, Inc., 143 W. 51st St., New York, N. Y.
Tungsten Contact Mfg. Co., North Bergen, N. J.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Walsh Engineering Co., 34 DeHart Place, Elizabeth, N. J.
Webster Electric Co., 1900 Clark St., Racine, Wis.
Weller Mfg. Co., 516 Northampton St., Easton, Pa.
Wellman Mfg. Co., 7122 Melrose Ave., Los Angeles 46, Calif.
Western Electric Co. Inc., 120 Broadway, New York 5, N. Y.
Westinghouse Electric Corp., East Pittsburg, Pa.
Wheeler Insulated Wire Co., Inc., 378 Washington Ave., Bridgeport, Conn.
Whisk Laboratories, 87 Maiden Lane, New York 7, N. Y.
Wickwire Spencer Metallurgical Corp., 260 Sherman St., Newark, N. J.

R. F. RECEIVING or TRANSMITTING COILS

Advance Transformer Co., 14 N. May St., Chicago, Ill.
Aero Communications, Inc., 231 Main St., Hempstead, L. I., N. Y.
Aladdin Radio Industries, Inc., 501 W. 35th St., Chicago 16, Ill.
Albion Coil Co., Albion, Ill.
Alden Products Co., 117 North Main St., Brockton 64, Mass.
American Communications Corp., 306 Broadway, New York, N. Y.
American Transformer Co., 178 Emmett St., Newark, N. J.
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y.
Andrew Co., 363 E. 75th St., Chicago 19, Ill.
Aray Mfg. & Supply Co., Inc., 3107 Pine St., St. Louis 3, Mo.
Automatic Mfg. Corp., 900 Passaic Ave., E. Newark, N. J.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bittermann Electric Co., 50 Henry St., Brooklyn, N. Y.
Bridgeport Mfg. Co., Bridgeport, Ill.
Burnett Radio Lab., Wm. W. L., 4814 Idaho St., San Diego, Calif.
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Communication Parts, 1101 N. Paulina St., Chicago 22, Ill.
Control Corp., 600 Stinson Blvd., Minneapolis, Minn.
Coto-Coil Company, Inc., 65 Pavilion Ave., Providence, R. I.
Dinion Coil Co., Inc., 1 North St., Caledonia, N. Y.
DX Crystal Co., 1200 N. Claremont Ave., Chicago 22, Ill.
Electrical Reactance Corp., Franklinville, N. Y.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electrical Specialty Co., 2304 Washington St., Boston, Mass.
Electricoil Transformer Co., 421 Canal St., New York 13, N. Y.
Electronic Transformer Co., 207 West 25th Street, New York, N. Y.
Electronic Winding Co., 5031 Broadway, Chicago 40, Ill.
Engineering Laboratories, Inc., 602 East Fourth St., Tulsa 3, Okla.
Erco Radio Labs., Inc., Fenimore Ave., Hempstead, N. Y.
Essex Electronics, 1060 Broad St., Newark 2, N. J.
Federal Instrument Co., 3931 47th Ave., Long Island City 4, N. Y.
Ferranti Electric Inc., 30 Rockefeller Plaza, New York 20, N. Y.
Gardner Electric Mfg. Co., 4227 Hollis St., Emeryville 8, Calif.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., Schenectady 5, N. Y.
General Winding Co., 420 West 45th St., New York, N. Y.
Glenn Roberts Co., 3100 East Tenth St., Oakland 1, Calif.
Guthman & Co., E. I., 15 So. Throop St., Chicago, Ill.
Hammarlund Mfg. Co. Inc., 460 W. 34th St., New York 1, N. Y.
Hercules Electric & Mfg. Co., Inc., 2500 Atlantic Ave., Brooklyn 7, N. Y.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Johnson Co., E. F., Waseca, Minn.
Langevin Co., Inc., 37 W. 65th St., New York, N. Y.
Lawton Products Co., 624 Madison Ave., New York 22, N. Y.
Lenoxite Div., Lenox Inc., 65 Prince St., Trenton 5, N. J.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Meissner Mfg. Div., Maguire Industries, Inc., Mount Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
Monarch Mfg. Co., 2014 N. Major Ave., Chicago, Ill.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Co., Inc., 61 Sherman St., Malden 48, Mass.
New York Transformer Co., 26 Waverly Place, New York 3, N. Y.
Philco Corp., Tioga & C Sts., Philadelphia 34, Pa.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Printloid, Inc., 95 Mercer St., New York 12, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Craftsmen, 1341 So. Michigan Ave., Chicago 5, Ill.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Ross Mfg. Co., 2241 S. Indiana Ave., Chicago 27, Ill.
S-W Inductor Co., 1056 N. Wood St., Chicago, Ill.
Sandman Electric Motor Co., 164 Oliver St., Boston 10, Mass.
Sickles Co., F. W., 165 Front St., Chicopee, Mass.
Small Motors, Inc., 1322 Elston Ave., Chicago 22, Ill.
Sonora Radio & Television Corp., 2626 W. Washington St., Chicago 28, Ill.
Sound Equipment Corp. of California, 3903 San Fernando Road, Glendale 4, Calif.
Standard Coil Products Co., 2329 N. Pulaski Road, Chicago 18, Ill.
Standard Winding Corp., 44-62 Johnes St., Newburgh, N. Y.
Stanwyck Winding Co., 102 South Lander St., Newburgh, N. Y.
Super Electric Products Corp., 1057 Summit Ave., Jersey City, N. J.
Teleradio Engineering Corp., 99 Wall St., New York 5, N. Y.
Transmitter Equipt. Mfg. Co. Inc., 345 Hudson St., New York 14, N. Y.
Wheeler Insulated Wire Co., Inc., 378 Washington Ave., Bridgeport, Conn.

SOLENOID COILS

Advance Transformer Co., 14 N. May St., Chicago, Ill.
Airdesign & Fabrication Inc., 241 Fairfield Ave., Upper Darby, Pa.
Aladdin Radio Industries, Inc., 501 West 35th St., Chicago 16, Ill.
Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wis.
Allied Control Co., Inc., 2 East End Ave., New York 10, N. Y.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Automatic Mfg. Corp., 900 Passaic Ave., E. Newark, N. J.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif.
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Connecticut Telephone & Electric Div. of Great American Industries, Inc., 70 Brittania St., Meriden, Conn.
Communications Parts, 1101 N. Paulina St., Chicago 22, Ill.
Consolidated Radio Products Co., 350 W. Erie St., Chicago 10, Ill.
Coto-Coil Company, Inc., 65 Pavilion Ave., Providence, R. I.
Davis & Co., Dean W., Kentland, Ind.
Dinion Coil Co., Inc., 1 North St., Caledonia, N. Y.
DX Crystal Co., 1200 N. Claremont Ave., Chicago 22, Ill.
Eastern Specialty Co., 3617-19 N. Eighth St., Philadelphia 40, Pa.
Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.
Electric Auto-Lite Co., Toledo 1, Ohio
Electric Heat Control Co., 9123 Inman Ave., Cleveland 5, Ohio
Electrical Coil Winding Co., 2733 Saunders St., Camden, N. J.
Electricoil Transformer Co., 421 Canal St., New York 13, N. Y.
Electronic Transformer Co., 207 West 25th St., New York, N. Y.
Electronic Winding Co., 5031 Broadway, Chicago 40, Ill.
Essex Electronics, 1060 Broad St., Newark 2, N. J.
Federal Instrument Co., 3931 47th Ave., Long Island City 4, N. Y.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.
Foster Co., A. P., 719 Wyoming Ave., Lockland 15, Ohio
Gardner Electric Mfg. Co., 4227 Hollis St., Emeryville 8, Calif.
General Electric Co., Schenectady 5, N. Y.
Glenn Roberts Co., 3100 East Tenth St., Oakland 1, Calif.
Gramer Co., 2734 N. Pulaski Rd., Chicago 39, Ill.
Guardian Electric Mfg. Co., 1400 Washington Blvd., Chicago 7, Ill.
Hadley Co., Robert M., 711 East 61st St., Los Angeles, Calif.
Halldorson Co., The, 4500 Ravenswood Ave., Chicago 28, Ill.
Hercules Electric & Mfg. Co., Inc., 2500 Atlantic Avenue, Brooklyn 7, N. Y.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Instrument Resistors Co., Little Falls, N. J.
International Transformer Co., 396 Broadway, New York, N. Y.
Jefferson Electric Co., Bellwood, Ill.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Langevin Co., Inc., 37 West 65th St., New York, N. Y.
Leotone Radio Co., 65 Dey St., New York 7, N. Y.
Madison Electrical Prods. Corp., Madison, New Jersey
Magnavox Co., The, 2131 Bueter Rd., Fort Wayne 4, Ind.
Magnetic Windings Co., Div. of Essex Wire Corp., 416 South 16th St., Easton, Pa.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
National Co. Inc., 61 Sherman St., Malden 48, Mass.
New York Transformer Co., 26 Waverly Place, New York 3, N. Y.
Northelfer Winding Labs., 111 Albermarle Ave., Trenton, N. J.
Northern Communications Mfg. Co., 210 East 40th St., New York, N. Y.
Parker Engineering Products Co., 16 W. 22nd St., New York 10, N. Y.
Presto Electric Co., 4511 New York Ave., Union City, N. J.
R. B. M. Mfg. Co., Div. of Essex Wire Corp., Logansport, Ind.
Radionic Controls, 3758 Belmont Ave., Chicago 18, Ill.
Radionic Transformer Co., 411 S. Sangamon St., Chicago, Ill.
Red Arrow Electric Corp., 100 Coit St., Irvington, N. J.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
S-W Inductor Co., 1056 N. Wood St., Chicago, Ill.
Sandman Electric Motor Co., 164 Oliver St., Boston 10, Mass.
Smith Mfg. Co., Nathan R., 105 Pasadena Ave., South Pasadena, Calif.
Standard Coil Products Co., 2329 N. Pulaski Rd., Chicago 18, Ill.
Standard Winding Co., 44-62 Johnes St., Newburgh, N. Y.
Thermador Elec. Mfg. Co., 5119 S. Riverside Drive, Los Angeles 22, Calif.
Transformer Products, Inc., 143 W. 51st St., New York, N. Y.

ELECTRONIC and ALLIED PRODUCTS

Trebor Radio Co., Pasadena, Calif.
Tungsten Contact Mfg. Co., North Bergen, N. J.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
Universal X-Ray Products Inc., 1800 North Francisco Ave., Chicago 47, Ill.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Webster Electric Co., 1900 Clark St., Racine, Wisc.
Weller Mfg. Co., 516 Northampton St., Easton, Pa.
Wellman Manufacturing Co., 7122 Melrose Ave., Los Angeles 46, Calif.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wheeler Insulated Wire Co., Inc., 378 Washington Ave., Bridgeport, Conn.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio

Coil Winding Machines

see Machines

Colorimeters

PHOTO-ELECTRIC COLORIMETERS

Central Scientific Co., 1700 Irving Park Blvd., Chicago 13, Ill.
Coleman Electric Co., 318 Madison St., Maywood, Ill.
DeJur Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.
Electronic Products Co., 19 North First St., Geneva, Ill.
Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.
Gamma Instrument Co., Inc., 95 Madison Ave., New York 16, N. Y.
General Electric Co., Schenectady, N. Y.
Leitz, Inc., E., 730 Fifth Ave., New York 19, N. Y.
Pfaltz & Bauer, Inc., 350 Fifth Ave., New York, N. Y.
Photovolt Corp., 95 Madison Ave., New York 16, N. Y.
Pho-Tron Instrument Co., 5713 Euclid Ave., Cleveland, Ohio
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Saxl Instrument Co., 38-40 James St., East Providence 14, R. I.
Schaar & Co., 754 W. Lexington St., Chicago 7, Ill.
Scientific Glass Apparatus Co., Bloomfield, N. J.
Technical Products Co., 158 Madison Ave. at 3rd St., Memphis, Tenn.
White Research, 899 Boylston St., Boston, Mass.
Wilkens-Anderson Co., 111 N. Canal St., Chicago 6, Ill.

Comparators

see Analyzers, Surface

see Meters, pH

Condensers

see Capacitors

Connectors

CABLE CONNECTORS and COUPLINGS

A. B. C. Products, Inc., 11952 Montana Ave., W. Los Angeles 24, Calif.
Air Shields, Inc., Hatboro, Pa.
Airadio, Inc., Melrose Ave. & Battery Pl., Stamford, Conn.
Aircraft-Marine Prods., Inc., 1523 N. Fourth St., Harrisburg, Pa.
Aircraft Products Co., 3502 E. Pontiac St., Fort Wayne, Ind.
Aircraft Radio Corp., Boonton, N. J.
Alden Products Co., 117 North Main St., Brockton 64, Mass.
American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.
American Radio Hardware Co. Inc., 152 MacQuesten Pkway, S., Mt. Vernon, N. Y.
Andrew Co., 363 E. 75 St., Chicago 19, Ill.
Astatic Corp., 830 Market St., Conneaut, Ohio
Atlas Products Corp., 30 Rockefeller Plaza, New York 20, N. Y.
Atlas Sound Corp., 1443 39th St., Brooklyn, N. Y.
Automatic Metal Products Co., 315 Berry St., Brooklyn, N. Y.
Birnbach Radio Co., Inc., 145 Hudson St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Burndy Engineering Co., 107 Bruckner Blvd., New York 54, N. Y.
Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif.
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Cole-Hersee Co., 54 Old Colony Ave., Boston 27, Mass.
Connector Division, International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.
Dante Electric Mfg. Co., Bantam, Conn.
Diamond Instrument Co., North Ave., Wakefield, Mass.
Dossert & Co., 249 Huron St., Bklyn, N. Y.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia 13, Pa.
Electric Auto-Lite Co., Wire & Cable Div., Port Huron, Mich.
Electric Service Mfg. Co., 17th & Cambria St., Philadelphia 32, Pa.
Federal Mfg. & Engrg. Corp., 199-217 Steuben St., Brooklyn, N. Y.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., Schenectady 5, N. Y.
General Electronics Mfg. Co., 2225 S. Hoover St., Los Angeles 7, Calif.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Harwood Co., Division of Los Angeles Corp., 540 N. La Brea, Los Angeles 36, Calif.
Heyman Mfg. Co., Kenilworth, N. J.
Hubbell, Inc., Harvey, Bridgeport 2, Conn.
Ideal Commutator Dresser Co., 1291 Park Ave., Sycamore, Ill.
Ilsco Copper Tube & Product Inc., Mariemont Ave., Mariemont 27, Ohio
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Isolantite Inc., 343 Cortlandt St., Belleville 9, N. J.
Johnson Co., E. F., Waseca, Minn.
Jones, Howard B., 2460 W. George St., Chicago 18, Ill.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Kings Electronics Co., 372 Classon Ave., Brooklyn 5, N. Y.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
Lapp Insulator Co., LeRoy, N. Y.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Mendelsohn Speedgun Co., 457 Bloomfield Ave., Bloomfield, N. J.
Monowatt Electric Corp., 66 Bissell St., Providence 7, R. I.
Morse Co., Frank W., 301 Congress St., Boston 10, Mass.
National Electronic Mfg. Corp., 22-78 Steinway Street, Long Island City 5, N. Y.
National Fabricated Products, 2650 Belden Ave., Chicago 47, Ill.
Northam Warren Corp., Stamford, Conn.
Northern Communications Mfg. Co., 210 East 40th St., New York, N. Y.
Oxford-Tartak Radio Corp., 3911 S. Michigan Ave., Chicago 15, Ill.
O. Z. Electrical Mfg. Co., 262 Bond St., Brooklyn, N. Y.
Penn-Union Electric Corp., 315 State St., Erie, Pa.
Precision Specialties, 220 North Western Ave., Los Angeles, Calif.
Pyle-National Co., 1334 N. Kostner Ave., Chicago 51, Ill.
Remler Co., Ltd., 2101 Bryant St., San Francisco 10, Calif.
Rice's Sons, Inc., Bernard, 325 Fifth Ave., New York, N. Y.
Selectar Mfg. Co., 21-10 49th Ave., Long Island City, N. Y.
Sherman Mfg. Co., H. B., 22 Barney St., Battle Creek, Mich.
Stamford Metal Specialty Co., 428 Broadway, New York 13, N. Y.
Techno-Scientific Co., 901 Nepperhan Ave., Yonkers 3, N. Y.
Thomas & Betts Co., Inc., 36 Butler St., Elizabeth 1, N. J.
Trumbull Electric Mfg. Co., Plainville, Conn.
Ucinite Co., 459 Watertown St., Newtonville, Mass.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Wood Electric Co., Inc., C. D., 826 Broadway, New York 3, N. Y.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.
Zierick Mfg. Corp., 385 Gerard Ave., New York, N. Y.

Contacts

see Points

Contactors

Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 2, Wisc.
Allied Control Co., Inc., 2 East End Ave., New York 10, N. Y.
Arrow-Hart & Hegeman Elec. Co., 103 Hawthorn St., Hartford, Conn.
Automatic Electric Mfg. Co., 10 State St., Mankato, Minn.
Automatic Metal Products Corp., 315 Berry St., Brooklyn, N. Y.
Cutler-Hammer Inc., 315 North 12th St., Milwaukee 1, Wisc.
Connecticut Telephone Electric Div. of Great American Industries, Inc., 70 Brittania St., Meriden, Conn.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago 32, Ill.
General Electric Co., Schenectady 5, N. Y.
Graphite Metallizing Corp., 1055 Nepperhan Ave., Yonkers 3, N. Y.
Guardian Electric Mfg. Co., 1400 Washington Blvd., Chicago 7, Ill.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford 1, Conn.
Johnson Co., E. F., Waseca, Minn.
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Calif.
Monitor Controller Co., 51 S. Gay St., Baltimore 2, Md.
Sperry Gyroscope Co., Manhattan Bridge Plaza, Brooklyn 1, N. Y.
Struthers-Dunn, Inc., 1321 Arch St., Philadelphia 7, Pa.
Tork Clock Co., 1 Grove St., Mt. Vernon, N. Y.
Trumbull Electric Mfg. Co., Plainville, Conn.
Ward Leonard Electric Co., 31 South St., Mt. Vernon, N. Y.
Warrick, Charles F., 16251 Hamilton Ave., Detroit 3, Mich.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

Controls

ATTENUATORS

Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 2, Wisc.
Centralab Div., Globe Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc.
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Calif.
Clarostat Mfg. Co., Inc., 130 Clinton Street, Brooklyn 1, N. Y.
Collins Radio Co., 855-35th St. N.E., Cedar Rapids, Iowa
Daven Co., 191 Central Ave., Newark 4, N. J.
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electronic Components, 423 N. Western Ave., Los Angeles 4, Calif.
Electronic Products Co., 19 North First St., Geneva, Ill.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.
International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Madison Electrical Products Corp., Madison, N. J.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.

Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago 44, Ill.
Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Rowe Radio Research Laboratory Co., 2422 N. Pulaski Rd., Chicago 39, Ill.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Stokes Rubber Co., Jos., Taylor & Wehster Sts., Trenton, N. J.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
Trefz Manufacturing Co., 38-11 Main St., Flushing, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
White Research, 899 Boylston St., Boston, Mass.

MOTOR CONTROLS

Cutler-Hammer, Inc., 315 North 12th St., Milwaukee 1, Wisc.
Electron Equipment Corp., 917 Meridian Ave., South Pasadena, Calif.
General Electric Co., Schenectady 5, N. Y.
Hetherington & Son, Inc., Robert, Sharon Hill, Pa.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Yardeny Engrg. Co., 105 Chambers St., New York, N. Y.

VOLUME and TONE CONTROLS

Allen Bradley Co., 136 W. Greenfield Ave., Milwaukee 2, Wisc.
Centralab Div., Globe Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc.
Chicago Telephone Supply Co., 1142 W. Beardsley Ave., Elkhart, Ind.
Clarostat Mfg. Co., Inc., 130 Clinton Street, Brooklyn 1, N. Y.
Daven Co., 191 Central Ave., Newark 4, N. J.
DeJur Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Stackpole Carbon Co., St. Marys, Pa.
Stokes Rubber Co., Jos., Taylor & Webster Sts., Trenton, N. J.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
Trefz Manufacturing Co., 38-11 Main St., Flushing, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Wirt Co., 5521 Greene St., Philadelphia, Pa.
Wurlitzer Mfg. Co., Rudolph, North Tonawanda, New York

WELDING CONTROLS

see Timers, Welding

Converters

ROTARY CONVERTERS

see Generators

VIBRATOR TYPE

ABC Radio Laboratories, 3334 N. New Jersey St., Indianapolis 5, Ind.
American Television & Radio Co., 300 E. Fourth St., St. Paul 1, Minn.
Electronic Laboratories Inc., Indianapolis, Ind.
Electronic Measurements Co., Red Bank, N. J.
James Vibrapower Co., 1551 Thomas St., Chicago 22, Ill.
Kurman Electric Co., 135-18-37th St., Long Island City 1, N. Y.
Mallory & Co., P. R., Inc., 3029 E. Washington St., Indianapolis 6, Ind.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.
Richardson-Allen Corp., 15 West 20th, New York 11, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.

Cores

COMPLETE LAMINATED

Westinghouse Electric Corp., East Pittsburgh, Pa.

POWDERED IRON CORES

Aladdin Radio Industries, Inc., 501 W. 35th St., Chicago 16, Ill.
American Brass Co., Waterbury 88, Conn.
Crowley & Co., Inc., H. L., 1 Central Ave., West Orange, N. J.
Electro Products Laboratories, 549 W. Randolph St., Chicago, Ill.
Mallory Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Micro-Ferrocart Products Div., Maguire Industries, Inc., Greenwich, Conn.
Moraine Products Div., General Motors Corp., Dayton, Ohio
National Moldite Co., 25 Montgomery St., Hillside 5, N. J.
Pyroferric Corp., 175 Varick St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Stackpole Carbon Co., St. Marys, Pa.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Couplings

COAXIAL CABLE COUPLINGS

see Connectors

Crystals

CRYSTAL FINISHING EQUIPMENT

Consolidated Diamond Saw Blade Co., 320 Yonkers Ave., Yonkers 2, N. Y.
Cryco, Inc., 1516 Mission St., South Pasadena, Calif.
Diamond Tool Replacements, Div. of Oscap Mfg. Co., Inc., 207 W. Saratoga St., Baltimore 1, Md.
Felker Mfg. Co., 1132 Border Ave., Torrence, Calif.
Finch Telecommunications, Inc., Passaic, N. J.
General Crystals Corp., 1775 Foster Ave., Schenectady, N. Y.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Neb.
Hunt & Sons, G. C., 544 Hanover, Carlisle, Pa.
Jefferson, Inc., Ray, 40 E. Merrick Rd., Freeport, L. I., N. Y.
Leuck Crystal Laboratory, 245 South 11th St., Lincoln 8, Nebr.
Leiman Bros., 203 Christie St., Newark 5, N. J.
Linick & Co., Leslie L., 29 E. Madison St., Chicago, Ill.
Martindale Electric Co., 617 Edgewater Br., Cleveland, Ohio
Merkle-Korff Gear Co., 213 N. Morgan St., Chicago 7, Ill.
National Research Corp., Vacuum Engineering Div., 100 Brookline Ave., Boston 15, Mass.
Piezo Electric Prods. Co., 104 Fifth Ave., Brooklyn Park, Baltimore 25, Md.
Plastic Fabricators Co., 440 Sansome St., San Francisco, Calif.
Volkel Bros. Machine Works, 1943 W. Manchester, Los Angeles 44, Calif.
Vreeland Mfg. Co., 2020 Southwest Jefferson St., Portland 1, Oregon

QUARTZ CRYSTALS and HOLDERS

Aireon Manufacturing Corp., Fairfax & Funston Rds., Kansas City 15, Kansas
Alden Products Co., 117 North Main St., Brockton 64, Mass.
American Jewels Corp., Attleboro, Mass.
Bassett, Inc., Rex, 500 S. E. Second St., Fort Lauderdale, Fla.
Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y.
Beaumont Electric Supply Co., 1304 S. Indiana Ave., Chicago, Ill.
Bendix Radio Div., Bendix Aviation Corp., Baltimore 4, Md.
Bliley Electric Co., Erie, Pa.
Breon Laboratories, 607 Rose St., Williamsport, Pa.
Burnett Radio Lab., Wm. W. L., 4814 Idaho St., San Diego, Calif.
C. W. Mfg., 3800 Brooklyn Ave., Los Angeles 33, Calif.
Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass.
Carlisle Crystal Corp., 132 N. Hanover St., Carlisle, Pa.
Collins Radio Co., 855 35th St., N. E., Cedar Rapids, Iowa
Commercial Crystal Co., 112 N. Water St., Lancaster, Pa.
Commercial Equipment Co., 1416 McGee St., Kansas City, Mo.
Commercial Radio Equip. Co., 321 East Gregory Blvd., Kansas City 5, Mo.
Cryco, Inc., 1516 Mission St., S. Pasadena, Calif.
Crystal Laboratories, 801 W. Maple St., Wichita, Kansas
Crystal Products Co., 1519 McGee St., Kansas City 8, Mo.
Crystal Research Labs., Inc., 29 Allyn St., Hartford, Conn.
Dallons Laboratories, 5066 Santa Monica Blvd., Los Angeles, Calif.
Daughetee Mfg., 228 N. Clinton St., Chicago, Ill.
Diamond Drill Carbon Co., 63 Park Row, New York, N. Y.
Dow, L. A., 2208 4th Ave., Seattle, Wash.
DX Crystal Co., 1200 N. Claremont Ave., Chicago 22, Ill.
Eidson's, 1309 N. Second St., Temple, Texas
Electric Appliances Inc., 120 W. North St., Indianapolis 4, Ind.
Electrical Prod. Corp., 950-30th St., Oakland 8, Calif.
Electronic Ind. (Ill.), Sandwich, Ill.
Electronic Ind. (Iowa), 517 Fourth Ave., S. E., Cedar Rapids, Iowa
Electronic Mechanics, Inc., 70 Clifton Blvd., Clifton, N. J.
Elkay Radio Products, 305-309 E. Walnut St., Oglesby, Ill.
Etched Products Corp., 39-01 Queens Blvd., Long Island City, N. Y.
Federal Engineering Co., 37 Murray St., New York 7, N. Y.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Felsenthal & Sons, G., 4122 W. Grand Ave., Chicago 51, Ill.
Finch Telecommunications Inc., Passaic, N. J.
Franklin Transformer, 65 22nd Ave., N. E., Minneapolis 13, Minn.
Frequency Measuring, 1816 Walnut St., Kansas City, Mo.
Galvin Mfg. Corp., 4545 W. Augusta Blvd., Chicago 51, Ill.
General Ceramics & Steatite Corp., Keasbey, N. J.
General Crystal Corp., 1775 Foster Ave., Schenectady, N. Y.
General Electric Co., 1 River Road, Schenectady 5, N. Y.
General Piezo Co., 2614 State Ave., Kansas City, Kans.
General Quartz Lab., Cosmopolitan Bldg., Irvington on Hudson, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Gibbs & Co., Thomas B., Div. of George W. Borg Corp., 814 Michigan St., Delavan, Wis.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Neb.
Harvey Radio Labs., Inc., 447 Concord Ave., Cambridge, Mass.
Hatcher & Fisk, 125 Kansas Ave., Topeka, Kan.
Hearing Aid Lab., 1404 Franklin St., Michigan City, Ind.
Henney Motor Co., Gentleman Products Div., Freeport, Ill.

ELECTRONIC and ALLIED PRODUCTS

Henry Mfg. Co., 10860 Santa Monica Blvd., Los Angeles 25, Calif.
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
Hipower Crystal Co., 2033 W. Charleston St., Chicago, Ill.
Hoffman Co., P. R., 321 Cherry St., Carlisle, Pa.
Hollister Crystal Co., Boulder, Colo.
Howard Mfg. Co., 15 Fourth St., Council Bluffs, Iowa
Hunt & Sons, G. C., 544 Hanover, Carlisle, Pa.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Jefferson Inc., Ray, 40 E. Merrick Rd., Freeport, Long Island, N. Y.
Jefferson Travis Radio Mfg. Corp., 245 East 23rd St., New York 10, N. Y.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.
Kemlite Laboratories, 1809 N. Ashland Ave., Chicago, Ill.
Keystone Piezo Co., 2143 W. Liberty Ave., Pittsburgh 16, Pa.
Knights Co., James, 131 S. Wells St., Sandwich, Ill.
Lenoxite Div., Lenox, Inc., 65 Prince St., Trenton, N. J.
Leuck Crystal Laboratory, 245 S. 11th St., Lincoln, Neb.
Link, Fred M., 125 W. 17th St., New York, N. Y.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Majestic Radio & Television Corp., 2600 W. 50th St., Chicago, Ill.
Meck Industries, John, Liberty St., Plymouth, Ind.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller, August E., 9226 Hudson Blvd., North Bergen, N. J.
Monitor Piezo Products Co., 815 Fremont St., South Pasadena, Cal.
National Co., 61 Sherman St., Malden 48, Mass.
National Electronic Mfg. Corp., 22-78 Steinway St., Long Island City 5, N. Y.
National Scientific Products Co., 5013 N. Kedzie Ave., Chicago 25, Ill.
North American Philips Co., Inc., 100 E. 42nd St., New York 17, N. Y.
Ogush, Inc., William B., 33 W. 60th St., New York, N. Y.
Pacific Clay Products Co., 306 West Avenue 26, Los Angeles 31, Calif.
Pacific Radio Crystal Co., 1035 Post St., San Francisco, Cal.
Pan-Electronics Laboratories, Inc., 498 Spring St., N. W., Atlanta, Ga.
Parisian Novelty Co., 3510 S. Western Ave. Chicago 9, Ill.
Petersen Radio Co., 2800 W. Broadway, Council Bluffs, Iowa
Philco Corp., Tioga & C Sts., Philadelphia 34, Pa.
Piezo Electric Products Co., 104 Fifth Ave., Brooklyn Park, Baltimore 25, Md.
Precision Piezo Service, 427 Mayflower St., Baton Rouge, La.
Premier Crystal Labs., Inc., 63 Park Row, New York, N. Y.
Quartz Lab., Inc., 1513 Oak St., Kansas City, Mo.
Quartz Products Co. of New York, 304 E. 45th St., New York, N. Y.
R. E. C. Mfg. Corp., 1250 Highland St., Holliston, Mass.
R-9 Crystal Co., Inc., 632 Grant St., Pittsburgh, Pa.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Specialty Mfg. Co., 403 N. W. 9th Ave., Portland, Oregon
Reeves Sound Lab., Inc., 62 W. 47th St., New York, N. Y.
Remler Co. Ltd., 2101 Bryant St., San Francisco 10, Calif.
Ross Mfg. Co., 2241 S. Indiana Ave., Chicago 27, Ill.
Scientific Radio Products Co., 738 W. Broadway, Council Bluffs, Iowa
Scientific Radio Service, 4301 Sheridan St., University Park, Md.
Sentry Crystal Co., 206 S. W. Washington St., Portland 4, Ore.
Sherron Electronics Co., 1201 Flushing Ave., Brooklyn 6, N. Y. (test equipment.)
Sillcocks-Miller Co., 10 Parker Ave. W., South Orange, N. J.
Sipp-Eastwood Corp., 39 Keen St., Paterson, N. J.
Smith Lab., M. L., 16 Field St., Kane, Pa.
Somerset Laboratories, 306 Valleybrook Ave., Lyndhurst, N. J.
Sperry Gyroscope Co., Manhattan Bridge Plaza, Brooklyn 1, N. Y.
Standard Coil Products Co., 2329 N. Pulaski Rd., Chicago 18, Ill.
Standard Piezo Co., Woolworth Bldg., Carlisle, Pa.
Standard Plastics, 1548 S. Robertson Blvd., Los Angeles 35, Calif.
Telephonics Corp., 350 West 31st St., New York, N. Y.
Telicon Corp., 851 Madison Ave., New York, N. Y.
Union Piezo Corp., 701 McCarter Highway, Newark, N. J.
Universal Television System, 112 W. 18th St., Kansas City 8, Mo.
Valpey Crystals, Highland St., Holliston, Mass.
Wallace Mfg. Co., Wm. T., Chili & Madison Aves., Peru, Indiana
Wellman Mfg. Co., 7122 Melrose Ave., Los Angeles 46, Calif.
Western Electric Co., 120 Broadway, New York 5, N. Y.
Wilcox Elec. Co., 1400 Chestnut St., Kansas City, Mo.
Wynne Precision Co., 114½ N. Hill St., Griffin, Ga.

ROCHELLE SALT CRYSTALS

Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Tibbetts Laboratories, Camden, Maine
Western Electric Co. Inc., 120 Broadway, New York 5, N. Y.

Cutting Heads

see Recorders, Sound

Dial Lights

see Lights

Dials

see also Knobs, Pointers

Alden Products Co., 117 North Main St., Brockton 64, Mass.
American Radio Hardware Co., Inc., 152 MacQuesten Pkway. S., Mt. Vernon, N. Y.
Ansonia Clock Co., Inc., 103 Lafayette St., New York 13, N. Y.
Austin Co., O., 42 Greene St., New York, N. Y.
B. & C. Insulation Products, Inc., 261 Fifth Ave., New York 16, N. Y.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bastian Bros. Co., 1600 N. Clinton Ave., Rochester, N. Y.
Birnbach Radio Co. Inc., 145 Hudson St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Cardy-Lundmark, 1801 West Bryon St., Chicago 13, Ill.
Croname, Inc., 3701 Ravenswood Ave., Chicago, Ill.
Daven Co., 191 Central Ave., Newark 4, N. J.
Dearborn Glass Co., 2414 W. 21st St., Chicago, Ill.
Eastern Etching & Mfg. Co., Chicopee, Mass.
Emeloid Co., 291 Laurel Ave., Arlington, N. J.
Erie Resistor Corp., 644 W. 12th St., Erie, Pa.
Etched Products Corp., 39-01 Queens Blvd., Long Island City, N. Y.
Felsenthal & Sons, G., 4122 W. Grand Ave., Chicago 51, Ill.
Finch Telecommunications, Inc., Passaic, N. J.
Flock Process Co., 53 W. 31st St., New York 10, N. Y. (Also, 3 Quincy St., Norwalk, Conn.)
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Grammes & Sons, Inc., L. F., 389 Union St., Allentown 2, Pa.
Hopp Press, Inc., 460 W. 34th St., New York, N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Kurz-Kasch Co., 1415 So. Broadway, Dayton 1, Ohio
Long Island Engraving Co., 19 West 21st St., New York 10, N. Y.
McInerney Plastic Co., 655 Godfrey Ave., S. W., Grand Rapids 1, Michigan
Marion Electrical Instrument Co., Manchester, N. H.
Mica Insulator Co., 797 Broadway, Schenectady 1, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, 48, Mass.
New England Etching & Plating Co., 25 Spring St., Holyoke, Mass.
New England Radiocrafters, 1156 Commonwealth Ave., Boston 34, Mass.
Parisian Novelty Co., 3510 S. Western Ave., Chicago 9, Ill.
Plastic Fabricators Co., 440 Sansome St., San Francisco 11, Calif.
Premier Metal Etching Co., 21-03 44th Ave., Long Island City, N. Y.
Printloid, Inc., 95 Mercer St., New York, N. Y.
Richardson Co., Melrose Park, Ill.
Screenmakers, 64 Fulton St., New York 1, N. Y.
Silk Screen Supplies, Inc., 33 Lafayette Ave., Brooklyn, N. Y.
Sillcocks-Miller Co., 10 Parker Ave., W. South Orange, N. J.
Technical Radio Co., 275 Ninth St., San Francisco, Calif.
Waterbury Button Co., 835 S. Main St., Waterbury, Conn.
Worcester Moulded Plastics Co., 8 Grafton St., Worcester 8, Mass.

Direction Finders

see Radio Compass Receivers

Discs

BLANK RECORDING DISCS

Advance Recording Products Co., 36-12 34th St., Long Island City, N. Y.
Allied Recording Products Co., 21-09 43d Ave., Long Island City 1, N. Y.
Audio Devices, Inc., 444 Madison Ave., New York 22, N. Y.
Bakelite Corp., 30 East 42nd St., New York 17, N. Y.
Dearborn Glass Co., 2414 W. 21st St., Chicago, Ill.
Duotone Co., 799 Broadway, New York, N. Y.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Federal Recorder, Elkhart, Ind.
Galvin Mfg. Corp., 4545 W. Augusta Blvd., Chicago 51, Ill.
General Electric Co., Schenectady 5, N. Y.
Gould-Moody Co., 395 Broadway, New York, N. Y.
Gray Mfg. Co., 16-30 Arbor St., Hartford, Conn.
Home Recording Co., 9 E. 19th St., New York, N. Y.
Howard Radio Co., 1735 Belmont Ave., Chicago 13, Ill.
Memovox, Inc., 9242 Beverly Blvd., Beverly Hills, Calif.
Mirror Record Corp., 58 W. 25th St., New York, N. Y.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles 34, Calif.
Sound Devices Co., 160 East 116th St., New York 20, N. Y.
SoundScriber Corp., The, 82 Audubon St., New Haven 11, Conn.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.
Talking Devices Co., 4447 W. Irving Park Rd., Chicago, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wilcox Gay Corp., Charlotte, Mich.
Zephyr Products Corp., 160 E. 116th St., New York 29, N. Y.

Discs, Rectifier

see Rectifiers

Dividers

VOLTAGE DIVIDERS

see Resistors, Wire Wound

Drafting Equipment

Alteneder Co., Theo., 1217 Spring Garden St., Philadelphia 23, Pa.
American Pencil Co., 500 Willow Ave., Hoboken, N. J.
American Photocopy Equipment Co., 2849 N. Clark St., Chicago, Ill.
Arkwright Finishing Co., Turks Head Bldg., Providence, R. I.
Bruning Co., Inc., Charles, 4700 Montrose Ave., Chicago 41, Ill.
Cardinell Corp., Montclair, N. J.
Carter's Ink Co., Cambridge, Mass.
Dietzgen Co., Eugene, 2425 Sheffield Ave., Chicago, Ill.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Eagle Pencil Co., 703 East 13th St., New York, N. Y.
Eberhard Faber Pencil Co., 37 Greenpoint Ave., Brooklyn 22, N. Y.
Eclipse Moulded Products Co., 5151 North 32nd St., Milwaukee 9, Wisc.
Emmert Mfg. Co., Waynesboro, Pa.
Eraser Co., 231 W. Water St., Syracuse 2, N. Y.
Faber, Inc., A. W., 41 Dickerson St., Newark 4, N. J.
General Pencil Co., 67 Fleet St., Jersey City, N. J.
Gold Shield Products Co., 25 W. Broadway, New York 7, N. Y.
Higgins Ink Co., Inc., 271 Ninth St., Brooklyn 15, N. Y. (Drafting inks)
Holliston Mills, Inc., Norwood, Mass.
Hunter Electro Copyist, Inc., 430 S. Warren St., Syracuse, N. Y.
Keuffel & Esser Co., 300 Adams St., Hoboken, N. J.
Koh-I-Noor Pencil Co., Bloomsbury, N. J.
Ozalid Div., General Aniline & Film Corp., 770 Ansco Rd., Johnson City, N. Y.
Paragon-Revolute Corp., 97 South Ave., Rochester 4, N. Y.
Pease Company, C. F., 2601 W. Irving Park Rd., Chicago 18, Ill.
Photo Reproducing Eqpt. Co., Chatham, N. J.
Plastic Fabricators Co., 440 Sansome St., San Francisco 11, Calif.
Post Co., Frederick, 3650 Avondale Ave., Chicago 90, Ill.
Reliance Devices Co., Inc., 30 Irving Place, New York 3, N. Y.
Staedtler, J. S., Inc., 53-55 Worth St., New York, N. Y.
Starrett Co., L. S., 165 Crescent St., Athol, Mass.
Technical Products Co., 158 Madison at Third St., Memphis, Tenn.
United States Blue Print Paper Co., 207 S. Wabash Ave., Chicago, Ill.
Universal Drafting Machine Co., 1426 W. Third St., Cleveland 13, Ohio
Weber Co., F., 1220 Buttonwood St., Philadelphia 23, Pa.
White Co., David, 315 Court St., Milwaukee, Wisc.
Wickes Bros., 515 N. Washington St., Saginaw, Mich.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia. Pa.

Dynamotors

see Generators

Enamels

see Finishes

Equalizers

see Filters

Escutcheons

see also Dials, Scales

Alden Products Co., 117 North Main St., Brockton 64, Mass.
American Emblem Co., Utica, N. Y.
American Radio Hardware Co., Inc., 152 MacQuesten Pkway. S., Mt. Vernon, N. Y.
Ansonia Clock Co., Inc., 103 Lafayette St., New York 13, N. Y.
Austin Co., O., 42 Greene St., New York, N. Y.
B. & C. Insulation Products Inc., 261 Fifth Ave., New York 16, N. Y.
Bastian Bros. Co., 1600 N. Clinton Ave., Rochester, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Continental-Diamond Fibre Co., 16 Chapel St., Newark, Del.
Croname, Inc., 3701 Ravenswood Ave., Chicago, Ill.
Daven Co., 191 Central Ave., Newark 4, N. J.
Eastern Etching & Mfg. Co., Chicopee, Mass.
Emeloid Co., Inc., 291 Laurel Ave., Arlington, N. J.
Erie Resistor Corp., 644 W. 12 St., Erie, Pa.
Etched Products Corp., 39-01 Queens Blvd., Long Island City, N. Y.
Farley & Loetscher Mfg. Co., Dubuque, Iowa
Felsenthal & Sons, G., 4122 W. Grand Ave., Chicago 51, Ill.
Flock Process Co., 53 W. 21st St., New York 10, N. Y. (Also, 3 Quincy St., Norwalk, Conn.)
Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
General Electric Co., Plastics Div., 1 Plastics Ave., Pittsfield, Mass.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Grammes & Sons, Inc., L. F., 389 Union St., Allentown 2, Pa.
Hopp Press, Inc., 460 West 34th St., New York, N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Long Island Engraving Co., 19 West 21st St., New York 10, N. Y.
Meyercord Co., 5323 W. Lake St., Chicago, 44, Ill.
Mica Insulator Co., 797 Broadway, Schenectady 1, N. Y.
New England Etching & Plating Co., 25 Spring St., Holyoke, Mass.
New England Radiocrafters, 1156 Commonwealth Ave., Boston 34, Mass.
Panelyte Div., St. Regis Paper Co., 230 Park Ave., New York, N. Y.
Photox Silk Screen Supply Co., 30 Irving Place, New York 3, N. Y.
Plastic Fabricators Co., 440 Sansome St., San Francisco 11, Calif.
Plastic Manufacturers, Inc., Stamford, Conn.
Premier Metal Etching Co., 21-03 44th Ave., Long Island City, N. Y.
Scovill Mfg. Co., 99 Mill St., Waterbury 91, Conn.
Screenmakers, 64 Fulton St., New York 1, N. Y.
Sillcocks-Miller Co., 10 Parker Ave. W., South Orange, N. J.
Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N. Y.
Stamford Metal Specialty Co., 428 Broadway, New York 13, N. Y.
Syracuse Ornamental Co., 581 So. Clinton St., Syracuse, N. Y.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
Victory Mfg. Co., 1722 W. Arcade Pl., Chicago 12, Ill.
Waters Conley Co., 501 First St. N. W., Rochester, Minn.

Facsimile

Alden Products Co., 117 N. Main St., Brockton 64, Mass.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Engineering Laboratories, Inc., 602 E. Fourth St., Tulsa 3, Okla.
Finch Telecommunications, Inc., Passaic, N. J.
General Electric Co., Schenectady 5, N. Y.
Gilfillan Bros., Inc., 1815 Venice Blvd., Los Angeles, Calif.
Hallicrafters Co., 2611 Indiana Ave., Chicago 16, Ill.
Megard Corp., 1601 S. Burlington St., Los Angeles, Calif.
Press Wireless, Inc., 1475 Broadway, New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Record-O-Vox, Inc., 721 N. Martel Ave., Hollywood 46, Calif.
United States Television Mfg. Corp., 106 Seventh Ave., New York, N. Y.
Wilcox Gay Corp., Charlottle, Mich.

Fasteners & Fastening Devices

Adel Precision Products Corp., Burbank, Calif.
An-cor-lox Div., Laminated Shim Co., Inc., Union St., Glenbrook, Conn.
Automatic Nut Co., Inc., Lebanon, Pa.
Boots Aircraft Nut Corp., New Canaan, Conn.
Camloc Fastener Corp., 420 Lexington Ave., New York 17, N. Y.
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Clark Bros. Bolt Co., Milldale, Conn.
Columbia Nut & Bolt Co., 945 Main St., Bridgeport, Conn.
Dzus Fasteners Co., Inc., Box 605, Babylon, Long Island, N. Y.
Elastic Stop Nut Corp. of America, 2371 Vauxhall Rd., Union, N. J.
Federal Screw Products Co., 224 W. Huron St., Chicago 10, Ill.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Bridgeport, Conn.
Hartford Machine Screw Co., Hartford, Conn.
Industrial Screw & Supply Co., 713 W. Lake St., Chicago 6, Ill.
Lamson & Sessions Co., 1971 West 85th St., Cleveland, Ohio
Manufacturers Screw Products, 270 W. Hubbard St., Chicago, Ill.
National Screw & Mfg. Co., 2440 E. 75th St., Cleveland 4, Ohio
Palnut Co., Inc., 77 Cordier St., Irvington 11, N. J.
Pittsburgh Screw & Bolt Corp., P. O. Box 1708, Pittsburgh, Pa.
Russell, Burdsall & Ward Bolt & Nut Co., Midland Ave., Port Chester, N. Y.
Scovill Mfg. Co., 99 Mill St., Waterbury 91, Conn.
Security Locknut Corp., 630 S. Wabash Ave., Chicago 5, Ill.
Simmons Machine Tool Corp., Fastener Div., Albany 1, N. Y.
Standard Locknut & Lockwasher, Inc., 33-35 West St. Clair St., Indianapolis, Ind.
Standard Pressed Steel Co., Jenkintown, Pa.
Thomas & Betts Co., Inc., 36 Butler St., Elizabeth 1, N. J.
Thompson-Bremer & Co., 1640 W. Hubbard St., Chicago, Ill.
Tinnerman Products, Inc., 2106 Fulton Rd., Cleveland 13, Ohio
Union Aircraft Products Corp., 380 Second Ave., New York, N. Y.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.

Fibre

see Insulation

Filter Chokes

see Chokes, Power & Audio

Filters

ELECTRIC WAVE SECTION FILTERS

American Transformer Co., 178 Emmett St., Newark, N. J.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Audio Development Co., 2833 13th Ave., S., Minneapolis 7, Minn.
Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y.
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, North Hollywood, Calif.

Best Mfg. Co., Inc., 1200 Grove St., Irvington 1, N. J.
Chicago Transformer Div., Essex Wire Corp., 3501 W. Addison St., Chicago 18, Ill.
Electronic Engineering Co., 3223 West Armitage Ave., Chicago, Ill.
Electronic Transformer Co., 207 West 25th St., New York, N. Y.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.
Foster Co., A. P., 719 Wyoming Ave., Lockland 15, Ohio
Freed Transformer Co., 72 Spring St., New York 12, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles 36, Calif.
International Transformer Co., 396 Broadway, New York, N. Y.
Kenyon Transformer Co., 840 Barry St., New York 59, N. Y.
Lavoie Laboratories, Morganville, N. J.
Northern Communications Mfg. Co., 210 East 40th St., New York, N. Y.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
S-W Inductor Co., 1056 N. Wood St., Chicago, Ill.
Techno-Scientific Co., 901 Nepperhan Ave., Yonkers 3, N. Y.
Thordarson Electric Mfg. Div., Maguire Industries, Inc., 500 W. Huron St., Chicago, Ill.
Transformer Products, Inc., 143 W. 51st St., New York, N. Y.
United Transformer Corp., 150 Varick St., New York 13, N. Y.

EQUALIZER FILTERS

Airdesign & Fabrication, Inc., 241 Fairfield Ave., Upper Darby, Pa.
Altec Lansing Corp., 1680 N. Vine St., Los Angeles 28, Calif.
American Transformer Co., 178 Emmett St., Newark, N. J.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Audio Development Co., 2833 13th Ave. S., Minneapolis 7, Minn.
Audio Tone Oscillator Co., 237 John St., Bridgeport 3, Conn.
Daven Co., 191 Central Ave., Newark 4, N. J.
Electronic Engineering Co., 3223 West Armitage Ave., Chicago, Ill.
Electronic Transformer Co., 207 West 25th St., New York, N. Y.
Ferranti Electric Inc., 30 Rockefeller Plaza, New York 20, N. Y.
Freed Transformer Co., 72 Spring St., New York 12, N. Y.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles 36, Calif.
International Transformer Co., 396 Broadway, New York, N. Y.
Kenyon Transformer Co., 840 Barry St., New York 59, N. Y.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Northern Communications Mfg. Co., 210 East 40th St., New York, N. Y.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles 34, Calif.
S-W Inductor Co., 1056 N. Wood St., Chicago, Ill.
Simpson Mfg. Co., Inc., Mark, 188 West Fourth St., New York, N. Y.
Thordarson Electric Mfg. Div., Maguire Industries, Inc., 500 W. Huron St., Chicago 10, Ill.
Transformer Products, Inc., 143 W. 51st St., New York, N. Y.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.

NOISE FILTERS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
American Television & Radio Co., 300 East Fourth St., St. Paul 1, Minn.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Andrea Radio Corp., 43-20 34th St., Long Island City, N. Y.
Automatic Mfg. Co., 900 Passaic Ave., E. Newark, N. J.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, North Hollywood, Calif.
Birnbach Radio Co., Inc., 145 Hudson St., New York, N. Y.
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Electronic Transformer Co., 207 West 25th St., New York, N. Y.
Erie Resistor Corp., 644 West 12th St., Erie, Pa.
Fast & Co., John E., 3101 N. Pulaski Rd., Chicago 41, Ill.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.
Freed Radio Corp., 200 Hudson St., New York, N. Y.
Freed Transformer Co., 72 Spring St., New York 12, N. Y.
General Winding Co., 420 West 45th St., New York, N. Y.
Girard-Hopkins, 1000 40th Ave., Oakland 1, Cal.
Halldorson Company, The, 4500 Ravenswood Ave., Chicago 28, Ill.
Industrial Condenser Corp., 3243 North California Ave., Chicago 18, Ill.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Kenyon Transformer Co., 840 Barry St., New York 59, N. Y.
Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Measurements Corp., Boonton, N. J.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Calif.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
Presto Recording Corp., 242 West 55th St., New York, N. Y.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
S-W Inductor Co., 1056 N. Wood St., Chicago, Ill.
Solar Mfg. Corp., 285 Madison Ave., New York 17, N. Y.
Sprague Electric Co., 189 Beaver St., North Adams, Mass.
Technical Appliance Corp., 516 W. 34th St., New York 1, N. Y.
U. S. Television Mfg. Corp., 106 Seventh Ave., New York 11, N. Y.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Whisk Laboratories, 87 Maiden Lane, New York 7, N. Y.

Finders, Direction

see Radio Compass Receivers

Finishes

INSULATING ENAMELS

Alden Products Co., 117 North Main St., Brockton 64, Mass.
Bakelite Corp., 30 E. 42nd St., New York 17, N. Y.
Day & Co., James B., 1872 Clybourn Ave., Chicago 14, Ill.
Dolph Co., John C., 1060 Broad St., Newark, N. J.
Du Pont de Nemours & Co., Inc., E. I., Wilmington 98, Del.
Electric Service Manufacturing Co., 17th & Cambria Sts., Philadelphia 32, Pa.
Franklin Paint & Varnish Co., Benjamin, 4820 Langdon St., Philadelphia 24, Pa.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Schenectady 5, N. Y.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
International Products Corp., Baltimore 18, Md.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington 11, N. J.
Lilly Varnish Co., 670 S. California St., Indianapolis, Ind.
Lowe Bros. Co., 436 E. Third St., Dayton, Ohio
Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J.
Murphy Finishes Corp., 224 McWhorter St., Newark 1, N. J.
New Wrinkle, Inc., 314 W. First St., Dayton 2, Ohio
Pratt & Lambert, Inc., 75 Tonawanda St., Buffalo 17, N. Y.
Roxalin Flexible Finishes, Inc., 800 Magnolia Ave., Elizabeth, F, N. J.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Standard Varnish Works, 2600 Richmond Terrace, Staten Island 3, N. Y.
Watson-Standard Co., 225 Galveston St., Pittsburgh, Pa.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Zapon Div., Atlas Powder Co., Ludlow St., Stamford, Conn.

INSULATING VARNISH

Aluminum Finishing Corp., 1119 E. 22nd St., Indianapolis, Ind.
American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.
American Products Mfg. Co., 8127 Oleander St., New Orleans, La.
Arco Co., 7301 Bessemer Ave., Cleveland, 4, Ohio
B & C Insulation Products, Inc., 261 Fifth Ave., New York 16, N. Y.
Bakelite Corp., 30 E. 42d St., New York 17, N. Y.
Communication Parts, 1101 N. Paulina St., Chicago 22, Ill.
Day & Co., James B., 1872 Clybourn Ave., Chicago 14, Ill.
Dolph Co., John C., 1060 Broad St., Newark, N. J.
Dow Corning Corp., Box 592, Midland, Mich.
Du Pont de Nemours & Co., Inc., E. I., Wilmington 98, Del.
Durez Plastics & Chemicals, Inc., 1922 Walck Road, North Tonawanda, N. Y.
Electric Service Manufacturing Co., 17th & Cambria Sts., Philadelphia 32, Pa.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Pittsfield, Mass.
George Co., P. D., 5200 N. Second St., St. Louis, Mo.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Haynes Laboratories, Inc., C. W., 61 Chandler St., Springfield, Mass.
Hilo Varnish Corp., 42 Stewart Ave., Brooklyn, N. Y.
Insl-X Co., Inc., 857 Meeker Ave., Brooklyn, N. Y.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington 11, N. J.
Jones-Dabney Co., Smith & Proback Sts., Louisville, Ky.
Lastik Products Co., Keenan Bldg., Pittsburgh, Pa.
Lilly Varnish Co., 670 S. California St., Indianapolis, Ind.
Lowe Brothers Co., 436 E. Third St., Dayton, Ohio
Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J.
Makalot Corp., 262 Washington St., Boston, Mass.
Marblette Corp., 37-21-30th St., Long Island City 1, N. Y.
Mica Insulator Co., 797 Broadway, Schenectady 1, N. Y.
Mitchell-Rand Insulation Co., Inc., 51 Murray St., New York 7, N. Y.
Murphy Finishes Corp., 224 McWhorter St., Newark 1, N. J.
New Wrinkle, Inc., 314 W. First St., Dayton 2, Ohio
Pratt & Lambert, Inc., 75 Tonawanda St., Buffalo 17, N. Y.
Production Engrg. Corp., 666 Van Houten Ave., Clifton, N. J. (Service)
Robertson Chemical Co., 9808 Meech Ave., Cleveland, Ohio
Roxalin Flexible Finishes Inc., 800 Magnolia Ave., Elizabeth, F, N. J.
Schott Co. Walter L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J.
Standard Varnish Works, 2600 Richmond Terrace, Staten Island 3, N. Y.
Sterling Varnish Co., Haysville, Pa.

Watson-Standard Co., 225 Galveston St., Pittsburgh, Pa.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wipe-On Corp., 105 Hudson St., New York 13, N. Y.
Zapon Div., Atlas Powder Co., Ludlow St., Stamford, Conn.

LACQUER FINISHES

Alden Products Co., 117 North Main St., Brockton 64, Mass.
Ambroid Co., 305 Franklin St., Boston 10, Mass.
American Products Mfg. Co., 8127 Oleander St., New Orleans, La.
Arco Co., 7301 Bessemer Ave., Cleveland 4, Ohio
Bakelite Corp., 30 E. 42d St., New York 17, N. Y.
Communication Products Co., Inc., Route # 36 & Palmer Ave., Keansburg, N. J.
Day & Co., James B., 1872 Clybourn Ave., Chicago 14, Ill.
Dolph Co., John C., 1060 Broad St., Newark, N. J.
Du Pont de Nemours & Co., Inc., E. I., Wilmington 98, Del.
Durez Plastics & Chemicals, Inc., 1922 Walck Road, North Tonawanda, N. Y.
Egyptian Lacquer Mfg. Co., 1270 Sixth Ave., New York, N. Y.
Franklin Paint & Varnish Co., Benjamin, 4820 Langdon St., Philadelphia 24, Pa.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Schenectady 5, N. Y.
Haynes Laboratories, Inc., C. W., 61 Chandler St., Springfield, Mass.
Hilo Varnish Corp., 42 Stewart Ave., Brooklyn, N. Y.
Howe & French, Inc., 99 Broad St., Boston 10, Mass.
Johnson & Co., S. C., Industrial Div., Racine, Wisc.
Jones-Dabney Co., Smith & Proback Sts., Louisville, Ky.
Lilly Varnish Co., 670 S. California St., Indianapolis, Ind.
Lowe Brothers Co., 436 E. Third St., Dayton, Ohio
Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J.
Makalot Corp., 262 Washington St., Boston, Mass.
Marblette Corp., 37-21-30th St., Long Island City 1, N. Y.
Monsanto Chemical Co., Merrimac Div., Everett, Mass.
Murphy Finishes Corp., 224 McWhorter St., Newark 1, N. J.
New England Radiocrafters, 1156 Commonwealth Ave., Boston 34, Mass.
New Wrinkle, Inc., 314 W. First St., Dayton 2, Ohio
Pratt & Lambert, Inc., 75 Tonawanda St., Buffalo 17, N. Y.
Roxalin Flexible Finishes, Inc., 800 Magnolia Ave., Elizabeth F, N. J.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Standard Varnish Works, 2600 Richmond Terrace, Staten Island 3, N. Y.
Technical Products Co., 158 Madison Ave. at Third St., Memphis, Tenn.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Watson-Standard Co., 225 Galveston St., Pittsburgh, Pa.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Zapon Div., Atlas Powder Co., Ludlow St., Stamford, Conn.

Flock & Flocked Paper

Austin Co., O., 42 Greene St., New York, N. Y.
Auburn Mfg. Co., 110 Stack St., Middletown, Conn
Cellusuede Products, Inc., Rockford, Ill.
Flock Process Co., 53 West 21st St., New York 10, N. Y. Also, 3 Quincy St., Norwalk, Conn.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Calif.

Flux, Solder

Allen Co., L. B., 6719 Bryn Mawr Ave., Chicago, Ill.
American Chemical Paint Co., Ambler, Pa.
American Solder & Flux Co., 2152 E. Norris St., Philadelphia 25, Pa.
Benson Co., Alex R., 4 E. Court St., Hudson, N. Y.
Burnley Battery & Mfg. Co., Clay St., North East, Pa.
Day & Co., James B., 1872 Clybourn Ave., Chicago, Ill.
Dunton Co., M. W., 670 Eddy St., Providence, R. I.
DuPont de Nemours & Co., E. I., Grasselli Chemicals Dept., Wilmington, Del.
Farrelloy Co., 1245 N. 26th St., Philadelphia, Pa.
Garden City Laboratory, 2744 W. 37th Pl., Chicago, Ill.
Geko Chemical Co., 143-05 Franconia Ave., Flushing, N. Y.
General Electric Co., Bridgeport, Conn.
Glaser Lead Co., Inc., 31 Wyckoff Ave., Brooklyn, N. Y.
Handy & Harman, 82 Fulton St., New York 7, N. Y.
Hercules Chemical Co., 332 Canal St., New York, N. Y.
Johnson Co., Lloyd S., 2241 Indiana Ave., Chicago, Ill.
Johnson Mfg. Co., 729 W. Washington Blvd., Chicago, Ill.
Jordan Co., 51st & S. Merrimac, Chicago 38, Ill.
Kester Solder Co., 4212 Wrightwood Ave., Chicago, Ill.
Lukens Metal Co., Thomas F., 3000 E. Hedley St., Philadelphia 37, Pa.
McGill Mfg. Co., Box 670, Valparaiso, Ind.
Mico Instrument Co., 80 Trowbridge St., Cambridge 38, Mass.
Mitchell-Rand Insulation Co., 51 Murray St., New York 7, N. Y.
Ogden Chemical Laboratories, 324 E. Third St., Cincinnati, Ohio
Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio
Paragon Insulating Co., 5716 Euclid Ave., Cleveland, Ohio
Pfanstiehl Chemical Co., 104 Lake View Ave., Waukegan, Ill.
Rodale Mfg. Co., 6th & Minor Sts., Emaus, Pa.
Rotax Mfg. Co., 24 Bathgate Place, Newark 7, N. J.
Ruby Chemical Co., 68 McDowell St., Columbus, Ohio
Special Chemicals Co., 30 Irving Place, New York, N. Y.
Weaver Specialty Co., 6344 Aurelia St., Pittsburgh, Pa.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Forks

ELECTRICALLY DRIVEN TUNING FORKS

American Time Products, Inc., 580 Fifth Ave., New York 19, N. Y.
Cambridge Instrument Co., 3732 Grand Central Terminal, New York 17, N. Y.
Central Scientific Co., 1700 Irving Park Blvd., Chicago 13, Ill.
Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago, Ill.
Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Gibbs & Co., Thomas B., Div. of George W. Borg Corp., 814 Michigan St., Delavan, Wisc.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles 34, Calif.
Riverbank Laboratories, Geneva, Ill.
Stoelting Co., C. H., 424 N. Homan Ave., Chicago, Ill.
Stokes Rubber Co., Jos., Taylor & Webster Sts., Trenton, N. J.
Times Telephoto Equipment, Inc., 229 West 43rd St., New York, N. Y.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.

Forms

COIL FORMS

Accurate Spring Mfg. Co., 3811 W. Lake St., Chicago, Ill.
Alden Products Co., 117 North Main St., Brockton 64, Mass.
American Lava Corp., Kruesi Bldg., Chattanooga 5, Tenn.
American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.
Auburn Mfg. Co., 110 Stack St., Middletown, Conn.
Automatic Mfg. Co., 900 Passaic Ave., E. Newark, N. J.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bud Radio Inc., 2118 E. 55th St., Cleveland 3, Ohio
Centralab, Div. of Globe Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc.
Continental-Diamond Fibre Co., 16 Chapel St., Newark, Del.
Corning Glass Works, Corning, N. Y.
Creative Plastics Corp., 963 Kent Ave., Brooklyn, N. Y.
Crowley & Co., Inc., Henry L., 1 Central Ave., West Orange, N. J.
DX Crystal Co., 1200 N. Claremont Ave., Chicago 22, Ill.
Electrical Insulation Co., Inc., 12 Vestry St., New York, N. Y.
Electronic Mechanics, Inc., 70 Clifton Blvd., Clifton, N. J.
Essex Electronics, 1060 Broad St., Newark 2, N. J.
General Ceramics & Steatite Corp., Keasbey, N. J.
General Winding Co., 420 West 45th St., New York, N. Y.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Hammarlund Mfg. Co., Inc., 460 W. 34th St., New York 1, N. Y.
Hawley Products Co., St. Charles, Ill.
Haydu Bros., Mt. Bethel Rd., Plainfield, N. J.
Insulator Tube Co., Inc., 26 Cottage St., P. O. Box 1, Poughkeepsie, N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Isolantite, Inc., 343 Cortlandt St., Belleville 9, N. J.
Johnson Co., E. F., Waseca, Minn.
Lenoxite Div. Lenox, Inc., 65 Prince St., Trenton, N. J.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Mica Insulator Co., 797 Broadway, Schenectady 1, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Munsell & Co., Eugene, 200 Varick St., New York, N. Y.
Mycalex Corp. of America, 60 Clifton Blvd., Clifton, N. J.
Mykroy, Inc., 1917 N. Springfield Ave., Chicago 47, Ill.
National Co., 61 Sherman St., Malden, 48, Mass.
National Fabricated Products, 2650 Belden Ave., Chicago 47, Ill.
National Tile Co., 1200 East 26th St., Anderson, Ind.
National Vulcanized Fibre Co., Maryland Ave., Wilmington, Del.
New England Radiocrafters, 1156 Commonwealth Ave., Boston 34, Mass.
Northern Industrial Chemical Co., 11 Elkins St., So. Boston, Mass.
Pacific Clay Products Co., 306 West Avenue 26, Los Angeles 31, Calif.
Parker Engineering Prods. Co., 16 West 22nd St., New York 10, N. Y.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Plastic Manufacturers, Inc., Stamford, Conn.
Plax Corp., 133 Walnut St., Hartford 5, Conn.
Precision Paper Tube Co., 2033 W. Charleston St., Chicago 47, Ill.
Saxonburg Potteries, Saxonburg, Pa.
Small Motors, Inc., 1322 Elton Ave., Chicago 22, Ill.
Spaulding Fibre Co., 310 Wheeler St., Tonawanda, N. Y.
Speer Resistor Corp., St. Marys, Pa.
Stokes Rubber Co., Jos., Taylor & Webster Sts., Trenton, N. J.
Taylor Fibre Co., Norristown, Pa.
Thomas & Sons Co., R., Lisbon, Ohio
Ucinite Corp., 459 Watertown St., Newtonville, Mass.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
Victory Manufacturing Co., 1722 W. Arcade Place, Chicago 12, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.

ELECTRONIC and ALLIED PRODUCTS

Fuses

Aireon Manufacturing Corp., Fairfax & Funston Rds., Kansas City 15, Kans.
Automatic Electric Co., 1033 West Van Buren St., Chicago 7, Ill.
Bussmann Mfg. Co., University at Jefferson, St. Louis 7, Mo.
Chase-Shawmut Co., Newburyport, Mass.
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Eagle Electric Mfg. Co., Inc., 23-10 Bridge Plaza S., Long Island City, N. Y.
Foote Pierson & Co. Inc., 75 Hudson St., Newark 4, N. J.
General Electric Co., Bridgeport, Conn.
Littelfuse, Inc., 4755 Ravenswood Ave., Chicago, Ill.
Monarch Fuse Co., Ltd., Jamestown, N. Y.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Pierce Renewable Fuses Inc., 211 Hertel Ave., Buffalo 7, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.

Galvanometers

See Meters

Gases

GASES, RARE

Air Reduction Sales Co., 60 East 42nd St., New York, N. Y.
American Gas & Chemical Co., 360 Warren St., Harrison, N. J.
Giannini & Co., Inc., G. M., 161 California St., Pasadena, Calif.
Linde Air Products Co., 30 E. 42nd St., New York 17, N. Y.

Gauges, Strain

American Instrument Company, Silver Springs, Md.
Baldwin-Locomotive Works, Eddystone, Pa.
Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Consolidated Engineering Corp., 595 E. Colorado St., Pasadena 1, California
Foxboro Co., Foxboro, Mass.
General Electric Co., Schenectady 5, N. Y.
Giannini & Co., Inc., C. M., 161 E. California St., Pasadena, Calif.
Hathaway Instrument Company, 1315 S. Clarkson St., Denver 10, Colorado
Metzger & Son, F. F., 2600 North Sixth St., Philadelphia 33, Pa.
Olsen Testing Machine Company, Philadelphia, Pa.
Pratt & Whitney Div., Niles-Bement-Pond Co., West Hartford, Conn.
Saxl Instrument Company, 38-40 James St., East Providence 14, R. I.
Starrett Company, L. S., 165 Crescent St., Athol, Mass.
Waugh Labs, Div. of Waugh Equipment Co., 420 Lexington Ave., New York, 17, N. Y.

Gears, Precision

Ace Mfg. Corp., 1255 E. Erie Ave., Philadelphia, Pa.
Beaver Gear Works Inc., Rockford, Ill.
Gear Specialties, 2635 W. Medill Ave., Chicago 47, Ill.
Gray Mfg. Co., 16-30 Arbor St., Hartford, Conn.
Lear, Incorporated, Piqua, Ohio
Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.
Penn Fibre & Specialty Co., 2030 E. Westmoreland St., Philadelphia 34, Pa.
Perkins Machine & Gear Co., 130 Circuit Ave., Springfield, Mass.
Pratt & Whitney Div., Niles-Bement-Pond Co., West Hartford 1, Conn.
Quaker City Gear Works, 1910-32 N. Front St., Philadelphia, Pa.
Shakeproof, Inc., 2501 N. Keeler Ave., Chicago 39, Ill.
Teleoptic Co., 1241 Mound Ave., Racine, Wisc.

Generators

DYNAMOTORS, ROTARY CONVERTERS

Air-Way Electric Appliance Corp., 2101 Auburn Ave., Toledo, Ohio
Alliance Mfg. Co., Lake Park Blvd., Alliance, Ohio
Allis Co., Louis, 427 E. Stewart St., Milwaukee 7, Wisc.
Allis Chalmers Mfg. Co., Milwaukee 1, Wisc.
Anco Products Corp., Paterson, N. J.
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, North Hollywood, Calif.
Bogue Electric Co., Paterson, N. J.
Branston Electric Mfg. Co., 61-65 Gill Place, Buffalo 13, N. Y.
Burke Electric Co., 12th & Cranberry Sts., Erie, Pa.
Carson Machine & Supply Co., Box 4547, Oklahoma City 9, Okla.
Carter Motor Co., 1606 Milwaukee Ave., Chicago 47, Ill.
Caterpillar Tractor Co., Peoria 8, Ill.
Century Electric Co., 1806 Pine St., St. Louis 3, Mo.
Columbia Electric Mfg. Co., 4519 Hamilton Ave., N. E., Cleveland 14, Ohio
Communications Equipment Corp., 134 W. Colorado St., Pasadena 1, Calif.
Continental Electric Co., Inc., 325 Ferry St., Newark 5, N. J.
Crocker-Wheeler Elec. Mfg. Co., Div. of Joshua Hendy Iron Works, Ampere, N. J.
Diehl Mfg. Co., Finderne Plant, Somerville, N. J.
Eastern Air Devices, Inc., 585 Dean St., Brooklyn 17, N. Y.
Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.
Eicor, Inc., 1501 W. Congress St., Chicago 7, Ill.
Electric Indicator Co., 21 Parker Ave., Stamford, Conn.
Electric Products Co., 1725 Clarkstone Road, Cleveland 12, Ohio
Electric Specialty Co., 211 South St., Stamford, Conn.
Electrical Engrg. & Mfg. Corp., 4606 W. Jefferson Blvd., Los Angeles 16, Calif.
Electrolux Corp., Old Greenwich, Conn.
Engineering Laboratories, Inc., 602 East Fourth St., Tulsa 3, Okla.
Eureka Vacuum Cleaner Co., Detroit, Michigan
Fidelity Electric Co., 332 No. Arch St., Lancaster, Pa.
Fisher Research Laboratory, 1961 University Ave., Palo Alto, Calif.
General Electric Co., Schenectady 5, N. Y.
Gibbs & Co., Thomas B., Div. of George W. Borg Corp., 814 Michigan St., Delavan, Wisc.
Holtzer-Cabot, Signal Div., 400 Stuart St., Boston 17, Mass.
Homelite Corp., Port Chester, N. Y.
Imperial Electric Co., 84 Ira Ave., Akron 1, Ohio
Janette Mfg. Co., 556 W Monroe St., Chicago 40, Ill.
Kato Engineering Co., 530 N. Front St., Mankato, Minn.
L. A. B. Corp., Summit, N. J.
Lear, Incorporated, Piqua, Ohio
Leland Electric Co., 1501 Webster St., Dayton, Ohio
Master Electric Co., 126 Davis Ave., Dayton, Ohio
Midco Mfg. & Distr. Co., Sheboygan, Wis.
National Mineral Co., 2628 N. Pulaski Rd., Chicago 39, Ill.
Onan & Sons, D. W., 3264 Royalston Ave., Minneapolis 5, Minn.
Penn Boiler & Burner Mfg. Corp., Fruitville Road, Lancaster, Pa.
Pioneer Gen-E-Motor Corp., 5841 W. Dickens Ave., Chicago 39, Ill.
Quality Electric Co., Ltd., 1235 East Olympic Bldg., Los Angeles 21, Calif.
Redmond Co. Inc., Monroe St., Owosso, Mich.
Reliance Electric & Engrg. Co., Ivanhoe Rd., Cleveland 10, Ohio
Robbins & Myers, 1345 Lagonda Ave., Springfield, Ohio
Russell Electric Co., 364 W. Huron St., Chicago 10, Ill.
Scientific Service Laboratories, 2225 So. Hoover St., Los Angeles 7, Calif.
Sheridan Electronics Corp., 2850 S. Michigan Ave., Chicago, Ill.
Small Motors, Inc., 1322 Elston Ave., Chicago 22, Ill.
Stockwell Transformer Corp., 569 S. Main St., Akron, Ohio
Trav-Ler Karenola Radio & Television Corp., 571 W. Jackson Blvd., Chicago, Ill.
Webster Chicago Corp., Electronics Div., 3825 Armitage Ave., Chicago 47, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wincharger Corp., 7th & Division, Sioux City, Iowa
Wyse Laboratories, 211 S. Ludlow St., Dayton, Ohio

GAS AND HAND-DRIVEN GENERATORS

Burke Electric Co., 12 & Cranberry Sts., Erie, Pa.
Carter Motor Co., 1606 Milwaukee Ave., Chicago 47, Ill.
Connecticut Telephone & Electric Div. of Great American Industries, Inc., 70 Brittania St., Meriden, Conn.
Continental Electric Co., Inc., 325 Ferry St., Newark 5, N. J.
Delco Appliance Div., General Motors Corp., 391 Lyell Ave., Rochester, N. Y.
Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.
Electric Specialty Co., 211 South St., Stamford, Conn.
Electrical Engrg. & Mfg. Corp., 4606 W. Jefferson Blvd., Los Angeles 16, Calif.
Fidelity Electric Co., 332 N. Arch St., Lancaster, Pa.
General Electric Co., Schenectady 5, N. Y.
General Television & Radio Corp., 2701 N. Lehman Ct., Chicago 14, Ill.
Homelite Corp., Port Chester, N. Y.
Imperial Electric Co., 84 Ira Ave., Akron 1, Ohio
Kato Engineering Co., 530 N. Front St., Mankato, Minn.
Midco Mfg. & Distributing Co., S. 13th & Kentucky Ave., Sheboygan, Wis.
National Mineral Co., 2628 N. Pulaski Rd., Chicago 39, Ill.
Onan & Sons, D. W., 3264 Royalston Ave., Minneapolis 5, Minn.
Pioneer Gen-E-Motor Corp., 5841 W. Dickens Ave., Chicago 39, Ill.
Quality Electric Co., Ltd., 1235 Olympic Blvd., Los Angeles 21, Calif.
Small Motors, Inc., 1322 Elston Ave., Chicago 22, Ill.
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago, Ill.

SIGNAL GENERATORS

Airadio, Inc., Stamford, Conn.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Belmont Radio Corp., 5921 W. Dickens Ave., Chicago, Ill.
Bendix Aviation Corp., Marine Div., 1 Hanson Place, Brooklyn, N. Y.
Bendix Radio Div., Bendix Aviation Corp., Baltimore 4, Md.
Boonton Radio Corp., Boonton, N. J.
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Clough-Brengle Co., 5501 N. Broadway, Chicago 22, Ill.
Control Corp., 600 Stinson Blvd., Minneapolis, Minn.
Dayco Radio Corp., 915 Valley St., Dayton 4, Ohio
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Eastern Specialty Co., 3617 N. Eighth St., Philadelphia 40, Pa.
Electric Indicator Co., 21 Parker Ave., Stamford, Conn.
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
Fada Radio & Electric Co., Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Federal Mfg. & Engineering Corp., 199-217 Steuben St., Brooklyn, N. Y.
Ferris Instrument Co., 110-112 Cornelia St., Boonton, N. J.
Freed Radio Corp., 200 Hudson St., New York, N. Y.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.

General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Grenby Mfg. Co., Plainville, Conn.
Harvey-Wells Electronics, Inc., North St., Southbridge, Mass.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Cal.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio
Jackson Electrical Instrument Co., 6-18 S. Patterson Blvd., Dayton 1, Ohio
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Lewyt Corp., 60 Broadway, Brooklyn, N. Y.
Madison Electrical Products Corp., Madison, N. J.
Measurements Corp., Boonton, N. J.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Meissner Mfg. Div., Maguire Industries, Inc., Mt. Carmel, Ill.
Monarch Mfg. Co., 2014 N. Major Ave., Chicago, Ill.
National Mineral Co., 2628 N. Pulaski Rd., Chicago 39, Ill.
Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.
Packard Bell Co., 1115 So. Hope St., Los Angeles, Calif.
Philharmonic Radio Corp., 528 E. 72nd St., New York 21, N. Y.
Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y.
Radex Corp. of America, 53 West Jackson Blvd., Chicago 4, Ill.
Radio City Products Co., 127 W. 26th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Design Co., 1353 Sterling Place, Brooklyn, N. Y.
Reiner Electronics Co., 152 West 25th St., New York, N. Y.
Remler Co., Ltd., 2101 Bryant St., San Francisco 10, Cal.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles 34, Calif.
Scientific Radio Products Co., 738 W. Broadway, Council Bluffs, Iowa
Signal Electronic & Mfg. Co., 114 East 16th Street, New York 3, N. Y.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Sperry Gyroscope Co., Manhattan Bridge Plaza, Brooklyn 1, N. Y.
Superior Instruments Co., 227 Fulton St., New York 7, N. Y.
Technical Devices Corp., Beaufort & Eagle Rock Aves., Roseland, N. J.
Transmitter Equipment Mfg. Co., Inc., 345 Hudson St., New York 14, N. Y.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 913 W. Van Buren St., Chicago 7, Ill.
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.
Westinghouse Electric Corp., East Pittsburgh, Pa.
White Research, 899 Boylston St., Boston, Mass.

SQUARE WAVE GENERATORS

American Radio Co., 611 E. Garfield Ave., Glendale, Calif.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Audio Tone Oscillator Co., 237 John St., Bridgeport 3, Conn.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Belmont Radio Corp., 521 W. Dickens Ave., Chicago, Ill.
Browning Labs., Inc., 750 Main St., Winchester, Mass.
DuMont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
Fada Radio & Electric Co., Inc., 30-20 Thomson Ave., Long Island City, N. Y.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Grenby Mfg. Co., Plainville, Conn.
Herbach & Rademan Co., Mfg. Div., 517 Ludlow St., Philadelphia 6, Pa.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio
Measurements Corp., Boonton, New Jersey
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Philharmonic Radio Corp., 528 E. 72nd St., New York 21, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Reiner Electronics Co., 152 West 25th St., New York, N. Y.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Transmitter Equipment Mfg. Co. Inc., 345 Hudson St., New York 14, N. Y.
White Research, 899 Boylston St., Boston, Mass.

Geophysical Apparatus

Associated Research, Inc., 231 S. Green St., Chicago 7, Ill.
Atlas Exploration Co., 1911 West Alabama, Houston 6, Texas
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Cambridge Instrument Co., 3732 Grand Central Terminal, New York 17, N. Y.
Engineering Laboratories, Inc., 602 E. Fourth St., Tulsa 3, Okla.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.
Fisher Research Lab., 1961 University Ave., Palo Alto, Calif.
Geophysical Instrument Co., Key Blvd. & Nash St., Arlington, Va.
Hathaway Instrument Co., 1315 S. Clarkson St., Denver 10, Colo.
Heiland Research Corp., 130 East Fifth St., Denver 9, Colo.
Illinois Testing Laboratories, Inc., 420 N. La Salle St., Chicago, Ill.
Mico Instrument Co., 80 Trowbridge St., Cambridge 38, Mass.
Miller Corp., Wm., 362 W. Colorado St., Pasadena, Calif.
Technical Products Co., 158 Madison Ave. at Third St., Memphis, Tenn.
Western Geophysical Co., 711 Edison Bldg., Los Angeles 11, Calif.
White Research, 899 Boylston St., Boston, Mass.

Getters

King Laboratories, Inc., 205 Oneida St., Syracuse 4, N. Y.
Kemet Laboratories Co., Inc., West 117th St. & Madison Ave., Cleveland 1, Ohio
Radio Corp. of America, RCA Victor Div., Harrison, N. J.

Glass Insulation

see Insulation, Glass

Glass—Metal Sealing

Corning Glass Works, Corning, N. Y.
Polan Industries, Huntington 19, West Va.

Glass Tubing

see Tubing, Glass

Graphite

COLLOIDAL GRAPHITE

Acheson Colloids Corp., Port Huron, Mich.
Asbury Graphite Mills, Asbury, N. J.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Grafo Colloids Corp., Sharon, Pa.

Harnesses

WIRE HARNESSES

Air Shields, Inc., Hatboro, Pa.
Aircraft-Marine Products, Inc., 1523 N. Fourth St., Harrisburg, Pa.
Aircraft Products Co., 3502 E. Pontiac St., Fort Wayne, Ind.
Airplane & Marine Instruments, Inc., Clearfield, Pa.
Alden Products Co., 117 North Main St., Brockton 64, Mass.
Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Electric Cable Co., Holyoke, Mass.
American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.
Ansonia Electrical Co., Ansonia, Conn.
Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago 44, Ill.
Branston Electric Mfg. Co., 61-65 Gill Place, Buffalo 13, N. Y.
Cole-Hersee Co., 54 Old Colony Ave., Boston 27, Mass.
Columbia Wire & Supply Co., 4106 N. Pulaski Road, Chicago 41, Ill.
Concord Radio Corp., 901 W. Jackson Blvd., Chicago, Ill.
Crescent Co., Pawtucket, R. I.
Diamond Instrument Co., North Ave., Wakefield, Mass.
Eagle Electric Mfg. Co., 23-10 Bridge Plaza S., Long Island City, N. Y.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Eastern Specialty Co., 3617 N. Eighth St., Philadelphia 40, Pa.
Eby, Inc., Hugh, H., 18 W. Chelton Ave., Philadelphia 13, Pa.
Electric Auto-Lite Co., Toledo 1, Ohio
Electric Auto-Lite Co., Wire & Cable Div., Port Huron, Mich.
Electronic Supply Co., 207 Main St., Worcester, Mass.
Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
General Motors Corp., Packard Electric Div., Warren, Ohio
Holyoke Wire & Cable Co., Holyoke, Mass.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Jefferson, Inc., Ray, 40 E. Merrick Rd., Freeport, L. I., N. Y.
Jefferson Travis Radio Mfg. Corp., 245 East 23rd St., New York 10, N. Y.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Kraft & Kraft, Peekskill, New York
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
Lenz Electric Mfg. Co., 1751 N. Western Avenue, Chicago 47, Ill.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Lewyt Corp., 60 Broadway, Brooklyn, N. Y.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Meissner Mfg. Div., Maguire Industries Inc., Mt. Carmel, Ill.
National Varnished Products Corp., 211 Randolph Ave., Woodbridge, N. J.
Packard Electric Div., General Motors Corp., Warren, Ohio
Paranite Wire & Cable Div., Essex Wire Corp., Fort Wayne 6, Ind.
Radiotechnic Laboratory, 1328 Sherman Ave., Evanston, Ill.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Sherron Electronics Co., 1201 Flushing Ave., Brooklyn 6, N. Y. (test equipment)
Union Aircraft Products Corp., 380 Second Ave., New York, N. Y.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Wallace Mfg. Co., Wm. T., Chili & Madison Aves., Peru, Ind.
Whitney-Blake Co., Dixwell Ave., New Haven 4, Conn.
Whittaker Cable Corp., North Kansas City, Mo.
Wood Electric Co., Inc., C. D., 826 Broadway, New York 3, N. Y.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio

ELECTRONIC and ALLIED PRODUCTS

Headphones

Automatic Electric Co., 1033 W. Van Buren St., Chicago 1, Ill.
Aviometer Corp., 370 West 35th St., New York 1, N. Y.
Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Cannon Co., C. F., Springwater, N. Y.
Connecticut Telephone & Electric Div. of Great American Industries, 70 Britannia St., Meriden, Conn.
Consolidated Radio Products Co., 350 W. Erie St., Chicago 10, Ill.
Eby Co., Hugh H., 18 W. Chelton Ave., Philadelphia 13, Pa.
Federal Telephone & Radio Corp., 591 Broad St., Newark, N. J.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Murdock Mfg. Co., William J., Chelsea, Mass.
Myers & Sons, E. A., Radioear Bldg., Mt. Lebanon, Pittsburgh, Pa.
National Scientific Products Co., 5013 N. Kedzie Ave., Chicago 25, Ill.
Permoflux Corp., 4900 W. Grand Ave., Chicago, Ill.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Presto Recording Corp., 242 West 55th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Speakers, Inc., 221 E. Cullerton St., Chicago, Ill.
Shure Brothers, 225 W. Huron St., Chicago, Ill.
Sonotone Corp., P. O. Box 200, Saw Mill Rd., Elmsford, N. Y.
Speak-O-Phone Recording & Equipment Co., 23 W. 60 St., New York, N. Y.
Telex Products Co., Telex Park, Minneapolis, Minn.
Telephonics Corp., 350 West 31st St., New York, N. Y.
Tibbetts Laboratories, Camden, Maine
Trimm, Inc., 1770 W Berteau Ave., Chicago 13, Ill.

Heads, Cutting

see Recorders—Sound

Heating, Electronic

Aero Communications, Inc., 231 Main St., Hempstead, Long Island, N. Y.
Ajax Electrothermic Corp., Ajax Park, Trenton, N. J.
Allis Chalmers Mfg. Co., Milwaukee 1, Wisc. (Dielectric & Induction)
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa. (Dielectric & Induction)
Belmont Radio Corp., 5921 W. Dickens Ave., Chicago 39, Ill.
Budd Induction Heating, Inc., Detroit, Mich.
Cutler-Hammer, Inc., 315 North 12th St., Milwaukee 1, Wisc. (Dielectric)
Cyclonics Mfg. Co., Inc., 3906 Hudson Blvd., Union City, N. J.
DeForest Labs., Lee, 5106 Wilshire Blvd., Los Angeles, Calif.
Duramold Div. of Fairchild Engine & Airplane Co., Girts Rd., Jamestown, N. Y.
Ecco High Frequency Electric Corp., 7020 Hudson Blvd., North Bergen, N. J. (Induction)
Electron Equipment Corp., 917 Meridian Ave., South Pasadena, Calif.
Electronic Supply Co., 207 Main St., Worcester, Mass.
Federal Electric Co., Inc., 8700 South State St., Chicago 19, Ill.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Fischer, Robert A., 1720 Hillcrest Ave., Glendale 2, Calif.
General Electric Co., Schenectady 5, N. Y. (Induction & Dielectric)
Girdler Corp., Thermex Div., 224 E. Broadway, Louisville 1, Ky. (Dielectric)
Harvey-Wells Electronics, Inc., North St., Southbridge, Mass.
Hunt & Sons, G. C., 544 Hanover, Carlisle, Pa.
Illinois Tool Works, 2501 N. Keeler Ave., Chicago 39, Ill.
Induction Heating Corp., 389 Lafayette St., New York, N. Y. (Dielectric & Induction)
Intra-Therm Corp., Third & Keo Way, Des Moines 9, Iowa
Johnson Co., E. F., Waseca, Minn.
Kahle Engineering Co., 1307 Seventh St., North Bergen, N. J.
Lepel High Frequency Laboratories, 39 West 60th St., New York, N. Y. (Dielectric & Induction)
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif, (Dielectric & Induction)
Ohio Crankshaft Co., 3800 Harvard Ave., Cleveland 1, Ohio (Induction)
Radio Corp. of America, RCA Victor Div., Camden, N. J. (Dielectric & Induction)
Radio Craftsmen, 1341 S. Michigan Ave., Chicago 5, Ill.
Radio Receptor Co., 251 West 19th St., New York 11, N. Y. (Dielectric)
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass. (Dielectric & Induction)
Remler Co., Ltd., 2101 Bryant St., San Francisco 10, Calif.
Scientific Equipment Div. of "S" Corrugated Quenched Gap Co., 111 Monroe St., Garfield, N. J. (Dielectric & Induction)
Shakeproof, Inc., 2501 N. Keeler Ave., Chicago 39, Ill. (Dielectric)
Sherron Electronics Co., 1201 Flushing Ave., Brooklyn 6, N. Y.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.
Transmitter Equipment Mfg. Co., Inc., 345 Hudson St., New York 14, N. Y. (Dielectric)
Universal X-Ray Products, Inc., 1800 N. Francisco Ave., Chicago 47, Ill. (Induction)
Westinghouse Electric Corp., Industrial Electronics & X-Ray Div., Baltimore 3, Md. (Dielectric & Induction)
Westinghouse Electric Corp., E. Pittsburgh, Pa.
Weltronic Co., 3080 E. Outer Drive, Detroit, Mich.

Holders

CRYSTAL HOLDERS

see Crystals

Horns

SPEAKER PROJECTOR HORNS

Altec Lansing Corp., 1680 North Vine St., Los Angeles 28, Calif.
Atlas Sound Corp., 1443 39th St., Brooklyn, N. Y.
Chicago Sound Systems Co., 2124 S. Michigan Ave., Chicago, Ill.
Electronic Sound Engineering Co., 109 N. Dearborn St., Chicago 2, Ill.
Cinaudagraph Speakers, Inc., 3911 S. Michigan Ave., Chicago, Ill.
Erwood Co., 223 W. Erie St., Chicago, Ill.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Hawley Products Co., St. Charles, Ill.
Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill.
Langevin Co., Inc., 37 West 65th Street, New York, N. Y.
Lifetime Sound Equipment Co., 1101 Adams St., Toledo, Ohio
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
National Scientific Products Co., 5013 N. Kedzie Ave., Chicago 25, Ill.
Olesen Illuminating Co., Ltd., Otto, 1560 Vine St., Hollywood 28, Calif.
Operadio Mfg. Co., St. Charles, Ill.
Racon Electric Co., Inc., 52 E. 19th St., New York 3, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Rauland Corp., 4245 N. Knox Ave., Chicago 41, Ill.
Rosen & Co., Raymond, 32nd & Walnut Sts., Philadelphia 4, Pa.
SOS Cinema Supply Co., 449 West 42nd Street, New York 18, N. Y.
Signal Engineering & Mfg. Co., 154 West 14th Street, New York, N. Y.
Simpson Mfg. Co., Inc., Mark, 188 W. Fourth St., New York, N. Y.
University Laboratories, 225 Varick St., New York, N. Y.
Utah Radio Products Co., 820 Orleans Street, Chicago, Ill.
Western Electric Co., Inc., 120 Broadway, New York, N. Y.

Indicators

CAPACITOR LEAKAGE INDICATORS

Amplifier Co. of America, 396 Broadway, New York, N. Y.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electric Heat Control Co., 9123 Inman Ave., Cleveland 5, Ohio
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
H-W Mfg. Co., 3124 Larga Ave., Los Angeles, Calif.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Industrial Instruments, Inc., 156 Culver Ave., Jersey City 5, N. J.
Jackson Electrical Instrument Co., 16-18 S. Patterson Blvd., Dayton 1, Ohio
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Radio City Products Co., 127 West 26th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Springfield Sound Co., Electronics Div., 12 Cass St., Springfield, Mass.
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.

POWER LEVEL INDICATORS and RECORDERS

Amplifier Co. of America, 396 Broadway, New York, N. Y.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Boes Co., W. W., 3001 Salem Ave., Dayton 3, Ohio
Daven Co., 191 Central Ave., Newark 4, N. J.
DeJur-Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., Schenectady 5, N. Y.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Marion Electrical Instrument Co., Manchester, N. H.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Monarch Mfg. Co., 2014 N. Major Ave., Chicago, Ill.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

VOLUME INDICATORS

see Meters

Inductors

see Coils

Insulation

see also Tubing, Finishes

ASBESTOS INSULATION

Carey Mfg. Co., Philip, Lockland, Cincinnati, Ohio
Johns-Manville, 20 East 40th St., New York, N. Y.
Keasbey & Mattison, Ambler, Pa.
Powhatan Mining Co., Baltimore 7, Md.

BEAD INSULATION

American Lava Corp., Kruesi Bldg., Chattanooga 5, Tenn.
American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.
Centralab Div., Globe Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc.
Corning Glass Works, Corning, N. Y.
Electronic Mechanics, Inc., 70 Clifton Blvd., Clifton, N. J.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
International Products Corp., Baltimore 18, Md.
Isolantite, Inc., 343 Cortlandt St., Belleville 9, N. J.
Johnson Co., E. F., Waseca, Minn.
Lenoxite Div., Lenox Inc., 65 Prince St., Trenton, N. J.
Mycalex Corp. of America, 60 Clifton Blvd., Clifton, N. J.
Mykroy, Inc., 1917 N. Springfield Ave., Chicago 47, Ill.
National Tile Co., 1200 East 26th St., Anderson, Ind.
Ogush, Inc., William B., 33 W. 60th St., New York, N. Y.
Pacific Clay Products Co., 306 West Avenue 26, Los Angeles 31, Calif.
Plax Corp., 133 Walnut St., Hartford 5, Conn.
Printloid, Inc., 95 Mercer St., New York 12, N. Y.
Saxonburg Potteries, Saxonburg, Pa.
Sperti, Inc., Norwood Station, Cincinnati 12, Ohio
Steward Mfg. Co., D. M., E. 36th St., Chattanooga, Tenn.
Taylor Fibre Co., Norristown, Pa.

CERAMIC INSULATION

Akron Porcelain Co., Cory Ave., & Belt Line, Akron, Ohio
American Lava Corp., Kruesi Bldg., Chattanooga 5, Tenn.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Birnbach Radio Co., Inc., 145 Hudson St., New York, N. Y.
Bud Radio Inc., 2118 East 55th St., Cleveland 3, Ohio
Centralab Div. of Globe Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc.
Cook Ceramic Mfg. Co., 501 Prospect St., Trenton 1, N. J.
Crowley & Co., Inc., Henry L., 1 Central Ave., West Orange, N. J.
Electronic Mechanics, Inc., 70 Clifton Blvd., Clifton, N. J.
Fleron & Son, Inc., M. M., 113 N. Broad St., Trenton, N. J.
General Ceramics & Steatite Corp., Keasbey, N. J.
General Electric Co., Schenectady 5, N. Y.
General Porcelain Co., 951 Pennsylvania Ave., Trenton, N. J.
Hartford Faience Co., 271 Hamilton St., Hartford, Conn.
Illinois Electric Porcelain Co., Macomb, Ill.
International Products Corp., Baltimore 18, Md.
Isolantite, Inc., 343 Cortlandt St., Belleville 9, N. J.
Johnson Co., E. F., Waseca, Minn.
Knox Porcelain Corp., 200 Mynderse Ave., Knoxville, Tenn.
Lapp Insulator Co., 31 Gilbert St., Le Roy, N. Y.
Lenoxite Div., Lenox, Inc., 65 Prince St., Trenton, N. J.
Louthan Mfg. Co., 2000 Harvey Ave., East Liverpool, Ohio
Metsch Refractories Co., East Liverpool, Ohio
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Mycalex Corp. of America, 60 Clifton Blvd., Clifton, N. J.
Mykroy, Inc., 1917 N. Springfield Ave., Chicago 47, Ill.
National Ceramic Co., 400 Southard St., Trenton 2, N. J.
National Tile Co., 1200 East 26th St., Anderson, Ind.
Ohio Brass Co., Mansfield, Ohio
Pacific Clay Products Co., 306 West Ave., 26, P. O. Box 145, Sta. A., Los Angeles 31, Calif.
Pass & Seymour Inc., Solvay Station, Syracuse, N. Y.
Pemco Corp., Plastics Div., 5601 Eastern Ave., Baltimore 24, Md.
Porcelain Insulator Corp., 447 E. Main St., Lima, N. Y.
Porcelain Products, Inc., 124 West Front St., Findlay, Ohio
Porcelier Mfg. Co., Greensburg, Pa.
Radio Corp. of America, Tube Div., RCA, Harrison, N. J.
Saxonburg Potteries, Saxonburg, Pa.
Sperti, Inc., Norwood Station, Cincinnati 12, Ohio
Square D Co., 6060 Rivard St., Detroit 11, Mich.
Star Porcelain Co., 61 Muirhead Ave., Trenton 9, N. J.
Steward Mfg. Co., D. M., East 36th St., Chattanooga, Tenn.
Stupakoff Ceramic & Mfg. Co., Latrobe, Pa.
Thomas & Sons Co., R., Lisbon, Ohio
Union Electrical Porcelain Works, Van St., Trenton 5, N. J.
Universal Clay Products Co., 1505 E. First St., Sandusky, Ohio
Washington Porcelain Co., Washington, N. J.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wisconsin Porcelain Co., Sun Prairie, Wisc.

FABRIC INSULATION

Auburn Mfg. Co., 110 Stack St., Middletown, Conn.
B. & C. Insulation Products, Inc., 261 Fifth Ave., New York 16, N. Y.
Baer Co., N. S., 9 Montgomery St., Hillside, N. J.
Creative Plastics Corp., 963 Kent Ave., Brooklyn, N. Y.
Dobeckmun Co., 3300 Monroe Ave., Cleveland, Ohio
Du Pont de Nemours & Co., Inc., E. I., Wilmington 98, Del.
Electric Service Manufacturing Co., 17th & Cambria Sts., Philadelphia 32, Pa.
Electro Technical Products, Inc., Nutley 10, N. J.
Endurette Corp. of America, Cliffwood, N. J.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Bridgeport, Conn.
Greenhut Insulation Co., 31 West 21 St., New York, N. Y.
Holliston Mills, Inc., Norwood, Mass.
Industrial Screw & Supply Co., 713 W. Lake St., Chicago 6, Ill.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington 11, N. J.
McInerney Plastics Co., 655 Godfrey Ave., S. W., Grand Rapids 1, Mich.
Mica Insulator Co., 797 Broadway, Schenectady 1, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Mitchell-Rand Insulation Co., Inc., 51 Murray St., New York 7, N. Y.
National Varnished Products Corp., 211 Randolph Ave., Woodbridge, N. J.
New Jersey Wood Finishing Co., Inc., Electrical Insulation Dept., Woodbridge, N. J.
Racon Electric Co., 52 East 19th St., New York 3, N. Y.
Saxonburg Potteries, Saxonburg, Pa.
Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J.
Taylor Fibre Co., Norristown, Pa.
Tingstol Corp., 1461 W. Grand Ave., Chicago, Ill.
Varflex Corp., N. Jay St., Rome, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wright & Sons Co., Wm. E., West Warren, Mass.

FIBRE INSULATION

Acme Folding Box Co., Inc., 141 East 25th St., New York, N. Y.
American Felt Co., Glenville, Conn.
Auburn Mfg. Co., 110 Stack St., Middletown, Conn.
B. & C. Insulation Products, Inc., 261 Fifth Ave., New York 16, N. Y.
Baer Co., N. S., 9 Montgomery St., Hillside, N. J.
Bakelite Corp., Unit of Union Carbide & Carbon Corp., 30 East 42nd St., New York 17, N. Y.
Brandywine Fibre Products Co., 14th & Walnut Sts., Wilmington, Del.
Continental-Diamond Fibre Co., 16 Chapel St., Newark, Del.
Dobeckmun Co., 3300 Monroe Ave., Cleveland, Ohio
Electric Service Manufacturing Co., 17th & Cambria Sts., Philadelphia 32, Pa.
Felters Co., The, 210 South St., Boston, Mass.
Franklin Fibre-Lamitex Corp., 12th & French Sts., Wilmington, Del.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Bridgeport, Conn.
Hawley Products, St. Charles, Ill.
Industrial Screw & Supply Co., 713 W. Lake St., Chicago 6, Ill.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.
Lamicoid Fabricators, 3600 W. Potomac Ave., Chicago, Ill.
McInerney Plastics Co., 655 Godfrey Ave., S W., Grand Rapids 1, Mich.
Mica Insulator Co., 797 Broadway, Schenectady 1, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Mitchell-Rand Insulation Co., Inc., 51 Murray St., New York 7, N. Y.
National Vulcanized Fibre Co., Maryland Ave., Wilmington, Del.
Penn Fibre & Specialty Co., 2030 E. Westmoreland St., Philadelphia 34, Pa.
Precision Fabricators, Inc., 120 N. Fitzhugh St., Rochester, N. Y.
Printloid, Inc., 95 Mercer St., New York 12, N. Y.
Rogers Paper Mfg. Co., Manchester, Conn.
Spaulding Fibre Co., 310 Wheeler St., Tonawanda, N. Y.
Stevens Paper Mills, Inc., Windsor, Conn.
Taylor Fibre Co., Norristown, Pa.
Tingstol Corp., 1461 W. Grand Ave., Chicago, Ill.
Varflex Corp., N. Jay St., Rome, N. Y.
West Virginia Pulp & Paper Co., 230 Park Ave., New York, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wilmington Fibre Specialty Co., P. O. Drawer 1028, Wilmington 99, Del.

GLASS & FIBERGLAS INSULATION

Aerolux Light Corp., 653-11th Ave., New York 19, N. Y.
B. & C. Insulation Products, Inc., 261 Fifth Ave., New York 16, N. Y.
Bentley, Harris Mfg. Co., Hector & Lime Sts., Conshohocken, Pa.
Brand & Co., William, 276 Fourth Ave., New York 10, N. Y.
Corning Glass Works, Corning, N. Y.
Creative Plastics Corp., 963 Kent Ave., Brooklyn, N. Y.
Electro Technical Products, Inc., Nutley 10, N. J.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.
International Products Corp., Baltimore 18, Md.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington 11, N. J.
Kilburn Glass Co., Inc., J. R., 22 S. Worcester St., Chartley, Mass.
Kopp Glass, Inc., 1 East 42nd St., New York 17, N. Y.
Mica Insulator Co., 797 Broadway, Schenectady 1, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Mitchell-Rand Insulation Co., Inc., 51 Murray St., New York 7, N. Y.
National Varnished Products Corp., 211 Randolph Ave., Woodbridge, N. J.
New Jersey Wood Finishing Co., Inc., Electrical Insulation Dept., Woodbridge, N. J.
Owens-Corning Fiberglas Corp., 1860 Nicholas Bldg., Toledo 1, Ohio
Rome Cable Corp., 330 Ridge St., Rome, N. Y.

ELECTRONIC and ALLIED PRODUCTS

Spaulding Fibre Co., 310 Wheeler St., Tonawanda, N. Y.
Sperti, Inc., Norwood Station, Cincinnati 12, Ohio
Standard Insulation Co., 74 Paterson Ave., E. Rutherford, N. J.
Varflex Corp., N. Jay St., Rome, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.

GLASS BONDED MICA INSULATION

Brand & Co., William, 276 Fourth Avenue, New York 10, N. Y.
Electronic Mechanics, Inc., 70 Clifton Blvd., Clifton, N. J.
General Electric Co., Schenectady 5, N. Y.
International Products Corp., Baltimore 18, Md.
Johnson Co., E. F., Waseca, Minn.
Macallen Co., 16 Macallen St., Boston, Mass.
Mica Insulator Co., 797 Broadway, Schenectady, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Mycalex Corp. of America, 60 Clifton Blvd., Clifton, N. J.
Mykroy, Inc., 1917 N. Springfield Ave., Chicago 47, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.

PAPER INSULATION

Acme Folding Box Co., Inc., 141 East 25th St., New York, N. Y.
Auburn Mfg. Co., 110 Stack St., Middletown, Conn.
Baer Co., N. S., 9 Montgomery St., Hillside, N. J.
Central Paper Co., Muskegon, Michigan
Continental-Diamond Fibre Co., 16 Chapel St., Newark, Del.
Cottrell Paper Co., 88 Purchase St., Fall River, Mass.
Creative Plastics Corp., 963 Kent Ave., Brooklyn, N. Y.
Dobeckmun Co., 3300 Monroe Ave., Cleveland, Ohio
Electric Service Manufacturing Co., 17th & Cambria Sts., Philadelphia 32, Pa.
Electro Technical Products, Inc., Nutley 10, N. J.
Endurette Corp. of America, Cliffwood, N. J.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Bridgeport, Conn.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Hartford City Paper Co., Hartford City, Indiana
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington 11, N. J.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
Lamicoid Fabricators, 3600 W. Potomac Ave., Chicago, Ill.
Manning Paper Co., Inc., John A., Troy, N. Y.
Mica Insulator Co., 797 Broadway, Schenectady, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Mitchell-Rand Insulation Co., Inc., 51 Murray St., New York 7, N. Y.
National Varnished Products Corp., 211 Randolph Ave., Woodbridge, N. J.
New Jersey Wood Finishing Co., Inc., Electrical Insulation Dept., Woodbridge, N. J.
Penn Fibre & Specialty Co., 2030 E. Westmoreland St., Philadelphia 34, Pa.
Precision Fabricators, Inc., 120 N. Fitzhugh St., Rochester, N. Y.
Riegel Paper Corp., 342 Madison Ave., New York 17, N. Y.
Rogers Paper Mfg. Co., Manchester, Conn.
Rome Cable Corp., 330 Ridge St., Rome, N. Y.
Schweitzer Paper Co., 142 Miller St., Newark, N. J.
Smith Paper Co., Inc., Lee, Mass.
Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N. Y.
Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J.
Stevens Paper Mills, Inc., Windsor, Conn.
Taylor Fibre Co., Norristown, Pa.
Tingstol Corp., 1461 W. Grand Ave., Chicago, Ill.
West Virginia Pulp & Paper Co., 230 Park Ave., New York, N. Y.

Westinghouse Electric Corp., East Pittsburgh, Pa.
Wilmington Fibre Specialty Co., P. O. Drawer 1028, Wilmington 99, Del.

PLASTIC INSULATION

Acadia Synthetic Products, Div. Western Felt Works, 4035 Ogden Ave., Chicago 23, Ill.
Accurate Molding Corp., 116 Nassau St., Brooklyn 1, N. Y.
Alden Products Co., 117 North Main St., Brockton 64, Mass.
Aluminum Finishing Corp., 1119 E. 22nd St., Indianapolis, Ind.
American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.
American Products Mfg. Co., 8127 Oleander St., New Orleans, La.
Anchor Plastics Co., 533-41 Canal St., New York 13, N. Y.
Ansonia Clock Co., Inc., 108 Lafayette St., New York 13, N. Y.
Atlas Products Corp., 30 Rockefeller Plaza, New York 20, N. Y.
Auburn Button Works, Inc., 48 Canoga St., Auburn, N. Y.
B. & C. Insulation Products, Inc., 261 Fifth Ave., New York 16, N. Y.
Baer Co., N. S., 9 Montgomery St., Hillside, N. J.
Bakelite Corp., Unit of Union Carbide & Carbon Corp., 30 East 42nd St., New York 17, N. Y.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bastian Bros. Co., 1600 N. Clinton St., Rochester, N. Y.
Birnbach Radio Co., Inc., 145 Hudson St., New York, N. Y.
Biwax Corp., 3445 Howard St., Skokie, Ill.
Brand & Co., William, 276 Fourth Ave., New York 10, N. Y.
Brandywine Fibre Products Co., 14th & Walnut Sts., Wilmington, Del.
Burndy Engrg. Co., Inc., 107 Bruckner Blvd., New York 54, N. Y.
Carter Products Co., 6921 Carnegie Ave., Cleveland, Ohio
Celanese Plastics Corp., 180 Madison Ave., New York 16, N. Y.
Cincinnati Molding Co., 2037 Florence Ave., Cincinnati 6, Ohio
Cochrane Chemical Co., 432 Danforth Ave., Jersey City, N. J.
Continental-Diamond Fibre Co., 16 Chapel St., Newark, Del.
Creative Plastics Corp., 963 Kent Ave., Brooklyn, N. Y.
Davis Plastics Co., Joseph, Arlington, N. J.
Dow Chemical Co., Midland, Mich.
Du Pont de Nemours & Co., Inc., E. I., Wilmington 98, Del.
Durez Plastics & Chemicals, Inc., 1922 Walck Rd., North Tonawanda, N. Y.
Eastman Kodak Co., Rochester 4, N. Y.
Electrical Insulation Co., Inc., 12 Vestry St., New York, N. Y.
Extruded Plastics, Inc., Norwalk, Conn.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Formica Insulation Co., 4662 Spring Grove Ave., Cincinnati, Ohio
Franklin Fibre-Lamitex Corp., 12th & French St., Wilmington, Del.
Garfield Mfg. Co., Garfield, N. J.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, Long Island, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
Gering Products, Inc., 7th & Monroe Ave., Kenilworth, N. J.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Goodyear Tire & Rubber Co., Plastics & Chemical Div., 1144 E. Market St., Akron 16, Ohio
Hodgman Rubber Co., Framingham, Mass.
Hope Webbing Co., Providence, R. I.
Industrial Synthetics Corp., 60 Woolsey St., Irvington, N. J.
Insulating Tube Co., Inc., 26 Cottage St., P. O. Box 1, Poughkeepsie, N. Y.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.
International Products Corp., Baltimore 18, Md.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington 11, N. J.
Johnson Co., E. F., Waseca, Minn.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
Kurz-Kasch Co., 1415 S. B'way, Dayton 1, Ohio
Makalot Corp., 262 Washington St., Boston, Mass.
McInerney Plastics Co., 655 Godfrey Ave., S. W., Grand Rapids 1, Mich.
Mica Insulator Co., 797 Broadway, Schenectady, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Micarta Fabricators, Inc., 5324 Ravenswood Ave., Chicago 40, Ill.
Mills Corp., Elmer E., 812 W. Van Buren St., Chicago, Ill.
Mitchell-Rand Insulation Co., Inc., 51 Murray St., New York 7, N. Y.
Monsanto Chemical Co., Plastics Div., Springfield 2, Mass.
Mycalex Corp. of America, 60 Clifton Blvd., Clifton, N. J.
Mykroy, Inc., 1917 N. Springfield Ave., Chicago 47, Ill.
National Varnished Products Corp., 211 Randolph Ave., Woodbridge, N. J.
National Vulcanized Fibre Co., Maryland Ave., Wilmington, Del.
New Jersey Wood Finishing Co., Inc., Electrical Insulation Dept., Woodbridge, N. J.
Northwest Plastics, Inc., 2333 University Ave., St. Paul 4, Minn.
Oris Mfg. Co., Inc., Thomaston, Conn.
Panelyte Div., St. Regis Paper Co., 230 Park Ave., New York, N. Y.
Parisian Novelty Co., 3510 S. Western Ave., Chicago 9, Ill.
Penn Fibre & Specialty Co., 2030 E. Westmoreland St., Philadelphia 34, Pa.
Plastic Fabricators Co., 440 Sansome St., San Francisco 11, Calif.
Plax Corp., 133 Walnut St., Hartford, 5, Conn.
Precision Fabricators, Inc., 120 N. Fitzhugh St., Rochester, N. Y.
Printloid, Inc., 95 Mercer St., New York 12, N. Y.
Resistoflex Corp., Belleville 9, N. J.
Respro, Inc., Wellington Ave., Cranston, N. J.
Richardson Co., Melrose Park, Ill.
Rogers Paper Mfg. Co., Manchester, Conn.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N. Y.
Standard Products Co., 505 Boulevard Bldg., Detroit 2, Mich.
Surprenant Electrical Insulation Co., 84 Purchase St., Boston 10, Mass.
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.
Technical Products Co., 158 Madison Ave., at Third St., Memphis, Tenn.
Ucinite Co., 459 Watertown St., Newtonville, Mass.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
Varflex Corp., N. Jay St., Rome, N. Y.
Waterbury Button Co., 835 S. Main St., Waterbury, Conn.
Werner Co., Inc., R. D., 295 Fifth Ave., New York 16, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Whitney-Blake Co., Dixwell Ave., New Haven, Conn.
Wilmington Fibre Specialty Co., P. O. Drawer 1028, Wilmington 99, Del.

STEATITE INSULATION

American Lava Corp., Kruesi Bldg., Chattanooga 5, Tenn.
Birnbach Radio Co., Inc., 145 Hudson St., New York, N. Y.
Bud Radio, Inc., 2118 East 55th St., Cleveland 3, Ohio
Centralab Div. of Globe Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc.
Cook Ceramic Mfg. Co., 501 Prospect St., Trenton 1, N. J.
Crowley & Co., Inc., Henry, 1 Central Ave., West Orange, N. J.
General Ceramics and Steatite Corp., Keasbey, N. J.
General Electric Co., Schenectady 5, N. Y.
Isolantite, Inc., 343 Cortlandt St., Belleville 9, N. J.
Johnson Co., E. F., Waseca, Minn.
Lapp Insulator Co., 31 Gilbert St., LeRoy, N. Y.
Lenoxite Div., Lenox, Inc., 65 Prince St., Trenton, N. J.
Louthan Mfg. Co., 2000 Harvey Ave., E. Liverpool, Ohio
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.

National Ceramic Co., 400 Southard St., Trenton 2, N. J.
National Tile Co., 1200 East 26th St., Anderson, Indiana
Ohio Brass Co., Mansfield, Ohio
Pacific Clay Products Co., 306 West Ave., Los Angeles 31, Calif.
Pass & Seymour, Inc., Solvay Station, Syracuse, N. Y.
Radio Corp. of America, Tube Div., RCA, Harrison, N. J.
Saxonburg Potteries, Saxonburg, Pa.
Star Porcelain Co., Trenton 9, N. J.
Steward Mfg. Co., D. M., Chattanooga, Tenn.
Stupakoff Ceramic & Mfg. Co., Latrobe, Pa.
Wisconsin Porcelain Co., Sun Prairies, Wisc.

Insulators

Acme Folding Box Co., Inc., 141 East 25th St., New York, N. Y.
Akron Porcelain Co., Cory Ave., & Belt Line, Akron, Ohio
Alden Products Co., 117 North Main St., Brockton 64, Mass.
American Lava Corp., Kruesi Bldg., Chattanooga 5, Tenn.
American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.
Arens Controls, Inc., 2253 S. Halsted St., Chicago 8, Ill.
Armstrong Cork Co., Lancaster, Pa.
Birnbach Radio Co. Inc., 145 Hudson St., New York, N. Y.
Cardy-Lundmark Co., 1801 W. Byron St., Chicago 13, Ill.
Centralab Div., Globe Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc.
Creative Plastics Corp., 963 Kent Ave., Brooklyn, N. Y.
Electronic Mechanics, Inc., 70 Clifton Blvd., Clifton, N. J.
Fleron & Son, Inc., M. M., 113 N. Broad St., Trenton, N. J.
General Electric Co., Schenectady 5, N. Y.
Hanovia Chemical & Mfg. Co., 233 New Jersey & R. R. St., Newark, N. J.
Insulation Mfg. Co., 11 New York Ave., Brooklyn, N. Y.
International Products Corp., Baltimore 18, Md.
Isolantite, Inc., 343 Cortlandt St., Belleville 9, N. J.
Johnson Co., E. F., Waseca, Minn.
Lapp Insulator Co., 31 Gilbert St., LeRoy, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Mycalex Corp. of America, 60 Clifton Blvd., Clifton, N. J.
Mykroy, Inc., 1917 N. Springfield Ave., Chicago 47, Ill.
National Co., Inc., 61 Sherman St., Malden 48, Mass.
National Tile Co., 1200 East 26th St., Anderson, Ind.
Pacific Clay Products Co., 306 West Ave., 26, Los Angeles 31, Calif.
Parisian Novelty Co., 3510 S. Western Ave., Chicago 9, Ill.
Philadelphia Mica Corp., 3515 N. 10 St., Philadelphia 40, Pa.
Porcelain Products, Inc., 124 W. Front St., Findlay, Ohio
Premax Products Div., Chisholm Ryder Co., College & Highland Aves., Niagara Falls 2, N. Y.
Radio Corp. of America, Tube Div., RCA, Harrison, N. J.
Saxonburg Potteries, Saxonburg, Pa.
Spertl, Inc., Norwood Station, Cincinnati 12, Ohio
Stupakoff Ceramic & Mfg. Co., Latrobe, Pa.
Taylor Fibre Co., Norristown, Pa.
Thomas & Sons Co., R., Lisbon, Ohio
Union Electrical Porcelain Works, Van St., Trenton 5, N. J.
Victor Insulators, Inc., Victor, N. Y.
Waterbury Button Co., 835 S. Main St., Waterbury, Conn.
Westinghouse Electric Corp., East Pittsburgh, Pa.

INSULATORS, TRANSMITTING ANTENNA

Aireon Manufacturing Corp., Fairfax & Funston Rds., Kansas City 15, Kans.
American Lava Corp., Kruesi Bldg., Chattanooga 5, Tenn.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Birnbach Radio Co., Inc., 145 Hudson St., New York, N. Y.
Centralab Div. of Globe Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc.
Electronic Mechanics, Inc., 70 Clifton Blvd., Clifton, N. J.
Johnson Co., E. F., Waseca, Minn.
Mycalex Corp. of America, 60 Clifton Blvd., Clifton, N. J.
Premax Products Div., Chisholm Ryder Co., College & Highland Ave., Niagara Falls, N. Y.

Insulators, Vibration

see Mountings

Intercommunicators

American Radio Co., 611 E. Garfield Ave., Glendale, Calif.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Banks Mfg. Co., 1105 W. Lawrence Ave., Chicago 40, Ill.
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Belmont Radio Corp., 5921 W. Dickens Ave., Chicago 39, Ill.
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, North Hollywood, Calif.
Bogen Co., David, 663 Broadway, New York 12, N. Y.
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
California Telephone & Elec. Co., 6075 W. Pico Blvd., Los Angeles 35, Calif.
Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif.
Connecticut Telephone & Electric Div. of Great American Industries, Inc., 70 Brittania St., Meriden, Conn.
Dalmo Victor, San Carlos, Calif.
De Wald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Eastern Amplifier Corp., 794 East 140th St., Bronx, New York 54, N. Y.
Eckstein Radio & Television Co., 918 La Salle Ave., Minneapolis 2, Minn.
Electronic Sound Engineering Co., 109 N. Dearborn St., Chicago 2, Ill.
Erwood Co., 223 W. Erie St., Chicago, Ill.
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
Executone, Inc., 415 Lexington Ave., New York 17, N. Y.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
General Electric Co., Schenectady 5, N. Y.
General Electronics, Inc., 101 Hazel St., Paterson, N. J.
Globe Phone Mfg. Corp., 2 Linden St., Reading, Mass.
Godfrey Mfg. Co., 171 S. 2nd St., Milwaukee 4, Wisc.
Halstead Traffic Communications Corp., 155 E. 44th St., New York, N. Y.
Industrial Sound Products Co., 3597 Mission St., San Francisco, Calif.
Kegron Mfg. Co., Inc., 18 West 20th St., New York 11, N. Y.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Lake Mfg. Co., 2323 Chestnut St., Oakland 7, Calif.
Magnavox Co., The, 2131 Bueter Rd., Fort Wayne 4, Ind.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Meissner Mfg. Div., Maguire Industries, Inc., Mt. Carmel, Ill.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Minerva Corp. of America, 238 William St., New York 7, N. Y.
National Intercommunicating Systems, 2434 Montrose Ave., Chicago 18, Ill.
Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles 18, Calif.
Operadio Mfg. Co., St. Charles, Ill.
Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.
Philco Corp., Philadelphia 34, Pa.
Powers Electronic & Communication Co., Glencove, L. I., N. Y.
Racon Electric Co., 52 East 19th St., New York 3, N. Y.
Radio Corp., RCA Victor Div., of America, Camden, N. J.
Radio Laboratories, Inc., 2701 California Ave., Seattle 6, Wash.
Rauland Corp., 4245 N. Knox Ave., Chicago 41, Ill.
Regal Electronics Corp., 20 West 20th St., New York, N. Y.
Remler Co., Ltd., 2101 Bryant St., San Francisco 10, Calif.
Schulmerich Electronics Co., Sellersville, Pa.
Select-O-Phone Co., 1012 Eddy St., Providence, R. I.
Setchell Carlson, Inc., 2233 University Ave., St. Paul 4, Minn.
Simpson Mfg. Co., Inc., Mark, 188 West Fourth St., New York, N. Y.
Talk-A-Phone Mfg. Co., 1512 S. Pulaski Road, Chicago 23, Ill.
Taybern Equipment Co., 120 Greenwich St., New York 6, N. Y.
Tech-Master Products Co., 12 Prince St., New York, N. Y.
TelAutograph Corp., 16 West 61st St., New York 23, N. Y.
Telemotor Corp., 260 Fifth Ave., New York, N. Y.
Telephonics Corp., 350 West 31st St., New York 1, N. Y.
Templetone Radio Mfg. Corp., New London, Conn.
Trebor Radio Co., Pasadena, Calif.
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago, Ill.
Watterson Radio Mfg. Co., P. O. Box 54, Dallas 1, Texas
Webster Electric Co., 1900 Clark St., Racine, Wisc.
Western Sound & Electric Laboratories, 3512 W. St. Paul Ave., Milwaukee, Wisc.
Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

Inverters

Air-Way Electric Appliance Corp., 2101 Auburn Ave., Toledo, Ohio
Allis-Chalmers Mfg. Co., Milwaukee 1, Wisc.
American Television & Radio Co., 300 E. Fourth St., St. Paul 1, Minn.
Anco Products Corp., Paterson, N. J.
Apex Electric Mfg. Co., 1070 E. 152nd St., Cleveland, Ohio
Carter Motor Co., 1606 Milwaukee Ave., Chicago 47, Ill.
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Eastern Air Devices, Inc., 585 Dean St., Brooklyn 17, N. Y.
Eclipse-Pioneer Div., Bendix Corp., Teterboro, N. J.
Eicor, Inc., 1501 W. Congress St., Chicago 7, Ill.
Electric Specialty Co., Stamford, Conn.
Electrical Engineering & Mfg. Co., 4606 W. Jefferson Blvd., Los Angeles, Calif.
Electrolux Corp., Old Greenwich, Conn.
Electron Equipment Corp., 917 Meridian Ave., South Pasadena, Calif.
Electronic Laboratories, Inc., Indianapolis, Ind.
General Electric Co., Schenectady 5, N. Y.
Gibbs & Co., Thomas B., Div. of George W. Borg Corp., 814 Michigan St., Delavan, Wisc.
Holtzer-Cabot, Signal Division, 400 Stuart St., Boston 17, Mass.
International Transformer Co., 396 Broadway, New York, N. Y.
Janette Mfg. Co., 556 W. Monroe St., Chicago 40, Ill.
Leland Electric Co., 1501 Webster St., Dayton, Ohio
Linde Air Products Co., 30 East 42nd St., New York 17, N. Y.
Master Electric Co., 126 Davis Avenue, Dayton, Ohio
Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.
Pioneer Gen-E-Motor Co., 5841 Dickens Avenue, Chicago 39, Ill.
Quality Electric Co., Ltd., 1235 E. Olympic Blvd., Los Angeles 21, Calif.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Russell Electric Co., 364 W. Huron St., Chicago 10, Ill.
Small Motors, Inc., 1322 Elston Ave., Chicago 22, Ill.
Union Switch & Signal Co., Swissvale, Pa.
Webster Chicago Corp., Electronics Div., 3825 Armitage Ave., Chicago 47, Ill.

ELECTRONIC and ALLIED PRODUCTS

Westinghouse Elec. Corp., Lima, Ohio
Wincharger Corp., 7th & Division, Sioux City, Iowa

Irons

ELECTRIC SOLDERING IRONS

Acme Electric Heating Co., 1217 Washington St., Boston, Mass.
American Electrical Heater Co., 6110 Cass Ave., Detroit 2, Mich.
Baker-Phillips Co., 3017 Lyndale Ave. S., Minneapolis 8, Minn.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Cole Radio Works, 86 Westville Ave., Caldwell, N. J.
Drake Electric Works, 3656 Lincoln Ave., Chicago 13, Ill.
Eagle Electric Mfg. Co., Inc., 23-10 Bridge Plaza S., Long Island City, N. Y.
Electric Soldering Iron Co., Deep River, Conn.
General Electric Co., Schenectady 5, N. Y.
Glaser Lead Co., Inc., 31 Wyckoff Ave., Brooklyn, N. Y.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Hexacon Electric Company, 161 W. Clay Ave., Roselle Park, N. J.
Ideal Commutator Dresser Co., 1291 Park Ave., Sycamore, Ill.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Jackson Electro Corp., 124 Bleeker St., New York, N. Y.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Kelnor Mfg. Co., Central Tower Bldg., San Francisco, Calif.
Lenk Mfg. Co., Newton Lower Falls, Mass.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Sound Equipment Corp. of California, 3903 San Fernando Road, Glendale 4, Calif.
Stanley Works, New Britain, Conn.
Trent Co., Harold E., Leverington Ave. & Wilde St., Philadelphia 27, Pa.
Ungar Electric Tools, Inc., 615 Ducommun St., Los Angeles 54, Calif.
Vasco Electrical Mfg. Co., 4116 Avalon Blvd., Los Angeles 11, Calif.
Vulcan Electric Co., 88 Holten St., Danvers, Mass.
Weller Mfg. Co., 516 Northampton St., Easton, Pa.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio

Jacks

see also Plugs

A.B.C. Products, Inc., 11952 Montana Ave., W. Los Angeles, Calif.
Aircraft Products Co., 3502 E. Pontiac St., Fort Wayne, Ind.
Alden Products Co., 117 North Main St., Brockton 64, Mass.
Amalgamated Radio & Television Corp., 476 Broadway, New York 13, N. Y.
American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.
American Radio Hardware Co., Inc., 152 MacQuesten Pkway. S., Mt. Vernon, N. Y.
Audio Development Co., 2833 13th Ave., S., Minneapolis 7, Minn.
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Automatic Metal Products Corp., 315 Berry St., Brooklyn, N. Y.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bead Chain Mfg. Co., 110 Mt. Grove St., Bridgeport 5, Conn.
Birnbach Radio Co., Inc., 145 Hudson St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Connecticut Telephone & Elec. Div. of Great American Industries, Inc., 70 Brittania St., Meriden, Conn.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia 13, Pa.
Electronic Products Mfg. Corp., 7300 Huron River Drive, Dexter, Mich.
Federal Mfg. & Engrg. Corp., 199 Steuben St., Brooklyn, N. Y.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electronics Mfg. Co., 2225 S. Hoover St., Los Angeles 7, Calif.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Heinze Electric Co., Lowell, Mass.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Jones, Howard B., 2460 W. George St., Chicago 18, Ill.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Mossman, Inc., Donald P., 612 North Michigan Ave., Chicago 11, Ill.
National Electronic Mfg. Corp., 22-78 Steinway St., Long Island City 5, N. Y.
National Fabricated Products, 2650 Belden Ave., Chicago 47, Ill.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Presto Electric Co., 4511 New York Ave., Union City, N. J.
Scovill Mfg. Co., 99 Mill St., Waterbury 91, Conn.
Standard Electric Time Co., 89 Logan St., Springfield, Mass.
Telephonics Corp., 350 West 31st St., New York, N. Y.
Trav-Ler Karenola Radio & Television Corp., 571 W. Jackson Blvd., Chicago, Ill.
Ucinite Co., 459 Watertown St., Newtonville, Mass.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Wood Electric Co., Inc., C. D., 826 Broadway, New York 3, N. Y.

Keys and Coding Equipment

Alden Products Co., 117 North Main St., Brockton 64, Mass.
American Radio Hardware Co., Inc., 152 MacQuesten Pkway. S., Mt. Vernon, N. Y.
Bud Radio, Inc., 2118 E. 55 St., Cleveland, 3, Ohio
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago 30, Ill.
Electro-Medical Laboratory, Inc., Hollis-ton, Mass.
Federal Manufacturing & Engineering Corp., 199-217 Steuben St., Brooklyn, N. Y.
Fleron & Son, Inc., M. M., 113 N. Broad St., Trenton, N. J.
Foote Pierson & Co., Inc., 75 Hudson St., Newark 4, N. J.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Gray Manufacturing Co., 16-30 Arbor St., Hartford, Conn.
Haydon Manufacturing Co., Inc., Forestville, Conn.
McElroy Manufacturing Corp., 82 Brookline Ave., Boston, Mass.
Mechanitron Corp., 711 Boylston St., Boston 16, Mass.
Reynolds Electric Co., 2650 W. Congress St., Chicago 12, Ill.
Signal Electric Mfg. Co., 1915 Broadway, Menominee, Mich.
Telegraph Apparatus Co., 325 W. Huron St., Chicago, Ill.
Telephonics Corp., 350 West 31st St., New York 1, N. Y.
Teleplex Co., 107 Hudson St., Jersey City, N. J.
Vibroplex Co., Inc., 833 Broadway, New York, N. Y.
Wallace & Tiernan Products, Inc., Belleville, N. J.
Winslow Co., 31 Fulton St., Newark 2, N. J.

Knobs

see Dials

also Pointers

Alden Products Co., 117 North Main St., Brockton 64, Mass.
American Insulator Corp., New Freedom, Pa.
American Radio Hardware Co., Inc., 152 MacQuesten Pkway. S., Mt. Vernon, N. Y.
Birnbach Radio Co. Inc., 145 Hudson St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Creative Plastics Corp., 963 Kent Ave., Brooklyn, N. Y.
Croname, Inc., 3701 Ravenswood Ave., Chicago, Ill.
Daven Co., 191 Central Ave., Newark 4, N. J.
Davies Molding Co., Harry, 1428 N. Wells St., Chicago 10, Ill.
Diemolding Corp., Canastota, N. Y.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia 13, Pa.
Eclipse Moulded Products Co., 5151 North 32nd St., Milwaukee 9, Wisc.
Emeloid Co., 291 Laurel Ave., Arlington, N. J.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Erie Resistor Corp., 644 W. 12 St., Erie, Pa.
Garfield Mfg. Co., Garfield, N. J.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Imperial Molded Products Corp., 2925 W. Harrison St., Chicago, Ill.
Insulation Mfg. Co., 11 New York Ave., Brooklyn, N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Kurz-Kasch, Inc., 1415 S. Bway, Dayton, 1, Ohio
Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Mykroy, Inc., 1917 N. Springfield Ave., Chicago 47, Ill.
National Co., Inc., 61 Sherman St., Malden 48, Mass.
New England Radiocrafters, 1156 Commonwealth Ave., Boston 34, Mass.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Radio City Products Co., 127 West 26th St., New York, N. Y.
Richardson Co., Melrose Park, Ill.
Rogan Brothers, 2001 S. Michigan Ave., Chicago, Ill.
Stokes Rubber Co., Jos., Taylor & Webster Sts., Trenton, N. J.
Syracuse Ornamental Co., 581 So. Clinton St., Syracuse, N. Y.
Victory Mfg. Co., 1722 W. Arcade Place, Chicago 12, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Worcester Moulded Plastics Co., 8 Grafton St., Worcester 8, Mass.

Lacquer

see Finishes

Lights

DIAL LIGHTS

Aerolux Light Corp., 653 11th Ave., New York 19, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Carlton Lamp Corp., 730 South 13th St., Newark 3, N. J.
Cinch Mfg. Corp., 2335 W. Van Buren St., Chicago, Ill.
Dial Light Co. of America, 900 Broadway, New York 3, N. Y.
Drake Mfg. Co., 1713 Hubbard St., Chicago, Ill.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Federal Screw Products Co., 224 W. Huron St., Chicago 10, Ill.
General Electric Co., Schenectady 5, N. Y.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Kirkland Co., H. R., 8-10 King St., Morristown, N. J.

Kopp Glass, Inc., 1 E. 42nd St., New York 17, N. Y.
Micarta Fabricators Inc., 5324 Ravenswood Ave., Chicago 40, Ill.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
Signal Indicator Corp., 894 Broadway, New York 3, N. Y.
Tung-Sol Lamp Works, Inc., 95 Eighth Ave., Newark, N. J.
Westinghouse Electric Corp., Lamp Div., Bloomfield, N. J.
Westinghouse Electric Corp., East Pittsburgh, Pa.

PILOT LIGHTS

Alden Products Co., 117 North Main St., Brockton 64, Mass.
Bardwell & McAllister, 7636 Santa Monica Blvd., Hollywood, Calif.
Bryant Electric Co., 1421 State St., Bridgeport, Conn.
Bud Radio, Inc., 2118 East 55 St., Cleveland 3, Ohio
Carlton Lamp Corp., 730 South 13th St., Newark 3, N. J.
Cole-Hersee Co., 54 Old Colony Ave., Boston 27, Mass.
Conn, Ltd., C. G., Elkhart, Ind.
Cutler-Hammer, Inc., 315 North 12th St., Milwaukee 1, Wisc.
Dial Light Co. of America, Inc., 900 Broadway, New York 3, N. Y.
Drake Mfg. Co., 1713 W. Hubbard St., Chicago, Ill.
Federal Screw Products Co., 224 W. Huron St., Chicago 10, Ill.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
General Electric Co., Schenectady 5, N. Y.
Gothard Mfg. Co., 1300 North 9th St., Springfield, Ill.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford 1, Conn.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Kirkland Co., H. R., 8–10 King St., Morristown, N. J.
Kopp Glass, Inc., 1 E. 42nd St., New York 17, N. Y.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
Pass & Seymour, Inc., Solvay Station, Syracuse, N. Y.
Signal Indicator Corp., 894 Broadway, New York, N. Y.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.
Tingstol Corp., 1461 W. Grand Ave., Chicago, Ill.
Westinghouse Electric Corp., Lamp Div., Bloomfield, N. J.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wood Electric Co., Inc., C. D., 826 Broadway, New York 3, N. Y.

Lines

COAXIAL LINES

see Cable

Locknuts

see Nuts

Lockwashers

see Washers

Loudspeakers

Altec Lansing Corp., 1680 N. Vine St., Los Angeles 28, Cal.
American Communications Corp., 306 Broadway, New York, N. Y.
Atlas Sound Corp., 1443 39th St., Brooklyn, N. Y.
Austin Electronic Mfg. Co., Warren, Pa.
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Best Mfg. Co., 1200 Grove St., Irvington, N. J.
Boom Electric Amplifier Corp., 1227 W. Washington Blvd., Chicago, Ill.
Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Chicago Sound Systems Co., 2124 S. Michigan Ave., Chicago, Ill.
Cinaudagraph Speakers, Inc., 3911 S. Michigan Ave., Chicago, Ill.
Consolidated Radio Products Co., 350 W. Erie St., Chicago 10, Ill.
DX Crystal Co., 1200 N. Claremont Ave., Chicago 22, Ill.
Dilks, Inc., Norwalk, Conn.
Electronic Sound Engineering Co., 109 N. Dearborn St., Chicago 2, Ill.
Erwood Co., 223 W. Erie St., Chicago, Ill.
Flock Process Corp., 53 W. 21st St., New York 10, N. Y. (Also 3 Quincy St., Norwalk, Conn.)
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., Schenectady 5, N. Y.
General Instrument Corp., 829 Newark Ave., Elizabeth F, N. J.
Guided Radio Corp., 161 Sixth Ave., New York 13, N. Y.
Hallicrafters Co., 2611 Indiana Ave., Chicago 16, Ill.
Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill.
Langevin Co., Inc., 37 W. 65th St., New York, N. Y.
Lifetime Sound Equipment Co., 1101 Adams St., Toledo, Ohio
Magnavox Co., The, 2131 Bueter Rd., Fort Wayne 4, Ind.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
National Co., Inc., 61 Sherman St., Malden 48, Mass.
National Scientific Products Co., 5013 N. Kedzie Ave., Chicago 25, Ill.
Olesen Illuminating Co., Ltd., Otto, 1560 Vine St., Hollywood 28, Calif.
Operadio Mfg. Co., 13th & Indiana Sts., St. Charles, Ill.
Permoflux Corp., 4900 W. Grand Ave., Chicago, Ill.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Powers Electronic & Communication Co., Inc., Glen Cove, N. Y.
Quam-Nichols Co., 526 East 33rd Place, Chicago 16, Ill.
Racon Electric Co., Inc., 52 E. 19th St., New York 3, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Speakers, Inc., 221 E. Cullerton St., Chicago, Ill.
Radionic Controls, Inc., 3758 Belmont Ave., Chicago 18, Ill.
Rola Co., Inc., 2530 Superior Ave., Cleveland, Ohio
Schulmerich Electronics Co., Sellersville, Pa.
Simpson Mfg. Co., Mark, 188 West Fourth St., New York, N. Y.
Stephens Mfg. Co., 10416 National Blvd., Los Angeles 34, Calif.
Taybern Equipment Co., Inc., 120 Greenwich St., New York 6, N. Y.
Techno-Scientific Co., 901 Nepperhan Ave., Yonkers 3, N. Y.
University Laboratories, 225 Varick St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.

Lugs & Terminals

Aircraft Products Co., 3502 E. Pontiac St., Fort Wayne, Ind.
Aircraft-Marine Products, Inc., 1523 N. Fourth St., Harrisburg, Pa.
American Brass Co., Waterbury 88, Conn.
Atlas Products Corp., 30 Rockefeller Plaza, New York 20, N. Y.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bead Chain Mfg. Co., 110 Mt. Grove St., Bridgeport 5, Conn.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago 44, Ill.
Birnbach Radio Co. Inc., 145 Hudson St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55 St., Cleveland 3, Ohio
Burndy Engineering Co., 107 Bruckner Blvd., New York 54, N. Y.
Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass.
Cinch Mfg. Corp., 2335 W. Van Buren St., Chicago, Ill.
Cole-Hersee Co., 54 Old Colony Ave., Boston 27, Mass.
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Dante Electric Mfg. Co., Bantam, Conn.
Dossert & Co., 249 Huron St., Brooklyn, N. Y.
Eastern Specialty Co., 3617-19 N. Eighth St., Philadelphia 40, Pa.
Electric Auto-Lite Co., Wire & Cable Div., Port Huron, Mich.
Federal Screw Products Co., 224 W. Huron St., Chicago 10, Ill.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Bridgeport, Conn.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Grammes & Sons, Inc., L. F., 389 Union St., Allentown 2, Pa.
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Hatheway Mfg. Co., Bridgeport, Conn.
Heyman Mfg. Co., Kenilworth, N. J.
Ideal Commutator Dresser Co., 1291 Park Ave., Sycamore, Ill.
Ilsco Copper & Tube Product Inc., Mariemont Ave., Mariemont 27, Ohio
Industrial Screw & Supply Co., 713 W. Lake St., Chicago 6, Ill.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Jones, Howard B., 2460 W. George St., Chicago 18, Ill.
Kellogg Switchboard & Supply So., 6650 S. Cicero Ave., Chicago 38, Ill.
Krueger & Hudepohl, 232-8 Vine St., Cincinnati 5, Ohio
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Manufacturers Screw Products, 270 W. Hubbard St., Chicago, Ill.
Morse Co., Frank W., 301 Congress St., Boston 10, Mass.
National Fabricated Products, 2650 Belden Ave., Chicago 47, Ill.
Penn-Union Electric Corp., 315 State St., Erie, Pa.
Philmore Mfg. Co., 113 University Place, New York, N. Y.
Rajah Co., Locust Ave., Bloomfield, N. J.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Scovill Mfg. Co., 99 Mill St., Waterbury 91, Conn.
Shakeproof, Inc., 2501 N. Keeler Ave., Chicago 39, Ill.
Sherman Mfg. Co., H. B., Battle Creek, Mich.
Smith Mfg. Co., Nathan R., 105 Pasadena Ave., South Pasadena, Calif.
Sperti, Inc., Norwood Station, Cincinnati 12, Ohio
Stewart Stamping Corp., 630 Central Park Ave., Yonkers 4, N. Y.
Stimpson Co., Inc., Edwin B., 74 Franklin Ave., Brooklyn 5, N. Y.
Templetone Radio Mfg. Corp., New London, Conn.
Thompson-Bremer & Co., 1640 W. Hubbard St., Chicago, Ill.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
Waterbury Button Co., 835 S. Main St., Waterbury, Conn.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.
Zierick Mfg. Corp., 385 Gerard Ave., New York, N. Y.

Machinery, Printing Blue and Blue White

see Blue and Black-White Printing Machines

Machines

COIL WINDING MACHINES

Armature Coil Equipment, Inc., 2605 Vega Ave., Cleveland 3, Ohio
Automatic Manufacturing Co., 900 Passaic Ave., E. Newark, N. J.

ELECTRONIC and ALLIED PRODUCTS

Chapman Electrical Works, P. E., 1820 Chouteau Ave., St. Louis, Mo.
Electric Service Manufacturing Co., 17th & Cambria Sts., Philadelphia 32, Pa.
Engineering Laboratories, Inc., 602 East Fourth St., Tulsa 3, Okla.
Giannini & Co., Inc., G. M., 161 E. California St., Pasadena, Calif.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Neb.
Guthman & Co., Edwin I., 15 S. Throop St., Chicago, Ill.
Ideal Commutator Dresser Co., 1291 Park Ave., Sycamore, Ill.
Kahle Engrg. Co., 1307 Seventh St., North Bergen, N. J.
Meissner Mfg. Div., Maguire Industries, Inc., Mt. Carmel, Ill.
Mico Instrument Co., 80 Trowbridge St., Cambridge 38, Mass.
Potter & Rayfield, Inc., Box 1042, 1570 Northside Drive, Atlanta, Ga.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Small Motors, Inc., 1322 Elston Ave., Chicago 22, Ill.
Sorensen & Co., 375 Fairfield Ave., Stamford, Conn.
Stevens Machinery Co., 1461 W. Grand Ave., Chicago 22, Ill.
Universal Winding Co., 1655 Elmwood Ave., Cranston 3, R. I.

MARKING MACHINES

see Plastics & Metal Marking

TESTING MACHINES

see Tube Mfrs'. Test Equipment

TUBE MANUFACTURING MACHINES

Ecco High Frequency Corp., 7020 Hudson Blvd., North Bergen, N. J.
Eisler Engineering Co., 740 S. 13th St., Newark 3, N. J.
Electronic Manufacturing Co., 20 Orange St., Newark 2, N. J.
Engineering Co., 27 Wright St., Newark, N. J.
International Machine Works, 2027 46th St., North Bergen, N. J.
Kahle Engineering Co., 1307 Seventh St., North Bergen, N. J.
Litton Engineering Labs., P. O. Box 749, Redwood City, Calif.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.

Magnesium

see Metals

Magnets

PERMANENT MAGNETS

Advance Transformer Co., 14 N. May St., Chicago, Ill.
Arnold Engrg. Co., 147 E. Ontario St., Chicago, Ill.
Cinaudagraph Corp., 2 Selleck St., Stamford, Conn.
Crucible Steel Co. of America, 405 Lexington Ave., New York 17, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Magnetic Corp., 2126 E. Fort St., Detroit 7, Mich.
Indiana Steel Products Co., 6 N. Michigan Ave., Chicago, Ill.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Scherr, George D., 200 Lafayette St., New York, N. Y.
Simonds Saw & Steel Co., Lockport, N. Y.
Smith Mfg. Co., Nathan R., 105 Pasadena Ave., South Pasadena, Calif.
Taylor-Wharton Iron & Steel Co., Highbridge, N. J.
Thomas & Skinner Steel Products Co., 1120 E. 23d St., Indianapolis, Ind.
Tri-United Plastics Corp., 390 Nye Ave., Irvington, N. J.

Metal Marking Machines —

see Plastics & Metal Marking

Metal Plating on Plastics

see Plating-Metal

Metals

ALUMINUM

Aluminum Co. of America, Gulf Bldg., Pittsburgh, Pa.
Aluminum Finishing Corp., 1119 E. 22nd St., Indianapolis, Ind.
Belmont Smelting & Refining Works, Inc., 330 Belmont Ave., Brooklyn 7, N. Y.
Fairmont Aluminum Co., Fairmont, West Va.
Reynolds Metal Co., Federal Reserve Bldg., Richmond, Va.
Uniform Tubes, Shurs Lane & Lauriston St., Roxborough, Philadelphia, Pa.

MAGNESIUM

American Magnesium Corp., 2210 Harvard Ave., Cleveland, Ohio
Belmont Smelting & Refining Works, Inc., 330 Belmont Ave., Brooklyn 7, N. Y.
Bohn Aluminum & Brass Corp., Lafayette Bldg., Detroit, Mich.
Dow Chemical Co., Midland, Mich.

NICKEL

Ingersoll Steel & Disc Co., New Castle, Ind.
International Nickel Co., 67 Wall St., New York 5, N. Y.
Lukens Steel Co., Coatesville, Pa.
Superior Metal Corp., Clearing, Ill.

POWDERED METAL PRODUCTS

American Electro Metal Corp., 320 Yonkers Ave., Yonkers, N. Y.
Belmont Smelting & Refining Works, Inc., 330 Belmont Ave., Brooklyn 7, N. Y.
Chrysler Corp., Amplex Div., Detroit, Mich.
Cleveland Tungsten, Inc., 10200 Meech Ave., Cleveland, Ohio
Crowley & Co., Inc., Henry L., 1 Central Ave., West Orange, N. J.
Division Lead Co., 836 W. Kinzie St., Chicago 22, Ill.
Foote Mineral Co., 1609 Summer St., Philadelphia, Pa.
General Aniline & Film Corp., Special Products Sales Dept., 270 Park Ave., New York 17, N. Y.
Goldsmith Bros. Smelting & Refining Co., 58 East Washington St., Chicago, Ill.
Handy & Harman, 82 Fulton St., New York 7, N. Y.
Johnson Bronze Co., New Castle, Pa.
Keystone Carbon Co., Inc., 1935 State St., St. Marys, Pa.
Magna Mfg. Co., 444 Madison Ave., New York, N. Y.
Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Mepham Corp., G. S., 2001 Lynch Ave., East St. Louis, Ill.
Micro-Ferrocart Products Div., Maguire Industries, Inc., Greenwich, Conn.
Moraine Products Div., General Motors Corp., Dayton, Ohio
National Lead Co., 111 Broadway, New York 6, N. Y.
Powder Metallurgy Corp., 30-48 Greenpoint Ave., Long Island City, N. Y.
Wickwire Spencer Metallurgical Corp., 260 Sherman St., Newark, N. J.

SPECIAL METALS

Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Alloy Metal Wire Co., Prospect Park, Pa.
American Platinum Works, New Jersey R. R. Ave., at Oliver St., Newark 5, N. J.
Baker & Co., 113 Astor St., Newark 5, N. J.
Belmont Smelting & Refining Works, Inc., 330 Belmont Ave., Brooklyn 7, N. Y.
Bishop & Co., Platinum Works, J., 12 Channing Ave., Malvern, Pa.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Callite Tungsten Corp., 544 39th St., Union City, N. J.
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Chace Co., W. M., 1600 Beard Ave., Detroit, Mich.
Cohn & Co., Sigmund, 44 Gold St., New York, N. Y.
Cross, H., 15 Beekman St., New York, N. Y.
Division Lead Co., 836 W. Kinzie St., Chicago 22, Ill.
Driver Co., William B., 150 Riverside Ave., Newark, N. J.
Driver Harris Co., Harrison, N. J.
Fansteel Metallurgical Corp., 2200 Sheridan Rd., North Chicago, Ill.
Foote Mineral Co., 1609 Summer Street, Philadelphia, Pa.
General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
Goldsmith Bros. Smelting & Refining Co., 58 E. Washington St., Chicago, Ill.
Handy & Harman, 82 Fulton St., New York 7, N. Y.
Haydu Bros., Mt. Bethel Rd., Plainfield, N. J.
International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.
Kemet Laboratories Co., Inc., West 117th St. & Madison Ave., Cleveland 1, Ohio
King Laboratories, Inc., 205 Oneida St., Syracuse 4, N. Y.
Makepeace Co., D. E., Attleboro, Mass.
Ney Co., J. M., Hartford, Conn.
North American Philips Co., Inc., 100 East 42nd St., New York 17, N. Y.
Olin Industries, East Alton, Ill.
Peerless Roll Leaf Co., Inc., 4517 New York Ave., Union City, N. J.
Rapid Electroplating Process, Inc., 1414 S. Wabash Ave., Chicago 5, Ill. (electroplating & treating)
Revere Copper & Brass Inc., 230 Park Ave., New York 17, N. Y.
Riverside Metal Co., Riverside, N. J.
Scovill Mfg. Co., 99 Mill St., Waterbury 91, Conn.
Simonds Saw & Steel Co., Lockport, N. Y.
Swedish Iron & Steel Corp., 17 Battery Place, New York, N. Y.
Western Brass Mills, Div. of Olin Industries, Inc., East Alton, Ill.
Westinghouse Electric Corp., Lamp Div., Bloomfield, N. J.
Wickwire Spencer Metallurgical Corp., 260 Sherman St., Newark, N. J.
Wilson Co., H. A., 105 Chestnut St., Newark 5, N. J.

STEEL ELECTRICAL

Allegheny Ludlum Steel Corp., Brackenridge, Pa.
American Rolling Mill Co., Curtis St., Middletown, Ohio
American Steel & Wire Co., Rockefeller Building, Cleveland 13, Ohio
Carnegie-Illinois Steel Corp., Carnegie Bldg., Pittsburgh, Pa.
Crucible Steel Co., of America, 405 Lexington Ave., New York, N. Y.
Empire Steel Corporation, N. Bowman St., Mansfield, Ohio
Follansbee Steel Corp., Third & Liberty Sts., Pittsburgh, Pa.
Granite City Steel Co., Granite City, Ill.
Newport Rolling Mill Co., Ninth & Lowell Sts., Newport, Ky.
Republic Steel Corp., Republic Bldg., Cleveland 1, Ohio
Thomas Steel Co., Delaware Ave., Warren Ohio
Union Drawn Steel Div., Republic Steel Corp., Harsh Ave., S. E. Massillon, Ohio
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wheeling Steel Corp., Wheeling Steel Corp., Bldg., Wheeling, W. Va.
Youngstown Sheet & Tube Co., Stambaugh Bldg., Youngstown, Ohio

THERMOSTATIC METALS

Baker & Co., 113 Astor St., Newark 5, N. J.
Brainin Co., C. S., 233 Spring St., New York 13, N. Y.
Callite Tungsten Corp., 544 39th St., Union City, N. J.
Chace Co., W. M., 1600 Beard Ave., Detroit, Mich.
General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
Wilson Co., H. A., 105 Chestnut St., Newark 5, N. J.

Meters

AMMETERS

Associated Research Inc., 231 S. Green St., Chicago 7, Ill.
Boes Co., W. W., 3001 Salem Ave., Dayton, 3, Ohio
Bristol Co., Waterbury 91, Conn.
Burlington Instrument Co., 214 North 4th St., Burlington, Iowa
Burton-Rogers Co., 857 Boylston Street, Boston 16, Mass.
Cambridge Instrument Co., 3732 Grand Central Terminal, New York 17, N. Y.
De Jur-Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.
Electric Auto-Lite Corp., Toledo 1, Ohio
Electric Heat Control Co., 9123 Inman Ave., Cleveland 5, Ohio
Electro-Mechanical Instrument Co., 812 Chestnut St., Perkasie, Pa.
Electronic Development Co., 1336 North Saddle Creek Road, Omaha 3, Nebr.
Esterline-Angus Co., Inc., P. O. Box 597, Indianapolis, Ind.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Electronic Mfg. Co., 2225 So. Hoover St., Los Angeles 7, Calif.
Hickok Eléctrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
J-B-T Instruments, Inc., 441 Chapel St., New Haven 8, Conn.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
MB Manufacturing Co., New Haven, Conn.
Marion Electrical Instrument Co., Manchester, N. H.
Meters, Inc., 915 Riveria Drive, Indianapolis 5, Ind.
Norton Electrical Instrument Co., 79 Hilliard St., Manchester, Conn.
Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, L. I., N. Y.
Radio City Products Co., 127 West 26th St., New York, N. Y.
Radio Corp. of America. RCA Victor Div., Camden, N. J.
Rawson Electrical Instrument Co., Inc., 110 Potter St., Cambridge 42, Mass.
Readrite Meter Works, College Ave., Bluffton, Ohio
Reliance Instrument Co., 715 N. Kedzie Ave., Chicago, Ill.
Rhamstine, J. Thos., 301 Beaubien St., Detroit 26, Mich.
Roller-Smith, Bethlehem, Pa.
Scientific Service Laboratories, 2225 So. Hoover St., Los Angeles 7, Calif.
Sensitive Research Instrument Co., 9 Elm Ave., Mt. Vernon, N. Y.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Sun Mfg. Co., 6323 Avondale Ave., Chicago, Ill.
Superior Instruments Co., 227 Fulton St., New York 7, N. Y.
Supreme Instruments Corp., Greenwood, Miss.
Technical Products Co., 158 Madison Ave., at Third St., Memphis, Tenn.
Thwing-Albert Instrument Co., Penn St., & Pulaski Ave., Philadelphia 44, Pa.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.
Western Electro-Mechanical Co., Inc., 300 Broadway, Oakland, Calif.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Freylinghuysen Ave., Newark 5, N. Y.

FIELD INTENSITY METERS

Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Fada Radio & Electric Co., Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Freed Radio Corp., 200 Hudson St., New York, N. Y.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Marion Electrical Instrument Co., Manchester, N. H.
Measurements Corp., Boonton, N. J.
Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.
Radio Corp. of America, RCA Victor Div., Camden, New Jersey
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.

FREQUENCY METERS

Aero Communications, Inc., 231 Main St., Hempstead, L. I., N. Y.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bendix Radio Div. of Bendix Aviation Corp., Baltimore 4, Md.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Browning Laboratories, Inc., 750 Main St., Winchester, Mass.
Burlington Instrument Corp., 214 North 4th St., Burlington, Iowa
Burnett Radio Lab., Wm. W. L., 4814 Idaho St., San Diego, Calif.
Cambridge Instrument Co., 3732 Grand Central Terminal, New York 17, N. Y.
Collins Radio Co., 855-35th St., N. E. Cedar Rapids, Iowa
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Conn Ltd., C. G., Elkhart, Ind.
Daven Co., 191 Central Ave., Newark 4, N. J.
Doolittle Radio, Inc., 7421 South Loomis Blvd., Chicago, Ill.
Engineering Laboratories, Inc., 602 East Fourth St., Tulsa 3, Okla.
Erco Radio Laboratories, Inc., Fenimore Ave., Hempstead, N. Y.
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
Fada Radio & Electric Co., Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Ferris Instrument Co., 110-112 Cornelia St., Boonton, N. J.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Gurley, W. & L. E., 514 Fulton St., Troy, N. Y.
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Herbach & Rademan Co., Mfg. Div., 517 Ludlow St., Philadelphia, Pa.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
Hoffman Radio Corp., 3430 S. Hill St., Los Angeles 7, Calif.
J-B-T Instruments, Inc., 441 Chapel St., New Haven 8, Conn.
Jefferson, Inc., Ray, 40 E. Merrick Rd., Freeport, Long Island, N. Y.
Lampkin Laboratories, Bradenton, Fla.
Lavoie Laboratories, Mattawan-Freehold Rd., Morganville, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Link, Fred M., 125 West 17 St., New York, N. Y.
Mico Instrument Co., 80 Trowbridge St., Cambridge 38, Mass.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden 48, Mass.
North American Philips Co., Inc., 100 East 42nd St., New York, N. Y.
Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Roller-Smith, Bethlehem, Pa.
Schuttig & Co., 9th & Kearney St., N.E., Washington 17, D. C.
Sorensen & Co., 375 Fairfield Ave., Stamford, Conn.
Sperry Gyroscope Co., Manhattan Bridge Plaza, Brooklyn 1, New York
Telicon Corp., 305 East 63rd St., New York, N. Y.
Transmitter Equipment Mfg. Co. Inc., 345 Hudson St., New York 14, N. Y.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

GALVANOMETERS

Boes Co., W. W., 3001 Salem Ave., Dayton 3, Ohio
Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Cambridge Instrument Co., 3732 Grand Central Terminal, New York 17, N. Y.
Central Scientific Co., 1700 Irving Park Blvd., Chicago 13, Ill.
Communication Measurements Laboratory, 120 Greenwich St., New York, N. Y.
Consolidated Engineering Corp., 595 E. Colorado St., Pasadena 1, Calif.
De Jur Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.
Engineering Laboratories, Inc., 602 East Fourth St., Tulsa 3, Okla.
Engelhard, Inc., Charles, 233 New Jersey R. R. Ave., Newark 5, N. J.
Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
General Electric Co., Schenectady 5, N. Y.
Geophysical Instrument Co., Key Blvd. & Nash St., Arlington, Va.
Giannini & Co., Inc.; G. M., 161 E. California St., Pasadena, Calif.
Hathaway Instrument Co., 1315 S. Clarkson St., Denver 10, Colo.
Heiland Research Corp., 130 East Fifth St., Denver 9, Colo.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
J-B-T Instruments, Inc., 441 Chapel St., New Haven 8, Conn.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
MB Manufacturing Co., 1060 State St., New Haven, Conn.
Marion Electrical Instrument Co., Manchester, N. H.
Meters, Inc., 915 Riveria Drive, Indianapolis 5, Ind.
Miller Corp., Wm., 362 W. Colorado St., Pasadena, Calif.
Pfaltz & Bauer, Inc., 350 Fifth Ave., New York, N. Y.
Portable Products Corp., C. J. Tagliabue Div., 550 Park Ave., Brooklyn 5, N. Y.
Rawson Electrical Instrument Co., Inc., 110 Potter St., Cambridge 42, Mass.
Roller-Smith, Bethlehem, Pa.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Sanborn Co., 39 Osborne St., Cambridge 39, Mass.
Scientific Service Laboratories, 2225 So. Hoover St., Los Angeles 7, Calif.
Sensitive Research Instrument Co., 9 Elm Ave., Mt. Vernon, N. Y.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Technical Products Co., 158 Madison Ave., at Third St., Memphis, Tenn.
Thwing-Albert Instrument Co., Penn St. & Pulaski Ave., Philadelphia 44, Pa.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
Winslow Co., 31 Fulton St., Newark 2, N. J.

LIGHT METERS

De Jur-Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.
General Electric Co., Schenectady 5, N. Y.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
MB Manufacturing Co., 1060 State St., New Haven, Conn.
Marion Electrical Instrument Co., Manchester, N. H.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Pfaltz & Bauer, Inc., 350 Fifth Ave., New York, N. Y
Photovolt Corp. 95 Madison Ave., New York 16, N. Y.
Pho-Tron Instrument Co., 5713 Euclid Ave., Cleveland, Ohio

ELECTRONIC and ALLIED PRODUCTS

Rhamstine, J. Thos., 301 Beaubien St., Detroit 26, Mich.
Scientific Service Laboratories, 2225 So. Hoover St., Los Angeles 7, Calif.
Technical Products Co., 158 Madison Ave. at 3rd St., Memphis, Tenn.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

MODULATION METERS

Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Boes Co., W. W., 3001 Salem Ave., Dayton 3, Ohio
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
MB Mfg. Co., 1060 State St., New Haven, Conn.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Sundt Engineering Co., 4757 Ravenswood Ave., Chicago, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

OHMMETERS

Associated Research, Inc., 231 South Green St., Chicago 7, Ill.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Boes Co., W. W., 3001 Salem Ave., Dayton 3, Ohio
Burlington Instrument Corp., 214 North 4th St., Burlington, Iowa
De Jur Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electric Heat Control Co., 9123 Inman Ave., Cleveland 5, Ohio
Electronic Development Co., 1336 North Saddle Creek Road, Omaha 3, Nebr.
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Electronics Mfg. Co., 2225 So. Hoover St., Los Angeles 7, Calif.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Gray Instrument Co., 64½ W. Johnson St., Germantown, Philadelphia, Pa.
Grenby Mfg. Co., Plainville, Conn.
Hatry & Young, 203 Ann St., Hartford, Conn.
Hearing Aid Labs, 1404 Franklin St., Michigan City, Ind.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Holtzer-Cabot Signal Division, 400 Stuart St., Boston 17, Mass.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Marion Electrical Instrument Co., Manchester, N. H.
MB Mfg. Co., 1060 State St., New Haven, Conn.
Norton Electrical Instrument Co., 79 Hilliard St., Manchester, Conn.
Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y.
Radio City Products Co., 127 W. 26th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, New Jersey
Radio Design Co., 1353 Sterling Place, Brooklyn, N. Y.
Reiner Electronics Co., 152 W. 25th St., New York, N. Y.
Roller-Smith, Bethlehem, Pa.
Scientific Radio Products Co., 738 W. Broadway, Council Bluffs, Iowa
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Springfield Sound Co., Electronics Div., 12 Cass St., Springfield, Mass.
Sticht Co., Inc., Herman H., 27 Park Place, New York 7, N. Y.
Superior Instruments Co., 227 Fulton St., New York 7, N. Y.
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.

Techno Scientific Co., 901 Nepperhan Ave., Yonkers 3, N. Y.
Thwing-Albert Instrument Co., Penn St. & Pulaski Ave., Philadelphia 44, Pa.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 913 W. Van Buren St., Chicago 7, Ill.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
Winslow Co., 31 Fulton St., Newark 2, N. J.

pH METERS, RECORDERS & COMPARATORS

Bristol Company, Waterbury 91, Conn.
Cambridge Instrument Co., 3732 Grand Central Terminal, New York 17, N. Y.
Central Scientific Co., 1700 Irving Park Blvd., Chicago 13, Ill.
Coleman Electric Co., 318 Madison St., Maywood, Ill.
Colloid Equipment Co., Inc., 50 Church St., New York, N. Y.
Commercial Research Labs., Inc., 20 Bartlett Ave., Detroit 3, Mich.
Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.
Foxboro Co., Foxboro, Mass.
Gamma Instrument Co., Inc., 95 Madison Ave., New York 16, N. Y.
General Electric Co., 1 River Rd., Schenectady 5, N. Y.
Hellige, Inc., 3718 Northern Blvd., Long Island City 1, N. Y.
LaMotte Chemical Products Co., Towson 4, Baltimore, Md.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
MB Mfg. Co., 1060 State St., New Haven, Conn.
Machlett & Son, E., 220 East 23rd St., New York 10, N. Y.
National Technical Labs., 820 Mission St., South Pasadena, Calif.
Pfaltz & Bauer, Inc., 350 Fifth Ave., New York, N. Y.
Portable Products Corp., C. J. Tagliabue Div., 550 Park Ave., Brooklyn 5, N. Y.
Photovolt Corp., 95 Madison Ave., New York 16, N. Y.
Rascher & Betzold, 829-835 Orleans St., Chicago, Ill.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Scientific Service Laboratories, 2225 So. Hoover St., Los Angeles 7, Calif.
Taylor & Co., W. A., 7300 York Road, Baltimore 4, Md.
Technical Products Co., P. O. Box 93, 158 Madison Ave. at 3rd St., Memphis, Tenn.
Thwing-Albert Instrument Co., Penn St. at Pulaski Ave., Philadelphia 44, Pa.
Wallace & Tiernan Products Inc., Belleville, N. J.
Welch Manufacturing Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.
Wilkens-Anderson Co., 111 N. Canal St., Chicago 6, Ill.

PHASE ANGLE METERS

Amplifier Co. of America, 396 Broadway, New York, N. Y.
Andrew Co., 363 East 75th St., Chicago 19, Ill.
Edison, Inc., Thomas A., Instrument Div., 51 Lakeside Ave., West Orange, N. J.
General Electric Co., Schenectady 5, N. Y.
Hickok Electrical Instrument Co., 10514 Du Pont Ave., Cleveland, Ohio
Johnson Co., E. F. Waseca, Minn.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Sorenson & Co., 375 Fairfield Ave., Stamford, Conn.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

POWER LEVEL METERS

see Indicators

"Q" METERS

Boonton Radio Corp., Boonton, N. J.

Communication Parts, 1101 N. Paulina St., Chicago 22, Ill.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electronic Measurements Co., Red Bank, N. J.
MB Mfg. Co., 1060 State St., New Haven, Conn.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.

THERMOCOUPLE METERS

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio
Boes Co., W. W., 3001 Salem Ave., Dayton 3, Ohio
Brown Instrument Co., 4428 Wayne Ave., Philadelphia 44, Pa.
Burlington Instrument Corp., 214 North Fourth St., Burlington, Iowa
Cambridge Instrument Co., 3732 Grand Central Terminal, New York 17, N. Y.
Electronic Development Co., 1336 North Saddle Creek Road, Omaha 3, Nebr.
Foxboro Co., Foxboro, Mass.
General Electric Co., Schenectady 5, N. Y.
General Electronics Mfg. Co., 2225 So. Hoover St., Los Angeles 7, Calif.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Illinois Testing Labs., Inc., 420 N. LaSalle St., Chicago, Ill.
J-B-T Instruments, Inc., 441 Chapel St., New Haven 8, Conn.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
MB Mfg. Co., 1060 State St., New Haven, Conn.
Meters, Inc., 915 Riveria Drive, Indianapolis 5, Ind.
Portable Products Corp., C. J. Tagliabue Div., 550 Park Ave., Brooklyn 5, N. Y.
Rawson Electrical Instrument Co., Inc., 110 Potter St., Cambridge 42, Mass.
Roller-Smith, Bethlehem, Pa.
Sensitive Research Instrument Co., 9 Elm Ave., Mt. Vernon, N. Y.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Thwing Albert Instrument Co., Penn St. & Pulaski Ave., Philadelphia 44, Pa.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Illinois
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

TIME METERS

Amercian Time Products, Inc., 580 Fifth Ave., New York 19, N. Y.
Cramer Co., R. W., Centerbrook, Conn.
Electric Tachometer Corp., Broad & Spring Garden Sts., Philadelphia, Pa.
Esterline-Angus Co., Inc., P. O. Box 596, Indianapolis, Ind.
General Electric Co., Schenectady 5, N. Y.
Haydon Manufacturing Co. Inc., Forestville, Conn.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio
Industrial Timer Corp., 117 Edison Place, Newark 5, N. J.
J-B-T Instruments, Inc., 441 Chapel St., New Haven 8, Conn.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Lumenite Electric Co., 407 S. Dearborn St., Chicago, Ill.
National Instrument Co., 246 Walnut St., Newtonville 60, Mass.
Potter Instrument Co., 136-56 Roosevelt Ave., Flushing, Long Island, N. Y.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Rowe Radio Research Laboratory Co., 2422 N. Pulaski Rd., Chicago 39, Ill.
Standard Electric Time Co., 89 Logan St., Springfield, Mass.
Warren Telechron Co., Homer Ave., Ashland, Mass.
Westinghouse Electric Corp., East Pittsburgh, Pa.

VACUUM TUBE VOLTMETERS

American Radio Co., 611 E. Garfield Ave., Glendale, Calif.
Ballantine Laboratories, Inc., Boonton, N. J.
Barber Labs, Alfred W., 34-04 Francis Lewis Blvd., Flushing, New York.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electronic Development Co., 1336 North Saddle Creek Road, Omaha 3, Nebr.

Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
Ferris Instrument Co., 110-112 Cornelia St. Boonton, N. J.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Grenby Mfg. Co., Plainville, Conn.
Herbach & Rademan Co., Mfg. Div., 517 Ludlow St., Philadelphia 6, Pa.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Jackson Electrical Instrument Co., 16-18 S. Patterson Blvd., Dayton 1, Ohio
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Lawton Products Co., Inc., 624 Madison Ave., New York 22, N. Y.
MB Manufacturing Co., 1060 State St., New Haven, Conn.
Measurements Corp., Boonton, N. J.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
National Technical Laboratories, 820 Mission St., South Pasadena, Calif.
Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y.
Radio City Products Co., 127 West 26th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Design Co., 1353 Sterling Place, Brooklyn, N. Y.
Reiner Electronics Co., 152 W. 25th St., New York, N. Y.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Scientific Radio Products Co., 738 W. Broadway, Council Bluffs, Iowa
Scientific Service Laboratories, 2225 So. Hoover St., Los Angeles 7, Calif.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Sound Apparatus Co., 233 Broadway, New York 7, N. Y.
Springfield Sound Co., Electronics Div., 12 Cass St., Springfield, Mass.
Standard Instruments Corp., 568 Prospect Ave., New York 55, N. Y.
Superior Instruments Co., 227 Fulton St., New York 7, N. Y.
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.
Technical Devices Corp., Beaufort & Eagle Rock Ave., Roseland, N. J.
Televiso Products, Inc., 6533 N. Olmstead Ave., Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
White Research, 899 Boylston St., Boston, Mass.

VOLTMETERS

Aerolux Light Corp., 653 Eleventh Ave., New York 19, N. Y.
Associated Research, Inc., 231 S. Green St., Chicago 7, Ill.
Ballantine Laboratories, Inc., Boonton, N. J.
Boes Co., W. W., 3001 Salem Ave., Dayton 3, Ohio
Bristol Co., Waterbury 91, Conn.
Burlington Instrument Co., 214 North 4th St., Burlington, Iowa
Burton-Rogers Co., 857 Boylston St., Boston 16, Mass.
De Jur-Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.
Electric Heat Control Co., 9123 Inman Ave., Cleveland 5, Ohio
Electro-Mechanical Instrument Co., 812 Chestnut St., Perkasie, Pa.
Electronic Development Co., 1336 North Saddle Creek Road, Omaha 3, Nebr.
Engelhard, Inc., Charles, 233 N. J. R. R. Ave., Newark, N. J.
Espey Mfg. Co., Inc., 33 West 46th St., New York, N. Y.
Esterline-Angus Co., Inc., P. O. Box 596, Indianapolis, Ind.
Ferranti Electric, Inc., 30 Rockfeller Plaza, New York 20, N. Y.
Ferris Instrument Co., 110-112 Cornelia St., Boonton, N. J.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Hatry & Young, 203 Ann St., Hartford, Conn.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Jackson Electrical Instrument Co., 16-18 S. Patterson Blvd., Dayton 1, Ohio
J-B-T Instruments, Inc., 441 Chapel St., New Haven 8, Conn.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Marion Electrical Instrument Co., Manchester, N. H.
MB Manufacturing Co., 1060 State St., New Haven, Conn.
Meck Industries, John, Plymouth, Ind.
Meters, Inc., 915 Riveria Drive, Indianapolis 5, Ind.
Norton Electrical Instrument Co., 79 Hilliard St., Manchester, Conn.
Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y.
Radio City Products Co., 127 W. 26th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Rawson Electrical Instrument Co., Inc., 110 Potter St., Cambridge 42, Mass.
Readrite Meter Works, College Ave., Bluffton, Ohio
Reliance Instrument Co., 715 N. Kedzie Ave., Chicago, Ill.
Rhamstine, J. Thos., 301 Beaubien St., Detroit, Mich.
Roller-Smith, Bethlehem, Pa.
Scientific Radio Products Co., 738 W. Broadway, Council Bluffs, Iowa
Sensitive Research Instrument Co., 9 Elm St., Mt. Vernon, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Sun Mfg. Co., 6323 Avondale Ave., Chicago, Ill.
Superior Instruments Co., 227 Fulton St., New York 7, N. Y.
Supreme Instruments Corp., Greenwood, Miss.
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.
Televiso Products, Inc., 6533 N. Olmstead Ave., Chicago, Ill.
Thwing-Albert Instrument Co., Penn St. & Pulaski Ave., Philadelphia 44, Pa.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Freylinghuysen Ave., Newark 5, N. J.

VOLUME INDICATOR METERS

Amplifier Co. of America, 396 Broadway, New York, N. Y.
Boes Co., W. W., 3001 Salem Ave., Dayton 3, Ohio
Daven Co., 191 Central Ave., Newark 4, N. J.
De Jur Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.
Eastern Electronics Corp., 41 Chester St., New Haven, Conn.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., Schenectady 5, N. Y.
General Electronics Mfg. Co., 2225 So. Hoover St., Los Angeles 7, Calif.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
MB Mfg. Co., New Haven, Conn.
Marion Electrical Instrument Co., Manchester, N. H.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Meters, Inc., 915 Riveria Drive, Indianapolis 5, Ind.
Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Rek-O-Kut Co., 173 Lafayette St., New York 13, N. Y.
Scientific Service Laboratories, 2225 So. State St., Los Angeles 7, Calif.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
Worcester Moulded Plastics Co., 8 Grafton St., Worcester 8, Mass.

WATTMETERS

Bristol Co., Waterbury 91, Conn.
Esterline-Angus Co., Inc., P. O. Box 596, Indianapolis, Ind.
General Electric Co., Schenectady 5, N. Y.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Radio City Products Co., 127 West 26th St., New York, N. Y.
Rawson Electrical Instrument Co., Inc., 110 Potter St., Cambridge 42, Mass.
Roller-Smith, Bethlehem, Pa.
Sensitive Research Instrument Co., 9 Elm Ave., Mt. Vernon, N. Y.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Sperry Gyroscope Co., Manhattan Bridge Plaza, Brooklyn 1, N. Y.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

Mica

Asheville Mica Co., 5 River Rd., Biltmore, N. C.
Brand & Co., William, 276 Fourth Ave., New York 10, N. Y.
Continental-Diamond Fibre Co., 16 Chapel St., Newark, Del.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
English Mica Co., 220 E. 42d St., New York, N. Y.
Ford Radio & Mica Corp., 538 63rd St., Brooklyn, N. Y.
General Electric Co., Schenectady 5, N. Y.
Huse Liberty Mica Co., 171 Camden St., Boston, Mass.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.
International Products Corp., Baltimore 18, Md.
Macallen Co., 16 Macallen St., Boston, Mass.
Mica Insulator Co., 797 Broadway, Schenectady 1, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Mitchell-Rand Insulation Co., Inc., 51 Murray St., New York 7, N. Y.
Munsell & Co., Eugene, 200 Varick St., New York, N. Y.
New England Mica Co., Waltham, Mass.
New Hampshire Mica & Mining Co., Washington St., Keene, N. H.
Philadelphia Mica Corp., 3515 N. 10th St., Philadelphia 40, Pa.
Schoonmaker Insulation Co., Inc., A. O., 635 Greenwich St., New York 14, N. Y.
Southern Mica Co., Johnson City, Tenn.
Spruce Pine Mica Co., Spruce Pine, N. C.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.
Tar Heel Mica Co., Plumtree, N. C.
U. S. Mica Mfg. Co., 1521 Circle Ave., Forest Park, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Microammeters

see Ammeters

Microfaradmeters

see Bridges

Micrometers

ELECTRONIC MICROMETERS

Carson Micrometer Corp., Box 57, Little Falls, N. J.
Hathaway Instrument Co., 1315 S. Clarkson St., Denver 10, Colo.
Televiso Products, Inc., 6533 N. Olmsted Ave., Chicago, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.

ELECTRONIC and ALLIED PRODUCTS

Microphones

American Microphone Co., 1915 S. Western Ave., Los Angeles, Calif.
Amperite Co., 561 Broadway, New York, N. Y.
Astatic Corp., Conneaut, Ohio
Aurex Corp., 1117 N. Franklin St., Chicago, Ill.
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Aviometer Corp., 370 West 35th St., New York 1, N. Y.
Ballantine Laboratories, Inc., Boonton, N. J.
Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
California Telephone & Elec. Co., 6075 W. Pico Blvd., Los Angeles 35, Calif.
Chicago Sound Systems Co., 2124 S. Michigan Ave., Chicago, Ill.
Connecticut Telephone & Electric Div. of Great American Industries, Inc., 70 Brittania St., Meriden, Conn.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia 13, Pa.
Electro Voice Corp., 1239 South Bend Ave., South Bend, Ind.
Erwood Co., 223 W. Erie St., Chicago, Ill.
Engineering Laboratories, Inc., 602 East Fourth St., Tulsa 3, Okla.
Federal Telephone & Radio Corp., 591 Broad St., Newark, N. J.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., Schenectady 5, N. Y.
Globe Phone Mfg. Corp., 2 Linden St., Reading, Mass.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Lektra Labs, Inc., 30 East Tenth St., New York, N. Y.
Lifetime Sound Equipment Co., 1101 Adams St., Toledo, Ohio
Magnavox Co., 2131 Bueter Rd., Fort Wayne 4, Ind.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Massa Laboratories, Inc., 3868 Carnegie Ave., Cleveland, Ohio (Laboratory Standards)
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Minerva Corp. of America, 238 William St., New York 7, N. Y.
Permoflux Corp., 4900 W. Grand Ave., Chicago, Ill.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Quam-Nichols Co., 526 East 33rd Place, Chicago 16, Ill.
Racon Electric Co., 52 East 19th St., New York 3, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Rauland Corp., 4245 N. Knox Ave., Chicago 41, Ill.
Remler Co. Ltd., 2101 Bryant St., San Francisco 10, Calif.
Shure Brothers, 225 W. Huron St., Chicago, Ill.
Telephonics Corporation, 350 West 31st St., New York, N. Y.
Tibbetts Laboratories, Camden, Maine
Turner Co., 909 17th St., Cedar Rapids, Iowa
Universal Microphone Co., 424 Warren Lane, Inglewood, Calif.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.

Microphone Stands

see Stands, Microphone

Microscopes

ELECTRON MICROSCOPES

Farrand Optical Co., Inc., Bronx Blvd. at 238th St., New York 66, N. Y.
General Electric Co., Schenectady 5, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.

Milliammeters

see Ammeters

Mirrors

American Lens Co., Inc., 45 Lispenard St., New York 13, N. Y.
Austin Co., O., 42 Greene St., New York, N. Y.
Bache & Co., Semon, 636 Greenwich St., New York 14, N. Y.
Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y.
Farrand Optical Co., Bronx Blvd., & East 238th St., New York 6, N. Y.
Glendale Optical Co., 250 Pennsylvania Ave., Brooklyn, N. Y.
Laboratory Specialties, 144 South Wabash St., Wabash, Ind.
Maberg Optical, Inc., 235 East 45th St., New York 17, N. Y.
Mogey & Sons, Inc., Wm., 76 Interhaven Ave., Plainfield, N. J.
Pancro Mirrors, Inc., 2958 Los Feliz Blvd., Los Angeles, Calif.
Practo Photo Access. Corp., 383 Pearl St., Brooklyn, N. Y.
Spencer Lens Co., Buffalo 11, N. Y.
Zenith Optical Laboratory, 123 West 64th St., New York 23, N. Y.

Moisture Proofing Equipment

General Electric Co., Schenectady 5, N. Y.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Production Engineering Corp., 666 Van Houten Ave., Clifton, N. J.

Monitors, Broadcast

Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
DuMont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Harvey-Wells Electronics, Inc., North St., Southbridge, Mass.
Hart & Co., Inc., Frederick, Recordgraph Div., 350 Madison Ave., New York 17, N. Y.
Howard Radio Co., 1735 Belmont Ave., Chicago 13, Ill.
Link, Fred M., 125 West 17th St., New York, N. Y.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
Transmitter Equipment Mfg. Co. Inc., 345 Hudson St., New York 14, N. Y.

Motor Controls

see Controls, Motor

Motor-Generators

see Generators

Motors

FRACTIONAL HORSEPOWER and MINIATURE

Air Associates, Inc., Teterboro, N. J.
Air-Way Electric Appliance Corp., 2101 Auburn Ave., Toledo, Ohio
Alliance Mfg. Co., Lake Park Blvd., Alliance, Ohio
Anco Products Company, Paterson, N. J.
Arma Corp., 254 36th St., Brooklyn, N. Y.
Baldor Electric Co., 4353 Duncan Ave., St. Louis, Mo.
Barber-Colman Co., River & Loomis Sts., Rockford, Ill.
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, North Hollywood, Calif.
Bodine Electric Co., 2262 W. Ohio St., Chicago, Ill.
Bogue Electric Company, Paterson, N. J.
Brown-Brockmeyer Co., 1000 S. Smithville Rd., Dayton 1, Ohio
Burke Electric Co., 12th & Cranberry Sts., Erie, Pa.
Carter Motor Co., 1606 Milwaukee Ave., Chicago 47, Ill.
Century Electric Co., 1806 Pine St., St. Louis 3, Mo.
Clements Mfg. Co., 6650 S. Narragansett Ave., Chicago, Ill.
Controls Corp., 98 Union St., Worcester 8, Mass.
Delco Products Div., General Motors Corp., 329 E. First St., Dayton, Ohio
Delco Appliance Division, General Motors Corp., 391 Lyell Ave., Rochester, N. Y.
Diehl Mfg. Co., Finderne Plant, Somerville, N. J.
Dumore Co., 14th & Racine Sts., Racine, Wis.
Eastern Air Devices, Inc., 585 Dean St., Brooklyn 17, N. Y.
Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.
Eicor, Inc., 1501 W. Congress St., Chicago 7, Ill.
Electric Auto-Lite Co., Toledo 1, Ohio
Electric Indicator Co., 21 Parker Ave., Stamford, Conn.
Electric Motor Corp., Racine, Wis.
Electric Specialty Co., 211 South St., Stamford, Conn.
Electrical Engrg. & Mfg. Corp., 4606 W. Jefferson Blvd., Los Angeles 16, Calif.
Electrolux Corporation, Old Greenwich, Conn.
Emerson Electric Mfg. Co., 1824 Washington Ave., St. Louis 3, Mo.
Fairchild Camera & Instrument Corp., 475 Tenth Ave., New York 18, N. Y.
Fidelity Electric Co., 332 N. Arch St., Lancaster, Pa.
Franklin Transformer Mfg. Co., 65 22nd Ave., N. E., Minneapolis 13, Minn.
General Electric Co., Schenectady 5, N. Y.
General Industries Co., Taylor & Olive Sts., Elyria, Ohio
Gibbs & Co., Thomas B., Div. of George W. Borg Corp., 814 Michigan St., Delavan, Wisc.
Gorrell & Gorrell, 40 Littlefield Rd., Newton Center, Mass.
Hamilton Beach Company, Racine, Wisc.
Hansen Mfg. Co., Inc., Princeton, Ind.
Heinze Electric Co., Lowell, Mass.
Holtzer-Cabot, Signal Div., 400 Stuart St., Boston 17, Mass.
Howell Electric Motors Company, Howell, Mich.
Janette Mfg. Co., 556 W. Monroe St., Chicago 40, Ill.
Kingston-Conley Electric Co., 68 Brook Ave., North Plainfield, N. J.
Kollsman Instrument Div. of Square D Company, 80-08 45th Ave., Elmhurst, N. Y.
Lamb Electric Co., Kent, Ohio
Lear, Incorporated, Piqua, Ohio
Leece-Neville Company, 5363 Hamilton Ave. N. E., Cleveland 14, Ohio
Leland Electric Co., 1501 Webster St., Dayton, Ohio
Marathon Electric Mfg. Corp., Randolph & Cherry Sts., Wausau, Wisc.
Master Electric Co., 126 Davis Ave., Dayton, Ohio
Merkle-Korff Gear Co., 213 N. Morgan St., Chicago 7, Ill.
National Mineral Co., 2628 N. Pulaski Rd., Chicago 39, Ill.
Ohio Electric Mfg. Co., 5908 Maurice Ave., Cleveland 4, Ohio
Oster Mfg. Co. of Illinois, John, Genoa, Ill.
Otis Elevator Company, Yonkers, N. Y.
Packard Electric Div. of General Motors Corp., Warren, Ohio
Peerless Electric Co., 740 W. Market St., Warren, Ohio
Pioneer Gen-E-Motor Corp., 5841 W. Dickens Ave., Chicago 39, Ill.
Radex Corp. of America, 53 West Jackson Blvd., Chicago 4, Ill.
Redmond Co. Inc., Monroe St., Owosso, Mich.
Reynolds Electric Co., 2650 W. Congress St., Chicago 12, Ill.
Robbins & Myers, 1345 Lagonda Ave., Springfield, Ohio
Russell Electric Co., 364 W. Huron St., Chicago 10, Ill.
Signal Electric Mfg. Co., 1915 Broadway, Menominee, Mich.
Small Motors, Inc., 1322 Elston Ave., Chicago 22, Ill.
Smith Mfg. Co., F. A., P. O. Box 509, Rochester 2, N. Y.

Speedway Mfg. Co., 1834 S. 52nd Avenue, Cicero 50, Ill.
Star Electric Motor Co., 200 Bloomfield Ave., Bloomfield, N. J.
Sunlight Electrical Div., General Motors Corp., 523 Dana Ave., Warren, Ohio
Thermador Elec. Mfg. Co., 5119 S. Riverside Drive, Los Angeles 22, Calif.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Victor Electric Products, Inc., 2950 Robertson Ave., Cincinnati 9, Ohio
Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.
Webster Chicago Corp., Electronics Div., 3825 Armitage Ave., Chicago 47, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wincharger Corp., 7th & Division, Sioux City, Iowa

PHONOGRAPH

Alliance Mfg. Co., Lake Park Blvd., Alliance, Ohio
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Garrard Sales Corp., 401 Broadway, New York 13, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Industries Co., Taylor & Olive Sts., Elyria, Ohio
Pacific Sound Equipment Co., 1534 Cahuenga Blvd., Hollywood, Calif.
Philmore Mfg. Co., 113 University Place, New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, New Jersey
Robbins & Myers, 1345 Lagonda Ave., Springfield, Ohio
Small Motors, Inc., 1322 Elston Ave., Chicago 22, Ill.
Thermador Elec. Mfg. Co., 5119 S. Riverside Drive, Los Angeles 22, Calif.
Webster Chicago Corp., Electronics Div., 3825 Armitage Ave., Chicago 47, Ill.

TIMING

Alliance Mfg. Co., Lake Park Blvd., Alliance, Ohio
Barber-Colman Co., Rockford, Ill.
Bodine Electric Co., 2262 W. Ohio St., Chicago, Ill.
Delco Appliance Division, General Motors Corp., Rochester, N. Y.
Eastern Air Devices, Inc., 585 Dean St., Brooklyn 17, N. Y.
General Electric Co., Schenectady 5, N. Y.
Gilbert Clock Co., Wm. L., Winsted, Conn.
Hansen Mfg. Co., Princeton, Ind.
Haydon Manufacturing Co., Inc., Forestville, Conn.
Holtzer-Cabot Signal Division, 400 Stuart St., Boston 17, Mass.
Ingraham Clock Co., Bristol, Conn.
Leich Electric Co., 565 W. Washington Blvd., Chicago 6, Ill.
Lumenite Electric Co., 407 S. Dearborn St., Chicago, Ill.
Lux Clock Manufacturing Co., 95 Johnson St., Waterbury, Conn.
Merkle-Korff Gear Co., 213 N. Morgan St., Chicago 7, Ill.
Ohio Electric Mfg. Co., 5908 Maurice Ave., Cleveland 4, Ohio
Quality Electric Co., Ltd., 1235 E. Olympic Blvd., Los Angeles 21, Calif.
Reynolds Electric Co., 2650 W. Congress St., Chicago 12, Ill.
Russell Electric Co., 364 W. Huron St., Chicago 10, Ill.
Speedway Mfg. Co., 1834 S. 52nd Ave. Cicero 50, Ill.
Square D Co., 6060 Rivard St., Detroit 11, Mich.
Synchronous Products, Inc., 4513 Brooklyn Ave., Cleveland 9, Ohio
Thompson Clock Co., H. C., Bristol, Conn.
Times Telephoto Equipment, Inc., 229 West 43rd St., New York, N. Y.
Victor Electric Products, Inc., 2950 Robertson Ave., Cincinnati 9, Ohio
Wallace & Tiernan Products, Inc., Belleville, N. J.
Warren Telechron Co., Ashland, Mass.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Mountings

VIBRATION INSULATING

A.B.C. Products, Inc., 11952 Montana Ave., West Los Angeles, Calif.
Barry Co., L. N., 119 Sidney St., Cambridge, Mass.
Chamberlain Laboratories, 637 Ardson Rd., E. Lansing, Mich.
Firestone Industrial Products Co., 1200 Firestone Parkway, Akron 17, Ohio
General Tire & Rubber Co., Akron, Ohio and Wabash, Ind.
Goodrich Co., B. F., 500 S. Main St., Akron, Ohio
Goodyear Tire & Rubber Co., Inc., Akron 16, Ohio
Hamilton Kent Mfg. Co. Inc., Div. U. S. Stoneware, Kent, Ohio
Harris Products Co., 5105 Cowan Ave., Cleveland, Ohio
Johns-Manville, 22 E. 40th St., New York, N. Y.
Korfund Co., Inc., 48-15 32nd Place, Long Island City, N. Y.
Lord Mfg. Co., 1635 W. 12th St., Erie, Pa.
MB Manufacturing Co., Inc., 250 Dodge Ave., East Haven 12, Conn.
Racon Electric Co., Inc., 52 E. 19th St., New York 3, N. Y.
Robinson Aviation Inc., 730 Fifth Ave., New York 19, N. Y.
Russell & Stoll Co., 125 Barclay St., New York 7, N. Y.
Sponge Rubber Co., Shelton, Conn.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Vendo Co., 1907 Grand Ave., Kansas City, 8, Mo.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Multipliers

VOLTMETER

Associated Research, Inc., 231 S. Green St., Chicago 7, Ill.
Ballantine Laboratories, Inc., Boonton, N. J.
Boes Co., W. W., 3001 Salem Avenue, Dayton 3, Ohio
Burlington Instrument Corp., 214 North 4th St., Burlington, Iowa
Daven Co., 191 Central Ave., Newark 4, N. J.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electric Heat Control Co., 9123 Inman Ave., Cleveland 5, Ohio
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
Federal Instrument Co., 3931 47th Ave., Long Island City 4, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Electronics Mfg. Co., 2225 So. State St., Los Angeles 7, Calif.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.
Instrument Resistors Co., 25 Amity St., Little Falls, N. J.
International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Marion Electrical Instrument Co., Manchester, N. H.
Precision Resistor Co., 334 Badger Ave., Newark 8, N. J.
Rawson Electrical Instrument Co., Inc., 110 Potter St., Cambridge 42, Mass.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Sprague Electric Co., North Adams, Mass.
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

Name Plates

see Escutcheons

Needles

CUTTING

Acton Co., H. W., 370 Seventh Ave., New York, N. Y.
Audio Devices, Inc., 444 Madison Ave., New York 22, N. Y.
Capps Co., Frank L., 244 W. 49th St., New York 19, N. Y.
Diamond Tool Replacements Div., Oscap Mfg. Co., 207 W. Saratoga St., Baltimore 1, Md.
Duotone Co., 799 Broadway, New York, N. Y.
DX Crystal Co., 1200 N. Claremont Ave., Chicago 22, Ill.
Eldeen Co., 504 N. Water St., Milwaukee, Wisc.
Electrovox Co., 169 Maplewood Ave., Maplewood, N. J.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Federal Recorder Co., Elkhart, Ind.
Galvin Mfg. Corp., 4545 W. Augusta Blvd., Chicago 51, Ill.
Garod Radio Corp., 70 Washington St., Brooklyn, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Phonograph Co., Putnam, Conn.
Gould-Moody Co., 395 Broadway, New York, N. Y.
Howard Radio Co., 1735 Belmont Ave., Chicago 13, Ill.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkway., Brooklyn, N. Y.
Memovox, Inc., 9242 Beverly Blvd., Beverly Hills, Calif.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Mirror Record Corp., 58 West 25th St., New York, N. Y.
Music Master Mfg. Co., 542 S. Dearborn St., Chicago 5, Ill.
Paraloy Co., 600 S. Michigan Ave., Chicago, Ill.
Permo Incorporated, 6415 Ravenswood Ave., Chicago, Ill.
Phonograph Needle Mfg. Co., Inc., 42 Dudley St., Providence 5, R. I.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Recordisc Corp., 395 Broadway, New York, N. Y.
Recotone Corp., 212 Fifth Ave., New York, N. Y.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.
Wilcox Gay Corp., Charlotte, Michigan

PLAY BACK

Acton Co., H. W., 370 Seventh Ave., New York, N. Y.
Audak Co., 500 Fifth Ave., New York, N. Y.
Audio Devices Inc., 444 Madison Ave., New York 22, N. Y.
Boetsch Brothers, 221 E. 144th St., New York 51, N. Y.
Capps Co., Frank L., 244 W. 49th St., New York 19, N. Y.
Duotone Co., 799 Broadway, New York, N. Y.
DX Crystal Co., 1200 N. Claremont Ave., Chicago 22, Ill.
Eldeen Co., 504 N. Water St., Milwaukee, Wisc.
Electrovox Co., 169 Maplewood Ave., Maplewood, N. J.
Galvin Mfg. Corp., 4545 W. Augusta Blvd., Chicago 51, Ill.
Garod Radio Corp., 70 Washington St., Brooklyn, N. Y.
Garrard Sales Corp., 401 Broadway, New York 13, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Phonograph Co., Putnam, Conn.
Gerett Corp., M. A., 724 W. Winnebago St., Milwaukee 5, Wisc.
Gould-Moody Co., 395 Broadway, New York, N. Y.
Harris Mfg. Co., 2422 W. Seventh St., Los Angeles, Calif.
Howard Radio Co., 1735 Belmont Ave., Chicago 13, Ill.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkway., Brooklyn, N. Y.
Jensen Industries, Inc., 737 N. Michigan Ave., Chicago 11, Ill.
Lowell Needle Co., 1 Wildore St., Putnam, Conn.

ELECTRONIC and ALLIED PRODUCTS

Lux Clock Manufacturing Co., Waterbury, Conn.
Memovox, Inc., 9242 Beverly Blvd., Beverly Hills, Calif.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Mirror Record Corp., 58 W. 25th St., New York, N. Y.
Music Master Mfg. Co., 542 S. Dearborn St., Chicago 5, Ill.
Paraloy Co., 600 S. Michigan Ave., Chicago, Ill.
Permo Incorporated, 6415 Ravenswood Ave., Chicago, Ill.
Pfanstiehl Chemical Co., 104 Lakeview Ave., Waukegan, Ill.
Phonograph Needle Mfg. Co., Inc., 42 Dudley St., Providence 5, R. I.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Recotone Corp., 212 Fifth Ave., New York, N. Y.
Recordit Co., The, 555 Bedford Ave., University City, Mo.
Shure Brothers, 225 W. Huron St., Chicago, Ill.
Speak-O-Phone Recording & Equipment, 23 W. 60th St., New York, N. Y.
Stark Sound Engrg. Corp., P. O. 493, Fort Wayne 1, Ind.
Wilcox Gay Corp., Charlotte, Mich.

Nickel

see Metals

Nickel Tubing

see Tubing, Metal & Alloy

Noise Analyzers

see Analyzers

Noise Filters

see Filters

Noise Recorders

see Recorders

Nuts, Self-Locking

see Fasteners

Optical Equipment

American Lens Co., Inc., 45 Lispenard St., New York 13, N. Y.
American Optical Co., Scientific Instrument Div., Buffalo 11, N. Y.
Bausch & Lomb Optical Co., 635 St. Paul Street, Rochester 2, N. Y.
Distillation Products, Inc., 755 Ridge Rd. W., Rochester, N. Y.
Eastman Kodak Co., Rochester 4, N. Y.
Electronic Products Mfg. Co., 7300 Huron River Drive, Dexter, Mich.
Farrand Optical Co., Inc., Bronx Blvd. & East 238th St., New York 66, N. Y.
Federal Mfg. & Engrg. Corp., 199-217 Steuben St., Brooklyn, N. Y.
Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
Gamma Instrument Co., Inc., 95 Madison Ave., New York 16, N. Y.
Herron Optical Co., 705 West Jefferson Blvd., Los Angeles 7, Calif.
Instrument Optics Co., 1872 Genesee St., Buffalo 11, N. Y.
International Industries, Inc., Ann Arbor, Mich.
Knights Co., James, 131 S. Wells St., Sandwich, Ill.
Maberg Optical, Inc., 235 East 45th St., New York 17, N. Y.
Mogey & Sons, Inc., Wm., 76 Interhaven Ave., Plainfield, N. J.
Parker Engineering Products Co., 16 W. 22nd St., New York 10, N. Y.
Perkin-Elmer Corp., Glenbrook, Conn.
Scherr, George, 128 Lafayette St., New York, N. Y.
Square D Company, 6060 Rivard St., Detroit 11, Michigan
Times Telephoto Equipment, Inc., 229 West 43rd St., New York, N. Y.
Zenith Optical Co., 123 West 64th St., New York 23, N. Y.

Oscillators

AUDIO-FREQUENCY

American Instrument Co., 8030 Georgia Ave., Silver Spring, Md.
American Radio Co., 611 E. Garfield Ave., Glendale, Calif.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Audio Tone Oscillator Co., 237 John St., Bridgeport 3, Conn.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Boonton Radio Corp., Boonton, N. J.
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Clough-Brengle Co., 5501 N. Broadway, Chicago 22, Ill.
Collins Radio Co., 855-35th St., N. E., Cedar Rapids, Iowa
Control Corp., 600 Stinson Blvd., Minneapolis, Minn.
Dayco Radio Corp., 915 Valley St., Dayton 4, Ohio
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electro Engineering & Mfg. Co., 627 W. Alexandrine Ave., Detroit 1, Mich.
Electro Products Laboratories, 549 W. Randolph St., Chicago, Ill.
Espey Mfg. Co., Inc., 33 West 46th St., New York, N. Y.
Fada Radio & Electric Co., 30-20 Thomson Ave., Long Island City, N. Y.
Federal Telephone & Radio Corp., 591 Broad St., Newark, N. J.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Hearing Aid Labs., 1404 Franklin St., Michigan City, Ind.
Herbach & Rademan Co., Mfg. Div., 517 Ludlow St., Philadelphia 6, Pa.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Cal.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Jackson Electrical Instrument Co., 16-18 S. Patterson Blvd., Dayton 1, Ohio
Jefferson, Inc., Ray, 40 E. Merrick Rd., Freeport, L. I., N. Y.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Maico Co., Inc., 25 North 3rd St., Minneapolis 1. Minn.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.
Philharmonic Radio Corp., 528 East 72nd St., New York 21, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Design Co., 1353 Sterling Place, Brooklyn, N. Y.
Reiner Electronics Co., 152 W. 25th St., New York, N. Y.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles 34, Calif.
Rowe Radio Research Laboratory Co., 2422 N. Pulaski Rd., Chicago 39, Ill.
Scientific Service Laboratories, 2225 So. Hoover St., Los Angeles 7, Calif.
Signal Electronic & Mfg. Co., 114 East 16th St., New York 3, N. Y.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Simpson Mfg. Co., Inc., Mark, 188 W. Fourth St., New York, N. Y.
Sonora Radio & Television Corp., 2626 W. Washington St., Chicago 28, Ill.
Standard Instruments Corp., 568 Prospect Ave., New York 55, N. Y.
Supreme Instruments Corp., Greenwood, Miss.
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.
Telegraph Apparatus Co., 325 W. Huron St., Chicago, Ill.
Televiso Products, Inc., 6533 N. Olmsted Ave., Chicago, Ill.
Templetone Radio Mfg. Corp., New London, Conn.
Transmitter Equipment Mfg. Co., Inc., 345 Hudson St., New York 14, N. Y.
Triumph Mfg. Co., 913 W. Van Buren St., Chicago 7, Ill.
United Cinephone Corp., 35 New Litchfield St., Torrington, Conn.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
Western Electric Co. Inc., 120 Broadway, New York 5, N. Y.
White Research, 899 Boylston St., Boston, Mass.

RADIO-FREQUENCY

A. R. F. Products, 7627 Lake St., River Forest, Ill.
Baldwin Locomotive Works, Eddystone, Pa.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Belmont Radio Corp., 5921 Dickens Ave., Chicago, Ill.
Breon Laboratories, 607 Rose Street, Williamsport, Pa.
Burnett Radio Lab., Wm. W. L., 4814 Idaho St., San Diego, Calif.
Clough-Brengle Co., 5501 N. Broadway, Chicago 22, Ill.
Collins Radio Co., 855 35th St., N.E., Cedar Rapids, Iowa
Control Corp., 600 Stinson Blvd., Minneapolis, Minn.
Crystal Research Labs., Inc., 29 Allyn St., Hartford, Conn.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Eastern Specialty Co., 3617-19 N. Eighth St., Philadelphia 40, Pa.
Electronic Measurements Co., Red Bank, N. J.
Electronic Products Co., 111 E. Third St., Mt. Vernon, N. Y.
Electronic Winding Co., 5031 Broadway, Chicago 40, Ill.
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
Federal Telephone & Radio Corp., 591 Broad St., Newark, N. J.
Ferris Instrument Co., 110-112 Cornelia St., Boonton, N. J.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
General Crystal Corp., 1775 Foster Ave., Schenectady, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Herbach & Rademan Co., Mfg. Div., 517 Ludlow St., Philadelphia 6, Pa.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Intra-Therm Corp., Third & Keo Way, Des Moines 9, Iowa
Jackson Electrical Instrument Co., 16-18 S. Patterson Blvd., Dayton 1, Ohio
Jefferson Inc., Ray, 40 E. Merrick Rd., Freeport, L. I., N. Y.
Lavoie Laboratories, Morganville, N. J.
Lawton Products Co., Inc., 624 Madison Ave., New York 22, N. Y.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Meissner Mfg. Div., Maguire Industries, Inc., Mt. Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden 48, Mass.
Pacific Electronics, Sprague at Jefferson, Spokane, Wash.
Philharmonic Radio Corp., 528 East 72nd St., New York 21, N. Y.
Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y.
Premier Crystal Laboratories, Inc., 63 Park Row, New York, N. Y.
Radio City Products Co., 127 West 26th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Craftsmen, 1341 So. Michigan Ave., Chicago 5, Ill.
Reiner Electronics Co., 152 West 24th St., New York, N. Y.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles 34, Calif.
Scientific Service Laboratories, 2225 So. Hoover St., Los Angeles 7, Calif.

Signal Electronic & Mfg. Co., 114 East 16th Street, New York 3, N. Y.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Sonora Radio & Television Corp., 2626 W. Washington St., Chicago 28, Ill.
Standard Coil Products Co., 2329 N. Pulaski Rd., Chicago 18, Ill.
Standard Instruments Corp., 568 Prospect Ave., New York 55, N. Y.
Standard Piezo Co., Woolworth Bldg., Carlisle, Pa.
Supreme Instruments Corp., Greenwood, Miss.
Telegraph Apparatus Co., 325 W. Huron St., Chicago, Ill.
Televiso Products, Inc., 6533 N. Olmsted Ave., Chicago, Ill.
Templetone Radio Mfg. Corp., New London, Conn.
Transmitter Equipment Mfg. Co., Inc., 345 Hudson St., New York 14, N. Y.
Triumph Mfg. Co., 913 W. Van Buren St., Chicago 7, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
White Research, 899 Boylston St., Boston, Mass.

Oscilloscopes

CATHODE-RAY INSTRUMENTS

Annis Co., R. B., 1101 N. Delaware St., Indianapolis 2, Ind.
Baker Chemical Co., J. T., N. Broad St., Philipsburg, N. J.
Belmont Radio Corp., 5921 Dickens Ave., Chicago, Ill.
Browning Labs., Inc., 750 Main St., Winchester, Mass.
Clough-Brengle Co., 5501 N. Broadway, Chicago 22, Ill.
Commercial Research Labs. Inc., 20 Bartlett Ave., Detroit 3, Mich.
Dayco Radio Corp., 915 Valley St., Dayton 4, Ohio
DuMont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Grenby Mfg. Co., Plainville, Conn.
Hearing Aid Labs., 1404 Franklin St., Michigan City, Ind.
Heiland Research Corp., 130 East Fifth St., Denver 9, Colo.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Islip Radio Mfg. Corp., Foot of Beech St., Islip, New York
Jackson Electrical Instrument Co., 16-18 S. Patterson Blvd., Dayton 1, Ohio
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.
Panoramic Radio Corp., 242 W. 55th St., New York 19, N. Y.
Philharmonic Radio Corp., 528 East 72nd St., New York 21, N. Y.
Radio City Products Co., Inc., 127 West 26th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Reiner Electronics Co., 152 West 25th St., New York, N. Y.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles 34, Calif.
Signal Electronic & Mfg. Co., 114 East 16th Street, New York 3, N. Y.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Standard Instruments Corp., 568 Prospect Ave., New York 55, N. Y.
Supreme Instrument Corp., Greenwood, Miss.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.
Templetone Radio Corp., New London, Conn.
Triumph Mfg. Co., 913 W. Van Buren St., Chicago 7, Ill.
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.
Waugh Labs. Div. of Waugh Equipment Co., 420 Lexington Ave., New York 17, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
White Research, 899 Boylston St., Boston, Mass.

Oscillographs

MOVING-CONDUCTOR

Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Cambridge Instrument Co., 3732 Grand Central Terminal, New York 17, N. Y.
Engineering Laboratories, 602 East Fourth St., Tulsa 3, Okla.
General Electric Co., Schenectady 5, N. Y.
Geophysical Instrument Co., Key Blvd. & Nash St., Arlington, Va.
Hathaway Instrument Co., 1315 S. Clarkson St., Denver 10, Colo.
Heiland Research Corp., 130 East Fifth St., Denver 9, Colo.
Miller Corp., Wm., 362 W. Colorado St., Pasadena, Calif.
Sanborn Co., 39 Osborne St., Cambridge 39, Mass.
Waugh Labs., Div., of Waugh Equipment Co., 420 Lexington Ave., New York 17, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.

MULTI-ELEMENT

Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Cambridge Instrument So., 3732 Grand Central Terminal, New York 17, N. Y.
Electro-Medical Laboratory, Inc., Holliston, Mass.
Engineering Laboratories, Inc., 602 East Fourth St., Tulsa 3, Okla.
General Electric Co., Schenectady 5, N. Y.
Hathaway Instrument Co., 1315 S. Clarkson St., Denver 10, Colo.
Heiland Research Corp., 130 East Fifth St., Denver 9, Colo.
Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.
Miller Corp., Wm., 362 W. Colorado St., Pasadena, Calif.
Sanborn Co., 39 Osborne St., Cambridge 39, Mass.
Waugh Labs., Div., of Waugh Equipment Co., 420 Lexington Ave., New York, 17, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.

PIEZOELECTRIC

Aireon Manufacturing Corp., Fairfax & Funston Rds., Kansas City, Kans.
Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Tibbetts Laboratories, Camden, Maine
Transmitter Equipment Mfg. Co. Inc., 345 Hudson St., New York 14, N. Y.
Waugh Labs., Div., of Waugh Equipment Co., 420 Lexington Ave., New York 17, N. Y.

RECORDING

Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Consolidated Engineering Corp., 595 E. Colorado, Pasadena 1, Calif.
Electro Medical Lab. Inc., Holliston, Mass.
Electronic Supply Co., 207 Main St., Worcester, Mass.
General Electric Co., Schenectady 5, N. Y.
Giannini & Co., Inc., G. M., 161 E. California St., Pasadena, Calif.
Offner Electronics Inc., 5320 N. Kedzie Ave., Chicago 25, Ill.
Rahm Instruments, Inc., 12 West Broadway, New York, N. Y.
Waugh Labs., Div. of Waugh Equipment Co., 420 Lexington Ave., New York 17, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Panels

see Cabinets

Paper

see Capacitors, Fixed
see Insulation, Paper
see Tubing, Paper

Parts, Precision

Ace Mfg. Corp., 1255 E. Erie Ave., Philadelphia 24, Pa.
Teleoptic Co., 1241 Mound Ave., Racine, Wisc.
Wadsworth Watch Case Co. Inc., Dayton, Ky. (suburb of Cincinnati, Ohio)

Parts, Tube

see Tube Parts

Phonographs

ELECTRIC PHONOGRAPHS and RECORD PLAYERS

Admiral Corp., 3800 W. Cortland St., Chicago 47, Ill.
Andrea Radio Corp., 43-20 34th St., Long Island City, N. Y.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Audio Industries, Michigan City, Ind.
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Bendix Radio Corp., Baltimore 4, Md.
Boetsch Bros., 221 E. 144th St., New York 51, N. Y.
Chicago Sound Systems Co., 2124 S. Michigan Ave., Chicago, Ill.
Colonial Radio Corp., 254 Rano St., Buffalo 7, N. Y.
Columbia Associates, 141 West 24th St., New York, N. Y.
Connecticut Telephone & Elec. Div., Great American Industries, Meriden, Conn.
Crosley Corp., 1329 Arlington St., Cincinnati 3, Ohio
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
DX Crystal Co., 1200 N. Claremont Ave., Chicago 22, Ill.
Dynavox Corp., 40-05 21st St., Long Island City, N. Y.
Electro Acoustic Co., 2131 Bueter Rd., Fort Wayne, Ind.
Electromatic Mfg. Corp., 88 University Place, New York, N. Y.
Electronic Corp. of America, 45 West 18th St., New York 11, N. Y.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
Fada Radio & Electric Co., Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3702 Pontiac St., Fort Wayne, Ind.
Freed Radio Corp., 200 Hudson St., New York, N. Y.
Galvin Mfg. Corp., 4545 W. Augusta Blvd., Chicago 51, Ill.
Garod Radio Corp., 70 Washington St., Brooklyn, N. Y.
Garrard Sales Corp., 401 Broadway, New York 13, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Television & Radio Corp., 2701 North Lehmann Ct., Chicago 14, Ill.
Godfrey Mfg. Co., 171 S. 2nd St., Milwaukee 4, Wisc.
Hamilton Radio Corp., 510 Sixth Ave., New York, N. Y.
Harris Mfg. Co., 2422 W. Seventh St., Los Angeles 5, Calif.
Hearing Aid Labs., 1404 Franklin St., Michigan City, Ind.
Herbach & Rademan Co., 517 Ludlow St., Philadelphia 6, Pa.
Hoffman Radio Corp., 3430 S. Hill St., Los Angeles, Calif.
Keith Radio Products, 16th & K St., Bedford, Ind.
Magnavox Co., The, 2131 Bueter Rd., Fort Wayne 4, Ind.
Meck Industries, John, Plymouth, Ind.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.

ELECTRONIC and ALLIED PRODUCTS

Meissner Mfg. Div., Maguire Industries, Inc., Mt. Carmel, Ill.
Memovox, Inc., 9242 Beverly Blvd., Beverly Hills, Calif.
Midwest Radio Corp., 909 Broadway, Cincinnati 2, Ohio
Mills Industries, Inc., 4100 Fullerton Ave., Chicago 39, Ill. (Coin operated).
Minerva Corp. of America, 238 William St., New York 17, N. Y.
Music Master Mfg. Co., 542 S. Dearborn St., Chicago 5, Ill.
Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles 18, Calif.
Noblitt Sparks Industries, Inc., Columbus, Ind.
Northern Communications Mfg. Co., 210 East 40th St., New York, N. Y.
Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.
Pacific Sound Equipment Co., 1534 Cahuenga Blvd., Hollywood, Calif.
Philco Corp., Tioga & C Sts., Philadelphia 34, Pa.
Philharmonic Radio Corp., 528 East 72nd St., New York 24, N. Y.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Ray Energy & Television Corp. of America, 521 Fifth Ave., New York, N. Y.
Record-O-Vox, Inc., 721 N. Martel Ave., Hollywood 46, Calif.
Regal Electronics Corp., 20 West 20th St., New York, N. Y.
Rehtron Corp., 4313 Lincoln Ave., Chicago 18, Ill.
Rex Products Co., 1313 W. Randolph St., Chicago 7, Ill.
Robinson Recording Laboratories, 351 Ninth St., Philadelphia, Pa.
Rock-Ola Mfg. Corp., 867 N. Kedzie Ave., Chicago, Ill. (Coin Operated)
Seeburg Corp., J. P., 1510 N. Dayton St., Chicago, Ill.
Sentinel Radio Corp., 2020 Ridge Ave., Evanston, Ill.
Sheridan Electro Corp., 2850 S. Michigan Ave., Chicago, Ill.
Signal Electronic & Mfg. Co., 114 East 16th Street, New York 3, N. Y.
Simpson Mfg. Co., Inc., Mark, 188 West Fourth St., New York, N. Y.
Sonora Radio & Television Corp., 325 N. Hoyne Ave., Chicago 12, Ill.
SOS Cinema Supply Co., 449 W. 42nd St., New York 18, N. Y.
Sparkes Mfg. Co., 318 Jefferson St., Newark, N. J.
Sparks Withington Co., Jackson, Mich.
Stewart Warner Corp., 1836 Diversey Pkwy., Chicago, Ill.
Stromberg-Carlson Co., 100 Carlson Rd., Rochester, N. Y.
Symphonic Radio & Electronic Corp., 258 Park Sq. Bldg., Boston, Mass.
Talk-A-Phone Mfg. Co., 1512 S. Pulaski Road, Chicago 23, Ill.
Tech-Master Products Co., 123 Prince St., New York, N. Y.
Trav-Ler Karenola Radio & Television Corp., 571 W. Jackson Blvd., Chicago 6, Ill.
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.
Viewtone Co., 203 East 18th St., New York, N. Y.
Waters Conley Co., 501 First St., N. W., Rochester, Minn.
Watterson Radio Mfg. Co., P. O. Box 54, Dallas, Texas
Wilcox Gay Corp., Charlotte, Mich.
Wurlitzer Mfg. Co., Rudolph, North Tonawanda, N. Y.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

Photocells

see Tubes (Phototubes & Cells)

Phototubes

see Tubes

Pickups

INDUSTRIAL PICKUPS

Audak Co., 500 Fifth Ave., New York, N. Y.
Audio Tone Oscillator Co., 237 John St., Bridgeport 3, Conn.
Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Consolidated Engineering Corp., 595 E. Colorado St., Pasadena 1, Calif.
Electro Products Laboratories, 549 W. Randolph St., Chicago, Ill.
Electronic Control Corp., 1573 E. Forest St., Detroit, Mich.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Giannini & Co., Inc., G. M., 161 E. California St., Pasadena, Calif.
Hathaway Instrument Co., 1315 S. Clarkson St., Denver 10, Colo.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles 34, Calif.
Shure Brothers, 225 W. Huron St., Chicago, Ill.
Simpson Mfg. Co. Inc., Mark, 188 W. Fourth St., New York, N. Y.
Webster Electric Co., 1900 Clark St., Racine, Wisc.

PHONOGRAPH PICKUPS

Aray Mfg. & Supply Co., Inc., 3107 Pine St., St. Louis 3, Mo.
Astatic Corp., Conneaut, Ohio
Audak Co., 500 Fifth Ave., New York, N. Y.
Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Boetsch Bros., 221 E. 144th St., New York 51, N. Y.
Garrard Sales Corp., 401 Broadway, New York 13, N. Y.
General Electric Co., Schenectady 5, N. Y.
Miller Corp., Wm., 362 W. Colorado St., Pasadena, Calif.
Pacific Sound Equipment Co., 1534 Cahuenga Blvd., Hollywood, Calif.
Pfanstiehl Chemical Co., 104 Lakeview Ave., Waukegan, Ill.
Philmore Mfg. Co., 113 University Place, New York, N. Y.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Rek-O-Kut Co., 173 Lafayette St., New York 13, N. Y.
Shure Brothers, 225 W. Huron St., Chicago, Ill.
Techno Scientific Co., 901 Nepperhan Ave., Yonkers 3, N. Y.
Tibbetts Laboratories, Camden, Maine
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.
Webster Electric Co., 1900 Clark St., Racine, Wisc.

Pilot Lights

see Lights

Plastics

FABRICATORS of PLASTICS

Acadia Synthetic Products Div., Western Felt Works, 4035 Ogden Ave., Chicago 23, Ill.
Accurate Molding Corp., 116 Nassau St., Brooklyn 1, N. Y.
Alden Products Co., 117 North Main St., Brockton 64, Mass.
American Insulator Corp., New Freedom, Pa.
American Molded Products Co., 1751 N. Honore St., Chicago, Ill.
American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.
Anchor Plastics Co., 533-41 Canal St., New York 13, N. Y.
Atlas Products Corp., 30 Rockefeller Plaza, New York 20, N. Y.
Auburn Button Works, Inc., 48 Canoga St., Auburn, N. Y.
Baer Co., N. S., 9 Montgomery St., Hillside, N. J.
Biwax Corp., 3445 Howard St., Skokie, Ill.
Boonton Molding Co., Boonton, N. J.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Breeze Corp., 41 S. Sixth St., Newark, N. J.
Bridgeport Molded Products, Inc., 303 Myrtle Ave., Bridgeport, Conn.
Brilhart Ltd., Arnold, 435 Middle Neck Rd., Great Neck, L. I., New York
Celluplastic Corp., 50 Avenue L, Newark 5, N. J.
Chicago Molded Products Corp., 1020 N. Kolmar Ave., Chicago 51, Ill.
Cincinnati Molding Co., 2037 Florence Ave., Cincinnati 6, Ohio
Cleveland Plastics, Inc., 1611 East 21st St., Cleveland 14, Ohio
Colt's Patent Fire Arms Mfg. Co., Plastics Div., Hartford, Conn.
Consolidated Molded Products Corp., 309 Cherry St., Scranton 2, Pa.
Continental-Diamond Fibre Co., 16 Chapel St., Newark, Del.
Creative Plastics Corp., 963 Kent Ave., Brooklyn, N. Y.
Cutler-Hammer Inc., 315 North 12th St., Milwaukee 1, Wisc.
Davies Molding Co., Harry, 1428 N. Wells St., Chicago 10, Ill.
Davis Plastics Co., Joseph, Arlington, N. J.
Diemolding Corp., Rasbach St., Canastota, N. Y.
Dimco Plastics, 207 E. 6th St., Dayton, Ohio
Eagle Electric Mfg. Co., Inc., 23-10 Bridge Plaza S., Long Island City, N. Y.
Eagle Plastics Corp., 23-10 Bridge Plaza So., Long Island City, N. Y.
Eclipse Moulded Products Co., 5151 North 32nd St., Milwaukee 9, Wis.
Electric Auto-Lite Co., Toledo 1, Ohio
Electrical Insulation Co., 12 Vestry St., New York, N. Y.
Electronic Products Co., 19 North First St., Geneva, Ill.
Emeloid Co., 291 Laurel Ave., Arlington, N. J.
Erie Resistor Corp., 644 W. 12th St., Erie, Pa.
Felsenthal & Sons, G., 4122 W. Grand Ave., Chicago 51, Ill.
Formica Insulation Co., 4662 Spring Grove Ave., Cincinnati, Ohio
Franklin Fibre-Lamitex Corp., 12th & French Sts., Wilmington, Del.
Franklin Mfg. Corp., A. W., 175 Varick St., New York 14, N. Y.
Garfield Mfg. Co., Garfield, N. J.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, L. I., N. Y.
General Electric Co., Plastics Div., 1, Plastics Ave., Pittsfield, Mass.
General Laminated Products, Inc., 175 Varick St., New York, N. Y.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Hopp Press, Inc., 460 W. 34th St., New York, N. Y.
House of Plastics, 1720 Euclid Ave., Cleveland 15, Ohio
Howard Plastics, Inc., 2600 Grand Ave., Kansas City 8, Mo.
Imperial Molded Products Corp., 2925 W. Harrison St., Chicago, Ill.
Industrial Synthetics Corp., 60 Woolsey St., Irvington, N. J.
Insulating Fabricators Inc., 12 East 12th St., New York 3, N. Y.
Insulating Fabricators of New England, Inc., 22 Elkins St., S. Boston, Mass.
Insulation Mfg. Co., 11 New York Ave., Brooklyn, N. Y.
Insulation Products Co., 504 Richland St., Pittsburgh, Pa.
International Products Corp., Baltimore 18, Md.
Jorgensen Mfg. Co., 1547 West Farms Rd., New York 60, N. Y.
Keystone Specialty Co., 1372½ Cove Ave., Cleveland, Ohio
Kirk Molding Co., F. J., 142 Brook St., Clinton, Mass.
Knoedler Co., A., Lancaster, Pa.
Kuhn & Jacob Moulding & Tool So., 1200 Southard St., Trenton, N. J.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
Kurz-Kasch Co., 1415 S. Broadway, Dayton 1, Ohio
Lacey-Webber Co., Kalamazoo, Mich.
Lamicoid Fabricators, 3600 W. Potomac Ave., Chicago, Ill.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Meissner Mfg. Div., Maguire Industries, Inc., Mt. Carmel, Ill.
Mills Corp., Elmer, E., 812 W. Van Buren St., Chicago, Ill.
Molded Insulation Co., Aircraft Control Div., 335 E. Price St., Philadelphia, Pa.
Mycalex Corp. of America, 60 Clifton Blvd., Clifton, N. J.
National Fabricated Products, 2650 Belden Avenue, Chicago 47, Ill.

Northern Industrial Chemical Co., 7-11 Elkins St. South Boston 27, Mass.
Northwest Plastics, Inc., 2333 University Ave., St. Paul 4, Minn.
Norton Laboratories, 520 Mill St., Lockport, N. Y.
Panelyte Div., St. Regis Paper Co., 230 Park Ave., New York 17, N. Y.
Parisian Novelty Co., 3510 S. Western Ave., Chicago 9, Ill.
Parker Engineering Prods. Co., 16 West 22nd St., New York 10, N. Y.
Patent Button Co. of Tenn., Inc., 2221 Century St., Knoxville 8, Tenn.
Plastic Manufacturers, Inc., Stamford, Conn.
Plax Corp., 133 Walnut St., Hartford, 5, Conn.
Poinsetta, Inc., 95 Cedar Ave., Pitman, N. J.
Precision Fabricators, Inc., Rochester, N. Y.
Printloid, Inc., 95 Mercer St., New York 12, N. Y.
R. E. C. Mfg. Corp., 1250 Highland St., Holliston, Mass.
Recto Molded Products, Appleton St. & B. & O. R. R., Cincinnati, Ohio
Remler Co., Ltd., 2101 Bryant St., San Francisco 10, Calif.
Resinous Products & Chemical Co., 222 W. Washington Sq., Philadelphia, Pa.
Resistoflex Corp., Belleville 9, N. J.
Reynolds Spring Co., Molded Plastics Div., Reynolds Bldg., Jackson, Mich.
Richardson Co., Melrose Park, Ill.
Rogan Brothers, 2001 S. Michigan Ave., Chicago, Ill.
Rohm & Haas, 222 W. Washington Sq., Philadelphia, Pa.
Royal Moulding Co., 69 Gordon Ave., Providence 5, R. I.
Santay Corporation, 351 N. Crawford Ave., Chicago 24, Ill.
Sillcocks-Miller Co., 10 Parker Ave., W. South Orange, N. J.
Standard Molding Corp., Dayton, Ohio
Standard Product Co., 505 Boulevard Bldg., Detroit 2, Mich.
Stokes Rubber Co., Jos. Taylor & Webster Sts., Trenton, N. J.
Synthetic Plastics Co., 88 St. Francis St., Newark, N. J.
Syracuse Ornamental Co., 581 So. Clinton St., Syracuse, N. Y.
Talking Devices Co., 4447 W. Irving Park Rd., Chicago, Ill.
Tech-Art Plastics Co., 41-01 36th Ave., Long Island City 1, N. Y.
Technical Plastics Co., 618 Clyde St., Pittsburgh 13, Pa.
Tri-United Plastics Corp., 390 Nye Ave., Irvington, N. J.
Tungsten Contact Mfg. Co., North Bergen, N. J.
Universal Plastics Corp., 235 Jersey Ave., New Brunswick, N. J.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
Varflex Corp., N. Jay St., Rome, N. Y.
Victory Manufacturing Co., 1722 W. Arcade Place, Chicago 12, Ill.
Waterbury Companies, Inc., 835 Main St., Waterbury, Conn.
Watertown Mfg. Co., Watertown, Conn.
Werner Co. Inc., R. D., 295 Fifth Avenue, New York 16, N. Y.
Western Felt Works, 4029 Ogden Ave., Chicago, Ill.
Western Lithograph Co., 2nd St., Los Angeles, Calif.
Westinghouse Elec. Corp., East Pittsburgh, Pa.
White Dental Mfg. Co., S. S., Industrial Division, 10 East 40th St., New York, N. Y.
Willor Mfg. Corp., 794 East 140th St., New York 54, N. Y.
Windman Bros., 3325 Union Pacific Ave., Los Angeles 23, Calif.
Worcester Moulded Plastics Co., 8 Grafton St., Worcester 8, Mass.

MANUFACTURERS of PLASTICS

American Cyanamid Co., Plastics Div., 30 Rockefeller Plaza, New York 20, N. Y.
American Phenolic Corp., 1830 S. 54th Ave., Chicago, Ill.
Bakelite Corp., 30 E. 42nd St., New York 17, N. Y.
Carbide & Carbon Chemicals Corp., 30 E. 42nd St., New York, N. Y.
Catalin Corp., 1 Park Ave., New York, N. Y.
Celanese Plastics Corp., 180 Madison Ave., New York 16, N. Y.
Ciba Co., Inc., 627 Greenwich St., New York 14, N. Y.
Continental-Diamond Fibre Co., 16 Chapel St., Newark, Del.
Dow Chemical Co., Midland, Mich.
duPont de Nemours & Co., Inc., E. I., Wilmington 98, Del.
Durez Plastics & Chemicals, Inc., 1922 Walck Rd., North Tonawanda, N. Y.
Durite Plastics, Inc., 5010 Summerdale Ave., Philadelphia 24, Pa.
Eastman Kodak Co., Rochester 4, N. Y.
General Electric Co., Plastics Div., 1, Plastics Ave., Pittsfield, Mass.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Industrial Synthetics Corp., 60 Woolsey St., Irvington, N. J.
Interlake Chemical Corp., Union Commerce Bldg., Cleveland 14, Ohio
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington 11, N. J.
Makalot Corp., 262 Washington St., Boston, Mass.
Marblette Corp., 37-21 30th St., Long Island City 1, N. Y.
Mica Insulator Co., 200 Varick St., New York 14, N. Y.
Monsanto Chemical Co., Plastics Div., Springfield 2, Mass.
National Vulcanized Fibre Co., Maryland Ave., Wilmington, Del.
Nixon Nitration Works, Nixon, N. J.
Panelyte Div., St. Regis Paper Co., 230 Park Ave., New York, N. Y.
Plaskon Div., Libbey-Owens-Ford-Glass Co., 2112 Sylvan Ave., Toledo 6, Ohio
Plax Corp., 133 Walnut St., Hartford 5, Conn.
Poinsetta, Inc., 95 Cedar St., Pitman, N. J.
Reilly Tar & Chemical Corp., Merchants Bank Bldg., Indianapolis, Ind.
Respro, Inc., Wellington Ave., Cranston, R. I.
Richardson Co., Melrose Park, Ill.
Rogers Paper Mfg. Co., Manchester, Conn.
Rohm & Haas, 222 Washington Sq., Philadelphia 5, Pa.
Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N. Y.
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.
Tennessee Eastman Corp., Kingsport, Tenn.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Plastics and Metal Marking Machines & Stencils

Aircraft Products Co., 3502 E. Pontiac St., Fort Wayne, Ind.
Annis Co., R. B., 1101 N. Delaware St., Indianapolis 2, Ind.
Ansonia Clock Co., Inc., 103 Lafayette St., New York 13, N. Y.
Austin Co., O., 42 Greene St., New York, N. Y.
Auto Engraver Co., 1776 Broadway, New York, N. Y.
B. & C. Insulation Products, Inc., 261 Fifth Ave., New York 16, N. Y.
Bastian Bros. Co., 1660 N. Clinton Ave., Rochester, N. Y.
Becker Bros. Engraving Co., 103 Lafayette St., New York, N. Y.
Burndy Engrg. Co., 107 Bruckner Blvd., New York 54, N. Y.
Croname, Inc., 3701 Ravenswood Ave., Chicago, Ill.
Eastern Etching & Mfg. Co., Chicopee, Mass.
Edwards, Inc., J. T., 121 Beach St., Boston 5, Mass.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Neb.
Ideal Commutator Dresser Co., 1291 Park Ave., Sycamore, Ill.
Leiman Bros., 203 Christie St., Newark, 5, N. J.
Lenoxite Div., Lenox Inc., 65 Prince St., Trenton 5, N. J.
Long Island Engraving Co., 19 West 21st St., New York 10, N. Y.
Markem Machine Co., Keene, N. H.
Micarta Fabricators, Inc., 5324 Ravenswood Ave., Chicago 40, Ill.
Mico Instrument Co., 80 Trowbridge St., Cambridge 38, Mass.
National Varnished Products Corp., 211 Randolph Ave., Woodbridge, N. J.
New Method Steel Stamps, Inc., 149 Joseph Campau Ave., Detroit 7, Mich.
Numberall Stamp & Tool Co., 379 Huguenot Ave., Huguenot Park, Staten Island 12, N. Y.
Parisian Novelty Co., 3510 S. Western Ave., Chicago 9, Ill.
Plastic Fabricators Co., 440 Sansome St., San Francisco 11, Calif.
Preis Engraving Machine Co., H. P., 155 Summit St., Newark 4, N. J.
Rogan Bros., 2001 S. Michigan Ave., Chicago, Ill.
Screenmakers, 64 Fulton St., New York 1, N. Y.
Sparkes Mfg. Co., 318 Jefferson St., Newark, N. J.

Plastic Insulation

see Insulation, Plastic

Plating, Metal, on Plastics

Airplane & Marine Instruments, Inc., Clearfield, Pa.
Aluminum Finishing Corp., 1119 E. 22nd St., Indianapolis, Ind.
Austin Co., O., 42 Greene St., New York, N. Y.
Diamond Tool Replacements Div., Oscap Mfg. Co., 207 W. Saratoga St., Baltimore 1, Md.
Distillation Products, Inc., 755 Ridge Road W., Rochester, N. Y.
Electro Plastic Processes, 2035 West Charleston St., Chicago 47, Ill.
Lenoxite Div., Lenox Inc., 65 Prince St., Trenton 5, N. J.
Metaplast Company, 205 West 19th Street, New York 11, N. Y.
Monroe Auto Equipment Co., Monroe, Michigan
Na Mac Products Co., 1027 N. Seward Street, Los Angeles 38, Calif.
Pacific Plastic & Mfg. Co., Inc., 4865 Exposition Blvd., Los Angeles 16, Calif.
Philadelphia Rust-Proof Co., 3229 Frankford Ave., Philadelphia 34, Pa.
Sievering, Inc., Philip, 199 Lafayette Street, New York, N. Y.

Players, Record

see Phonographs

Plugs

TERMINAL PLUGS

see also Jacks

Airadio, Inc., Melrose Ave. & Battery Place, Stamford, Conn.
Aircraft-Marine Prods., Inc., 1523 N. Fourth, St. Harrisburg, Pa.
Aircraft Products Co., 3502 E. Pontiac St., Fort Wayne, Ind.
Aircraft Radio Corp., Boonton, N. J.
Alden Products Co., 117 North Main St., Brockton 64, Mass.
Amalgamated Radio & Television Corp., 476 Broadway, New York 13, N. Y.
American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.
American Radio Hardware Co., Inc., 152 MacQuesten Pkway. St., Mt. Vernon, N. Y.
Atlas Products Corp., 30 Rockefeller Plaza, New York, N. Y.
Audio Development Co., 2833 13th Ave. S., Minneapolis 7, Minn.
Automatic Electric Co., 1033 West Van Buren St., Chicago 7, Ill.
Automatic Metal Products Corp., 315 Berry St., Brooklyn, N. Y.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Birnbach Radio Co., Inc., 145 Hudson St., New York, N. Y.
Brach Co., L. S., 55 Dickerson St., Newark 4, N. J.
Breeze Corp., 41 South Sixth St., Newark, N. J.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Burndy Engrg. Co., 107 Bruckner Blvd., New York 54, N. Y.
Cinch Mfg. Corp., 2335 W. Van Buren St., Chicago, Ill.
Cole-Hersee Co., 54 Old Colony Ave., Boston 27, Mass.

ELECTRONIC and ALLIED PRODUCTS

Communication Measurements Laboratory, 120 Greenwich St., New York, N. Y.
Connecticut Telephone & Electric Div., Great American Industries, Inc., 70 Britannia St., Meriden, Conn.
Connector Div., International Resistance Co., 401 North Broad St., Philadelphia 8, Pa.
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Eagle Electric Mfg. Co., Inc., 23-10 Bridge Plaza S., Long Island City, N. Y.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia 13, Pa.
Electrix Corp., 158 Middle St., Pawtucket, R. I.
Federal Mfg. & Engrg., Corp., 199 Steuben St., Brooklyn, N. Y.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Bridgeport, Conn.
General Electronics Mfg. Co., 2225 S. Hoover St., Los Angeles 7, Calif.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Heinze Electric Co., Lowell, Mass.
Hubbell Inc., Harvey, Bridgeport 2, Conn.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkway., Brooklyn, N. Y.
Johnson Co., E. F., Waseca, Minn.
Jones, Howard B., 2460 W. George St., Chicago 18, Ill.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
National Co., Inc., 61 Sherman St., Malden 48, Mass.
National Electronic Mfg. Corp., 22-78 Steinway Street, Long Island City 5, N. Y.
North Electric Mfg. Co., 501 S. Market St., Galion, Ohio
Northam Warren Corp., Stamford, Conn.
Northwest Plastics, Inc., 2333 University Ave., St. Paul 4, Minn.
Pass & Seymour, Inc., Solvay Station, Syracuse, N. Y.
Philmore Mfg. Co., 113 University Place New York, N. Y.
Precision Specialties, 220 No. Western Ave., Los Angeles, Calif.
Pyle-National Co., 1334 N. Kostner Ave., Chicago 51, Ill.
Remler Company, Ltd., 2101 Bryant Street San Francisco, Cal.
Russell & Stoll Co., 125 Barclay St., New York 7, N. Y.
Selector Mfg. Corp., 21-10 49th Ave., Long Island City, N. Y.
Sorenz Mfg. Corp., 1901 Clybourn Ave., Chicago 14, Ill.
Standard Electric Time Co., 89 Logan St., Springfield, Mass.
Standard Winding Co., 44-62 Johnes St., Newburgh, N. Y.
Telephonics Corp., 350 West 31st St., New York, N. Y.
Trav-Ler Karenola Radio & Television Corp., 571 W. Jackson Blvd., Chicago, Ill.
Ucinite Co., 459 Watertown St., Newtonville, Mass.
United-Carr Fastener Corp., 31 Ames St., Cambrdge 42, Mass.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Whittaker Cable Corp., North Kansas City, Mo.
Willows Mfg. Corp., 341 39th St., Brooklyn, N. Y.
Wood Electric Co., Inc., C. D., 826 Broadway, New York 3, N. Y.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.

Pointers

DIAL POINTERS

see also Knobs
also Dials

American Brass Co., Waterbury 88, Conn.
American Radio Hardware Co., Inc., 152 MacQuesten Pkway. S., Mt. Vernon, N. Y.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bastian Bros. Co., 1600 N. Clinton Ave., Rochester, N. Y.
Birbach Radio Co. Inc., 145 Hudson St., New York, N. Y.
Bud Radio, Inc., 2118 East 55th St., Cleveland 3, Ohio
Croname, Inc., 3701 Ravenswood Ave., Chicago, Ill.
Eclipse Moulded Products Co., 5151 North 32nd St., Milwaukee 9, Wis.
Felsenthal & Sons, G., 4122 W. Grand Ave., Chicago 51, Ill.
General Electric Co., Schenectady 5, N. Y.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Grammes & Sons, Inc., L. F., 389 Union St., Allentown 2, Pa.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Kurz-Kasch Co., 1415 S. Broadway, Dayton 1, Ohio
National Co., 61 Sherman St., Malden 48, Mass.
New England Radiocrafters, 1156 Commonwealth Ave., Boston 34, Mass.
Parisian Novelty Co., 3510 S. Western Ave., Chicago 9, Ill.
Plastic Fabricators, Inc., 440 Sansome St., San Francisco 11, Calif.
Printloid, Inc., 95 Mercer St., New York 12, N. Y.
Radio City Products Co., 127 West 26th St., New York, N. Y.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
Victory Mfg. Co., 1722 W. Arcade Place, Chicago 2, Ill.
Winn Sons, J. H., Winchester, Mass.
Worcester Moulded Plastics Co., 8 Grafton St., Worcester 8, Mass.

Points

CONTACT POINTS and ASSEMBLIES

American Platinum Works, New Jersey R. R. Ave. at Oliver St., Newark 5, N. J.
Baker & Co., 113 Astor St., Newark 5, N. J.
Bead Chain Mfg. Co., 110 Mt. Grove St., Bridgeport 5, Conn.
Bishop & Co., Platinum Works, J., 12 Channing Ave., Malvern, Pa.
Brainin Co., C. S., 233 Spring St., New York 13, N. Y.
Callite Tungsten Corp., 544 39th St., Union City, N. J.
Cleveland Tungsten, Inc., 10200 Meech Ave., Cleveland, Ohio
Fansteel Metallurgical Corp., 2200 Sheridan Rd., North Chicago, Ill.
General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
General Tungsten Mfg. Co., 502 23d St., Union City, N. J.
Gibson Electric Co., 8350 Frankstown Ave., Pittsburgh 21, Pa.
Graphite Metallizing Corp., 1055 Nepperhan Ave., Yonkers 3, N. Y.
Goldsmith Bros. Smelting & Refining Co., 58 East Washington St., Chicago, Ill.
Independent Contact Mfg. Co., 540 39th St., Union City, N. J.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt Vernon, N. Y.
Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Metroloy Co., 57 E. Alpine St., Newark, N. J.
National Carbon Co., Inc., 30 East 42nd St., New York 17, N. Y.
Noble Co., F. H., 535 West 59th St., Chicago, Ill.
Progressive Mfg. Co., 52 Norwood St., Torrington, Conn.
Speer Carbon Co., St. Marys, Pa.
Tricon Manufacturing Co., 8310 S. Racine Ave., Chicago, Ill.
Tubular Rivet & Stud Co., Wollaston 70, Mass.
Tungsten Contact Mfg. Co., North Bergen, N. J.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wilson Co., H. A., 105 Chestnut St., Newark 5, N. J.

Porcelain

see Insulation—Ceramic

Posts

BINDING POSTS and TERMINALS

Aircraft-Marine Prods. Inc., 1523 North Fourth St., Harrisburg, Pa.
Aircraft Products Co., 3502 E. Pontiac St., Fort Wayne, Ind.
Aircraft Radio Corp., Boonton, N. J.
Alden Products Co., 117 North Main St., Brockton 64, Mass.
American Brass Co., Waterbury 88, Conn.
American Insulator Corp., New Freedom, Pa.
American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.
American Radio Hardware Co., Inc., 152 MacQuesten Pkway, S., Mt. Vernon, N. Y.
Ansonia Clock Co., Inc., 103 Lafayette St., New York 13, N. Y.
Atlas Products Corp., 30 Rockefeller Plaza, New York 20, N. Y.
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Baer Co., N. S., 9 Montgomery St., Hillside, N. J.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bead Chain Mfg. Co., 110 Mt. Grove St., Bridgeport 5, Conn.
Birnbach Radio Co., Inc., 145 Hudson St., New York, N. Y.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Burke Electric Co., 12th & Cranberry Sts., Erie, Pa.
Burndy Engineering Co., Inc., 107 Bruckner Blvd., New York 54, N. Y.
Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif.
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Cinch Mfg. Corp., 2335 W. Van Buren St., Chicago, Ill.
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Calif.
Comar Electric Co., 3150 N. Washtenaw Ave., Chicago 28, Ill.
Continental-Diamond Fibre Co., 16 Chapel St., Newark, Del.
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Creative Plastics Corp., 963 Kent Ave., Brooklyn, N. Y.
Curtis Development & Mfg. Co., 1 N. Crawford Ave., Chicago 24, Ill.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Eastern Specialty Co., 3617-19 N. Eighth St., Philadelphia 40, Pa.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia 13, Pa.
Electronic Mechanics, Inc., 70 Clifton Blvd., Clifton, N. J.
Federal Screw Products Co., 224 W. Huron St., Chicago 10, Ill.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Guided Radio Corp., 161 Sixth Ave., New York 13, N. Y.
Industrial Screw & Supply Co., 713 W. Lake St., Chicago 6, Ill.
Insulation Mfg. Co., 11 New York Ave., Bklyn., N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Jones, Howard B., 2460 W. George St., Chicago 18, Ill.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Kings Electronics Co., 372 Classon Ave., Brooklyn 5, N. Y.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
McInerney Plastics Co., 655 Godfrey Ave., S. W., Grand Rapids 1, Mich.
Mica Insulator Co., 797 Broadway, Schenectady 1, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Calif.
National Co., 61 Sherman St., Malden 48, Mass.
National Fabricated Products, 2650 Belden Ave., Chicago 47, Ill.

National Vulcanized Fibre Co., Maryland Ave., Wilmington, Del.
Northern Industrial Chemical Co., 7-11 Elkins St., South Boston 27, Mass.
Philmore Mfg. Co., 113 University Place, New York, N. Y.
Plastic Manufacturers, Stamford, Conn.
Precision Specialties, 220 No. Western Ave., Los Angeles, Calif.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Sorenz Manufacturing Corp., 1901 Clybourn Ave., Chicago 14, Ill.
Small Motors, Inc., 1322 Elston Ave., Chicago 22, Ill.
Standard Electric Time Co., 89 Logan St., Springfield, Mass.
States Co., 19 New Park Ave., Hartford 6, Conn.
Taylor Fibre Co., Norristown, Pa.
Templetone Radio Mfg. Corp., New London, Conn.
Thomas & Betts Co., Inc., 36 Butler St., Elizabeth 1, N. J.
Thwing-Albert Instrument Co., Penn St., & Pulaski Ave., Philadelphia 44, Pa.
Ucinite Co., 459 Watertown St., Newtonville, Mass.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
Waterbury Companes, Inc., 835 S. Main St., Waterbury, Conn.
Wood Electric Co., Inc., C. D., 826 Broadway, New York 3, N. Y.

Potentiometers

see Variable Resistors

Pots, Soldering

Acme Electric Heating Co., 1217 Washington St., Boston 18, Mass.
Adams, Inc., Carman, 15476 James Couzens Highway, Detroit, Mich.
Drake Electric Works, Inc., 3656 Lincoln Ave., Chicago 13, Ill.
Electric Soldering Iron Co., 1845 W. Elm St., Deep River, Conn.
Falls Electric Furnace Corp., 660 Grant St., Buffalo, N. Y.
General Electric Co., Schenectady 5, N. Y.
Kentworthy, Inc., Charles F., 195 Piedmont St., Waterbury 23, Conn.
Lectrohm, Inc., 5141 W. 25th St., Cicero 50, Ill.
Lydon Brothers, 229 Colden St., Jersey City, N. J.
Newton Junior Corp., 682 Third Ave., West Haven, Conn.
Russell Electric Co., 340 W. Huron St., Chicago, Ill.
Sta-Warm Electric Co., N. Chestnut St., Ravenna, Ohio
Struthers-Dunn, Inc., 1321 Arch St., Philadelphia, Pa.
Trent Co., Harold E., Leverington Ave. at Wilde St., Philadelphia 27, Pa.
Vasco Electrical Mfg. Co., 4116 Avalon Blvd., Los Angeles, Calif.
Vulcan Electric Co., Danvers, Mass.
Waage Electric Co., A. H., 54 Park Place, New York 7, N. Y.
Westinghouse Electric Corp., E. Pittsburgh, Pa.
Wiegand Co., Edwin L., 7544 Thomas Blvd., Pittsburgh 8, Pa.

Power Cord

see Wire

Power Plants

see Generators

Power Supplies

Altec Lansing Corp., 1680 N. Vine St., Los Angeles 28, Calif.
American Radio Co., 611 E. Garfield Ave., Glendale, Calif.
American Television & Radio Co., 300 E. Fourth St., St. Paul 1, Minn.
American Transformer Co., 178 Emmet St., Newark, N. J.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Benwood Linze Co., 1815 Locust St., St. Louis, Mo.
Browning Labs., Inc., 750 Main St., Winchester, Mass.
Carter Motor Co., 1606 Milwaukee Ave., Chicago 47, Ill.
Communications Equipment Corp., 134 West Colorado St., Pasadena 1, Calif.
Communication Measurements Laboratory, 120 Greenwich St., New York, N. Y.
Consolidated Engineering Corp., 595 E. Colorado St., Pasadena 1, Calif.
Daven Co., 191 Central Ave., Newark 4, N. J.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electro Engineering & Mfg. Co., 627 W. Alexandrine Ave., Detroit 1, Mich.
Electro Products Laboratories, 549 W. Randolph St., Chicago, Ill.
Electron Equipment Corp., 917 Meridian Ave., South Pasadena, Calif.
Electronic Corp. of America, 45 West 18th St., New York 11, N. Y.
Electronic Laboratories, Inc., Indianapolis, Ind.
Electronic Products Co., 19 North First St., Geneva, Ill.
Electronic Supply Co., 207 Main St., Worcester, Mass.
Espey Mfg. Co., 33 West 46th St., New York 19, N. Y.
Fisher Research Laboratory, 1961 University Ave., Palo Alto, Calif.
Freed Transformer Co., 72 Spring St., New York 12, N. Y.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
General Transformer Corp., 1250 W. Van Buren St., Chicago 7, Ill.
Green Electric Co., Inc., W., 130 Cedar St., New York 6, N. Y.
Hamilton Radio Corp., 510 Sixth Ave., New York, N. Y.
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Harvey-Wells Electronics, Inc., North St., Southbridge, Mass.
Heath Co., Benton Harbor, Mich.
Herbach & Rademan Co., Mfg. Div., 517 Ludlow St., Philadelphia 6, Pa.
Hercules Electric & Mfg. Co., Inc., 2500 Atlantic Ave., Brooklyn 7, N. Y.
International Transformer Co., 396 Broadway, New York, N. Y.
Jefferson, Inc., Ray, 40 E. Merrick Rd., Freeport, L. I., N. Y.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.
Lear, Inc., Piqua, Ohio
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Mellaphone Corp., Rochester 2, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
National Co., 61 Sherman St., Malden 48, Mass.
Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles 18, Calif.
Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.
Philharmonic Radio Corp., 528 E. 72nd St., New York
Press Wireless, Inc., 1475 Broadway, New York, N. Y.
Radiart Corp., 3571 West 62nd St., Cleveland, Ohio
Radio Mfg. Engineers, Inc., 304 First Ave., Peoria, Ill.
Radio-Television Institute, Inc., 480 Lexington Ave., New York 17, N. Y.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Rehtron Corp., 4313 Lincoln Ave., Chicago 18, Ill.
Richardson-Allen Corp., 15 W. 20th St., New York 11, N. Y.
Schuttig & Co., 9th & Kearney Sts., N. E., Washington 17, D. C.
Scientific Radio Products Co., 738 W. Broadway, Council Bluffs, Iowa
Scientific Service Laboratories, 2225 So. Hoover St., Los Angeles 7, Calif.
Simpson Mfg. Co., Inc., Mark, 188 W. Fourth St., New York, N. Y.
Springfield Sound Co., Electronics Div., 12 Cass St., Springfield, Mass.
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.
Techno-Scientific Co., 901 Nepperhan Ave., Yonkers 3, N. Y.
Thordarson Electric Mfg. Div., Maguire Industries, Inc., 500 W. Huron St., Chicago 10, Ill.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
Ward Leonard Electric Co., Mount Vernon, N. Y.
Waugh Labs., Div. of Waugh Equipment Co., 420 Lexington Ave., New York 17, N. Y.
Webster Chicago Corp., Electronics Div., 3825 Armitage Ave., Chicago 47, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wilcox Electric Co., 1400 Chestnut St., Kansas City, Mo.

Powdered Metal Products

see Metals

Public Address Systems

see Sound

Pumps

VACUUM PUMPS

Aireon Manufacturing Corp., Fairfax & Funston Rds., Kansas City 15, Kans.
Allis Chalmers Mfg. Co., Milwaukee 1, Wis.
Central Scientific Co., 1700 Irving Park Blvd., Chicago 13, Ill.
Distillation Products, Inc., 755 Ridge Rd. W., Rochester, N. Y.
Eastern Engineering Co., 45 Fox St., New Haven, Conn.
Eastman Kodak Co., Rochester 4, N. Y.
Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.
Eisler Engrg. Co., 740 S. 13th St., Newark 3, N. J.
Eitel-McCullough, Inc., San Bruno, Calif.
General Electric Co., Schenectady 5, N. Y.
Haydu Bros., Mt. Bethel Rd., Plainfield, N. J.
International Machine Works, 2207 46th St., North Bergen, N. J.
Kahle Engineering Co., 1307 Seventh St., North Bergen, N. J.
Kinney Mfg. Co., 3529 Washington St., Boston, Mass.
Kraissl Co., Inc., 303 Williams Ave., Hackensack, N. J.
Leiman Bros., 203 Christie St., Newark 5, N. J.
Litton Engineering Labs., P. O. Box 749, Redwood City, Calif.
McIntyre Co., 15 Riverdale Ave., Newton, Mass.
Machlett & Son, E., 220 East 23rd St., New York 10, N. Y.
National Research Corp., Vacuum Engrg. Div., 100 Brookline Ave., Boston 15, Mass.
Nelson Vacuum Pump Co., Geo. F., 2134 Fourth St., Berkeley 2, Calif.
New Jersey Machine Corp., 16th & Willow Ave., Hoboken, N. J.
Robbins & Myers, Inc., 1345 Lagonda Ave., Springfield, Ohio
Stokes Machine Co., F. J., 5850 Tabor Rd., Olney P. O., Philadelphia 20, Pa.
Sullivan Machinery Co., 929 Woodland Ave., Michigan City, Ind.
Technical Products Co., 158 Madison Ave. at Third St., Memphis, Tenn.
Universal X-Ray Products Inc., 1800 North Francisco Ave., Chicago 47, Ill.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Worthington Pump & Machinery Corp., Harrison, N. J.
Yeomans Bros. Co., 1433 N. Dayton St., Chicago, Ill.

"Q" Meters

see Meters

ELECTRONIC and ALLIED PRODUCTS

Racks, Relay

Armature Coil Equipment, Inc., 2605 Vega Ave., Cleveland 3, Ohio
Automatic Electric Co., 1033 West Van Buren St., Chicago 7, Ill.
Barker & Williamson, Upper Darby, Pa.
Cinema Engineering Co., 1508 N. Verdugo Ave., Burbank, Calif.
Communications Equipment Corp., 134 West Colorado St., Pasadena 1, Calif.
Corry Jamestown Mfg. Corp., Corry, Pa.
Dahlstrom Metallic Door Co., Buffalo St., Jamestown, New York
Falstrom Co., 7 Falstrom Court, Passaic, New Jersey
Hadley Co., Robert M., 711 East 61st St., Los Angeles, Calif.
Hudson American Corp., 25 West 43rd St., New York, N. Y.
Karp Metal Products Co., Inc., 129 Thirtieth St., Brooklyn, N. Y.
National Co., Malden 48, Mass.
Par Metal Products Corp., 32-62 49th St., Long Island City, N. Y.
Plax Corporation, 133 Walnut St., Hartford 5, Conn.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.

Radar, Complete Equipment

(INCLUDING I.F.F. AND RADAR BEACONS

Admiral Corp., 3800 W. Cortland St., Chicago, Ill.
Airadio, Inc., Barry Place, Stamford, Conn.
Belmont Radio Corp., 5921 W. Dickens Ave., Chicago, Ill.
Bendix Radio, Div. of Bendix Aviation Corp., Baltimore, Md.
Crosley Corp., 1329 Arlington St., Cincinnati 25, Ohio
Du Mont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Fada Radio & Electric Co., Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Fairchild Camera & Instrument Corp., 475 Tenth Ave., New York 18, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago 51, Ill.
General Electric Co., 1 River Road, Schenectady 5, N. Y.
General Motors Corp., Detroit, Mich.
Gilfillan Bros., Inc., 1815 Venice Blvd., Los Angeles, Calif.
Hallicrafters Co., 2611 S. Indiana Ave., Chicago, Ill.
Harvey Radio Labortories, Inc., 447 Concord Ave., Cambridge, Mass.
Hazeltine Electronics Corp., 1775 Broadway, New York, N. Y.
Pacific Electronics, Sprague at Jefferson, Spokane, Wash.
Philco Corp., Ontario & C Sts., Philadelphia, Pa.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
Radio Mfg. Engineers, Inc., 304 First Ave., Peoria, Ill.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
Raytheon Manufacturing Co., 190 Willow St., Waltham, Mass.
Sparks-Withington Co., North St., Jackson, Mich.
Sperry Gyroscope Co., Manhattan Bridge Plaza, Brooklyn, N. Y.
Stewart-Warner Corp., 1826 Diversey Parkway, Chicago, Ill.
Stromberg-Carlson Co., 100 Carlson Road, Rochester, N. Y.
Submarine Signal Co., 160 State, Boston, Mass.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York, N. Y.
Western Electric Co., Inc., 120 Broadway, New York, N. Y.
Westinghouse Electric Corp., 2519 Wilkens Ave., Baltimore 3, Md.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

Receivers, Home—AM

AM COMBINATIONS

Admiral Corporation, 3800 W. Cortland St., Chicago, Ill.
Air-King Products Co., Inc., 1523-63rd St., Bklyn, N. Y.
Ansley Radio Corp., 21-10 49th Avenue, Long Island City, N. Y.
Automatic Radio Mfg. Co. Inc., 122 Brookline Avenue, Boston, Mass.
Belmont Radio Corporation, 5921 West Dickens Avenue, Chicago 39, Ill.
Bendix Radio Corp., Baltimore 4, Md.
Colonial Radio Corp., 254 Rano Street, Buffalo, N. Y.
The Crosley Corporation, Cincinnati 25, Ohio
Delco Radio Division, General Motors Corporation, Kokomo, Indiana
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Dynavox Corporation, 40-05 21st St., Long Island City, N. Y.
Echophone Radio, Div. of Hallicrafters Co., 2611 S. Indiana Ave., Chicago, Ill.
Electrical Research & Mfg. Co., 3001 E. Pico Blvd., Los Angeles, Calif.
Electromatic Mfg. Corp., 88 University Place, New York, N. Y.
Electronic Corp. of America, 45 West 18th St., New York, N. Y.
Espey Mfg. Co. Inc., 33 West 46th St., New York, N. Y.
Fada Radio & Electric Co. Inc., 30-20 Thomson Avenue, Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Garod Radio Corp., 70 Washington St., Bklyn, N. Y.
General Electric Company, Bridgeport, Conn.
General Television & Radio Corp., 2701 North Lehmann Court, Chicago 14, Ill.
Gilfillan Bros. Inc., 1815 Venice Blvd., Los Angeles, Calif.
Hamilton Radio Corp., 510 Sixth Avenue, New York, N. Y.
Herbach & Rademan Co., 517 Ludlow St., Philadelphia 6, Pa.
Hoffman Radio Corp., 3430 S. Hill St., Los Angeles, Calif.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
International Detrola Corp., 1501 Beard Avenue, Detroit, Michigan
Keith Radio Products, 16th & K St., Bedford, Ind.
Kingston Products Corp., Kokomo, Indiana
Lear, Inc., Piqua, Ohio
Magnavox Company, 2131 Bueter Road, Fort Wayne, Indiana
Majestic Radio & Television Corp., St. Charles, Ill.
Meck Industries, John, Liberty at Pennsylvania, Plymouth, Ind.
Medco Mfg. Co., 5 West 45th St., New York, N. Y.
Megard Corporation, 1601 S. Burlington Avenue, Los Angeles 6, Calif.
Meissner Manufacturing Division, Maguire Industries, Inc., Mt. Carmel, Ill.
Midwest Radio Corp., 909 Broadway, Cincinnati, Ohio
Minerva Corp. of America, 238 William St., New York, N. Y.
Noblitt Sparks Industries, Columbus, Indiana
Packard-Bell Co., 3443 Welshire Blvd., Los Angeles 5, Calif.
Philco Corporation, Tioga & C Streets, Philadelphia 34, Pa.
Philharmonic Radio Corporation, 528 East 72nd Street, New York 21, N. Y.
Precision Specialties, 210-26 N. Western Ave., Los Angeles, Calif.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Record-O-Vox, Inc., 721 N. Martel Avenue. Hollywood 46, Calif.
Remler Company, Ltd., 2101 Bryant Street, San Francisco 10, Calif.
Rex Products Co., 1313 W. Randolph St., Chicago 7, Ill.
Sentinel Radio Corp., 2020 Ridge Avenue, Evanston, Ill.
Sheridan Electro Corp., 2850 S. Michigan Ave., Chicago, Ill.
Signal Electronics, Inc., 114 East 16th St., New York 3, N. Y.
Sonora Radio & Television Corp., 325 N. Hoyne Avenue, Chicago, Ill.
Sparks Withington Company, Jackson, Michigan
Stewart Warner Corporation, 1836 Diversey Parkway, Chicago, Ill.
Stromberg-Carlson Co., 100 Carlson Road, Rochester, N. Y.
Symphonic Radio & Electronic Corp., 292-98 Main St., Cambridge 42, Mass.
Tech-Master Prods. Co., 123 Prince St., New York, N. Y.
Telicon Corp., 851 Madison Ave., New York, N. Y.
Templetone Radio Mfg. Corp., Templetone Building, New London, Conn.
Trav-Ler Karenola, 571 W. Jackson Blvd., Chicago, Ill.
United States Television Mfg. Corp., 106 Seventh Avenue, New York, N. Y.
Viewtone Co., 203 East 18th St., New York, N. Y.
Vlectrical Engineering Co., 828 North Highland Avenue, Los Angeles 38, Calif.
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago, Ill.
Watterson Radio Mfg. Co., P O Box 54, Dallas, Texas
Wells Gardner & Co., 2701 North Kildare, Chicago 39, Ill.
Westinghouse Electric Corp., 2519 Wilkens Ave., Baltimore 3, Md.
Wilcox Gay Corp., Charlotte, Michigan
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

AM CONSOLES

Admiral Corporation, 3800 W. Cortland St., Chicago, Ill.
Andrea Radio Corp., 43-20 34th Street, Long Island City, N. Y.
Ansley Radio Corp., 21-10 49th Avenue, Long Island City, N. Y.
Automatic Radio Mfg. Co. Inc., 122 Brookline Avenue, Boston, Mass.
Belmont Radio Corporation, 5921 West Dickens Avenue, Chicago 39, Ill.
Bendix Radio Corp., Baltimore 4., Md.
Colonial Radio Corp., 254 Rano St., Buffalo, N. Y.
Crosley Corporation, Cincinnati, Ohio
Delco Radio Division, General Motors Corporation, Kokomo, Indiana
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Echophone Radio, Division of Hallicrafters Co., 2611 S. Indiana Avenue, Chicago, Ill.
Eckstein Radio & Television Co., Inc., 914 LaSalle, Minneapolis, Minn.
Electrical Research & Mfg. Co., 3001 E. Pico Blvd., Los Angeles, Calif.
Fada Radio & Electric Co. Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Garod Radio Corp., 70 Washington St., Bklyn, N. Y.
General Electric Company, Bridgeport, Conn.
Hamilton Radio Corp., 510 Sixth Avenue, New York, N. Y.
Herbach & Rademan Co., 517 Ludlow St., Philadelphia 6, Pa.
Hoffman Radio Corp., 3430 S. Hill St., Los Angeles, Calif.
International Detrola Corp., 1501 Beard Ave., Detroit, Michigan
Kingston Products Corp., Kokomo, Indiana
Lear, Inc., Piqua, Ohio
Magnavox Company, 2131 Bueter Road, Fort Wayne, Indiana
Majestic Radio & Television Corp., St. Charles, Ill.
Meck Industries, John, Liberty at Pennsylvania, Plymouth, Ind.
Megard Corporation, 1601 S. Burlington Avenue, Los Angeles 6, Calif.
Meissner Manufacturing Division, Maguire Industries, Inc., Mt. Carmel, Ill.
Midwest Radio Corp., 909 Broadway, Cincinnati, Ohio
Minerva Corp. of America, 238 William Street, New York, N. Y.
Noblitt Sparks Industries, Columbus, Indiana
Packard-Bell Co., 3443 Welshire Blvd., Los Angeles 5, Calif.
Philco Corporation, Tioga & C Streets, Philadelphia 34, Pa.
Philharmonic Radio Corporation, 528 East 72nd Street, New York 21, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.

Record-O-Vox, Inc., 721 N. Martel Ave., Hollywood 46, Calif.
Regal Electronics Corp., 20 West 30th St., New York, N. Y.
Remler Company, Ltd., 2101 Bryant St., San Francisco 10, Calif.
Searle Aero Industries, Inc., Orange, Calif.
Sentinel Radio Corp., 2020 Ridge Ave., Evanston, Ill.
Signal Electronics, Inc., 114 East 16th St., New York 3, N. Y.
Sonora Radio & Television Corp., 325 N. Hoyne Avenue, Chicago, Ill.
Sparks Withington Compny, Jackson, Michigan
Stewart Warner Corporation, 1836 Diversey Parkway, Chicago, Ill.
Stromberg-Carlson Co., 100 Carlson Road, Rochester, N. Y.
Symphonic Radio & Electronic Corp., 292-98 Main St., Cambridge 42, Mass.
Telicon Corp., 851 Madison Ave., New York, N. Y.
Templetone Radio Mfg. Corp., Templetone Building, New London, Conn.
United States Television Mfg. Corp., 106 Seventh Avenue, New York, N. Y.
Viewtone Co., 203 East 18th St., New York, N. Y.
Vlectrical Engineering Co., 828 North Highland Avenue, Los Angeles 38, Calif.
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago, Ill.
Watterson Radio Mfg. Co., P O Box 54, Dallas, Texas
Wells Gardner & Co., 2701 North Kildare, Chicago 39, Ill.
Wilcox Gay Corporation, Charlotte, Michigan
Zenith Radio Corp., 6001 Dickens Avenue, Chicago, Ill.

AM PORTABLES

Admiral Corporation, 3800 W. Cortland St., Chicago, Ill.
Air King Products Co., Inc., 1523-63rd St., Bklyn, N. Y.
Andrea Radio Corp., 43-20 34th St., Long Island City, N. Y.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Automatic Radio Mfg. Co., Inc., 122 Brookline Ave., Boston, Mass.
Belmont Radio Corporation, 5921 West Dickens Ave., Chicago 39, Ill.
Bendix Radio Corp., Baltimore 4, Md.
Colonial Radio Corp., 254 Rano St., Buffalo, N. Y.
Crosley Corporation, Cincinnati, Ohio
Delco Radio Division, General Motors Corporation, Kokomo, Indiana
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Echophone Radio, Div. of Hallicrafters Co., 2611 S. Indiana Ave., Chicago, Ill.
Eckstein Radio & Television Co. Inc., 914 La Salle, Minneapolis, Minn.
Electrical Research & Mfg. Co., 3001 E. Pico Blvd., Los Angeles, Calif.
Electromatic Mfg. Corp., 88 University Place, New York, N. Y.
Electronic Corp. of America, 45 West 18th St., New York, N. Y.
Fada Radio & Electric Co. Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Garod Radio Corp., 70 Washington St., Bklyn, N. Y.
General Electric Company, Bridgeport, Conn.
General Television & Radio Corp., 2701 North Lehmann Court, Chicago 14, Ill.
Gilfillan Bros. Inc., 1815 Venice Blvd., Los Angeles, Calif.
Hamilton Radio Corp., 510 Sixth Ave., New York, N. Y.
Hoffman Radio Corp., 3430 S. Hill St., Los Angeles, Calif.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
International Detrola Corp., 1501 Beard Ave., Detroit, Michigan
Keith Radio Products, 16th & K St., Bedford, Ind.
Kingston Products Corp., Kokomo, Indiana
Majestic Radio & Television Corp., St. Charles, Ill.
Meck Industries, John, Liberty at Pennsylvania, Plymouth, Ind.
Medco Mfg. Co., 5 West 45th St., New York, N. Y.
Minerva Corp. of America, 238 William St., New York, N. Y.
Noblitt Sparks Industries, Columbus, Indiana
Packard-Bell Co., 3443 Welshire Blvd., Los Angeles 5, Calif.
Philco Corporation, Tioga & C Sts., Philadelphia 34, Pa.
Philharmonic Radio Corporation, 528 East 72nd St., New York 21, N. Y.
Pilot Radio Corp., 37-06 36th St., Long Island City, N. Y.
Radio Corp. of America, RCA Victor Division, Camden, N. J.
Record-O-Vox, Inc., 721 N. Martel Ave., Hollywood 46, Calif.
Remler Co., Ltd., 2101 Bryant St., San Francisco, Calif.
Rex Products Co., 1313 W. Randolph St., Chicago 7, Ill.
Searle Aero Industries, Inc., Orange, Calif.
Sentinel Radio Corp., 2020 Ridge Ave., Evanston, Ill.
Setchell Carlson, 2233 University Ave., St. Paul, Minn.
Sheridan Electro Corp., 2850 S. Michigan Ave., Chicago, Ill.
Signal Electronics, Inc., 114 East 16th St., New York 3, N. Y.
Sonora Radio & Television Corp., 325 N. Hoyne Ave., Chicago, Ill.
Sparks Withington Company, Jackson, Michigan
Stewart Warner Corporation, 1836 Diversey Parkway, Chicago, Ill.
Stromberg-Carlson Co., 100 Carlson Road, Rochester, N. Y.
Symphonic Radio & Electronic Corp., 292-98 Main St., Cambridge 42, Mass.
Tech-Master Prods. Co., 123 Prince St., New York, N. Y.
Telicon Corp., 851 Madison Ave., New York, N. Y.
Templetone Radio Mfg. Corp., Templetone Building, New London, Conn.
Trav-Ler Karenola, 571 W. Jackson Blvd., Chicago, Ill.
United States Television Mfg. Corp., 106 Seventh Avenue, New York, N. Y.
Viewtone Co., 203 East 18th St., New York, N. Y.
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago, Ill.
Whiting & Davis Company, Inc., 23 West Bacon St., Plainville, Mass.
Wells Gardner & Co., 2701 North Kildare, Chicago 39, Ill.
Westinghouse Electric Corp., 2519 Wilkens Ave., Baltimore 3, Md.
Wilcox Gay Corp., Charlotte, Michigan
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

AM TABLE MODELS

A R F Products Co., 7627 Lake St., River Forest, Ill.
Admiral Corporation, 3800 W. Cortland St., Chicago, Ill.
Air King Products Co. Inc., 1523-63rd St., Bklyn, N. Y.
Andrea Radio Corp., 43-20 34th St., Long Island City, N. Y.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Automatic Radio Mfg. Co. Inc., 122 Brookline Ave., Boston, Mass.
Belmont Radio Corporation, 5921 West Dickens Ave., Chicago 39, Ill.
Bendix Radio Corp., Baltimore 4, Md.
Colonial Radio Corp., 254 Rano St., Buffalo, N. Y.
The Crosley Corporation, Cincinnati 25, Ohio
Crystal Products Co., 1519 McGee Trafficway, Kansas City, Mo.
Delco Radio Division, General Motors Corporation, Kokomo, Indiana
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Echophone Radio, Division of Hallicrafters Co., 2611 S. Indiana Avenue, Chicago, Ill.
Eckstein Radio & Television Co. Inc., 914 LaSalle, Minneapolis, Minn.
Electrical Research & Mfg. Co., 3001 E. Pico Blvd., Los Angeles, Calif.
Electromatic Mfg. Corp., 88 University Place, New York, N. Y.
Electronic Corp. of America, 45 West 18th St., New York, N. Y.
Espey Mfg. Co. Inc., 33 West 46th St., New York, N. Y.
Fada Radio & Electric Co. Inc., 30-20 Thomson Avenue, Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Garod Radio Corp., 70 Washington St., Brooklyn, N. Y.
General Electric Company, Bridgeport, Conn.
General Television & Radio Corp., 2701 North Lehmann Court, Chicago 14, Ill.
Gilfillan Bros. Inc., 1815 Venice Blvd., Los Angeles, Calif.
Hamilton Radio Corp., 510 Sixth Avenue, New York, N. Y.
Hoffman Radio Corp., 3430 S. Hill St., Los Angeles, Calif.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Industrial Tool & Die Works, Inc., 2824 University Avenue, S. E., Minneapolis, Minn.
International Detrola Corp., 1501 Beard Ave., Detroit, Michigan
Keith Radio Products, 16th & K St., Bedford, Ind.
Kingston Products Corp., Kokomo, Indiana
Lear, Inc., Piqua, Ohio
Majestic Radio & Television Corp., St. Charles, Ill.
Meck Industries, John, Liberty at Pennsylvania, Plymouth, Ind.
Medco Mfg. Co., 5 West 45th St., New York, N. Y.
Megard Corporation, 1601 S. Burlington Avenue, Los Angeles 6, Calif.
Meissner Manufacturing Division, Maguire Industries, Inc., Mt. Carmel, Ill.
Midwest Radio Corp., 909 Broadway, Cincinnati, Ohio
Minerva Corp. of America, 238 William St., New York, N. Y.
Noblitt Sparks Industries, Columbus, Indiana
Packard-Bell Co., 3443 Welshire Blvd., Los Angeles 5, Calif.
Philco Corporation, Tioga & C Streets, Philadelphia 34, Pa.
Philharmonic Radio Corporation, 528 East 72nd Street, New York 21, N. Y.
Pilot Radio Corp., 37-06 36th St., Long Island City, N. Y.
Precision Specialties, 210-26 N. Western Ave., Los Angeles, Calif.
Radio Corp. of America, RCA Victor Division, Camden, N. J.
Record-O-Vox, Inc., 721 N. Martel Ave., Hollywood 46, Calif.
Regal Electronics Corp., 20 West 30th St., New York, N. Y.
Remler Company, Ltd., 2101 Bryant Street, San Francisco 10, Calif.
Rex Products Co., 1313 W. Randolph St., Chicago 7, Ill.
Searle Aero Industries, Inc., Orange, Calif.
Sentinel Radio Corp., 2020 Ridge Avenue, Evanston, Ill.
Setchell Carlson, 2233 University Ave., St. Paul, Minn.
Sheridan Electro Corp., 2850 S. Michigan Ave., Chicago, Ill.
Signal Electronics, Inc., 114 East 16th St., New York 3, N. Y.
Sonora Radio & Television Corp., 325 N. Hoyne Avenue, Chicago, Ill.
Sparks Withington Company, Jackson, Michigan
Stewart Warner Corporation, 1836 Diversey Parkway, Chicago, Ill.
Stromberg-Carlson Co., 100 Carlson Rd., Rochester, N. Y.
Symphonic Radio & Electronic Corp., 292-98 Main St., Cambridge 42, Mass.
Tech-Master Prods. Co., 123 Prince St., New York, N. Y.
Telicon Corp., 851 Madison Ave., New York, N. Y.
Templetone Radio Mfg. Corp., Templetone Building, New London, Conn.
Trav-Ler Karenola, 571 W. Jackson Blvd., Chicago, Ill.
United States Television Mfg. Corp., 106 Seventh Avenue, New York, N. Y.
Viewtone Co., 203 East 18th St., New York, N. Y.
Vlectrical Engineering Co., 828 North Highland Avenue, Los Angeles 38, Calif.
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago, Ill.
Watterson Radio Mfg. Co., P O Box 54, Dallas, Texas
Wells Gardner & Co., 2701 North Kildare, Chicago 39, Ill.

ELECTRONIC and ALLIED PRODUCTS

Westinghouse Electric Corp., 2519 Wilkens Ave., Baltimore 3, Md.
Whiting & Davis Company, Inc., 23 West Bacon Street, Plainville, Mass.
Wilcox Gay Corp., Charlotte, Michigan
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

AM VEST POCKETS

Automatic Radio Mfg. Co. Inc., 122 Brookline Ave., Boston, Mass.
Bendix Radio Corp., Baltimore 4, Md.
Colonial Radio Corp., 254 Rano St., Buffalo, N. Y.
Delco Radio Division, General Motors Corporation, Kokomo, Indiana
Electronic Corp. of America, 45 West 18th St., New York, N. Y.
Fada Radio & Electric Co., Inc., 30-20 Thomson Avenue, Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Gilfillan Bros. Inc., 1815 Venice Blvd., Los Angeles, Calif.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
International Detrola Corp., 1501 Beard Avenue, Detroit, Mich.
Keith Radio Products, 16th & K St., Bedford, Ind.
Meck Industries, John, Liberty at Pennsylvania, Plymouth, Ind.
Noblitt Sparks Industries, Columbus, Indiana
Philco Corporation, Tioga & C Streets, Philadelphia 34, Pa.
Philharmonic Radio Corporation, 528 East 72nd Street, New York 21, N. Y.
Sentinel Radio Corp., 2020 Ridge Avenue, Evanston, Ill.
Sheridan Electro Corp., 2850 S. Michigan Ave., Chicago, Ill.
Telicon Corp., 851 Madison Ave., New York, N. Y.
Templetone Radio Mfg. Corp., Templetone Building, New London, Conn.
Wells Gardner & Co., 2701 North Kildare, Chicago 39, Ill.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

Receivers, Home—AM-FM

AM-FM COMBINATIONS

Admiral Corporation, 3800 W. Cortland St., Chicago, Ill.
Air-King Products Co. Inc., 1523-63rd St., Brooklyn, N. Y.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Belmont Radio Corporation, 5921 West Dickens Avenue, Chicago 39, Ill.
Bendix Radio Corp., Baltimore 4, Md.
Colonial Radio Corp., 254 Rano Street, Buffalo, N. Y.
The Crosley Corporation, Cincinnati 25, Ohio
Delco Radio Division, General Motors Corporation, Kokomo, Indiana
Echophone Radio, Division of Hallicrafters Co., 2611 S. Indiana Avenue, Chicago, Ill.
Electrical Research & Mfg. Co., 3001 E. Pico Blvd., Los Angeles, Calif.
Electronic Corp. of America, 45 West 18th Street, New York, N. Y.
Espey Mfg. Co. Inc., 33 West 46th St., New York, N. Y.
Fada Radio & Electric Co. Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Freed Radio Corp., 200 Hudson St., New York, N. Y.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Garod Radio Corp., 70 Washington St., Brooklyn, N. Y.
General Electric Co., Bridgeport, Conn.
Gilfillan Bros. Inc., 1815 Venice Blvd., Los Angeles, Calif.
Herbach & Rademan Co., 517 Ludlow Street, Philadelphia 6, Pa.
Hoffman Radio Corp., 3430 S. Hill St., Los Angeles, Calif.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
International Detrola Corp., 1501 Beard Avenue, Detroit, Mich.
Keith Radio Products, 16th & K St., Bedford, Ind.
Kingston Products Corp., Kokomo, Ind.
Lear, Inc., Piqua, Ohio
Magnavox Company, Fort Wayne, Indiana.
Majestic Radio & Television Corp., St. Charles, Ill.
Meck Industries, Plymouth, Ind.
Medco Mfg. Co., 5 West 45th St., New York, N. Y.
Megard Corporation, 1601 S. Burlington Avenue, Los Angeles 6, Calif.
Meissner Manufacturing Division, Maguire Industries, Inc., Mt. Carmel, Ill.
Midwest Radio Corp., Cincinnati, Ohio.
Noblitt Sparks Industries, Columbus, Ind.
Packard-Bell Co., 3443 Welshire Blvd., Los Angeles 5, Calif.
Philco Corporation, Philadelphia 34, Pa.
Philharmonic Radio Corporation, 528 East 72nd Street, New York 21, N. Y.
Pilot Radio Corp., 37-06 36th Street, Long Island City, N. Y.
Precision Specialties, 210-26 N. Western Ave., Los Angeles, Calif.
Radio Corp. of America, RCA Victor Division, Camden, N. J.
Ray Energy and Television Corp. of America, 521 5th Avenue, New York, N. Y.
Record-O-Vox, Inc., 721 N. Martel Ave., Hollywood 46, Calif.
Remler Co. Ltd., 2101 Bryant St., San Francisco, Calif.
Scott Radio Labs. Inc., 4541 Ravenswood Avenue, Chicago, Ill.
Sentinel Radio Corp., 2020 Ridge Avenue, Evanston, Ill.
Sheridan Electro Corp., 2850 S. Michigan Ave., Chicago, Ill.
Signal Electronics, Inc., 114 East 16th St., New York 3, N. Y.
Sonora Radio & Television Corp., 325 N. Hoyne Avenue, Chicago, Ill.
Sparks Withington Co., Jackson, Michigan
Stewart Warner Corporation, 1836 Diversey Parkway, Chicago, Ill.
Stromberg-Carlson Co., Rochester, N. Y.
Tech-Master Prods. Co., 12 Prince St., New York, N. Y.
Telicon Corp., 851 Madison Ave., New York, N. Y.
Templetone Radio Mfg. Corp., Templetone Building, New London, Conn.
Viewtone Co., 203 East 18th St., New York, N. Y.
Vlectrical Engineering Co., 828 North Highland Avenue, Los Angeles 38, Calif.
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago, Ill.
Wells Gardner & Co., 2701 North Kildare, Chicago 39, Ill.
Westinghouse Electric Corp., 2519 Wilkens Ave., Baltimore 3, Md.
Wilcox Gay Corporation, Charlotte, Mich.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

AM-FM CONSOLES

Admiral Corporation, 3800 W. Cortland St., Chicago, Ill.
Andrea Radio Corp., 43-20 34th St., Long Island City, N. Y.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Belmont Radio Corporation, 5921 West Dickens Avenue, Chicago 39, Ill.
Bendix Radio Corp., Baltimore 4, Md.
Colonial Radio Corp., 254 Rano St., Buffalo, N. Y.
Crosley Corporation, Cincinnati 25, Ohio
Delco Radio Division, General Motors Corporation, Kokomo, Indiana
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Echophone Radio Division of Hallicrafters Co., 2611 S. Indiana Ave., Chicago, Ill.
Electrical Research & Mfg. Co., 3001 E. Pico Blvd., Los Angeles, Calif.
Electronic Corp. of America, 45 West 18th St., New York, N. Y.
Fada Radio & Electric Co. Inc., 30-20 Thomas Ave., Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Garod Radio Corp., 70 Washington St., Bklyn, N. Y.
General Electric Co., Bridgeport, Conn.
Gilfillan Bros. Inc., 1815 Venice Blvd., Los Angeles, Calif.
Hamilton Radio Corp., 510 Sixth Ave., New York, N. Y.
Herbach & Rademan, 517 Ludlow St., Philadelphia 6, Pa.
Hoffman Radio Corp., 3430 S. Hill St., Los Angeles, Calif.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
International Detrola Corp., 1501 Beard Ave., Detroit, Mich.
Kingston Radio Products Corp., Kokomo, Indiana
Lear, Inc., Piqua, Ohio
Magnavox Company, 2131 Bueter Road, Fort Wayne, Indiana
Majestic Radio & Television Corp., St. Charles, Illinois
Meck Industries, John, Liberty at Pennsylvania, Plymouth, Ind.
Medco Mfg. Co., 5 West 45th St., New York, N. Y.
Megard Corporation, 1601 S. Burlington Ave., Los Angeles 6, Calif.
Meissner Manufacturing Division, Maguire Industries, Inc., Mt. Carmel, Ill.
Midwest Radio Corp., 909 Broadway, Cincinnati, Ohio
Minerva Corp. of America, 238 William St., New York, N. Y.
Noblitt Sparks Industries, Columbus, Ind.
Packard-Bell Co., 3443 Welshire Blvd., Los Angeles 5, Calif.
Philco Corporation, Tioga & C Sts., Philadelphia 34, Pa.
Philharmonic Radio Corporation, 528 East 72nd St., New York 21, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Record-O-Vox, Inc., 721 N. Martel Ave., Hollywood 46, Calif.
Remler Co. Ltd., 2101 Bryant St., San Francisco, Calif.
Scott Radio Labs. Inc., 4541 Ravenswood Ave., Chicago, Ill.
Sentinel Radio Corp., 2020 Ridge Ave., Evanston, Ill.
Sheridan Electro Corp., 2850 S. Michigan Ave., Chicago, Ill.
Signal Electronics, Inc., 114 East 16th St., New York 3, N. Y.
Sonora Radio & Television Corp., 325 N. Hoyne Ave., Chicago, Ill.
Stewart Warner Corporation, 1836 Diversey Parkway, Chicago, Ill.
Stromberg-Carlson Co., 100 Carlson Road, Rochester, N. Y.
Telicon Corp., 851 Madison Ave., New York, N. Y.
Templetone Radio Mfg. Corp., Templetone Building, New London, Conn.
United States Television Mfg. Corp., 106 Seventh Avenue, New York, N. Y.
Viewtone Co., 203 East 18th St., New York, N. Y.
Vlectrical Engineering Co., 828 North Highland Ave., Los Angeles 38, Calif.
Wells Gardner & Co., 2701 North Kildare, Chicago 39, Ill.
Westinghouse Electric Corp., 2519 Wilkens Ave., Baltimore 3, Md.
Wilcox Gay Corporation, Charlotte, Michigan
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

AM-FM PORTABLES

Admiral Corporation, 3800 W. Cortland St., Chicago, Ill.
Echophone Radio Division of Hallicrafters Co., 2611 S. Indiana Ave., Chicago, Ill.
Electrical Research & Mfg. Co., 3001 E. Pico Blvd., Los Angeles, Calif.
Fada Radio & Electric Co. Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Hallicrafters Co., 2611 Indiana Ave., Chicago 16, Ill.
Hoffman Radio Corp., 3430 S. Hill St., Los Angeles, Calif.
Keith Radio Products, 16th & K Sts., Bedford, Ind.
Minerva Corp. of America, 238 William St., New York, N. Y.
Packard-Bell Co., 3443 Welshire Blvd., Los Angeles 5, Calif.
Philco Corporation, Tioga & C Sts., Philadelphia 34, Pa.
Philharmonic Radio Corporation, 528 East 72nd St., New York 21, N. Y.
Ray Energy and Television Corp. of America, 521 Fifth Ave., New York, N. Y.
Sentinel Radio Corp., 2020 Ridge Ave., Evanston, Ill.
Signal Electronics, Inc., 114 East 16th St., New York 3, N. Y.
Sonora Radio & Television Corp., 325 N. Hoyne Ave., Chicago, Ill.
Telicon Corp., 851 Madison Ave., New York, N. Y.
Vlectrical Engineering Co., 828 North Highland Ave., Los Angeles 38, Calif.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

AM-FM TABLE MODELS

A R F Products Co., 7627 W. Lake St., River Forest, Ill.
Admiral Corporation, 3800 W. Cortland St., Chicago, Ill.
Air-King Products Co. Inc., 1523-63rd St., Bklyn, N. Y.
Andrea Radio Corp., 43-20 34th St., Long Island City, N. Y.
Belmont Radio Corporation, 5921 West Dickens Avenue, Chicago 39, Ill.
Bendix Radio Corp., Baltimore 4, Md.
Colonial Radio Corp., 254 Rano St., Buffalo, N. Y.
Crosley Corporation, Cincinnati 25, Ohio
Delco Radio Division, General Motors Corporation, Kokomo, Indiana
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Echophone Radio Division of Hallicrafters Co., 2611 S. Indiana Ave., Chicago, Ill.
Electrical Research & Mfg. Co., 3001 E. Pico Blvd., Los Angeles, Calif.
Electronic Corp. of America, 45 West 18th Street, New York, N. Y.
Fada Radio & Electric Co. Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Garod Radio Corp., 70 Washington St., Bklyn, N. Y.
General Electric Co., Bridgeport, Conn.
Gilfillan Bros. Inc., 1815 Venice Blvd., Los Angeles, Calif.
Hamilton Radio Corp., 510 Sixth Ave., New York, N. Y.
Hoffman Radio Corp., 3430 S. Hill St., Los Angeles, Calif.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Industrial Tool & Die Works, Inc., 2824 University Ave., S. E., Minneapolis, Minn.
International Detrola Corp., 1501 Beard Ave., Detroit, Mich.
Keith Radio Products, 16th & K St., Bedford, Ind.
Kingston Radio Products Corp., Kokomo, Indiana
Majestic Radio & Television Corp., St. Charles, Illinois
Meck Industries, John, Liberty at Pennsylvania, Plymouth, Ind.
Medco Mfg. Co., 5 West 45th St., New York, N. Y.
Megard Corporation, 1601 S. Burlington Ave., Los Angeles 6, Calif.
Midwest Radio Corp., 909 Broadway, Cincinnati, Ohio
Minerva Corp. of America, 238 William St., New York, N. Y.
Noblitt Sparks Industries, Columbus, Indiana
Packard-Bell Co., 3443 Welshire Blvd., Los Angeles 5, Calif.
Philco Corporation, Tioga & C Sts., Philadelphia 34, Pa.
Philharmonic Radio Corporation, 528 East 72nd St., New York 21, N. Y.
Pilot Radio Corp., 37-06 36th St., Long Island City, N. Y.
Precision Specialties, 210-26 N. Western Ave., Los Angeles, Calif.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Ray Energy and Television Corp. of America, 521 Fifth Avenue, New York, N. Y.
Record-O-Vox, Inc., 721 N. Martel Ave., Hollywood 46, Calif.
Remler Co. Ltd., 2101 Bryant St., San Francisco, Calif.
Searle Aero Industries, Inc., Orange, Calif.
Sentinel Radio Corp., 2020 Ridge Ave., Evanston, Ill.
Sheridan Electro Corp., 2850 S. Michigan Ave., Chicago, Ill.
Signal Electronics, Inc., 114 East 16th St., New York 3, N. Y.
Sonora Radio & Television Corp., 325 N. Hoyne Ave., Chicago, Ill.
Sparks Withington Co., Jackson, Michigan
Stewart Warner Corporation, 1836 Diversey Parkway, Chicago, Ill.
Stromberg-Carlson Co., 100 Carlson Rd., Rochester, N. Y.
Tech-Master Prods. Co., 123 Prince St., New York, N. Y.
Telicon Corp., 851 Madison Ave., New York, N. Y.
Templetone Radio Mfg. Corp., Templetone Building, New London, Conn.
Trav-Ler Karenola, 571 W. Jackson Blvd., Chicago, Ill.
Viewtone Co., 203 East 18th St., New York, N. Y.
Vlectrical Engineering Co., 828 North Highland Ave., Los Angeles 38, Calif.
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago, Ill.
Wells Gardner & Co., 2701 North Kildare, Chicago 39, Ill.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

Receivers, Home—FM

FM COMBINATIONS

Belmont Radio Corporation, 5921 West Dickens Ave., Chicago 39, Ill.
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Fada Radio & Electric Co. Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Gilfillan Bros. Inc., 1815 Venice Blvd., Los Angeles, Calif.
Medco Mfg. Co., 5 West 45th St., New York, N. Y.
Megard Corp., 1601 S. Burlington Ave., Los Angeles 6, Calif.
Ray Energy and Television Corp. of America, 521 Fifth Ave., New York, N. Y.
Telicon Corp., 851 Madison Ave., New York, N. Y.

FM CONSOLES

Belmont Radio Corporation, 5921 West Dickens Ave., Chicago 39, Ill.
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Fada Radio & Electric Co. Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Gilfillan Bros. Inc., 1815 Venice Blvd., Los Angeles, Calif.
Megard Corporation, 1601 S. Burlington Ave., Los Angeles 6, Calif.
Telicon Corp., 851 Madison Ave., New York, N. Y.

FM PORTABLES

Fada Radio & Electric Co. Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Gilfillan Bros. Inc., 1815 Venice Blvd., Los Angeles, Calif.
Medco Mfg. Co., 5 West 45th St., New York, N. Y.
Ray Energy and Television Corp. of America, 521 Fifth Avenue, New York, N. Y.
Telicon Corp., 851 Madison Ave., New York, N. Y.
Trav-Ler Karenola, 571 W. Jackson Blvd., Chicago, Ill.

FM TABLE MODELS

Belmont Radio Corporation, 5921 West Dickens Ave., Chicago 39, Ill.
Colonial Radio Corp., 254 Rano St., Buffalo 7, N. Y.
DeWald Radio Mfg. Corp., 440 Lafayette St., New York, N. Y.
Fada Radio & Electric Co. Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Gilfillan Bros. Inc., 1815 Venice Blvd., Los Angeles, Calif.
Industrial Tool & Die Works, Inc., 2824 University Ave., S. E., Minneapolis, Minn.
Medco Mfg. Co., 5 West 45th St., New York, N. Y.
Megard Corporation, 1601 S. Burlington Ave., Los Angeles 6, Calif.
Meissner Manufacturing Division, Maguire Industries, Inc., Mt. Carmel, Ill.
Ray Energy and Television Corp. of America, 521 Fifth Ave., New York, N. Y.
Sonora Radio & Television Corp., 325 N. Hoyne Ave., Chicago, Ill.
Stromberg-Carlson Co., 100 Carlson Rd., Rochester, N. Y.
Telicon Corp., 851 Madison Ave., New York, N. Y.
Trav-Ler Karenola, 571 W. Jackson Blvd., Chicago, Ill.

FM VEST POCKETS

Fada Radio & Electric Co. Inc., 30-20 Thomson Avenue, Long Island City, N. Y.
Ray Energy and Television Corp. of America, 521 Fifth Ave., New York, N. Y.
Telicon Corp., 851 Madison Ave., New York, N. Y.

RADIO, AIRCRAFT

Bendix Radio Corp., Baltimore 4, Md.
Collins Radio Co., Cedar Rapids, Iowa
Colonial Radio Corp., 254 Rano St., Buffalo 7, N. Y.
Gates Radio & Supply Co., Quincy, Ill.
General Electric Co., Bridgeport, Conn.
Gilfillan Bros., Inc., 1815 Venice Blvd., Los Angeles, Calif.
Hallicrafters Co., 2611 S. Indiana Ave., Chicago, Ill.
Herbach & Rademan Co., 517 Ludlow St., Philadelphia 6, Pa.
Lear, Inc., Piqua, Ohio
Midwest Radio Corp., 909 Broadway, Cincinnati, Ohio
Radio Receptor Co., Inc., 251 West 19th St., New York, N. Y.
Raytheon Mfg. Co., 60 East 42nd St., New York 17, N. Y.
Searle Aero Industries, Inc., Orange, Calif.

PANORAMIC RECEIVERS

Hallicrafters Co., 2611 Indiana Avenue, Chicago 16, Ill.
Panoramic Radio Corporation, 242 West 55th St., New York 19, N. Y.

RADIO COMPASS RECEIVERS

Air Communications, Inc., 2233 Grand Ave., Kansas City 8, Mo.
Aireon Manufacturing Corp., Fairfax & Funston Rds., Kansas City 15, Kansas
Airplane & Marine Instruments, Inc., Clearfield, Pa.
Andrea Radio Corp., 43-20 34th St., Long Island City, N. Y.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bassett, Inc., Rex, 500 S. E. Second St., Ft. Lauderdale, Fla.
Belmont Radio Corp., 5921 W. Dickens Ave., Chicago 39, Ill.
Bendix Radio Div., Bendix Aviation Corp., Baltimore 4, Md.
Collins Radio Co., 855-35th St. N. E., Cedar Rapids, Iowa
Communications Co., Inc., 300 Greco Ave., Coral Gables 34, Fla.
Communications Equipment Corp., 134 West Colorado St., Pasadena 1, Calif.
Crosley Corp., 1329 Arlington St., Cincinnati 3, Ohio
Fairchild Camera & Instrument Corp., 475 Tenth Ave., New York 18, N. Y.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Finch Telecommunications, Inc., Passaic, N. J.
Fisher Research Laboratory, 1961 University Ave., Palo Alto, Cal.
Garod Radio Corp., 70 Washington St., Brooklyn, N. Y.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
General Electric Co., Schenectady 5, N. Y.
Giannini & Co., Inc., G. M., 161 E. California St., Pasadena, Calif.
Grady Instrument Co., 11 Bailey Ave., Watertown 72, Mass.
Gray Radio Co., 730 Okeeshobee Rd., West Palm Beach, Fla.
Hallicrafters Co., 2611 Indiana Ave., Chicago 16, Ill.
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Harvey-Wells Electronics, Inc., North St., Southbridge, Mass.
Heath Co., Benton Harbor, Mich.
Hudson American Corp., 25 W. 43rd St., New York, N. Y.
Islip Radio Manufacturing Corp., Foot of Beech St., Islip, New York
Jefferson, Inc., Ray, 40 E. Merrick Rd., Freeport, L. I., N. Y.
Jefferson-Travis Radio Mfg. Corp., 245 East 23rd St., New York 10, N. Y.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Lear, Inc., Piqua, Ohio
Magnavox Co., The, 2131 Bueter Rd., Fort Wayne 4, Ind.
McGrade Mfg. Co., E. W., 406 West 34th St., Kansas City, Mo.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
National Co., 61 Sherman St., Malden 48, Mass.

ELECTRONIC and ALLIED PRODUCTS

Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.
Panoramic Radio Corp., 242 W. 55th St., New York 19, N. Y.
Philharmonic Radio Corp., 528 E. 72nd St., New York 21, N. Y.
Press Wireless, Inc., 1475 Broadway, New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Laboratories, Inc., 2701 California Ave., Seattle 6, Washington
Radio Mfg. Engineers, Inc., 304 First Ave., Peoria, Ill.
Radio Navigational Instrument Corp., 500 Fifth Ave., New York, N. Y.
Radiomarine Corp. of America, 75 Varick St., New York, N. Y.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Rehtron Corp., 4313 Lincoln Ave., Chicago 18, Ill.
Sargent Co., E. M., 212 Ninth St., Oakland, Calif.
Sonora Radio & Television Corp., 325 N. Hoyne Ave., Chicago 12, Ill.
Sorensen & Co., 375 Fairfield Ave., Stamford, Conn.
Sperry Gyroscope Co., Inc., Manhattan Bridge Plaza, Brooklyn 1, N. Y.
Technical Radio Co., 275 Ninth St., San Francisco, Calif.
U. S. Television Manufacturing Corp., 106 Seventh Ave., New York 11, N. Y.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Wilcox Electric Co., 1400 Chestnut St., Kansas City, Mo.

RAILROAD RECEIVERS

Aireon Mfg. Corp., Kansas City, Kans.
Bendix Radio Corp., Baltimore 4, Md.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
General Electric Co., Bridgeport, Conn.
Hallicrafters Co., 2611 S. Indiana Ave., Chicago, Ill.
Herbach & Rademan Co., 517 Ludlow St., Philadelphia 6, Pa.
Medco Mfg. Co., 5 West 45th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Raytheon Mfg. Co., 60 East 42nd St., New York 17, N. Y.
Westinghouse Electric Corp., 2519 Wilkens Ave., Baltimore 3, Md.

TELEVISION RECEIVERS

Andrea Radio Corp., 43-20 34th St., Long Island City, N. Y.
Allen B. DuMont Laboratories, Inc., 2 Main Ave., Passaic, N. J.
Echophone Radio Div. of Hallicrafters Co., 2611 S. Indiana Ave., Chicago, Ill.
General Electric Co., Bridgeport, Conn.
Hallicrafters Co., 2611 Indiana Ave., Chicago 16, Ill.
Philco Corporation, Tioga & C Sts., Philadelphia 34, Pa.
Pilot Radio Corp., 37-06 36th St., Long Island City, N. Y.
Sonora Radio & Television Corp., 325 N. Hoyne Ave., Chicago, Ill.
Telicon Corporation, 851 Madison Ave., New York, N. Y.
United States Television Mfg. Corp., 106 Seventh Avenue, New York. New York
Viewtone Co., 203 East 18th St., New York, N. Y.

RECEIVERS, OTHER

Abbott Instrument, Inc., 8 West 18th St., New York, N. Y.
Aero Communications, Inc., 231 Main St., Hempstead, Long Island, N. Y.
Air Associates, Inc., 5827 W. Century Blvd., Los Angeles 45, Calif.
Air Communications, Inc., 2233 Grand Ave., Kansas City, Mo.
Aireon Manufacturing Corp., Fairfax & Funston Rds., Kansas City 15, Kans.
Aircraft Radio Corp., Boonton, N. J.
Airplane & Marine Instruments, Inc., Clearfield, Pa.
American Communications Corp., 306 Broadway, New York, N. Y.
American Radio Co., 611 E. Garfield Ave., Glendale, Calif.
Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bassett, Inc., Rex, 500 S. E. Second St., Ft. Lauderdale, Fla.
Collins Radio Co., 855 35th St., N. E., Cedar Rapids, Iowa
Communications Co., 300 Greco Ave., Coral Gables 34, Fla.
Communications Equipment Corp., 134 W. Colorado St., Pasadena 1, Calif.
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
Electrical Engineering Co., Los Angeles, Calif.
Electronic Specialty Co., 3456 Glendale Blvd., Los Angeles, Calif.
Electronic Measurements Co., Red Bank, N. J.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Fisher Research Laboratory, 1961 University Ave., Palo Alto, Calif.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
Harvey Machine Co., 6200 Avalon Blvd., Los Angeles, Calif.
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Harvey-Wells Electronics, Inc., North St., Southbridge, Mass.
Hatcher & Fisk, 125 Kansas Ave., Topeka, Kans.
Hazeltine Electronics Corp., 1775 Broadway, New York, N. Y.
Heath Co., Benton Harbor, Mich.
Higgins Industries, 2221 Warwick Ave., Santa Monica, Calif.
Hudson American Corp., 25 West 43rd St., New York, N. Y.
Islip Radio Mfg. Corp., foot of Beech St., Islip, N. Y.
Jefferson, Inc., Ray, 40 E. Merrick Rd., Freeport, Long Island, N. Y.
Jefferson-Travis Radio Mfg. Corp., 245 East 23rd St., New York 10, N. Y.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Link, Fred M., 125 West 17th St., New York, N. Y.
Maritime Radio Corp., 24 Whitehall St., New York, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden 48, Mass.
Oregon Electric Mfg. Co., 206 S. W. Washington St., Portland, Ore.
Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.
Press Wireless Inc., 1475 Broadway, New York, N. Y.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Radio Craftsmen, 1341 S. Michigan Ave., Chicago 5, Ill.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
Radio Laboratories Inc., 2701 California Ave., Seattle 6, Wash.
Radio Mfg. Engineers, Inc., 304 First Ave., Peoria, Ill.
Radio Navigational Instrument Corp., 500 Fifth Ave., New York, N. Y.
Radiomarine Corp. of America, 75 Varick St., New York, N. Y.
Richardson-Allen Corp., 15 W. 20th St., New York 11, N. Y.
Sargent Co., E. M., 212 Ninth St., Oakland, Calif.
Schuttig & Co., 9th & Kearney Sts., N. E., Washington 17, D. C.
Sherron Electronics, 1201 Flushing Ave., Brooklyn 6, N. Y.
Sperry Gyroscope Co., Manhattan Bridge Plaza, Brooklyn 1, N. Y.
Taybern Equipment Co., 120 Greenwich St., New York 6, N. Y.
Technical Devices Corp., Beaufort & Eagle Rock Ave., Roseland, N. J.
Technical Radio Co., 275 Ninth St., San Francisco, Calif.
Telex Products Co., Telex Park, Minneapolis, Minn.
Transmitter Equipment Mfg. Co., Inc., 345 Hudson St., New York, N. Y.
Trebor Radio Co., Pasadena, Calif.
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.
Walsh Engineering Co., 34 De Hart Place, Elizabeth, N. J.
Western Electric Co., Inc., 120 Broadway, New York, N. Y.
Wilcox Electric Co., 1400 Chestnut St., Kansas City, Mo.

Record Changers

see Changers, Record

Record Players

see Phonographs

Recorders

see Indicators

FREQUENCY RECORDERS

Audio Tone Oscillator Co., 237 John St., Bridgeport 3, Conn.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Conn Ltd., C. G., Elkhart, Ind.
General Electric Co., Schenectady 5, N. Y.
Hathaway Instrument Co., 1315 S. Clarkson St., Denver 10, Colo.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Sound Apparatus Co., 233 Broadway, New York 7, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
White Research, 899 Boylston St., Boston, Mass.

NOISE RECORDERS

Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Chicago Sound Systems Co., 2124 S. Michigan Ave., Chicago, Ill.
Electronic Supply Co., 207 Main St., Worcester, Mass.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Massa Laboratories, Inc., 3868 Carnegie Ave., Cleveland, Ohio
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Presto Recording Corp., 242 West 55th St., New York, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.

pH RECORDERS

see pH Meters

SOUND RECORDERS and CUTTING HEADS

Allied Recording Products Co., 21-09 43rd Ave., Long Island City 1, N. Y.
Andrea Radio Corp., 43-20 24th St., Long Island City 1, N. Y.
Annis Co., R. B., 1101 N. Delaware St., Indianapolis 2, Ind.
Astatic Corp., Conneaut, Ohio
Audak Co., 500 Fifth Ave., New York, N. Y.
Audio Tone Oscillator Co., 237 John St., Bridgeport 3, Conn.
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Belmont Radio Corp., 5921 W. Dickens Ave., Chicago, Ill.
Boetsch Brothers, 221 E. 144th St., New York 51, N. Y.
Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Carrilitone Mfg. Corp., 30 N. Penn St., York, Pa.
Chicago Sound Systems Co., 2124 S. Michigan Ave., Chicago, Ill.
Dictaphone Corp., 420 Lexington Ave., New York, N. Y.
Duotone Co., 799 Broadway, New York, N. Y.
Electronic Sound Engineering Co., 109 N. Dearborn St., Chicago 2, Ill.

Engineering Laboratories, Inc., 602 East Fourth St., Tulsa 3, Okla.
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
Fairchild Camera & Instrument Corp., 475 Tenth Ave., New York, N. Y.
Federal Instrument Co., 3931-47th Ave., Long Island City 4, N. Y.
Federal Recorder Co., Elkhart, Ind.
Galvin Mfg. Corp., 4545 W. Augusta Blvd., Chicago 51, Ill.
Garod Radio Corp., 70 Washington St., Brooklyn, N. Y.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., Schenectady 5, N. Y.
General Industries Co., Taylor & Olive Sts., Elyria, Ohio
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Gray Mfg. Co., 16-30 Arbor St., Hartford, Conn.
Hart & Co., Inc., Frederick, Recordgraph Div., 350 Madison Ave., New York 17, N. Y.
Howard Radio Co., 1735 Belmont Ave., Chicago 13, Ill.
Jefferson-Travis Radio Mfg. Corp., 245 East 23rd St., New York 10, N. Y.
Lear, Inc., Piqua, Ohio
Lewyt Corp., 60 Broadway, Bklyn, N. Y.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Meissner Mfg. Div. Maguire Industries, Inc., Mt. Carmel, Ill.
Memovox Incorporated, 9242 Beverly Blvd., Beverly Hills, Calif.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Mirror Record Corp., 58 West 25th St., New York, N. Y.
Montgomery Bros., 61 Fremont St., San Francisco 5, Calif.
Music Master Mfg. Co., 542 S. Dearborn St., Chicago 5, Ill.
Pacific Sound Equipment Co., 1534 Cahuenga Blvd., Hollywood, Calif.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Proctor Co., Inc., B. A., 2 W. 45th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radiotechnic Laboratory, 1328 Sherman Ave., Evanston, Ill.
Radiotone Div., Robinson Houchin Optical Co., Columbus, Ohio
Record-O-Vox, Inc., 721 N. Martel Ave., Hollywood 46, Calif.
Rehtron Corp., 4313 Lincoln Ave., Chicago 18, Ill.
Rek-O-Kut Co., 173 Lafayette St., New York 13, N. Y.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles 34, Calif.
Robinson Recording Laboratories, 35 S. Ninth St., Philadelphia, Pa.
Scully Machine Co., 62 Walter St., Bridgeport, Conn.
Seeburg Corp., J. P., 1510 N. Dayton St., Chicago, Ill.
Shure Brothers, 225 W. Huron St., Chicago, Ill.
Simpson Mfg. Co., Inc., Mark, 188 West Fourth St., New York, N. Y.
SOS Cinema Supply Co., 449 West 42nd St., New York 18, N. Y.
Sonora Radio & Television Corp., 325 N. Hoyne Ave., Chicago 12, Ill.
Sound Apparatus Co., 233 Broadway, New York 7, N. Y.
SoundScriber Corp., 82 Audubon St., New Haven 11, Conn.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.
Talk-A-Phone Mfg. Co., 1512 S. Pulaski Road, Chicago 23, Ill.
Talking Devices Co., 4447 W. Irving Park Rd., Chicago, Ill.
Universal Microphone Co., 424 Warren Lane, Inglewood, Calif.
Webster Electric Co., 1900 Clark St., Racine, Wisc.
Webster Chicago Corp., Electronics Div., 3825 Armitage Ave., Chicago 47, Ill.
Western Sound & Electric Laboratories, 3512 W. St. Paul Ave., Milwaukee, Wisc.
Wilcox Gay Corp., Charlotte, Mich.

STEEL TAPE AND WIRE RECORDERS

Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
California Telephone & Electric Co., 6075 W. Pico Blvd., Los Angeles, Calif.
Colonial Radio Corp., 254 Rano St., Buffalo, N. Y.
Conn, Ltd., C. G., Elkhart, Ind.
Echophone Radio, Div. of Hallicrafters Co., 2611 S. Indiana Ave., Chicago 16, Ill.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Ft. Wayne, Ind.
General Electric Co., Schenectady 5, N. Y.
Hallicrafters Co., 2611 Indiana Ave., Chicago 16, Ill.
Hoffman Radio Corp., 3430 S. Hill St., Los Angeles, Calif.
International Detrola Corp., Beard at Chatfield, Detroit, Mich.
Lear, Inc., Piqua, Ohio
Lewyt Corp., 60 Broadway, Brooklyn 11, N. Y.
Magnograph Corp., 5800 W. Third St., Los Angeles, Calif.
Magnavox Co., 2131 Bueter Rd., Ft. Wayne, Ind.
Mechanitron Corp., 711 Boylston St., Boston 16, Mass.
Meck Industries, John, Liberty at Pennsylvania, Plymouth, Ind.
Meissner Mfg. Div., Maguire Industries, Inc., Mt. Carmel, Ill.
Packard-Bell Co., 3443 Welshire Blvd., Los Angeles 5, Calif.
Precision Specialties, 210-26 North Western Ave., Los Angeles, Calif.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radiotechnic Laboratory, 1328 Sherman Ave., Evanston, Ill.
Raytheon Mfg. Co., Newton, Mass.
Scott Radio Laboratories, Inc., E. H., 4450 N. Ravenswood Ave., Chicago 40, Ill.
Seeburg Corp., J. P., 1500 N. Dayton Ave., Chicago 22, Ill.
Signal Electronics, Inc., 114 East 16th St., New York 3, N. Y.
Sonora Radio & Television Corp., 325 N. Hoyne Ave., Chicago 12, Ill.
Sparks Withington Co., Jackson, Mich.
Stromberg-Carlson Co., Rochester, N. Y.
Utah Radio Products Corp., 820 Orleans St., Chicago, Ill.
Vlectrical Engineering Co., 828 N. Highland Ave., Los Angeles 38, Calif.
Western Electric Co., 195 Broadway, New York, N. Y.
WiRecorder Corp., Detroit, Mich.
Wire Recorder Development Corp. (Armour Research Foundation), 8 S. Michigan Ave., Chicago 3, Ill.

TIME AND MOTION RECORDERS

Gorrell & Gorrell, 40 Littlefield Road, Newton Center, Mass.
Marsto Instrument Co., 1637A Beacon St., Waban, Mass.

Recording Blanks

see Discs

Records

PHONOGRAPH RECORDS

Audio Tone Oscillator Co., 237 John St., Bridgeport 3, Conn.
Carillitone Corp., 30 N. Penn St., York, Pa.
Chicago Sound Systems Co., 2124 S. Michigan Ave., Chicago, Ill.
Columbia Recording Corp., 1473 Barnum Ave., Bridgeport, Conn.
Decca Records, Inc., 50 West 57th St., New York 19, N. Y.
Majestic Records, Inc., St. Charles, Ill.
Poinsetta, Inc., 95 Cedar Ave., Pitman, N. J.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Riggs & Jeffreys, Inc., 73 Winthrop St., Newark 4, N. J.
Robinson Recording Laboratories, 35 S. Ninth St., Philadelphia, Pa.
Sonart Record Corp., 251 West 42nd St., New York 18, N. Y.
Sonora Radio & Television Corp., 325 N. Hoyne Ave., Chicago 12, Ill.
Stark Sound Engrg. Corp., P. O. 493, Fort Wayne 1, Ind.
Talking Devices Co., 4447 W. Irving Park Rd., Chicago, Ill.
WOR Feature Records, 1440 Broadway, New York, N. Y.
World Broadcasting System, 711 Fifth Ave., New York 22, N. Y.

Rectifiers

see also Tubes

DRY DISC RECTIFIERS

American Battery Co., 17 S. Jefferson St., Chicago, Ill.
American Television & Radio Co., 300 E. Fourth St., St. Paul 1, Minn.
American Transformer Co., 178 Emmet St., Newark, N. J.
Benwood Linze Co., 1815 Locust St., St. Louis 3, Mo.
Bradley Labs., Inc., 82 Meadow St., New Haven 10, Conn.
Conant Electrical Labs. 6500 O Street, Lincoln, Nebr.
DeJur-Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.
Electrical Facilities, Inc., 4224 Holden St., Oakland 8, Calif.
Electricoil Transformer Co., 421 Canal St., New York 13, N. Y.
Electro Engineering & Mfg. Co., 627 W. Alexandrine Ave., Detroit 1, Mich.
Electro Products Laboratories, 549 W. Randolph St., Chicago, Ill.
Electron Equipment Corp., 917 Meridian Ave., South Pasadena, Calif.
Fansteel Metallurgical Corp., 2200 Sheridan Rd., North Chicago, Ill.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
General Electric Co., Bridgeport, Conn.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Green Electric Co., Inc., W., 130 Cedar St., New York 6, N. Y.
Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
McColpin-Christie Corp., Ltd., 4922 S. Figueroa St., Los Angeles 37, Calif.
McInerney Plastics Co., 655 Godfrey Ave. S. W., Grand Rapids, Mich.
Radio Receptor Co., Inc., 251 West 19th St., New York, N. Y.
Schauer Machine Co., 2060 Reading Rd., Cincinnati 2, Ohio
Selenium Corp. of America, 1719 W. Pico Blvd., Los Angeles 15, Calif.
Union Switch & Signal Co., Swissvale, Pa.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Freylinghuysen Ave., Newark 5, N. J.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.

TUBE RECTIFIERS

Allis Chalmers Mfg. Co., Milwaukee 1, Wisc.
American Battery Co., 17 S. Jefferson St., Chicago, Ill.
American Transformer Co., 178 Emmet St., Newark, N. J.
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Baldor Electric Co., 4353 Duncan Ave., St. Louis, Mo.
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Communications Co., Inc., 300 Greco Ave., Coral Gables 34, Fla.
Continental Electric Co., 903 Merchandise Mart, Chicago 54, Ill.
Eitel-McCullough, Inc., San Bruno, Calif.
Electric Heat Control Co., 9123 Inman Ave., Cleveland 5, Ohio
Electricoil Transformer Co., 421 Canal St., New York 13, N. Y.
Electro Products Laboratories, 549 W. Randolph St., Chicago, Ill.
Electron Equipment Corp., 917 Meridian Ave., South Pasadena, Calif.
Electronic Products Co., 111 E. Third St., Mt. Vernon, N. Y.
Electrons, Inc., 127 Sussex Ave., Newark, N. J.
Eureka X-Ray Tube Corp., 3250 N. Kilpatrick Ave., Chicago, Ill.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
France Mfg. Co., 10325 Berea Rd., Cleveland, Ohio
General Electric Co., Bridgeport, Conn.
General Electronics, Inc., 101 Hazel St., Paterson, N. J.
Green Electric Co., Inc., W., 130 Cedar St., New York 6, N. Y.

Hytron Radio & Electronics Corp., 76 Lafayette St., Salem, Mass.
Kalb Electric Co., 2711 Big Bend Blvd., St. Louis, Mo.
Lewis Electronics, Inc., Los Gatos, Calif.
Litton Engineering Labs., P. O. Box 749, Redwood City, Calif.
McColpin-Christie Corp., Ltd., 4922 S. Figueroa St., Los Angeles 37, Calif.
Master Electric Co., 126 Davis Ave., Dayton, Ohio
Mellaphone Corp., Rochester 2, N. Y.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
Pier Equipment Mfg. Co., Benton Harbor, Mich.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Selenium Corp. of America, 1800 West Pico Blvd., Los Angeles 15, Calif.
SOS Cinema Supply Co., 449 West 42nd St., New York 18, N. Y.
Sperti, Inc., Norwood Station, Cincinnati 12, Ohio
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.
Taylor Tubes, Inc., 2312 Wabansia Ave., Chicago 47, Ill.
Transmitter Equipment Mfg. Co., Inc., 345 Hudson St., New York 14, N. Y.
Universal X-Ray Products, Inc., 1800 North Francisco Ave., Chicago 47, Ill.
Weltronic Co., 3080 E. Outer Drive, Detroit 17, Mich.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Worner Electronic Devices, 609 West Lake St., Chicago 6, Ill.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.

Regulators

see also Transformers
also Tubes

VOLTAGE REGULATORS and STABILIZERS

Acme Electric & Mfg. Co., 31 Water St., Cuba, N. Y.
Allis Chalmers Mfg. Co., Milwaukee 1, Wisc.
American Transformer Co., 178 Emmet St., Newark, N. J.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Avia Products Co., 7266 Beverly Blvd., Los Angeles 36, Cal. (Bases)
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bogue Electric Co., Paterson, N. J.
Burlington Instrument Corp., 214 North 4th St., Burlington, Iowa
Clarostat Mfg. Co., Inc., 130 Clinton St., Brooklyn 1, N. Y.
Commercial Research Labs. Inc., 20 Bartlett Ave., Detroit 3, Mich.
Control Corp., 600 Stinson Blvd., Minneapolis, Minn.
Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, New Jersey
Electric Auto-Lite Co., Toledo, Ohio
Electric Sorting Machine Co., 410 Dennis Road, S.W., Grand Rapids, Mich.
Electron Equipment Corp., 917 Meridian Ave., South Pasadena, Calif.
Electronic Engineering Co., 3223 West Armitage Ave., Chicago, Ill.
Electronic Measurements Co., Red Bank, N. J.
Electronic Products Co., 19 North First St., Geneva, Ill.
Ferranti Electric, 30 Rockefeller Plaza, New York 20, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Electronics, Inc., 101 Hazel St., Paterson, N. J.
Halldorson Company, The, 4500 Ravenswood Ave., Chicago 28, Ill.
Hytron Radio & Electronics Corp., 76 Lafayette St., Salem, Mass.
International Transformer Co., 396 Broadway, New York, N. Y.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Leece-Neville Co., 5363 Hamilton Ave. N.E., Cleveland 14, Ohio
Leland Electric Co., 1501 Webster St., Dayton, Ohio
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
Philadelphia Thermometer Co., 6th & Cayuga Sts., Philadelphia, Pa.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radionic Controls, 3758 Belmont Ave., Chicago 18, Ill.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Richardson-Allen Corp., 15 W. 20th St., New York 11, N. Y.
Sola Electric Co., 2525 Clybourn Ave., Chicago 14, Ill.
Sorensen & Co., 375 Fairfield Ave., Stamford, Conn.
SOS Cinema Supply Co., 449 West 42nd St., New York 18, N. Y.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Stockwell Transformer Corp., 569 S. Main St., Akron, Ohio
Sundt Engrg. Co., 4757 Ravenswood Ave., Chicago, Ill.
Superior Electric Co., 83 Laurel St., Bristol, Conn.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.
Technical Products Co., 158 Madison Ave. at Third St., Memphis, Tenn.
Techno-Scientic Co., 901 Nepperhan Ave., Yonkers 3, N. Y.
Transmitter Equipment Mfg. Co., Inc., 345 Hudson St., New York, N. Y.
Thordarson Electric Mfg. Div., Maguire Industries, Inc., 500 W. Huron St., Chicago 10, Ill.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
Waugh Labs., Div. of Waugh Equipment Co., 420 Lexington Ave., New York 17, N. Y.
Webster Chicago Corp., Electronics Div., 3825 Armitage Ave., Chicago 47, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wirt Co., 5221 Greene St., Philadelphia, Pa.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.
Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

Relays

CAPACITY OPERATED RELAYS

Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Auth Electrical Specialty Co., Inc., 422 East 53rd St., New York 22, N. Y.
Browning Labs., Inc., 750 Main St., Winchester, Mass.
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Federal Instrument Co., 3917-47th Ave., Long Island City, N. Y.
General Electric Co., Schenectady 5, N. Y.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Lumenite Electric Co., 407 S. Dearborn St., Chicago, Ill.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Price Brothers Co., Frederick, Md.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Sorenson & Co., 375 Fairfield Ave., Stamford, Conn.

HEAVY DUTY RELAYS

Adams & Westlake Co., Michigan St., Elkhart, Ind.
Advance Electric and Relay Co., 1260 W. Second St., Los Angeles, Calif.
Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.
Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford 6, Conn.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Automatic Electric Co., 1033 West Van Buren St., Chicago 7, Ill.
Automatic Electric Mfg. Co., 10 State St., Mankato, Minn.
Automatic Switch Co., 41 East 11th St., New York 3, N. Y.
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Cutler-Hammer, Inc., 315 N. 12th Street, Milwaukee 1, Wisc.
Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.
General Controls Co., 801 Allen Ave., Glendale, Cal.
General Electric Co., Schenectady 5, N. Y.
Glenn Roberts Co., 3100 East Tenth St., Oakland 1, Calif.
H-B Electric Co., 6109 North 21st St., Philadelphia 38, Pa.
Heinze Electric Co., Lowell, Mass.
Johnson Co., E. F., Waseca, Minn.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Kurman Electric Co., 35-18 37th St., Long Island City 1, N. Y.
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Calif.
Leece-Neville Co., 5363 Hamilton Ave., Cleveland 14, Ohio
Minneapolis-Honeywell Reg. Co., 2753 Fourth Ave., S., Minneapolis, Minn.
Monitor Controller Co., 51 S. Gay St., Baltimore 2, Md.
Price Brothers Co., Frederick, Md.
Philadelphia Thermometer Co., 6th & Cayuga Sts., Philadelphia, Pa.
R. B. M. Mfg. Co., Div. of Essex Wire Corp., Logansport, Ind.
Signal Engineering & Mfg. Co., 154 W. 14th St., New York, N. Y.
Square D Co., 6060 Rivard St., Detroit 11, Mich.
Struthers-Dunn, Inc., 1321 Arch St., Philadelphia 7, Pa.
Tork Clock Co., 1 Grove St., Mt. Vernon, N. Y.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

MERCURY RELAYS

Adams & Westlake, Michigan St., Elkhart, Ind.
American Instrument Co., 8030 Georgia Ave., Silver Springs, Md.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Automatic Temperature Control Co., 34 E. Logan St., Philadelphia, Pa.
Brown Instrument Co., 4428 Wayne Ave., Philadelphia, Pa.
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago 30, Ill.
Durakool, Inc., 1010 N. Main St., Elkhart, Ind.
General Electric Co., Schenectady 5, N. Y.
Guardian Electric Mfg. Co., 1400 Washington Blvd., Chicago 7, Ill.
H-B Electric Co., 6109 N. 21st St., Philadelphia 38, Pa.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford 1, Conn.
Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill.
Philadelphia Thermometer Co., 6th & Cayuga Sts., Philadelphia, Pa.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.
Sperti, Inc., Norwood Station, Cincinnati, Ohio
Standard Electrical Products Co., 400 Linden Ave., Dayton 3, Ohio
Struthers-Dunn, Inc., 1321 Arch St., Philadelphia 7, Pa.

PHOTOELECTRIC RELAYS

Advance Electric and Relay Co., 1260 W. Second St., Los Angeles, Calif.
Allied Control Co., Inc., 2 East End Avenue, New York 21, N. Y.
American Instrument Co., 8030 Georgia Ave., Silver Springs, Md.
Audio Tone Oscillator Co., 237 John St., Bridgeport 3, Conn.
Auth Electrical Specialty Co., Inc., 422 East 53rd St., New York 22, N. Y.
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago 30, Ill.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia 13, Pa.
Electronic Control Corp., 1573 E. Forest St., Detroit, Mich.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
Electronic Products Co., 19 N. First St., Geneva, Ill.

Federal Instrument Co., 3917-47th Ave., Long Island City, N. Y.
Fisher-Pierce Co., 80 Ceylon St., Boston, Mass.
General Electric Co., Schenectady 5, N. Y.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Neb.
Hatton Co., Arthur T., 410 Asylum St., Hartford, Conn.
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Cal.
Lumenite Electric Co., 407 S. Dearborn St., Chicago, Ill.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Parker Engineering Pdts. Co., 16 W. 22nd St., New York 10, N. Y.
Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Rehtron Corp., 4313 Lincoln Ave., Chicago 18, Ill.
Springfield Sound Co., Electronics Div., 12 Cass St., Springfield, Mass.
Standard Electrical Products Co., 400 Linden Ave., Dayton 3, Ohio.
Technical Products Co., 158 Madison Ave., at Third St., Memphis, Tenn.
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.
Ward Leonard Electric Co., 31 South St., Mt. Vernon, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
White Research, 899 Boylston St., Boston, Mass.
Worner Electronic Devices, 609 West Lake St., Chicago 6, Ill.

PHOTOTUBE RELAYS

Advance Electric and Relay Co., 1260 W. Second St., Los Angeles, Calif.
Aerolux Light Corp., 653 11th Ave., New York 19, N. Y.
Allied Control Co., Inc., 2 East End Avenue, New York 21, N. Y.
Audio Tone Oscillator Co., 237 John St., Bridgeport 3, Conn.
Auth Electrical Specialty Co., Inc., 422 E. 53rd St., New York 22, N. Y.
Automatic Electric Co., 1033 West Van Buren St., Chicago 7, Ill.
Brown Instrument Co., 4428 Wayne Ave., Philadelphia 44, Pa.
Electronic Control Corp., 1573 E. Forest St., Detroit, Mich.
Electronic Products Co., 19 N. First St., Geneva, Ill.
Federal Instrument Co., 3917-47th Ave., Long Island City, N. Y.
Fisher-Pierce Co., 80 Ceylon St., Boston, Mass.
General Electric Co., Schenectady 5, N. Y.
Hatton Co., Arthur T., 410 Asylum St., Hartford, Conn.
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Cal.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Parker Engineering Pdts. Co., 16 W. 22nd St., New York 10, N. Y.
Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass.
Potter & Brumfield Mfg. Co., Inc., 617-621 No. Gibson St., Princeton, Indiana
Radio Corp. of America, RCA Victor Div., Camden, N. J.
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
White Research, 899 Boylston St., Boston, Mass.
Worner Electronic Devices, 609 West Lake St., Chicago 6, Ill.

POLARIZED RELAYS

Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.
Auth Electrcal Specialty Co., Inc., 422 East 53 St., New York 22, N. Y.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Barber-Colman Co., Rockford, Ill.
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Eastern Air Devices, Inc., 585 Dean St., Brooklyn 17, N. Y.
General Electric Co., Schenectady 5, N. Y.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Leece-Neville Co., 5363 Hamilton Ave., Cleveland 14, Ohio
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.
Price Brothers Co., Frederick, Md.
Signal Engrg. & Mfg. Co., 154 W. 14th St., New York, N. Y.
Struthers-Dunn, Inc., 1321 Arch St., Philadelphia 7, Pa.
Union Switch & Signal Co., Swissvale, Pa.
Ward Leonard Electric Co., 31 South St., Mt. Vernon, N. Y.
Westinghouse Electre Corp., East Pittsburgh, Pa.

SENSITIVE CONTROL RELAYS

Advance Electric and Relay Co., 1260 W. Second St., Los Angeles, Cal.
Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 2, Wisc.
Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.
American Instrument Co., Silver Springs, Md.
Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Arrow-Hart & Hageman Elec. Co., Hartford, Conn.
Auth Electrical Specialty Co., Inc., 422 E. 53rd St., New York 22, N. Y.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Automatic Electric Mfg. Co., 10 State St., Mankato, Minn.
Automatic Temperature Co., 34 E. Logan St., Philadelphia 44, Pa.
Bank's Mfg. Co., 1105 W. Lawrence Ave., Chicago 40, Ill.
Barber-Colman Co., Rockford, Ill.
Birtcher Corp., 5087 Huntington Drive, Los Angeles 32, Cal.
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Burlington Instrument Corp., 214 North 4th St., Burlington, Iowa
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago 30, Ill.
Connecticut Telephone & Electric Div. of Great American Industries, Inc., 70 Brittania St., Meriden, Conn.
Control Corp., 600 Stinson Blvd., Minneapolis, Minn.
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Cutler-Hammer, Inc., 315 N. 12th Street, Milwaukee 1, Wisc.
Davis & Co., Inc., Dean W., Kentland, Ind.
Dayton Acme Co., 930 York St., Cncinnati, Ohio
Distillation Products, Inc., 755 Ridge Rd., W., Rochester, N. Y.
Eastern Air Devices, Inc., 585 Dean St., Brooklyn 17, N. Y.
Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.
Electric Auto-Lite Co., Toledo 1, Ohio
Electrical Products Supply Co., 1140 Venice Blvd., Los Angeles 15, Calif.
Engineering Laboratories, Inc., 602 East Fourth St., Tulsa 3, Okla.
Federal Instrument Co., 3917-47th Ave., Long Island City, N. Y.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
General Controls Co., 801 Allen Ave., Glendale, Calif.
General Electric Co., Schenectady 5, N. Y.
Guardian Electric Mfg. Co., 1400 Washington Blvd., Chicago 7, Ill.
H-B Electric Co., 6109 North 21st St., Philadelphia 38, Pa.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford 1, Conn.
Haydon Manufacturing Co., Inc., Forestville, Conn.
Holtzer-Cabot, Signal Division, 400 Stuart St., Boston 17, Mass.
Jennings Radio Mfg. Co., 1098 E. William St., San Jose 12, Cal.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Kurman Electric Co., 35-18 37th St., Long Island City 1, N. Y.
Leach Relay Company, 5915 Avalon Blvd., Los Angeles, Calif.
Lewis Electronics, Inc., Los Gatos, Calif.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Lumenite Electric Co., 407 S. Dearborn St., Chicago, Ill.
Magnetic Devices, Inc., Frederick, Md.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Mossman, Inc., Donald P., 612 N. Michigan Ave., Chicago 31, Ill.
Naxon Utilities Corp., 2101-11 W. Walnut St., Chicago 12, Ill.
North Electric Mfg. Co., 501 S. Market St., Galion, Ohio
Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.
Parker Engrg. Products Co., 16 West 22nd St., New York 10, N. Y.
Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass.
Potter & Brumfield Mfg. Co., Inc., 617 N. Gibson St., Princeton, Ind.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.
Price Brothers Co., Frederick, Md.
R.B.M. Mfg. Co., Div. of Essex Wire Corp., Logansport, Ind.
Radionic Controls, Inc., 3758 Belmont Ave., Chicago 18, Ill.
Remler Co. Ltd., 2101 Bryant St., San Francisco 10, Calif.
Sigma Instruments, Inc., 70 Ceylon St., Boston 21, Mass.
Signal Engrg. & Mfg. Co., 154 W. 14th St., New York, N. Y.
Smith Mfg. Co., Inc., Nathan R., 105 Pasadena Ave., South Pasadena, Cal.
Sorensen & Co., 375 Fairfield Ave., Stamford, Conn.
Square D Co., 6060 Rivard St., Detroit 11, Mich.
Standard Electrical Products Co., 400 Linden Ave., Dayton 3, Ohio
Struthers-Dunn, Inc., 1321 Arch St., Philadelphia 7, Pa.
Technical Products Co., 158 Madison Ave., at Third St., Memphis, Tenn.
Thordarson Electric Mfg. Div., Maguire Industries, Inc., 500 W. Huron St., Chicago 10, Ill.
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Wallace & Tiernan Products, Inc., Belleville, N. J.
Ward Leonard Electric Co., 31 South St., Mt. Vernon, N. Y.
Warrick, Chas. F., 16251 Hamilton Ave., Detroit 3, Mich.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

STEPPING RELAYS

Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago 30, Ill.
Connecticut Telephone & Electric Div. of Great American Industries, 70 Brittania St., Meriden, Conn.
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Eagle Signal Corp., 202-20th St., Moline, Ill.
Guardian Electric Mfg. Co., 1400 Washington Blvd., Chicago 7, Ill.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
North Electric Mfg. Co., 501 S. Market St., Galion, Ohio
Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.
Price Brothers Co., Frederick, Md.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Signal Engrg. & Mfg. Co., 154 West 14th St., New York, N. Y.
Struthers-Dunn, Inc., 1321 Arch St., Philadelphia 7, Pa.
Union Switch & Signal Co., Swissvale, Pa.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio

TELEPHONE RELAYS

Advance Electric and Relay Co., 1260 West Second St., Los Angeles, Calif.

ELECTRONIC and ALLIED PRODUCTS

Allied Control Co., Inc., 2 East End Ave., New York 10, N. Y.
Auth Electrical Specialty Co., Inc., 422 East 53rd St., New York 22, N. Y.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago 30, Ill.
Control Corp., 600 Stinson Blvd., Minneapolis, Minn.
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Federal Telephone & Radio Corp., 591 Broad St., Newark, N. J.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago, Ill.
Guardian Electric Mfg. Co., 1400 Washington Blvd., Chicago 7, Ill.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Kurman Electric Co., 35-18 37th St., Long Island City 1, N. Y.
Lake Mfg. Co., 2323 Chestnut St., Oakland 7, Calif.
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Calif.
Leich Electric Co., 565 W. Washington Blvd., Chicago 6, Ill.
Magnetic Devices Inc., Frederick, Md.
Maico Co. Inc., 25 North 3rd St., Minneapolis, Minn.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
North Electric Mfg. Co., 501 S. Market St., Galion, Ohio
Parker Engineering Products Co., 16 West 22nd St., New York 10, N. Y.
Potter & Brumfield Mfg. Co., Inc., 617 N. Gibson St., Princeton, Ind.
Price Brothers Co., Frederick, Md.
R.B.M. Mfg. Co., Div. of Essex Wire Corp., Logansport, Ind.
Radionic Controls, Inc., 3758 Belmont Ave., Chicago 18, Ill.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Signal Engrg. & Mfg. Co., 154 West 14th St., New York, N. Y.
Standard Electrical Products Co., 400 Linden Ave., Dayton 3, Ohio
Struthers-Dunn, Inc., 1321 Arch St., Philadelphia 7, Pa.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Western Electro-Mechanical Co., Inc., 300 Broadway, Oakland, Calif.

TIME DELAY RELAYS

Adams & Westlake Co., Michigan St., Elkhart, Ind.
Advance Electric and Relay Co., 1260 W. Second St., Los Angeles, Calif.
Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 2, Wisc.
Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.
American Gas Accumulator Co., 1029 Newark Ave., Elizabeth, N. J.
Amperite Co., 561 Broadway, New York, N. Y.
Auth Electrical Specialty Co., Inc., 422 East 53rd St., New York 22, N. Y.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Automatic Temperature Control Co., 34 E. Logan St., Philadelphia 44, Pa.
Betts & Betts Corp., 551 West 52nd St., New York, N. Y.
Burlington Instrument Corp., 214 North 4th St., Burlington, Iowa
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago 30, Ill.
Clark Controller Co., 1146 E. 152nd St., Cleveland, Ohio
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Cramer Co., R. W., Centerbrook, Conn.
Curtis Development & Mfg. Co., 1 N. Crawford Ave., Chicago 24, Ill.
Cutler-Hammer, Inc., 315 North 12th St., Milwaukee 1, Wisc.
Dayton Acme Co., 930 York St., Cincinnati, Ohio
Eagle Signal Corp., Moline, Ill.
Edison, Inc., Thomas A., Instrument Div., 51 Lakeside Ave., West Orange, N. J.
Electrical Products Supply Co., 1140 Venice Blvd., Los Angeles 15, Calif.
Electronic Products Co., 19 North First St., Geneva, Ill.
General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass.
General Electric Co., Schenectady 5, N. Y.
Gibbs & Co., Thomas B., Div. of George W. Borg Corp., 814 Michigan St., Delavan, Wisc.
Glenn Roberts Co., 3100 East Tenth St., Oakland 1, Calif.
Guardian Electric Mfg. Co., 1400 Washington Blvd., Chicago 7, Ill.
H-B Electric Co., 6109 North 21st St., Philadelphia 38, Pa.
Haydon Manufacturing Co., Inc., Forestville, Conn.
Holtzer-Cabot Signal Division, 400 Stuart St., Boston 17, Mass.
Industrial Timer Corp., 117 Edison Pl., Newark 5, New Jersey
Kurman Electric Co., 35-18 37th St., Long Island City 1, N. Y.
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Calif.
Luers, J. Milton, 12 Pine St., Mt. Clemens, Mich.
Lumenite Electric Co., 407 S. Dearborn St., Chicago, Ill.
Magnetic Devices, Inc., Frederick, Md.
Magnetic Gauge Co., 60 E. Bartges St., Akron, Ohio
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Monitor Controller Co., 51 S. Gay St., Baltimore 2, Md.
New Haven Clock Co., New Haven 4, Conn.
North Electric Mfg. Co., 501 S. Market St., Galion, Ohio
Paragon Electric Co., 37 W. Van Buren St., Chicago 5, Ill.
Partlow Corp., 2 Campion Rd., New Hartford, N. Y.
Philharmonic Radio Corp., 528 . 72nd St., New York 21, N. Y.
Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass.
Photovolt Corp., 95 Madison Ave., New York 16, N. Y.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.
Price Brothers Co., Frederick, Md.
R. B. M. Mfg. Co., Div., of Essex Wire Corp., Logansport, Ind.
Rehtron Corp., 4313 Lincoln Ave., Chicago 18, Ill.
Reliance Automatic Lighting Co., 1920 Mead St., Racine, Wisc.
Reynolds Electric Co., 2650 W. Congress St., Chicago 12, Ill.
Rhodes, Inc., M. H., 30 Bartholomew Ave., Hartford, Conn.
Richardson-Allen Corp., 15 W. 20th St., New York 11, N. Y.
Sigma Instruments, Inc., 70 Ceylon St., Boston 21, Mass.
Signal Engrg. & Mfg. Co., 154 W. 14th St., New York, N. Y.
Sorenson & Co., 375 Fairfield Ave., Stamford. Conn.
Spencer Thermostat Co., 34 Forest St., Attleboro, Mass.
Springfield Sound Co., Electronics Division, 12 Cass St., Springfield, Mass.
Square D Co., 6060 Rivard St., Detroit 11, Mich.
Standard Electrical Products Co., 400 Linden Ave., Dayton 3, Ohio
Struthers-Dunn, Inc., 1321 Arch St., Philadelphia 7, Pa.
Ulanet Co., George, 88 E. Kinney St., Newark 5, N. J.
Union Switch & Signal Co., Swissvale, Pa.
United Cinephone Corp., 65 New Litchfield. Torrington, Conn.
Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
White-Rodgers Electric Co., 1209 Cass Ave., St. Louis, Mo.
Worner Electronic Devices, 609 West Lake St., Chicago 6, Ill.
Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

VACUUM CONTACT RELAYS

Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, North Hollywood, Calif.
Edison, Inc., Thomas A., Instrument Div., 51 Lakeside Ave., W. Orange, N. J.
Eitel-McCullough, Inc., San Bruno, Calif.
General Electric Co., Schenectady 5, N. Y.
H-B Electric Co., 6109 N. 21st St., Philadelphia 38, Pa.
Industrial & Commercial Electronics, Belmont, Calif.
Monitor Controller Co., 51 S. Gay St., Baltimore 2, Md.
Price Brothers Co., Frederick, Md.
R.B.M. Mfg. Co. Div. of Essex Wire Corp., Logansport, Ind.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Signal Engineering & Mfg. Co., 154 West 14 St., New York, N. Y.
Sperti, Inc., Norwood Station, Cincinnati 12, Ohio
Struthers-Dunn, Inc., 1321 Arch St., Philadelphia 7, Pa.
Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio

Repairs, Tube

see Tube Repairs

Resistors

FIXED RESISTORS

Acme Electric Heating Co., 1217 Washington St., Boston, Mass.
Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 2, Wisc.
Atlas Resistor Co., 423 Broome St., New York, N. Y.
Carborundum Co., Globar Div., Niagara Falls, N. Y.
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Calif.
Clarostat Mfg. Co., Inc., 130 Clinton St., Brooklyn 1, N. Y.
Continental Carbon Inc., 13900 Lorain Ave., Cleveland, Ohio
Cutler-Hammer, Inc., 315 North 12th Street, Milwaukee 1, Wisc.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Eastern Specialty Co., 3617-19 N. Eighth St., Philadelphia 40, Pa.
Electric Service Manufacturing Co., 17th & Cambria Sts., Philadelphia 32, Pa.
Erie Resistor Corp., 644 W. 12 St., Erie, Pa.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Globar Div., Carborundum Co., Buffalo Ave., Niagara Falls, N. Y.
Instrument Resistors Co., Little Falls, N. J.
International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.
Madison Electrical Products Corp., Madison, N. J.
Mallory & Co., Inc., P. R. 3029 E. Washington St., Indianapolis, Ind.
Monitor Controller Co., 51 S. Gay St., Baltimore 2, Md.
Muter Co., 1255 S. Michigan Ave., Chcago, Ill.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
Ohio Carbon Co., 12508 Berea Rd., Cleveland Ohio
Ohmite Manufacturing Co., 4835 W. Flournoy St., Chicago, Ill.
Philmore Mfg. Co., 113 University Place, New York, N. Y.
Precision Machine Works Inc., 14 South Ninth St., Minneapolis, Minn.
Precision Resistor Co., 334 Badger Ave., Newark 8, N. J.
Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, N. Y.
Schaefer Bros. Co., 1059 W. 11th St., Chicago, Ill.
Shallcross Mfg. Co., 10 Jackson Ave., Collingsdale, Pa.
Speer Resistor Corp., St. Marys, Pa.
Sprague Electric Co., North Adams, Mass.
Stackpole Carbon Co., Tannery St., St Marys, Pa.
States Co., 19 New Park Ave., Hartford 6, Conn.
Trefz Mfg. Co., 28-11 Main St., Flushing, N. Y.
Tuttle & Co., H. W., 261 W. Maumee St., Adrian, Mich.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio

Ward Leonard Electric Co., 31 South St., Mt. Vernon, N. Y.
White Dental Manufacturing Co., S. S. (Industrial Div.) 10 E. 40th St., New York, N. Y.
Wirt Co., 5221 Greene St., Philadelphia, Pa.
Wright Machine & Tool Corp., 7 West 30th St., New York 1, N. Y.

VARIABLE RESISTORS POTENTIOMETERS and RHEOSTATS

A. B. C. Products, Inc., 11952 Montana Ave., W. Los Angeles, Calif.
Acme Electric Heating Co., 1217 Washington St., Boston, Mass.
Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 2, Wis.
Atlas Resistor Co., 423 Broome St., New York, N. Y.
Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, O.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Bristol Co., Waterbury 91, Conn.
Brown Instrument Co., 4428 Wayne Ave., Philadelphia 44, Pa.
Cambridge Instrument Co., 3732 Grand Central Terminal, New York 17, N. Y.
Centralab Div. of Globe Union, Inc., 900 Keefe Ave., Milwaukee 1, Wisc.
Central Scientific Co., 1700 Irving Park Blvd., Chicago 13, Ill.
Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago, Ill.
Chicago Telephone Supply Co., 1142 W. Beardsley Ave., Elkhart, Ind.
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Calif.
Clarostat Mfg. Co., Inc., 130 Clinton St., Brooklyn, N. Y.
Columbia Electric Mfg. Co., 4519 Hamilton Ave., N. E. Cleveland 14, Ohio
Curtis Development & Mfg. Co., 1 N. Crawford Ave., Chicago 24, Ill.
Cutler-Hammer, Inc., 315 North 12th St., Milwaukee 1, Wisc.
Daven Co., 191 Central Ave., Newark 4, N. J.
DeJur-Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.
Eagle Electric Mfg. Co. Inc., 23-10 Bridge Plaza S., Long Island City, N. Y.
Eastern Specialty Co., 3619 N. Eighth St., Philadelphia 40, Pa.
Electronic Products Co., 19 N. First St., Geneva, Ill.
Fairchild Camera & Instrument Corp., 475 Tenth Ave., New York 18, N. Y.
General Electric Co., Schenectady 5, New York
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Giannini & Co., Inc., G. M., 161 E. California St., Pasadena, Calif.
Gibbs & Co., Thomas B., Div. of George W. Borg Corp., 814 Michigan St., Delavan, Wisc.
Gilbert Clock Co., Wm. L., Winsted, Conn.
Gray Instrument Co., 64½ W. Johnson St., Philadelphia, Pa.
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
Helipot Corp., 1011 Mission St., South Pasadena, Calif.
Hewlett Packard Co., 395 Page Mill Rd., Palo Alto, Calif.
International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.
Lectrohm, Inc., 5125 W. 25th St., Cicero 50, Ill.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Madison Electrical Prods. Corp., Madison, N. J.
Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Morganite Brush Co., 33-02 48th Ave., Long Island City, N. Y.
Mossman, Inc., Donald P., 612 N. Michigan Ave., Chicago 11, Ill.
National Electric Controller Co., 5307 Ravenswood Ave., Chicago, Ill.
Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio
Ohmite Manufacturing Co., 4835 W. Flournoy St., Chicago 44, Ill.
Presto Electric Co., 4511 New York Ave., Union City, N. J.
Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, N. Y.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Rowe Radio Research Laboratory Co., 2422 N. Pulaski Rd., Chicago 39, Ill.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Schaefer Bros. Co., 1059 W. 11th St., Chicago, Ill.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Small Motors, Inc., 1322 Elston Ave., Chicago 22, Ill.
Speer Carbon Co., St. Marys, Pa.
Stackpole Carbon Co., St. Marys, Pa.
Sticht Co., Inc., Herman H., 27 Park Place, New York 7, N. Y.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
Thwing-Albert Instrument Co., Penn St., & Pulaski Ave., Philadelphia 44, Pa.
Trefz Mfg. Co., 38-11 Main St., Flushing, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wirt Co., 5221 Greene St., Philadelphia, Pa.
Wright Machine & Tool Corp., 7 West 30th St., New York, N. Y.

WIRE WOUND RESISTORS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Associated Research, Inc., 231 S. Green St., Chicago, Ill.
Atlas Resistor Co., 423 Broome St., New York, N. Y.
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Birnbach Radio Co. Inc., 145 Hudson St., New York, N. Y.
Centralab Div. of Globe Union, Inc., 900 N. Keefe Ave., Milwaukee 1, Wis.
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Calif.
Clarostat Mfg. Co., 130 Clinton St., Brooklyn, N. Y.
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio
Cutler-Hammer, Inc., 315 North 12th St., Milwaukee 1, Wisc.
Daven Co., 191 Central Ave., Newark 4, N. J.
DeJur-Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.
Eagle Electric Mfg. Co., Inc., 23-10 Bridge Plaza S., Long Island City, N. Y.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Eastern Specialty Co., 3617-19 N. Eighth St., Philadelphia 40, Pa.
Elco Resistors Co., 112 W. 18th St., New York, N. Y.
Electrical Reactance Corp., Franklinville, N. Y.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Federal Instrument Co., 3931 47th Ave., Long Island City 4, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Electronics Mfg. Co., 2225 So. Hoover St., Los Angeles 7, Calif.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Gibbs & Co., Thomas B., Div., of George W. Borg Corp., 814 Michigan St., Delavan, Wisc.
Gilbert Clock Co., Wm. L., Winsted, Conn.
Groves Corporation, Cape Girardeau, Mo.
Hardwick Hindle, Inc., 40 Hermon St., Newark, N. J.
Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif.
Instrument Resistors Co., 25 Amity St., Little Falls, N. J.
International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.
Lecthrohm, Inc., 5125 W. 25th St., Cicero, 50, Ill.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Madison Electrical Products Corp., Madison, N. J.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Marion Electrical Instrument Co., Manchester, N. H.
Micamold Radio Corp., 1087 Flushing Ave., Brooklyn 6, N. Y.
Monitor Controller Co., 51 S. Gay St., Baltimore 2, Md.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Electric Controller Co., 5307 Ravenswood Ave., Chicago, Ill.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
Nilsson Electrical Laboratory, Inc., 103 Lafayette St., New York 13, N. Y.
Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago 44, Ill.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Precision Machine Works, Inc., 14 South Ninth St., Minneapolis, Minn.
Precision Resistor Co., 334 Badger Ave., Newark 8, N. J.
Presto Electric Co., 4511 New York Ave., Union City, N. J.
Reimers Electric Appliance Co., Inc., 596-56th St., West New York, N. J.
Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, N. Y.
Richardson-Allen Corp., 15 W. 20th St., New York 11, N. Y.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Schaefer Bros. Co., 1059 W. 11th St., Chicago, Ill.
Scientific Radio Products Co., 738 W. Broadway, Council Bluffs, Iowa
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Sprague Electric Co., North Adams, Mass.
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.
Techno-Scientific Co., 901 Nepperhan Ave., Yonkers 3, N. Y.
Trefz Mfg. Co., 38-11 Main St., Flushing, N. Y.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wirt Co., 5221 Greene St., Philadelphia, Pa.
Wright Machine & Tool Corp., 7 West 30th St., New York, N. Y.

Rheostats

see Variable Resistors

Rings, Oil Sealing

Auburn Mfg. Co., 110 Stack St., Middletown, Conn.
Graphite Metallizing Corp., 1055 Nepperhan Ave., Yonkers 3, N. Y.
Sealol Corp., 45 Willard St., Providence, R. I.

Rings, Retaining

Waldes Kohinoor, Inc., Long Island City 1, N. Y.

Rivets

American Brass Co., Waterbury 88, Conn.
Atlas Tack Corp., Pleasant St., Fairhaven, Mass.
Blake & Johnson Co., 1495 Thomaston Ave., Waterville, Conn.
Central Screw Co., 3511 Shields Ave., Chicago 9, Ill.
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Cherry Rivet Co., 231 Winston St., Los Angeles 13, Calif.
Chicago Rivet & Machine Co., 9600 W. Jackson Blvd., (Bellwood) Chicago, Ill.
Clark Bros. Bolt Co., Milldale, Conn.
Clendenin Bros., 108 South St., Baltimore, Md.
Cobb & Drew, Kingston St., Plymouth, Mass.
Federal Screw Products Co., 224 W. Huron St., Chicago 10, Ill.
Harper Co., H. M., 2630 Fletcher St., Chicago 18, Ill.
Hassall Inc., John, Clay & Oakland Sts., Brooklyn, N. Y.

Industrial Screw & Supply Co., 713 W. Lake St., Chicago 6, Ill.
Johnson Co. E. F., Waseca, Minn.
Lamson & Sessions Co., 1971 West 85th St., Cleveland, Ohio
Manufacturer's Belt Hook Co., 1321 W. Congress St., Chicago, Ill.
Manufacturers' Screw Products, 270 W. Hubbard St., Chicago, Ill.
Milford Rivet & Machine Co., Milford, Conn. (Eastern Div.), Elyria, Ohio (Central Div.)
National Screw & Mfg. Co., 2440 E. 75th St., Cleveland 4, Ohio
New England Screw Co., Keene, N. H.
Plume & Atwood Mfg. Co., 470 Bank St., Waterbury, Conn.
Progressive Mfg. Co., 52 Norwood St., Torrington, Conn.
Reed & Prince Mfg. Co., Duncan Ave., Worcester, Mass.
Russell, Burdsall & Ward Bolt & Nut Co., Midland Ave., Port Chester, N. Y.
Scovill Mfg. Co., 99 Mill St., Waterbury 91, Conn.
Stimpson Co., Inc., Edwin B., 74 Franklin Ave., Brooklyn 5, N. Y.
Tubular Rivet & Stud Co., Wollaston 70, Mass.

Rubber Insulating Compounds

see Waxes

Saws Crystal

see Crystal Finishing Equipment

Scales

DIAL SCALES

see also Dials
also Escutcheons

American Insulator Corp., New Freedom, Pa.
Ansonia Clock Co., Inc., 103 Lafayette St., New York 13, N. Y.
Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Austin Co., O., 42 Greene St., New York, N. Y.
B. & C. Insulation Products, Inc., 261 Fifth Ave., New York 16, N. Y.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bastian Bros. Co., 1600 N. Clinton Ave., Rochester, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Cardy-Lundmark Co., 1801 W. Byron St., Chicago 13, Ill.
Chatillon & Sons, John, 85-93 Cliff St., New York, N. Y.
Croname, Inc., 3701 Ravenswood Ave., Chicago, Ill.
Etched Products Corp., 3901 Queens Blvd., Long Island City, N. Y.
Emeloid Co., Inc., 291 Laurel Ave., Arlington, N. J.
Felsenthal & Sons, G., 4122 W. Grand Ave., Chicago 51, Ill.
Finch Telecommunications, Inc., Passaic, N. J.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Electronics Mfg. Co., 2225 So. Hoover St., Los Angeles 7, Calif.
Grammes & Sons, Inc., L. F., 389 Union St., Allentown 2, Pa.
Hopp Press, Inc., 460 West 34th St., New York, N. Y.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
New England Etching & Plating Co., 25 Spring St., Holyoke, Mass.
New England Radiocrafters, 1156 Commonwealth Ave., Boston 34, Mass.
Parisian Novelty Co., 3510 S. Western Ave., Chicago 9, Ill.
Plastic Fabricators Co., 440 Sansome St., San Francisco 11, Calif.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.

Screws

RECESSED HEAD SCREWS

Allen Mfg. Co., Hartford, Conn.
American Screw Co., Providence, R. I.
Atlantic Screw Works, Hartford, Conn.
Bristol Co., Waterbury 91, Conn.
Central Screw Co., 3511 Shields Ave., Chicago 9, Ill.
Chandler Products Co., 1475 Chardon Rd., Cleveland, Ohio
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., High, Myrtle & Grove Sts., New Britain, Conn.
Federal Screw Products Co., 224 W. Huron St., Chicago 10, Ill.
General Screw & Mfg. Co., 1228 W. Monroe St., Chicago 7, Ill.
Harper Co., H. M., 2620 Fletcher St., Chicago 18, Ill.
Hartford Machine Screw Co., Hartford, Conn.
Industrial Screw & Supply Co., 713 W. Lake St., Chicago 25, Ill.
International Screw Co., 9444 Roselawn Ave., Detroit, Mich.
Lamson & Sessions Co., 1971 W. 85th St., Cleveland, Ohio
Manufacturers Screw Products, 270 W. Hubbard St., Chicago, Ill.
Milford Rivet & Machine Co., Milford, Conn.
National Screw & Mfg. Co., 2440 E. 75th St., Cleveland 4, Ohio
Parker-Kalon Corp., 200 Varick St., New York 14, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., 5700 Roosevelt Rd., Chicago 50, Ill.
Reading Screw Co., Norristown, Pa.
Reed & Prince Mfg. Co., Duncan Ave., Worcester, Mass.
Russell, Burdsall & Ward Bolt & Nut Co., Midland Ave., Port Chester, N. Y.
Scovill Mfg. Co., Waterbury 91, Conn.
Shakeproof, Inc., 2501 N. Keeler Ave., Chicago 39, Ill.
Southington Hdwe. Mfg. Co., Southington, Conn.
St. Louis Screw & Bolt Co., 6900 N. Broadway, St. Louis 15, Mo.
Sterling Bolt Co., 209 W. Jackson Blvd., Chicago, Ill.
United Screw & Bolt Corp., 2513 W. Cullerton St., Chicago, Ill.
Whitney Screw Co., Nashua, N. H.
Wolverine Bolt Co., Detroit, Mich.

SET and CAP SCREWS

Allen Mfg. Co., Hartford, Conn.
Bristol Co., Waterbury 91, Conn.
Chandler Products Corp., 1475 Chardon Rd., Cleveland, Ohio
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., High, Myrtle & Grove Sts., New Britain, Conn.
Federal Screw Products Co., 224 W. Huron St., Chicago 10, Ill.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Harper Co., H. M., 2620 Fletcher St., Chicago 18, Ill.
Hartford Machine Screw Co., Hartford, Conn.
Industrial Screw & Supply Co., 713 W. Lake St., Chicago 6, Ill.
Lamson & Sessions Co., 1971 W. 85th St., Cleveland, Ohio
Manufacturers Screw Products, 270 W. Hubbard St., Chicago, Ill.
National Screw & Mfg. Co., 2440 E. 75th St., Cleveland 4, Ohio
Parker-Kalon Corp., 200 Varick St., New York 14, N. Y.
Pheoll Manufacturing Co., 5700 Roosevelt Rd., Chicago 50, Ill.
Reed & Prince Mfg. Co., Duncan Ave., Worcester, Mass.
Republic Steel Corp., Republic Bldg., Cleveland 1, Ohio
Russell, Burdsall & Ward Bolt & Nut Co., Midland Ave., Port Chester, N. Y.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Scovill Mfg. Co., 99 Mill St., Waterbury, 91, Conn.
Shakeproof, Inc., 2501 N. Keeler Ave., Chicago 39, Ill.
St. Louis Screw & Bolt Co., 6900 B'way, St. Louis 15, Mo.
Standard Pressed Steel Co., Jenkintown, Pa.
Sterling Bolt Co., 209 W. Jackson Blvd., Chicago, Ill.

SPECIAL SCREWS

Ericsson Screw Machine Products Co., Inc., 25 Lafayette St., Brooklyn 1, N. Y.
New England Screw Co., Keene, N. H.
Progressive Mfg. Co., Torrington, Conn.
Scovill Mfg. Co., 99 Mill St., Waterbury 91, Conn.
Waltham Screw Co., 77 Rumford Ave., Waltham, Mass.
White Dental Mfg. Co., S. S. Industrial Div., 10 East 40th St., New York, N. Y.

Seals, Hermetic

Aerolux Light Corp., 653 Eleventh Ave., New York 19, N. Y.
Cincinnati Electric Products Co., Carthage at Hannaford, Cincinnati 12, Ohio
Dongan Electric Mfg. Co., 2987 Franklin St., Detroit, Mich.
Electrical Industries, Inc., 42 Summer Ave., Newark 4, N. J.
Electronic Mechanics, Inc., 70 Clifton Blvd., Clifton, N. J.
Federal Electric Co., Inc., 8700 S. State St., Chicago 19, Ill.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.
General Ceramics & Steatite Corp., Keasbey, N. J.
H-B Electric Co., 6109 North 21st St., Philadelphia 38, Pa.
Hermaseal Co., Riverside Drive, Elkhart, Indiana
Kopp Glass Inc., 1 East 42nd Street, New York 17, N. Y.
Marion Electrical Instrument Co., Manchester, N. H.
Mycalex Corp. of America, 60 Clifton Blvd., Clifton, N. J.
Pacific Clay Products Co., 306 West Avenue 26, Los Angeles 31, Calif.
Radio Frequency Labs., Inc., Boonton, N. J.
Sperti, Inc., Norwood Station, Cincinnati 12, Ohio
Universal X-Ray Products, Inc., 1800 North Francisco Ave., Chicago 47, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Selsyns

Diehl Mfg. Co., Finderne Plant, Somerville, N. J.
Electric Engineering & Mfg. Co., Los Angeles, Calif.
Electric Indicator Co., 21 Parker Ave., Stamford, Conn.
Electric Specialty Co., 211 South Street, Stamford, Conn.
Electrical Engineering & Mfg. Corp., 4606 W. Jefferson Blvd., Los Angeles 16, Calif.
Electrolux Corp., Old Greenwich, Conn.
Electromatic Typewriters, Inc., Rochester, N. Y.
General Electric Co., Fort Wayne, Ind.
General Electric Co., Schenectady 5, N. Y.
Hobart Mfg. Co., Troy, Ohio
Philharmonic Radio Corp., 528 E. 72nd St., New York 21, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Servos, Solenoid & Plunger

American Television & Radio Co., 300 E. Fourth St., St. Paul 1, Minn.
Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Electricoil Transformer Co., 421 Canal St., New York 13, N. Y.
Eastern Air Devices, Inc., 585 Dean St., Brooklyn 17, N. Y.
Hercules Electric & Mfg. Co., Inc., 2500 Atlantic Ave., Brooklyn 7, N. Y.
Lear, Inc., Piqua, Ohio
Reeves Sound Lab., Inc., 62 West 47th St., New York, N. Y.
Sperti, Inc., Norwood Sta., Cincinnati, Ohio
Westinghouse Electric Corp., East Pittsburgh, Pa.

Shafts

FLEXIBLE SHAFTS

Breeze Corp., 41 S. Sixth St., Newark, N. J.

Croname, Inc., 3701 Ravenswood Ave., Chicago, Ill.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Haskins Co., R. G., 615 S. California Ave., Chicago 12, Ill.
Invincible Tool Co., 611 Empire, Pittsburgh 22, Pa.
J. F. D. Mfg. Co., 4111 Ft. Hamilton Pkwy, Brooklyn, N. Y.
Lear Incorporated, Piqua, Ohio
Linick & Co., Leslie L., 29 E. Madison St., Chicago, Ill.
Martindale Electric Co., 1371 Hird Ave., Cleveland, Ohio
Pratt & Whitney Div. Niles-Bement-Pond Co., West Hartford 1, Conn.
Stewart Mfg. Corp., F. W., 4311 Ravenswood Ave., Chicago 13, Ill.
Stow Mfg. Co., 445 State St., Binghamton, N. Y.
Walker-Turner Co. Inc., 1463 Berckman St., Plainfield, N. J.
White Dental Mfg. Co., S. S. Industrial Div., 10 E. 40th St., New York, N. Y.

Shields

TUBE SHIELDS

Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Aluminum Goods Mfg. Co., Manitowoc, Wisc.
American Brass Co., Waterbury 88, Conn.
American Radio Hardware Co., Inc., 152 MacQuesten Pkway, S., Mt. Vernon, N. Y.
Bud Radio, Inc., 2118 East 55th St., Cleveland 3, Ohio
Erie Can Co., 816 W. Erie St., Chicago, Ill.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Guthman & Co., Edwin I., 15 S. Throop St., Chicago, Ill.
Hegeler Zinc Co., Danville, Ill.
J. F. D. Mfg. Co., 4111 Ft. Hamilton Parkway, Brooklyn, N. Y.
Johnson Co., E. F., Waseca, Minn.
National Co., Inc., 61 Sherman St., Malden 48, Mass.
Paul & Beekman, 18th & Cortland Sts., Philadelphia, Pa.
Rice's Sons, Inc., Bernard, 325 Fifth Avenue, New York 16, N. Y.
Sperry Gyroscope Co., Manhattan Bridge Plaza, Brooklyn 1, N. Y.
Union Aircraft Products Corp., 380 Second Ave., New York, N. Y.

Shunts

AMMETER SHUNTS

Associated Research, Inc., 231 S. Green St., Chicago 7, Ill.
Avia Products Co., 7266 Beverly Blvd., Los Angeles 36, Calif.
Boes Co., W. W., 3001 Salem Ave., Dayton 3, Ohio
Burlington Instrument Corp., 214 North 4th St., Burlington, Iowa
Electric Heat Control Co., 9123 Inman Ave., Cleveland 5, Ohio
Esterline-Angus Co., Inc., P. O. Box 596, Indianapolis, Ind.
Federal Instrument Co., 3931 47th Ave., Long Island City 4, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Electronics Mfg. Co., 2225 So. Hoover St., Los Angeles 7, Calif.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Instrument Resistors Co., 25 Amity St., Little Falls, N. J.
International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Marion Electrical Instrument Co., Manchester, N. H.
Meters, Inc., 915 Riveria Drive, Indianapolis 5, Ind.
Norton Electrical Instrument Co., 79 Hilliard St., Manchester, Conn.
Precision Resistor Co., 334 Badger Ave., Newark 8, N. J.
Rawson Electrical Instrument Co., Inc., 110 Potter St., Cambridge 42, Mass.
Roller-Smith, Bethlehem, Pa.
Scientific Service Laboratories, 2225 So. Hoover St., Los Angeles 7, Calif.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Sun Mfg. Co., 6623 Avondale Ave., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.
Westinghouse Electrical Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Freylinghuysen Ave., Newark 5, N. J.

Sleeves and Tubes, Cathode

General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass. (seamless tubing)
Lenoxite Div., Lenox Inc., 65 Prince St., Trenton 5, N. J.
Precision Laboratories, Inc., Irvington, N. J. (lockseam type)
Precision Tube Co., 3828 Terrace St., Philadelphia 28, Pa.
Radio Corp. of America, RCA Victor Div., Camden, N. J. (lockseam type)
Superior Tube Co., Norristown, Pa. (lapseam, lockseam, seamless type)
Swedish Iron & Steel Corp., 17 Battery Place, New York, N. Y.
Westinghouse Electrical Corp., East Pittsburgh, Pa.

Sockets

DIAL LIGHT SOCKETS

Alden Products Co., 117 North Main St., Brockton 64, Mass.
American Radio Hardware Co., Inc., 152 MacQuesten Pkway S., Mt. Vernon, N. Y.
Cole-Hersee Co., 54 Old Colony Ave., Boston 27, Mass.
Dial Light Co. of America, 900 Broadway, New York 3, N. Y.
Drake Mfg. Co., 1713 Hubbard St., Chicago, Ill.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Federal Screw Products Co., 224 W. Huron St., Chicago 10, Ill.
Franklin Mfg. Co., A. W., 175 Varick St., New York, N. Y.
General Electric Co., Bridgeport, Conn.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Kirkland Co., H. R., 8-10 King St., Morristown, N. J.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Scovill Mfg. Co., 99 Mill St., Waterbury, Conn.
Tingstol Corp., 1461 W. Grand Ave., Chicago. Ill.
Ucinite Co., 459 Watertown St., Newtonville, Mass.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wood Electric Co., Inc., 826 Broadway, New York 3, N. Y.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.

TUBE SOCKETS

Alden Products Co., 117 North Main St., Brockton 64, Mass.
American Brass Co., Waterbury 88, Conn.
American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.
American Radio Hardware Co.. Inc., 152 MacQuesten Pkway, S., Mt. Vernon, N. Y.
Automatic Metal Prods. Corp., 315 Berry St., Brooklyn, N. Y.
Birnbach Radio Co., Inc., 145 Hudson St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Cinch Mfg. Co., 2335 W. Van Buren St., Chicago, Ill.
Cole-Hersee Co., 54 Old Colony Ave., Boston 27, Mass.
Eby, Inc., H. H., 18 W. Chelton Ave., Philadelphia 13, Penn.
Electronic Mechanics, Inc., 70 Clifton Blvd., Clifton, N. J.
Electronic Products Co., North First St., Geneva, Ill.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Federal Manufacturing & Engrg. Corp., 199 Steuben St., Brooklyn, N. Y.
Franklin Mfg. Corp., W., 175 Varick St., New York, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford. Ill.
General Electric Co., Schenectady 5, N. Y.
Hammarlund Mfg. Co., Inc., 460 West 34th St., New York 1, N. Y.
Hubbell, Inc., Harvey, Bridgeport 2, Conn.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Mykroy, Inc., 1917 N. Springfield Ave., Chicago 47, Ill.
National Co., Inc., 61 Sherman St., Malden 48, Mass.
National Fabricated Products, 2650 Belden Ave., Chicago 47, Ill.
National Tile Co., 1200 East 26th St., Anderson, Ind.
Philmore Mfg. Co., 113 University Place, New York, N. Y.
Precision Specialties, 220 No. Western Ave., Los Angeles, Calif.
Radio Corp. of America, Tube Div., RCA Harrison, N. J.
Remler Co., Ltd., 2101 Bryant St., San Francisco 10, Cal.
Standard Winding Corp., 44-62 Johnes St., Newburgh, N. Y.
Ucinite Co., 459 Watertown St., Newtonville, Mass.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Solder

Allen Co., Inc., L. B., 6730 Bryn Mawr Ave., Chicago 31, Ill.
Alpha Metals, Inc., 363 Hudson Ave., Brooklyn 1, N. Y.
American Brass Co., Waterbury 88, Conn.
Belmont Smelting & Refining Works, Inc., 330 Belmont Ave., Brooklyn 7, N. Y.
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Division Lead Co., 836 W. Kinzie St., Chicago 22, Ill.
Dunton Co., M. W., 670 Eddy St., Providence 3, R. I.
Eutetic Welding Alloys Co., 40 Worth St., New York, N. Y.
Gardiner Metal Co., 4820 S. Campbell Ave., Chicago 32, Ill.
General Electric Co., Bridgeport, Conn.
General Plate Div., Metals & Control Corp., 34 Forest St., Attleboro, Mass.
Glaser Lead Co., Inc., 31 Wycoff Ave., Brooklyn, N. Y.
Goldsmith Bros. Smelting & Refining Co., 58 East Washington St., Chicago, Ill.
Handy & Harman, 82 Fulton St., New York 7, N. Y.
Industrial Screw & Supply Co., 745 W. Lake St., Chicago 6, Ill.
Kester Solder Co., 4212 Wrightwood Ave., Chicago 39, Ill.
Lenk Mfg. Co., Newton Lower Falls, Mass.
Makepeace Co., D. E., Attleboro, Mass.
National Lead Co., 111 Broadway, New York 6, N. Y.
New York Solder Co., 15 Crosby St., New York, N. Y.
Ruby Chemical Co., 68 McDowell St., Columbus 1, Ohio
Westinghouse Electric Corp., East Pittsburgh, Pa.

Solder Flux

see Flux, Solder

Soldering Irons

see Irons, Solder

ELECTRONIC and ALLIED PRODUCTS

Soldering Pots

see Pots, Soldering

Sound

COMPLETE SOUND SYSTEMS

Altec Lansing Corp., 1680 N. Vine St., Los Angeles 28, Cal.
American Radio Co., 611 E. Garfield Ave., Glendale, Calif.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Atlas Sound Corp., 1443 39th St., Brooklyn, N. Y.
Banks Mfg. Co., 1105 W. Lawrence Ave., Chicago 40, Ill.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Belmont Radio Corp., 5921 W. Dickens Ave., Chicago, Ill.
Bogen Co., David, 663 Broadway, New York 12, N. Y.
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Boom Electric Amplifier Corp., 1227 W. Washington Blvd., Chicago, Ill.
Carillitone Mfg. Corp., 30 N. Penn St., York, Pa.
Chicago Sound Systems Co., 2124 S. Michigan Ave., Chicago, Ill.
Dilks, Inc., Norwalk, Conn.
Eastern Amplifier Corp., 794 East 140th St., Bronx 54, N. Y.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Eckstein Radio & Television Co., 914 LaSalle Ave., Minneapolis 2, Minn.
Electronic Sound Engineering Co., 109 N. Dearborn St., Chicago 2, Ill.
Electronic Transformer Co., 207 West 25th St., New York, N. Y.
Erwood Co., 223 W. Erie St., Chicago, Ill.
Executone, Inc., 415 Lexington Ave., New York 17, N. Y.
Federal Instrument Co., 3931 47th Ave., Long Island City 4, N. Y.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., Schenectady 5, N. Y.
Gibson, Inc., 225 Parsons St., Kalamazoo, Mich.
Globe Phone Mfg. Corp., 2 Linden St., Reading, Mass.
Godfrey Mfg. Co., 171 S. 2nd St., Milwaukee 4, Wisc.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Neb.
Guided Radio Corp., 161 Sixth Ave., New York 13, N. Y.
Halstead Traffic Communications Corp., 155 East 44th St., New York, N. Y.
Harris Mfg. Co., 2422 W. Seventh St., Los Angeles 5, Calif.
Herbach & Rademan Co., Mfg. Div., 517 Ludlow St., Philadelphia 6, Pa.
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
Hofmann Corp., C. L., 436 Boulevard of the Allies, Pittsburgh, Pa.
Holtzer-Cabot Signal Div., 400 Stuart St., Boston 17, Mass.
Hudson American Corp., 25 W. 43rd St., New York, N. Y.
Industrial Sound Products Co., 3597 Mission St., San Francisco, Calif.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Langevin Co., Inc., 37 W. 65th St., New York, N. Y.
Laurehk Radio Mfg. Co., 3931 Monroe Ave., Wayne, Mich.
Lifetime Sound Equipment Co., 1101 Adams St., Toledo, Ohio
Lincrophone Co., 1661 Howard Ave., Utica, N. Y.
Maico Co., Inc., 25 North 3rd St., Minneapolis, Minn.
Meck Industries, John, Liberty St., Plymouth, Ind.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Meissner Mfg. Co., Div. Maguire Industries, Mt. Carmel, Ill.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Minerva Corp. of America, 238 William St., New York 7, N. Y.
National Inter-Communicating Systems, 2434 Montrose Ave., Chicago 18, Ill.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles 18, Calif.
Northern Communications Mfg. Co., 210 East 40th St., New York, N. Y.
Operadio Mfg. Co., St. Charles, Ill.
Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.
Pacific Sound Equipment Co., 1534 Cahuenga Blvd., Hollywood, Calif.
Philco Corp., Tioga & "C" Sts., Philadelphia 34, Pa.
Powers Electronic & Communication Co., Inc., Glen Cove, N. Y.
Racon Electric Co., Inc., 52 E. 19th St., New York 3, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Laboratories, Inc., 2701 California Ave., Seattle 6, Wash.
Radio Receptor Co., 251 West 19th St., New York 11, N. Y.
Radolek Co., 601 W. Randolph St., Chicago 6, Ill.
Rauland Corp., 4245 N. Knox Ave., Chicago 41, Ill.
Record-O-Pox, Inc., 721 N. Martel Ave., Hollywood 46, Calif.
Regal Electronics Corp., 20 West 20 St., New York, N. Y.
Rehtron Corp., 4313 Lincoln Ave., Chicago 18, Ill.
Remler Co., 2101 Bryant St., San Francisco 10, Calif.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Riggs & Jeffreys, Inc., 73 Winthrop St., Newark 4, N. J.
Robinson Houchin Optical Co., Radiotone Div., Columbus, Ohio
Rosen & Co., Raymond, 32nd & Walnut Sts., Philadelphia 4, Pa.
Ruby Electric Co., 729 Seventh Ave., New York, N. Y.
S. O. S. Cinema Supply Corp., 449 West 42nd St., New York, N. Y.
Schulmerich Electronics Co., Sellersville, Pa.
Scientific Radio Products Co., 738 W. Broadway, Council Bluffs, Iowa
Setchell Carlson, Inc., 2233 University Ave., St. Paul 4, Minn.
Sheridan Electronics Corp., 2850 S. Michigan Ave., Chicago, Ill.
Simpson Mfg. Co., Inc., Mark, 188 W. Fourth St., New York, N. Y.
Sound Equipment Corp. of California, 3903 San Fernando Road, Glendale 4, Calif.
Springfield Sound Co., Electronics Div., 12 Cass St., Springfield, Mass.
Stark Sound Engrg. Corp., Box 493, Fort Wayne 1, Ind.
Stromberg-Carlson Co., 100 Carlson Rd., Rochester, N. Y.
Taybern Equipment Co., 120 Greenwich St., New York 6, N. Y.
Tech-Master Products Co., 123 Prince St., New York, N. Y.
Waters Conley Co., 501 First St., N. W., Rochester, Minn.
Webster Electric Co., 1900 Clark St., Racine, Wisc.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Western Sound & Electric Laboratories, 3512 W. St. Paul Ave., Milwaukee, Wisc.

Sound Recorders

see Recorders, Sound

Speakers

see Loudspeakers

Springs

Accurate Spring Mfg. Co., 3811 W. Lake St., Chicago, Ill.
All-Weather Springs, 140 Cedar St., New York 6, N. Y.
American Coil Spring Co., 2034 Keating Ave., Muskegon, Mich.
American Spiral Spring & Mfg. Co., 5528 Harrison St., Pittsburgh, Pa.
American Spring & Wire Specialty Co., 816 N. Spaulding St., Chicago, Ill.
American Steel & Wire Co., Rockefeller Bldg., Cleveland 13, Ohio
Art Wire & Stamping Co., 227 High St., Newark 2, N. J.
Barnes Co., Wallace, Div. of Associated Spring Corp., Bristol, Conn.
Barnes-Gibson-Raymond Div. of Associated Spring Corp., 6400 Miller Ave., Detroit 11, Mich.
Chatillon & Sons, John, 85-93 Cliff St., New York 7, N. Y.
Cleveland Wire Spring Co., 1281 East 38th Street, Cleveland, Ohio
Cuyahoga Spring Co., 10272 Berea Rd., Cleveland, Ohio
Dunbar Bros. Co., Div. of Associated Spring Corp., 76 South St., Bristol, Conn.
Garrett Co., Inc., George K., 1421 Chestnut St., Philadelphia 2, Pa.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Gibson Co., Wm. D., Div. of Associated Spring Corp., 1800 Clybourn Ave., Chicago, Ill.
Hubbard Spring Co., M. D., Central Ave., Pontiac, Mich.
Hunter Pressed Steel Co., Lansdale, Pa.
Industrial Screw & Supply Co., 713 W. Lake St., Chicago 6, Ill.
Instrument Specialties Co., 246 Bergen Blvd., Little Falls, N. J.
Jones Spring Co., W. B., 124 E. Seventh St., Cincinnati, Ohio
Lee Spring Co., 30 Main St., Brooklyn, N. Y.
Lizen Mfg. Co., 6832 S. Chicago Ave., Chicago 37, Ill.
Manross & Son, F. N. Div. of Associated Spring Corp., Bristol, Conn.
Mid-West Spring Mfg. Co., 4632 S. Western Ave., Chicago 9, Ill.
Muelhausen Spring Corp., 255 Michigan Ave., Logansport, Ind.
Newcomb Spring Corp., 238 40th St., Brooklyn 32, N. Y.
Peck Spring Co., Plainville, Conn.
Precision Products Co., 26 Bedford St., Waltham, Mass.
Raymond Mfg. Co., Div. of Associated Spring Corp., 226 S. Center St., Corry, Pa.
Reliable Spring & Wire Forms Co., 3167 Fulton Rd., Cleveland 9, Ohio
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Tuck Mfg. Co., 74 Ames, Brockton 46, Mass.
Union Spring & Mfg. Co., New Kensington, Pa.
Wickwire Spencer Steel Co., 500 Fifth Ave., New York, N. Y.

Stabilizers

VOLTAGE STABILIZERS

see Regulators

Stampings

METAL STAMPINGS, Small

Ace Manufacturing Corp., 1255 East Erie Ave., Philadelphia, Pa.
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
American Brass Co., Waterbury 88, Conn.
American Emblem Co., Utica, N. Y.
American Nut & Bolt Fastener Co., 2045 Doerr St., Pittsburgh, Pa.
American Radio Hardware Co., Inc., 152 MacQuesten Pkway South, Mt. Vernon, N. Y.
American Spring & Wire Specialty Co., 816 N. Spaulding St., Chicago, Ill.
Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Art Wire & Stamping Co., 227 High St., Newark 2, N. J.
Atlas Tool & Design Co., Castor & Kensington Aves., Philadelphia 24, Pa.
Banks Mfg. Co., 1105 W. Lawrence Ave., Chicago 40, Ill.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Barnes-Gibson-Raymond Div. of Associated Spring Corp., 6400 Miller Ave., Detroit 11, Mich.
Belmont Smelting & Refining Works, Inc., 330 Belmont Ave., Brooklyn 7, N. Y.
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Cole Steel Equipment, 349 Broadway, New York 13, N. Y.
Corry-Jamestown Manufacturing Corp., Corry, Pa.

Croname, Inc., 3701 Ravenswood Ave., Chicago, Ill.
Dahlstrom Metallic Door Co., Buffalo St., Jamestown, N. Y.
Dayton Rogers Mfg. Co., 2835 12th Ave., South, Minneapolis 7, Minn.
Diamond Tool Replacements Div., Oscap Mfg. Co., Baltimore 1, Md.
Diebel Die & Mfg. Co., 3654 N. Lincoln Ave., Chicago, Ill.
Eastern Specialty Co., 3617-19 N. Eighth St., Philadelphia 40, Pa.
Electric Auto-Lite Co., Toledo 1, Ohio
Electronic Supply Co., 207 Main St., Worcester, Mass.
Engineering Co., 27 Wright St., Newark, N. J.
Erie Art Metal Co., 1602 East 18th St., Erie, Pa.
Erie Can Co., 816 W. Erie St., Chicago 22, Ill.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
Garrett Co., Inc., George K., 1421 Chestnut St., Philadelphia 2, Pa.
Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Grammes & Sons, L. F., 389 Union St., Allentown 2, Pa.
Heyman Mfg. Co., Kenilworth, N. J.
Hubbard Spring Co., M. D., 573 Central Ave., Pontiac, Mich.
Hunter Pressed Steel Co., Lansdale, Pa.
Industrial Screw & Supply Co., 713 W. Lake St., Chicago 6, Ill.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
King Laboratories, Inc., 205 Oneida St., Syracuse 4, N. Y.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
Lewyt Corp., 60 Broadway, Brooklyn, N. Y.
Lizen Mfg. Co., 6832 S. Chicago Ave., Chicago 37, Ill.
Manufacturers Screw Products Co., 270 W. Hubbard St., Chicago, Ill.
Master Industries, Inc., 2415 Prairie Ave., Chicago 16, Ill.
Metallic Arts Co., 243 Broadway, Cambridge, Mass.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
National Co., Inc., 61 Sherman St., Malden 48, Mass.
National Mineral Co., 2628 N. Pulaski Rd., Chicago 39, Ill.
New England Etching & Plating Co., 25 Spring St., Holyoke, Mass.
Oiljack Mfg. Co., Inc., Montclair, N. J.
Olympic Tool & Mfg. Co., 37 Chambers St., New York 7, N. Y.
O'Neil-Irwin Mfg. Co., 316 Eighth Ave. S., Minneapolis 15, Minn.
Patton-MacGuyer Co., 17 Virginia Ave., Providence 5, R. I.
Penn Fibre & Specialty Co., 2030 E. Westmoreland St., Philadelphia 34, Pa.
Porter Metal Products, 121 Ingraham St., Bklyn 6, N. Y.
Precision Fabricators, Inc., 120 N. Fitzhugh St., Rochester, N. Y.
Premax Products Div., Chisholm-Ryder Co., Niagara Falls 2, N. Y.
Quadriga Mfg. Co., 213 W. Grand Ave., Chicago 11, Ill.
Radiad Service, 720 West Schubert Ave., Chicago 14, Ill.
Radio Corp. of America, Tube Div. RCA, Harrison, N. J.
Raymond Mfg. Co., Div. of Associated Spring Corp., 226 S. Center Street, Corry, Pa.
Revere Copper & Brass Inc., 230 Park Ave., New York 17, N. Y.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Scovill Mfg. Co., 99 Mill St., Waterbury 91, Conn.
Small Motors, Inc., 1322 Elston Ave., Chicago 22, Ill.
Smith Mfg. Co., Nathan R., 105 Pasadena Ave., South, Pasadena, Calif.
Stamford Metal Specialty Co., 428 Broadway, New York 13, N. Y.
Standard Pressed Steel Co., Jenkintown, Pa.
Stanley Works, New Britain, Conn.
Stewart Stamping Corp., 630 Central Park Ave., Yonkers 4, N. Y.
Stimpson Co., Inc., Edwin B., 74 Franklin Ave., Brooklyn 5, N. Y.
Swedish Iron & Steel Corp., 17 Battery Place, New York, N. Y.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.
Thermador Electric Mfg. Co., 5119 S. Riverside Dr., Los Angeles, Calif.
Thomas & Skinner Steel Prod. Co., 1120 E. 23rd St., Indianapolis, Ind.
Tricon Manufacturing Co., 8318 S. Racine Ave., Chicago, Ill.
Ucinite Co., 459 Watertown St., Newtonville, Mass.
Union Aircraft Products Corp., 380 Second Ave., New York, N. Y.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
Waters Conley Co., 501 First St., N.W., Rochester, Minn.
Webster-Chicago Corp., Manufacturing Div., 5622 Bloomingdale Ave., Chicago 39, Ill.
Western Brass Mills, Div. of Olin Industries, East Alton, Ill.
Whitehead Stamping Co., 1691 W. Lafayette Blvd., Detroit 16, Mich.
Willor Mfg. Co., 794 East 140th St., New York 53, N. Y.
Worcester Pressed Steel Co., 100 Barber Ave., Worcester, Mass.
Wrought Washer Mfg. Co., 2100 S. Bay St., Milwaukee 7, Wisc.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio
Zell Co., 538 Broadway, New York 12, N. Y.
Zierick Mfg. Corp., 385 Gerard Ave., New York, N. Y.

NON-METALLIC STAMPINGS, Small

Aircraft Products Co., 3502 E. Pontiac St., Fort Wayne 1, Ind.
Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Auburn Mfg. Co., 110 Stack St., Middletown, Conn.
Baer Co., N. S., 9 Montgomery St., Hillside, N. J.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Continental-Diamond Fibre Co., 16 Chapel St., Newark, Del.
Diamond Tool Replacements Div., Oscap Mfg. Co., 207 W. Saratoga St., Baltimore 1, Md.
Electric Auto-Lite Co., Toledo 1, Ohio
Electronic Supply Co., 207 Main St., Worcester, Mass.
Franklin Fibre-Lamitex Corp., Wilmington, Del.
Franklin Mfg., A. W., 175 Varick St., New York, N. Y.
Hopp Press, Inc., 460 West 34th St., New York, N. Y.
Industrial Screw & Supply Co., 713 W. Lake St., Chicago 6, Ill.
Insulating Fabricators, Inc., 12 East 12th St., New York 3, N. Y.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington 11, N. J.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
Mica Insulator Co., 200 Varick St., New York 14, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Munsell & Co., Eugene, 200 Varick St., New York, N. Y.
National Vulcanized Fibre Co., Maryland Ave., Wilmington, Del.
Panelyte Div., St. Regis Paper Co., 230 Park Ave., New York, N. Y.
Penn Fibre & Specialty Co., 2030 E. Westmoreland St., Philadelphia 34, Pa.
Plastic Fabricators Co., 440 Sansome St., San Francisco 11, Calif.
Premax Products Div., Chisholm-Ryder Co., Niagara Falls 2, N. Y.
Radiad Service, 720 West Schubert Ave., Chicago 14, Ill.
Richardson Co., Melrose Park, Ill.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Rogers Paper Mfg. Co., Manchester, Conn.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Smith Mfg. Co., Nathan R., 105 Pasadena Ave., South Pasadena, Calif.
Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N. Y.
Stamford Metal Specialty Co., 428 Broadway, New York 13, N. Y.
Synthane Corp., Oaks, Pa.
Tatlor Fibre Co., Norristown, Pa.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Westinghouse Elec. Corp., Lamp Div., Bloomfield, N. J.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Willor Mfg. Co., 794 East 140th St., New York 54, N. Y.
Zierick Mfg. Corp., 385 Gerard Ave., New York, N. Y.

Standards

CAPACITANCE STANDARDS

Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City 5, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Standard Instruments Corp., 568 Prospect Ave., New York 55, N. Y.
White Research, 899 Boylston St., Boston, Mass.
Winslow Co., 9 Liberty St., Newark 5, N. J.
Winters & Crampton Corp., 150 Wilson Ave., Grandville, Michigan

FREQUENCY STANDARDS

Aero Communications, Inc., 231 Main St., Hempstead, Long Island, N. Y.
Aireon Manufacturing Corp., Fairfax & Funston Rds., Kansas City 15, Kansas
American Time Products, Inc., 580 Fifth Ave., New York 19, N. Y.
Barker & Williamson, 255 Fairfield Ave., Upper Darby, Pa.
Browning Labs., Inc., 750 Main St., Winchester, Mass.
Burnett Radio Lab., Wm. W. L., 4814 Idaho St., San Diego, Calif.
Conn, Ltd., C. G., Elkhart, Ind.
Crystal Research Labs, Inc., 29 Allyn St., Hartford, Conn.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Eidson's, 1309 N. Second St., Temple, Texas
Electro Products Labs., 549 W. Randolph St., Chicago, Ill.
Erco Radio Labs., Inc., Fenimore Ave., Hempstead, N. Y.
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
Ferris Instrument Co., 110-112 Cornelia St., Boonton, N. J.
Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
General Crystal Corp., 1775 Foster Ave., Schenectady, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Gibbs & Co., Thomas B., Division of George W. Borg Corp., 814 Michigan St., Delavan, Wisc.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Hallicrafters Co., 2611 Indiana Ave., Chicago 16, Ill.
Hearing Aid Labs., 1404 Franklin St., Michigan City, Ind.
Herbach & Rademan Co., Mfg. Div., 517 Ludlow St., Philadelphia 6, Pa.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
Jefferson, Inc., Ray, 40 E. Merrick Rd., Freeport, L. I., N. Y.
Knights Co., James, 131 S. Wells St., Sandwich, Ill.
Lavoie Laboratories, Morganville, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Leuck Crystal Laboratory, 245 S. 11th St., Lincoln 8, Nebr.
Meissner Mfg. Div., Maguire Industries, Inc., Mt. Carmel, Ill.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.

ELECTRONIC and ALLIED PRODUCTS

Radio Corp. of America, RCA Victor Div., Camden, N. J.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles 34, Calif.
Scientific Radio Products Co., 738 W. Broadway, Council Bluffs, Iowa
Standard Instruments Corp., 568 Prospect Ave., New York 55, N. Y.
White Research, 899 Boylston St., Boston, Mass.

INDUCTANCE STANDARDS

Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electronic Transformer Co., 207 West 25th St., New York, N. Y.
General Radio Co., 275 Massachusestts Ave., Cambridge 39, Mass.
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
New York Transformer Co., 26 Waverly Place, New York 3, N. Y.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
S-W Inductor Co., 1056 N. Wood St., Chicago, Ill.
Standard Instruments Corp., 568 Prospect Ave., New York 55, N. Y.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
White Research, 899 Boylston St., Boston, Mass.

RESISTANCE STANDARDS

Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio
Industrial Instruments, Inc., 156 Culver Ave., Jersey City 5, N. J.
Instrument Resistors Co., 25 Amity St., Little Falls, N. J.
International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Scientific Radio Products Co., 738 W. Broadway, Council Bluffs, Iowa
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
White Research, 899 Boylston St., Boston, Mass.

Stands

MICROPHONE STANDS

American Microphone Co., 1915 S. Western Ave., Los Angeles, Cal.
Amperite Co., 561 Broadway, New York, N. Y.
Art Specialty Co., 3245 Lake St., Chicago, Ill.
Astatic Corp., Conneaut, Ohio
Atlas Sound Corp., 1443 39th St., Brooklyn, N. Y.
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Chicago Sound Systems Co., 2124 S. Michigan Ave., Chicago, Ill.
Eastern Mike-Stand Co., 56 Christopher Ave., Brooklyn 12, N. Y.
Electro Voice Corp., South Bend 24, Ind.
Electronic Sound Engineering Co., 109 N. Dearborn St., Chicago 2, Ill.
Erwood Co., 223 W. Erie St., Chicago, Ill.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Electric Co., Schenectady 5, N. Y.
Lifetime Sound Equipment Co., 1101 Adams St., Toledo, Ohio
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles 18, Cal.
Oleson Illuminating Co., Ltd., Otto, 1560 Vine St., Hollywood 28, Calif.
Racon Electric Co., Inc., 52 East 19th St., New York 3, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radolek Co., 601 W. Randolph St., Chicago 6, Ill.
Rauland Corp., 4245 N. Knox Ave., Chicago 41, Ill.
Shure Brothers, 225 W. Huron St., Chicago, Ill.
Simpson Mfg. Co., Mark, 188 W. Fourth St., New York, N. Y.
Turner Co., Cedar Rapids, Iowa
Universal Microphone Co., 424 Warren Lane, Inglewood, Cal.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.

SPEAKER STANDS

Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Art Specialty Co., 3245 Lake St., Chicago, Ill.
Atlas Sound Corp., 1443 39th St., Brooklyn, N. Y.
Electronic Sound Engineering Co., 109 N. Dearborn St., Chicago 2, Ill.
Erwood Co., 223 W. Erie St., Chicago, Ill.
Lifetime Sound Equipment Co., 1101 Adams St., Toledo, Ohio
Racon Electric Co., Inc., 52 E. 19th St., New York 3, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Simpson Mfg. Co., Inc., 188 W. Fourth St., New York, N. Y.
Vac-O-Grip Co., 2025 Detroit Ave., Toledo 6, Ohio

Steel

ELECTRICAL STEEL

see Metals

Strain Gauges

see Gauges, Strain

Strips

TERMINAL STRIPS

see Posts

Stroboscopes

Aerolux Light Corp., 653 11th Ave., New York 19, N. Y.
American Time Products, Inc., 580 Fifth Ave., New York 19, N. Y.
Communication Measurements Lab., 120 Greenwich St., New York, N. Y.
Conn, Ltd., C. G., Elkhart, Ind.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
J. F. D. Mfg. Co., 4111 Fort Hamilton Parkway, Brooklyn, N. Y.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Saxl Instrument Co., 38-40 James St., East Providence 14, R. I.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.

Switches

LIMIT SWITCHES

Acro Electric Co., 1305 Superior Ave., Cleveland, Ohio
Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 2, Wis.
Allied Control Co., Inc., 2 East End Ave., New York 10, N. Y.
Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Atlas Products Corp., 30 Rockefeller Plaza, New York 20, N. Y.
Burling Instrument Co., 253 Springfield Ave., Newark, N. J.
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago 30, Ill.
Cutler-Hammer, Inc., 315 North 12th St., Milwaukee 1, Wisc.
Electronic Control Corp., 1573 E. Forest St., Detroit, Mich.
General Electric Co., Schenectady 5, N. Y.
Hetherington & Son, Inc., Robert, Sharon Hill, Pa.
Master Electric Co., 126 Davis Ave., Dayton, Ohio
Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill.
Micro Switch Div. of First Industrial Corp., 7 Spring St., Freeport, Ill.
Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave. S., Minneapolis, Minn.
Monitor Controller Co., 51 S. Gay St., Baltimore 2, Md.
Mu-Switch Corp., Canton 31, Mass.
Photoswitch, Inc 77 Broadway, Cambridge 42, Mass.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Titan Valve & Mfg. Co., 9913 Elk Ave., Cleveland, Ohio
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.
Ward Leonard Electric Co., 31 South St., Mt. Vernon, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Worner Electronic Devices, 609 West Lake St., Chicago 6, Ill.

MERCURY SWITCHES

Adams & Westlake Co., Michigan St., Elkhart, Ind.
Aerolux Light Corp., 653-11th Ave., New York 19, N. Y.
Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford, Conn.
Bacon Electric Timer Corp., 4513 Brooklyn Ave., Cleveland 9, Ohio
Brown Instrument Co., 4428 Wayne Ave., Philadelphia 44, Pa.
Cole-Hersee Co., 54 Old Colony Ave., Boston 27, Mass.
Durakool, Inc., 1010 N. Main St., Elkhart, Ind.
Electric Switch Corp., 14th at Union St., Columbus, Ind.
General Electric Co., Bridgeport, Conn.
H-B Electric Co., 6109 North 21st St., Philadelphia 38, Pa.
Littelfuse, Inc., 4755 Ravenswood Ave., Chicago, Ill.
Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill.
Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave., S., Minneapolis, Minn.
Pass & Seymour, Inc., Solvay Station, Syracuse, N. Y.
Sperti, Inc., Norwood Station, Cincinnati 12, Ohio
Westinghouse Electric Corp., East Pittsburgh, Pa.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.

PRECISION SNAP ACTION SPRING

Acro Electric Co., 1305 Superior Avenue, Cleveland, Ohio
Cole-Hersee Co., 54 Old Colony Ave., Boston 27, Mass.
Connecticut Telephone & Electric Div. of Great American Industries, Inc., 70 Brittania St., Meriden, Conn.
Cutler-Hammer, Inc., 315 North 12th St., Milwaukee 1, Wisc.
Electrical Products Supply Co., 1140 Venice Blvd., Los Angeles 15, Calif.
General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass.
General Electric Co., Schenectady 5, N. Y.
Grayhill Corp., 1 N. Pulaski Rd., Chicago, Ill.
Micro Switch Div. of First Industrial Corp., 7 Spring St., Freeport, Ill.
Mu-Switch Corp., 38 Pequit St., Canton 31, Mass.
Pass & Seymour, Inc., Solvay Station, Syracuse, N. Y.
Soreng Mfg. Corp., 1901 Clybourn Ave., Chicago 14, Ill.
Spencer Thermostat Co., 34 Forest St., Attleboro, Mass.
Standard Plastics, 1548 S. Robertson Blvd., Los Angeles 35, Calif.
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.

ROTARY and BAND CHANGE SWITCHES

Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 2, Wisc.
Autocall Co., 1142 Tucker Ave., Shelby, Ohio
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Birnbach Radio Co. Inc., 145 Hudson St., New York, N. Y.
Bristol Co., Waterbury 91, Conn.

Brown Instrument Co., 4428 Wayne Ave., Philadelphia 44, Pa.
Bryant Electric Co., Bridgeport 2, Conn.
Bud Radio, Inc., 2118 East 55 St., Cleveland 3, Ohio
Centralab Div., Globe Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc.
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Calif.
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago 30, Ill.
Clarostat Mfg. Co., Inc., 130 Clinton St., Brooklyn 1, N. Y.
Cole-Hersee Co., 54 Old Colony Ave., Boston 27, Mass.
Connecticut Telephone & Electric Div. of Great American Industries, Inc., 70 Brittania St., Meriden, Conn.
Cutler-Hammer, Inc., 315 North 12th St., Milwaukee 1, Wisc.
Daven Co., 191 Central Ave., Newark 4, N. J.
Eastern Air Devices, Inc., 585 Dean St., Brooklyn 17, N. Y.
Electronic Mechanics, Inc., 70 Clifton Blvd., Clifton, N. J.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass.
General Electric Co., Bridgeport, Conn.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Grayhill Corp., 1 N. Pulaski Rd., Chicago, Ill.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford 1, Conn.
JBL Instrument Co., 420 E. Providence Rd., Aldan, Pa.
J-B-T Instruments, Inc., 441 Chapel St., New Haven 8, Conn.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Marion Electrical Instrument Co., Manchester, N. H.
Metallic Arts Co., 243 Broadway, Cambridge, Mass.
Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave. S., Minneapolis, Minn.
Monitor Controller Co., 51 S. Gay St., Baltimore 2, Md.
Mossman, Inc., Donald P., 612 N. Michigan Ave., Chicago 11, Ill.
National Co., 61 Sherman St., Malden 48, Mass.
North Electric Mfg. Co., 501 S. Market St., Galion, Ohio
Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago 44, Ill.
Peerless Labs, 461 Tenth Ave., New York 18, N. Y.
Philmore Mfg. Co., 113 University Place, New York, N. Y.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Roller-Smith, Bethlehem, Pa.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Soreng Mfg. Corp., 1901 Clybourn Ave., Chicago 14, Ill.
Super Electric Products Corp., 1057 Summit Ave., Jersey City, N. J.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
Thwing-Albert Instrument Co., Penn St. & Pulaski Ave., Philadelphia 44, Pa.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Ucinite Co., 459 Watertown St., Newtonville, Mass.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Winslow Co., 31 Fulton St., Newark 2, N. J.
Wirt Co., 5221 Greene St., Philadelphia, Pa.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.

TIME SWITCHES

American Time Products, Inc., 580 Fifth Ave., New York 19, N. Y.
Ansonia Clock Co., Inc., 103 Lafayette St., New York 13, N. Y.
Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Atlas Products Corp., 30 Rockefeller Plaza, New York 20, N. Y.
Automatic Electric Mfg. Co., 10 State St., Mankato, Minn.
Automatic Temperature Control Co., 34 E. Logan St., Philadelphia 44, Pa.
Bacon Electric Timer Corp., 4513 Brooklyn Ave., Cleveland 9, Ohio
Cleveland Time Clock & Service Co., Superior Ave. at E. 27th St., Cleveland, Ohio
Cutler-Hammer, Inc., 315 North 12th St., Milwaukee 1, Wisc.
Cramer Co., R. W., Centerbrook, Conn.
Eagle Signal Corp., Moline, Ill.
Edison, Inc., Thomas A., Instrument Div., 51 Lakeside Ave., West Orange, N. J.
General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass.
General Electric Co., Schenectady 5, N. Y.
Haydon Manufacturing Co. Inc., Forestville, Conn.
Industrial Timer Corp., 117 Edison Pl., Newark 5, N. J.
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Calif.
Leich Electric Co., 565 W. Washington Blvd., Chicago 6, Ill.
Lektra Laboratories, Inc., 30 E. Tenth St., New York, N. Y.
Lumenite Electric Co., 407 S. Dearborn St., Chicago, Ill.
Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.
Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave., S. Minneapolis, Minn.
Northwestern Clock Co., 514-15 Brown Bldg., Omaha, Neb.
Paragon Electric Co., 37 W. Van Buren St., Chicago 5, Ill.
Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass.
Presto Electric Co., 4511 New York Ave., Union City, N. J.
Reliance Automatic Lighting Co., 1920 Mead St., Racine, Wis.
Reynolds Electric Co., 2650 W. Congress St., Chicago 12, Ill.
Rhodes, Inc., M. H., 30 Bartholomew Ave., Hartford, Conn.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Sangamo Electric Co., Springfield, Ill.
Schaar & Co., 754 W. Lexington St., Chicago 7, Ill.
States Co., 19 New Park Ave., Hartford 6, Conn.
Stoelting Co., C. H., 424 North Homan Ave., Chicago, Ill.
Techno-Scientific Co., 901 Nepperhan Ave., Yonkers 3, N. Y.
Thompson Clock Co., H. C., 38 Federal St., Bristol, Conn.
Tork Clock Co., 1 Grove St., Mount Vernon, N. Y.
Ulanet Co., George, 88 E. Kinney St., Newark 5, N. J. (thermal time delay)
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.
Wadsworth Electric Mfg. Co., Inc., 20 W. 11th St., Covington, Ky.
Walser Automatic Timer Co., 420 Lexington Ave., New York, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Worner Electronic Devices, 609 West Lake St., Chicago 6, Ill.
Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

TOGGLE and PUSHBUTTON SWITCHES

Acro Electric Co., 1305 Superior Ave., Cleveland, Ohio
Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 2, Wisc.
Allis Chalmers Mfg. Co., Milwaukee 1, Wisc.
Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford, Conn.
Atlas Products Corp., 30 Rockefeller Plaza, New York 20, N. Y.
Aviometer Corp., 370 West 35th St., New York 1, N. Y.
Birnbach Radio Co. Inc., 145 Hudson St., New York, N. Y.
Brown Instrument Co., 4428 Wayne Ave., Philadelphia 44, Pa.
Bryant Electric Co., Bridgeport 2, Conn.
Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio
Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif.
Centralab Div., of Globe Union, Inc., 900 E. Keefe Ave., Milwaukee, Wisc.
Clare & Co., C. P., 4719 Sunnyside Ave., Chicago 30, Ill.
Cole-Hersee Co., 54 Old Colony Ave., Boston 27, Mass.
Connecticut Telephone & Electric Div. of Great American Industries, Inc., 70 Brittania St., Meriden, Conn.
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Cutler-Hammer Inc., 315 North 12th St., Milwaukee 1, Wisc.
Electronic Control Corp., 1573 E. Forest St., Detroit, Mich.
Electronic Products Mfg. Co., 7300 Huron River Drive, Dexter, Mich.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass.
General Electric Co., Bridgeport, Conn.
General Electric Co., Schenectady, N. Y.
Gits Molding Corp., 4600 Huron St., Chicago, Ill.
Grayhill Corp., 1 N. Pulaski Rd., Chicago, Ill.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford 1, Conn.
Hetherington & Son, Inc., Robert, Sharon Hill, Pa.
Hubbell, Inc., Harvey, Bridgeport 2, Conn.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
J. F. D. Mfg. Co., 4111 Fort Hamilton Parkway, Brooklyn, N. Y.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Kulka Electric Mfg. Co., Inc., 30 South St., Mt. Vernon, N. Y.
Leece-Neville Co., 5363 Hamilton Ave., Cleveland 14, Ohio
Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Metallic Arts Co., 243 Broadway, Cambridge, Mass.
Micro Switch Div. of First Industrial Corp., 7 Spring St., Freeport, Ill.
Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave., S. Minneapolis, Minn.
Monitor Controller Co., 51 S. Gay St., Baltimore 2, Md.
Mossman, Inc., Donald P., 612 N. Michigan Ave., Chicago 11, Ill.
Mu-Switch Corp., Canton 31, Mass.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.
Pass & Seymour, Inc., Solvay Station, Syracuse, N. Y.
Philmore Mfg. Co., 113 University Place, New York, N. Y.
R.B.M. Mfg. Co., Div. of Essex Wire Corp., Logansport, Ind.
Remler Co., Ltd., 2101 Bryant St., San Francisco 10, Calif.
Shure Brothers, 225 W. Huron St., Chicago, Ill.
Signal Engineering & Mfg. Co., 154 West 14th Street, New York, N. Y.
Soreng Mfg. Corp., 1901 Clybourn Ave., Chicago 14, Ill.
Stackpole Carbon Co., St. Marys, Pa.
Ucinite Co., 459 Watertown St., Newtonville, Mass.
United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.
Warrick, Chas. F., 16251 Hamilton Ave., Detroit 3, Mich.
Westinghouse Electric Corp., East Pittsburgh, Pa.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.

Tape

CELLULOSE and PLASTIC TAPE

Acadia Synthetic Products Div., Western Felt Works, 4035 Ogden Ave., Chicago 23, Ill.
American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.
Bakelite Corp., 30 East 42nd St., New York 17, N. Y.
Dobeckmun Co., 3300 Monroe Ave., Cleveland, Ohio
Du Pont de Nemours & Co., Inc., E. I., Wilmington 98, Del.

Extruded Plastics, Inc., Norwalk, Conn.
General Electric Co., Schenectady 5, N. Y.
Industrial Screw & Supply Co., 713 W. Lake St., Chicago 6, Ill.
Industrial Synthetics Corp., 60 Woolsey St., Irvington, N. J.
Industrial Tape Corp., New Brunswick, N. J.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington 11, N. J.
Linton & Bro., Horace, 3081 Ruth St., Philadelphia, Pa.
Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
Minnesota Mining & Mfg. Co., 900 Fauquier Ave., St. Paul, Minn.
Mitchell-Rand Insulation Co., Inc., 51 Murray St., New York 7, N. Y.
National Varnished Products Corp., 211 Woodland Ave., Woodbridge, N. J.
Plax Corp., 133 Walnut St., Hartford 5, Conn.
Respro, Inc., Wellington Ave., Cranston, R. I.
Traver Corp., 358 W. Ontario St., Chicago 10, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wright & Sons Co., Wm. E., West Warren, Mass.

COTTON or SILK TAPE

Anchor Webbing Co., 1005 Main St., Pawtucket, R. I.
Carolina Narrow Fabric Co., 1036 N. Chestnut St., Winston-Salem, N. C.
Electro-Technical Products, Inc., Nutley 10, N. J.
Elizabeth Webbing Mills, Pawtucket, R. I.
General Electric Co., Bridgeport, Conn.
Goldmark Wire Co., James, 116 West St., New York 7, N. Y.
Hope Webbing Co., Providence, R. I.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.
Linton & Bro., Horace, 3081 Ruth St., Philadelphia, Pa.
Mica Insulator Co., 797 Broadway, Schenectady 1, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Mitchell-Rand Insulation Co., Inc., 51 Murray St., New York 7, N. Y.
National Varnished Products Corp., 211 Randolph Ave., Woodbridge, N. J.
Priscilla Braid Co., 1461 High St., Central Falls, R. I.
Sidebotham, Inc., John, 4317 Griscom St., Philadelphia, Pa.
Sullivan & Sons Mfg. Co., J., 2224 N. Ninth St., Philadelphia 33, Pa.
Westinghouse Electric Corp., East Pittsburg, Pa.
Wright & Sons Co., Wm. E., West Warren, Mass.

VARNISHED TAPE

B.&C. Insulation Products, Inc., 261 Fifth Ave., New York 16, N. Y.
Electro-Technical Products, Inc., Nutley 10, N. J.
Endurette Corp. of America, Cliffwood, N. J.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Bridgeport, Conn.
Goldmark Wire Co., James, 116 West St., New York 7, N. Y.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington 11, N. J.
Mica Insulator Co., 797 Broadway, Schenectady 1, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Mitchell-Rand Insulation Co. Inc., 51 Murray St., New York 7, N. Y.
National Varnished Products Corp., 211 Randolph Ave., Woodbridge, N. J.
New Jersey Wood Finishing Co., Inc., Electrical Insulation Dept., Woodbridge, N. J.
Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J.
Westinghouse Electric Corp., East Pittsburgh, Pa.

TAPES, TELEGRAPH

Foote Pierson & Co., Inc., 75 Hudson St., Newark 4, N. J.
Paper Manufacturers Co., Philadelphia 18, Pa.

Television Mirrors

see Mirrors

Television Receivers

see Receivers

Television Transmitters

see Transmitters

Terminal Plugs

see Plugs

Terminal Strips

see Posts, Binding

Terminals and Lugs

see Lugs

Test Equipment for Tube Mfrs.

see Tube Manufacturers, Test Equip.

Testers

BATTERY TESTERS

Burton-Rogers Co., 857 Boylston St., Boston 16, Mass.
Chaslyn Co., 1952 Irving Park Rd., Chicago 13, Ill.
Eagle Electric Mfg. Co., Inc., 23-10 Bridge Plaza S., Long Island City, N. Y.
Electric Heat Control Co., 9123 Inman Ave., Cleveland 5, Ohio
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
Franklin Transformer, 65-22nd Ave. N. E., Minneapolis 13, Minn.
General Electric Co., Bridgeport, Conn.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
McColpin-Christie Corp., Ltd., 4922 S. Figueroa St., Los Angeles 37, Calif.
Philco Corp., Tioga & C Sts., Philadelphia, 34, Pa.
Precison Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, L. I., N. Y.
Radio City Products Co., 127 West 26th St., New York, N. Y.
Radio Design Co., 1353 Sterling Place, Brooklyn, N. Y.
Sanborn Co., 39 Osborne St., Cambridge 39, Mass.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Sterling Mfg. Co., 9205 Detroit Ave., Cleveland, Ohio
Sun Mfg. Co., 6323 Avondale Ave., Chicago, Ill.
Supreme Instruments Corp., Greenwood, Miss.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
Willard Storage Battery Co., 246 East 131st Street, Cleveland 1, Ohio
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.

CAPACITOR TESTERS

Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
Clough-Brengle Co., 5501 N. Broadway, Chicago 22, Ill.
Communication Measurements Laboratory, 120 Greenwich St., New York, N. Y.
Connecticut Telephone & Electric Div. of Great American Industries, Inc., 70 Brittania St., Meriden, Conn.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electric Heat Control Co., 9123 Inman Ave., Cleveland 5, Ohio
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
Federal Instrument Co., 3931-47th Ave., Long Island City 4, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge, Mass.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio
Industrial Instruments, Inc., 156 Culver Ave., Jersey City 5, N. J.
Jackson Electrical Instrument Co., 16-18 S. Patterson Blvd., Dayton 1, Ohio
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Music Master Mfg. Co., 542 S. Dearborn St., Chicago 5, Ill.
Philco Corp., Tioga & C Sts., Philadelphia, 34, Pa.
Radio City Products Co., 127 West 26th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Design Co., 1353 Sterling Place, Brooklyn, N. Y.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Simpson Electric Co., 5218 W. Kinzie St., Chicago 44, Ill.
Solar Mfg. Corp., 285 Madison Ave., New York 17, N. Y.
Sprague Electric Co., North Adams, Mass.
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

ELECTRICAL METER TESTERS

Aerolux Light Corp., 653-11th Ave., New York 19, N. Y.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Cambridge Instrument Co., 3732 Grand Central Terminal, New York 17, N. Y.
Communication Measurements Laboratory, 120 Greenwich St., New York, N. Y.
Eagle Electric Mfg. Co., Inc., 23-10 Bridge Plaza S., Long Island City, N. Y.
Eastern Specialty Co., 3619 N. Eighth St., Philadelphia 40, Pa.
Electronic Measurements Co., Red Bank, N. J.
General Electric Co., Schenectady 5, N. Y.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Marion Electrical Instrument Co., Manchester, N. H.
McFarlin Co., 29 W. Marion Ave., Youngstown, Ohio
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Scientific Radio Products Co., 738 W. Broadway, Council Bluffs, Iowa
States Co., 19 New Park Ave., Hartford 6, Conn.
Superior Instruments Co., 227 Fulton St., New York 7, N. Y.
Supreme Instruments Corp., Greenwood, Miss.
Westinghouse Electric Corp., East Pittsburg, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

INSULATION TESTERS

Acme Electric & Mfg. Co., 31 Water St., Cuba, New York
American Transformer Co., 178 Emmet St., Newark, N. J.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Associated Research, Inc., 231 S. Green St., Chicago 7, Ill.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Communication Measurements Laboratory, 120 Greenwich St., New York, N. Y.
Electric Service Mfg. Co., 17th & Cambria Sts., Philadelphia 32, Pa.
Federal Instrument Co., 3931-47th Ave., Long Island City 4, N. Y.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
H-W Mfg. Co., 3124 Larga Ave., Los Angeles, Calif.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Holtzer Cabot. Signal Division, 400 Stuart St., Boston 17, Mass.
Ideal Commutator Dresser Co., 1291 Park Ave., Sycamore, Ill.

Industrial Instruments, Inc., 156 Culver Ave., Jersey City 5, N. J.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Miller Co., B. F., Trenton, N. J.
Radio City Products Co., 127 West 26th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Frequency Laboratories, Inc., Boonton, N. J.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Rubicon Co., 3751 Ridge Ave., Philadelphia, Pa.
Springfield Sound Co., Electronics Division, 12 Cass St., Springfield, Mass.
Sticht Co., Inc., Herman H., 27 Park Place, New York 7, N. Y.
Superior Instruments Co., 227 Fulton St., New York 7, N. Y.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.
U. S. Television Manufacturing Corp., 106 Seventh Ave., New York 11, N. Y.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
Winslow Co., 9 Liberty St., Newark 5, N. J.

SPRING TESTERS

Skyway Precision Tool Co., 3217 Casistas Ave., Los Angeles 26, Calif.

TUBE TESTERS

Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Clough-Brengle Co., 5501 N. Broadway, Chicago 22, Ill.
Dayco Radio Corp., 915 Valley St., Dayton 4, Ohio
Dayton Acme Co., 930 York St., Cincinnati, Ohio
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Grenby Mfg. Co., Plainville, Conn.
Hearing Aid Labs., 1404 Franklin St., Michigan City, Ind.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Jackson Electrical Instrument Co., 16-18 S. Patterson Blvd., Dayton 1, Ohio
Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.
Philco Corp., Tioga & C Sts., Philadelphia 34, Pa.
Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y.
Radio City Products Co., 127 W. 26th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radiotechnic Laboratory, 1328 Sherman Ave., Evanston, Ill.
Readrite Meter Works, College Ave., Bluffton, Ohio
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill.
Standard Instruments Corp., 568 Prospect Ave., New York 55, N. Y.
Superior Instruments Co., 227 Fulton St., New York 7, N. Y.
Supreme Instruments Corp., Greenwood, Miss.
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.
Technical Devices Corp., Beaufort & Eagle Rock Aves., Roseland, N. J.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

VIBRATION TESTERS

All American Tool & Mfg. Co., 1014 W. Fullerton St., Chicago 14, Ill.
Commercial Research Labs., Inc., 20 Bartlett Ave., Detroit 3, Mich.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
L. A. B. Corp., Summit, N. J.
MB Manufacturing Co., 1060 State St., New Haven, Conn.
Offner Electronics, Inc., 5320 N. Kedzie Ave., Chcago 25, Ill.
Scientific Radio Products Co., 738 W. Broadway, Council Bluffs, Iowa
Technical Products Co., 158 Madison Ave. at Third St., Memphis, Tenn.
Waugh Labs., Div. of Waugh Equipment Co., 420 Lexington Ave., New York 17, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Westinghouse Electric Corp., Industrial & X-Ray Divs., Baltimore 3, Md.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio

VOLTAGE TESTERS

Aerolux Light Corp., 653 Eleventh Ave., New York 19, N. Y.
American Transformer Co., 178 Emmet St., Newark, N. J.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Associated Research, Inc., 231 S. Green St., Chicago 7, Ill.
Electrical Facilities, Inc., 4224 Holden St., Oakland 8, Calif.
Electro Products Laboratories, 549 West Randolph St., Chicago, Ill.
Electronic Measurements Co., Red Bank, N. J.
Espey Mfg. Co., Inc., 33 West 46th St., New York 19, N. Y.
General Electric Co., Schenectady 5, N. Y.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio
Ideal Commutator Dresser Co., 1291 Park Ave., Sycamore, Ill.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City 5, N. J.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Lepel High Frequency Laboratories, 39 West 60th Street, New York, N. Y.
Miller Co., B. F., Trenton, N. J.
Northern Laboratories, Ltd., 3-01 27th Ave., Long Island City, N. Y.
Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y.
Radio City Products Co., 127 West 26th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Raytheon Mfg. Co., Waltham, Mass.
Roller-Smith, Bethlehem, Pa.
S-W Inductor Co., 1056 N. Wood St., Chicago, Ill.
Scientific Electric Div. of "S" Corrugated Quenched Gap Co., 111 Monroe St., Garfield, N. J.
Springfield Sound Co., Electronics Div., 12 Cass St., Springfield, Mass.
States Co., 19 New Park Ave., Hartford 6, Conn.
Takk Corporation, Newark, Ohio
Technical Apparatus Co., 1171 Tremont St., Boston 20, Mass.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Thermocouple Meters

see Meters

Thermocouples

VACUUM THERMOCOUPLES

Aerolux Light Corp., 653-11th Ave., New York 19, N. Y.
American Thermo-Electric Co., 67 East 8th St., New York 3, N. Y.
Avia Products Co., 7266 Beverly Blvd., Los Angeles 36, Calif.
Cambridge Instrument Co., 3732 Grand Central Terminal, New York 17, N. Y.
Engelhard, Inc., Charles, 233 N. J. R. R. Ave., Newark, N. J.
Eppley Laboratory, Inc., Newport, R. I.
Fenwal, Inc., Ashland, Mass.
Field Electric Instrument Co., 109 East 184th St., New York 53, N. Y.
Fredericks Co., Geo. E., Bethayres, Pa.
General Electric Co., Schenectady 5, N. Y.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Illinois Testing Laboratories, Inc., 420 N. LaSalle St., Chicago, Ill.
Jennings Radio Mfg. Co., 1098 E. William St., San Jose 12, Calif.
National Research Corp., Vacuum Engrg. Div., Boston 15, Mass.
Rawson Electrical Instrument Co., Inc., 110 Potter St., Cambridge 42, Mass.
Sensitive Research Instrument Co., 9 Elm Ave., Mt. Vernon, N. Y.
Sundt Engineering Co., 4757 Ravenswood Ave., Chicago, Ill.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.
Universal X-Ray Products Inc., 1800 North Francisco Ave., Chicago 47, Ill.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wheelco Instruments Corp., 847 W. Harrison St., Chicago 7, Ill.
Winslow Co., 9 Liberty St., Newark 5, N. J.
Xervac Instrument Co., 101 Vine St., Hartford 5, Conn.

Timers

AUTOMATIC CYCLE TIMERS

American Time Products, Inc., 580 Fifth Ave., New York 19, N. Y.
Ansonia Clock Co., Inc., 103 Lafayette St., New York 13, N. Y.
Auth Electrical Specialty Co., Inc., 422 East 53rd St., New York 22, N. Y.
Automatic Temperature Control Co., 34 E. Logan St., Philadelphia 44, Pa.
Barber-Colman Co., Rockford, Ill.
Bristol Co., Waterbury 91, Conn.
Cole-Hersee Co., 54 Old Colony Ave., Boston 27, Mass.
Cramer Co., R. W., Centerbrook, Conn.
Cutler-Hammer, Inc., 315 North 12th Street Milwaukee 1, Wisc.
Cyclotron Specialties Co., Moraga, Calif.
Eagle Signal Corp., Moline, Ill.
Electric Switch Corp., 14th at Union St., Columbus, Ind.
Electronic Measurements Co., Red Bank, N. J.
Foxboro Co., Foxboro, Mass.
General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass.
General Electric Co., Schenectady 5, N. Y.
Gorrell & Gorrell, 40 Littlefield Rd., Newton Centre, Mass.
Haydon Manufacturing Co., Inc., Forestville, Conn.
Holtzer-Cabot Signal Division, 400 Stuart St., Boston 17, Mass.
Industrial Timer Corp., 117 Edison Pl., Newark 5, N. J.
Luers, J. Milton, 12 Pine St., Mt. Clemens, Michigan
Lumenite Electric Co., 407 S. Dearborn St., Chicago, Ill.
Mallory & Co., Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
North Electric Mfg. Co., 501 S. Market St., Galion, Ohio
Paragon Electric Co., 37 W. Van Buren St., Chicago 5, Ill.
Philharmonic Radio Corp., 528 E. 72nd St., New York 21, N. Y.
Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass.
Portable Products Corp., C. J. Tagliabue Div., 550 Park Ave., Brooklyn 5, N. Y.
Potter Instrument Co., 136-56 Roosevelt Ave., Flushing, Long Island, N. Y.
Reynolds Electric Co., 2650 W. Congress St., Chicago 12, Ill.
Richardson-Allen Corp., 15 W. 20th St., New York 11, N. Y.
Rowe Radio Research Laboratory Co., 2422 N. Pulaski Rd., Chicago 39, Ill.
Sangamo Electric Co., Springfield, Ill.
Standard Electric Time Co., 89 Logan St., Springfield, Mass.
Stoelting Co., C. H., 424 N. Homan Ave., Chicago, Ill.
Stromberg Time Corp., 109 Lafayette St., New York, N. Y.
Struthers-Dunn, Inc., 1321 Arch St., Philadelphia 7, Pa.
Teleoptic Co., 1241 Mound Ave., Racine, Wisc.
Thompson Clock Co., H. C., 38 Federal St., Bristol, Conn.
Tork Clock Co., 1 Grove St., Mt. Vernon, N. Y.
Wallace & Tiernan Products, Inc., Belleville, N. J.

ELECTRONIC and ALLIED PRODUCTS

Walser Automatic Timer Co., 420 Lexington Ave., New York, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Worner Electronic Devices, 609 West Lake St., Chicago 6, Ill.
Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

AUTOMATIC INTERVAL TIMERS

Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 2, Wisc.
Allied Control Co., Inc., 2 East End Ave., New York 10, N. Y.
American Time Products, Inc., 580 Fifth Ave., New York 19, N. Y.
Ansonia Clock Co., Inc., 103 Lafayette St., New York 13, N. Y.
Automatic Electric Mfg. Co., 10 State St., Mankato, Minn.
Automatic Temperature Control Co., 34 E. Logan St., Philadelphia 44, Pa.
Bacon Electric Timer Corp., 4513 Brooklyn Ave., Cleveland 9, Ohio
Bristol Co., Waterbury 91, Conn.
Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio
Control Corp., 600 Stinson Blvd., Minneapolis, Minn.
Cyclotron Specialties Co., Moraga, Calif.
Cramer Co., R. W., Centerbrook, Conn.
Eagle Signal Corp., Moline, Ill.
Eastman Kodak Co., Rochester 4, N. Y.
Edison, Inc., Thomas A., Instrument Div., 51 Lakeside Ave., West Orange, N. J.
Electric Controller & Mfg. Co., 2694 East 79th St., Cleveland, Ohio
Electric Switch Corp., 14th at Union St., Columbus, Ind.
Electronic Control Corp., 1573 E. Forest St., Detroit, Mich.
Electronic Measurements Co., Red Bank, N. J.
Electronic Sound Engineering Co., 109 N. Dearborn St., Chicago 2, Ill.
Engineering Laboratories, Inc., 602 East Fourth St., Tulsa 3, Okla
Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
General Electric Co., Schenectady 5, N. Y.
General Electric X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill.
Gilbert Clock Co., Wm. M., Winsted, Conn.
Gorrell & Gorrell, 40 Littlefield Rd., Newton Centre, Mass.
Guardian Electric Mfg. Co., 1400 Washington Blvd., Chicago 7, Ill.
Haydon Manufacturing Co., Inc., Forestville, Conn.
Holtzer-Cabot Signal Division, 400 Stuart St., Boston 17, Mass.
Industrial Engineering Corp., Rea Building, Terre Haute, Ind.
Industrial Timer Corp., 117 Edison Pl., Newark 5, N. J.
Lektra Laboratories, Inc., 30 E. Tenth St., New York, N. Y.
Luers, J. Milton, 12 Pine St., Mt. Clemens, Michigan
Lumenite Electric Co., 407 S. Dearborn St., Chicago, Ill.
Lux Clock Manufacturing Co., Waterbury, Conn.
Mallory & Co. Inc., P. R., 3029 E. Washington St., Indianapolis 6, Ind.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave. S., Minneapolis, Minn.
National Electric Mfg. Co., 103 E. Ferry St., Berrien Springs, Michigan
Northwestern Clock Co., 514-15 Brown Bldg., Omaha, Neb.
Paragon Electric Co., 37 W. Van Buren St., Chicago 5, Ill.
Philharmonic Radio Corp., 528 E. 72nd St., New York 21, N. Y.
Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass.
Photovolt Corp., 95 Madison Ave., New York 16, N. Y.
Potter Instrument Co., 136-56 Roosevelt Ave., Flushing, Long Island, N. Y.
Rawson Electrical Instrument Co., Inc., 110 Potter St., Cambridge 42, Mass.
Reliance Automatic Lighting Co., 1920 Mead St., Racine, Wisc.
Reynolds Electric Co., 2650 W. Congress St., Chicago 12, Ill.
Richardson-Allen Corp., 15 W. 20th St., New York 11, N. Y.
Rieber, Inc., Frank 11916 W. Pico Blvd., Los Angeles 34, Calif.
Rowe Radio Research Laboratory, 2422 N. Pulaski Rd., Chicago 29, Ill.
Sangamo Electric Co., Springfield, Ill.
Schaar & Co., 754 W. Lexington St., Chicago 7, Ill.
Seth Thomas Clock, Div. of General Time Instrument Corp., Thomaston, Conn.
Signal Engineering & Manufacturing Co., 154 W. 14th St., New York, N. Y.
Sorenson & Co., 375 Fairfield Ave., Stamford, Conn.
Springfield Sound Co., Electronics Div., 12 Cass St., Springfield, Mass.
Standard Electric Time Co., 89 Logan St., Springfield, Mass.
Stoelting Co., C. H., 424 N. Homan Ave., Chicago, Ill.
Stromberg Time Corp., 109 Lafayette St., New York, N. Y.
Struthers-Dunn, Inc., 1321 Arch St., Philadelphia 7, Pa.
Technical Products Co., 158 Madison Ave., at Third St., Memphis, Tenn.
Teleoptic Co., 1241 Mound Ave., Racine, Wisc.
Thompson Clock Co., H. C., 38 Federal St., Bristol, Conn.
Tork Clock Co., 1 Grove St., Mt. Vernon, N. Y.
Union Switch & Signal Co., Swissvale, Pa.
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.
Wallace & Tiernan Products, Inc., Belleville, N. J.
Walser Automatic Timer Co., 420 Lexington Ave., New York, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

AUTOMATIC RESET TIMERS

American Type Founders, 11 West 42nd St., New York, N. Y.
Ansonia Clock Co., Inc., 103 Lafayette St., New York 13, N. Y.
Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Automatic Electric Mfg. Co., 10 State St., Mankato, Minn.
Automatic Temperature Control Co., 34 E. Logan St., Philadelphia 44, Pa.
Bristol Co., Waterbury 91, Conn.
Cramer Co., R. W., Centerbrook, Conn.
Eagle Signal Corp., Moline, Ill.
General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass.
Gorrell & Gorrell, 40 Littlefield Rd., Newton Centre, Mass.
Haydon Manufacturing Co., Inc., Forestville, Conn.
Holtzer-Cabot Signal Div., 400 Stuart St., Boston 17, Mass.
Industrial Timer Corp., 117 Edison Pl., Newark 5, N. J.
Luers, J. Milton, 12 Pine St., Mt. Clemens, Michigan
Lumenite Electric Co., 407 S. Dearborn St., Chicago, Ill.
Lux Clock Manufacturing Co., Waterbury, Conn.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
National Electric Mfg. Co., 103 E. Ferry St., Berrien Springs, Michigan
Paragon Electric Co., 37 W. Van Buren St., Chicago 5, Ill.
Partlow Corp., 2 Campion Rd., New Hartford, N. Y.
Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass.
Photovolt Corp., 95 Madison Ave., New York 16, N. Y.
Portable Products Corp., C. J., Tagliabue Div., 550 Park Ave., Brooklyn 5, N. Y.
Potter Instrument Co., 136-56 Roosevelt Ave., Flushing, Long Island, N. Y.
Reliance Automatic Lighting Co., 1920 Mead St., Racine, Wisc.
Richardson-Allen Corp., 15 W. 20th St., New York 11, N. Y.
Sangamo Electric Co., Springfield, Ill.
Schaar & Co., 754 W. Lexington St., Chicago 7, Ill.
Self Winding Clock Co., 205 Willoughby Avenue, Brooklyn 5, N. Y.
Sorensen & Co., 375 Fairfield Ave., Stamford, Conn.
Standard Electric Time Co., 89 Logan St., Springfield, Mass.
Stoelting Co. C. H., 424 North Homan Ave., Chicago, Ill.
Stromberg Time Corp., 109 Lafayette St., New York, N. Y.
Struthers-Dunn, Inc., 1321 Arch St., Philadelphia 7, Pa.
Technical Products Co., 158 Madison Ave., at Third St., Memphis, Tenn.
Teleoptic Co., 1241 Mound Ave., Racine, Wisc.
Tork Clock Co., 1 Grove St., Mt. Vernon, N. Y.
Ulanet Co., George, 88 E. Kinney St., Newark 5, N. J.
Westinghouse Electric Corp., East Pittsburg, Pa.
Worner Electronic Devices, 609 West Lake St., Chicago 6, Ill.
Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

PHOTO-ELECTRIC TIMERS

Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Cramer Co., R. W., Centerbrook, Conn.
Electronic Measurements Co., Red Bank, N. J.
Electronic Products Co., 19 North First St., Geneva, Ill.
General Electric Co., Schenectady 5, N. Y.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
National Electric Mfg. Co., 103 E. Ferry St., Berrien Springs, Mich.
Potter Instrument Co., 136-56 Roosevelt Ave., Flushing, Long Island, N. Y.
Richardson-Allen Corp., 15 W. 20th St., New York 11, N. Y.
Schaar & Co., 754 W. Lexington St., Chicago 7, Ill.
Sorensen & Co., 375 Fairfield Ave., Stamford, Conn.
Standard Electric Time Co., 89 Logan St., Springfield, Mass.
Stoelting Co., C. H., 424 North Homan Ave., Chicago, Ill.
Technical Products Co., 158 Madison Ave., at Third St., Memphis, Tenn.
United Cinephone Corp., 65 New Litchfield St., Torrington, Conn.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Worner Electronic Devices, 609 West Lake St., Chicago 6, Ill.

WELDING TIMERS

Clark Controller Co., 1146 East 152nd St., Cleveland, Ohio
Eisler Engineering Co., 740 S. 13th St., Newark 3, N. J.
Electric Controller & Mfg. Co., 2694 East 79th St., Cleveland, Ohio
Electronic Products Co., 19 N. First St., Geneva, Ill.
General Electric Co., Schenectady 5, N. Y.
Glenn-Roberts Co., 3100 E. Tenth St., Oakland 1, Calif.
Pier Equipment Mfg. Co., Benton Harbor, Mich.
Weltronic Co., 3080 E. Outer Drive, Detroit 17, Mich.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Tools

SCREWDRIVERS and SMALL INSULATED TOOLS

Atlas Tool & Designing Co., Castor & Kensington Aves., Philadelphia 24, Pa.
Bonney Forge & Tool Works, Allentown, Pa.
Bridgeport Hardware Mfg. Corp., Iranistan Ave., Bridgeport, Conn.
Burndy Engrg. Co., Inc., 107 Bruckner Blvd., New York 54, N. Y.
Detroit Power Screwdriver Co., 2801 W. Fort St., Detroit 16, Mich. (Magazine Feed Power Screwdriver)
Dumore Co., 14th & Racine Sts., Racine, Wisc.
Eastern Specialty Co., 3617-19 N. Eighth St., Philadelphia 40, Pa.
Fairmount Tool & Forge Co., 10611 Quincy Ave., Cleveland, Ohio
General Cement Mfg. Co., 919 Taylor, Rockford, Ill.
Greenlee Tool Co., 2136 Twelfth St., Rockford, Ill.
Hy-Pro Tool Co., New Bedford, Mass.
Invincible Tool Co., 611 Empire Bldg., Pittsburgh 22, Pa.
Linick & Co., Leslie L., 29 E. Madison St., Chicago, Ill.
O'Neil-Irwin Mfg. Co., 316 Eighth Ave., S. Minneapolis 15, Minn.
Park Metalware Co., 28 Bank St., Orchard Park, N. Y.
Richmont, Inc., 215 W. Seventh St., Los Angeles 14, Calif.
Scherr, George D., 128 Lafayette St., New York, N. Y.
Speedway Mfg. Co., 1834 South 52nd Ave., Cicero 50, Ill.
Stanley Works, New Britain, Conn.

Stedman, Robert L., Oyster Bay, New York.
Stevens Walden, Inc., 459 Schrewsbury St., Worcester, Mass.
Tuck Mfg. Co., 74 Ames St., Brockton 64, Mass.
Utica Drop Forge & Tool Corp., 2415 Whitesboro St., Utica 4, N. Y.
Vaco Products Co., 317 E. Ontario St., Chicago 11, Ill.
Webster Chicago Corp., Manufacturing Div., 5622 Bloomingdale Ave., Chicago 39, Ill.
Willor Mfg. Co., 794 East 140th St., New York 54, N. Y.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio

Transceivers

ARF Products Co., 7627 W. Lake St., River Forest, Ill.
Aireon Mfg. Corp., Kansas City 15, Kans.
Bendix Radio Corp., Baltimore 4, Md.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
General Electric Co., Bridgeport, Conn.
Hallicrafters Co., 2611 S. Indiana Ave., Chicago 16, Ill.
Herbach & Rademan Co., 517 Ludlow St., Philadelphia 6, Pa.
Hoffman Radio Corp., 3430 S. Hill St., Los Angeles, Calif.
Lear, Inc., Piqua, Ohio
Meck Industries, John, Liberty at Pennsylvania, Plymouth, Ind.
Medco Mfg. Co., 5 West 45th St., New York, N. Y.
Megard Corp., 1601 S. Burlington Ave., Los Angeles 6, Calif.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Receptor Co., Inc., 251 West 19th St., New York, N. Y.
Raytheon Mfg. Co., 60 East 42nd St., New York, N. Y.
Remler Co., Ltd., 2101 Bryant St., San Francisco, Calif.
Searle Aero Industries, Inc., Orange, Calif.
Tech-Master Products Co., 123 Prince St., New York, N. Y.
United States Television Mfg. Corp., 106 Seventh Ave., New York, N. Y.
Westinghouse Electric Corp., 2519 Wilkens Ave., Baltimore 3, Md.

Transformers

AUDIO & POWER TRANSFORMERS

Acme Electric & Mfg. Co., 31 Water St., Cuba, N. Y.
Advance Transformer Co., 14 N. May St., Chicago, Ill.
Airdesign & Fabrication, Inc., 241 Fairfield Ave., Upper Darby, Pa.
Allis Chalmers Mfg. Co., Milwaukee 1, Wisc.
Altec Lansing Corp., 1680 N. Vine St., Los Angeles 28, Calif.
American Television & Radio Co., 300 East Fourth Street, St. Paul 1, Minn.
American Transformer Co., 178 Emmett St., Newark, N. J.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Audio Development Co., 2833 13th Ave., S., Minneapolis 7, Minn.
Automatic Mfg. Co., 900 Passaic Ave., E. Newark, N. J.
Belmont Radio Corp., 5921 W. Dickens Ave., Chicago, Ill.
Best Mfg. Co., Inc., 1200 Grove St., Irvington 1, N. J.
Chicago Transformer Div., Essex Wire Corp., 3501 W. Addison St., Chicago 18, Ill.
Cinaudagraph Speakers, Inc., 3911 S. Michigan Ave., Chicago, Ill.
Consolidated Radio Products Co., 350 W. Erie St., Chicago 10, Ill.
Control Corp., 600 Stinson Blvd., Minneapolis, Minn.
Davis & Co., Inc., Dean W., Kentland, Ind.
Dinion Coil Co., Inc., 1 North St., Caledonia, N. Y.
Dongan Electric Mfg. Co., 2987 Franklin St., Detroit, Mich.
DX Crystal Co., 1200 N. Claremont Ave., Chicago 22, Ill.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Eastern Specialty Co., 3617-19 N. Eighth St., Philadelphia 40, Pa.
Electric Heat Control Co., 9123 Inman Ave., Cleveland 5, Ohio
Electrical Specialty Co., 2304 Washington St., Boston, Mass.
Electricoil Transformer Co., 421 Canal St., New York 13, N. Y.
Electron Equipment Corp., 917 Meridian Ave., South Pasadena, Calif.
Electronic Components, 423 N. Western Ave., Los Angeles 4, Calif.
Electronic Engineering Co., 3223 West Armitage Ave., Chicago, Ill.
Electronic Transformer Co., 207 W. 25th St., New York, N. Y.
Erie Electric Co., 120 Church St., Buffalo, N. Y.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.
Foster Co., A. P., 719 Wyoming Ave., Lockland 15, Ohio
France Mfg. Co., 10325 Berea Rd., Cleveland, Ohio
Freed Transformer Co., 72 Spring St., New York 12, N. Y.
Gardner Electric Mfg. Co., 4227 Hollis St., Emeryville 8, Calif.
General Electric Co., Schenectady 5, N. Y.
General Transformer Corp., 1250 W. Van Buren St., Chicago 7, Ill.
Glenn Roberts Co., 3100 East Tenth St., Oakland 1, Calif.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Gramer Co., 2734 N. Pulaski Rd., Chicago 39, Ill.
Guided Radio Corp., 161 Sixth Ave., New York 13, N. Y.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Calif.
Halldorson Company, The, 4500 Ravenswood Ave., Chicago 28, Ill.
Heinze Electric Co., Lowell, Mass.
Hercules Electric & Mfg. Co., Inc., 2500 Atlantic Ave., Brooklyn 7, N. Y.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles 36, Calif.
Hudson American Corp., 25 W. 43rd St., New York, N. Y.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
International Transformer Co., 396 Broadway, New York, N. Y.
Jefferson Electric Co., Bellwood, Ill.
Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill.
Kegron Mfg. Co., Inc., 18 West 20th St., New York 11, N. Y.
Kenyon Transformer Co., 840 Barry St., New York 59, N. Y.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Kyle Corp., South Milwaukee, Wisc.
Langevin Co., Inc., 37 West 65th St., New York, N. Y.
Magnavox Co., The, 2131 Bueter Road, Fort Wayne 4, Ind.
Magnetic Windings Co., Div. of Essex Wire Corp., 416 South 16th St., Easton, Pa.
Merit Coil & Transformer Corp., 4427 N. Clark St., Chicago 40, Ill.
Moloney Electric Co., 5390 Bircher Blvd., St. Louis 20, Mo.
National Co., 61 Sherman St., Malden 48, Mass.
National Mineral Co., 2628 N. Pulaski Rd., Chicago 39, Ill.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
New York Transformer Co., 26 Waverly Place, New York 3, N. Y.
Newark Transformer Co., 17 Frelinghuysen Ave., Newark, N. J.
Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles 18, Calif.
Northern Communications Mfg. Co., 210 East 40th St., New York, N. Y.
Peerless Electrical Products Co., 6920 McKinley Ave., Los Angeles 1, Calif.
Peerless Laboratories, 461 Tenth Ave., New York 18, N. Y.
Permoflux Corp., 4900 W. Grand Ave., Chicago, Ill.
Philmore Mfg. Co., 113 University Place, New York, N. Y.
Precision Transformer Co., 733 West Ohio St., Chicago 10, Ill.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radionic Controls Inc., 3758 Belmont Ave., Chicago 18, Ill.
Radionic Transformer Co., 411 S. Sangamon St., Chicago, Ill.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Red Arrow Electric Corp., 100 Coit St., Irvington, N. J.
Rola Co., Inc., 2530 Superior Ave., Cleveland, Ohio
Scientific Electric Div. of "S" Corrugated Quenched Gap Co., 111 Monroe St., Garfield, N. J.
Smith Mfg. Co., Nathan R., 105 Pasadena Ave., South Pasadena, Calif.
Sola Electric Co., 2525 Clybourn Ave., Chicago 14, Ill.
Sonotone Corp., P. O. Box 200, Saw Mill River Road, Elmsford, N. Y.
Sorensen & Co., 375 Fairfield Ave., Stamford, Conn.
Standard Electrical Products Co., 400 Linden Ave., Dayton 3, Ohio
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
States Co., 19 New Park Ave., Hartford 6, Conn.
Stockwell Transformer Corp., 569 S. Main St., Akron, Ohio
Super Electric Products Corp., 1057 Summit Ave., Jersey City, N. J.
Superior Electric Co., 83 Laurel St., Bristol, Conn.
Swain Nelson Co., 2320 Glenview Rd., Glenview, Ill.
Telex Products Co., Telex Park, Minneapolis 1, Minn.
Thermador Electric Mfg. Co., 5119 S. Riverside Drive, Los Angeles 22, Calif.
Thordarson Electric Mfg. Div., Maguire Industries, Inc., 500 W. Huron St., Chicago 10, Ill.
Transformer Products, Inc., 143 W. 51st St., New York, N. Y.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
Uptegraff Mfg. Co., R. E., Scottdale, Pa.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Walsh Engineering Co., 34 DeHart Place, Elizabeth, N. J.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wheeler Insulated Wire Co., Inc., 378 Washington Ave., Bridgeport, Conn.
Whisk Laboratories, 87 Maiden Lane, New York 7, N. Y.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio

CURRENT TRANSFORMERS

Advance Transformer Co., 14 N. May St., Chicago, Ill.
Airdesign & Fabrication, Inc., 241 Fairfield Ave., Upper Darby, Pa.
Allis Chalmers Mfg. Co., Milwaukee 1, Wis.
American Television & Radio Co., 300 East Fourth St., St. Paul 1, Minn.
American Transformer Co., 178 Emmett St., Newark, N. J.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Annis Co., R. B., 1101 N. Delaware St., Indianapolis 2, Ind.
Associated Research, Inc., 231 S. Green St., Chicago 7, Ill.
Burlington Instrument Corp., 214 North 4th St., Burlington, Iowa
Chicago Transformer Div., Essex Wire Corp., 3501 W. Addison St., Chicago 18, Ill.
Cinaudagraph Speakers, Inc., 3911 S. Michigan Ave., Chicago, Ill.
Davis & Co., Dean W., Kentland, Ind.
Dinion Coil Co., Inc., North St., Caledonia, N. Y.
Eastern Specialty Co., 3619 N. Eighth St., Philadelphia 40, Pa.
Eisler Engineering Co., 740 South 13th St., Newark 3, N. J.
Electrical Facilities, Inc., 4224 Holden St., Oakland 8, Calif.
Electricoil Transformer Co., 421 Canal St., New York 13, N. Y.
Electron Equipment Corp., 917 Meridian Ave., South Pasadena, Calif.
Electronic Engineering Co., 3223 West Armitage Ave., Chicago, Ill.
Electronic Transformer Co., 207 W. 25th St., New York, N. Y.
Engineering Laboratories, Inc., 602 East Fourth St., Tulsa 3, Okla.
Esterline Angus Co., Inc., P. O. Box 596, Indianapolis, Ind.
Federal Telephone & Radio Corp., 591 Broad St., Newark, N. J.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.
Freed Transformer Co., 72 Spring St., New York 12, N. Y.
General Controls Co., 801 Allen Ave., Glendale, Calif.

ELECTRONIC and ALLIED PRODUCTS

General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
General Transformer Corp., 1250 W. Van Buren St., Chicago 7, Ill.
Glenn Roberts Co., 3100 East Tenth St., Oakland 1, Calif.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala, Nebr.
Hadley Co., Robert M., 711 East 61st St., Los Angeles, Calif.
Halldorson Company, 4500 Ravenswood Ave., Chicago 28, Ill.
Hercules Electric & Mfg. Co., Inc., 2500 Atlantic Ave., Brooklyn 7, N. Y.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Jefferson Electric Co., Bellwood, Ill.
Johnson, E. F., Co., Waseca, Minn.
Kyle Corp., South Milwaukee, Wis.
Langevin Co., Inc., 37 West 65th St., New York, N. Y.
Merit Coil & Transformer Corp., 4427 N. Clark St., Chicago 40, Ill.
Moloney Electric Co., 5390 Bircher Blvd., St. Louis 20, Mo.
National Mineral Co., 2628 N. Pulaski Rd., Chicago 39, Ill.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
New York Transformer Co., 26 Waverly Place, New York 3, N. Y.
Newark Transformer Co., 17 Frelinghuysen Ave., Newark, N. J.
Niagara Electric Improvement Corp., 51 East 42nd St., New York, N. Y.
Northelfer Winding Labs., 111 Albermarle Ave., Trenton, N. J.
Peerless Laboratories, 461 Tenth Ave., New York 18, N. Y.
Presto Electric Corp., 4511 New York Ave., Union City, N. J.
Radionic Transformer Co., 411 S. Sangamon St., Chicago, Ill.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Red Arrow Electric Corp., 100 Colt St., Irvington, N. J.
Scientific Electric Div. of "S" Corrugated Quenched Gap Co., 111 Monroe St., Garfield, N. J.
Sola Electric Co., 2525 Clybourn Ave., Chicago 14, Ill.
Super Electric Products Corp., 1057 Summit Ave., Jersey City, N. J.
Superior Electric Co., 83 Laurel St., Bristol, Conn.
Thordarson Electric Mfg. Div., Maguire Industries, Inc., 500 W. Huron St., Chicago 10, Ill.
Transformer Products. Inc., 143 W. 51st St., New York, N. Y.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
Uptegraff Mfg. Co., R. E., Scottdale, Pa.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Walsh Engineering Co., 34 Dehart Place, Elizabeth, N. J.
Welch Scientific Co., W. M., 1515 Sedgwick St., Chicago 10, Ill.
Western Electro-Mechanical Co., 300 Broadway, Oakland, Calif.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
Wheeler Insulated Wire Co., Inc., 378 Washington Ave., Bridgeport, Conn.
Whisk Laboratories, 87 Maiden Lane, New York 7, N. Y.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio

INSTRUMENT TRANSFORMERS

Allis Chalmers Mfg. Co., Milwaukee 1, Wis.
American Transformer Co., 178 Emmett St., Newark, N. J.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Annis Co., R. B., 1101 N. Delaware St., Indianapolis 2, Ind.
Associated Research, Inc., 231 S. Green St., Chicago 7, Ill.
Automatic Mfg. Co., 900 Passaic Ave., E. Newark, N. J.
Best Mfg. Co., Inc., 1200 Grove St., Irvington 1, N. J.
Boes Co., W. W., 3001 Salem Ave., Dayton 3, Ohio
Burlington Instrument Corp., 214 North 4th St., Burlington, Ia.
Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass.
Chicago Transformer Div., Essex Wire Corp., 3501 W. Addison St., Chicago 18, Ill.
Davis & Co., Inc., Dean W., Kentland, Ind.
Dinion Coil Co. Inc., 1 North St., Caledonia, N. Y.
Eastern Specialty Co., 3617-19 N. Eighth St., Philadelphia 40, Pa.
Eisler Engineering Co., 740 South 13th St., Newark 3, N. J.
Electrical Facilities, Inc., 4224 Holden St., Oakland 8, Calif.
Electronic Engineering Co., 3223 West Armitage Ave., Chicago, Ill.
Electronic Transformer Co., 207 West 25th St., New York, N. Y.
Engineering Laboratories, Inc., 602 East Fourth St., Tulsa 3, Okla.
Erie Electric Co., 120 Church St., Buffalo, N. Y.
Esterline-Angus Co., Inc., P. O. Box 596, Indianapolis, Ind.
Ferranti Electric Inc., 30 Rockefeller Plaza, New York 20, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
General Transformer Corp., 1250 W. Van Buren St., Chicago 7, Ill.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles 36, Calif.
International Transformer Co., 396 Broadway, New York, N. Y.
Johnson Co., E. F., Waseca, Minn.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Magnetic Windings Co., Div. of Essex Wire Corp., 416 South 16th St., Easton, Pa.
Merit Coil & Transformer Corp., 4427 N. Clark St., Chicago 40, Ill.
National Co., 61 Sherman St., Malden 48, Mass.
National Mineral Co., 2628 N. Pulaski Rd., Chicago 39, Ill.
New York Transformer Co., 26 Waverly Place, New York 3, N. Y.
Newark Transformer Co., 17 Frelinghuysen Ave., Newark, N. J.
Niagara Electric Improvement Corp., 51 East 42nd St., New York, N. Y.
Northern Communications Mfg. Co., 210 East 40th St., New York, N. Y.
Presto Electric Co., 4511 New York Ave., Union City, N. J.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radionic Transformer Co., 411 S. Sangamon St., Chicago, Ill.
Red Arrow Electric Corp., 100 Colt St., Irvington, N. J.
Roller-Smith, Bethlehem, Pa.
Scientific Electric Div. of "S" Corrugated Quenched Gap Co., 111 Monroe St., Garfield, N. J.
Sparkes Mfg. Co., 318 Jefferson St., Newark, N. J.
Super Electric Products Corp., 1057 Summit Ave., Jersey City, N. J.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
Uptegraff Mfg. Co., R. E., Scottdale, Pa.
Walsh Engineering Co., 34 De Hart Place, Elizabeth, N. J.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
Wheeler Insulated Wire Co., Inc., 378 Washington Ave., Bridgeport, Conn.
Whisk Laboratories, 87 Maiden Lane, New York 7, N. Y.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio

RF AND IF TRANSFORMERS

Aladdin Radio Industries, Inc., 501 W. 35th St., Chicago 16, Ill.
Automatic Mfg. Co., 900 Passaic Ave., East Passaic, N. J.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Best Mfg. Co., Inc., 1200 Grove St., Irvington 1, N. J.
Bridgeport Mfg. Co., Bridgeport, Ill.
Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass.
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Control Corp., 600 Stinson Blvd., Minneapolis, Minn.
DX Crystal Co., 1200 N. Claremont Ave., Chicago 22, Ill.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electrical Specialty Co., 2304 Washington St., Boston, Mass.
Electricoil Transformer Co., 421 Canal St., New York 13, N. Y.
Electronic Transformer Co., 207 W. 25th St., New York, N. Y.
Electronic Winding Co., 5031 Broadway, Chicago 40, Ill.
Engineering Laboratories, Inc., 602 East Fourth St., Tulsa 3, Okla.
Essex Electronics 1060 Broad St., Newark 2, N. J.
Federal Instrument Co., 3931 47th Ave., Long Island City 4, N. Y.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.
Franklin Transformer Mfg. Co., 65 22nd Ave., N. E., Minneapolis 13, Minn.
General Electric Co., Schenectady 5, N. Y.
General Winding Co., 420 West 45th St., New York, N. Y.
Guthman & Co., E. I., 15 S. Throop St., Chicago, Ill.
Hammarlund Mfg. Co., Inc., 460 W. 34th St., New York 1, N. Y.
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Hercules Electric & Mfg. Co., Inc., 2500 Atlantic Ave., Brooklyn 7, N. Y.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
Johnson Co. E. F., Waseca, Minn.
Knickerbocker Development Corp., 116 Little St., Belleville 9, N. J.
Lawton Products Co., Inc., 624 Madison Ave., New York 22, N. Y.
Meissner Mfg. Div., Maguire Industries, Inc., Mt. Carmel, Ill.
Merit Coil & Transformer Corp., 4427 N. Clark St., Chicago 40, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., Inc., 61 Sherman St., Malden 48, Mass.
National Mineral Co., 2628 N. Pulaski Rd., Chicago 39, Ill.
New England Radiocrafters, 1156 Commonwealth Ave., Boston 34, Mass.
Philmore Mfg. Co., 113 University Place, New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
S-W Inductor Co., 1056 N. Wood St., Chicago, Ill.
Scientific Electric Div. of "S" Corrugated Quenched Gap Co., 111 Monroe St., Garfield, N. J.
Sickles Co., F. W., 165 Front St., Chicopee, Mass.
Sonora Radio & Television Corp., 325 N. Hoyne Ave., Chicago 12, Ill.
Sound Equipment Corp. of California, 3903 San Fernando Road, Glendale 4, Calif.
Standard Coil Products Co., 2329 N. Pulaski Rd., Chicago 18, Ill.
Super Electric Products Corp., 1057 Summit Ave., Jersey City, N. J.
Swain Nelson Co., 2320 Glenview Rd., Glenview, Ill.
Teleradio Engineering Corp., 99 Wall St., New York 5, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wyse Laboratories, 211 S. Ludlow St., Dayton 2, Ohio

TRANSMITTER TRANSFORMERS

Advance Transformer Co., 14 N. May St., Chicago, Ill.
Airdesign & Fabrication, Inc., 241 Fairfield Ave., Upper Darby, Pa.
American Transformer Co., 178 Emmett St., Newark, N. J.
Audio Development Co., 2833-13th Ave. S., Minneapolis 7, Minn.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Chicago Transformer Div., Essex Wire Corp., 3501 W. Addison St., Chicago 18, Ill.
Davis & Co., Inc., Dean W., Kentland, Ind.
Dinion Coil Co., Inc., Caledonia, N. Y.
Eisler Engineering Co., 740 South 13th St., Newark 3, N. J.
Electricoil Transformer Co., 421 Canal St., New York 13, N. Y.
Electronic Engineering Co., 3223 West Armitage Ave., Chicago, Ill.
Electronic Transformer Co., 207 W. 25th St., New York, N. Y.
Engineering Laboratories, Inc., 602 East Fourth St., Tulsa 3, Okla.

Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.
Foster Co., A. P., 719 Wyoming Ave., Lockland 15, Ohio
Freed Transformer Co., 72 Spring St., New York 12, N. Y.
Gardner Electric Mfg. Co., 4227 Hollis St., Emeryville 8, Calif.
General Electric Co., Schenectady 5, N. Y.
Glenn Roberts Co., 3100 East Tenth St., Oakland 1, Calif.
Gramer Co., 2734 N. Pulaski Rd., Chicago 39, Ill.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Calif.
Halldorson Company, 4500 Ravenswood Ave., Chicago 28, Ill.
Hercules Electric & Mfg. Co., Inc., 2500 Atlantic Ave., Brooklyn 7, N. Y.
Hudson American Corp., 25 W. 43rd St., New York, N. Y.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
International Transformer Co., 396 Broadway, New York, N. Y.
Jefferson Electric Co., Bellwood, Ill.
Kenyon Transformer Co., 840 Barry St., New York 59, N. Y.
Kyle Corp., South Milwaukee, Wisc.
Langevin Co., Inc., 37 West 65th St., New York, N. Y.
Lewyt Corp., 60 Broadway, Brooklyn, N. Y.
Magnetic Windings Co., Div. of Essex Wire Corp., 416 South 16th St., Easton, Pa.
National Mineral Co., 2628 N. Pulaski Rd., Chicago 39, Ill.
New York Transformer Co., 26 Waverly Place, New York 3, N. Y.
Newark Transformer Co., 17 Frelinghuysen Ave., Newark, N. J.
Northern Communications Mfg. Co., 210 East 40th St., New York, N. Y.
Northelfer Winding Labs., 111 Albemarle Ave., Trenton, N. J.
Peerless Electrical Products Co., 6920 McKinley Ave., Los Angeles 1, Calif.
Precision Transformer Co., 733 West Ohio St., Chicago 10, Ill.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radionic Controls, Inc., 3758 Belmont Ave., Chicago, Ill.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Rola Co., Inc., 2530 Superior Ave., Cleveland, Ohio
Scientific Electric Div. of "S" Corrugated Quenched Gap Co., 111 Monroe St., Garfield, N. J.
Sola Electric Co., 2525 Clybourn Ave., Chicago 14, Ill.
Sorenson & Company, 375 Fairfield Ave., Stamford, Conn.
Standard Electrical Products Co., 400 Linden Ave., Dayton 3, Ohio
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Super Electric Products Corp., 1057 Summit Ave., Jersey City, N. J.
Thermador Elec. Mfg. Co., 5119 S. Riverside Drive, Los Angeles 22, Calif.
Thordarson Electric Mfg. Div., Maguire Industries, Inc., 500 W. Huron St., Chicago 10, Ill.
Transformer Products, Inc., 143 W. 51st St., New York, N. Y.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wheeler Insulated Wire Co., Inc., 378 Washington Ave., Bridgeport, Conn.
Whisk Laboratories, 87 Maiden Lane, New York 7, N. Y.

VOLTAGE REGULATING TRANSFORMERS

Acme Electric & Mfg. Co., 31 Water St., Cuba, N. Y.
Airdesign & Fabrication, Inc., 241 Fairfield Ave., Upper Darby, Pa.
American Transformer Co., 178 Emmett St., Newark, N. J.
Amplifier Co. of America, 396 Broadway, New York, N. Y.
Davis & Co., Inc., Dean W., Kentland, Ind.
Eisler Engineering Co., 740 South 13th St., Newark 3, N. J.
Electrical Specialty Co., 2304 Washington St., Boston, Mass.
Electron Equipment Corp., 917 Meridian Ave., South Pasadena, Calif.
Electronic Engineering Co., 3223 W. Armitage Ave., Chicago, Ill.
Electronic Transformer Co., 207 W. 25th St., New York, N. Y.
Ferranti Electric Co., 30 Rockefeller Plaza, New York 20, N. Y.
Freed Transformer Co., 72 Spring St., New York 12, N. Y.
General Electric Co., Schenectady 5, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Gulow Corp., 26 Waverly Place, New York 3, N. Y.
Halldorson Company, 4500 Ravenswood Ave., Chicago 28, Ill.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
International Transformer Co., 396 Broadway, New York, N. Y.
National Mineral Co., 2628 N. Pulaski Rd., Chicago 39, Ill.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radionic Transformer Co., 411 S. Sangamon St., Chicago, Ill.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Scientific Electric Div. of "S" Corrugated Quenched Gap Co., 111 Monroe St., Garfield, N. J.
Sola Electric Co., 2525 Clybourn Ave., Chicago 14, Ill.
Sorensen & Co., 375 Fairfield Ave., Stamford, Conn.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Stockwell Transformer Corp., 569 S. Main St., Akron, Ohio
Superior Electric Co., 83 Laurel St., Bristol, Conn.
Thordarson Electric Mfg. Div., Maguire Industries, Inc., 500 W. Huron St., Chicago 10, Ill.
Transformer Products Inc., 143 W. 51st St., New York, N. Y.
United Transformer Corp., 150 Varick St., New York 13, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wheeler Insulated Wire Co., Inc., 378 Washington Ave., Bridgeport, Conn.
Whisk Laboratories, 87 Maiden Lane, New York 7, N. Y.

Transmitters

Abbott Instrument Inc., 8 W. 18th St., New York, N. Y.
Aero Communications, Inc., 231 Main St., Hempstead, L. I., N. Y.
Air Associates, Inc., 5827 W. Century Blvd., Los Angeles 45, Calif.
Air Communications, Inc., 2233 Grand Ave., Kansas City 8, Mo.
Air King Products Co., Inc., 1523 63rd St., Brooklyn, N. Y.
Airadio, Inc., Melrose Ave. & Battery Pl., Stamford, Conn.
Aireon Manufacturing Corp., Fairfax & Funston Rds., Kansas City 15, Kansas
Aircraft Radio Corp., Boonton, N. J.
Airplane & Marine Instruments Inc., Clearfield, Pa.
American Communications Corp., 306 Broadway, New York, N. Y.
American Radio Co., 611 E. Garfield Ave., Glendale, Calif.
Arnessen Electric Co., 116 Broad St., New York, N. Y.
Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.
Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.
Bassett, Inc., Rex., 500 S. E. Second St., Ft. Lauderdale, Fla.
Belmont Radio Corp., 5921 W. Dickens Ave., Chicago, Ill.
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, North Hollywood, Calif.
Bendix Radio Div., Bendix Aviation Corp., Baltimore 4, Md.
Boehme, Inc., H. O., 915 Broadway, New York, N. Y.
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Collins Radio Co., 855-35th St. N. E., Cedar Rapids, Iowa
Colonial Radio Corp., 254 Rano St., Buffalo 7, N. Y.
Communications Co., Inc., 300 Greco Ave., Coral Gables 34, Fla.
Communication Measurement Laboratory, 120 Greenwich St., New York, N. Y.
Communications Equipment Corp., 134 West Colorado St., Pasadena 1, Calif.
Crosley Corp., 1329 Arlington St., Cincinnati 3, Ohio
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
DuMont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J.
Eckstein Radio & Television Co., 914 La Salle Ave., Minneapolis 2, Minn.
Electronic Corp. of America, 45 West 18th St., New York 11, N. Y.
Electronic Specialty Co., 3456 Glendale Blvd., Los Angeles, Calif.
Erco Radio Labs, Inc., Fenimore Ave., Hempstead, N. Y.
Fada Radio & Electric Co., Inc., 30-20 Thomson Ave., Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3702 Pontiac St., Fort Wayne, Ind.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Fisher Research Laboratory, 1961 University Ave., Palo Alto, Calif.
Foote Pierson & Co., Inc., 75 Hudson St., Newark 4, N. J.
Freed Radio Corp., 200 Hudson St., New York, N. Y.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago 51, Ill.
Garod Radio Corp., 70 Washington St., Brooklyn, N. Y.
Gates Radio Co., 220 Hampshire St., Quincy, Ill.
General Communication Co., 530 Commonwealth Ave., Boston 15, Mass.
General Electric Co., 1 River Rd., Schenectady 5, New York
Grady Instrument Co., 11 Bailey Ave., Watertown 72, Mass.
Gray Radio Co., 730 Okeeshobee Rd., West Palm Beach, Fla.
Hallicrafters Co., 2611 Indiana Ave., Chicago 16, Ill.
Halstead Traffic Communications Corp., 155 E. 44 St., New York, N. Y.
Hamilton Radio Corp., 510 Sixth Ave., New York, N. Y.
Hammarlund Mfg. Co., Inc., 460 W. 34 St., New York 1, N. Y.
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Harvey-Wells Electronics, Inc., North St., Southbridge, Mass.
Hatcher & Fisk, 125 Kansas Ave., Topeka, Kans.
Hazeltine Electronics Corp., 1775 Broadway, New York, N. Y.
Heath Co., Benton Harbor, Mich.
Herbach & Rademan Co., Mfg. Div., 517 Ludlow St., Philadelphia 6, Pa.
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
Howard Radio Co., 1735 Belmont Ave., Chicago 13, Ill.
Hudson American Corp., 25 W. 43rd St., New York, N. Y.
Islip Radio Mfg. Corp., Foot of Beech St., Islip, New York
Jefferson, Inc., Ray, 40 E. Merrick Rd., Freeport, Long Island, N. Y.
Jefferson-Travis Radio Mfg. Corp., 245 East 23rd Street, New York 10, N. Y.
Johnson, E. F., Co., Waseca, Minn.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Calif.
Lear, Inc., Piqua, Ohio
Lewyt Corp., 60 Broadway, Brooklyn, New York
Link, Fred M., 125 W. 17th St., New York, N. Y.
Majestic Radio & Television Corp., 2600 W. 50th Street, Chicago, Ill.
Meck Industries, John, Plymouth, Ind.
Megard Corp., 1601 S. Burlington St., Los Angeles 6, Calif.
Meissner Mfg. Div., Maguire Industries, Inc., Mt. Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., Inc., 61 Sherman St., Malden 48, Mass.
Oregon Electric Mfg. Co., 206 S. W. Washington St., Portland 4, Oregon
Pacific Electronics, Sprague at Jefferson St., Spokane, Wash.
Packard Bell Co., 1115 So. Hope St., Los Angeles, Calif.
Philharmonic Radio Corp., 528 East 72nd St., New York 21, N. Y.
Press Wireless Inc., 1475 Broadway, New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Radio Craftsmen, 1341 S. Michigan Ave., Chicago, Ill.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
Radio Laboratories, Inc., 2701 California Ave., Seattle 6, Wash.
Radio Mfg. Engineers, Inc., 304 First Ave., Peoria, Ill.

ELECTRONIC and ALLIED PRODUCTS

Radio Navigational Instrument Corp., 500 Fifth Avenue, New York, N. Y.
Radio Receptor Co., 251 W. 19th St., New York 11, N. Y.
Radiomarine Corp. of America, 75 Varick St., New York, N. Y.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Scientific Radio Products Co., 738 W. Broadway, Council Bluffs, Iowa
Sheridan Electronics Corp., 2850 S. Michigan Ave., Chicago, Ill.
Sherron Electronics Co., 1201 Flushing Ave., Brooklyn 6, N. Y.
Sonora Radio & Television Corp., 325 N. Hoyne Ave., Chicago 28, Ill.
Sparks-Withington Co., 2400 E. Ganson St., Jackson, Mich.
Taybern Equipment Co., 120 Greenwich St., New York 6, N. Y.
Technical Devices Corp., Beaufort & Eagle Rock Aves., Roseland, N. J.
Technical Radio Co., 275 Ninth St., San Francisco, Calif.
Telephonics Corp., 350 West 31st St., New York 1, N. Y.
Televiso Products Inc., 6533 N. Olmsted Ave., Chicago, Ill.
Templetone Radio Mfg. Corp., New London, Conn.
Transmitter Equipment Mfg. Co. Inc., 345 Hudson St., New York 14, N. Y.
U. S. Television Manufacturing Corp., 106 Seventh Ave., New York 11, N. Y.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Westinghouse Electric & Mfg. Co., Electronics & X-Ray Divisions, Baltimore 3, Md.
Wilcox Electric Co., 1400 Chestnut St., Kansas City, Mo.
Wilcox Gay Corp., Charlotte, Mich.
Winters & Crampton Corp., 150 Wilson Ave., Grandville, Mich.

AIRCRAFT TRANSMITTERS

Air Communications, Inc., Kansas City 8, Mo.
Bendix Radio Corp., Baltimore 3, Md.
Collins Radio Co., Cedar Rapids, Iowa
Gates Radio & Supply Co., Quincy, Ill.
General Electric Co., Bridgeport, Conn.
Hallicrafters Co., 2611 S. Indiana Ave., Chicago, Ill.
Herbach & Rademan Co., 517 Ludlow St., Philadelphia 6, Pa.
Lear, Inc., Piqua, Ohio
Midwest Radio Corp., 909 Broadway, Cincinnati, Ohio
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Raytheon Mfg. Co., 60 East 42nd St., New York 17, N. Y.
Searle Aero Industries, Inc., Orange, Calif.
Western Electric Co., 120 Broadway, New York, N. Y.
Westinghouse Electric Corp., 2511 Wilkens Ave., Baltimore 3, Md.

RAILROAD TRANSMITTERS

Aireon Mfg. Co., Fairfax & Funston Rd., Kansas City 15, Kans.
Bendix Radio Corp., Baltimore 4, Md.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
General Electric Co., Bridgeport, Conn.
Hallicrafters Co., 2611 S. Indiana Ave., Chicago, Ill.
Herbach & Rademan Co., 517 Ludlow St., Philadelphia 6, Pa.
Medco Mfg. Co., 5 West 45th St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Raytheon Mfg. Co., 60 East 42nd St., New York 17, N. Y.
Westinghouse Electric Corp., 2519 Wilkens Ave., Baltimore 3, Md.

TELEVISION TRANSMITTERS

DuMont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
General Electric Co., Bridgeport, Conn.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Western Electric Co., 120 Broadway, New York, N. Y.
Westinghouse Electric Corp., 2519 Wilkens Ave., Baltimore 3, Md.

Tubes

CATHODE RAY TUBES

DuMont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J.
Electronic Tube Corp., 1200 E. Mermaid Ave., Chestnut Hill, Philadelphia, Pa.
Farnsworth Television Radio Corp., 3702 Pontiac St., Fort Wayne, Ind.
General Electric Co., Schenectady 5, New York
Ken-Rad Div., General Electric Co. Electronics Dept., Owensboro, Ky.
Lenoxite Div., Lenox Inc., 65 Prince St., Trenton 5, N. J.
Lewis Electronics, Inc., Los Gatos, Calif.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
North American Philips Co., 100 East 42nd St., New York 17, N. Y.
Philco Corp., Tioga & C Sts., Philadelphia 34, Pa.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Rauland Corp., 4245 N. Knox Ave., Chicago 41, Ill.
Standard Arcturus Corp., 30 Court St., Newark 2, N. J.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York, N. Y.
Western Electric Co., 120 Broadway, New York 5, N. Y.

CURRENT REGULATING TUBES (Ballast)

Amperite Co., 561 Broadway, New York, N. Y.
Clarostat Mfg. Co., Inc., 130 Clinton St., Brooklyn 1, N. Y.
Continental Electric Co., 903 Merchandise Mart, Chicago 54, Ill.
Electronic Enterprises, Inc., 65-67 Seventh Ave., Newark 4, N. J.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
General Electric Co., Schenectady 5, N. Y.
Hytron Radio & Electronics Corp., 76 Lafayette St., Salem, Mass.
J.F.D. Mfg. Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Magnetic Windings Co., Div. of Essex Wire Corp., 416 South 16th St., Easton, Pa.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Smith Mfg. Co., Nathan R., 105 Pasadena Ave., South Pasadena, Calif.
Standard Arcturus Corp., 30 Court St., Newark 2, N. J.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.
Taylor Tubes, Inc., 2312 Wabansia Ave., Chicago 47, Ill.
Western Electric Co. Inc., 120 Broadway, New York, N. Y.
Westinghouse Electric Corp., Lamp Div., Bloomfield, N. J.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

GEIGER-MUELLER TUBES and EQUIPMENT

Aerolux Light Corp., 653-11th Ave., New York 19, N. Y.
Cyclotron Specialties Co., Moraga, Calif.
Distillation Products Co., 1755 Ridge Road W., Rochester, N. Y.
General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Geophysical Instrument Co., Key Blvd. & Nash St., Arlington, Va.
Herbach & Rademan Co., Mfg. Div., 517 Ludlow St., Philadelphia 6, Pa.
North American Philips Co., 100 East 42nd St., New York 17, N. Y.
Universal X-Ray Products, Inc., 1800 North Francisco Ave., Chicago 47, Ill.
Westinghouse Electric Corp., E. Pittsburgh, Pa.

HEARING AID TUBES

Aurex Corp., 1117 N. Franklin St., Chicago 10, Ill.
Hytron Radio & Electronics Corp., 76 Lafayette St., Salem, Mass.
Ken-Rad Div., General Electric Co., Electronics Dept., Owensboro, Ky.
Myers & Sons, E. A., Radioear Bldg., Mt. Lebanon, Pittsburgh, Pa.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Sonotone Corp., P. O. Box 200, Saw Mill River Rd., Elmsford, N. Y.
Standard Arcturus Corp., 30 Court St., Newark 2, N. J.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

INDUSTRIAL TUBES

Aerolux Light Corp., 653 Eleventh Ave., New York 19, N. Y.
Amperex Electronic Co., 79 Washington St., Brooklyn, N. Y.
Chatham Electronics, 475 Washington St., Newark 2, N. J.
Continental Electric Co., 903 Merchandise Mart, Chicago 54, Ill.
Controls Corp., 98 Union St., Worcester 8, Mass.
Eitel-McCullough, Inc., San Bruno, Calif.
Electron Equipment Corp., 917 Meridian Ave., South Pasadena, Calif.
Electronic Enterprises, Inc., 65-67 Seventh Ave., Newark 4, N. J.
Electronic Products Co., 111 E. Third St., Mt. Vernon, N. Y.
Electrons, Inc., 127 Sussex Ave., Newark, N. J.
Farnsworth Television & Radio Corp., 3702 Pontiac St., Fort Wayne, Ind.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
Fredericks Co., Geo. E., Bethayres, Pa.
General Electric Co., Schenectady 5, N. Y.
General Electronics, Inc., 1819 Broadway, New York 23, N. Y.
Hanovia Chemical & Mfg. Co., 233 N. J. R. R. Ave., Newark, N. J.
Heintz & Kaufman, Ltd., South San Francisco, Calif.
Hytron Radio & Electronics Corp., 76 Lafayette St., Salem, Mass.
Jennings Radio Mfg. Co., 1098 E. William St., San Jose 12, Calif.
Ken-Rad Div., General Electric Co. Electronics Dept., Owensboro, Ky.
Litton Engineering Labs., Redwood City, Calif.
Machlett Laboratories, Springdale, Conn.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
North American Philips Co., 100 E. 42nd St., New York, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Slater Elec. & Mfg. Co., Inc., 728 Atlantic Ave., Brooklyn 17, N. Y.
Sperti, Inc., Norwood Station, Cincinnati 12, Ohio
Standard Arcturus Corp., 30 Court St., Newark 2, N. J.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.
Taylor Tubes, Inc., 2312 Wabansia Ave., Chicago 47, Ill.
United Electronics Co., 42 Spring St., Newark 2, N. J.
Universal X-Ray Products, Inc., 1800 North Francisco Ave., Chicago 47, Ill.
Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Westinghouse Electric Corp., Lamp Div., Bloomfield, N. J.

PHOTOTUBES & PHOTOCELLS

Aray Mfg. & Supply Co., 3107 Pine St., St. Louis 3, Mo.
Bradley Laboratories, 82 Meadow St., New Haven, Conn.
Continental Electric Co., 903 Merchandise Mart, Chicago 54, Ill.
DeJur Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.
Eby, Inc., Hugh H., 18 W. Chelton Ave., Philadelphia 13, Pa.
Eisler Engineering Co., 740 South 13th St., Newark 3, N. J.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago 32, Ill.
General Electric Co., Schenectady 5, N. Y.
General Scientific Corp., 4829 S. Kedzie Ave., Chicago, Ill.
Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio

Miles Reproducer Co., Inc., 812 Broadway, New York, N. Y.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
Pfaltz & Bauer, Inc., 350 Fifth Ave., New York, N. Y.
Photovolt Corp., 95 Madison Ave., New York 16, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Rauland Corp., 4245 N. Knox Ave., Chicago 41, Ill.
Rehtron Corp., 4313 Lincoln Ave., Chicago 18, Ill.
Selenium Corp. of America, 1719 W. Pico Blvd., Los Angeles 15, Calif.
Standard Arcturus Corp., 30 Court St., Newark 2, N. J.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Westinghouse Lamp Div., Westinghouse Electric & Mfg. Co., Bloomfield, N. J.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

RECEIVING TUBES

Admiral Corp., 3800 W. Cortland St., Chicago 11, Ill.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
General Electric Co., Schenectady 5, New York
Hytron Radio & Electronics Corp., 76 Lafayette St., Salem, Mass.
Ken-Rad Div., General Electric Co., Electronics Dept., Owensboro, Ky.
Magnavox Co., The, 2131 Bueter Rd., Fort Wayne 4, Ind.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
Philco Corp., Tioga & C Sts., Philadelphia, 34, Pa.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Slater Electric & Mfg. Co., Inc., 728 Atlantic Ave., Brooklyn 17, N. Y.
Standard Arcturus Corp., 30 Court St., Newark 2, N. J.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.
Tung-Sol Lamp Works Inc., 95 Eighth Ave., Newark, N. J.
Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio
Western Electric Co., Inc., 120 Broadway, New York, 5, N. Y.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

RECTIFYING TUBES

Amperex Electronic Corp., 25 Washington St., Brooklyn, N. Y.
Chatham Electronics, 475 Washington St., Newark 2, N. J.
Continental Electric Co., 903 Merchandise Mart, Chicago 54, Ill.
Eitel-McCullough, Inc., San Bruno, Calif.
Electric Heat Control Co., 9123 Inman Ave., Cleveland 5, Ohio
Electronic Products Co., 111 E. Third St., Mt. Vernon, N. Y.
Electrons, Inc., 127 Sussex Ave., Newark, N. J.
Federal Engineering Co., 37 Murray St., New York 7, N. Y.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
General Electric Co., Schenectady 5, N. Y.
General Electric X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill.
General Electronics, Inc., 1819 Broadway, New York 23, N. Y.
Heintz & Kaufman, Ltd., South San Francisco, Calif.
Hytron Radio & Electronics Corp., 76 Lafayette St., Salem, Mass.
Industrial & Commercial Electronics, Belmont, Calif.
Jennings Radio Mfg. Co., 1098 E. William St., San Jose 12, Calif.
Machlett Laboratories, Springdale, Conn.
Mellaphone Corp., Rochester 2, N. Y.
National Co., Inc., 61 Sherman St., Malden 48, Mass.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
North American Philips Co., 100 East 42nd St., New York 17, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Slater Electric & Mfg. Co., Inc., 728 Atlantic Ave., Brooklyn 17, N. Y.
Sperry Gyroscope Co., Manhattan Bridge Plaza, Brooklyn 1, N. Y.
Sperti, Inc., Norwood Station, Cincinnati 12, Ohio
Standard Arcturus Corp., 30 Court St., Newark 2, N. J.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.
Taylor Tubes, Inc., 2312 Wabansia Ave., Chicago 47, Ill.
Translite, Inc., 647 Kent Ave., Brooklyn, N. Y.
United Electronics Co., 42 Spring St., Newark 2, N. J.
Universal X-Ray Products, Inc., 1800 North Francisco Ave., Chicago 47, Ill.
Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Westinghouse Electric Corp., Lamp Div., Bloomfield, N. J.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

TRANSMITTING and POWER TUBES

Amperex Electronic Corp., 25 Washington St., Brooklyn, N. Y.
Chatham Electronics, 475 Washington St., Newark 2, N. J.
Controls Corp., 98 Union St., Worcester 8, Mass.
de Forest Laboratories, Lee, 5106 Wilshire Blvd., Los Angeles, Calif.
Eitel-McCullough, Inc., San Bruno, Cal.
Electron Equipment Corp., 917 Meridian Ave., South Pasadena, Calif.
Electronic Enterprises, Inc., 65-67 Seventh Ave., Newark 4, N. J.
Electronic Products Co., 111 E. Third St., Mt. Vernon, N. Y.
Electronic Tube Corp., 1200 E. Mermaid Ave., Chestnut Hill, Philadelphia, Pa.
Federal Engineering Co., 37 Murray St., New York 7, N. Y.
Federal Telephone and Radio Corp., 591 Broad St., Newark, N. J.
General Electric Co., Schenectady 5, New York
General Electronics, Inc., 1819 Broadway, New York 23, N. Y.
Heintz & Kaufman, Ltd., South San Francisco, Calif.
Hytron Radio & Electronics Corp., 76 Lafayette St., Salem, Mass.
Industrial & Commercial Electronics, Belmont, Calif.
Jennings Radio Mfg. Co., 1098 E. William St., San Jose 12, Calif.
Ken-Rad Div., General Electric Co., Electronics Dept., Owensboro, Ky.
Lewis Electronics, Inc., Los Gatos, Calif.
Litton Engineering Labs., P. O. Box 749, Redwood City, Calif.
Machlett Laboratories, Springdale, Conn.
National Union Radio Corp., 15 Washington St., Newark 2, N. J.
North American Philips Co., Inc., 100 East 42nd St., New York 17, N. Y.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.
Slater Electric & Mfg. Co., Inc., 728 Atlantic Ave., Brooklyn 17, N. Y.
Sperry Gyroscope Co., Manhattan Bridge Plaza, Brooklyn 1, N. Y.
Sperti, Inc., Norwood Station, Cincinnati 12, Ohio
Standard Arcturus Corp., 30 Court St., Newark 2, N. J.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.
Taylor Tubes, Inc., 2312 Wabansia Ave., Chicago 47, Ill.
Tung-Sol Lamp Works, Inc., 95 Eighth Ave., Newark, N. J.
United Electronics Co., 42 Spring St., Newark 2, N. J.
Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.
Westinghouse Electric Corp., Lamp Div., Bloomfield, N. J.
Westinghouse Electric Corp., East Pittsburgh, Pa.

VOLTAGE REGULATING TUBES

see Rectifying Tubes

X-RAY TUBES and EQUIPMENT

Eureka X-Ray Corp., 3250 N. Kilpatrick St., Chicago, Ill.
Fischer & Co., H. G., 2323 Wabansia Ave., Chicago 47, Ill.
Franklin X-Ray Co., 2100 Arch St., Philadelphia 3, Pa.
General Electric Co., Schenectady 5, N. Y.
General Electric X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill.
Machlett Laboratories, Springdale, Conn.
Newman X-Ray Corp., 518 Hankes Ave., Aurora, Ill.
North American Philips Co., Inc., Metallix Div., 100 East 42nd St., New York, N. Y.
Peerless Laboratories, 461 Tenth Ave., New York 18, N. Y.
Picker X-Ray Corp., 300 Fourth Ave., New York 10, N. Y.
Standard X-Ray Co., 1932 North Burling St., Chicago 14, Ill.
Universal X-Ray Products, Inc., 1800 N. Francisco Ave., Chicago 47, Ill.
Westinghouse Electric Corp., Industrial Electronics & X-Ray Divs. Baltimore 3, Md.
Westinghouse Electric Corp., Lamp Div., Bloomfield, N. J.
Westinghouse Electric Corp., East Pittsburgh, Pa.

Tube Manufacturers—Test Equipment

Sherron Electronics Co., 1201 Flushing Ave., Brooklyn 6, N. Y.

Tube Making Machines

see Machines, Tube Making

Tube Parts

Admak Manufacturing Co., 46 Cordier St., Irvington, N. J.
American Brass Co., Waterbury 88, Conn.
Art Wire & Stamping Co., 227 High St., Newark 2, N. J.
Bead Chain Mfg. Co., 110 Mt. Grove St., Bridgeport 5, Conn.
Callite Tungsten Corp., 544 39th St., Union City, N. J.
Electronic Manufacturing Co., 20 Orange St., Newark 2, N. J.
Electronic Products Co., 111 E. Third St., Mt. Vernon, N. Y.
Engineering Co., 27 Wright St., Newark, N. J.
Fansteel Metallurgical Corp., 2200 Sheridan Road, North Chicago, Ill.
Ford Radio & Mica Corp., 538 63rd St., Brooklyn, N. Y.
General Electric Co., Schenectady 5, N. Y.
Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.
Haydu Bros., Mt. Bethel Rd., Plainfield, N. J.
Huse Liberty Mica Co., 171 Camden St., Boston, Mass.
King Laboratories, Inc., 205 Oneida Street, Syracuse 4, N. Y.
Lewis Electronics Inc., Los Gatos, Calif.
Litton Engineering Labs., P. O. Box 749, Redwood City, Calif.
Makepeace Co., D. E., Attleboro, Mass.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Munsell & Co., Eugene, 200 Varick St., New York, N. Y.
National Carbon Co. Inc., 30 East 42nd St., New York 17, N. Y.
Northern Mfg. Co., Inc., 36 Spring St., Newark, N. J.
Pierce Paper Products Co., Rockford, Ill.
Radio Corp. of America, R.C.A. Victor Div., Camden, N. J.
Rice's Sons, Inc., Bernard, 325 Fifth Ave., New York, N. Y.
Springfield Sound Co., Electronics Div., 12 Cass St., Springfield, Mass.
Superior Tube Co., Norristown, Pa.
Thompson Corp., Geo. S., 5240 Huntington Drive, Los Angeles 32, Calif.
Tingstol Corp., 1461 W. Grand Ave., Chicago, Ill.
United-Carr Fastener Corp., 31 Ames St., Cambridge, Mass.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Wickwire Spencer Metallurgical Corp., 260 Sherman St., Newark 2, N. J.
Worcester Pressed Steel Co., 100 Barber Ave., Worcester, Mass.

Tube Repairs

Electronic Products Co., 111 E. Third St., Mt. Vernon, N. Y.
Freeland & Olschner Products, Inc., 611 Baronne St., New Orleans 13, La.

ELECTRONIC and ALLIED PRODUCTS

Lewis Electronics, Inc., Los Gatos, Calif.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
West Shore Laboratories, Box 117, Marblehead. Mass.

Tubing

BRASS and COPPER TUBING

American Brass Co., Waterbury 88, Conn.
Bridgeport Brass Co., E. Main St., Bridgeport, Conn.
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Edwards, Inc., T. J., 121 Beach St., Boston 5, Mass.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Ilsco Copper Tube & Product Inc., Mariemont 27, Ohio
Precision Tube Co., 3828 Terrace St., Philadelphia 28, Pa.
Revere Copper & Brass Inc., 230 Park Ave., New York 17, N. Y.
Scovill Mfg. Co., 99 Mill St., Waterbury 91, Conn.
Uniform Tubes, Shurs Lane & Lauriston St., Roxborough, Philadelphia, Pa.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Wolverine Tube Co. Div., Calumet & Hecla Consolidated Copper Co., 1411 Central Ave., Detroit 9, Mich.

CERAMIC TUBING

see Insulation

FABRIC TUBES and TUBING

Alpha Wire Corp., 50 Howard St., New York, N. Y.
Anchor Webbing Co., 1005 Main St., Pawtucket, R. I.
B. & C. Insulation Products, Inc., 261 Fifth Ave., New York 16, N. Y.
Brand & Co., William, 276 Fourth Ave., New York 10, N. Y.
Creative Plastics Corp., 963 Kent Ave., Brooklyn, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Bridgeport. Conn.
Hope Webbing Co., Providence, Rhode Island
Industrial Screw & Supply Co., 713 W. Lake St., Chicago 6, Ill.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington 11, N. J.
McInerny Plastics Co., 655 Godfrey Ave., S. W., Grand Rapids 1, Mich.
Mica Insulator Co., 797 Broadway, Schenectady 1, N. Y.
Mitchell-Rand Insulation Co., Inc., 51 Murray St., New York 7, N. Y.
National Varnished Products Corp., 211 Randolph Ave., Woodbridge, N. J.
Penn Fibre & Specialty Co., 2030 E. Westmoreland St., Philadelphia 34. Pa.
Surprenant Electrical Insulation Co., 84 Purchase St., Boston 10, Mass.
Tingstol Corp., 1461 W. Grand Ave., Chicago. Ill.
Varflex Corp., N. Jay St., Rome, N. Y.

FIBRE TUBING

see Insulation

GLASS TUBES and TUBING

Aerolux Light Corp., 653-11th Ave., New York 19, N. Y.
Alpha Wire Corp., 50 Howard St., New York, N. Y.
B. & C. Insulation Products, Inc., 261 Fifth Ave., New York 16, N. Y.
Bache & Co., Semon, 636 Greenwich St., New York 14, N. Y.
Bentley, Harris Mfg. Co. Hector & Lime Sts., Conshohocken, Pa.
Brand & Co., William, 276 Fourth Ave., New York 10, N. Y.
Corning Glass Works, Corning, N. Y.
Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Goodall Electric Mfg. Co., 320 N. Spruce St., Ogallala. Nebr.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington 11, N. J.
Libbey Glass Div. Owens-Illinois Glass Co., P. O. Box 1035-36, Toledo 1, Ohio
Mica Insulator Co., 797 Broadway, Schenectady 1, N. Y.
Varflex Corp., N. Jay St., Rome, N. Y.

KNITTED WIRE TUBES and TUBING

Alden Products Co., 117 North Main St., Brockton 64, Mass.
Alpha Wire Corp., 50 Howard St., New York, N. Y.
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y.
Chicago Metal Hose Corp., 1315 S. 3rd Ave., Maywood, Ill.
Electric Auto-Lite Co., Toledo 1, Ohio
Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
General Electric Co., Schenectady 5, N. Y.

METAL and ALLOY TUBING

American Brass Co., Waterbury 88, Conn.
General Plate Div.. Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
International Nickel Co., 67 Wall St., New York 5, N. Y.
Johnson Co. E. F., Waseca, Minn.
Makepeace Co., D. E.. Attleboro. Mass.
National Lead Co., 111 Broadway, New York 6, N. Y.
Precision Tube Co.. 3828 Terrace St., Philadelphia 28. Pa.
Revere Copper & Brass Inc., 230 Park Ave., New York 17, N. Y.
Summerill Tubing Co., Montgomery County, Bridgeport, Pa.
Superior Tube Co., Norristown, Pa.
Swedish Iron & Steel Corp., 17 Battery Place, New York, N. Y.
Uniform Tubes, Shurs Lane & Lauriston St., Roxborough, Philadelphia, Pa.
Westinghouse Electric Corp., East Pittsburgh, Pa.

PAPER TUBES and TUBING

American Paper Tube Co., Hazel St., Woonsocket, R. I.
B. & C. Insulation Products Inc., 261 Fifth Ave., New York 16. N. Y.
Bentley Harris Mfg. Co., Hector & Lime Sts.. Conshohocken, Pa.
Creative Plastics Corp., 963 Kent Ave., Brooklyn, N. Y.
Cross Paper Products Corp., 2595 Third Ave., New York, N. Y.
Franklin Fibre-Lamitex Corp., 12th & French Sts., Wilmington, Del.
General Electric Co., Bridgeport, Conn.
General Paper Tube Co., 430 E. Chelton Ave., Philadelphia, Pa.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.
Mica Insulator Co.. 797 Broadway, Schenectady 1, N. Y.
Mica Products Mfg. Co., 69 Wooster St., New York, N. Y.
Paramount Paper Tube Co.. 801 Glasgow Ave., Fort Wayne, Ind.
Pierce Paper Products Co., Rockford. Ill.
Precision Paper Tube Co.. 2033 W. Charleston St., Chicago 47. Ill.
Tingstol Corp., 1461 W. Grand Ave., Chicago, Ill.
Westinghouse Electric Corp., East Pittsburgh, Pa.

PLASTIC TUBING

see Insulation

Turntables

PHONOGRAPH and TRANSCRIPTION TURNTABLES

Alliance Mfg. Co., Lake Park Blvd., Alliance, Ohio
Allied Recording Products Co., 21-09 43rd Ave.. Long Island City 1. N. Y.
Chicago Sound Systems Co., 2124 S. Michigan Ave., Chicago, Ill.
Electro Acoustic Co., 2131 Bueter Rd., Fort Wayne, Ind.
Gates Radio Co., 200 Hampshire St., Quincy, Ill.
General Electric Co., Schenectady 5, N. Y.
Harris Mfg. Co., 2422 W. Seventh St., Los Angeles 5, Calif.
Merkle-Korff Gear Co., 213 N. Morgan St.. Chicago 7, Ill.
Newcomb Audio Products Co., 2815 S. Hill St., Los Angeles. Calif.
Northern Communications Mfg. Co., 210 East 40th St., New York, N. Y.
Pacific Sound Equipment Co., 1534 Cahuenga Blvd., Hollywood, Calif.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Proctor Co., B. A., Inc., 2 W. 45th St., New York, N. Y.
Radiad Service. 720 West Schubert Ave., Chicago 14, Ill.
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Rek-O-Kut Co., 173 Lafayette St.. New York 13, N. Y.
Robinson Recording Laboratories, 35 S. Ninth St., Philadelphia, Pa.
Talking Devices Co.. 4447 W. Irving Park Rd., Chicago, Ill.
United Cinephone Corp., 65 New Litchfield St., Torrington. Conn.
Webster Chicago Corp., Electronics Div., 3825 Armitage Ave., Chicago, Ill.

Varnish

see Finishes

Vibration Insulating Mountings

see Mountings

Vibrator Testers

see Testers, Vibration

Vibrators

Allis Chalmers Mfg. Co., Milwaukee, Wisc.
American Television & Radio Co., 300 E. Fourth St., St. Paul, Minn.
Collins Radio Co., 855 35th St., N. E., Cedar Rapids, Iowa
Ecco High Frequency Electric Corp., 7020 Hudson Blvd., North Bergen, N. J.
Electric Specialty Co., 211 South St., Stamford, Conn.
Electronic Laboratories, Inc., Indianapolis, Ind.
Electronic Products Mfg. Co., 7300 Huron River Drive, Dexter, Mich.
Fidelity Electric Co., 332 N. Arch St., Lancaster, Pa.
General Electric Co., Schenectady 5, N. Y.
James Vibrapowr Co., 1551 Thomas St., Chicago 22, Ill.
Kurman Electric Co., 35-18 37th St., Long Island City 1, N. Y.
Mallory & Co., Inc., P. R.. 3029 E. Washington St., Indianapolis 6, Ind.
Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.
Philmore Mfg. Co., 113 University Place, New York. N. Y.
Radiart Corp., 3571 West 62nd St., Cleveland 2, Ohio
Radio Corp. of America, RCA Victor Div., Camden, N. J.
Richardson-Allen Corp., 15 West 20th St., New York 11, N. Y.
Turner Co., 909 17th St., Cedar Rapids, Iowa
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Wilcox Gay Corp., Charlotte, Mich.

Voltage Dividers

see Dividers

Voltage Regulators

see Regulators

Voltmeter Multipliers

see Multipliers

Voltmeters

see Meters

Volume Controls

see Controls

Washers

LOCK WASHERS

American Nut & Bolt Fastener Co., 2045 Doerr St., Pittsburgh, Pa.
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Clark Bros. Bolt Co., Milldale, Conn.
Federal Screw Products Co., 224 W. Huron St., Chicago 10, Ill.
Garrett Co., Inc., Geo. K., 1421 Chestnut St., Philadelphia 2, Pa.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Harper Co., H. M., 2620 Fletcher St., Chicago 18, Ill.
Hartford Machine Screw Co., Hartford, Conn.
Industrial Screw & Supply Co., 713 W. Lake St., Chicago 6, Ill.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
Manufacturers Screw Products, 270 W. Hubbard St., Chicago, Ill.
National Lock Washer Co., 40 Hermon St., Newark 5, N. J.
Palnut Co., Inc., 77 Cordier St., Irvington, 11, N. J.
Penn Fibre & Specialty Co., 2030 E. Moreland St., Philadelphia 44, Pa.
Philadelphia Steel & Wire Corp., Penn St. & Belfield Ave., Philadelphia, Pa.
Positive Lock Washer Co., 181 Miller St., Newark, N. J.
Printloid, Inc., 95 Mercer St., New York 12, N. Y.
Quadriga Mfg. Co., 213 W. Grand Ave., Chicago 11, Ill.
St. Louis Screw & Bolt Co., 6900 N. B'way, St. Louis 15, Mo.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Scovill Mfg. Co., 99 Mill St., Waterbury 91, Conn.
Shakeproof, Inc., 2501 N. Keeler Ave., Chicago 39, Ill.
Spaulding Fibre Co., 310 Wheeler St., Tonawanda, N. Y.
Standard Locknut & Lockwasher Inc., 33-35 W. St. Clair St., Indianapolis 4, Ind.
Sterling Bolt Co., 209 W. Jackson Blvd., Chicago, Ill.
Thompson-Bremer & Co., 1640 W. Hubbard St., Chicago, Ill.
Worcester Pressed Steel Co., 100 Barber Ave., Worcester, Mass.
Wrought Washer Mfg. Co., 2100 S. Bay St., Milwaukee 7, Wis.

Wattmeters

see Meters

Waxes

WAX, RUBBER, ASPHALTUM, OR OTHER BASE INSULATING COMPOUNDS

Allied Asphalt & Mineral Corp., 217 Broadway, New York, N. Y.
American Phenolic Corp., Chicago, Ill.
American Products Mfg. Co., 8127 Oleander St., New Orleans, La.
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y.
Austin Co., M. B., 108 S. Desplaines St., Chicago, Ill.
Bakelite Corp., Unit of Union Carbide & Carbon Corp., 30 East 42nd St., New York 17, N. Y.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Biwax Corp., 3445 Howard St., Skokie, Ill.
Candy & Co., 2515 West 35th St., Chicago, Ill.
Cantol Wax Co., 211 N. Washington St., Bloomington, Ind.
Cochrane Chemical Co., 432 Danforth Ave., Jersey City, N. J.
Communication Parts, 1101 N. Paulina St., Chicago 22, Ill.
Dolph Co., John, 1060 Broad St., Newark, N. J.
Dow Corning Corp., Box 592, Midland, Mich.
duPont de Nemours & Co., E. I., Plastics Dept., 626 Schuyler Ave., Arlington, N. J.
Electrical Engineers Equipment Co., Melrose Park, Ill.
Federal Telephone & Radio Corp., 591 Broad St., Newark, N. J.
G & W Electric Specialty Co., 7800 Kenwood Ave., Chicago, Ill.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Schenectady 5, N. Y.
George Co., P. D., 4153 Bingham Ave., St. Louis, Mo.
Georgia Rosin Products Co., Savannah, Ga.
Glyco Products Co., Inc., 26 Court St., Brooklyn, N. Y.
Goodrich Chemical Co., B. F., Rose Bldg., Cleveland, Ohio
Impervious Varnish Co., Rochester, Pa.
Insl-X Co., Inc., 857 Meeker Ave., Brooklyn, N. Y.
Insulatine Co., 1 Broadway, New York, N. Y.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington 11, N. J.
Johns-Manville, 22 East 40th St., New York, N. Y.
Johnson & Co., S. C., Industrial Div., Racine, Wisc.
Line Material Co., 740 North 2nd St., Milwaukee, Wisc.
McGill Mfg. Co., Box 670, Valparaiso, Ind.
Mica Insulator Co., 797 Broadway, Schenectady 1, N. Y.
Minerallac Electric Co., 25 N. Peoria St., Chicago, Ill.
Mitchell-Rand Insulation Co., Inc., 51 Murray St., New York 7, N. Y.
National Electric Products Corp., Fulton Bldg., Pittsburgh, Pa.
Nukem Products Corp., 70 Niagara St., Buffalo, N. Y.
Paisley Products, Inc., 1770 Canalport Ave., Chicago 16, Ill.
Okonite Co., Canal St., Passaic, N. J.
Pioneer Asphalt Co., 435 N. Michigan Ave., Chicago, Ill.
Production Engineering Corp., 666 Van Houten Ave., Clifton, N. J. (service)
Robertson Chemical Co., 9808 Meech Ave., Cleveland, Ohio
Rockbestos Products Corp., 310 Nicoll St., New Haven, Conn.
Roebling's Sons Co., John A., 640 S. Broad St., Trenton, N. J.
Ruberoid Co., 500 Fifth Ave., New York, N. Y.
Rusgreen Mfg. Co., 14262 Birwood Ave., Detroit, Mich.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Sauereisen Cement Co., Sharpsburg Station, Pittsburgh, Pa.
Standard Oil Co. (Indiana), 910 S. Michigan Ave., Chicago 80, Ill.
Sterling Varnish Co., Haysville, Pa.
Standard Varnish Works, 2600 Richmond Terrace, Staten Island 3, N. Y.
Trotter & Co., E. T., 594 Johnson Ave., Brooklyn, N. Y.
United States Rubber Co., 1230 Sixth Ave., New York, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Witco Chemical Co., 295 Madison Ave., New York 17, N. Y.
Zophar Mills, Inc., 112 26th St., Brooklyn 32, N. Y.

Welding Controls & Timers

see Timers, Welding

Winders

COIL WINDERS

see Machines

WINDINGS

see Coils

Wire

ANTENNA WIRE

Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Brass Co., Waterbury 88, Conn.
American Steel & Wire Co., Rockefeller Bldg., Cleveland 13, Ohio
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y.
Ansonia Electrical Co., Ansonia, Conn.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago 44, Ill.
Birnbach Radio Co. Inc., 145 Hudson St., New York, N. Y.
Boston Insulated Wire & Cable Co., 65 Bay St. (Dorchester), Boston, Mass.
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Columbia Wire & Supply Co., 4106 N. Pulaski Road, Chicago 41, Ill.
Crescent Insulated Wire & Cable Co., N. Olden Ave., Trenton, N. J.
Diamond Wire & Cable Co., 128 E. 16th St., Chicago Heights, Ill.
Eagle Electric Mfg. Co. Inc., 23-10 Bridge Plaza S., Long Island City, N. Y.
Electric Auto-Lite Co., Wire & Cable Div., Port Huron, Mich.
Electric Auto-Lite Co., Toledo 1, Ohio
Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
Fleron & Son, Inc., M. M., 113 N. Broad St., Trenton, N. J.
Flexo Wire Co., 638 Genessee St. W., Syracuse 1, N. Y.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady 5, N. Y.
Johnson Co., E. F., Waseca, Minn.
New England Electrical Wks., Inc., 365 Main St., Lisbon, N. H.
Paranite Wire & Cable Div. of Essex Wire Corp., 1601 Wall St., Fort Wayne 6, Ind.
Roebling's Sons Co., John A., 640 S. Broad St., Trenton 2, N. J.
Schott Co., Walter L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Spencer Wire Co., West Brookfield, Mass.
Uniform Tubes, Shurs Lane & Lauriston St., Roxborough, Philadelphia, Pa.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Westinghouse Lamp Div., Westinghouse Electric Corp., Bloomfield, N. J.

HIGH VOLTAGE WIRE

Alden Products Co., 117 North Main St., Brockton 64, Mass.
Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Steel & Wire Co., Rockefeller Bldg., Cleveland 13, Ohio
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y.
Birnbach Radio Co. Inc., 145 Hudson St., New York, N. Y.
Boston Insulated Wire & Cable Co., 65 Bay St., Dorchester, Boston, Mass.
Columbia Wire & Supply Co., 4106 North Pulaski Road, Chicago 41, Ill.
Crescent Co., Inc., Front & Central Ave., Pawtucket, R. I.
Crescent Insulated Wire & Cable Co., N. Olden Ave., Trenton, N. J.
Diamond Wire & Cable Co., 128 E. 16th St., Chicago Heights, Ill.
Electric Auto-Lite Co., Toledo 1, Ohio
Electric Auto-Lite Co., Wire & Cable Div., Port Huron, Mich.
Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
Flexo Wire Co., 638 Genesee St. W., Syracuse 1, N. Y.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Bridgeport, Conn.
General Electric Co., Schenectady, N. Y.
Goldmark Wire Co., James, 116 West St., New York 7, N. Y.
Lenz Electric Mfg. Co., 1751 N. Western Avenue, Chicago 47, Ill.
National Electric Products Corp., Fulton Bldg., Pittsburgh, Pa.
Okonite Co., Canal St., Passaic, N. J.
Phelps Dodge Copper Products Corp., American Copper Prods. Div., 40 Wall St., New York, N. Y.
Rhode Island Insulated Wire Co., 50 Burnham Ave., Providence, R. I.
Roebling's Sons Co., John A., 640 S. Broad St., Trenton 2, N. J.
Rome Cable Corp., 330 Ridge St., Rome, N. Y.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Western Insulated Wire, Inc., 1151 South Broadway, Los Angeles 15, Calif.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.

HOOKUP WIRE

Acorn Insulated Wire Co., Inc., 225 King St., Brooklyn 31, N. Y.
Alden Products Co., 117 North Main St., Brockton 64, Mass.
Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Electric Cable Co., Holyoke, Mass.
American Phenolic Corp., 1830 S. 54 Chicago 50, Ill.

ELECTRONIC and ALLIED PRODUCTS

American Steel & Wire Co., Rockefeller Bldg., Cleveland 13, Ohio
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y.
Ansonia Electrical Co., Ansonia, Conn.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago 44, Ill.
Birnbach Radio Co., Inc., 145 Hudson St., New York, N. Y.
Boston Insulated Wire & Cable Co., 65 Bay St., (Dorchester), Boston, Mass.
Columbia Wire & Supply Co., 4106 N. Pulaski Road, Chicago 41, Ill.
Consolidated Wire & Associated Corps., 1635 S. Clinton St., Chicago 16, Ill.
Cornish Wire Co., 15 Park Row, New York, N. Y.
Crescent Co. Inc., Front & Central Ave., Pawtucket, R. I.
Crescent Insulated Wire & Cable Co., Trenton, N. J.
Diamond Wire & Cable Co., 128 East 16th St., Chicago Heights, Ill.
Electric Auto-Lite Co., Wire & Cable Div., Port Huron, Mich.
Electric Auto-Lite Co., Toledo 1, Ohio
Electric Switch Corp., 14th at Union St., Columbus, Ind.
Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
Flexo Wire Co., 638 Genesee St., West Syracuse 1, N. Y.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockland, Ill.
General Electric Co., Bridgeport, Conn.
General Insulated Wire Works, Inc., 69 Gordon Ave., Providence 5, R. I.
J. F. D. Mfg. Co., 4111 Ft. Hamilton Parkway, Brooklyn, N. Y.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Lenz Electric Mfg. Co., 1751 N. Western Ave., Chicago 47, Ill.
Lowell Insulated Wire Co., 171 Lincoln St., Lowell, Mass.
New England Electrical Wks., Inc., 365 Main St., Lisbon, N. H.
Packard Electric Div., General Motors Corp., Warren, Ohio
Paranite Wire & Cable Div. Essex Wire Corp., 1601 Wall St., Fort Wayne 6, Ind.
Phelps Dodge Copper Products Corp., American Copper Prods. Div., 40 Wall St., New York, N. Y.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Plastic Wire & Cable Corp., Norwich, Conn.
Rhode Island Insulated Wire Co., Providence, R. I.
Rockbestos Products Corp., 308 Nicoll St., New Haven 4, Conn.
Roebling's Sons Co., John A., 640 Broad St., Trenton 2, N. J.
Rome Cable Corp., 330 Ridge St., Rome, N. Y.
Surprenant Electrical Insulation Co., 84 Purchase St., Boston 10, Mass.
United States Rubber Co., 1230 Sixth Ave., New York, N. Y.
Westinghouse Lamp Div., Westinghouse Electric Corp., Bloomfield, N. J.
Whitney-Blake Co., Dixwell Ave., New Haven, Conn.
Wood Electric Co., Inc., C. D., 826 Broadway, New York 3, N. Y.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.

MAGNET WIRE

Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Steel & Wire Co., Rockefeller Bldg., Cleveland 13, Ohio
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y.
Ansonia Electrical Co., Ansonia, Conn.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago 44, Ill.
Birnbach Radio Co. Inc., 145 Hudson St., New York, N. Y.
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Consolidated Wire & Associated Corps., 1635 S. Clinton St., Chicago 16, Ill.
Electric Auto-Lite Co., Toledo 1, Ohio
Electric Auto-Lite Co., Wire & Cable Div., Port Huron, Mich.
Engineering Laboratories, Inc., 602 East Fourth St., Tulsa 3, Okla.
Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Bridgeport, Conn.
Goldmark Wire Co., James, 116 West St., New York 7, N. Y.
Guthman & Co., Edwin I., 15 S. Throop St., Chicago, Ill.
Hudson Wire Co., Winsted Div., Winsted, Conn.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago 38, Ill.
Knickerbocker Anunciator Co., 116 West St., New York, N. Y.
Lewyt Corp., 60 Broadway, Brooklyn, New York
Meissner Mfg. Div., Maguire Industries, Inc., Mt. Carmel, Ill.
New England Electrical Wks., Inc, 365 Main St., Lisbon, N. H.
Paranite Wire & Cable Corp., Div. Essex Wire Co., 1601 Wall St., Fort Wayne 6, Ind.
Phelps Dodge Copper Products Corp., American Copper Prods. Div., 40 Wall St., New York, N. Y.
Philadelphia Insulated Wire Co., 200 N. Third St., Philadelphia, Pa.
Rea Magnet Wire Co., Inc., E. Pontiac St., Extended Fort Wayne, Ind.
Rockbestos Products Corp., 308 Nicoll St., New Haven 4, Conn.
Roebling's Sons Co., John A., 640 S. Broad St., Trenton 2, N. J.
Rome Cable Corp., 330 Ridge St., Rome, N. Y.
Spencer Wire Co., West Brookfield, Mass.
Swedish Iron & Steel Corp., 17 Battery Place, New York, N. Y.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Wheeler Insulated Wire Co., Inc., 378 Washington Ave., Bridgeport, Conn.
Wickwire Spencer Metallurgical Corp., 260 Sherman St., Newark, N. J.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.

POWER CORDS

Aircraft Products Co., 3502 E. Pontiac St., Fort Wayne, Ind.
Alden Products Co., 117 North Main St., Brockton 64, Mass.
Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Steel & Wire Co., Rockefeller Bldg., Cleveland 13, Ohio
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y.
Ansonia Electrical Co., Ansonia, Conn.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago 44, Ill.
Birnbach Radio Co. Inc., 145 Hudson St., New York, N. Y.
Boston Insulated Wire & Cable Co., 65 Bay St., Dorchester, Boston, Mass.
Clarostat Mfg. Co., Inc., 130 Clinton St., Brooklyn, N. Y.
Columbia Wire & Supply Co., 4106 N. Pulaski Rd., Chicago 41, Ill.
Consolidated Wire & Associated Corps., 1635 S. Clinton St., Chicago 16, Ill.
Cornish Wire Co., 15 Park Row, New York, N. Y.
Crescent Co., Inc., Front & Central Ave., Pawtucket, R. I.
Crescent Insulated Wire & Cable Co., N. Olden Ave., Trenton, N. J.
Diamond Wire & Cable Co., 128 East 16th St., Chicago Heights, Ill.
Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.
Electric Auto-Lite Co., Wire & Cable Div., Port Huron, Mich.
Electric Auto-Lite Co., Toledo 1, Ohio
Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Bridgeport, Conn.
General Insulated Wire Works, Inc., 69 Gordon Ave., Providence 5, R. I.
Hazard Insulated Wire Works, Div. of The Okonite Co., Wilkes-Barre, Pa.
Insuline Corp. of America, 36-02 35th Ave., Long Island City, N. Y.
J. F. D. Mfg. Co., 4111 Fort Hamilton Parkway, Brooklyn, N. Y.
Kerite Insulated Wire & Cable Co., 30 Church St., New York 7, N. Y.
Lenz Electric Mfg. Co., 1751 N. Western Ave., Chicago 47, Ill.
Lowell Insulated Wire Co., 171 Lincoln St., Lowell, Mass.
National Electric Products Corp., Fulton Bldg., Pittsburgh, Pa.
Okonite Co., Canal St., Passaic, N. J.
Packard Electric Div., General Motors Corp., Warren, Ohio
Paranite Wire & Cable Div., Essex Wire Corp., 1601 Wall St., Fort Wayne 6, Ind.
Phelps Dodge Copper Products Corp., American Copper Products Div., 40 Wall St., New York, N. Y.
Philmore Mfg. Co., 113 University Place, New York, N. Y.
Roebling's Sons Co., John A., 640 S. Broad St., Trenton 2, N. J.
Rome Cable Corp., 330 Ridge St., Rome, N. Y.
Runzel Cord & Wire Co., 4731 W. Montrose Ave., Chicago, Ill.
Simplex Wire & Cable Corp., 79 Sidney St., Cambridge 39, Mass.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Western Insulated Wire, Inc., 1151 South Broadway, Los Angeles 15, Calif.
Whitney-Blake Co., Dixwell Ave., New Haven, Conn.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.

RESISTANCE and FILAMENT WIRE

Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Alloy Metal Wire Co., Prospect Park, Pa.
American Brass Co., Waterbury 88, Conn.
American Steel & Wire Co., Rockefeller Bldg., Cleveland 13, Ohio
Birnbach Radio Co., Inc., 145 Hudson St., New York, N. Y.
Callite Tungsten Corp., 544 39th St., Union City, N. J.
Chase Brass & Copper Co., Inc., 236 Grand St., Waterbury 91, Conn.
Cohn & Co., Sigmund, 44 Gold St., New York, N. Y.
Columbia Wire & Supply Co., 4106 N. Pulaski Road, Chicago 41, Ill.
Driver Co., Wilbur B., 150 Riverside Ave., Newark, N. J.
Driver-Harris Co., 201 Middlesex St., Harrison, N. J.
Electric Auto-Lite Co., Toledo 1, Ohio
General Electric Co., Bridgeport, Conn.
General Insulated Wire Works, Inc., 69 Gordon Ave., Providence 5, R. I.
Gibbs & Co., Thomas B., Div. of George W. Borg Corp., 814 Michigan St., Delavan, Wisc.
Goldmark Wire Co., James, 116 West St., New York 7, N. Y.
Haydu Bros., Mt. Bethel Rd., Plainfield, N. J.
Hoskins Mfg. Co., 4445 Lawton Ave., Detroit 8, Mich.
J. F. D. Manufacturing Co., 4111 Fort Hamilton Pkway., Brooklyn, N. Y.
Jelliff Mfg. Corp., C. O., 200 Pequot Ave., Southport, Conn.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
North American Philips Co., 100 East 42nd St., New York 17, N. Y.
Northern Mfg. Co., Inc., 36 Spring St., Newark, N. J.
Precision Resistor Co., 334 Badger Ave., Newark 8, N. J.
Radio Corp. of America, Tube Div., RCA, Harrison, N. J.
Spencer Wire Co., West Brookfield, Mass.
Swedish Iron & Steel Corp., 17 Battery Place, New York, N. Y.
Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Westinghouse Lamp Div., Westinghouse Electric Corp., Bloomfield, N. J.
Wickwire Spencer Metallurgical Corp., 260 Sherman St., Newark, N. J.
Wickwire Spencer Steel Co., 500 Fifth Ave., New York, N. Y.

SHIELDED WIRE

Acorn Insulated Wire Co., Inc., 225 King St., Brooklyn 31, N. Y.
Air Shields, Inc., Hatboro, Pa.
Alden Products Co., 117 North Main St., Brockton 64, Mass.
Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Steel & Wire Co., Rockefeller Bldg., Cleveland 13, Ohio
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y.
Ansonia Electrical Co., Ansonia, Conn.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago 44, Ill.
Birnbach Radio Co., Inc., 145 Hudson St., New York, N. Y.
Boston Insulated Wire & Cable Co., 65 Bay St. (Dorchester), Boston, Mass.

Columbia Wire & Supply Co., 4106 N. Pulaski Road, Chicago 41, Ill.
Connecticut Cable Corp., Jewett City, Conn.
Cornish Wire Co., Inc., 15 Park Row, New York, N. Y.
Crescent Insulated Wire & Cable Co., N. Olden Ave., Trenton, N. J.
Diamond Wire & Cable Co., 128 E. 16th St., Chicago Heights, Ill.
Electric Auto-Lite Co., Wire & Cable Div., Port Huron, Mich.
Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
Fishwick Radio Co., 430 Colorado Bldg., Washington, D. C.
Flexo Wire Co., 638 Genesee St., W., Syracuse 1, N. Y.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Bridgeport, Conn.
General Insulated Wire Works, Inc., 69 Gordon Ave., Providence 5, R. I.
Goldmark Wire Co., James, 116 West St., New York 7, N. Y.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkway., Brooklyn, N. Y.
Johnson Co., E. F., Waseca, Minn.
Lenz Electric Mfg. Co., 1751 N. Western Ave., Chicago 47, Ill.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Nonotuck Manufacturing Co., Holyoke, Mass.
Packard Electric Div., General Motors Corp., Warren, Ohio
Plastic Wire & Cable Corp., Norwich, Conn.
Precision Tube Co., 3828 Terrace St., Philadelphia 28, Pa.
Rockbestos Products Corp., 308 Nicoll St., New Haven 4, Conn.
Roebling's Sons Co., John A., 640 Broad St., Trenton 2, N. J.
Simplex Wire & Cable Co., 79 Sidney St., Cambridge 39, Mass.
Suprenant Electrical Insulation Co., 84 Purchase St., Boston 10, Mass.
Uniform Tubes, Shurs Lane & Lauriston St., Roxborough, Philadelphia, Pa.
United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.
Western Insulated Wire, Inc., 1151 South Broadway, Los Angeles 15, Calif.
Whitney-Blake Co., Dixwell Ave., New Haven, Conn.
York Wire & Cable Div., General Electric Co., Bridgeport, Conn.

X-ray Tubes & Equipment

see Tubes

COPIES OF THIS DIRECTORY AVAILABLE ON REQUEST

The editorial staff of ELECTRONICS, realizing the importance and timeliness of this Buyers' Guide, is again planning a limited number of reprints. This procedure has been followed for some years in order to provide all members of the engineering, production and maintenance departments, with complete and last minute reports on all reliable sources for electronic components as well as complete equipment.

This year, in view of resumed civilian and industrial production, this information is of vital importance. Copies are bound in convenient fashion and are available at ....

50¢ *per copy*

Send all requests for additional copies to the . . .
EDITORIAL DEPARTMENT, ELECTRONICS,
330 West 42nd Street, New York 18, N. Y.

NEW PRODUCTS

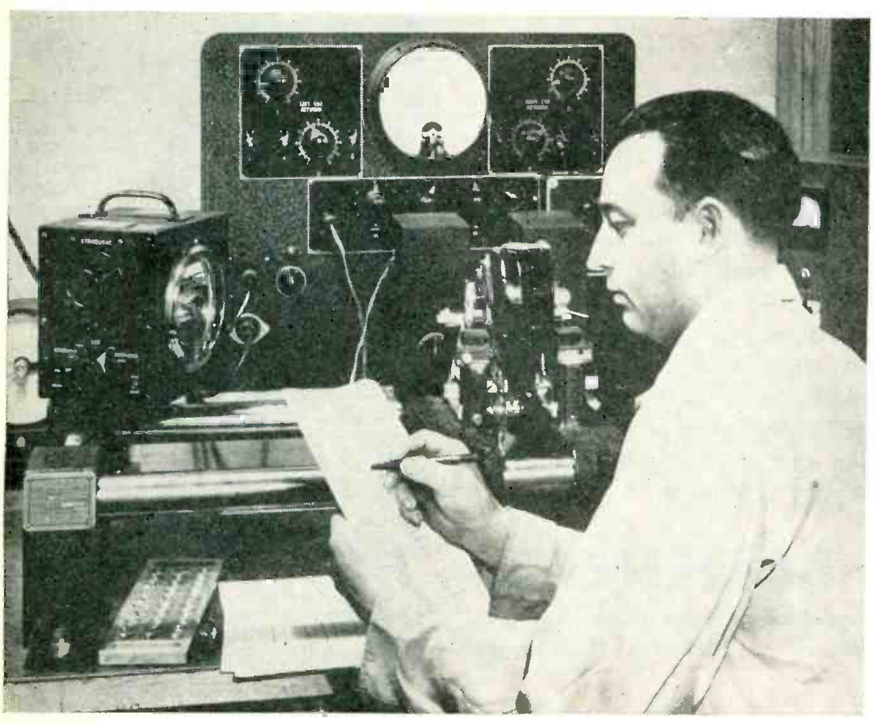
New materials, new components, new assemblies; new measuring equipment; new technical bulletins, and new catalogs

Features of Stroboscopic Light Source

FOR INSPECTION, stress study and timing of reciprocating and rotating motion and electron switch and relay applications, Sylvania Electric Products Inc., of Salem, Mass., now has available cold-cathode electron tubes with two internal trigger grids for operation in simple capacitor discharge circuits. Used as a source of stroboscopic light, these strobotron tubes provide pulse frequencies up to 240 pulses per second. Standard strobotrons measure $4\frac{9}{32}$ in. overall, including a T-9 bulb and a 4-pin base, $1\frac{3}{16}$ in. in diameter. Fifty milliamperes average current with 350-v d-c on the anode permits instantaneous surges of 5 amp. Grids are operated at 70-v d-c and 15 ma maximum. There is a drop of 75 volts during glow discharge and a 20-v drop during arc discharge. Starting is initiated by discharge between any two elements but usually between grids or either grid and cathode. Starting voltages range between 70 and 145-v d-c depending on the elements used in their polarity.

Applications of the strobotrons include continuous visual inspection of moving textiles and printing from high-speed rotary presses; precise timing of cams, shafts, flywheels, gears, pulleys, fan blades, spindles and shuttles, and many other rotating or reciprocating parts. The tubes also make visual study of stress or effect (during operation, in actual service) easy by creating stop, reverse or slow motion which may be photographed for reference or permanent record. Frequency of flashing may be readily controlled and calibrated over wide limits to produce a compact direct-reading instrument. High available peak currents make these tubes particularly adaptable to relay and control applications because they are fully enclosed and without moving parts and because they provide positive and powerful relay action in applications where other types of relays may fail or produce operating hazards in corrosive or explosive atmospheres.

Stroboscopic light played a large part in the exact balancing of rotating parts in the Norden bombsight where tolerances were kept within 20 millionths of an inch. Timed light flashes permitted precise determination of rotating speeds and visual study of imbalance during laboratory tests. In the photograph (bottom) light flashes were produced by a strobotron tube manufactured by Sylvania Electric. The technician is making production tests of bombsight equipment in the laboratory of the Victor Adding Machine Company, using a General Radio Strobotac and a Gisholt Dynetric Balancer.

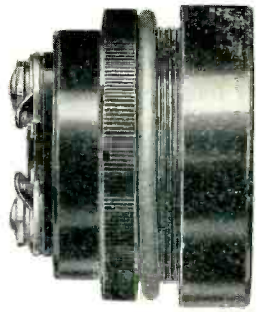


Folded Unipole Antennas

THESE FOLDED UNIPOLE antennas weigh 15 lb and are for use in transmitting and receiving at frequencies from 30 to 40 mc and for powers up to 5,000 w. Antennas for higher frequencies are being designed by the manufacturer, Andrew Co., 363 East 75th St., Chicago 19, Ill. Features of the units are as follows: Lightning hazard is minimized by grounded vertical element; "slide trombone" calibration permits exact adjustment for

Anyway you look at them...

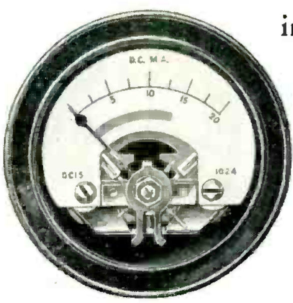
THEY'RE GREAT LITTLE METERS!



Side View

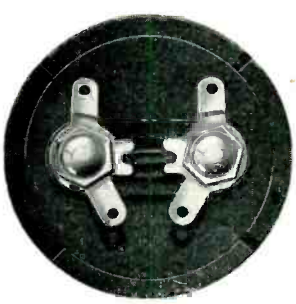
Front, side or back – inside and out – the 1½" Round Model 120 can do a whale of a job for you on a wide variety of applications.

External pivots provide maximum accuracy in mounting the moving element between the jewel bearings ... prevent rocking of pointer ... reduce side friction between jewels and pivots ... increase the life of bearing surfaces. Movements are designed to meet forthcoming JAN-I-6 specifications for 1½ inch instruments.



Front View

Built with fine precision, entirely self-contained ... with built-in resistors and shunts, this great little meter is also completely immersion-proof throughout. It has a special locking device for exerting pressure against rubber gaskets on either side of the glass. Watertight sealing includes terminal studs and a gasket back of the flange waterproofs the juncture between the meter and the panel. Installation is easy – a ring mounting eliminates mounting screws, The case is Black Anodized Aluminum.



Back View

Model 112 has all the features of the Model 120 except that it has a square, bakelite case. Like the 120 it is available either as a D.C. or A.C. (rectifier) instrument. Write for latest catalog.

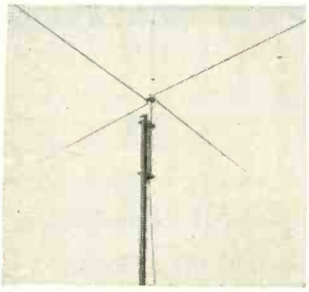
"Inside" View

BUY WAR BONDS

DeJUR-AMSCO CORPORATION

GENERAL OFFICE: NORTHERN BLVD. AT 45th STREET, LONG ISLAND CITY 1, N. Y.

any frequency between 30 and 40 mc; a non-reactive impedance with a resistive component varying between 62 and 75 ohms is provided;



when the antenna is used with transmitters there is no standing wave on the line, thus reducing line losses and voltage flashover, and freedom from reflections is obtained; the band-width is good for f-m because it is not less than 400-kc wide for a standing wave ratio of 1.2 to 1, and by careful selection of transmission-line impedance, may be made as wide as 1 mc; the antenna may be used with any 70-ohm coaxial cable, solid dielectric or beaded, up to 7/8-in diameter.

The problem of reflected light is solved by the horizontal mounting of the tube, and an adjustable shield is incorporated in the instrument to solve the problem of stray light. Tubes, resistors and capacitors are operated at no more than two-thirds maximum rating, and in most cases the safety factor is considerably greater.

An Electronic A-C Galvanometer for Commercial Use

HARVEY LABORATORIES, Inc., 447 Concórd Ave., Cambridge, Mass., has announced for commercial use their Galvascope, essentially an electronic a-c galvanometer which provides a visual means for detecting bridge balance. Since the instrument employs a 6E5 tube as an indicator and has no moving parts whatsoever, electrical overload and mechanical shock cannot injure it, and there is no waiting for an undamped galvanometer needle to come to rest. Difficulties sometimes encountered with vibration-type galvanometers have been eliminated from this instrument. The Galvascope is housed in a welded-steel cabinet with two operating controls (sensitivity and indicator bias) on a sloping panel. Side louvres and rear openings provide adequate ventilation and hold the temperature rise to a maximum of 30 C. All tubes except the indicator tube are conveniently mounted in a tube compartment which is easily accessible. Two permanently attached cords provide connections to a 115-v, 50-60 cycle a-c line and to the detector terminals of any 1000-cycle a-c bridge. The signal cord terminates in a specially designed banana-type plug having standard 3/4-in. spacing between terminals.

In designing the circuit of the instrument, use of the optical advantage of working with a small angular opening of the indicator tube eye is utilized. The circuit consists of an a-c amplifier, a signal rectifier, an indicator, and a self-contained power supply. The operation of the device involves amplification of the 1000-cycle bridge signal, followed by rectification of the amplified signal and application of the indicator tube. In the absence of signal, the eye of the indicator tube is closed or overlapped, depending upon the setting of the indicator bias control. When signal voltage is applied, the eye opens. As the bridge is brought into bal-

ance the signal decreases, and is indicated by closing of the eye. By proper manipulation of the controls, the eye is just closed (but not overlapped) at balance, whereas slightly off balance the eye is open to a small angle. The manufacturer states that the term balance as used here is intended to mean the nearest approach to a complete null, and may represent a minimum signal of some magnitude. In other words, two major accomplishments are achieved: detection of a very small signal, and detection of a very small change in a relatively large signal.

Master Coil Sets for Electronic Heating

THE INDUCTION HEATING Corporation (389 Lafayette St., New York 3, N. Y.) has developed master coil sets for users of Thermionic elec-

tronic heating equipment to aid them in immediately adapting the unit to any specific application in a minimum of time. The sets consist of master coils and removable inserts in diameter sizes ranging from 1/8 in. to 3 in., and of any desired thicknesses so that the coils are capable of heating axial bands of various widths to produce many heat patterns. Blank inserts are available to allow the user to cut the

desired contour to match a particular work. Inserts can be changed in a matter of seconds since they

This HARVEY Regulated Power Supply 106 PA Is Doing a Dependable Job for DOUGLAS

The HARVEY 106 PA pictured is in the El Segundo Division of Douglas Aircraft Research and Testing Division of the Engineering Department. Here, hooked up with an amplifier, it is helping to perform one of the many vital tests so important to the manufacture of airplanes.

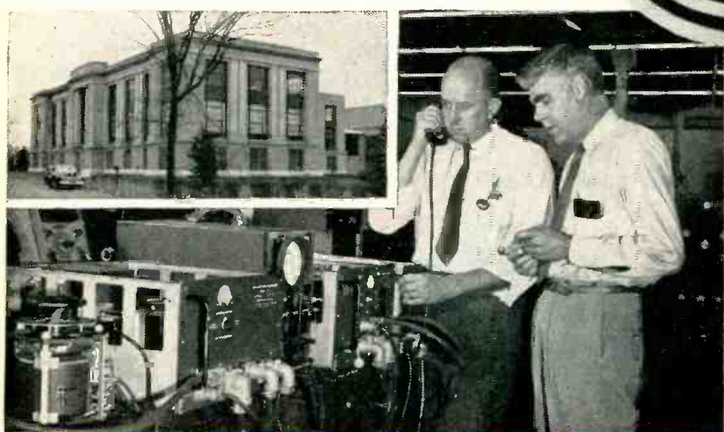
If, like Douglas, you need a constant dependable source of laboratory D. C. power between the range of 200–300 volts, select the HARVEY 106 PA. If you need laboratory D. C. power in a higher range, specify its big brother, the HARVEY 206 PA, 500 to 1000 volts.

Teamed with amplifiers, measurement equipment, constant frequency oscillators, pulse generators or any other apparatus requiring a constant source of D. C. power, HARVEY Regulated Power Supplies are proving the last word in efficiency and dependability. We'd like nothing better than the opportunity to show you why. May we send you illustrated bulletins containing the complete story?

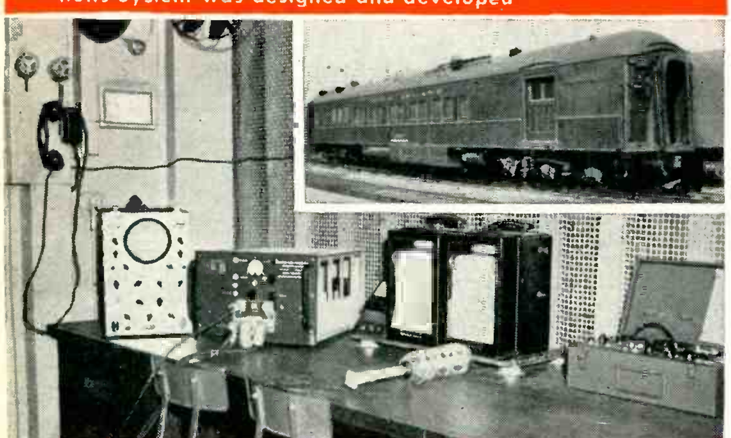
HARVEY RADIO LABORATORIES
INCORPORATED
439 CONCORD AVENUE, CAMBRIDGE 38, MASSACHUSETTS

Out of Two Laboratories

comes a *NEW* railroad communications



● Sperry's Research Laboratory where Railroad Communications System was designed and developed



● Rock Island's Mobile Electronic Laboratory where equipment was put to rugged test

THE ENGINEERING STAFF of the Sperry Gyroscope Company, in collaboration with engineers of Rock Island Lines, has perfected a new *system* of railroad communications.

Designed especially for railroads by Sperry and tested extensively by Rock Island, this system offers to the railroad industry microwave applications, secret until now, which Sperry's vast engineering group developed during the war years in co-operation with the U. S. Navy. With the aid of Rock Island engineers working in their specially equipped Electronic Car, the Sperry system has been completely tested and proved.

Sperry's Railroad Communications System makes possible *for the first time* clear, audible signals through tunnels, deep gorges, and the usual terrain and atmospheric conditions encountered in railroad service. No man-made

SPERRY GYROSCOPE COMPANY, INC.

Division of the Sperry Corporation

Leaders in the fields of • • • GYROSCOPICS • ELECTRONICS

system!

or atmospheric disturbance interferes with vital business!

Automatic relay stations, employing heretofore-restricted radar components that can be substituted for overhead land lines in treacherous storm areas, will link way stations and headquarters, and provide a continuous en route connection between trains and wayside points. A specially designed antenna provides any required degree of directional control.

Rock Island Lines, whose "sole purpose is to provide the finest in transportation," is being equipped with a Sperry Railroad Communications System.

If you would like our help in planning a complete radio communications system to expedite the handling of your freight and passenger traffic, write our Industrial Department for further information.

SPERRY RAILROAD COMMUNICATIONS SYSTEM

- **Microwave applications for the first time**
- **Designed especially for railroads**
- **Greater Range**
- **Increased Signal Strength**
- **FM Signal Audibility through any kind of interference**
- **Any degree of Directional Control**
- **Suitable for indoor and outdoor installations**
- **Available in both VHF and UHF**

GREAT NECK, N. Y. ★ LOS ANGELES · SAN FRANCISCO · SEATTLE · NEW ORLEANS · CLEVELAND · BROOKLYN · HONOLULU ★

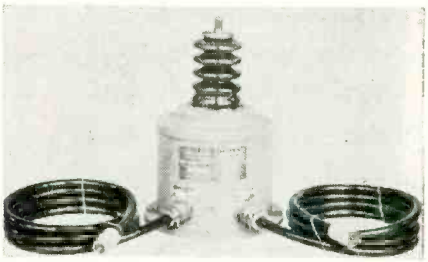
RADAR • AUTOMATIC COMPUTATION • SERVO-MECHANISMS

are held in place by easily-removable screws. When installed they are cooled by the thermal conduction from the master coil. The basic master coil consists of a rugged, water-cooled inductor block, machined to take the inserts. Advantages claimed for these master coil sets are that they aid in experimental work in designing a production coil for a given application, and that a number of master coil sets on hand increases the flexibility of the electronic heating equipment.

Capacitance Voltage Dividers

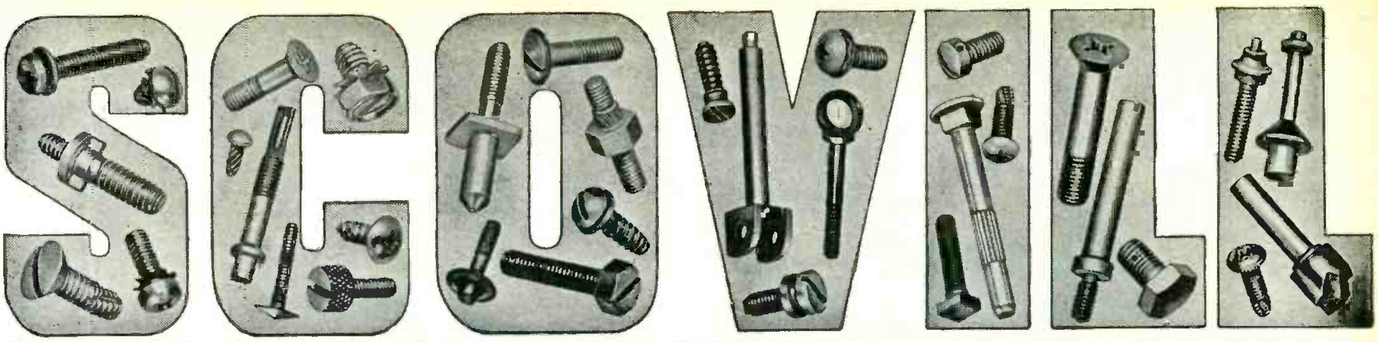
A NEW LINE OF capacitance voltage dividers for the accurate voltage measurement and wave-form observation of high-frequency voltages has been announced by General Electric's Transformer Division, Pittsfield, Mass. Available in ratings for 15,000-, 35,000-, or 50,000-volt peak pulse levels, each divider may be obtained with two independent voltage ratios of any desired value, for simultaneous pulse measurement and wave-form observation.

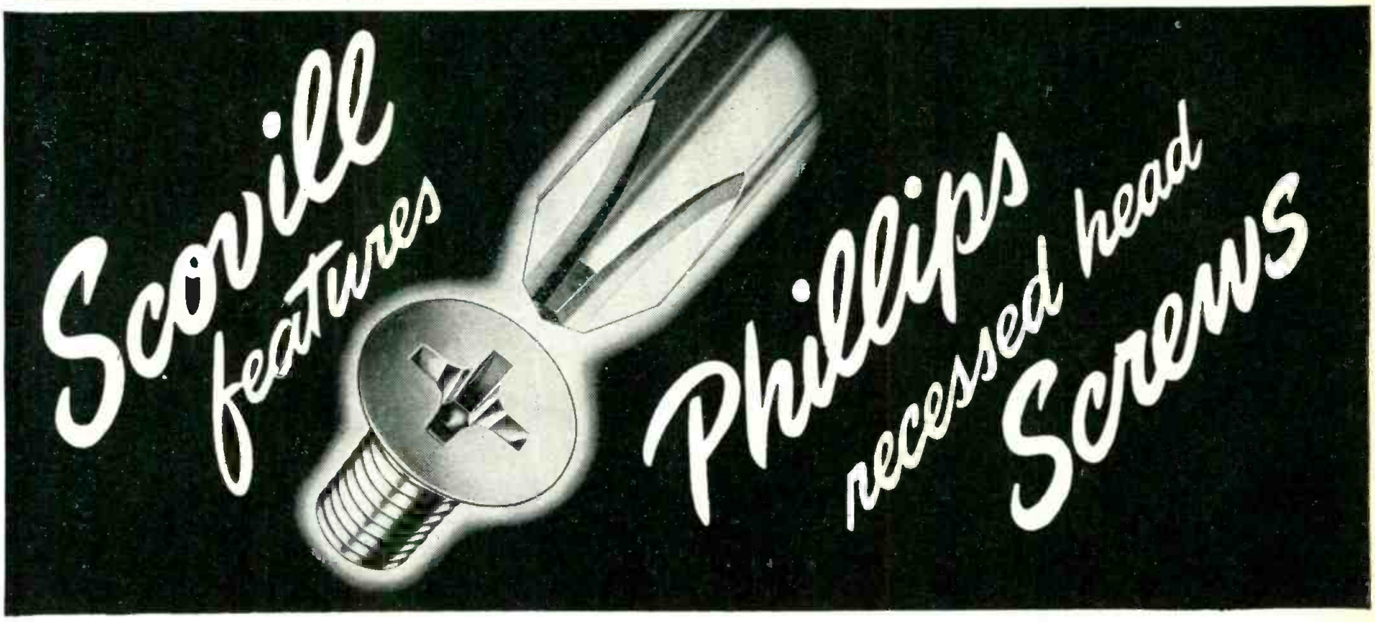
Connected to a high-potential high-frequency circuit, the capacitance voltage dividers provide one



or two step-down ratios, reducing the voltage to a suitably low value for connection to a voltage-measuring device, an oscilloscope, or both. For oscilloscopic observation, the new dividers give a faithful reproduction at low-voltage levels, of any high-voltage, high-frequency wave form.

These small compact units consist essentially of a high-voltage ceramic bushing which constitutes a low value of capacitance, in series with one or more standard molded-type Lectrofilm capacitors, assembled in a hermetically-sealed tank. The units can be supplied with mi-





...with four sound principles for economy and fast assembly

Scovill Phillips Recessed Head Screws are scientifically designed and engineered to offer these outstanding assembly features:

1. Speed: Driver point automatically centers in recess . . . fits snugly. Screw and driver become one unit . . . assembly speed often increases 50%.

2. Safety: The recessed head feature eliminates slotted screw burrs and screw driver skids which result in injuries to assembly workers . . . losses in time and money are eliminated.

3. Appearance: The attractive recessed head gives that "finishing touch" to products having visible screw heads . . . attractive appearance improves sales appeal.

4. Assembly Cost: The use of Scovill Phillips Screws reduces rejects – raises efficiency; curtails accidents – increases speed; eliminates burrs – saves man hours . . . all of which adds up to lower assembly cost.

The progressive features of Phillips Screws complement and expand Scovill's progressive program of producing specially designed cold-forged fastenings. Phillips Screws made by Scovill are backed by the quality and dependability for which Scovill is well known.

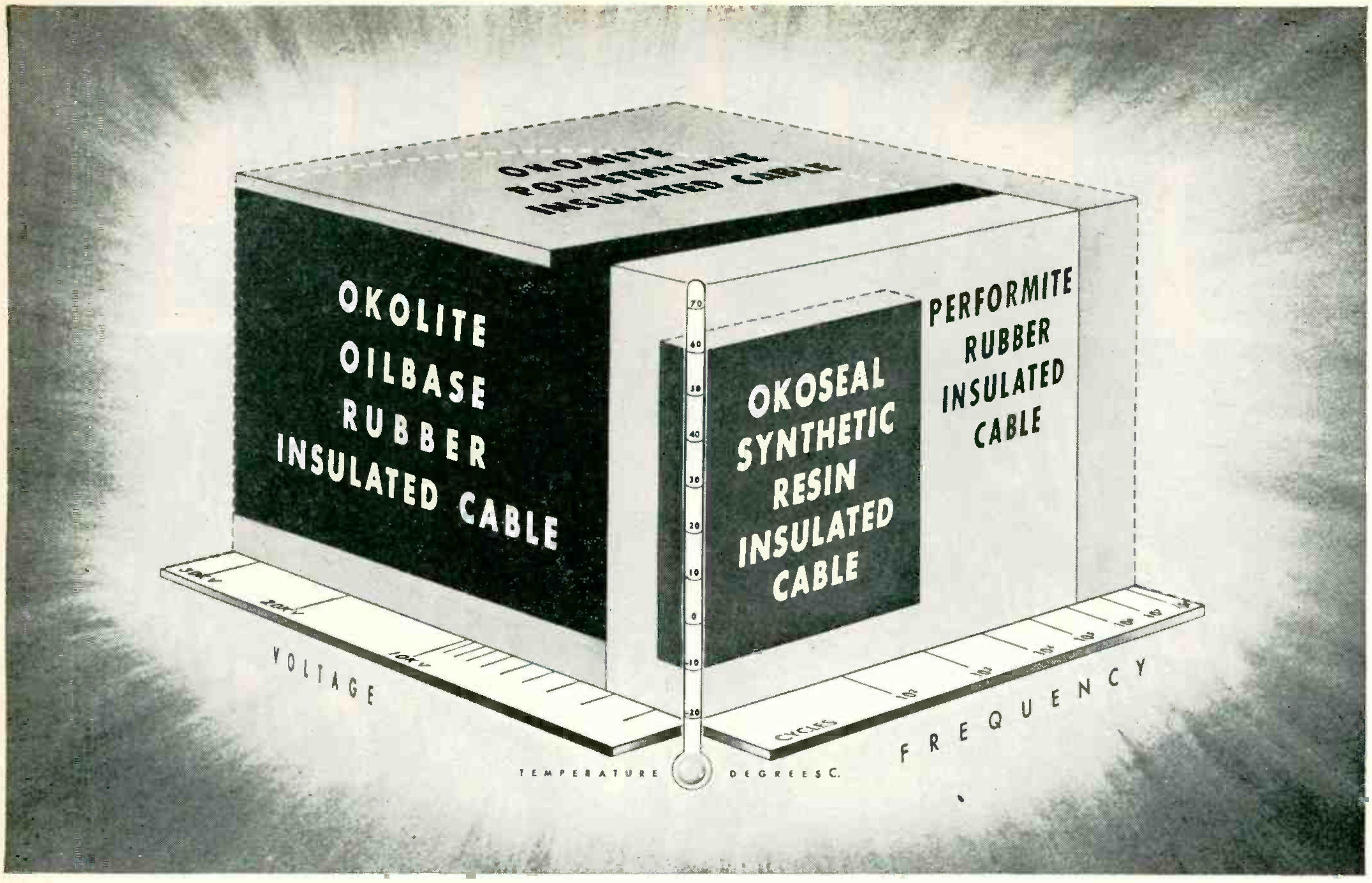
. . . buy *Scovill* Phillips Screws for quality, economy and fast assembly

SCOVILL MANUFACTURING COMPANY

WATERVILLE SCREW PRODUCTS DIVISION

WATERVILLE 48, CONN. SCOVILL **TEL. WATERBURY 3-3151**

NEW YORK, Chrysler Building • DETROIT, 6460 Kercheval Avenue • CHICAGO, 135 South LaSalle Street • PHILADELPHIA, 18 W. Chelten Avenue Building PITTSBURGH, 2882 W. Liberty Ave. • SYRACUSE, Syracuse-Kemper Insurance Bldg. • LOS ANGELES, 2627 S. Soto St. • SAN FRANCISCO, 434 Brannan St.



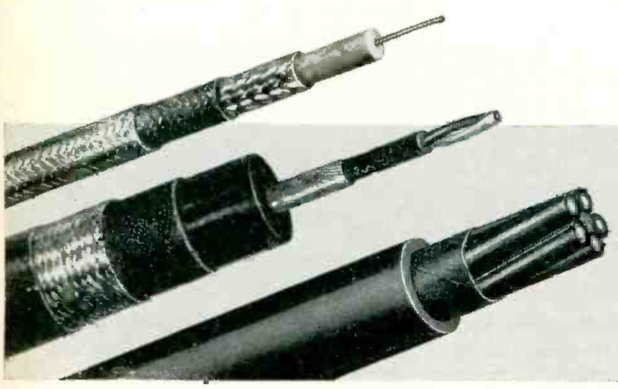
PERSPECTIVE: Selecting Insulated Cable Requires a Multi-Dimensional Approach

This 3-dimensional graph illustrates practical fields of usefulness of 4 widely-used types of cable insulation. Each type has particular characteristics that make it suitable for definite applications – but at the same time each possesses certain limitations.

The pictured values show the present maximum voltage, frequency and temperature limits for which these four insulations are commonly used. The insulations with the higher values can, in many cases, be used as alternatives for those having lower values.

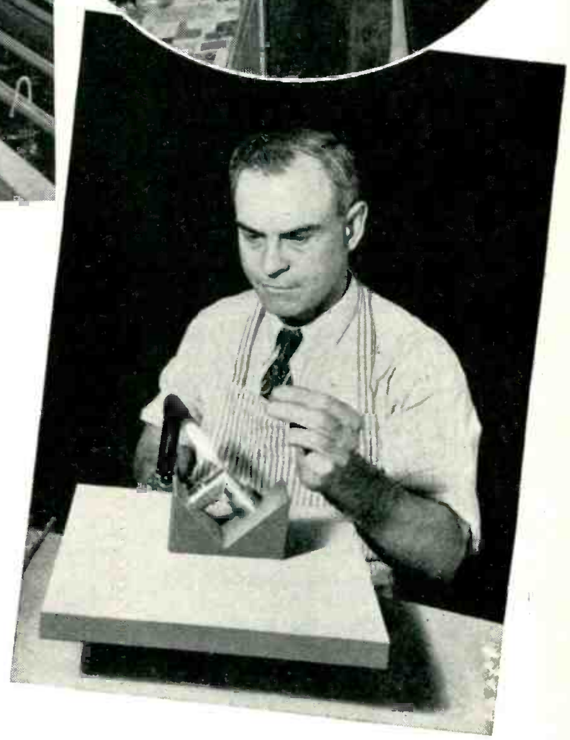
Design engineers may find this rather unusual graph helpful in selecting a cable for some specific application. The problem, however, is not always as simple as indicated because it is often necessary to obtain cables having additional characteristics not covered by this graph – such as resistance to moisture, oil, chemicals, flame, etc.

Actually there are available many other insulations developed through Okonite Research – such as glass, paper, cambric, rubber and many synthetics – that cover the full range of electrical applications. Through intensive laboratory and long field experience, our engineers have acquired the over-all perspective that can help you select the *one* cable best suited for your purposes from *every* angle. Just outline your problem and let us make recommendations. The Okonite Company, Passaic, New Jersey.



OKONITE SINCE 1878

insulated wires and cables



DICO FACILITIES

are now available to you in part or whole, for assistance in peacetime production and competition. Ask about them promptly; there is nothing quite like them elsewhere in a single plant. They are also of a quality and character that will soon result in full demands on them:

CASTING — in aluminum and bronze.

WELDING — machine, acetylene, electric.

MACHINING — hand and automatic, to the highest precision; particularly for the radio and electronic industries.

ASSEMBLING — including soldering, hard and soft, hand and automatic.

PLATING — in gold, silver, rhodium, palladium, copper, nickel, and chrome, under quality control and uniform processing.

FINISHING — buffing, polishing, lapping.

LABORATORIES — chemical, electrical, mechanical.

ENGINEERING AND DESIGN — electrical and mechanical, from the idea to the finished product, by an integrated group of competent engineers.

A UNIQUE AND UNRIVALED SERVICE TO INDUSTRY

DICO

DIAMOND INSTRUMENT CO.

WAKEFIELD · MASSACHUSETTS

crophone-type cable leads having suitable screw-in terminals, or with connectors for the attachment of coaxial cable.

Characteristics of the capacitance dividers are: insulation, 35-kv peak; total capacitance of porcelain bushing, 30 $\mu\mu f$; ratios, 200 to 1 and 50 to 1. View shows the porcelain capacitance divider bushing, two output cables and a hermetically-sealed tank. Output cables are "RG11/U" with Navy type CPH49190 plugs.

Photo Timer

CALTRON COMPANY (11744 West Pico Blvd., Los Angeles 34, Calif.) has developed an electronic timer for photo or interval timing. The instrument employs two vacuum tubes, and is easy to set. It has a pushbutton which provides positive control and prevents double-takes. No resetting is required between operational cycles. Once the instrument is set for a given inter-

val, it will repeat that time cycle each time the pushbutton is operated. The timer provides accurate interval control from 1/25 sec to 80 sec. The time cycle, once initiated, is independent of the pushbutton. Whether the operator keeps his finger on the pushbutton or takes it off before the time cycles is complete does not affect the cycle.

Flame-Resistant Plastic

A NEW FLAME-RESISTANT impression molding resin, called Thalid (XR540), has been announced by the Plastics Division of Monsanto Chemical Co., St. Louis 4, Mo. The material provides plastic-glass cloth laminates which are self-extinguishing and do not support com-

11 REASONS WHY YOU SHOULD BUY

THE RCA 2B ELECTRONIC PREHEATER

SCIENTIFICALLY DESIGNED ELECTRODES—Even and efficient heating is ensured by scientific electrode design—rounded edges — heat-reflective surfaces.

TOP OPENING AT WORKING LEVEL—Top-opening unit for operator convenience—an RCA first; no stooping for loading or unloading. Screen construction of safety cage provides good view of work and adequate ventilation.

AUTOMATIC OPENING AFTER HEATING—No wasted time when operators use the RCA Model 2B! Top opens, power goes off, upper electrode lifts — all automatically — when timer trips. Just reach in for uniformly plasticized preform.

SELF-LEVELING UPPER ELECTRODE—Ball-type joint with spring tension, automatically adjusts to any size preform; ensures good fit; keeps efficiency high.

AUXILIARY SURFACE HEATING—To prevent preform surface cooling and moisture condensation on electrodes, two infra-red lamps supply auxiliary surface heating. Lamps also provide light on work.

AUTOMATIC TUNING FOR MAXIMUM OUTPUT—Another RCA first — automatic electronic control adjusts heating rate to preselected level and *keeps it there.* Adjusts for changes in material, as it heats, and for variations in preform dimensions and material. Enables preheating up to 50% more material.

SAFETY INTERLOCKS ON CAGE AND DOORS—Complete safety for operators and maintenance men is provided by electrical safety switches, which shut off high-voltage circuits and ground them whenever cage or access doors are opened.

FRONT AND BACK DOORS FOR EASY ACCESS—For convenience in inspection and maintenance, front and back doors provide easy access to all working parts. Tumbler locks prevent unauthorized tampering.

AUTOMATIC OVERLOAD PROTECTION—In case of accidental overload of the generator, RCA fast-acting overload protection guards tubes and generator components.

COMPACTNESS; CONVENIENCE—Floor space required is only 30 by 25 inches. Right height plus handy controls and automatic features make operating convenient. Easy to move from press to press.

FORCED-DRAFT COOLING; FILTERED AIR—Efficient blower cools tubes and components with air drawn through spun-glass filter.

ORDER NOW FOR QUICK DELIVERY!

You can obtain *quick delivery* of RCA electronic preheating equipment if you order at once. Write: Radio Corporation of America, Electronic Apparatus Section, Box 70-197n, Camden, N. J.

RCA ELECTRONIC HEAT

BUY WAR BONDS

RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION • CAMDEN, N. J.

Mail This Today for FREE Booklets

RCA, Electronic Apparatus Section, Box 70-197n, Camden, N. J.

Please mail to me, without obligation, the following booklets on economical, high-speed electronic heat, which increases press output 50% or more.

RCA MODEL 2B HEATER—The 2000-Watt Automatic Unit with Automatic Compensation for Increased Heating Capacity.

RCA MODEL 15B HEATER—The 15,000-Watt Unit for Preheating Large Quantities of Molding Material.

BOOKLETS ON PREHEATING PLASTICS with high-speed electronic heat.

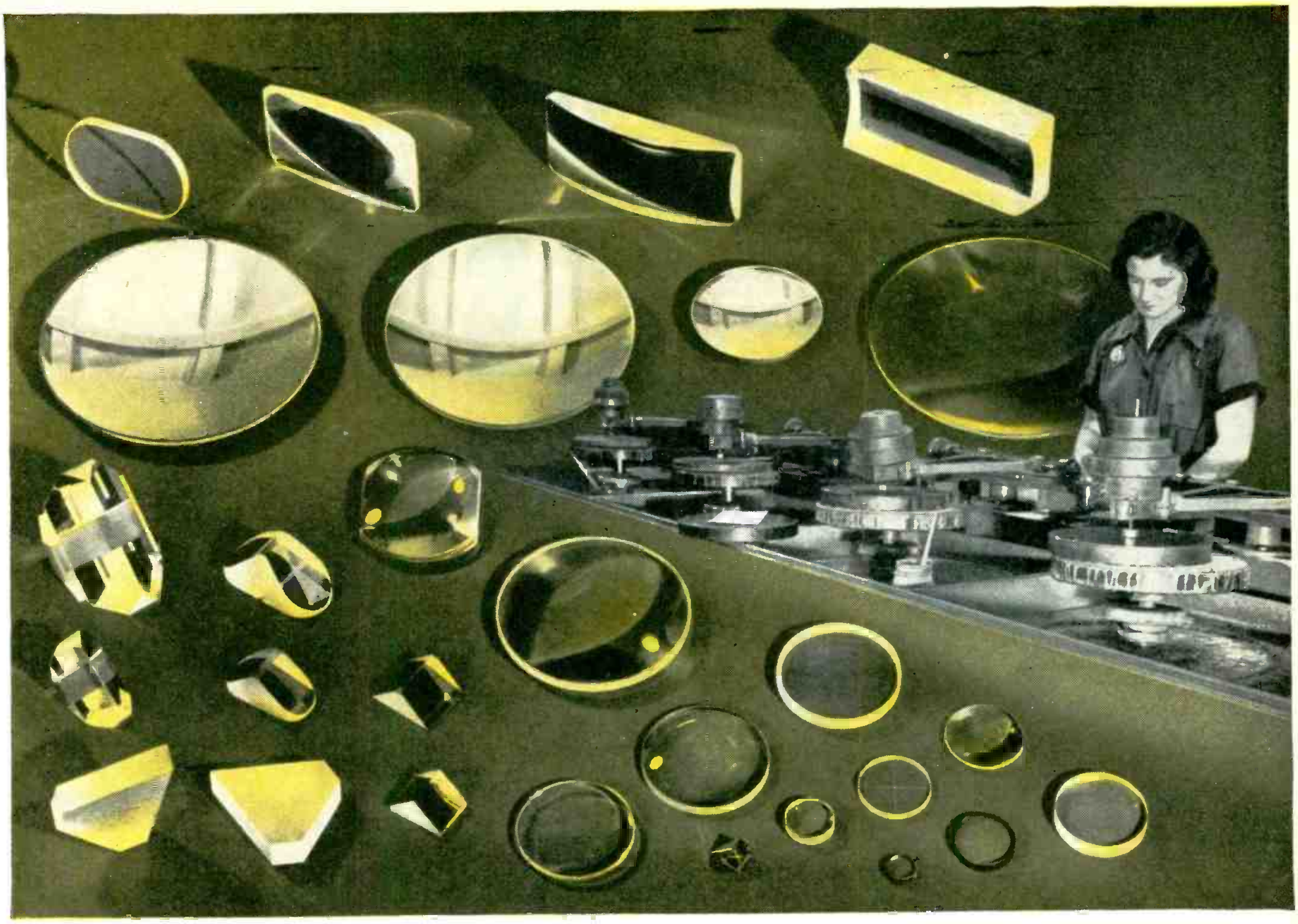
Name__________

Position__________

Company__________

Address__________

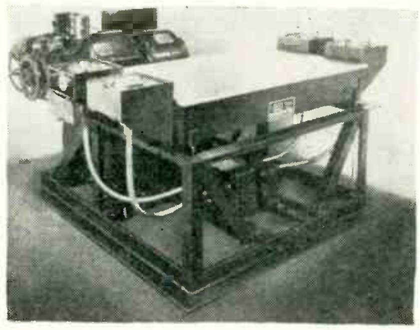
City__________ Zone____ State______ 70-6236-197



bustion. Thalid requires little or no pressure for fabrication and is used in conjunction with paper, cotton, or glass cloth or with other sheet materials. The combination provides a high degree of structural strength and permits manufacture of parts of almost unlimited sizes.

Vibration Test Table

THE TABLE TOP of these vibration test tables is supported by four vertical rods acting as flexible columns to permit free table vibration in the two horizontal directions. Four sets of rotating eccentric weights induce rectilinear and pure harmonic vibrations. These weights, mounted on vertical shafts, are driven by a variable-speed drive through a synchronizing gear box and flexible shafts. The amplitude ($\frac{1}{8}$ in. maximum excursion at 100 lb table load) and the direction of vibration (horizontal crosswise or lengthwise) are adjustable when the machine is not running. In-



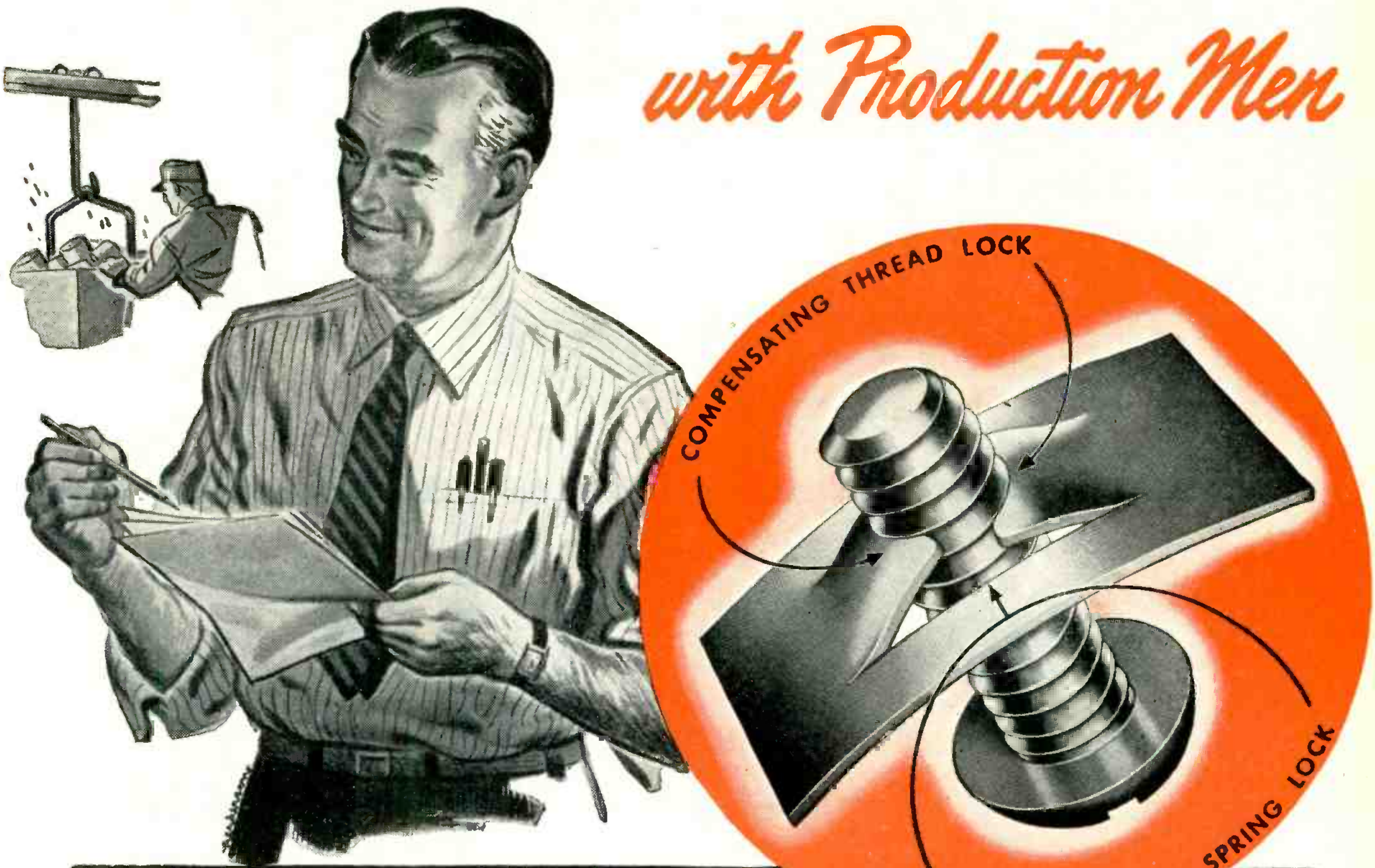
crease in load over 100 lb automatically reduces the amplitude.

Standard frequency range is 10 to 60 cps, which is adjustable while the machine is running, either by hand wheel or $\frac{1}{4}$ hp motor-driven automatic frequency change control, with 1 minute for a complete cycle. Amplitude does not vary with frequency. An acceleration of 10 G is produced between 50 and 60 cps at $\frac{1}{8}$ in. double amplitude. The equipment, which has a maximum capacity of 400 lb, weighs 1,500 lbs and is operated by a 5-hp motor. Its overall dimensions are 52 x 58 x 32 in. high. Table top is 24 x $40\frac{3}{4}$ in. Installations can be made on upper floors of buildings without concrete bases.

L.A.B. Corp., Summit, N. J.

Why Speed Nuts are First

with Production Men



NOTHING LOCKS LIKE A SPEED NUT

Only SPEED NUTS provide a COMPENSATING thread lock and a SELF-ENERGIZING spring lock. As the screw is tightened the two arched prongs move inward to lock against the root of the screw thread. These free-acting prongs COMPENSATE for tolerance variations. Compression of the arch in prongs and base creates a SELF-ENERGIZING spring lock. These two forces combine to definitely prevent vibration loosening.

PRODUCTION men who actually use them really appreciate the ease with which SPEED NUTS are applied. They'll tell you that SPEED NUTS start easier, tighten down faster, and eliminate fumbling around with hard-to-handle lock washers.

Production men also will tell you how much time is saved by using any of the self-retaining types of SPEED NUTS. They merely snap these fasteners into bolt-receiving position by hand, instead of welding or riveting cage nuts in place. Moreover, these self-retaining SPEED NUTS provide "float" to compensate for misalignment of clearance holes.

These are only a few reasons why production men prefer SPEED NUTS. But reasons enough for you to investigate SPEED NUTS for your own benefit by writing today.

TINNERMAN PRODUCTS, INC. • 2106 Fulton Road, Cleveland 13, Ohio

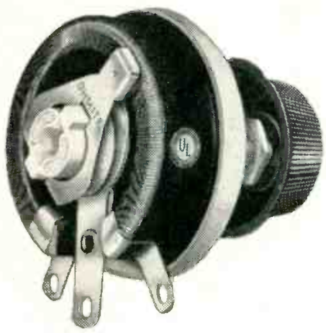
In Canada: Wallace Barnes Co., Ltd., Hamilton, Ontario
In France: Aerocessoires Simmonds, S. A., Paris
In England: Simmonds Aerocessories, Ltd., London
In Australia: Simmonds Aerocessories, Pty. Ltd., Melbourne

Speed Nuts* PATENTED

*Trade Mark Reg. U. S. Pat. Off.

FASTEST THING IN FASTENINGS... OVER 3000 SHAPES AND SIZES

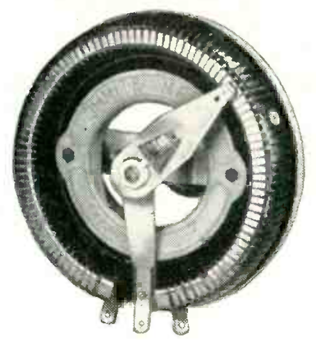
Wide range of OHMITE types and sizes best meets each Rheostat-Control need



Standard Rheostats

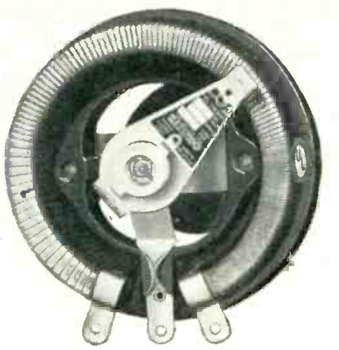
10 Sizes: 25*, 50*, 75, 100*, 150*, 225, 300*, 500*, 750, 1000 Watt

* Carried in Stock in a Wide Range of Resistance Values. Illustration Typical of Sizes 25 to 225 Watts.



Standard Rheostats

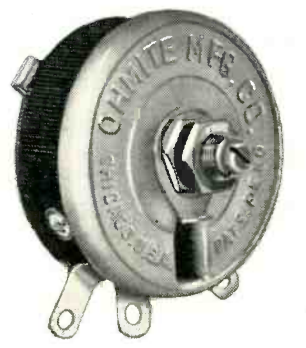
Available in a Wide Range of Resistance Values. Illustration Typical of Sizes 300 to 1000 Watts.



Rheostats with Tapered Winding

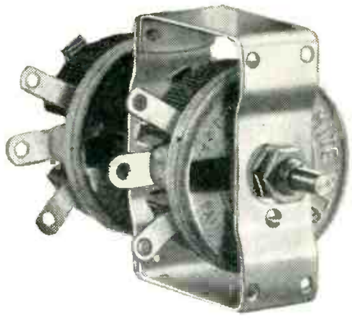
Available in all 10 sizes in a wide Range of Resistance Values.

Rheostats with Bushing for Special Panel Thickness

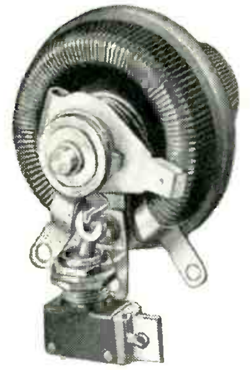


Rheostats with Shaft Having Screw Driver Slot

Rheostats with Snap-Action Off-Position



Rheostat
Tandem
Assembly



Rheostats
with
Toggle Switch

Rheostats
in Table
Mounting Cages

Hundreds of Stock and Special

RHEOSTATS

10 Wattage Sizes from 25 to 1000 Watts, from 1-9/16" to 12" Diameter, with Standard or Special Features, with Uniform or Tapered Windings, in Stock or Special Resistances, in Single, Tandem or Concentric Units.

ONLY Ohmite provides such wide range of types and sizes . . . to give you a quick and correct answer to your rheostat needs. Shown here are but a few of the many variations produced for innumerable control applications.

All models have the time-proved features of Ohmite design—the pioneer design that revolutionized rheostat construction. Every Ohmite unit assures permanently smooth close control . . . under every operating condition.

Extensive Ohmite experience . . . before the war and in the war . . . is at your service today. Let Ohmite engineers help you.

OHMITE MANUFACTURING COMPANY
4817 FLOURNOY STREET, CHICAGO 44, U.S.A.

Sealed, Completely
Enclosed
Models H and J
Rheostats

Send for Catalog and Engineering Manual No. 40

Write for 96-page book on your company letterhead. Gives valuable data on the selection and application of rheostats, resistors, chokes and tap switches. Address Ohmite Manufacturing Co., 4817 Flournoy Street, Chicago 44, Ill.

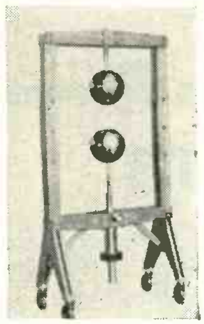
Be Right with

OHMITE

RHEOSTATS • RESISTORS • TAP SWITCHES

Sphere Gaps for High-Voltage Measurements

A COMPLETE LINE of sphere gaps, for accurate measurement of high voltages used in a-c or d-c testing, has been announced by General Electric's Transformer Division, Pittsfield, Mass. Available in standard diameters of 2, 6.25, 12.5, 25, 50, 75, and 100 cm for spark-over voltage ranges of 8.5-45 to 261-1338-kv crest, the sphere gaps are furnished complete with current-limiting series resistance assemblies. The units provide a direct and accurate method of gaging test voltages; serve as protective devices to prevent overvoltage on the test specimen or apparatus during high-potential testing; indicate crest voltage regardless of wave form; are relatively unaffected by humidity changes in the air; have practically no time lag; and provide consistent spark-over voltages.



The 2- and 6.25-cm gaps are both table-type, with electrodes mounted horizontally in wooden supports. The larger sizes are floor types with highly polished spheres mounted vertically in a rectangular frame. All of the sphere gaps are provided with precision adjustments for gap spacing. Sphere gaps of 25 cm and larger can be provided with casters for easy mobility, and a motor drive for gap adjustment if desired.

The current-limiting resistance assemblies are made of non-inductive, wire-wound rods mounted on treated wooden frames.

Receiver-Transmitter Unit

AIRADIO, INC. (Stamford, Conn.) announced final production plans for a receiver-transmitter unit weighing only 10.6 lb, for private air-

Pictured at left is a television projection installation in a London theatre before the war, operated by Cinema Television Ltd., associated with Gaumont-British, Ltd., and Baird Television. RAULAND owns American rights to all present and future television patents and processes of these British pioneers, thus combining the most advanced television thinking of two continents, to bring the finest in revolutionary entertainment to the American Public.

Here it is . . . a preview of what the RAULAND Theatre Television Projection Equipment will look like. This product of many years of development, while not yet available, is now in daily operation in the RAULAND Laboratory-Theatre, projecting scenes *as they occur on a full size theatre screen.* Here, advanced refinements are being constantly added to ready this equipment for the time when Theatre Television will make its public appearance.

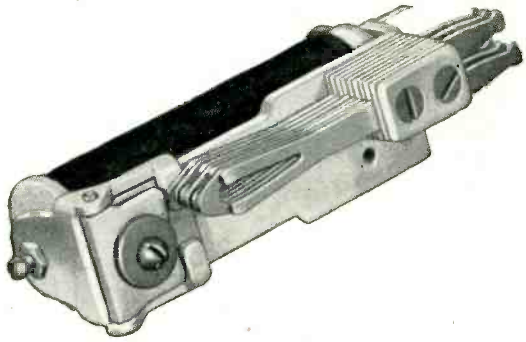
RADIO · RADAR · SOUND **Rauland** COMMUNICATIONS · TELEVISION

Electroneering is our business

THE RAULAND CORPORATION • CHICAGO 41, ILLINOIS

- SENSITIVITY
- CONTACT PRESSURE
- DEPENDABILITY
- COMPACTNESS
- VERSATILITY
- LONG LIFE

ALL THESE *in* THIS ONE RELAY



AUTOMATIC ELECTRIC'S CLASS "B" RELAY

Check Automatic Electric's Class "B" relay against *all* your requirements. It's one relay that gives you all six of the features you want—and gives you the *most* of each of them. Don't compromise with the requirements of the job; simply standardize on the Class "B" relay and get *all* the features you need!

Independent twin contacts for dependable contact closure... efficient magnetic circuit for sensitivity and high contact pressure . . . unique armature bearing for long wear under severe conditions . . . compact design for important savings in space and weight. Now available for coil voltages to 300 volts DC and 230 volts AC, with capacities up to 28 springs; also with magnetic shielding cover, when specified.

The Class "B" relay, and many others, are shown in Catalog 4071. Write today for your copy.

Relays by

AUTOMATIC ELECTRIC

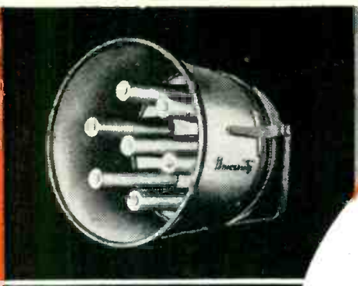
AUTOMATIC ELECTRIC SALES CORPORATION

1033 WEST VAN BUREN STREET • CHICAGO 7, ILLINOIS

In Canada: AUTOMATIC ELECTRIC (CANADA) LIMITED, TORONTO

PARTS AND ASSEMBLIES FOR EVERY ELECTRICAL CONTROL NEED

Models AA7, 4A4 and 2YR—MULTI-UNIT LOUDSPEAKERS: High powered directional units with power capacities from 50 to 250 watts and projection ranges from ¾ mile to 2 miles. AA7 illustrated.



Models 1B8 and 1BR—PAGING AND INTER-COMMUNICATION SPEAKERS: Two high efficiency speakers of extreme applicability. 1B8 is directional. 1BR is a radial projector. 1B8 illustrated.

Models LH, PH and SMH—REFLEX HORNS: Rugged sound projectors capable of ½ mile directional coverage. Each unit features different frequency cutoff. LH illustrated.

Models RCR and CR—HIGH EFFICIENCY BOOSTER SPEAKERS: These hermetically sealed units are designed to over-ride high noise levels in indoor or outdoor locations—docks, ship ping rooms, loading platforms. RCR is radial type; CR directional. CR illustrated.

Models RLH, RPH and RSH—RADIAL LOUDSPEAKERS: These units provide 360° coverage with three choices of low frequency cutoff. They are designed for minimum sound concentration beneath the speaker. RPH illustrated.

PAH and SAH—DRIVER UNITS: UNIVERSITY Driver units incorporate such special features as rim centering, all-weather construction—that increase efficiency and make possible a breakdown-proof guarantee. Designed to fit any UNIVERSITY PROJECTOR

Models RBP12 and RBP8—RADIAL CONE SPEAKERS PROJECTORS: Radial cone speaker projectors incorporating infinite baffle design for excellent low frequency response. RBP12 illustrated, takes 12" cone speaker; RBP8 takes 8" cone speaker.

University Speakers

..for every installation!

Backed by a record of leadership in the pioneering of the reflex, non-resonant, horn-type projectors, and high power, weatherproof breakdown proof driver units, the all-inclusive line of UNIVERSITY speakers represents the most diversified in the field.

As a result of the long, specialized experience, it is now possible to specify a UNIVERSITY unit exactly suited to any particular requirement. Both indoor and outdoor types are available for high fidelity reproduction, or with characteristics suitable for crisp clarity, and capable of over-riding high surrounding noise levels.

Each UNIVERSITY speaker incorporates special features—both electrical and mechanical—which assure maximum efficiency and dependable functioning at all times.

SPECIAL FEATURES

"U" BRACKET MOUNTING: This feature reduces mounting to a simple straightforward procedure and permits orientation of the projectors with the ease of spotting a searchlight.

RIM DAMPING: All UNIVERSITY speakers and projectors are rubber rim loaded to eliminate mechanical and acoustic resonance. All traces of rattle and reverberation are eliminated even at full power output.

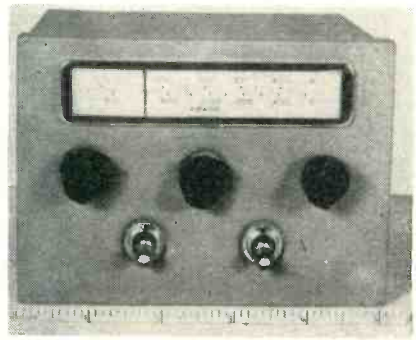
ALL WEATHER CONSTRUCTION: Climate and exposure can not impair the fine performance of UNIVERSITY loudspeakers. Heavy gauge metal construction, complete enclosure of the driver units, dust and water proof design recommends them for any installation indoor, outdoor or shipboard.

UNIVERSITY LABORATORIES

225 VARICK STREET
NEW YORK, 14, N.Y.

University

craft. This communications system is compact, highly sensitive, and ruggedly constructed. It provides standard plane-to-ground communication, radio range, weather broad-



cast, and standard broadcast reception, as well as interphone communication between pilot and passengers. A radio range filter is incorporated into the receiver. The range signal can be eliminated by merely flicking a toggle switch (located in the front panel of the receiver) to permit reception of voice only.

Newly Designed Radio Receiver

To PROVIDE EASIER accessibility of parts for servicing and maintenance of radio receivers, the National Radio Company of Malden, Mass., has completely redesigned its radio receivers. Lock handles, shown in the accompanying illustration at either side of the set, immediately release (by the flick of

the wrist) the panel section from the cabinet. Design of the interior mechanism utilizes a drawer slide which does away with the necessity of removing the receiver from the cabinet. With the receiver pulled out on this drawer slide, the

Modernize YOUR HIGH-VACUUM SYSTEMS

with these New Compact All-Metal Diffusion Pumps

THE DPI all-metal series of VMF pumps marks an entirely new application of the fractionating, self-conditioning pump principle for the production of high vacuum. The VMF series more than meets the demands of industry for a rugged and compact pump capable of reaching pressures of 10^{-6} and lower.

These high-vacuum pumps were designed for use on automatic exhaust machines for production of transmitter tubes, cathode ray tubes, television and receiving tubes. Other applications include electron microscopes, trolley exhaust systems, evaporation of metals, photospectography.

VMF pumps are made with speeds ranging from 2 liters to nearly 300 liters per second at pressures of 1×10^{-4}. High forepressure breakdown may be obtained by the proper selection of pump fluids. Choice of water or air cooling.

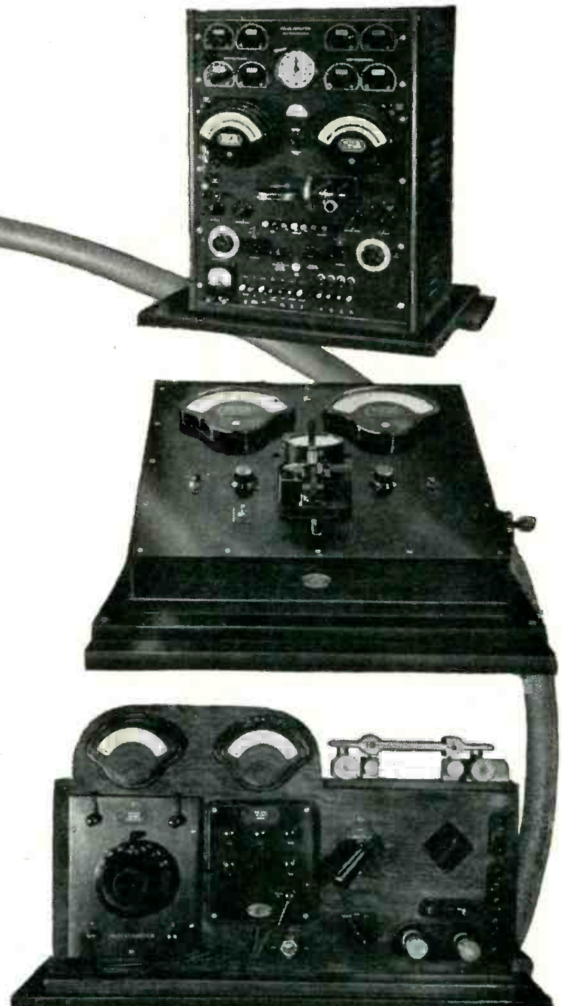
Write for details about these new diffusion pumps, as well as 20 other models of oil diffusion pumps, mercury vapor pumps, low vapor pressure fluids, greases, vacuum gauges, control circuits, and high-vacuum valves.

Vacuum Equipment Division

DISTILLATION PRODUCTS, INC.

Rochester 13, N. Y.

Start RIGHT AND YOU *End* RIGHT!



with WESTONS ON ALL PRODUCTION TEST-STANDS AND INSPECTION EQUIPMENT!

With the race for markets in full swing, electrical manufacturers are eliminating costly production bottlenecks by providing *uniform dependability* in testing procedure all along the line. From the inspection of purchased components right through to final product inspection, they insure accurate testing by using instruments they can trust.

And it's easy to insure *measurement dependability* at every step, because there are WESTONS for every testing need . . . including types for all special test-stand requirements, as well as a broad line of multi-range, multi-purpose test instruments. These compact, multi-purpose testers often afford new simplicity and economies in testing procedure, while assuring the dependability for which WESTONS are renowned.

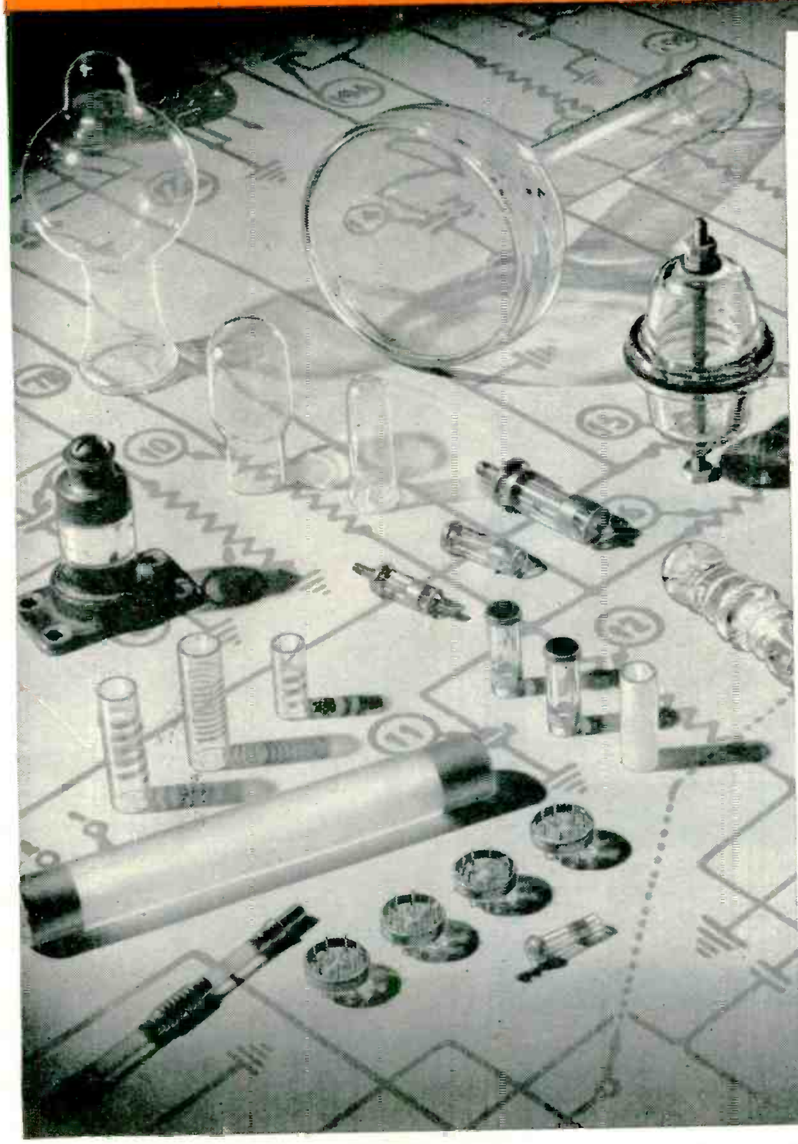
Literature describing the complete line of WESTON panel and test instruments is freely offered . . . Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark 5, New Jersey.

Weston *Instruments*

ALBANY • ATLANTA • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DENVER • DETROIT • JACKSONVILLE • KNOXVILLE • LOS ANGELES • MERIDEN
MINNEAPOLIS • NEWARK • NEW ORLEANS • NEW YORK • PHILADELPHIA • PHOENIX • PITTSBURGH • ROCHESTER • SAN FRANCISCO • SEATTLE • ST. LOUIS • SYRACUSE
In Canada, Northern Electric Co., Ltd., Powerlite Devices, Ltd.

WHAT WILL <u>YOU</u> NEED TO PRODUCE BETTER POST-WAR PRODUCTS?

CORNING GLASS GIVES YOU



Special Electrical Qualities
Thermal Endurance
Hermetic Sealing
Mechanical Strength
Corrosion Resistance
Precision
Permanence
Metallizing
Dimensional Stability

High dielectric strength — high resistivity—low power factor—wide range of dielectric constants—low losses at all frequencies.

Permanent hermetic seals against gas, oil and water readily made between glass and metal or glass and glass.

Commercial fabrication to the fine tolerances of precision metal working.

Corning's metallizing process produces metal areas of fixed and exact specification, permanently bonded to glass.

AS YOU plan post-war electronic products, give a thought to versatile glass. We really mean glasses, for Corning has, at its fingertips, 25,000 different glass formulae from which to select those especially suited to your electronic applications. Let us show what glass can do for you. We may already have a solution — or Corning Research can find the answer for you. Phone Corning 2852 or wire Electronic Sales Dept., E-11, Bulb and Tubing Division, Corning Glass Works, Corning, New York. We'll have a man on the job promptly.

CORNING
— means —
Research in Glass

Electronic Glassware

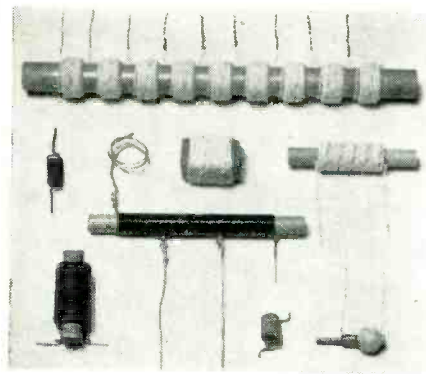
TRADE MARK VYCOR REG. U.S. PAT. OFF.
T.M. REG. CORNING U.S. PAT. OFF.
T.M. REG. PYREX U.S. PAT. OFF.

"PYREX", "VYCOR" and "CORNING" are registered trade-marks and indicate manufacture by Corning Glass Works, Corning, N. Y.

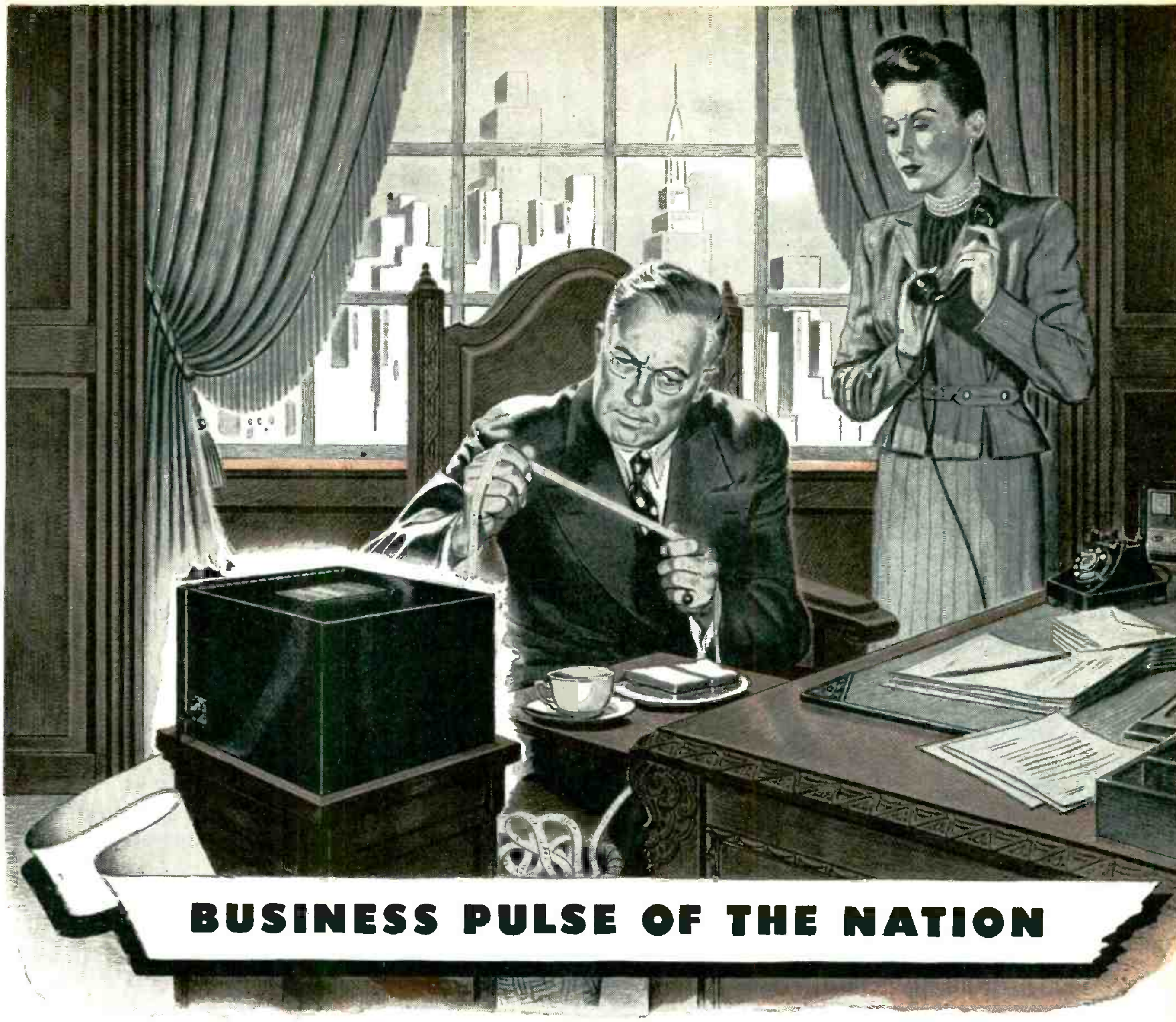
set can be tilted into three different positions so that all components can be reached easily. The manufacturer states that the mechanical features could be readily adapted to commercial models, including wall-flush home sets. The new type receiver will be installed aboard fleet units and at shore stations.

Coils

THE BITTERMANN Electric Co., 50 Henry St., Brooklyn, N. Y. uses a bank-winding process to produce in quantity coils of high inductance and low distributed capacity and for radar receivers. In the accompanying illustration, the upper coil is No. 24 DCE wound on $\frac{1}{2}$ x $\frac{5}{8}$ x 8-in. Phenolite XXR tubing, each pie having 46 turns and an inductance value of 38 μh, with a total of 380 μh for the 9 pies and a distributed capacitance of 2.8 $\mu\mu$f at a frequency of 24 mc. Bank-wound coils are also made with iron-dust cores or square tubing to be used in



conjunction with Hipersil cores. The small coil (lower right) is No. 32 SCE wound on $\frac{1}{4}$ in. iron dust core, 146 turns; the inductance is 690 μh with a Q of 92 at 150 kc, with an impedance of over 2,200 ohms at 30 mc. Winding is $\frac{7}{16}$ in. diameter by $\frac{7}{16}$ in. long. Another type of coil produced is one wound with taps without cutting the wire or leaving space between the windings. The method used here is to bring the wire up in tight loops, retaining full size and continuing the winding of the coil. The insulation is stripped and No. 18 stranded tinned leads are soldered to the loops. Wire sizes used are from 20 enameled to 14 single glass covered.



Instantly and simultaneously, stock quotation tickers flash minute-by-minute market reports from coast to coast. These business pulses of the nation must be accurate and reliable, and to help assure uninterrupted service, Western Union employs cables protected by VINYLITE plastic insulation!

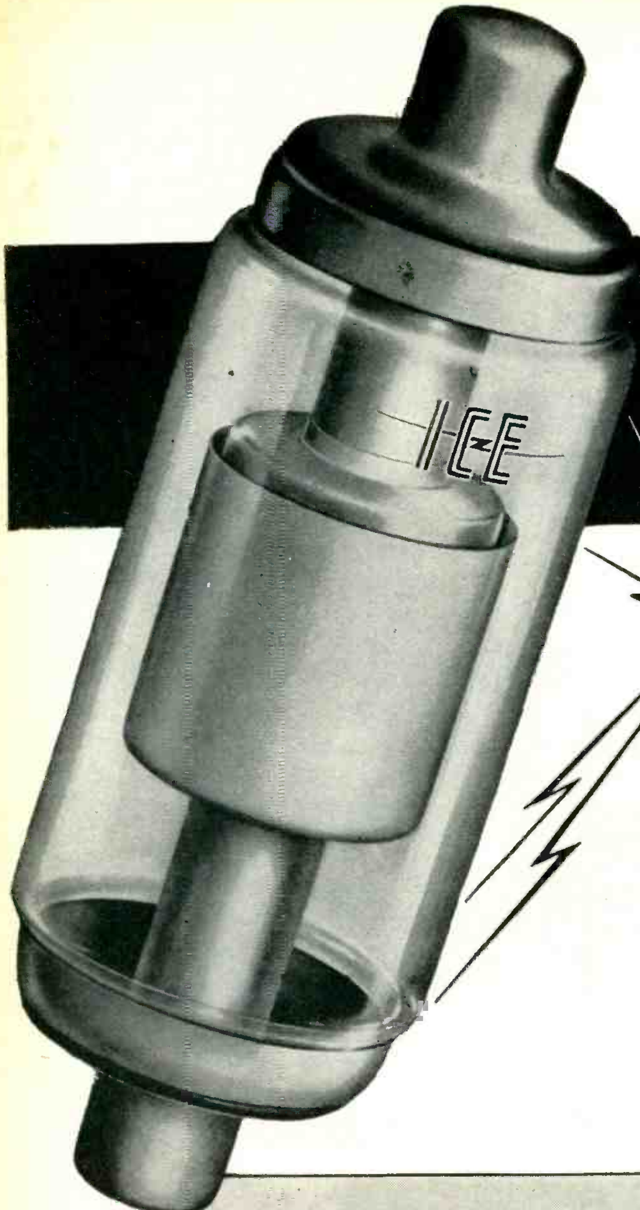
In this application—as in others, indoors and out—Western Union finds that VINYLITE plastic insulation brings valuable advantages over older types. Its dielectric strength permits thin-wall, small-diameter construction. It is highly resistant to aging, flame, moisture, abrasion, and most acids, alkalies, alcohols, and solvents. It remains flexible even at low temperatures. And VINYLITE plastic insulation can be made in a wide range of colors for easy identification — opaque, transparent, and crystal clear.

On instrument wire, you will probably find, like Western Union, that VINYLITE plastic insulation has better heat resistance than insulation formerly used. You will find, too, that it brings new standards of outdoor performance where wide temperature variations and heavy external loadings on the conductors are encountered. Write Department 18-VR for the booklet "VINYLITE Plastics for Wire and Cable Insulation."

BAKELITE CORPORATION
Unit of
Union Carbide and Carbon Corporation
UCC
30 East 42nd St., New York 17, N. Y.

Vinylite Plastics

TRADE-MARK



For your problems of induction heating . . .

I.C.E. CAPACITORS give you the precise capacitance value you want

Wherever *exact* capacitance values are needed . . . where exceedingly close tolerances are demanded . . . choose I.C.E. Capacitors. For induction heating . . . machine speed controllers . . . for current rectifiers . . . for any industrial application . . . I.C.E. Capacitors provide greater operating safety.

I. C. E. PRECISION GRADE VACUUM CAPACITORS

Value Range	*Accurate to*
6 mmfd. to 25 mmfd.	±0.5 mmfd.
26 mmfd. to 60 mmfd.	±1.0 mmfd.
61 mmfd. to 110 mmfd.	±1.5 mmfd.

I. C. E. XX GRADE VACUUM CAPACITORS

Value Range	*Accurate to*
6 mmfd. to 25 mmfd.	±0.2 mmfd.
26 mmfd. to 60 mmfd.	±0.3 mmfd.
61 mmfd. to 110 mmfd.	±0.5 mmfd.

Close Tolerances With I.C.E. Capacitors

Besides offering you a wide range of capacitance values, I.C.E. vacuum capacitors are built to give you previously unobtainable tolerances for extreme precision control

Full Details in the New I. C. E. Catalog

For full information on these outstanding I. C. E. Vacuum Capacitors, as well as other precision I. C. E. products, write today for the new I. C. E. Catalog.

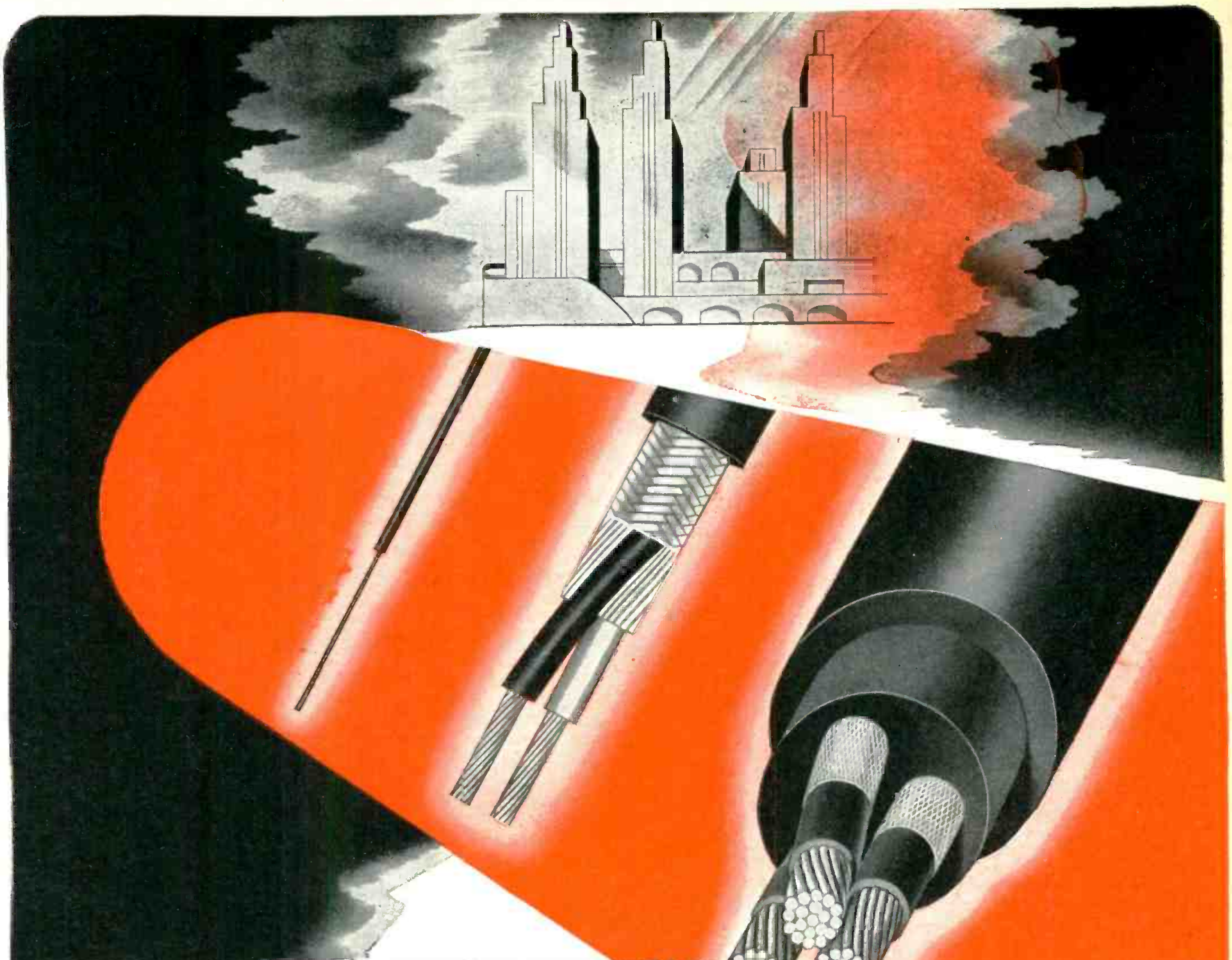
I.C.E.

ELECTRONIC TUBES

RESEARCH • DESIGN • PRODUCTION

INDUSTRIAL & COMMERCIAL ELECTRONICS

BELMONT, CALIFORNIA • NEW YORK CITY, N. Y.



ADVANTAGES OF THERMOPLASTIC

There are fourteen practical advantages of theremoplastic insulation over older types of construction . . . advantages which PLASTIC engineering now makes possible at what, in most cases, is NO PRICE PREMIUM. Check them yourself: 1. Superior aging properties, 2. High resistance to oxidation, 3. Low moisture absorption, 4. High dielectric strength, 5. High tensile strength, 6. Resistance to flame, 7. Flexibility at low temperatures, 8. Resistance to abrasion, 9. Resistance to chemicals, 10. Resistance to oils and greases, 11. Ease of installation, 12. Increased capacity, 13. Attractive appearance, 14. Broad color range. Remember . . . when you're thinking of PLASTIC you're thinking of US!

Thermoplastic insulation specialists . . . producing a complete line from fine wires to heavy power cables . . . serving: Public Utilities, Radio, Electronic, Appliance and Instrument Manufacturers, Telephone Companies and Contractors.

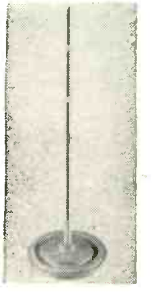
PLASTIC

WIRE & CABLE CORPORATION

NORWICH CONN

Microphone Floor Stand

TYPE A-63 MICROPHONE floor stand is being produced by Universal Microphone Co., Inglewood, Calif. for use with any microphone that has a $\frac{5}{8}$-27 thread. The unit uses three upright sections. It comes supplied with knurled adjustment collars, is satin chrome plated, and its base



is of cast iron with black wrinkle finish. Range of the adjustable height is from 26 to 64 in. It can be used as a table or floor stand. The base weighs 7 lb; total shipping weight is 10 lb. Base and stand are packaged separately. The unit is priced at $12.50.

Silicone Varnish

DC-993 SILICONE insulation for higher operating temperatures or extremely severe service conditions was announced in the literature column of June ELECTRONICS, and now Dow Corning Corporation (Midland, Mich.) announces type DC-996 insulation which cures at 300 F. DC-996 is a new heat-stable, waterproof varnish for impregnating electrical equipment to obtain good thermal stability, protection against failure due to sustained overloads, higher operating temperatures, and protection against excessive moisture even after prolonged exposure to elevated temperatures. Another advantage claimed for this new silicone varnish is that electrical equipment can be baked fully assembled without damaging the commutators or the slip rings. The temperature required to cure DC-996 does not affect shellac-bonded mica or core plating. Characteristics of the varnish are as follows: Electrical properties (measured on coated panels at 25 C and 50 percent relative humidity) dielectric strength, volts per mil

THE *Quiet* BALLENTINE
RECORD CHANGER MOTOR

Has these four characteristics achieved by advanced design, skilled engineering and precision manufacturing.

- Lowest Rumble • Highest Efficiency
- Most Compact Design • Longest Life

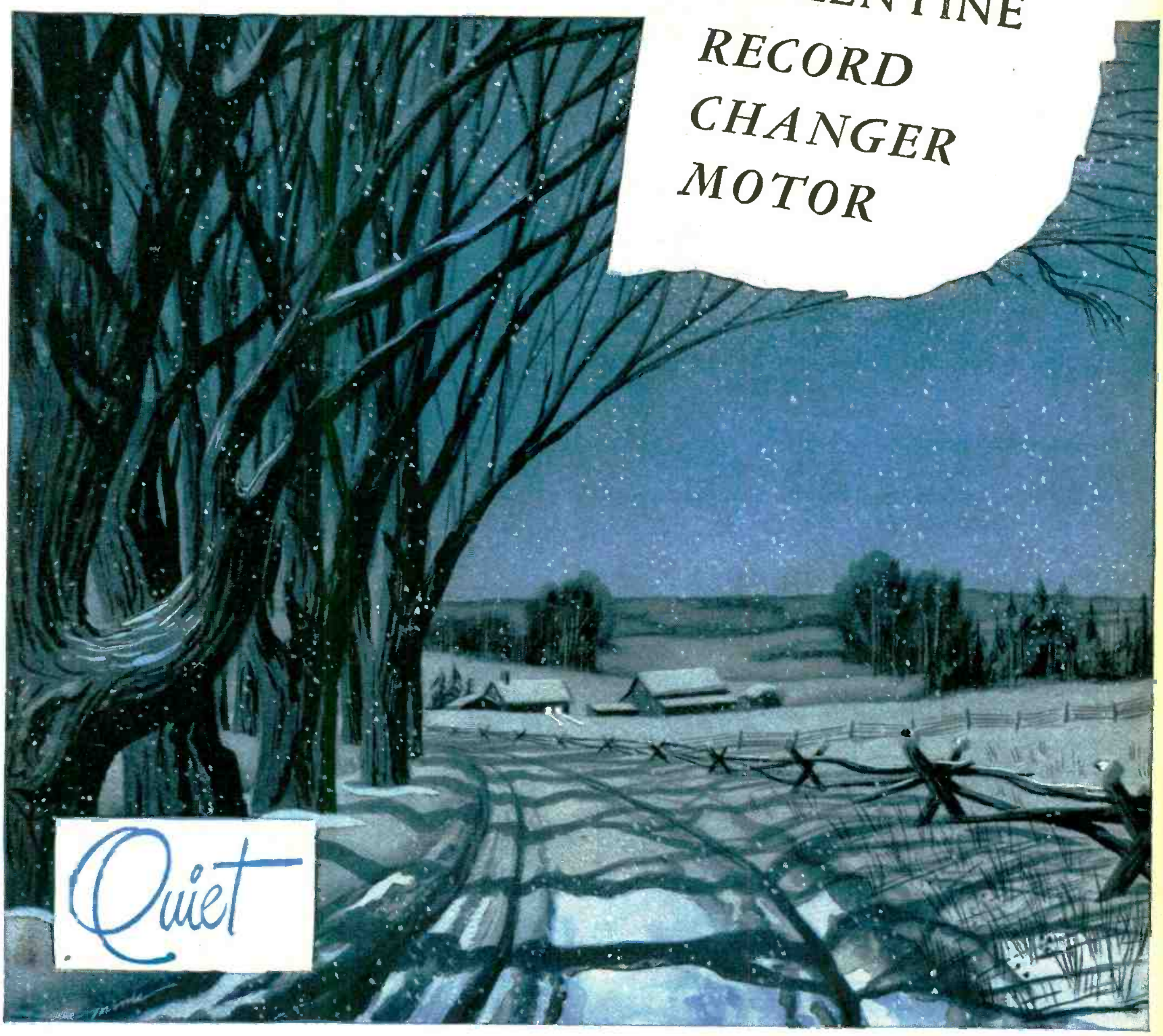
The *Quiet Ballentine* Changer Motor is recommended to record changer manufacturers seeking to provide the ultimate in performance.

RUSSELL ELECTRIC CO.

364 West Huron Street
Chicago 10, Illinois

Manufacturers of

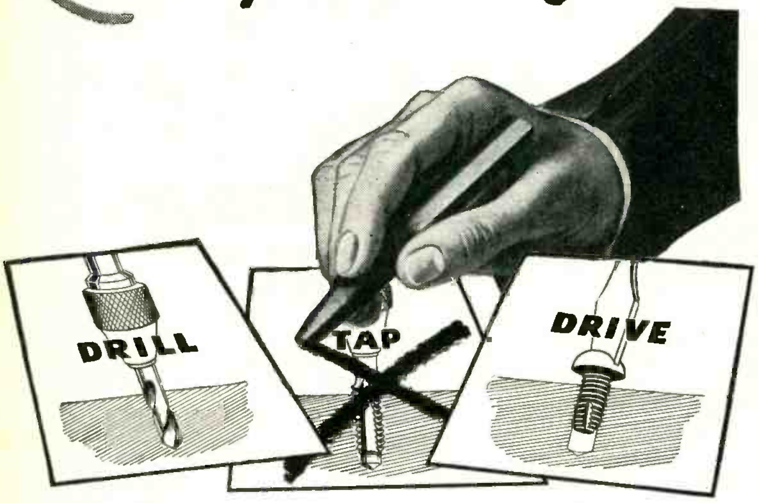
BALLENTINE
RECORD CHANGER MOTOR



TAKE THIS

Short Cut to Better Assemblies

...and save up to 50¢ on your fastening dollar



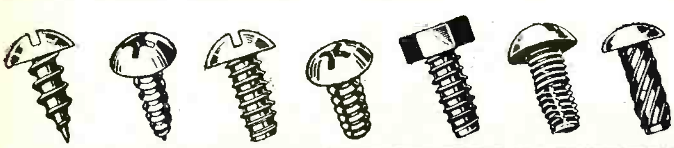
A FASTENING OPERATION BECOMES SIMPLY "DRILL-DRIVE", instead of drill-tap-drive, when you change over to P-K Self-tapping Screws. You eliminate tapping for machine screws ... end fumbling with bolts and nuts ... avoid troublesome inserts in plastics, and do away with riveting in hard-to-reach places.

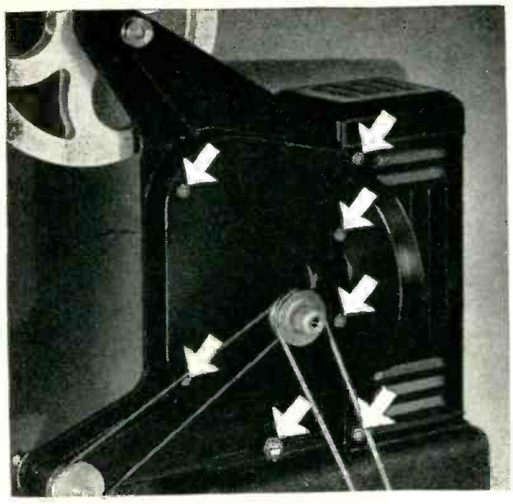
BESIDES SAVING YOU FROM 30% to 50% in fastening time and labor, the P-K "shortcut" method turns out a stronger assembly, because the extruded threads that are formed as P-K Screws are driven hold securely, and resist the severest vibration.

YOU CAN CHANGE to P-K Self-tapping Screws over night. No special equipment or special training of help is needed, although the "short cut" method often permits the use of power, in place of hand drivers.

CALL IN A P-K ASSEMBLY ENGINEER. He'll help you find all opportunities for saving time and money, and improving your product, with P-K Screws. Or, mail assembly details direct for recommendations. Parker-Kalon Corporation, 208 Varick Street, New York 14, N. Y.

SOLD ONLY THROUGH ACCREDITED DISTRIBUTORS





P-K "SHORT CUT" METHOD ADDS STRENGTH, PERMITS LOWER PRICE FOR PROJECTOR

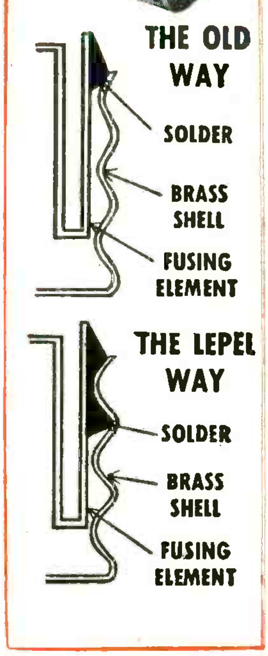
In the assembly of this home movie projector, Universal Camera Corp. found that the use of P-K Self-tapping Screws not only provided fastenings of improved security, but saved enough assembly work hours to permit a lower selling price. Eight sub-assemblies are made of light metal parts fastened to die castings with the use of 23 P-K Hex Head Self-tapping Cap Screws and Type "U" Hardened Metallic Drive Screws.

"HOW TO USE" BOOKLET – FREE on request – will give you quick facts on all the P-K Self-tapping Screws and other Fastening Devices ... tell you where and how to use them. Write for a copy ... ask for Form 480.

PARKER-KALON
Quality-Controlled
SELF-TAPPING SCREWS

For Every Metal and Plastic Assembly

How "Economy" makes better plug fuses faster with Lepel Induction Heating



When the progressive management of Economy Fuse & Manufacturing Company wanted to improve the quality of its plug fuses, it was natural to turn to Lepel High Frequency Induction Heating, the modern metal joining method that is contributing so much to product improvement and production efficiency.

Formerly, the zinc fusing element was laboriously soldered to the brass screw shell by hand. This produced a shallow edge union and worker efficiency was impaired by heat and fumes from the battery of soldering irons.

Today, the fuse assemblies with solder wedges manually "tucked in" between fusing element and screw shell are placed in a jig (solder facing upward) and conveyed through the area of a high frequency work coil operated from a Lepel Unit. The solder melts instantly and, with the assembly tilted slightly, flows by gravity, completely filling the element channel and establishing a firm, recessed bond between the parts that insures utmost dependability.

Soldering is performed so fast that twelve girls are kept busy "tucking in" solder wedges.

This is one of scores of metal joining jobs Lepel Induction Heating is doing faster, better, more economically with soldering and brazing alloys of any melting point.

Metals of any analysis — ferrous or non-ferrous—and in any form, can be joined quickly by the controlled, measured heat generated by the Lepel Unit, producing quality results never before obtained by other metal joining methods.

By assembling parts with joint surfaces pre-fluxed and solder or brazing alloy pre-placed, it is possible to produce parts heretofore considered impractical to make by metal joining.

The simple, compact, dependable Lepel Unit requires no special operating skill and can also be used without alteration for localized hardening, annealing, stress relieving or melting.

If you have a metal joining or heat treating problem, a Lepel field engineer will be glad to study it and offer suggestions for solving it by this modern heating method. Just write

Lepel
High Frequency
INDUCTION HEATING UNITS

LEPEL HIGH FREQUENCY LABORATORIES, INC.

PIONEERS IN INDUCTION HEATING

General Offices: 39 West 60th Street, New York 23, N. Y.

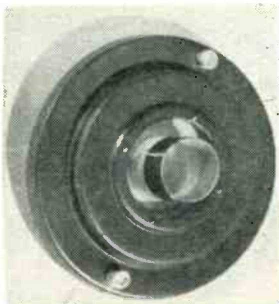
Lepel Units are now available without priority

DO IT FASTER, BETTER, MORE ECONOMICALLY BY LEPEL INDUCTION HEATING

1500 to 2000; dielectric constant, at 1000 cycles 3.0; power factor, at 1000 cycles 0.7 percent. Physical properties: Solid content (dried 3 hr at 135 C) 60 percent by weight; density 1.05 at 25 C; weight per gallon 8.75 lb; viscosity at 25 C, 2 to 5 poises; drying time to tack-free condition at 150 C, 1 to 4 hr.

New Loudspeaker Design

POSTWAR FEATURES of loudspeakers manufactured by Quam-Nichols Co., 33rd Place & Cottage Grove Ave., Chicago, Ill., incorporate a patented feature called the "adjust-a-cone". The spider of the loudspeaker is kept in position with a pressure or

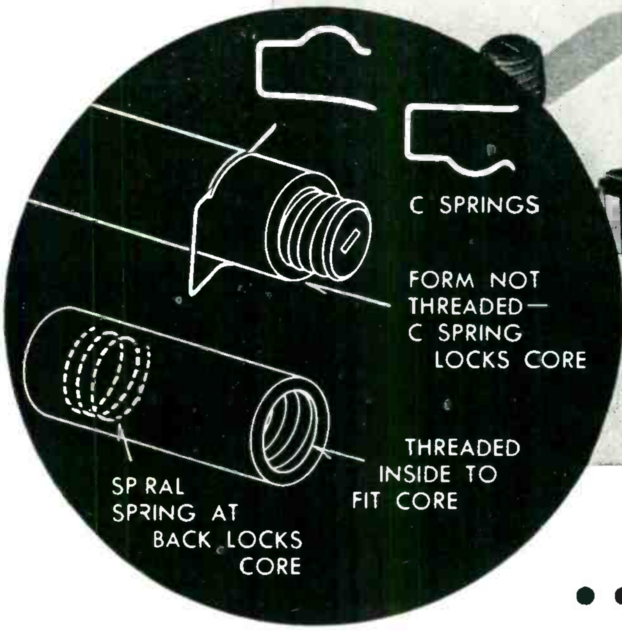


clamping ring that is in turn held down by two machine screws. By loosening the screws holding the pressure ring, a small lateral movement of the spider is permitted by which the voice coil can be re-centered concentrically around the pole-piece and within the gap.

Vacuum Oil-Impregnated Transformers

TO EFFECT SUBSTANTIAL space and weight savings in transformers for airborne applications, the American Transformer Company (178 Emmet St., Newark 5, N. J.) has introduced Amertran hermetically sealed transformers which are vacuum oil-impregnated. They state this new process also increases the dielectric strength of the insulating medium and reduces corona effect. To compensate for pressure changes and make possible complete filling, the transformer-enclosing case was redesigned. The new case incorporates a bellows. Part of the new process includes a combination of heat to 230 F and an absolute pres-

BETTER "Q"

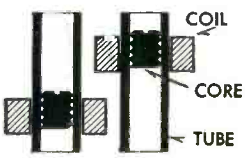


...with Stackpole Screw-type Molded Iron Cores

HIGHER "Q"—Since there is no brass core screw in field of coil and the core is not grounded.

SMALLER ASSEMBLIES—Overall length of coil and screw type core is less than that of conventional core, machine screw and bushing, thus permitting smaller coil assemblies and smaller cans.

FACILITATE DESIGN OF I-F TRANSFORMERS AND DUAL I-F transformers for AM and FM since all cores may be tuned from one end of the I-F transformer can by placing coils side by side.



Antenna, R-F and Oscillator coils for each band of a multi-band set become small and compact and may be mounted in groups for each band.

HIGHLY ECONOMICAL—Threaded coil forms unnecessary. See accompanying sketch for suggested use of wire clip in form slot. If desired, the tube can be threaded to fit core as illustrated.

Electronic Components Catalog!

Write for Stackpole Electronic Components Catalog RC6 covering switches, fixed and variable resistors and iron cores.

Samples and Engineering Data gladly sent on request

STACKPOLE CARBON COMPANY, St. Marys, Pa.

STACKPOLE

"EVERYTHING IN CARBON BUT DIAMONDS"

VICTORY REVEALS A MYSTERY

More than two years ago, an engineer of the Laboratories visited *U.S.S. Boise*, returned with a mysterious box which went into the Laboratories' vault. Now, victory opens the box and discloses a special kind of electron tube called a magnetron. It was part of a Radar which furnished data to aim *U.S.S. Boise's* guns during the night action off Savo Island on October 11-12, 1942. Because of the high frequency generated by this magnetron, the Radar was not detected by the enemy and the action was a complete surprise. Six Japanese warships were sent to the bottom of the sea.

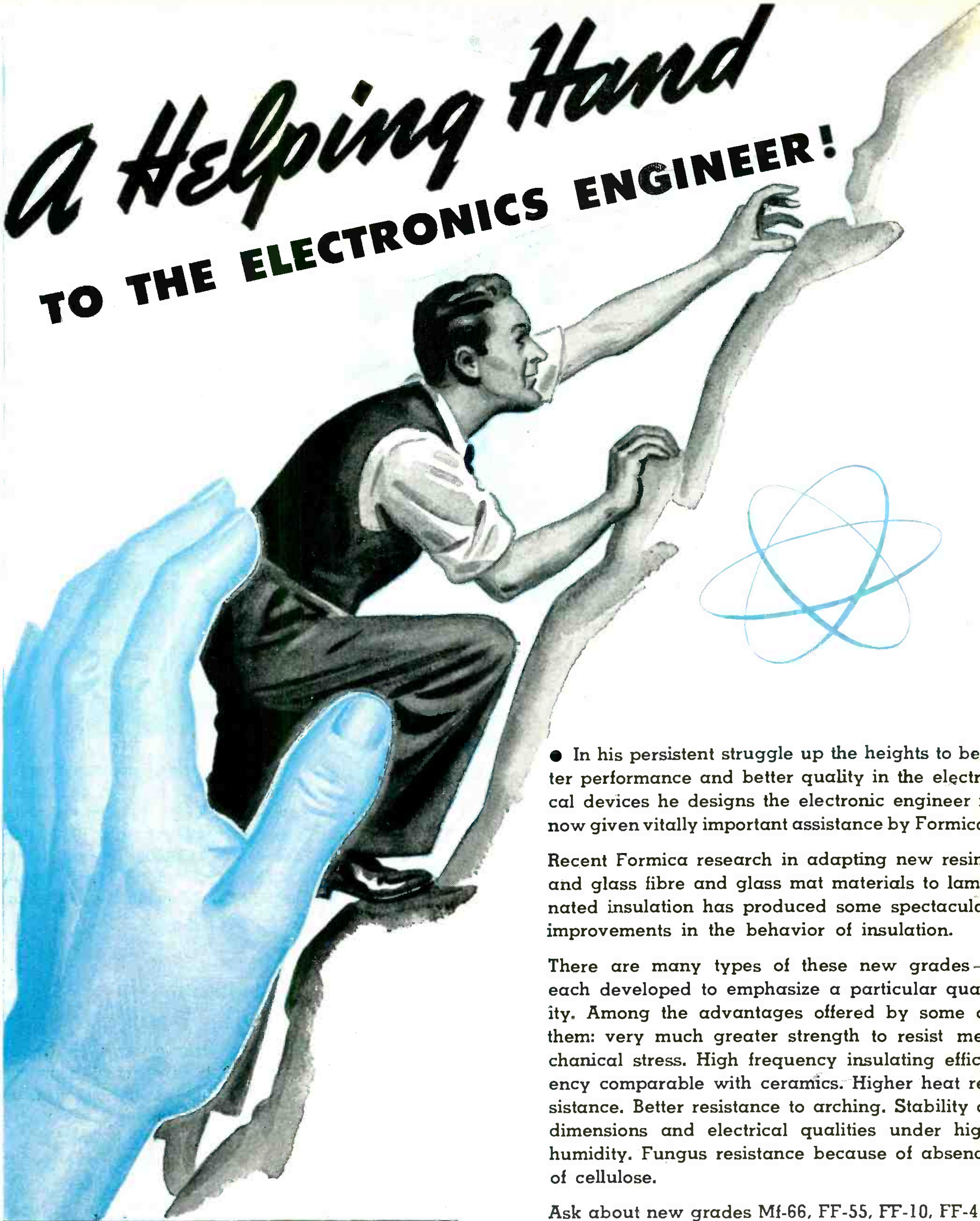
This magnetron is a symbol of the Laboratories' enormous war program. Half of it was devoted to Radar, the other half gave birth to radio transmitters and receivers, sonar apparatus for the Navy, loudspeaker systems for ships and beach-heads, fire-control apparatus for anti-aircraft artillery. Coming months will unfold the story of these and many other contributions of the Laboratories to the victory of our arms.

Bell Telephone Laboratories' war work began before the war; until now, it claimed practically all our attention. With victory, we will go back to our regular job—helping to bring you the world's finest telephone service.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting, for continued improvements and economies in telephone service.

A Helping Hand TO THE ELECTRONICS ENGINEER!



● In his persistent struggle up the heights to better performance and better quality in the electrical devices he designs the electronic engineer is now given vitally important assistance by Formica.

Recent Formica research in adapting new resins and glass fibre and glass mat materials to laminated insulation has produced some spectacular improvements in the behavior of insulation.

There are many types of these new grades—each developed to emphasize a particular quality. Among the advantages offered by some of them: very much greater strength to resist mechanical stress. High frequency insulating efficiency comparable with ceramics. Higher heat resistance. Better resistance to arching. Stability of dimensions and electrical qualities under high humidity. Fungus resistance because of absence of cellulose.

Ask about new grades Mf-66, FF-55, FF-10, FF-41.

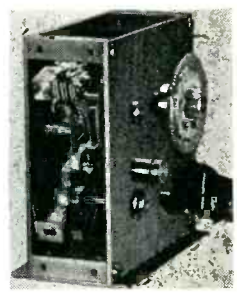
FORMICA

THE FORMICA INSULATION CO.
4661 SPRING GROVE AVENUE
CINCINNATI 32, OHIO

sure of 1 mm of mercury to rid the transformer oil of volatiles, air, and moisture. The oil is filtered to remove sludge and foreign matter. The transformers themselves are subjected to this combination of heat and vacuum for five hours to effect thorough dehydration. In addition to vacuum oil impregnation, the core and coil receive the vacuum varnish treatment. All units are tested under vacuum to detect the slightest possibility of leakage.

Constant-Speed D-C Motor

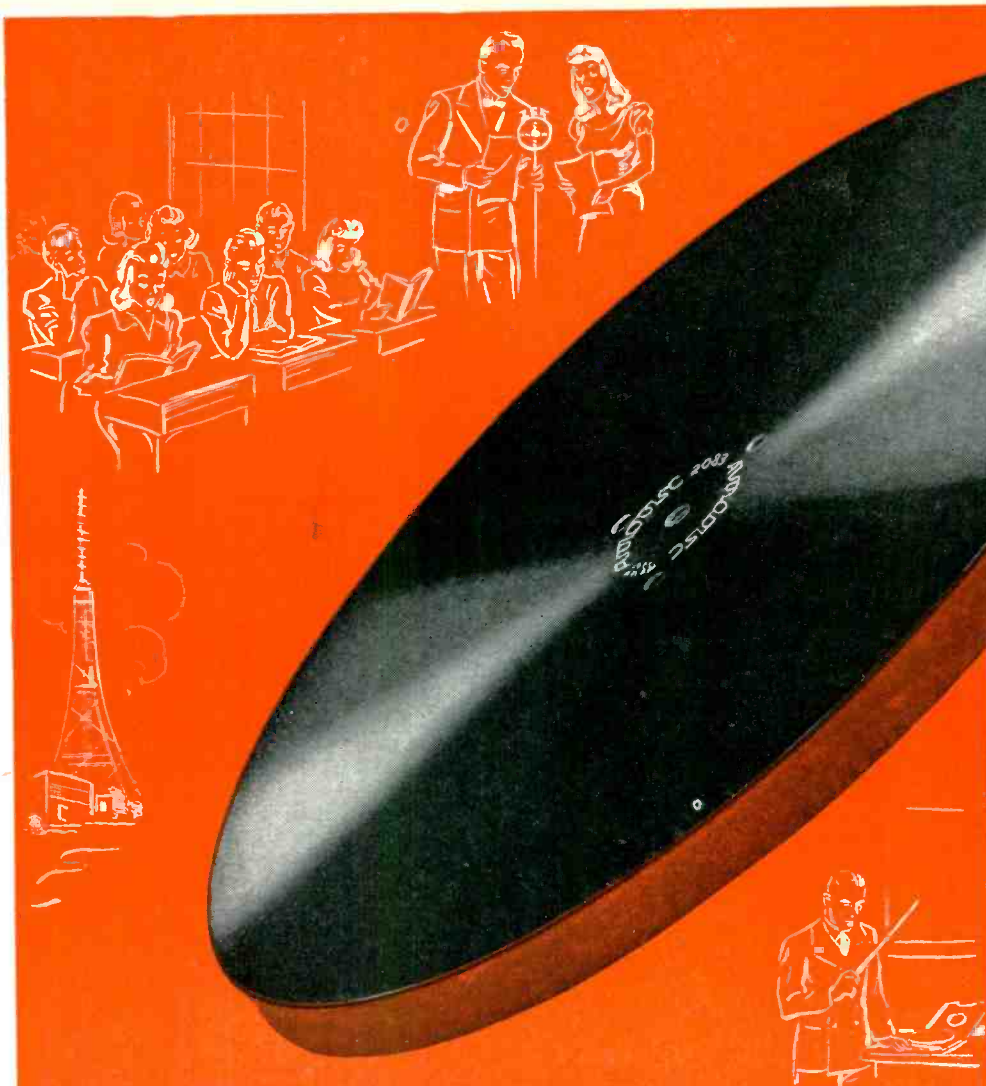
SMALL ENOUGH to be held in the palm of the hand, a new constant-speed d-c motor maintains a constant set speed regardless of variations in voltage. It is self-starting and builds up full speed almost



instantly. Current consumption is rated from 0.6 to 1 w, and shaft speeds may be geared from 1 revolution every 24 hr up to 600 rpm. Motors are available for use at 1½, 3, 6, 12, 24, 32 or 110 volts. Amglo Corp., 4234 Lincoln Ave., Chicago, Ill.

Direct-Reading Insulation Tester

THIS NEW INSTRUMENT, known as Model 799, is an extremely sensitive direct-reading insulation measuring device for applications where high testing potentials are not desired. It provides a single range for readings from 0.1 megohm to 10,000 megohm, with the 10,000 mark at 8 percent of the scale length, thus providing good readability. The circuit has a test potential of less than 50 volts d-c. An electrical guard circuit is provided for elimination of surface leakages when testing cables. All exposed parts are thoroughly insulated for operator's protection. A press-to-read



AUDIOPOINTS

Audiopoints, made by skilled craftsmen, are available in three types of recording styli and three types of playback points. Cutting and playback points are matched to give finest performance.

RECORDING POINTS

SAPPHIRE NO. 14, for professionals, designed to give proper thread throw. No finer made.

STELLITE NO. 34, professional type. Cuts quiet, shiny groove for several hours.

DIAMOND-LAPPED STEEL NO. 50, cuts a fine, quiet groove, gives from 15 to 30 minutes actual recording time.

PLAYBACK POINTS

SAPPHIRE NO. 113, finest obtainable. Complete fidelity and minimum disc wear.

BENT SHANK NO. 154, for heavy pickups.

STRAIGHT SHANK STEEL NO. 151, for light pickups.

Audio's resharpening and repolishing services give real economy in the use of **AUDIOPOINTS**, Nos. 14, 34 and 113. Consult your local dealer.

There Is An Audiodisc And An Audiopoint For Every Recording Need

AUDIODISCS have all of the features essential to high fidelity recording. A superior lacquer is applied by a unique process that gives a flawless surface. In cutting, the thread throws well and there is no static. In playback, whether at once or in the future, there is low surface noise. Their playback life is unequalled. There are six types of AUDIODISCS:

RED LABEL tops all accepted quality standards for professional use. Double-sided in 6½", 8", 10", 12" and 16" diameters.

SINGLE FACE RED LABEL brings new economy to applications requiring but one side. 12" and 16" diameters.

YELLOW LABEL, Double-sided blanks of uniform quality and "wide latitude." Extra-fine adjustments unnecessary. Sizes as Red Label.

REFERENCE permits extreme economy in test-cuts, filing and reference recordings. Double-sided in 10", 12" and 16" diameters.

MASTERS for choice copies (pressings) after electroplating. Double or single face in 12", 13¼" and 17¼" diameters.

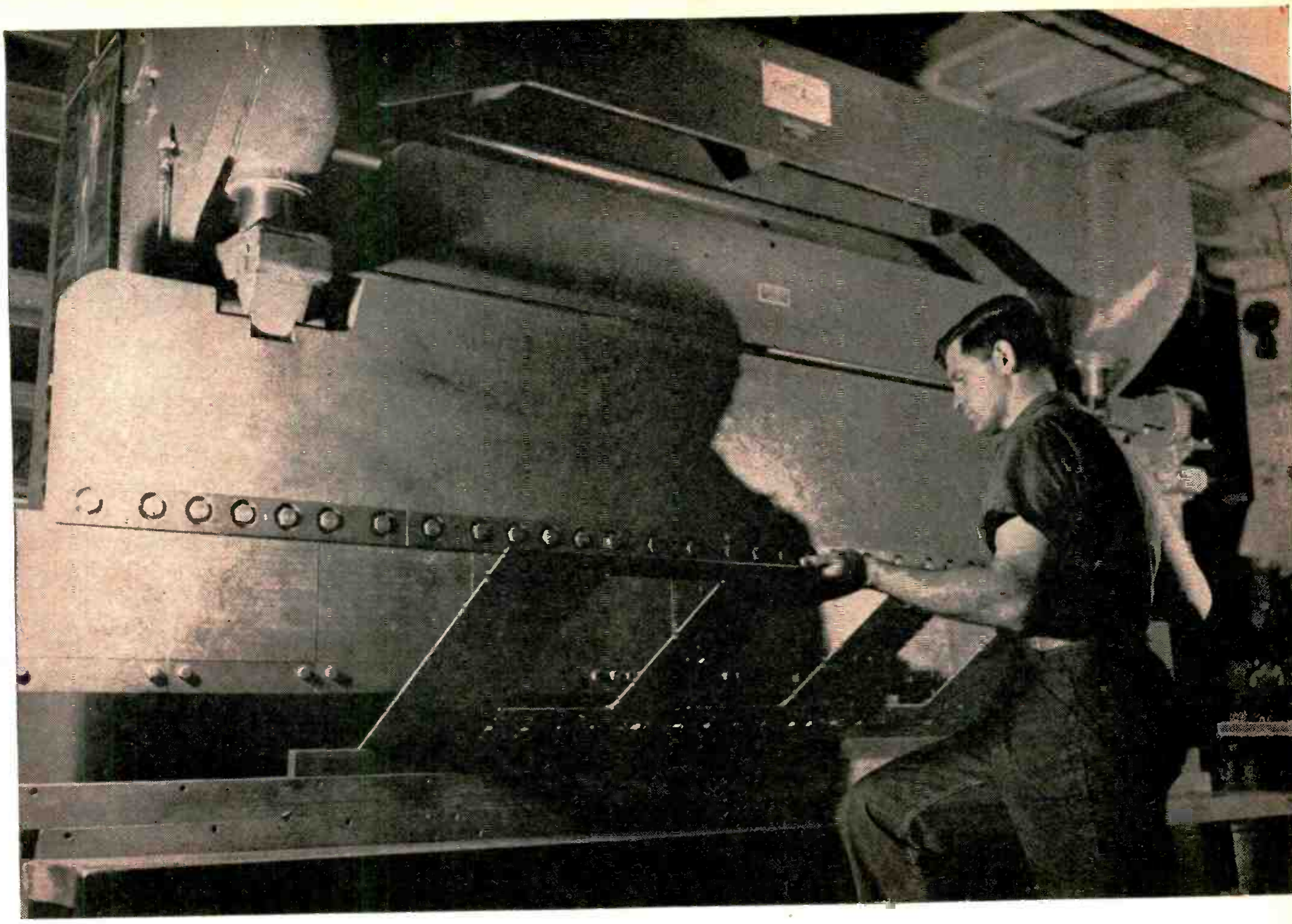
BLUE LABEL best discs at low cost. Thin aluminum base, same recording lacquer as professional AUDIODISCS. 6½", 8" and 10".

All AUDIODISCS are manufactured on aluminum base—and glass base too, except for the 6½" and Blue Label type.

AUDIO DEVICES, INC., 444 MADISON AVE., N. Y. C.

they speak for themselves **audiodiscs**

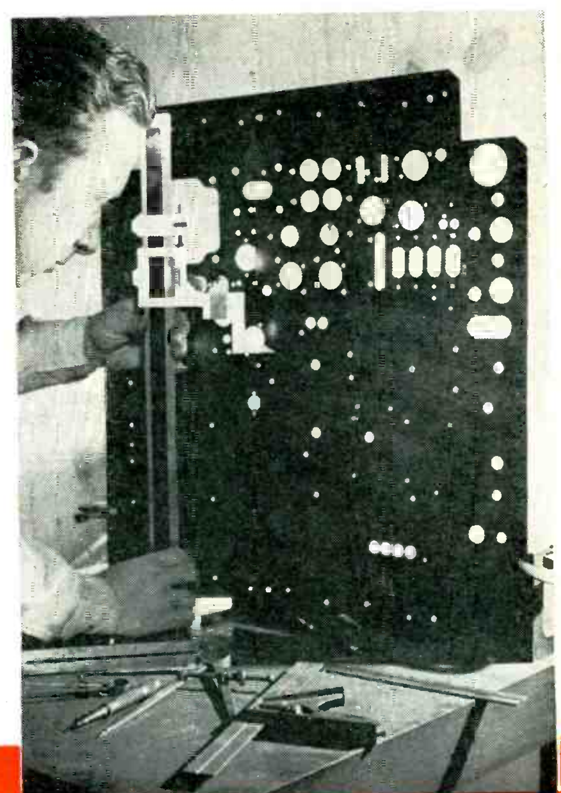

It's here!
The new
E·E TELEVISION RECTIFIER
A HIGH VACUUM TUBE WITH PEAK INVERSE VOLTAGE RATING OF 40KV. AVERAGE ANODE CURRENT 5 M.A.
2BT
100-TH
3B27
836
811
812
866-A
E·E TYPE 2BT
available now!
EE 2BT closes the gap in rectifier types suitable for television applications. It is a high vacuum type having high peak inverse rating, and expressly designed for plate supply in video receivers requiring potentials to 12,700 volts on the projector tube.
By incorporating the EE 2BT in television designs, engineers can now eliminate flashback trouble without specifying a rectifier with ratings considerably in excess of actual requirements. For complete specifications and for other important details that explain why the EE 2BT offers exceptional advantages to designers write today.
FAST DELIVERY!
The popular types (illustrated at left) are now supplied from stock. Write for data book, a thirty page compilation of electronic tube types, characteristics and operational information will be promptly furnished on request.
ELECTRONIC ENTERPRISES, INC.
ELECTRONIC ENTERPRISES
GENERAL OFFICES: 65-67 SEVENTH AVENUE, NEWARK, 4, N. J.
EXPORT DIVISION: 25 WARREN STREET, NEW YORK, 7, NEW YORK
CABLE ADDRESS: SIMONTRICE NEWYORK



No "Margin for Error" in PORTER operations

When you require sheet metal work — in any metal — and PRECISION to close tolerances is a must . . . Porter has the experience and equipment to meet your needs to your complete satisfaction.

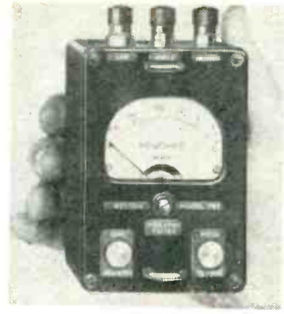
The skilled technicians and engineers of our thoroughly modern factory stand ready to help you work out money-saving and time-saving changes in design. Also, our large stock of available dies often helps speed up production while reducing manufacturing costs.



METAL BOXES * CASES * CABINETS * CHASSIS * ODD-SHAPED FLAT PIECES * STRIPS * PANELS * HOUSINGS * ETC.

PORTER METAL PRODUCTS COMPANY

121 INGRAHAM ST. BROOKLYN, N. Y.



switch automatically disconnects the battery circuit when the instrument is not in use. Ferrules in the panel permit attachment to a lineman's belt or shoulder strap. The unit measures $5\frac{3}{8} \times 3\frac{1}{4} \times 4\frac{7}{8}$ in. and is manufactured by Weston Electrical Instrument Corp., 617 Frelinghuysen Ave., Newark 5, N. J.

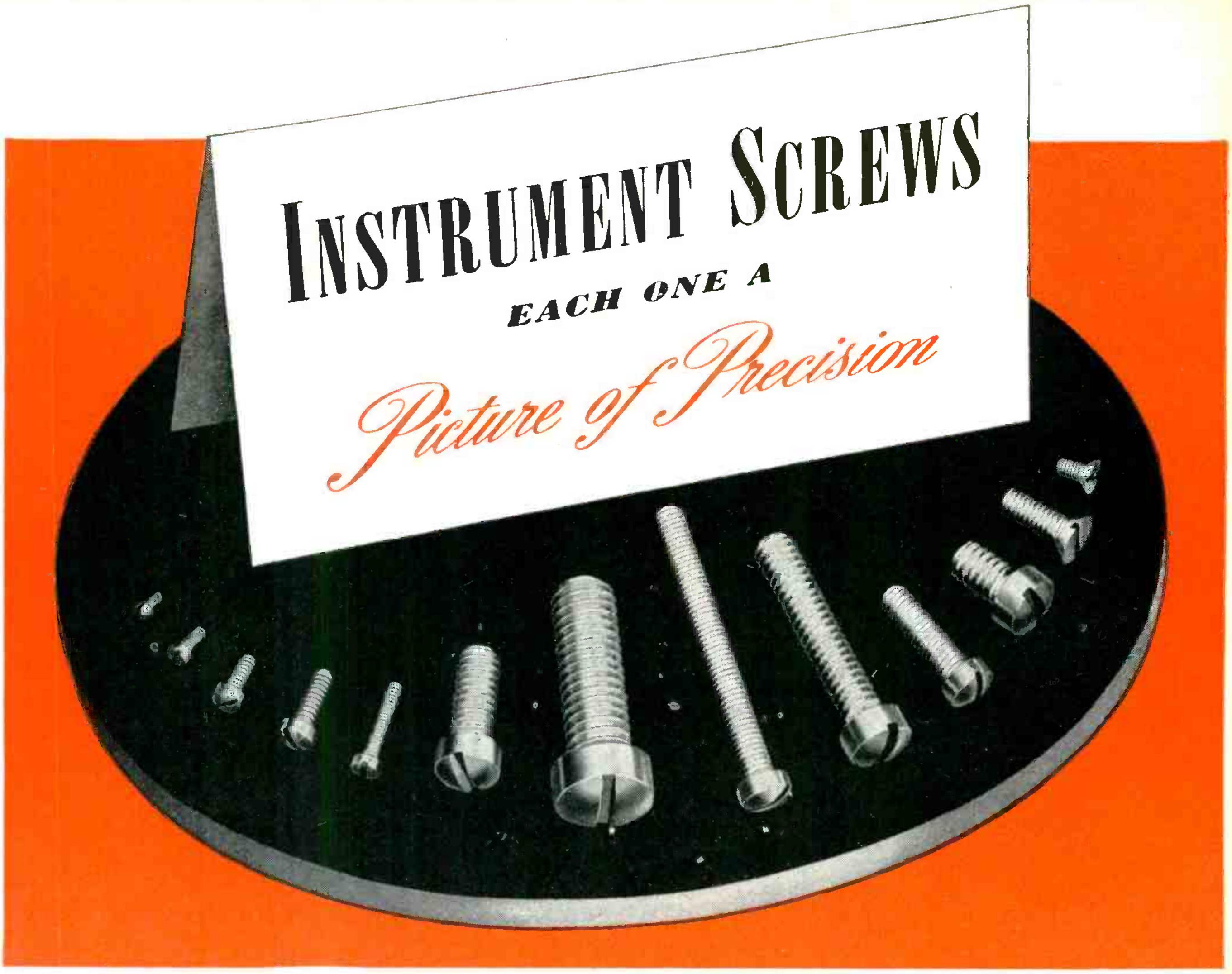
Tank Capacitor

ILLUSTRATED IS A large tank capacitor which was especially designed for a transoceanic transmitter. Its features are its space-saving design; the ability to operate under exacting circumstances with the

capacitance of much larger capacitors; and its low cost, which is 50 percent less than the type of capacitor it was built to replace. Cor-

Portable Power Supply

FEDERAL TELEPHONE & Radio Corp., Newark 1, N. J. has immediately available a portable d-c power supply unit (designated as FTR 3008-S), weighing only fifty pounds, which is convenient for laboratory and experimental work, or for public address systems. It can be used as a conversion unit in operating magnetic chucks, brakes, and all



National
HEADED AND THREADED
PRODUCTS

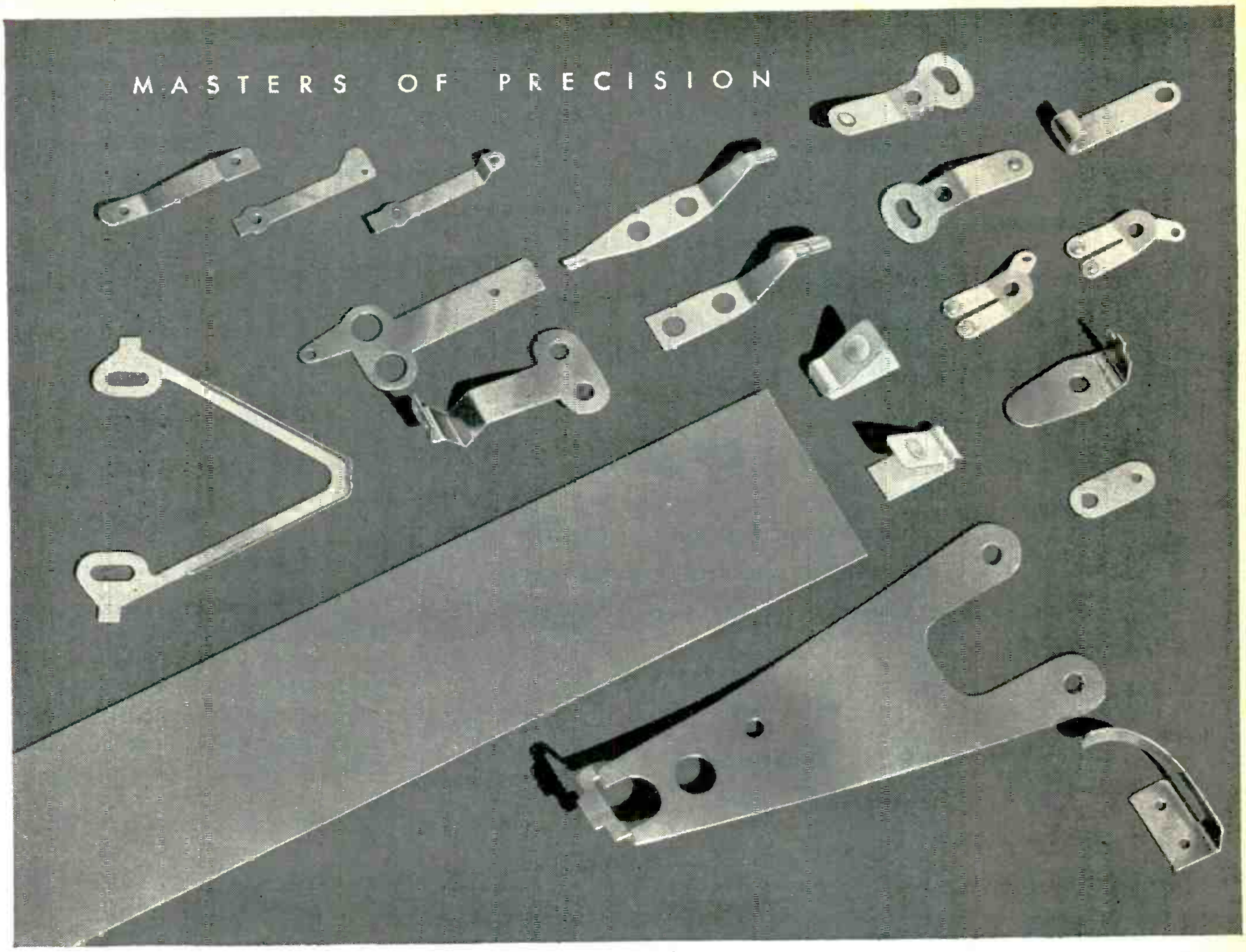
Many civilian products will require precision-made screws of the same high quality that has been perfected for aircraft instruments.

Formerly, it was considered necessary to use Swiss watch-making machinery to produce this fine precision which "National", by its method of upsetting and finishing the head and rolling the thread, has produced all through the war.

From the tiniest screw to the largest sizes, accuracy and uniformity are maintained through "National's" methods of manufacture and thorough inspection. Furnished in many grades of ferrous and nonferrous metals, e.g., carbon steels, stainless steels, brass or bronze.

Let us have your inquiry.

THE NATIONAL SCREW & MFG. CO., CLEVELAND 4, O.



Western Metals Have *It*

One of the world's most successful manufacturers of control instruments requires a great variety of springs. Each, of course, must be uniform and precise in its functioning.

After many rigid tests, this manufacturer selected Western Super-X phosphor bronze and nickel silver to insure faithful functioning of his instruments.

These metals are especially treated to incorporate extraordinary ductility in combination with excellent spring properties.

Western Mills at East Alton, Ill., and New Haven, Conn., are strategically located to supply users of copper-base alloys. We will welcome your inquiry regarding "tailor-made" metals.

Western Super-X PHOSPHOR BRONZE

WESTERN BRASS MILLS

DIVISION OF OLIN INDUSTRIES, INC.

East Alton, Illinois

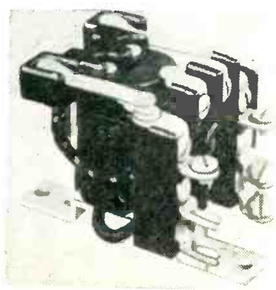
DIVISION OF OLIN INDUSTRIES INC.

BRASS • BRONZE • PHOSPHOR BRONZE • NICKEL SILVER • COPPER

similar activities, or as a means for testing electrical apparatus. The unit operates from any 115 or 230-v a-c outlet, and supplies from 5 to 10-v d-c power. The power supply is flexible; high or low voltage is available at the flip of a switch. Either output is adjustable by means of a 12-point primary tap switch. Federal's selenium rectifiers are used in units which are rated as follows: a-c input: 115 or 230 volts, 50 or 60 cycles, single phase; d-c output: 5 volts, 24 amp or 10 volts, 12 amp, resistive or inductive. Dimensions are: height 16½ in., width 10 in., depth 11 in.

Magnetic Relays

R-B-M MANUFACTURING Co., Logansport, Ind., announces a new and improved line of single and double-pole a-c and d-c magnetic relays for industrial and electronic applications. Ratings are: 10 amp at 24-v d-c and 110-v a-c; 5 amp at 220-v a-c; 1 hp single-phase 110 and 220-v a-c. Contact arrangements are normally open, normally closed, and double throw, silver to silver. The armatures are self-aligning. All wiring terminals (either screw or solder) are easily accessible from the front. For complete interchangeability in mounting, both the a-c and d-c relays have identical bases. Relays may be mounted from front or rear. Bulletin No. 510 describes the d-c relays, and bulletin No. 550 describes a-c relays.



Complete Airport Radio Station

A COMPLETE AIRPORT radio station, Type RS-1 50-w unit, is offered by Aireon Manufacturing Corp., Kansas City, Kan. This station contains all necessary equipment (with the exception of antenna support-

Save that Song on "The Wire that Remembers"

It's a precious strain — all her own. And priceless to those who love her. Will it be left only to fragile human memory? Will it fade forever?

No. Today it can be captured, cherished and repeated over and over. It can be heard again years from now.

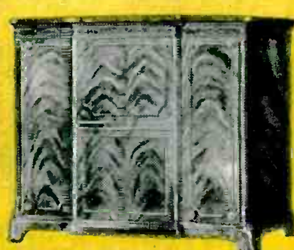
How? On the Lear wire that remembers — a simple way of making lasting recordings. It's a way that puts hours of song, voices or radio broadcasts on a spool of hair-like wire. Anything you don't want to keep is erased simply by recording something else over it.

Wire Recording is but one of the fine things you'll find in Lear Radios. There are advanced FM, television, far-reaching short wave and record-changing phonograph radio combinations with a new conception of rich-toned fidelity.

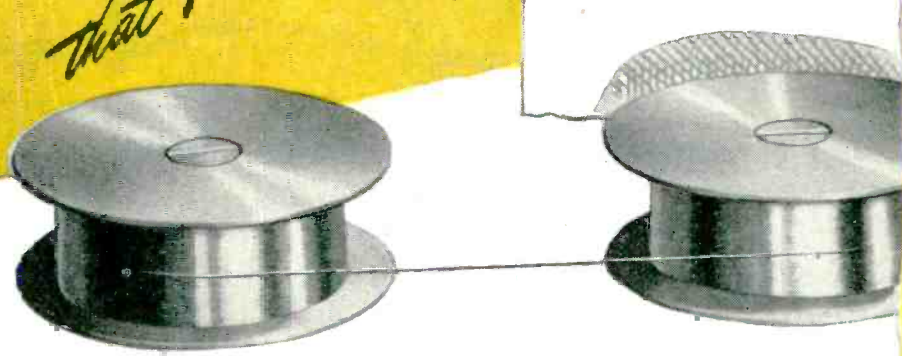
Such radios as these have never been available before. For Lear's fifteen years of radio design and manufacture have been devoted to the exacting needs of aircraft radio. So expect to be thoroughly pleased when you hear a Lear Home Radio. You'll know quickly that there is extra worth for every dollar you pay. See for yourself—visit your Lear dealer at your first opportunity.

LEAR, Incorporated. HOME RADIO SALES: 230 E. Ohio St., Chicago 11, Illinois. RADIO DIVISION: Grand Rapids 2, Michigan.

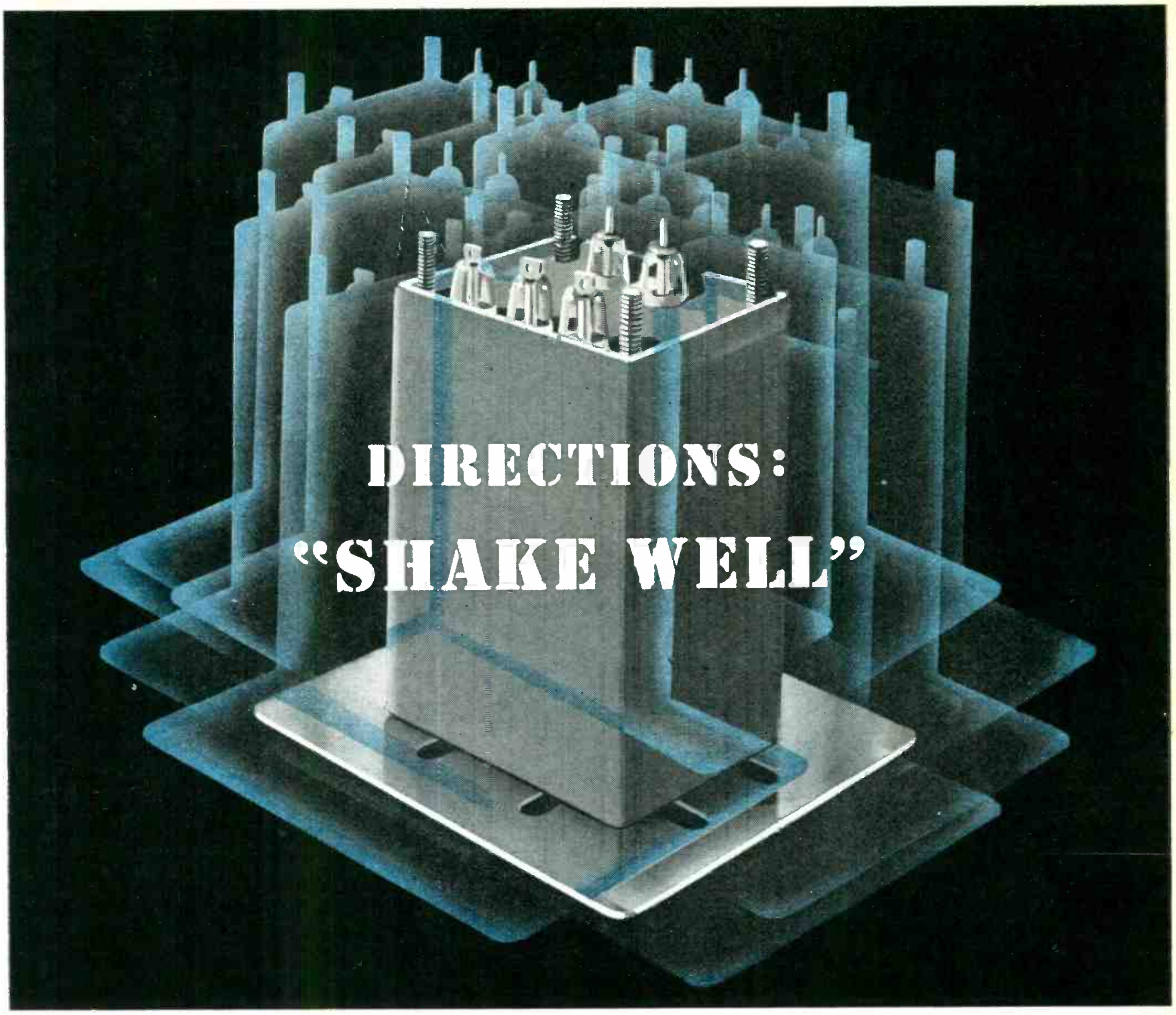
LEAR RADIO



Designed and Made in Grand Rapids



Listen to Orson Welles every Sunday afternoon 1:15 EST on your local station of the American Broadcasting System



Upside down and sideways—and this transformer puts in overtime!

This is just one more reason why Thermadors are known as America's quality transformers.

There is a machine called a Shaker. It goes up and down while it rotates. The motion varies from a gentle rhumba to an earthquake of cataclysmic proportions. In 10 minutes an ordinary transformer sails off into the steel mesh net.

At Aireon Manufacturing Corporation's Kansas City plant they bolted a Thermador transformer to the shake-bed of this machine. They turned the shaker on for an hour—then they left it going overnight, unbolted the Thermador transformer, connected it to the test line. The needle showed not an nth of variation.

Why this incredible performance? Just this. Transformers were formerly mounted to the cover of their cases. Thermador developed a strong stamped bracket from strip steel and projection-welded it to the case body—independent of terminal boards or covers. As a result, Thermador transformers can be mounted in any position—up and down and sideways—and take the worst beating you can give them.

THERMADOR ELECTRICAL MANUFACTURING COMPANY
5119 SOUTH RIVERSIDE DRIVE • LOS ANGELES 22, CALIF.

Thermador Transformers

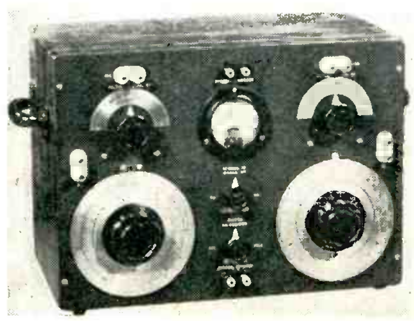
DEFEAT COLD • HEAT • HUMIDITY

Seven Leagues Ahead

ing poles) and is ready for immediate operation. Designed for simple operation, its pushbutton control enables instantaneous selection of channels. No dialing or tuning is necessary as each channel is pretuned and controlled by crystals. The unit can be used for point-to-point or ground-to-plane communications, or as a tower control station. Included in the system is two-channel telephone emission with frequency ranges for both day and night operation and 100-percent modulation in all frequency ranges. The channel range is from 2.0 to 8.0 mc, 200 to 410 kc, or 118 to 132 mc, with other frequencies available on special order.

Impedance Bridge

THE BROWN ENGINEERING Company of Portland, Oregon, manufacturers of precision mica capacitors, several types of rheostat-potentiometers, decade and low-capacitance switches, binding posts and impedance bridges have added to their line of products an impedance bridge, designated as Model 200-A, which is portable and self-contained and designed for the accurate measurement of capacitance, resistance and inductance over wide ranges. The instrument also measures the



storage factor (Q) of coils and the dissipation factor of capacitors. The range of measurement for capacitance is 1 $\mu\mu$f to 100 μf; for resistance, 1 milliohm to 1 megohm; for inductance, 1 μh to 100 henrys. Accuracy on the main decade is rated at 1 percent for capacitance or resistance measurements, and 2 percent for inductance tests. The readings are obtained from 6-in. direct-reading dials. All controls and connections are plainly marked and conveniently located on the panel.

Coils by the thousands —engineered one by one

REGARDLESS of the thousands of electrical coils Anaconda engineering has designed, still each one is strictly a custom-built job created to precisely meet a specific need.

Type, size, shape winding, insulation, treatment, cost—countless variables—are analyzed and specified to arrive at the proper coil for the intended use.

Anaconda magnet wire, another product of Anaconda engineering, is quality-controlled from copper mine to winding.

Think of that advantage—wire manufacture guided by long experience in making coils—coil production benefitting from the counsel of wire specialists.

Manufacturing facilities too are outstanding—modern, efficient plants and thoroughly skilled personnel.

For magnet wire and coils offering long, trouble-free service, contact our engineering service through any sales office.

45302

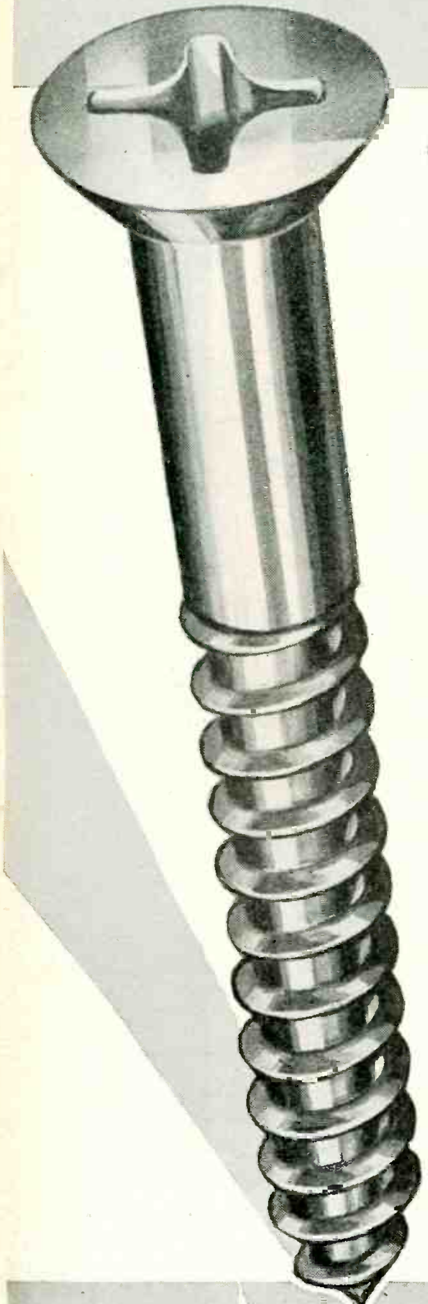
ANACONDA WIRE & CABLE COMPANY
Subsidiary of Anaconda Copper Mining Company
GENERAL OFFICES: 25 Broadway, New York City 4
CHICAGO OFFICE: 20 North Wacker Drive 6
Sales Offices in Principal Cities

Magnet wire and coils

ANACONDA WIRE & CABLE COMPANY

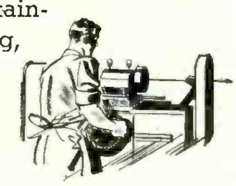
4 INSPECTIONS!

That's why Screw and Bolt Buyers Say:



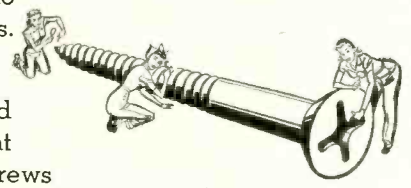
"AMERICAN brand is 100% OK!"

1. Raw Material Inspection: Every month, American buys hundreds of miles of steel, brass, bronze, and everdur. And every lot is checked for quality before going into production.



2. Process Inspection: Product-samples are checked every few minutes to make sure that machines are maintaining accuracy on every process . . . heading, slotting, shaving, threading.

3. Head, Thread & Point Inspection: Moving along on conveyor belts, screws are individually checked to make sure there are no burred heads, drunken threads, or dull points.



4. Automatic Weigh-Count: Each newly filled box of screws is weighed against a counted gross, to make sure that there are at least 144 perfect American Screws in every gross-box.

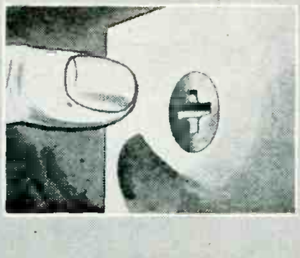
American's modern, high-speed manufacturing methods . . . checked by these four inspections . . . are easy-to-see reasons why more and more screw and bolt buyers are marking their orders: "American brand . . . don't substitute."

AMERICAN SCREW COMPANY
PROVIDENCE 1, RHODE ISLAND
Chicago 11: 589 E. Illinois Street
Detroit: 502 Stephenson Building

BUY VICTORY BONDS

. . . and here's WHY American Phillips Screws COST LESS on any Screw Driving job

1. Faster Starting—One hand holds driver, other holds work. No wobbling, no dropped screws. Phillips screw and driver remain as one self-aligned unit until screw is driven.



2. Cleaner Fastenings—*every time.* No slanted screws to back out. No gouged work-surfaces, or burred screw-heads. Even unskilled workers get skilled results right from the start.

The four batteries shown above are approximately ⅔ of actual size

EVEN BEFORE PEARL HARBOR, battery construction principles developed by National Carbon Company were making possible new strides in portable radio and electronic equipment. Then came the war. The company was called upon to develop even more radical improvements in battery construction to meet the needs of light and extremely portable military communications of all types, and so the tiny 22½ volt "Eveready" "Mini-Max" "B" battery was born—a battery well under half the size of anything of comparable voltage—easy to carry as a match box!

This is what this new, improved battery construction means. It means a brand new line of portable radio equipment—equipment that will give the idea of the "personal radio" an entirely new meaning. It makes possible radio sets for individual use—sets so small that they can be slipped into the pocket of a vest, or carried in a woman's handbag. Portable radio business will not merely pick up where it left off December 7, 1941. It will be years ahead of itself.

Engineers and designers are already aware of the possibilities of this new battery. They are already at work on new radio and electronic devices which exploit its portability. And at this time may we invite all these creative men to avail themselves of our experience, our laboratories and to consult with our engineers. National Carbon Company, Inc. extends to you complete cooperation.

The words "Eveready" and "Mini-Max" are registered trade-marks of National Carbon Company, Inc.

Now that radio batteries are back again, National Carbon Company is offering an extremely useful new Portable Radio Battery Replacement Guide. Write for your copy today to our nearest Division Office listed below.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

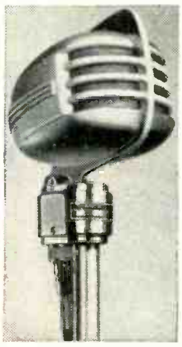
UCC

General Offices: NEW YORK, N. Y.

Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco.

Colored Microphones

THE TURNER CO., Cedar Rapids, Iowa, is introducing a new line of microphones, called "Colortones," made in richly-colored plastic finishes. The material used in the new mikes is tough, resilient cellulose acetate. These plastic castings can be produced in a wide variety



of solid colors and pastels, mottles and striated effects. Although primary emphasis has been placed on outward appearances of the new models, research has gone into their interiors. Materials and techniques discovered during wartime are incorporated into the circuits of both the dynamic and crystal units.

Soldering Iron

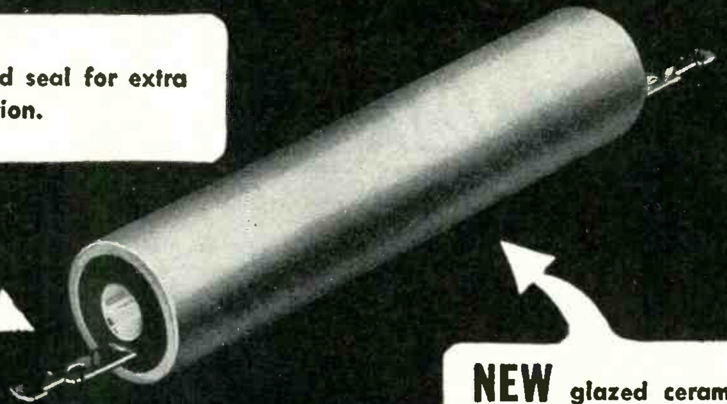
THE BAKER Electronic Manufacturing Co., 3017 Lyndale Ave., South Minneapolis, Minn., announce a new gun-type soldering iron for industrial use. Two models available include No. SF-100 for fine

and general soldering and No. HF-150 for heavy-duty work. Features of these irons include trigger control, instantaneous heating and operation from a 110-v transformer or directly from any standard car or truck storage battery.

ONE STANDARD TYPE

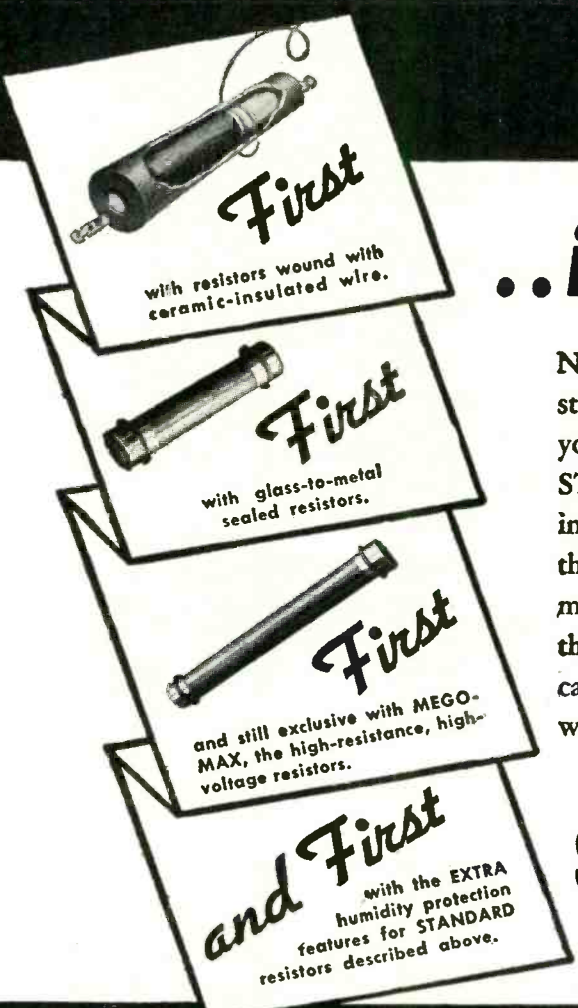
does the job...

NEW type end seal for extra humidity protection.



WOUND WITH CERAMIC INSULATED WIRE 1000°C. HEAT-PROOF!

NEW glazed ceramic shell to withstand thermal shock, humidity and corrosive conditions.



..in ANY climate!

No more "special orders" to obtain suitable resistors to withstand the extreme thermal and humidity conditions to which your product may be subjected in many parts of the world! STANDARD Sprague Koolohm Wire-Wound Resistors now incorporate these extra protection features — and this means that you can count on STANDARD Sprague Koolohms for maximum dependability in ANY climate, ANYwhere on the face of the globe. Write for new catalog of Sprague Koolohm wire-wound types for every requirement.

ARMY E NAVY

SPRAGUE KOOLOHM

TRADEMARK REGISTERED U.S. PAT. OFF.

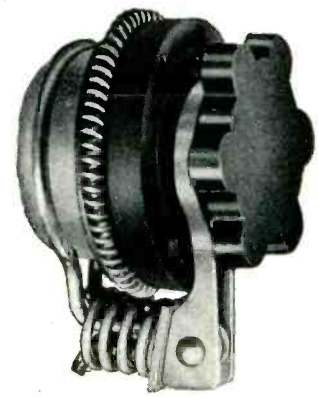
WIRE-WOUND RESISTORS

SPRAGUE ELECTRIC COMPANY, Resistor Division, North Adams, Mass.


AND NOW!
UNITED
Quality Standard
WATER COOLED TUBES
The progress of United Electronics has been characterized over the years, by the addition of new tubes in the higher power catagories. It is with reasonable pride therefore that we now announce UNITED external anode tubes in both water cooled and air radiator designs.
Type 893-A illustrated is rated for 20 KW anode dissipation and maximum power output of 50 KW.
Write for engineering information bulletins on UNITED external anode tubes.
Masterpiece of Skilled Hands
Ruggedizing: A United feature which enables tubes to withstand terrific shocks.
UNITED ELECTRONICS COMPANY
NEWARK 2, NEW JERSEY
Transmitting Tubes EXCLUSIVELY Since 1934

Waterproof Jack Cover

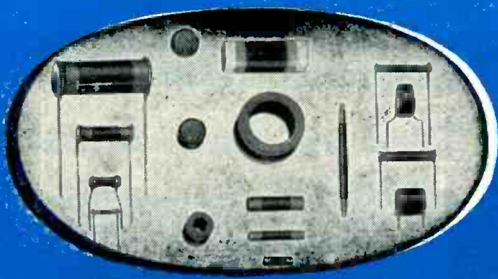
THIS JACK COVER is a simple device which completely seals electrical jacks used in radio and electrical equipment. It is not affected by adverse marine or climatic conditions. In the accompanying illustration the hinged seal-plug is shown



closed; when open a telephone-type plug may be inserted through the jack cover into the jack in the normal manner. No special holes or tools are required for installation of the seal-plugs. Seal-plugs are available in either black or red color. Waterproof Electric Co., 72 East Verudgo Ave., Burbank, Calif.

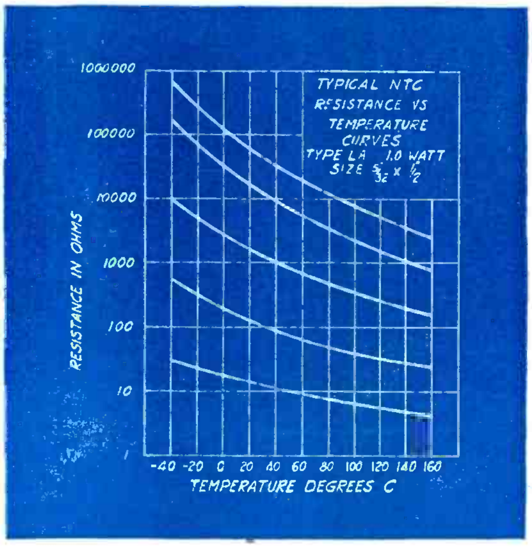
X-Ray Unit

ILLUSTRATED IS a complete contact and cavity x-ray unit (Type M-33) which is designed especially for x-radiation of body surfaces and cavities in treating certain diseases. The internal construction of the tube used in the unit is such that it provides an extremely intense x-ray beam with low inherent filtration. The anode produces radiation within 18 mm of the cap. The intensity is approximately 8000 roentgens per minute at a distance of 18 mm from the focal spot.



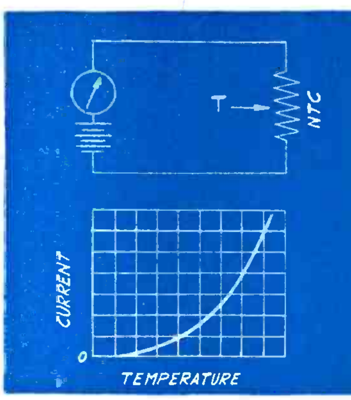
Do you have a

TEMPERATURE MEASUREMENT OR CONTROL PROBLEM?

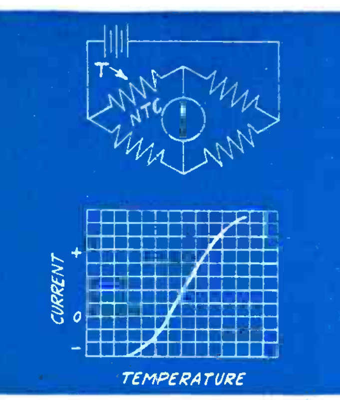


CHECK THESE ADVANTAGES OF KEYSTONE NTC UNITS FOR YOUR APPLICATION

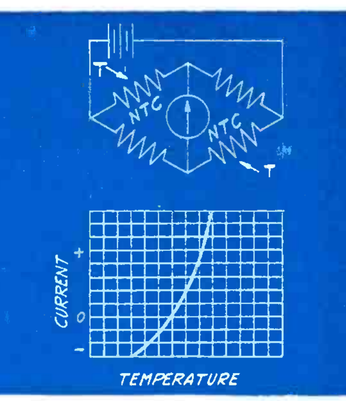
Keystone NTC units are electrical resistors especially developed to have an unusually high negative temperature coefficient of resistivity. The slopes are much greater than those observed with pure metals or their alloys. The result is an element with very high thermal sensitivity, useful on AC or DC, inherently suitable for remote indication, which has gained wide acceptance for temperature measurement and control purposes. NTC units are made in wide range of shapes, resistance values, temperature coefficients and wattage ratings, of which the characteristics at the left are typical. The circuits below suggest basic means for translating resistance changes into current or voltage variations. Modifications and extensions of these principles are many, especially in conjunction with electronic apparatus.



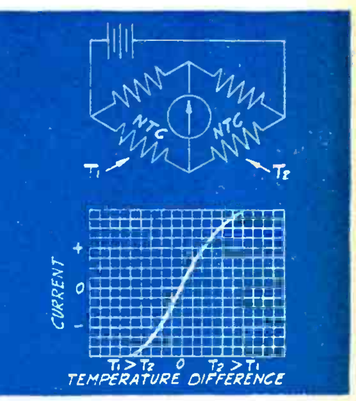
This simple series circuit of voltage source, instrument and NTC unit has been utilized to indicate engine coolant temperature, etc. It provides sufficient accuracy for many applications despite scale crowding at the bottom.



Basic bridge circuit straightens and steepens the characteristic. Zero-center meter may be used or balance point may be placed near the lowest temperature. Electronic balance indication provides enhanced sensitivity.



Adding a second NTC unit, and exposing both to the temperature to be indicated, gives a double unbalancing effect and increases sensitivity under certain conditions over part of the temperature range.



Two NTC units in adjacent arms is a method of indicating equality of two temperatures, or temperature difference or rise. Temperature of either source can be obtained by substitution of standard resistance for other NTC unit.

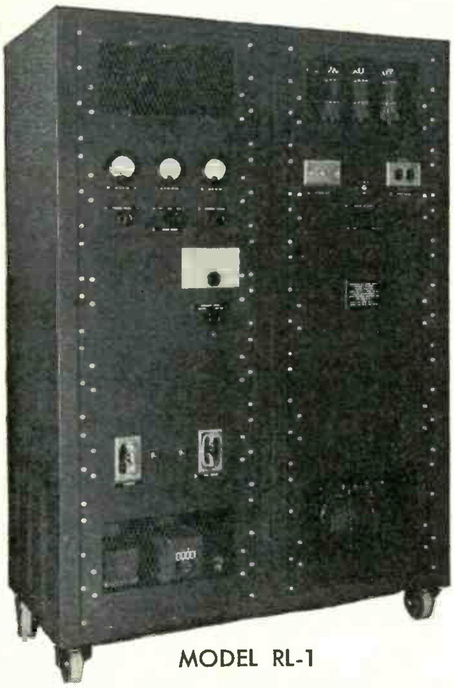
Keystone NTC resistors are also valuable for neutralizing the change in resistance with temperature of electrical indicating instruments and control devices, for introducing time delays and many other applications. Write and tell us about your problem—we'll be glad to analyze it for the applicability of NTC units.

KEYSTONE CARBON COMPANY, INC.

SAINT MARYS . . . . PENNA.

REGULATED POWER SUPPLIES

Excellent Regulation—Line Stability—Low Hum Level



MODEL RL-1

Maximum Power Output—300 Watts

**REGULATED A. C.
ELECTRONIC GENERATOR**

VARIABLE WAVEFORM-VARIABLE FREQUENCY
MODEL RL-1

This unit embodies a novel feature which maintains essentially constant RMS output voltage while permitting variation of waveform and frequency. The waveform of the output voltage can be varied from nearly square wave through sine wave to peaked wave covering amplitude factors $\frac{\text{Peak Volts}}{\text{RMS Volts}}$ of from 1.16 to 1.65. The frequency is variable over a range from 50 to 2400 c.p.s. Output voltage is 115 volts RMS nominally, adjustable between 110 and 120 volts. Regulation of output voltage is better than 3% from no load to full load and for line voltage changes from 110-120 volts A.C. The output voltage stays within the same limits for frequency changes over the whole range as well as for changes in amplitude factor from 1.16 to 1.65.
Units can be designed for other output voltages, power ratings and frequency ranges.

Model 44

OUTPUT VOLTAGE—Continuously variable from 0-300 Volts DC at 100 MA Max. Same characteristics as Model 44B except for lower current rating.

Model 44B

OUTPUT VOLTAGE—Continuously variable from 0-300 Volts DC at 250 MA Max. General purpose supply which will deliver very well-regulated DC.

OUTPUT VOLTAGE—Variable from 1.0 to 1.5 Volts DC at 500 MA Max. This model suitable for use in place of A Batteries.

Model 42A

Prices, delivery dates and priority requirements will be given upon request. Inquiries are invited both on power supplies and on our electronic consulting service.

DISTRIBUTED BY

RADIO-TELEVISION INSTITUTE, INC.
OF NEW YORK

480 LEXINGTON AVENUE PLaza 3-4585 NEW YORK 17, N.Y.

MITCHELL-RAND

VARNISHED TUBING HEADQUARTERS

Complete and Comprehensive is Mitchell-Rand's line of Varnished Tubings . . . Fiberglas or Cotton Yarn . . . to meet every known need of the Electrical or Electronic industries.

For Varnilshed Tubings that won't fray, burn or oxidize ...that will resist high temperatures, high dielectric and always remain flexible . . . check with Mitchell-Rand for the Varnished Tubing best suited to your needs.

FIBERGLAS *INORGANIC* VARNISHED TUBINGS

M-R Fiberglas Varnished Tubings are made in four grades:

Standard; Double Saturated; Triple Strength and Impregnated.

STANDARD GRADE has maximum flexibility, is treated with a minimum of varnish and recommended for high temperatures where dielectric strength is not a factor.

DOUBLE SATURATED has all qualities of the Standard Grade but with additional coats of varnish to bring the dielectric rating up to 1500 volts.

TRIPLE STRENGTH is built up with coats of especially flexible insulation varnish for dielectric ratings up to 3,000 volts and is particularly suited where assembly operations include the possibility of rough handling.

IMPREGNATED is the Optimum in Superiority for high gloss, non-hydroscopic, resistance to high temperatures, oils, acids, etc IMPREGNATED has a dielectric rating beyond 8,000 volts and is unequalled for Long Life Under Most Severe Conditions. *Write For Samples.*

FREE FOR THE ASKING! Write today for your Wall Chart with reference tables, electrical symbols, allowable capacities of conductors, dielectric averages, thicknesses of insulating materials and the M-R Wax and Compound Guide Book . . . they are full of valuable information . . .

FOR USERS OF COTTON YARN VARNISHED TUBINGS

The Mitchell-Rand MIRAC and HY-GRADE Varnished Tubings of long staple fibre yarn are comparable to Fiberglas Tubings in dielectric ratings, tensile strength, flexibility and long life.

MITCHELL-RAND *for 56 YEARS* THE ELECTRICAL INSULATION HEADQUARTERS

MITCHELL-RAND INSULATION COMPANY, INC.

51 MURRAY STREET *COrtlandt 7-9264* **NEW YORK 7, N.Y.**

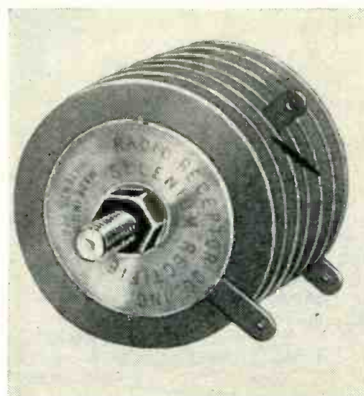
A PARTIAL LIST OF M-R PRODUCTS

- Fiberglas Varnished Tape and Cloth
- Insulating Papers and Twines
- Cable Filling and Pothead Compounds
- Friction Tape and Splice
- Transformer Compounds
- Fiberglas Braided Sleeving
- Cotton Tapes, Webbings and Sleevings
- Impregnated Varnish Tubing
- Insulating Varnishes of all types
- Fiberglas Saturated Sleeving and Varnished Tubing
- Asbestos Sleeving and Tape
- Extruded Plastic Tubing
- Varnished Cambric Cloth and Tape
- Mica Plate, Tape, Paper, Cloth and Tubing

The entire apparatus (including the tube and control) is constructed to protect the operator against electrical shock and stray radiation. The tube weighs but 11 lb so that it is easy to manipulate. Special cones and applicators adapt the equipment to a wide range of applications. Controls include the main switch, adjustment switch for line voltage, voltmeter, tube-filament control and milliammeter. A built-in timer with a range from 5 sec to 5 min insures accuracy of treatment time. The power supply unit has a rectifier tube and a capacitor to supply d-c having a low percentage of ripple. North American Philips Co., Inc., 100 East 42nd St., New York, N. Y.

Selenium Rectifiers

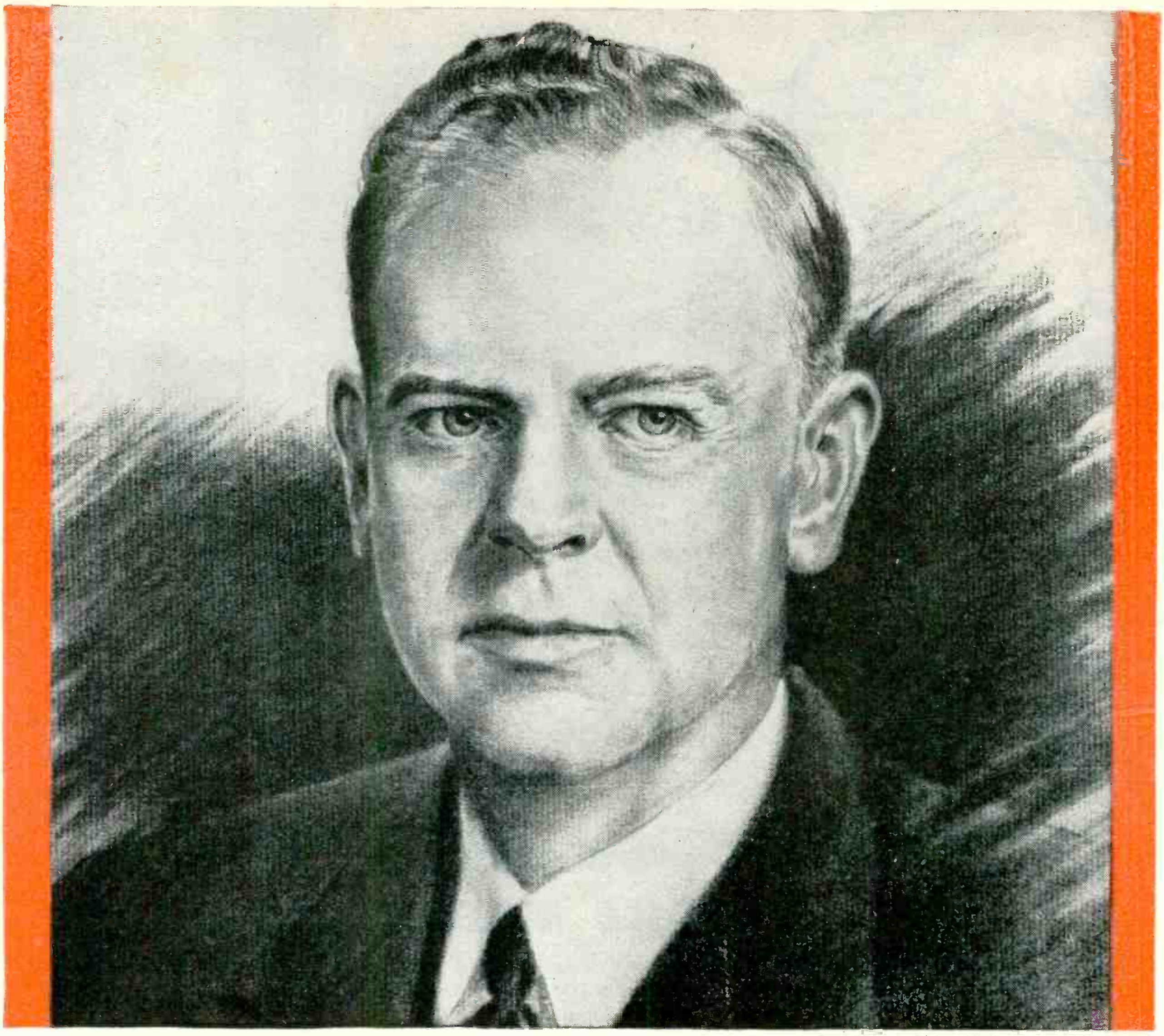
A LINE OF SELENIUM rectifiers, manufactured by Radio Receptor Co., Inc., of 251 West 19th St., New York, N. Y. utilize, in the main, aluminum in place of iron or similar metals. The units are hermetically sealed to assure maximum



performance under all extremes of climatic conditions. The new line includes units ranging from 25 mils up to capacities of hundreds of amperes, for use in all combinations of voltage and current outputs and for various types of circuits.

Shock-Resistant Ceramic

INDUSTRIAL ELECTRONIC manufacturers may be interested in a new ceramic material developed by General Ceramics and Steatite Corp., Keasbey, N. J. This material withstands temperature shocks from approximately 1400 F to the tempera-



Portrait of Randolph C. Walker by John Carlton

Engineers of Victory

NOW SERVE MEN AT PEACE

The creative engineering which armed our fighting men for Victory has no less a responsibility in the years of peace ahead. Now that the war is won, we have the job of making this a better world.

AIREON produced huge quantities of communications and radar equipment and other machinery for waging war. Its achievements were equal to its heavy responsibilities, and its workers established an outstanding record of performance.

AIREON enters peacetime production with a notable engineering organization, highly skilled personnel and great confidence in the future. We have developed many products which will contribute to better living, for the manufacture of which all 15 AIREON plants will continue in production.

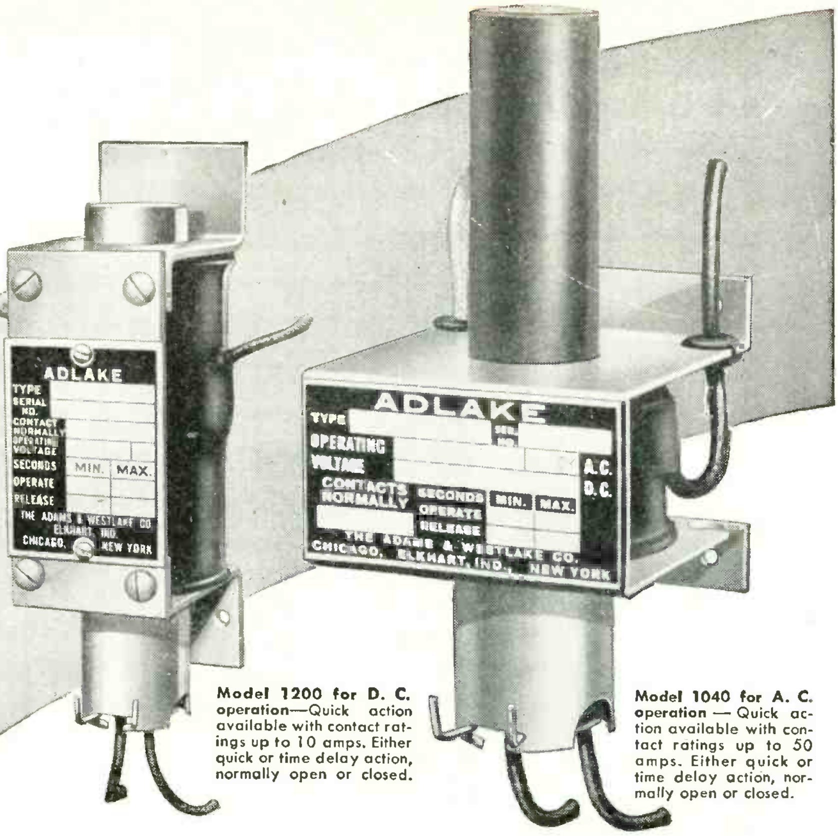
In order to extend our usefulness we recently established an experimental laboratory in Greenwich. AIREON's creative engineering in radio communications, electronics, musonics and hydraulics will team with production proficiency in contributing devices for future service.

In peace, as in war, AIREON will stand for quality and performance.

Randolph C. Walker
PRESIDENT

Aireon
MANUFACTURING CORPORATION

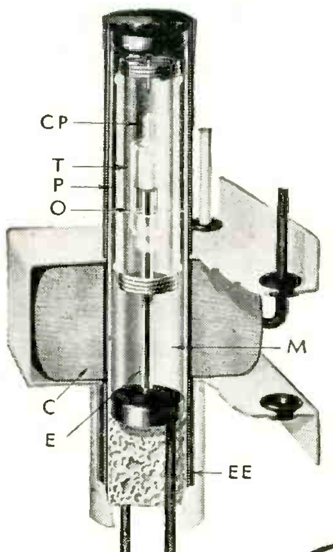
NEW YORK · GREENWICH · CHICAGO · KANSAS CITY · OKLAHOMA CITY · BURBANK · SAN FRANCISCO



Model 1200 for D. C. operation—Quick action available with contact ratings up to 10 amps. Either quick or time delay action, normally open or closed.

Model 1040 for A. C. operation — Quick action available with contact ratings up to 50 amps. Either quick or time delay action, normally open or closed.

Circuit Control with ADLAKE MERCURY RELAYS



HOW THEY WORK

ENERGIZED—Coil **C** pulls plunger **P** down into mercury **M.** Mercury thus displaced enters thimble **T** through orifice **O.** Inert gas in thimble gradually escapes through ceramic plug **CP,** thus producing time delay.

ENERGIZED—Mercury now fills thimble **T,** is completely leveled off and mercury-to-mercury contact established between electrodes **E** and **EE.** Degree of porosity of ceramic plug **CP** determines length of time delay.

Contacts and break-offs are as quick as a wink because Adlake Plunger-type Relays (models for A.C. or D.C.) use fast-moving, liquid metal mercury . . . positive in action; silent and chatterless; will not burn, pit, or stick.

Under the most exacting conditions . . . heat or cold, dirt, dust, or moisture they're ready and prompt to perform. Mechanisms, encased in armored glass or metal cylinders and then hermetically sealed, are impervious to the elements and oxidation.

No cleaning, no inspection, no servicing . . . relax and let an Adlake Mercury Relay work your timing, load, or control circuits—automatically and trouble-free.

Our bulletin tells the complete story, write for it today.

Adlake
TRADE MARK

THE ADAMS & WESTLAKE COMPANY

ESTABLISHED IN 1857 ELKHART, INDIANA NEW YORK · CHICAGO

MANUFACTURERS OF ADLAKE HERMETICALLY SEALED MERCURY RELAYS FOR TIMING, LOAD AND CONTROL CIRCUITS

YOU CAN'T KEEP A COLD CUSTOMER SOLD!

WHETHER he's Mr. Big of Industry or plain Mr. Homebody, the performance of your product's electrical insulation can make or break *his* good will, influence *your* future sales. Look at *all* the hazards of faulty or insufficient insulation. See why hundreds of manufacturers are protecting *their* products with BH Fiberglas Sleeving—the insulation that's way ahead in every important requirement, thanks to the *exclusive* BH process.

BH Fiberglas Sleeving is *permanently* flexible and non-fraying, the *original* sleeving to combine these qualities with heat resistance to 1200°F., with high tensile strength, and with resistance to moisture, oil, grease and most chemicals. It's easier to handle and install, and lasts longer in severest service. That's why BH Special Treated Fiberglas Sleeving, for instance, does a trouble-free job when the heat's on—why Mr. Room Heater Customer is sold *for good* when the heater's BH-equipped.

Whatever your product may be, if it depends on electrical insulation, you can count on one of the three BH Fiberglas Sleevings to meet your strictest needs. Send for free BH samples *today* —test them yourself—expect surprising results!

3 GREAT BH FIBERGLAS SLEEVINGS—*EACH 3 WAYS BETTER!*

NON-STIFFENING* **NON-FRAYING*** **NON-BURNING***

BH *EXTRA FLEXIBLE* FIBERGLAS SLEEVING • BH SPECIAL TREATED FIBERGLAS SLEEVING

BEN-HAR COATED FIBERGLAS SLEEVING

**Ask for sample folder giving degree above characteristics are combined in these three sleevings. All standard sizes and colors—available in standard 36-in. lengths and 500-ft. coils.*

BH PRODUCTS

ALSO SLOW-BURNING IMPREGNATED MAGNETO TUBING • SLOW-BURNING FLEXIBLE VARNISHED TUBING • SATURATED SLEEVING • A. S. T. M. SPECIFICATIONS

BENTLEY, HARRIS MANUFACTURING CO.

Dept. E Conshohocken, Penna.

ture of ice water, without cracking. The material is characterized by its extremely low thermal expansion coefficient which is in the range of Invar (1.6×10^{-6} up to 600 F and 1.9×10^{-6} up to 1000 F). The ceramic withstands a temperature of 2500 F and has a dielectric strength of 90 volts per mil. The dielectric constant at 1000 kc is 5.30 and the power factor is 0.54 percent. The manufacturer suggests the ceramic can be used in precision instruments where the low thermal expansion coefficient of a high-quality ceramic part is most desirable.

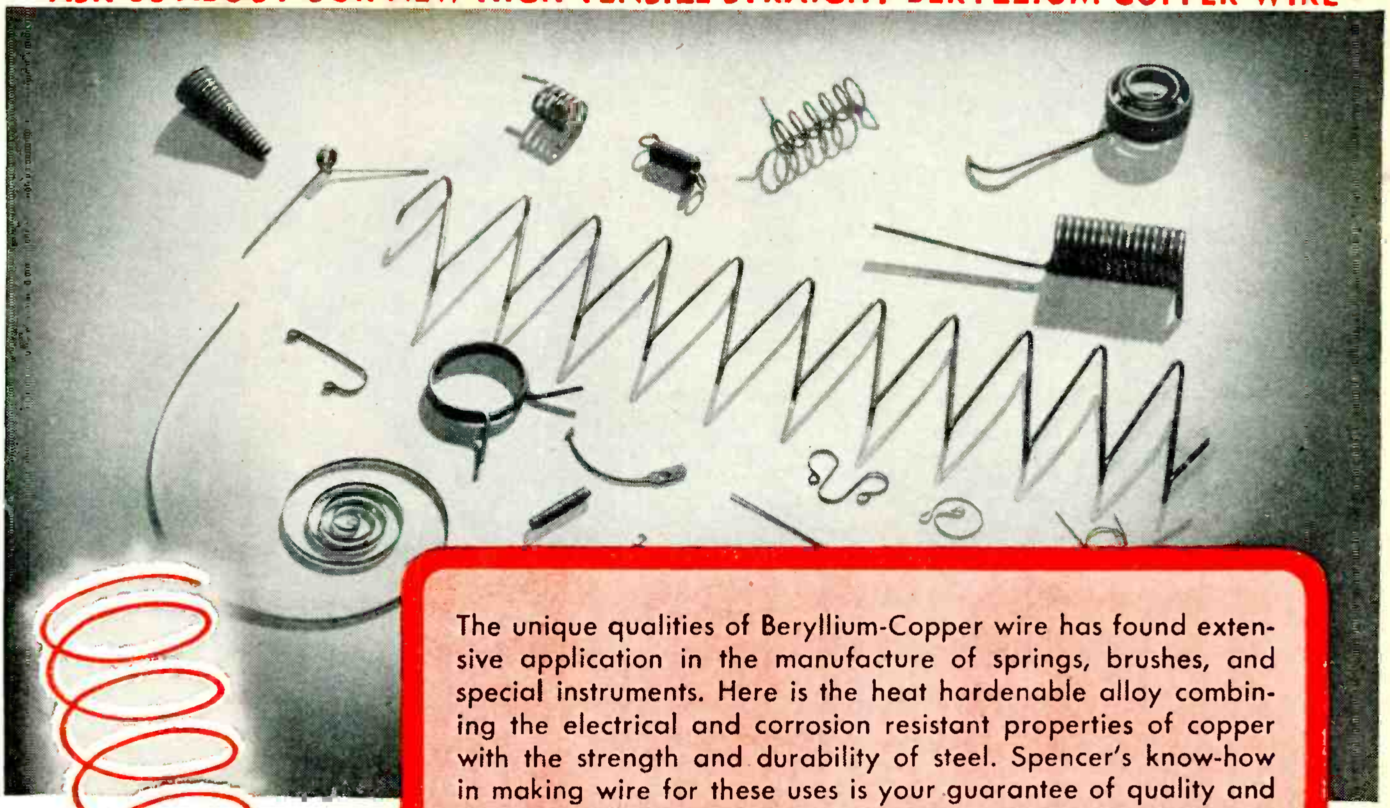
Literature

Electric Shock Hazard. A 34-page booklet entitled "Measurement of Electric Shock Hazard in Radio Equipment" is published by Underwriters' Laboratories, Inc., 161 Sixth Ave., New York 13, N. Y. This bulletin provides a general description of the factors relating to electric shock in radio receivers. A summary of the data from the literature furnishes background information regarding limits for the measurements and for the choice of a testing instrument. The development of a suitable vacuum-tube voltmeter (diode-peak meter) is described and its use is explained.

Design Principles of Spectrometer. A 12-page booklet (reprinted from *Electrical Manufacturing*) titled "Engineering-Design Development of X-Ray Spectrometer", written by J. S. Buhler, is available from North American Philips Co., Inc., 100 East 42 St., New York, N. Y. The material covers in detail the basic design principles involved in the Geiger-Counter x-ray spectrometer. Specifically, the author discusses x-ray diffraction principles, new instrument requirements, x-ray source, pulse conditioning, frequency meter circuit, counting meter circuit, meters and controls, and applications.

Automatic Voltage Regulators. For automatic line voltage control, Superior Electric Co., Bristol, Conn.,

• ASK US ABOUT OUR NEW HIGH-TENSILE STRAIGHT BERYLLIUM COPPER WIRE •



The unique qualities of Beryllium-Copper wire has found extensive application in the manufacture of springs, brushes, and special instruments. Here is the heat hardenable alloy combining the electrical and corrosion resistant properties of copper with the strength and durability of steel. Spencer's know-how in making wire for these uses is your guarantee of quality and performance. Play Safe! Specify Spencer's Beryllium-Copper wire in sizes .001-.050".

BERYLLIUM-COPPER FINE WIRE...

HIGH CARBON STEEL
PHOSPHOR BRONZE
STAINLESS STEEL
NICKEL CHROME
NICKEL SILVER
STERLING SILVER

Specify **SPENCER** *for exact specifications*

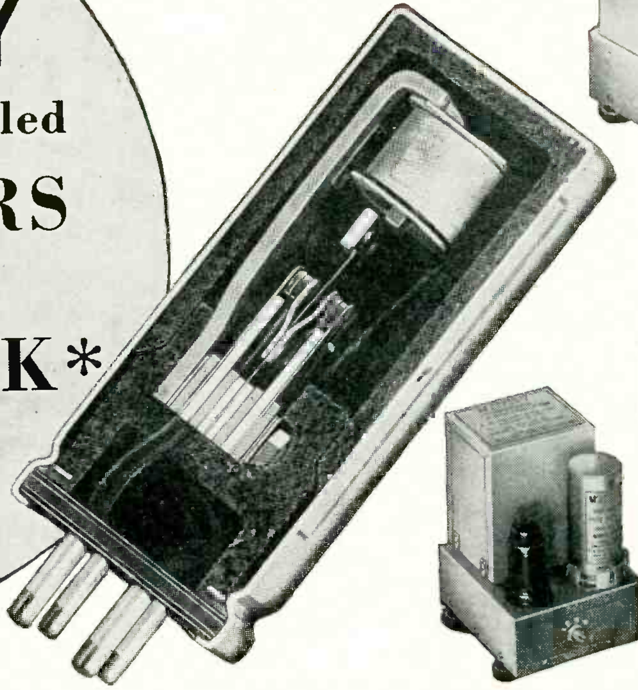
SPENCER WIRE

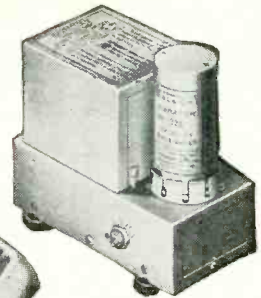
SPENCER WIRE COMPANY

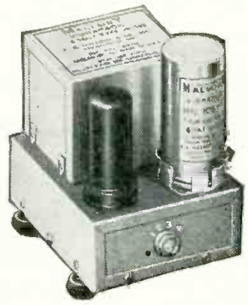
WEST BROOKFIELD PLANT
WEST BROOKFIELD • MASS.

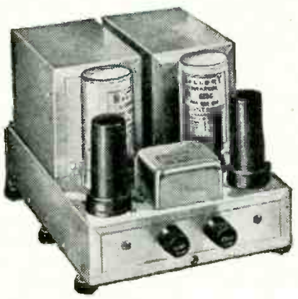
MALLORY
P. R. MALLORY & CO. Inc.

Hermetically-Sealed VIBRATORS Improve VIBRAPACK* Performance









DEVELOPED originally to meet exacting military requirements for aircraft communications in the sub-stratosphere, hermetically-sealed Mallory Vibrators are now standard equipment with every standard stock Vibrapack.

Hermetically-sealed vibrators assure longer life and greater dependability, because moisture and corrosive fumes are sealed out, and ionization breakdowns are prevented.

When you need a portable power supply to provide high voltage from a low voltage DC source, specify Vibrapacks. Other features include:

Nominal input voltages of 6, 12 and 32 volts DC.
Nominal output voltages from 125 to 400.
Models available with switch for four output voltages in approximate 25-volt steps.
Heavy-duty models with 60-watt capacity.

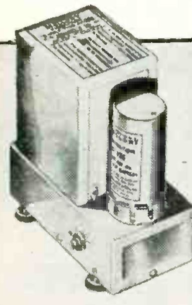
You can easily obtain Mallory Vibrators and Vibrapacks from your nearest Mallory Distributor. Ask him for free descriptive literature, or write us today.

ARMY E NAVY

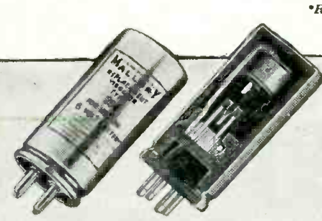
Inquiries are invited from manufacturers for Vibrators and Vibrapacks for use in original equipment.

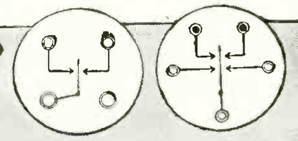
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

*Reg. U. S. Pat. Off. for vibrator power supplies



P. R. MALLORY & CO. Inc
MALLORY





VIBRATORS and VIBRATOR POWER SUPPLIES

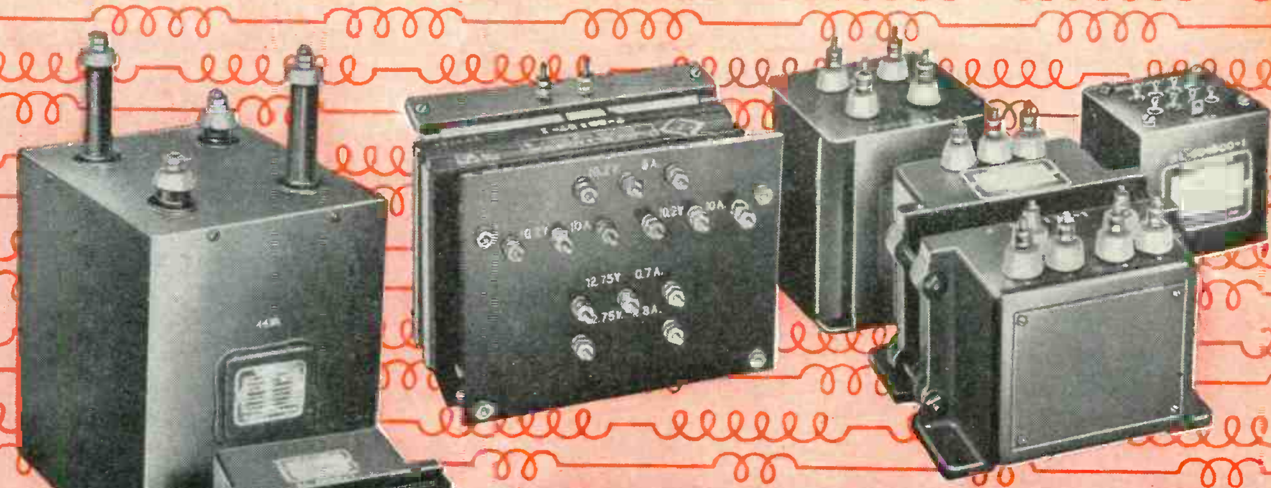
manufactures many types of automatic voltage regulators which are described in their bulletin No. 164. The Bulletin also describes Models 4101R, 4101H, 4102H, and 4106H which are now provided with a rapid-trip magnetic circuit breaker for overload protection and also as an on-off switch.

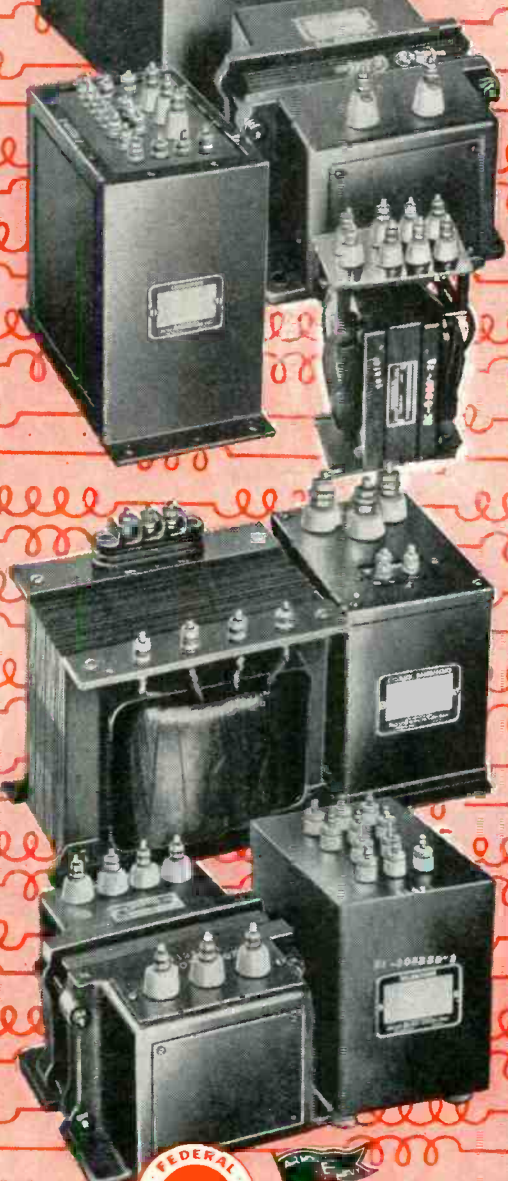
Quartz Crystals. An 8-page bulletin describes such crystals as supersonic curves, spherical or flat crystals for all uses; filter crystals (minimum drift) for precise frequencies; 100-kc frequency standard crystals which withstand severe shock and vibrations; 200-500 kc extremely stable crystals for high output and keying; and crystals for portable use in police and aircraft communication. These crystals are manufactured by Crystal Research Laboratories, Inc., 29 Allyn Street, Hartford 3, Conn., from raw quartz to the finished crystal.

Precision Tuning Fork. A low-frequency tuning fork with a vacuum-tube drive is described in a recent issue of General Radio Experimenter, published by General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. Other articles in this issue of interest to readers include "Balancing to 0.000070 Inch With the Strobotac" and "Production Testing With Impedances".

Allis-Chalmers. Two pieces of literature recently issued by Allis-Chalmers Manufacturing Co., Box 512, Milwaukee, Wis., include a "Directory of Products and Engineering Literature" which lists products made by Allis-Chalmers. Among these are electronic heaters ranging from 400,000 cycles and up which are described in Bulletin No. B-6372. The second piece of literature is titled "1944 Annual Review" which records the past year's engineering developments at Allis-Chalmers.

Silicones. Compounds and greases, fluids, varnishes and resins, and silastic silicones are described in a 12-page booklet available from Dow Corning Corp., P. O. Box 592, Midland, Mich.





Federal

Builds a Complete Range of

POWER SUPPLY

Transformers

AND

Reactors

Superior quality . . . combined with basically correct engineering design and sturdy construction . . . characterizes every transformer in the extensive Federal line ranging in capacity from milliwatts of audio transformers up to 50 kva of power supply transformers.

Federal builds all types of transformers and other iron core magnetic components . . . open frame, semi-enclosed, enclosed, hermetically sealed.

They are manufactured under close control to provide the stamina that assures long and dependable service.

Federal transformers and reactors . . . whether for ordinary or special application . . . incorporate decades of research and specialized experience.

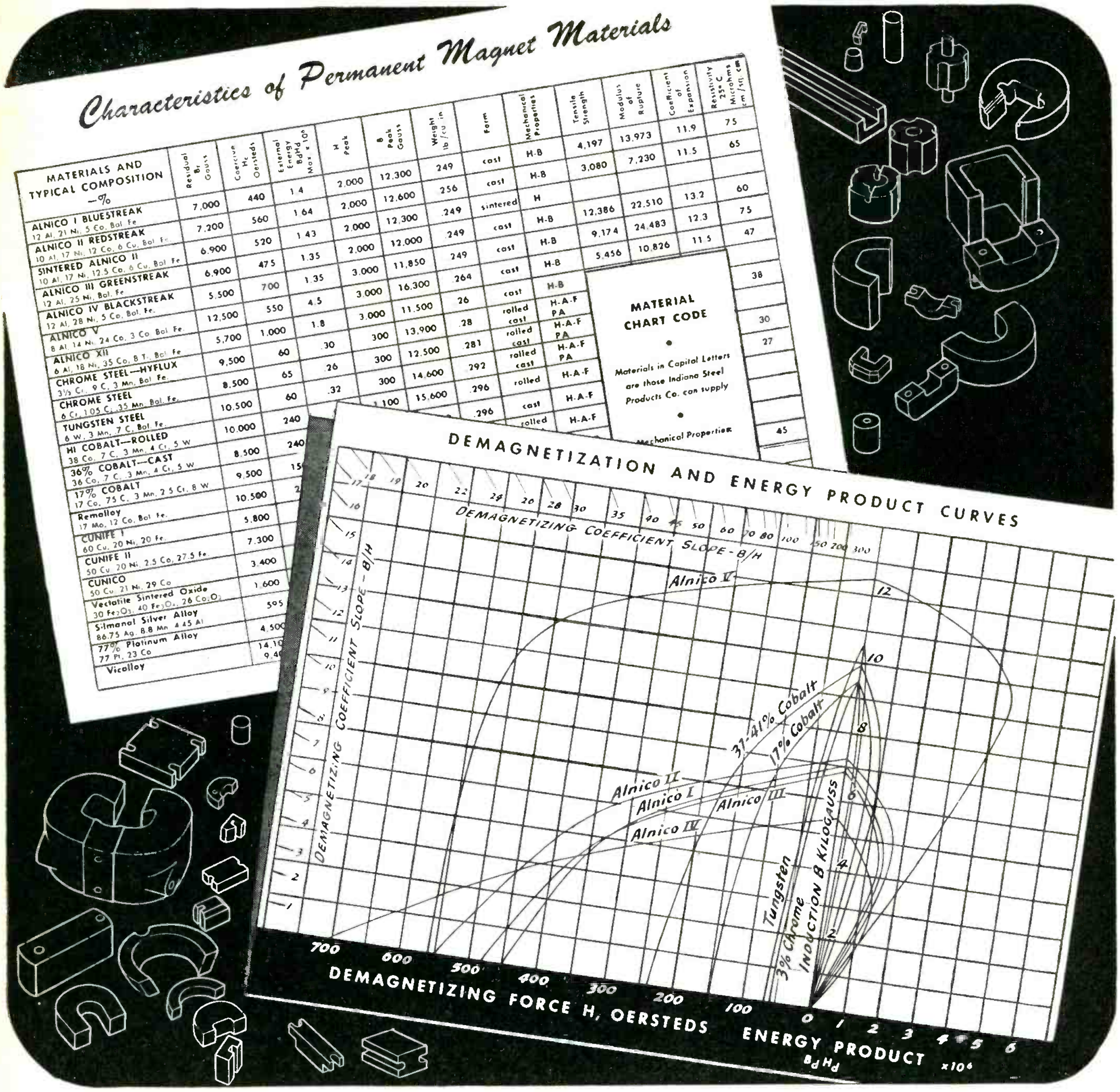
For custom-built types to suit your special requirements—see Federal.

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.

PERMANENT MAGNETS MAY DO IT BETTER



Reference Charts on Permanent Magnet Materials

Engineers! Product designers! For your convenience, in handy reference form, we have prepared two charts (shown in reduced size above) giving helpful data on the energy product and physical characteristics of permanent magnet materials. A supply of these, printed on durable ledger stock, 11″ x 16″, is available for prompt mailing to any firm or individual considering commercial applications of permanent magnets.

Write for your free copy today.

Our research and engineering specialists are at your service for consultation. Complete information on the facilities of The Indiana Steel Products Company—world's largest manufacturer of permanent magnets—is presented in our technical handbook, entitled "Permanent Magnet Manual," now on the press. We will be glad to send you a copy without charge.

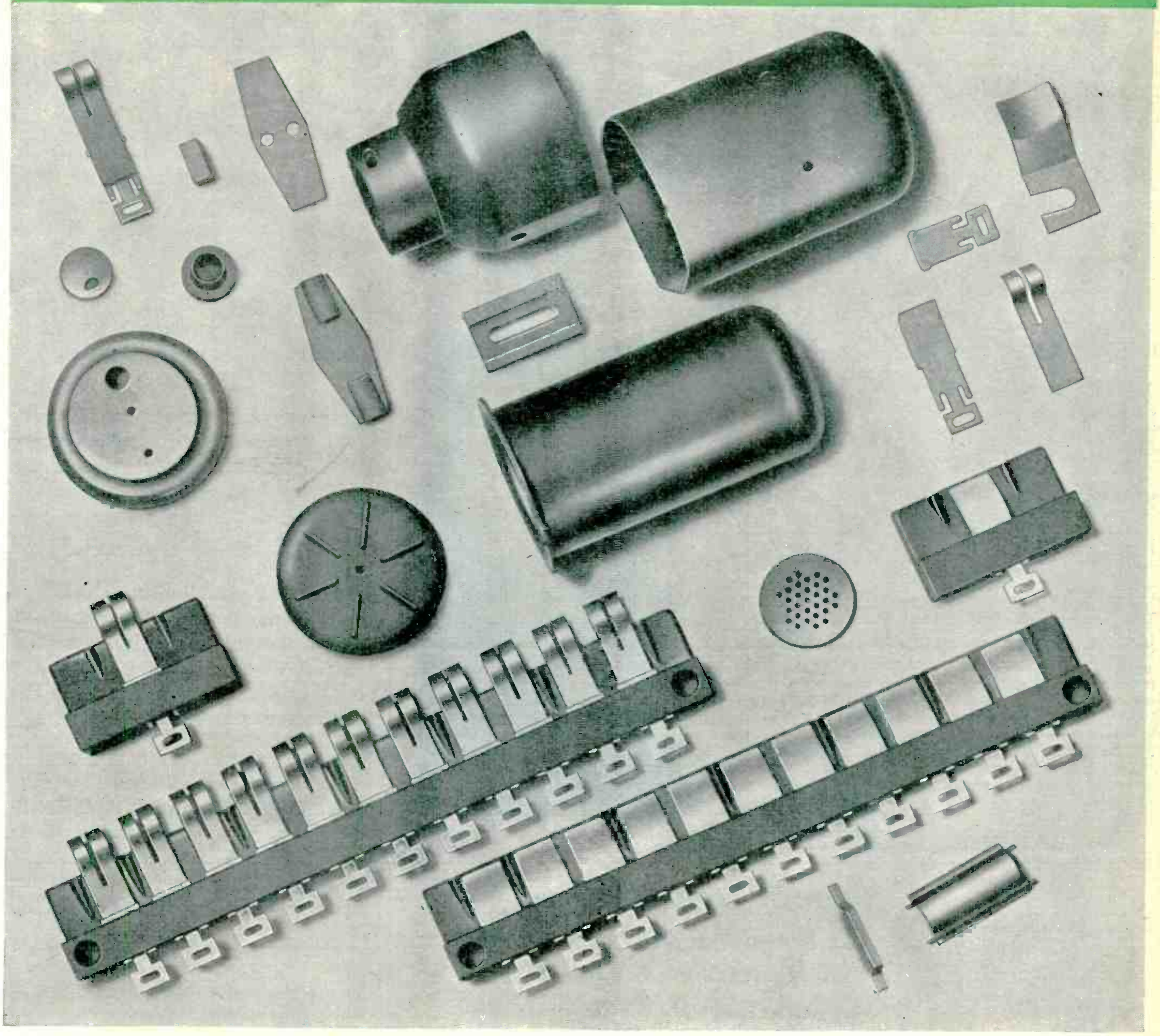
* * * **THE INDIANA STEEL PRODUCTS COMPANY** * * *

6 NORTH MICHIGAN AVENUE, CHICAGO, 2 ILLINOIS

SPECIALISTS IN PERMANENT MAGNETS SINCE 1910

ELECTRONIC COMPONENTS....

HIGH QUALITY AT LOW COST THROUGH LARGE VOLUME



Lower production cost becomes increasingly important as the American manufacturing industry moves rapidly into the bright new era of peacetime production. At the same time, the American market will demand that quality be maintained at the highest possible economic level.

To this end, Greene engineers have geared their own manufacturing equipment to produce in large volume for the electronic industry. Since 1904 our facilities, capacity, skill and know-how have steadily advanced. Our ability to produce NOW components of highest quality at lowest cost can be attributed to this long experience in metal stamping, fabricating and assembly, plus the fact that we are geared to handle large volume.

In order to maintain quality and reduce per-unit costs, our only requirement is that the minimum number of any specified part be 100,000 units. This minimum contract figure exists whether the unit is a simple metal stamping such as a lug, terminal or lamination; a coil form, choke or completely wound coil; a complicated chassis assembly; or etc.

Whatever the problem, if your volume requirements are above our minimum, we shall be very happy to quote on your specifications. Write us for further information.

MARK OF THE QUALITY
SINCE 1904

G. G. GREENE MANUFACTURING CORPORATION

WARREN . . . . PENNSYLVANIA

Erie Resistor Catalog. Performance data and specifications of resistors, ceramicons and silvered mica capacitors are contained in a new catalog available from Erie Resistor Co., Erie, Pa. The catalog is printed in color and contains many charts.

Tube Catalog. Many types of transmitting and special purpose tubes are illustrated and described and bottom views of socket connections are shown in a new catalog available from Hytron Radio & Electronics Corp., 76 Lafayette St., Salem, Mass. Also contained in the bulletin is a 4-page chart which gives all pertinent characteristics of these tubes.

Research and Engineering. A booklet entitled "We Did It This Way" tells of small but vital steps in the forward march of technology which ended in the great developments of the war, such as sonar, radar and loran. The types of equipment (including electronic equipment) developed for the war effort are interestingly described in this 32-page booklet published by Western Electric Co., Inc., 195 Broadway, New York 7, N. Y.

Steel and Wire Alloy. "Spencer Wire Comes Through" is the title of a 4-page bulletin which illustrates and describes precision wire and gives a list of applications. Spencer Wire Co., West Brookfield, Mass.

Radio and Phono Cabinets. Catalog Series-1946 illustrates and describes 28 different types of cabinets and cases available from Radio Merchandise Sales, 550 Westchester Ave., New York 55, N. Y.

Television Receivers. A large brochure illustrates and briefly describes projection-type television receivers for the home and for commercial use; direct view receivers for the home, classic and modern cabinets, all manufactured by Allen B. DuMont Laboratories, Inc., 2 Main Ave., Passaic, N. J. under the registered trademark of "Teleset".

War Developed, RADIART MIDGET VIBRATOR has Many Applications!

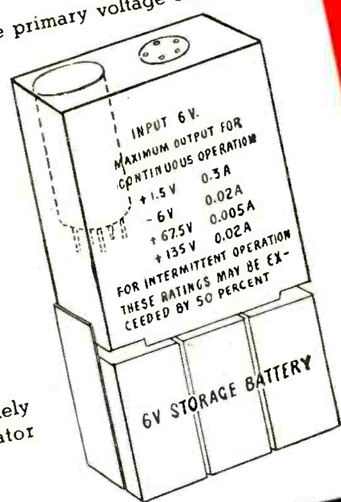
WAR NEED POINTS ONE IMPORTANT USE

A VIBRATOR OPERATED POWER SUPPLY WAS REQUIRED . . . to replace a dry battery and with same dimensions . . .

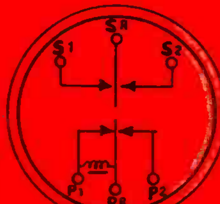
THE REQUIREMENTS WERE:

1. To supply A, B and C Power equivalent to dry battery
2. Infinite shelf life before usage.
3. To operate from a rechargeable primary voltage source

The original dry battery measured only 6-1/2" x 3-1/2" x 1-3/4". Within these dimensions RADIART produced a completely filtered, well regulated vibrator power supply and included provisions for a rechargeable storage battery



This necessitated the development of a completely new split-reed synchronous midget vibrator known as the Radiart Type VR-2



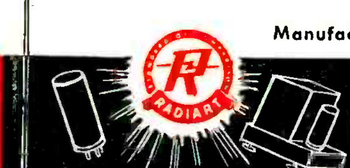
P- PRIMARY
S- SECONDARY
R- REED

SPECIFICATIONS

Vibrator Frequency . 185 CPS ± 10%
Input Voltage, Nominal . . . . . 6.0 V.
Input Voltage Range . . 4.5 to 7.5 V
Output Voltage . . 200 V. D.C. Max.
Potential Difference
Between PR & SR . . . . 25 V. Max.

The RADIART VR-2 Midget Vibrator can now be produced for civilian applications. Will this be of help in your product? Send us full information as to your requirements...our engineering department will fully cooperate.

Manufactured by makers of famous RADIART Rust Proof Aerials.



Radiart Corporation
3571 W. 62nd STREET • CLEVELAND 2, OHIO
Export Division 25 Warren St., New York 7, N.Y.
Canadian Office 455 Craig St., W., Montreal, Canada

INDUSTRIAL CONTROL

Electronic Regulator for Arc Furnaces

AS THE CHARGE in an arc furnace melts down, it is necessary that the electrode be lowered to maintain the arc. Withdrawal becomes necessary when melting scrap falls against the electrode, causing a short circuit. And normal consumption of the graphite in the electrode calls for a corresponding adjustment.

A recent Westinghouse development is an electronic unit which gives a wide range of speed and quick response in control of the motor drive which accomplishes this regulation. The system works by varying the armature voltage of a constant-field motor to produce the required speed of electrode motion.

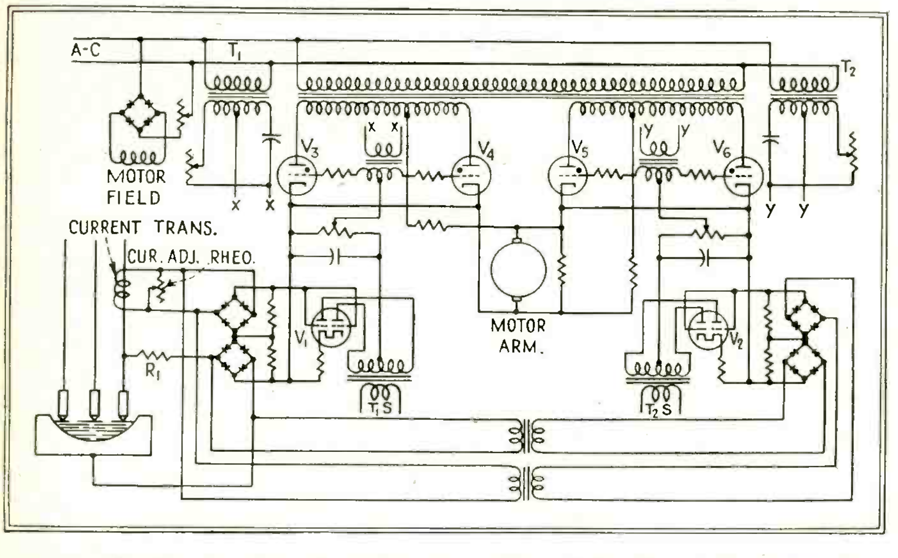


Fig. 1—Circuit of the electronic arc-furnace regulator. Tubes V_1 and V_2 regulate the firing of thyratrons V_3, V_4, V_5, and V_6, each pair of which is related to one direction of electrode-motor rotation

Circuit of One Channel

Figure 1 discloses the general scheme of the equipment. It shows three-phase electrodes but includes details on only one of the regulating channels. Also, certain elements of the grid balancing circuits have been omitted in the interest of a simplified diagram.

Grid control voltage proportional to electrode current is taken from the current transformer shown in the electrode circuit and passed through the upper of the pair of full-wave dry rectifiers connected to V_1. Another grid control voltage proportional to the arc potential comes through R_1 and the shell of the furnace to the other dry rectifier of the pair.

When operation is begun with the closing of the main circuit breaker, voltage on the potential circuit drives the cathode of V_1 positive, reducing plate current and the voltage drop across the potentiometer. This makes the grids of V_3 and V_4 less negative so the tubes start conducting. They then supply full-wave rectified voltage to the electrode motor in the direction necessary to produce lowering of the electrode.

As the first electrode strikes the metal, the voltage drops to zero. This produces an increase in the plate current of V_1 and a resulting increase in grid voltage on V_3 and V_4 which blocks their conduction and stops the motor. When the second electrode in the three-phase group strikes the metal at the end of a corresponding chain of events, current begins to flow in both. This results in a voltage which appears in each current-transformer circuit and imposes a negative voltage on the grid of V_2 through its associated pair of dry rectifiers.

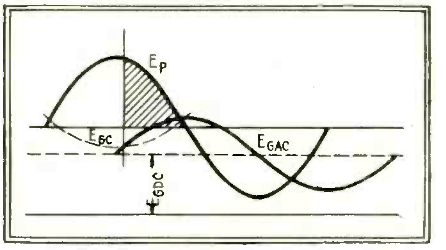


Fig. 2—Phase-angle firing control is used in the arc-furnace regulator. Variations in E_{GDC} cause E_{GAC} to intersect the E_{GC} curve at different points, instituting conduction for the remainder of the half-cycle. Motor power is represented by the shaded area

Positioning the Electrode

Tubes V_5 and V_6 then perform in the same fashion as V_3 and V_4 except that the armature voltage has the opposite polarity and drives the motor in the opposite direction, raising the electrode and establishing an arc whose voltage increases and current decreases as it lengthens. Ultimately a balance is established between the potential and current grid-control voltages and the electrode position is established. Thereafter, variations arising through diminishing electrode length, melting down of the metal, or a cave-in around an electrode, supply grid voltages such as to produce appropriate motion of the affected electrodes.

Variable voltage for the motors is obtained by superimposing an a-c voltage wave on the d-c grid voltage of the main thyratron tubes V_3, V_4, V_5, and V_6. Because this has a 90-deg lag behind the thyratron anode voltage, it cuts the critical grid-voltage line at different points as

A NEW ECONOMICAL RESISTOR LINE

PERMANENT LOW UNIT COST

CLOSE TOLERANCE LIMITS

PROMPT DELIVERY

QUALITY

IN-RES-CO

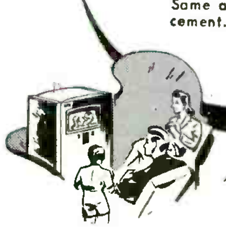
TYPE ALA — 3 WATTS
MAX RES: 25,000 Ohms (Nichrome)
MAX. RES: 5,000 Ohms (Manganin)
BODY SIZE: 1⅛" Lg. by ⅜" Dia.
MOUNTING: By Axial Leads
TERMINALS: No. 18 Tinned Copper Leads, 2 Inches Long
TOLERANCES: Standard 3% (1% at Slight Extra Cost)

TYPE ACA — 6 WATTS
Same as Type ALA except coated with high temperature cement.

TYPE BLA — 5 WATTS
MAX. RES: 50,000 Ohms (Nichrome)
MAX. RES: 10,000 Ohms (Manganin)
BODY SIZE: 1⅝" Lg. by ⅜" Dia.
MOUNTING: By Axial Leads
TERMINALS: No. 18 Tinned Copper Leads, 2 Inches Long
TOLERANCES: Standard 3% (1% at Slight Extra Cost)

TYPE BCA — 10 WATTS
Same as Type BLA except coated with high temperature cement.

Types ALA, ACA, BLA, BCA can be supplied with non-inductive winding with 50% reduction in maximum resistance. Add suffix "N" to code when specifying non-inductive types (ALAN, ACAN, BLAN, BCAN).



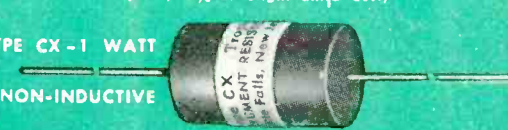
Dependable!

This new line of resistors—designed to meet current demands for small, low-cost, quality units of close tolerance—is immediately available. They cover the full range from 1 watt to 10 watts and 1 ohm to 1 megohm. Designed for long life and stability, these components have hard soldered connections between resistance wire and terminals, assuring permanent noise-less, trouble-free units. These new resistors are engineered for the manufacturer who desires to retain a reputation of top quality and performance in his equipment. Like all IN-RES-CO products they are produced under rigid control by modern facilities. Write for details.

TYPE BX — 1 WATT
NON-INDUCTIVE

MAX. RES: 1 Megohm (Nichrome)
MAX. RES: 30,000 Ohms (Manganin)
BODY SIZE: 1-5/16" Lg. by 9/16" Dia.
TOLERANCES: Standard 3%
(To 1/10% at Slight Extra Cost)

TYPE CX - 1 WATT
NON-INDUCTIVE



MAX. RES: 500,000 Ohms (Nichrome)
MAX. RES: 15,000 Ohms (Manganin)
BODY SIZE: ¾" Lg. by 9/16" Dia.
TOLERANCES: Standard 3%
(To 1/10% at Slight Extra Cost)

INSTRUMENT RESISTORS CO.

25 AMITY STREET, LITTLE FALLS, NEW JERSEY

the d-c grid voltage is raised or lowered. Figure 2 shows this relation which allows the thyratrons to conduct for varying portions of a half cycle.

For a high degree of accuracy in a system like this, the various grid voltages must have complete control over the regulating tubes without causing them to saturate because of the grids swinging positive. The self-biasing resistor is arranged so that the regulating tube works along the straight portion of its curve like a class-A amplifier. This results in high amplification, and a small change in grid voltage varies the output of the regulating tube over a wide range. A wide range of current adjustment is obtained by means of a rheostat shunting the

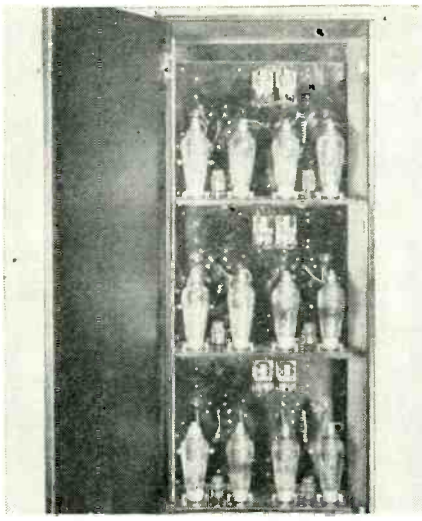


Fig. 3—Closeup view of the three channels of thyratrons and coordinated regulator stages for a three-phase arc furnace in their protective housing

current transformer. This method maintains the same sensitivity for all current settings.

Provision for controlling the electrodes manually, either individually or in a group, facilitates handling during charging, pouring, and changing electrodes. Physical construction of the unit which houses the gear is shown in Fig. 3. The control panel is disposed for setting into the wall of the furnace vault in accordance with standard practice with other types of regulators. Single-unit construction, as in this design, eases the problem of excluding dirt and protecting the apparatus against physical damage. It also facilitates factory testing of the whole operation including the electrode motors.

Phototube Weft Straightening in Textile Industry

In a textile industry control produced by General Electric Co., a pair of exciter-lamp and phototube scanning units count the number of weft threads at each side of a continuously moving web of cloth, compare them to detect skew, and provide impulses by which automatic correction is made. The controls are used in conjunction with weft-straightening equipment made by Winsor & Jerauld Mfg. Co.

Shown in Fig. 1 is a typical installation. A single unit is to be seen in Fig. 2 with parts marked. The method of operation is revealed

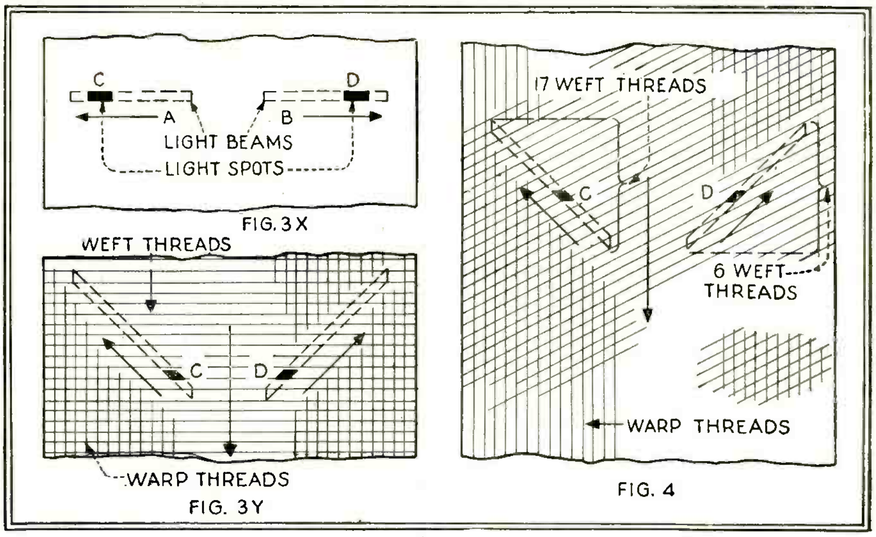


Fig. 3—Light beams shown at X are focused directly at the level of cloth, originating in optical system below. Selsyn-driven rotating disks cut beams down to spots. Effect when cloth moves is shown at Y

Fig. 4—When weft threads in moving cloth get askew, the spot of light on the leading side (left in this example) cuts across a greater number of threads to produce a higher frequency signal in the phototube

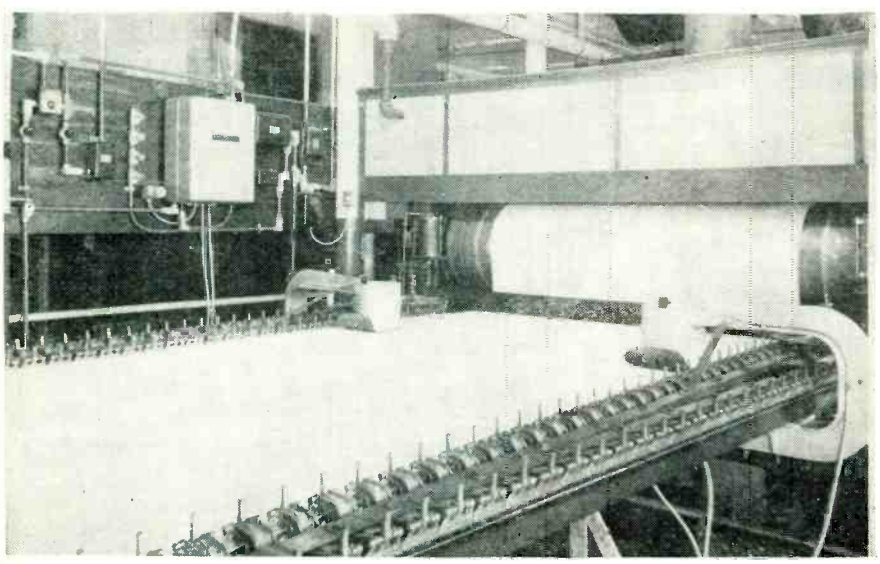


Fig. 1—Phototube weft straightening installation at Danvers Bleachery and Dye Works, Peabody, Mass. The light sources are below the level of cloth in the tenter

in the succeeding figures. Light beams A and B as illustrated in Fig. 3X are produced in the optical system which mounts below the moving cloth as can be seen in Fig. 2. These beams are approximately $2\frac{1}{8}$ by 0.004 in. and are reduced to spots, C and D, by rotating disks. Motion of the light spots bears a direct relation to the cloth speed, a relation which is maintained

GET THESE 2 ROLLER-SMITH FEATURES
IN YOUR SWITCHBOARD INSTRUMENTS

★ *Large Easy-to-Read Scale*

★ *Accuracy to within 1%*

★ The large $5^1/_4$ inch scale printed in jet black on a bone white background makes all Roller-Smith switchboard instruments easy-to-read.

The accurate calibration and careful construction and design hold the instrument to an accuracy of 1%. Each instrument is individually calibrated and the scale then accurately drawn.

There is a mounting and style to meet individual preferences and needs. Round cases for surface mounting. Rectangular cases for surface or flush mounting. A full range of sizes and capacities is available in each type case and mounting. For full information, write for Catalog 4220 to Department E-5

FOR EVERY SWITCHBOARD NEED

Round—Surface Mounted
Rectangular—Surface or Flush Mounted
Direct Current
- Ammeters
- Voltmeters

Alternating Current
- Ammeters
- Voltmeters
- Wattmeters
- Power Factor Meters
- Frequency Meters
- Synchroscopes

R/S **ROLLER SMITH**

Switchboard Instruments

BETHLEHEM·PENNSYLVANIA

In Canada: Roller-Smith Marsland, Ltd., Kitchener, Ontario

STANDARD AND PRECISION ELECTRICAL INSTRUMENTS • AIRCRAFT INSTRUMENTS • SWITCHGEAR
AIR AND OIL CIRCUIT BREAKERS • ROTARY SWITCHES • RELAYS • PRECISION BALANCES

WHERE do radio tubes go after inspection? Shipping cartons, or waste cans!

Imperfect tubes can't be fixed up. They have to be smashed up. So the manufacturer's problem is to keep down the number smashed up. And that calls for Nickel.

Consider the problems involved: Millions of intricate parts to be made to close dimensions... safeguarded against rust and corrosion while in storage, and through repeated handling . . . held to close dimensions in assembly . . . thoroughly degassed during bombardment.

No wonder manufacturers for over thirty years have stuck to Nickel. Nickel helps manufacturers produce tubes that are right in every respect . . . tubes that pass the inspector. And that means fewer rejections, increased yields, lower cost per finished tube . . . *saving where it counts the most.*

Pure Nickel and Nickel alloys serve many electrical applications. And among *your* metal problems, too, are some they'd doubtless solve.

Study Nickel's advantages, listed at right, and you'll see why.

Then write us for more information. Ask for your copy of "Nickel in the Radio Industry."

NICKEL

IMPORTANT ADVANTAGES
combined *exclusively* in NICKEL

1. Nickel's excellent forming quality simplifies production of precision parts.
2. Spot welds on Nickel make strong joints that are practically free of oxidation.
3. Nickel has strength to maintain precision during frequent handling in mounting parts.
4. Nickel is proof against rust during handling or storage, and it resists corrosion by solvents used for cleaning parts.
5. Nickel contains much less gas than other commercial metals and is degassed more readily. Higher temperatures can be used to speed up evacuation.
6. Nickel is stronger at the high evacuating temperatures and there is no crystal change on heating—both of which keep down dimensional changes, and preserve tube constants.
7. Better electron emission is obtained from coated Nickel cathodes.
8. Better, more adherent carbon coatings can be deposited on Nickel and the carbonizing process does not produce a brittle strip.
9. Nickel conducts heat better at elevated temperatures.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK 5, N. Y.

WHAT DO YOU WANT IN A CABLE?

ANSONIA and ANKOSEAL can supply the combination of Qualities You Need!

To do your job and do it right, you need cable with certain characteristics. Three or four or more factors—heat resistance, dielectric strength, flexibility and durability, for instance—must be satisfied in the *one* cable. You *can* settle for less—but when a cable fails, it's *your reputation* that suffers.

At Ansonia, electrical cable is engineered to meet *all* necessary requirements as far as that is possible. And, thanks to ANKOSEAL, a remarkable thermoplastic insulation, our engineers are usually able to combine in one cable all the qualities you need.

Simply tell us what you *want* in a cable—we'll design and produce it. It won't be the cheapest cable—but *it will be right!* The difference will result in longer life and better performance.

We'll be glad to describe in detail what Ansonia can offer you in the form of *job-engineered* cable. Write now for fuller information.

Why ANKOSEAL *solves cable problems*

Ankoseal, a thermoplastic insulation, can help solve many electrical engineering problems, now and in the future. *Polyvinyl* Ankoseal possesses notable flame-retarding and oil resisting characteristics; is highly resistant to acids, alkalies, sunlight, moisture, and most solvents. Polyethylene Ankoseal is outstanding for its low dielectric loss in high-frequency transmission. Both have many uses, particularly in the radio and audio fields. Ankoseal cables are the result of extensive laboratory research at Ansonia—the same laboratories apply engineering technique in the solution of cable problems of all types.

THE ANSONIA ELECTRICAL COMPANY

Specializing in "Ankoseal" a Thermoplastic Insulation

ANSONIA • CONNECTICUT

ARMY E NAVY

A Wholly-Owned Subsidiary of

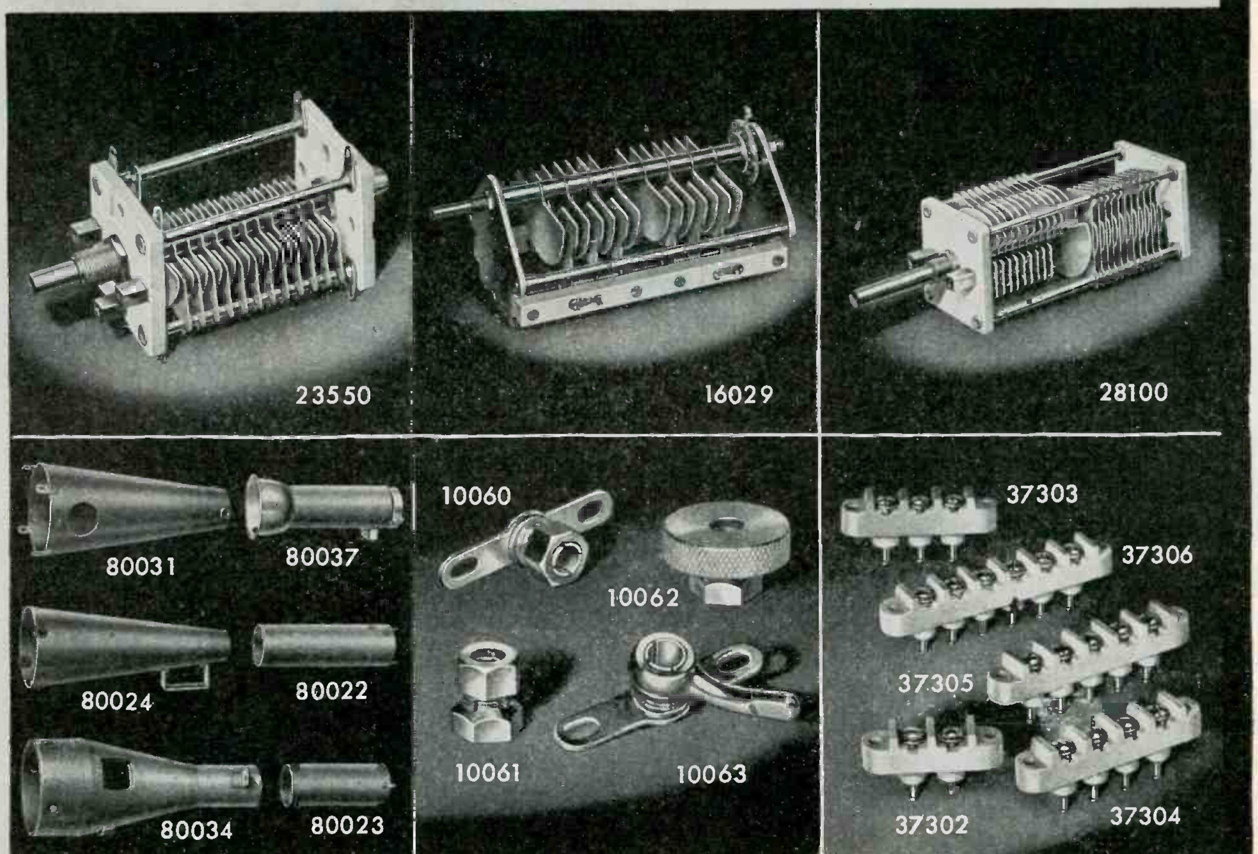
NOMA ELECTRIC CORPORATION

GENERAL OFFICES • NEW YORK, N. Y.

Makers of the famous Noma Lights—the greatest name in decorative lighting. Manufacturers of fixed mica dielectric capacitors and other radio, radar and electronic equipment.

Designed for Application

Millen "Designed for Application" components are different! As a designer and manufacturer for many years of complex electronic and communication equipment, we are our own best customer for component parts. Consequently, we have to perform an outstanding job of designing and manufacturing such parts in order to satisfy our own applications. Our parts are "different", also, because as symbolized by the "Gear wheel" of our registered trade mark, they are designed by mechanical engineers working in close cooperation with our electronic circuit group. Below are illustrated a typical half dozen of the thousand-odd items we manufacture.



Illustrated above, left to right; Top row: One each of the No. 23000, 16000, and 28000 series of variable air capacitors; Bottom row: some of the 80000 Series of Mumetal and Nicoloi cathode-ray tube shields; the 10060 series of shaft locks for use with potentiometers, variable capacitors, etc., and finally the 37300 series of ceramic terminal strips.

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY

MALDEN
MASSACHUSETTS

NEW YORK OFFICE
259 W. 14th ST.

CHICAGO OFFICE
549 W. WASHINGTON BLVD.

SALES OFFICES IN ALL OTHER PRINCIPAL CITIES throughout the speed range of the tenter by selsyn motors controlled by a transmitter on the main tenter drive. The relation is shown in Fig. 3Y where the cloth is in motion with weft threads straight.

When weft threads are askew as in Fig. 4, the light spot at the right

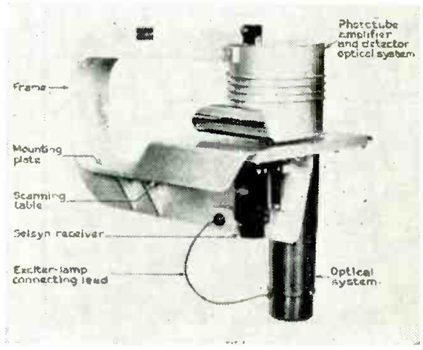


Fig. 2—Closeup of one of two units in a GE phototube weft-straightening control. Amplifier output goes to control unit and thence to operate straightening motor

intercepts more threads than does the one at the left. For skew in the opposite direction, the opposite situation prevails. Phototubes and related amplifiers are located in the cylindrical housings immediately above the moving cloth, where they receive impulses at the frequency of the passing threads—the same if the weft is straight but unequal in case of a skew.

Amplifier outputs are fed to a frequency-sensitive circuit in which a voltage output is produced

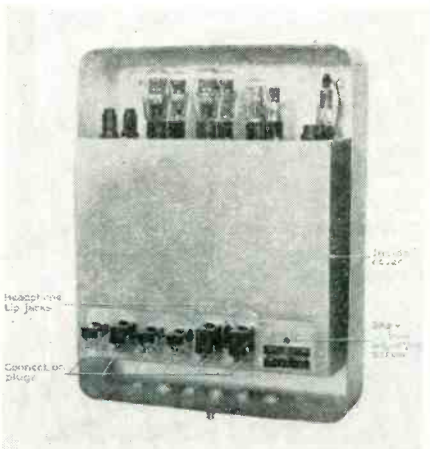
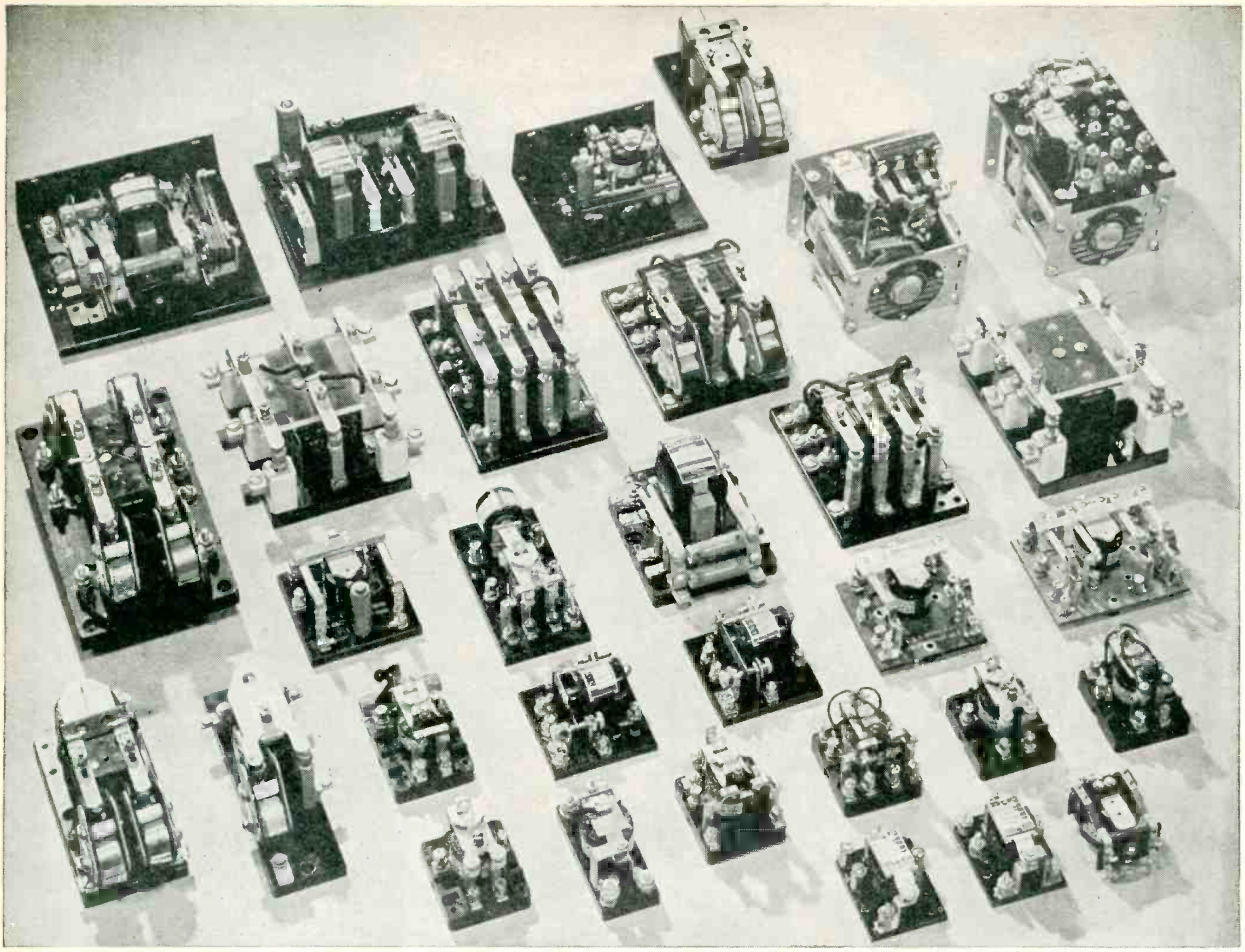


Fig. 5—Dustproof cover has been removed to show disposition of parts in weft control unit which is fed signals from the phototube amplifiers atop the sensing units



BECKMAN

Helipot

Now available for civilian electronic applications!

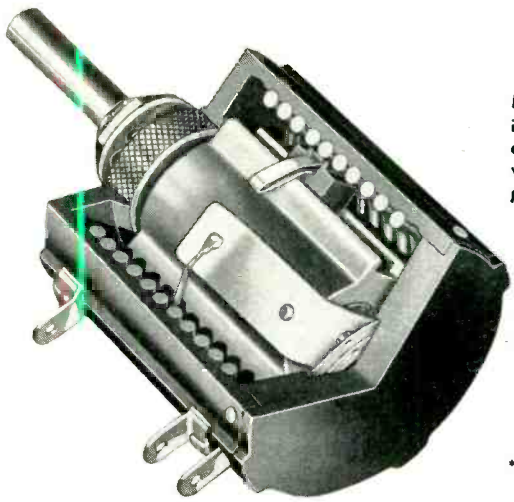
Can you use this important development to improve your product?

THE HELIPOT—a Beckman development widely used during the war on such precision instruments as radar, flight control units, depth sounding devices, and other critical electronic equipment—is now available to manufacturers and users of civilian electronic instruments!

The Beckman Helipot is a unique *new type* of potentiometer-rheostat which combines in *one compact unit* both the wide resistance range and extreme fineness of adjustment heretofore usually obtainable only through use of *two* separate rheostats, *two* control knobs, *two* adjusting operations. It is outstanding for all types of precision electronic equipment requiring high linearity, wide range and precise resistance control.

▶ WHAT IT IS: The Beckman Helipot consists of a long, precision slide wire coiled helically into a small case and equipped with a slider contact assembly that is moved in the usual manner—by rotation of a shaft. A simple device automatically guides the slider contact over the helical path of the resistance winding so that the entire length of the wire can be contacted by rotation of *one* knob.

This unique design enables the Helipot to occupy no more panel space than a conventional single-turn rheostat. Yet the greatly increased length of the resistance winding provides a new standard of high accuracy *and* wide resistance range *in one unit*. It means, for example, that a ten-turn Helipot has *ten times the fineness of adjustment* possible with a single-turn rheostat of the same range. Or conversely, for the same fineness of adjustment a ten-turn Helipot has *ten times the range.*



IMPORTANT HELIPOT FEATURES

High Linearity—As a result of fulfilling wartime requirements for ultra-precision circuit controls, Helipots are mass-produced with linearity tolerances of one *tenth* of one *per cent*—and even less!

Precise Settings—Because of the many-times longer slide wire, settings can be made with an accuracy impossible with single turn units.

Wide Range—By coiling a long potentiometer slide wire into a helix, the Helipot provides *many times* the range possible with a single turn unit of comparable diameter and panel space requirements.

Low Torque—Of special interest for power-driven applications—the Helipot has unusually low torque characteristics. The 1½" Helipot, for example, has a torque of *only one inch-ounce*.

Write for further details!

*HELIPOT—T. M. Reg.
(from HELIcal POTentiometer)

The Beckman Helipot is precision-built of the finest materials and is designed for use in all types of high quality electronic instruments where accuracy, sensitivity, wide range and positive operation are required. Why not investigate its use to increase the accuracy, the convenience, the efficiency of your quality electronic products? Our engineers will be glad to explain how the Helipot can fit your application. Write, briefly outlining your needs and ask for Helipot Bulletin!

VARIOUS SIZES AND TYPES

Current Helipot production is in several types and sizes, including . . .

Diameter	No. of Turns	Total Length Slide Wire
1½"	Up to 10	Up to 44"
3"	Up to 40	Up to 378"

Other sizes available on special order.

THE Helipot CORPORATION, South Pasadena, Calif.

proportional to the magnitude and also the direction of the skew. This voltage is used to control the operation of a straightening motor through the action of suitable electron tubes, no mechanical contactors being used in the gear.

Figure 5 shows the control unit in its dust-tight case. All external connections are made through non-interchangeable plugs. To facilitate maintenance, inoperative units are arranged for easy removal and replacement by factory adjusted units.

• • •

Circuit of Electronic Capacitance-type Fuel Gage

OPERATING DETAILS OF the aircraft fuel level gage developed by Minneapolis-Honeywell Regulator Co. and previously* described in general terms have been made available:

Operation of the gages is based on the general concept of the a-c bridge, discussed earlier** in connection with automatic pilot functions. The practical working circuit appears in Fig. 1. Sensing elements, as shown at the upper right, consist of concentric aluminum tubes of which the inner two form the opposite plates of a capacitor while the outer one serves as an electrostatic and mechanical shield and is grounded.

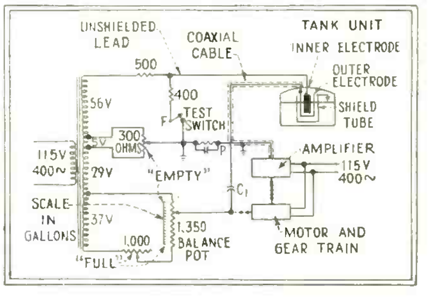
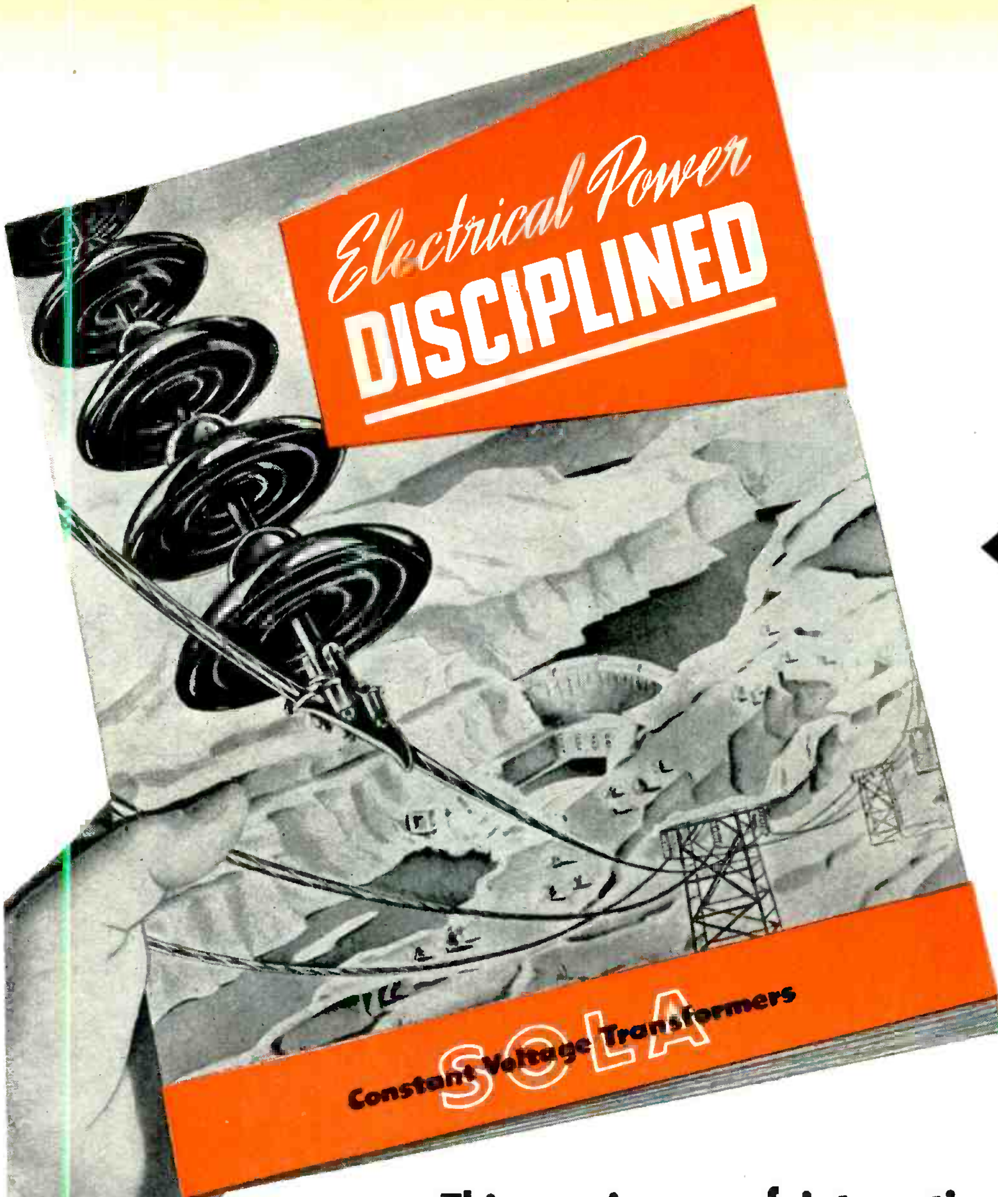


Fig. 1—The capacitance-type fuel gage utilizes this bridge circuit. The sensing element in upper right is a triple-coaxial aluminum tube

Gasoline flows through vents into the space between the tubes, varying the dielectric constant and thus changing the capacitance in a set relationship to the amount of fuel

*See, More Accurate Liquid Level Indicator for Aircraft Industry, ELECTRONICS, July 1945, p 152.
**See, Electronic Autopilot Circuits, ELECTRONICS, Oct. 1944, p 110.



for:

designers

•

manufacturers

•

maintenance engineers

•

salesmen

•

users of electronic and electrically operated equipment

Thirty minutes of interesting reading that will help you build a better product or get greater satisfaction from equipment now in use

What is a Constant Voltage Transformer?—why is it necessary?—how does it operate?—where can it be used?—what new developments have resulted from its world-wide, war-time use?—

. . . these and many other important questions are fully answered in this new SOLA handbook.

The Constant Voltage Transformer is an exclusive SOLA product—the ONLY voltage regulating TRANSFORMER. In principle, design and construction it is different and should not be confused with ordinary types of voltage regulating networks.

It employs no tubes and has no moving parts. It is fully automatic in operation, it is not dependent on manual control or supervision and protects both itself and the equipment it serves against voltage surges or short circuit. It instantly corrects voltage fluctuations as great as 30% to within ±1% of rated value.

Your product will serve more people—*better*—with built-in Constant Voltage. There are SOLA units specially designed for that purpose—fully described in this new handbook.

Write for your copy

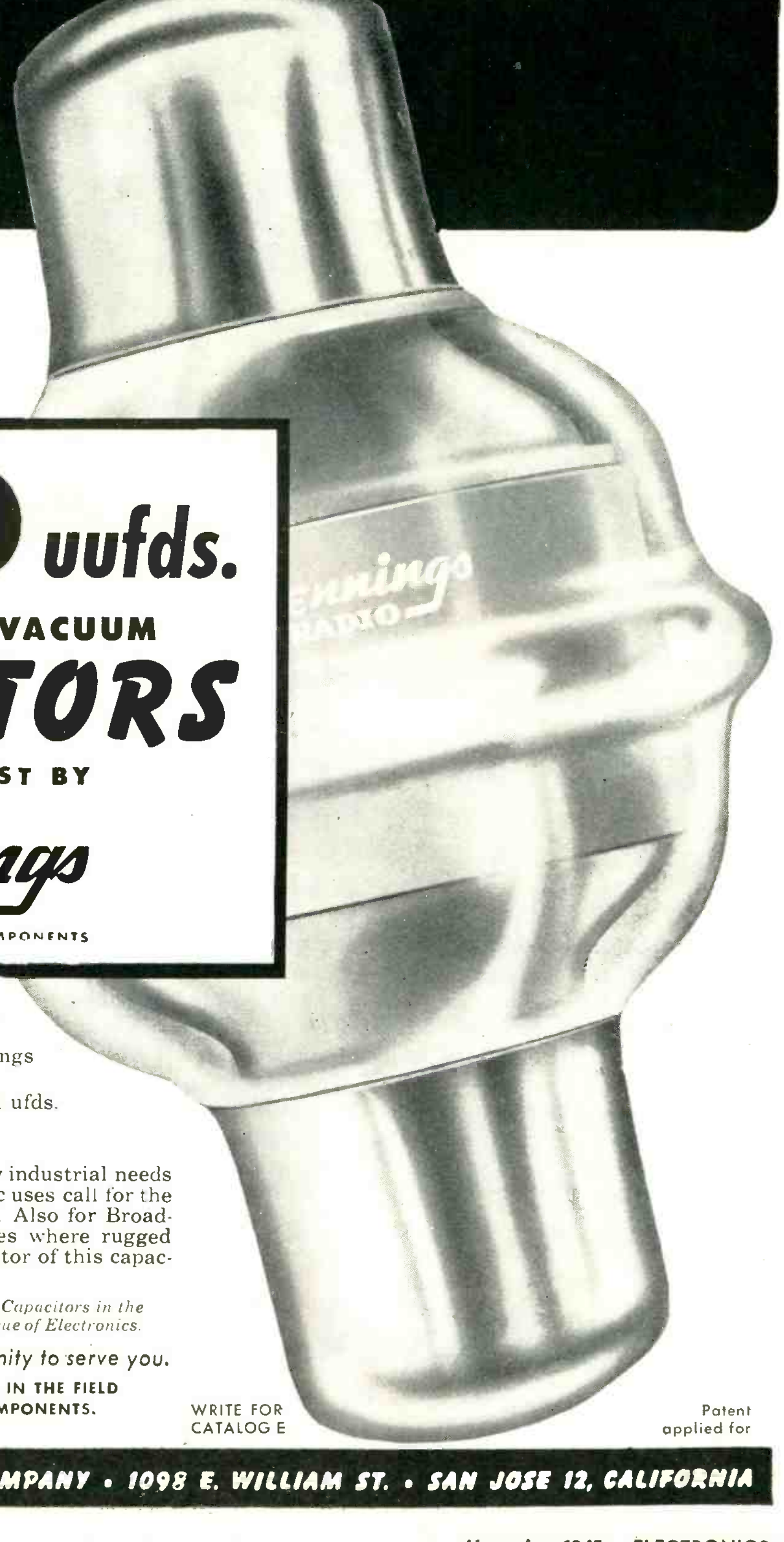
You will find in this handbook a final answer to the problem that confronts every manufacturer or user of electrically operated equipment.

Ask for Bulletin DCV-102

SOLA Constant Voltage Transformers

Transformers for: Constant Voltage • Cold Cathode Lighting • Mercury Lamps • Series Lighting • Fluorescent Lighting • X-Ray Equipment • Luminous Tube Signs Oil Burner Ignition • Radio • Power • Controls • Signal Systems • etc. **SOLA ELECTRIC COMPANY, 2525 Clybourn Avenue, Chicago 14, Illinois**

Revolutionary!



1000 uufds.

HIGH VOLTAGE VACUUM

CAPACITORS

ANOTHER FIRST BY

Jennings RADIO

VACUUM ELECTRONIC COMPONENTS

TENTATIVE CHARACTERISTICS

Peak Voltage, 10 KV (increased voltage ratings may be obtained upon request).

Peak Current, 100 amps. Capacity, .001 ufds.

Overall Length approximately 7⅞"

Maximum Diameter at center 4⅝"

This new Jennings unit is required for heavy industrial needs where induction heating and other electronic uses call for the unusual in capacities, size and performance. Also for Broadcast Studios and Experimental Laboratories where rugged mechanical construction in a vacuum capacitor of this capacity is essential.

See our complete listing of Jennings High Voltage Capacitors in the Electronic Buyers Guide bound in this November issue of Electronics.

We welcome your inquiry and the opportunity to serve you.

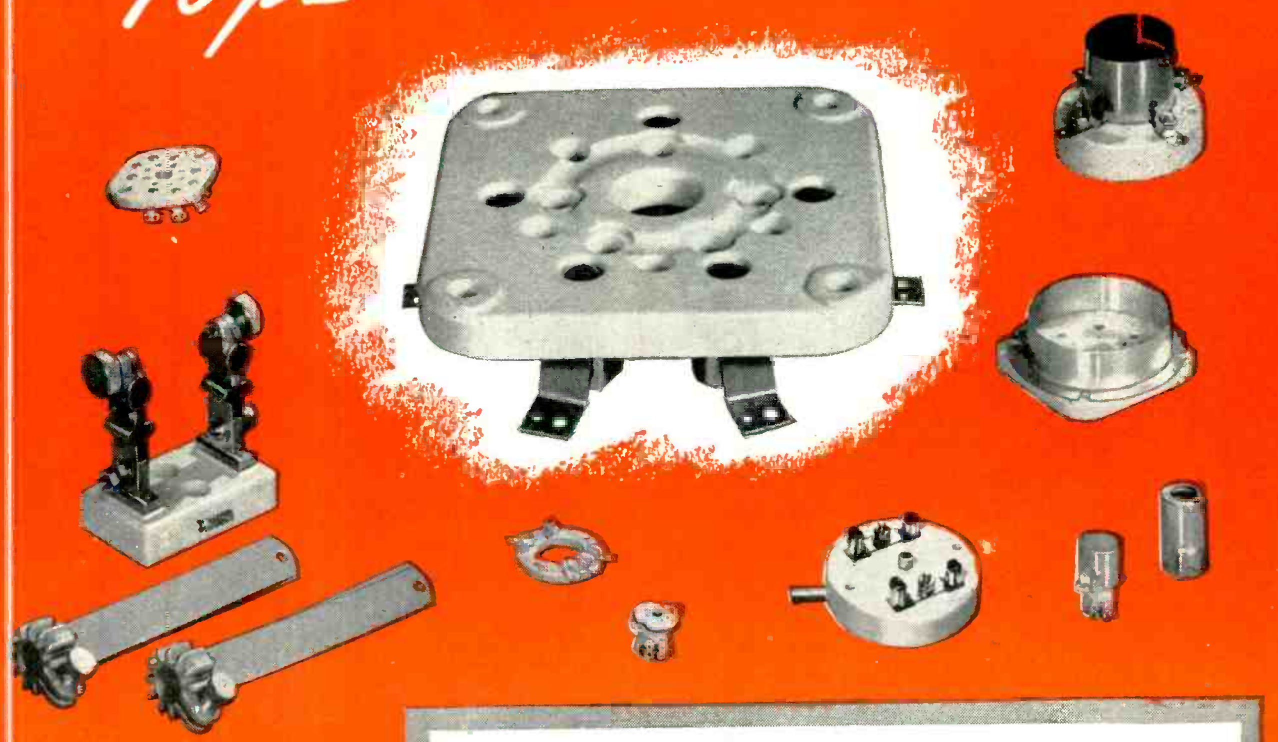
WATCH JENNINGS FOR NEW DEVELOPMENTS IN THE FIELD OF SPECIALIZED VACUUM ELECTRONIC COMPONENTS.

WRITE FOR CATALOG E

Patent applied for

JENNINGS RADIO MANUFACTURING COMPANY • 1098 E. WILLIAM ST. • SAN JOSE 12, CALIFORNIA

Tops in the Field



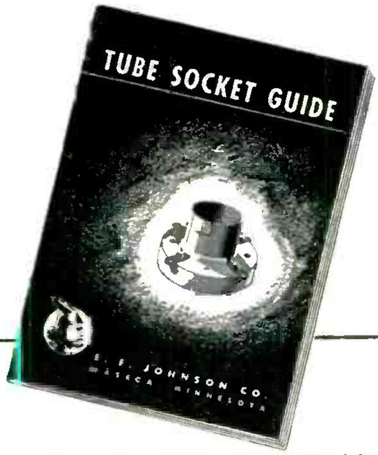
The latest addition to the famous line of Johnson tube sockets is the 275, Giant Five Pin socket with all the oustanding features which have made other Johnson sockets superior. A special feature of the 275 is the provision that has been made to allow forced ventilation from below the chassis, as required for the recently announced Eimac 4-125A and 4-250A. This socket may also be used for other Giant Five Base tubes when a wafer type socket is desired.

Johnson sockets are engineered to meet the most exacting requirements of industrial, commercial broadcast and "ham" applications. For more than 20 years Johnson engineers have designed, and Johnson production lines have produced, transmitting components known throughout the industry as tops in the field. With this background and the close association with tube manufacturers, Johnson is continually leading the way with tube sockets designed to meet the rigid requirements of present day electronic circuits and equipment.

If you have a special tube socket problem, write Johnson, today.

Write for

TUBE SOCKET GUIDE



Johnson sockets are stocked by leading radio-electronic parts jobbers.

JOHNSON

a famous name in Radio

E. F. JOHNSON COMPANY • WASECA • MINNESOTA in the tank. Liquid gasoline has a dielectric constant of about 2 whereas a mixture of gasoline vapor and air has a constant of about 1. This gives a capacitance variation of nearly twice for the difference between an empty and a full tank, a variation which is independent of fuel temperature.

Thermal Compensation

Temperature changes have a dual effect on gasoline. Thermal expansion is accompanied by a reduction in dielectric constant, which means that as a temperature increase causes the fuel to rise in the sensing tube, the resulting capacitance increase is opposed by the falling dielectric constant of the whole. See Fig. 2. Being based on capacitance, the indication of the gage, therefore, can be calibrated in gallons at 77 F or on a basis of weight which relates directly to engine power as volume does not.

For an example of the magnitude of error possible in a mechanical gage which can only measure volume, a plane taking off in India where ground temperatures run as

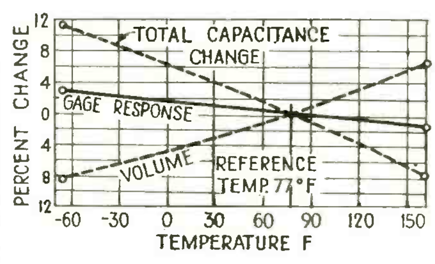
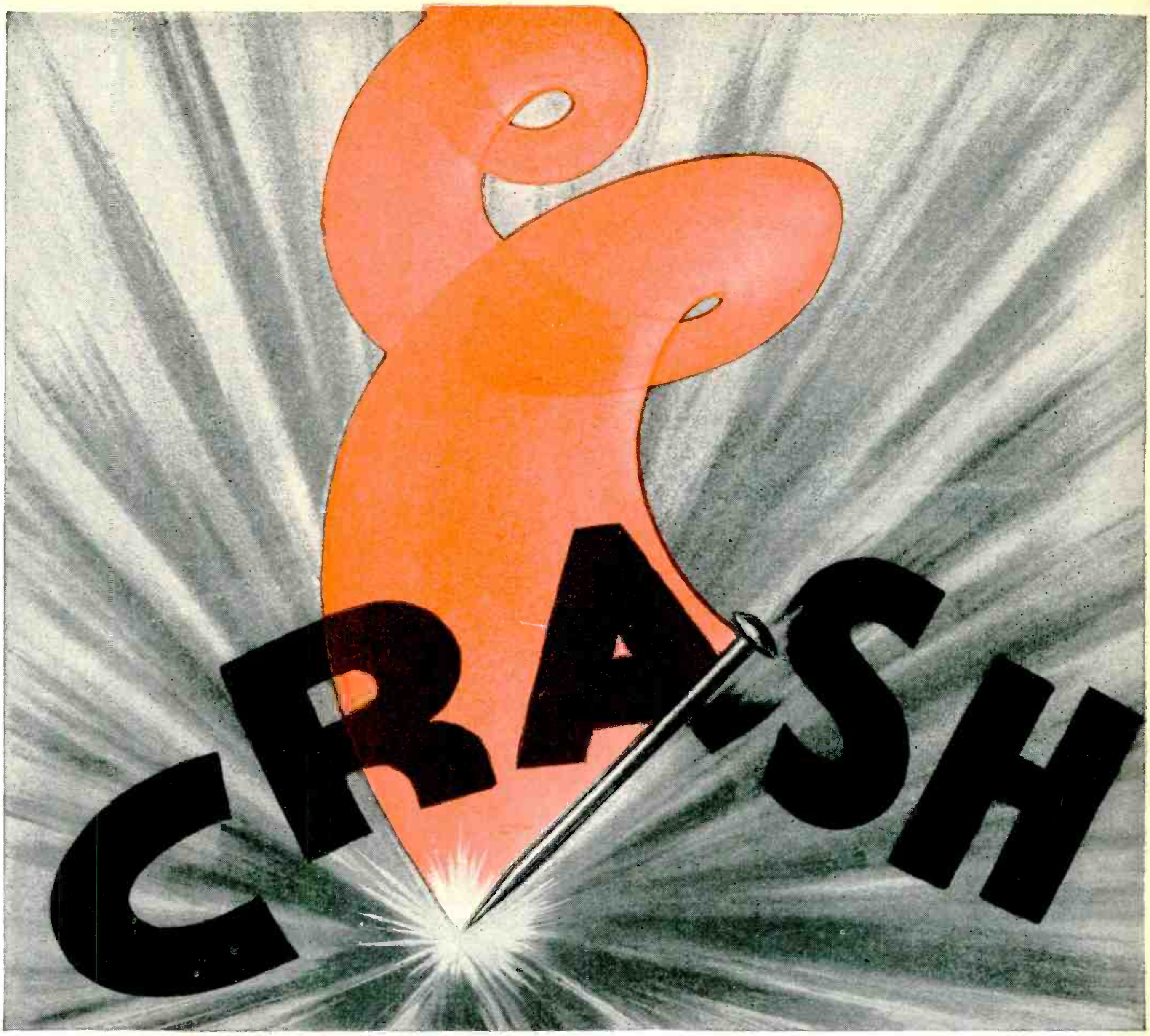


Fig. 2—Plot of temperature against percent change shows the opposition effect of volume and capacitance with resultant gage response

high as 140 F and climbing to 30,000 ft (minus 40 F) would lose fuel volume of 12 percent from shrinkage. Other factors such as play in linkages and sloshing of fuel, make it possible to gain as much as 15 percent in accuracy by capacitor-type sensing units.

In the bridge circuit of Fig. 1, the two arms consist of the capacitance of the tank unit and the fixed capacitor C_1 with unbalance voltage appearing across the transformer tap and point P. When the fuel level changes, unbalancing the bridge, this unbalance voltage signal is fed to a phase-sensitive amplifier which



THE IMPACT OF A FALLING PIN MAY BE LIKE A SLEDGEHAMMER BLOW

So delicately adjusted are many instruments—both mechanical and electronic—today, that better methods of reducing vibration have had to be found.

The "war of movement" with its highly complex weapons has emphasized this need for insulation against shock and vibration.

Electronic equipment in planes, tanks and fast surface craft; recording instruments of extreme precision; radio communications radar . . . all these have raised new problems of cushioning.

United States Rubber Company engineers have helped meet this challenge. Engineered rubber mountings of "U. S." design are lowering vibration to the "irreducible minimum"... providing practical protection for highly sensitive parts.

As in kindred fields, the experience, specialized technical skill and highly developed facilities of this 100-year old organization are in increasing demand by manufacturers of electronic equipment ... both for immediate and future needs.

Serving Through Science
with Engineered Rubber Mountings

UNITED STATES RUBBER COMPANY

1230 Sixth Avenue · Rockefeller Center · New York 20, N. Y.

Report on

NATVAR #400

a New Extruded Plastic Tubing

Excerpts from the E.T.L. report covering tests made on Natvar No. 400 in accordance with A.S.T.M. Standards.

DIELECTRIC STRENGTH — A.S.T.M. D350-43
Average volts per mil: At 28°C — 1090
At 85°C — 700
Wall thickness: .0235"

DIELECTRIC CONSTANT AND POWER FACTOR
Dielectric constant at 29°C and relative humidity 60%
At 60 cycles: 8.15
At 1 megacycle: 4.35
Power Factor: At 60 cycles: .056
At 1 megacycle: .064

ARC RESISTANCE — A.S.T.M. D495-42
Average — 135 seconds

OIL RESISTANCE — A.S.T.M. D295-43T
"Turbol 10" at 105°C was used. After 15 minutes immersion there was no apparent change in the tubing. After 24 and 48 hours there was no sign of change in the tubing. Three separate tests were made.

HEAT ENDURANCE — A.S.T.M. D350-43
After 7 days at 125°C the tubing did not crack or otherwise fail when bent 180° around a 5/16" mandrel.

TENSILE STRENGTH AND ELONGATION
At 200% elongation: Average 1980 lbs. per sq. in.
At Maximum: Average 2870 lbs. per sq. in.
Total elongation: 350%

LOW TEMPERATURE FLEXIBILITY
After 3 hrs. at minus 30°F specimens were bent around a mandrel 5/16" in diameter. There was no sign of cracking or other failure.

FLAME RESISTANCE — D350-43
Burned about 1/4 in. in 10 to 15 seconds and then went out. Three tests were made.

EFFECT OF CHEMICALS
Effect of 7 days immersion in solvents at room temperature; average of 3 tests in each solvent:

Solvent	Change in weight Per cent of weight of specimen as received	Change in dimensions Per cent of dimensions of specimen as received: Length	Outside diameter	Thickness
5 per cent sulfuric acid	+ 0.41	none	none	none
1 percent potassium hydroxide	+ 0.83	none	none	none
Petroleum	+ 6.62	+2.6	none	none
Ethyl Alcohol	+ 1.66	none	none	none
Benzol	+21.9	+6.6	+10.9	−24.0

WATER ABSORPTION
Average of 5 tests

Water absorption, per cent by weight of dry specimen	0.63
Soluble matter, per cent by weight of dry specimen	0.01
Total water absorption, per cent by weight of dry specimen	0.64
Change in dimensions: in length	none
in outside diametet	none
in thickness	none

This new tubing is now commercially available for war uses. For further information, write, wire or phone us.

THE NATIONAL VARNISHED PRODUCTS *Corporation*

TELEPHONE
RAHWAY 7-2171

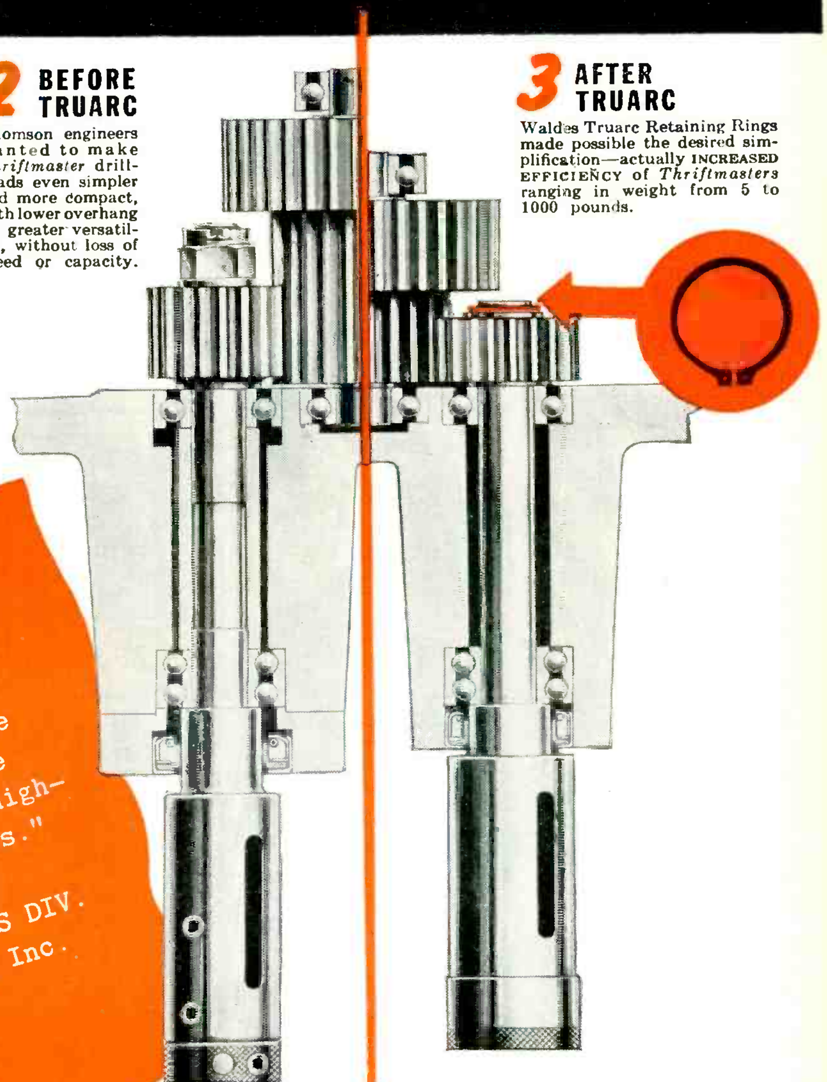
CABLE ADDRESS
NATVAR: RAHWAY, N. J.

201 RANDOLPH AVENUE ★ WOODBRIDGE NEW JERSEY

11-NVP-2

Another Proof that Waldes Truarc Retaining Rings hold moving parts together better!

1 Waldes Truarc Retaining Rings saved Thomson Industries *up to 10% in overall dimensions* on their well-known *Thriftmaster* multiple spindle drillheads.



2 BEFORE TRUARC

Thomson engineers wanted to make *Thriftmaster* drillheads even simpler and more compact, with lower overhang for greater versatility, without loss of speed or capacity.

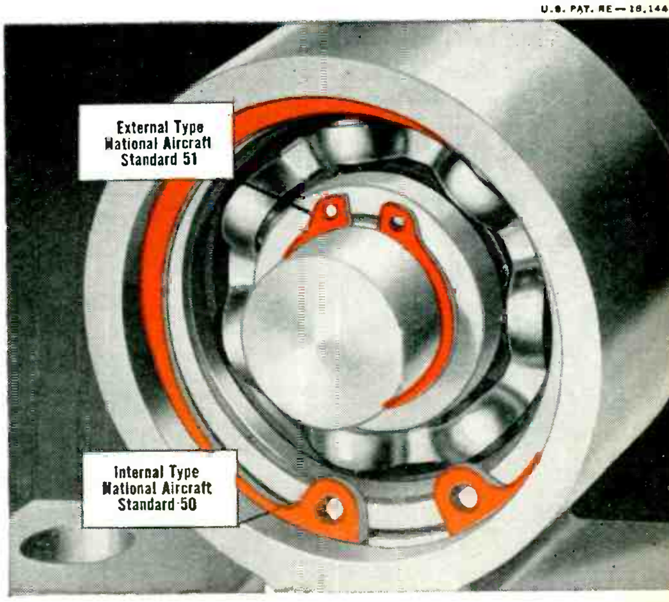
3 AFTER TRUARC

Waldes Truarc Retaining Rings made possible the desired simplification—actually INCREASED EFFICIENCY of *Thriftmasters* ranging in weight from 5 to 1000 pounds.

"Waldes Truarc Retaining Rings enabled us to make substantial time and labor savings in production of THRIFTMASTER drillheads...and made possible a much lighter, handier, more rugged tool, exceeding our highest performance requirements."

(Signed)
THRIFTMASTER PRODUCTS DIV.
Thomson Industries, Inc.

U.S. PAT. RE—18,144.



IN HOLDING and positioning machine parts, Waldes Truarc Retaining Rings offer distinct advantages over nuts, shoulders, collars and pins. They save cost by simplifying and speeding up production. They make assembly and disassembly much quicker, easier. They can be put on and taken off time and time again—and still retain the perfectly true circularity that gives them their never-failing grip. Test Waldes Truarc Retaining rings in your products and in the machines that make them. We'll furnish samples and complete data. Write Dept. H-11.

WALDES TRUARC TRADE MARK **RETAINING RING**

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

CANADIAN REPRESENTATIVES: PRENCO PROGRESS CORP., LTD., 72-74 STAFFORD STREET, TORONTO delivers power to one winding of a two-phase induction motor to drive the scale-calibrated potentiometer until the bridge is rebalanced. A discriminator stage in the amplifier determines the direction of rotation of the motor in accordance with phase relations. If the signal is in phase with the voltage on the transformer primary, the motor turns one way, if 180 degrees out of phase it turns the other way.

Maintenance

Also included are several calibrating and adjusting components. The "empty" calibrating potentiometer provides a means of balancing the bridge so the dial pointer is on zero when the tanks are empty. Similarly, the "full" calibration provides full-scale deflection with full tanks. Actual calibration is made at the time of installation with special calibrating devices which obviate the need for actual filling of the tanks.

A test button is located on the face of the indicating instrument as a means of determining whether the gage is operative. Consisting of a momentary contact switch, it unbalances the bridge, causing the motor to drive the pointer counterclockwise. When the button is released, the pointer should normally return to its original position.

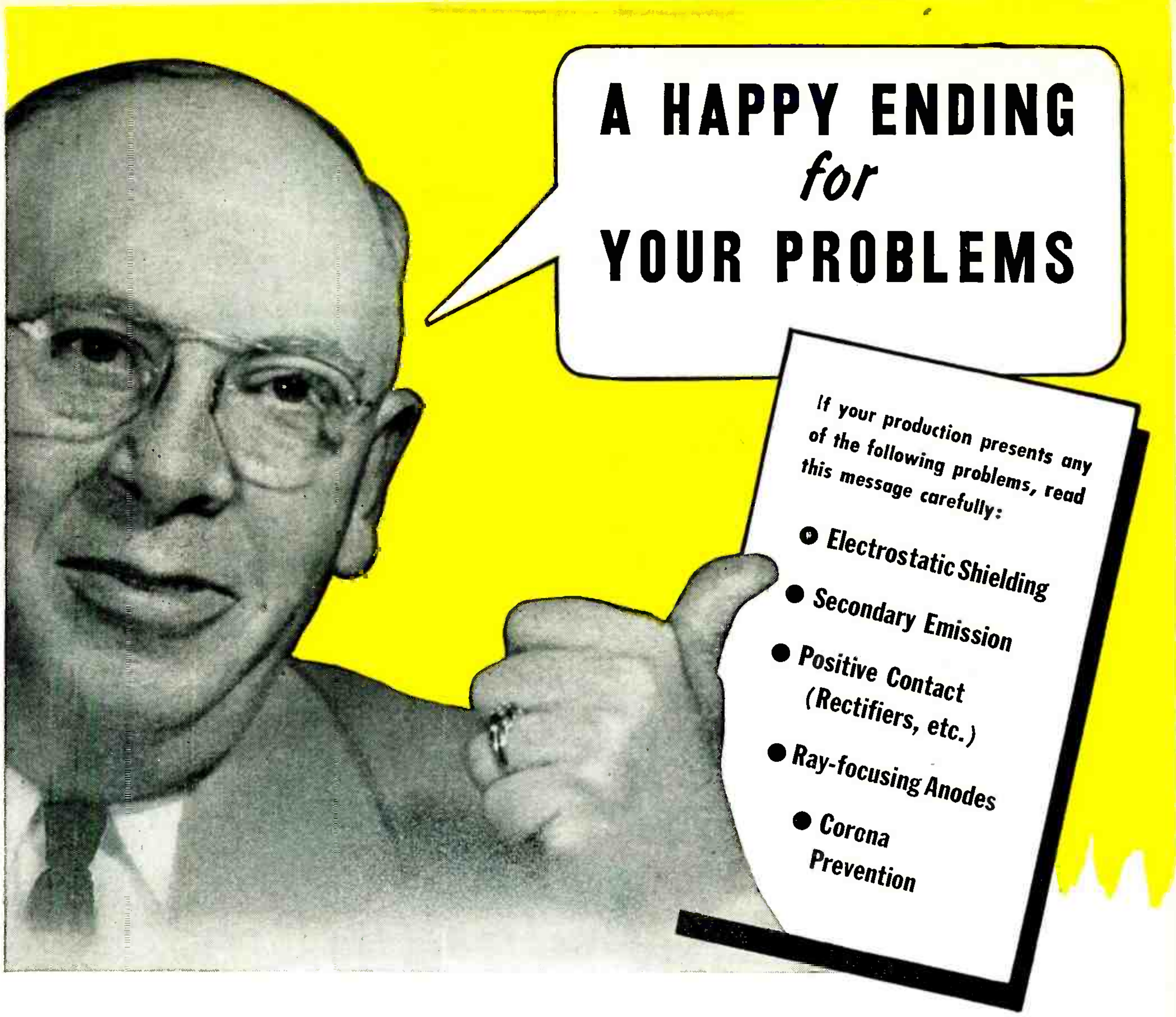
Various sizes of tanks are accommodated by a series of sensing elements of graduated lengths and the system is regarded as having active potentialities for application to industrial fuel telemetering in general.

• • •

Automatic Tuning of R-F Heating Generator

SMALL THYRATRONS and a reversible motor are the principle components of a unit devised at RCA in Camden and recently described by Wesley M. Roberds at a meeting of the Philadelphia section of IRE. These items serve in the automatic tuning of an electronic power generator to its load so that any predetermined power can be fed to the work continuously regardless of changes in the electrical characteristics of the material being processed.

Plate and grid currents of the os-



"Dag" Colloidal Graphite has made many a worried production executive smile because it solved his problem. But alert plant men don't look upon **"dag"** dispersions merely as trouble shooters. They use them all the time for regular production once they've discovered their versatility and what they can do.

Applications include high and low temperature lubrication, conductive films, parting compounds and surface coatings—and many others.

Let us show you how we can help you

These new bulletins on specific applications are jam-packed with information. They are free.

dag colloidal graphite

REG. U.S. PAT. OFF.

ACHESON COLLOIDS CORPORATION,
Port Huron, Michigan

This new literature on **"dag"** colloidal graphite is yours for the asking:

- **430** A general booklet on the story of **"dag"** colloidal graphite. 12 pages profusely illustrated.
- **440** A complete list of **"dag"** colloidal graphite dispersions with applications.
- **422** **"dag"** colloidal graphite as a PARTING COMPOUND.
- **423** **"dag"** colloidal graphite as a HIGH TEMPERATURE LUBRICANT.
- **431** **"dag"** colloidal graphite for IMPREGNATION AND SURFACE COATINGS.
- **432** **"dag"** colloidal graphite in the FIELD OF ELECTRONICS.

TO GET THESE . . . MAIL THIS

ACHESON COLLOIDS CORPORATION JMLCo.A-L1
PORT HURON, MICHIGAN DEPT. L-5

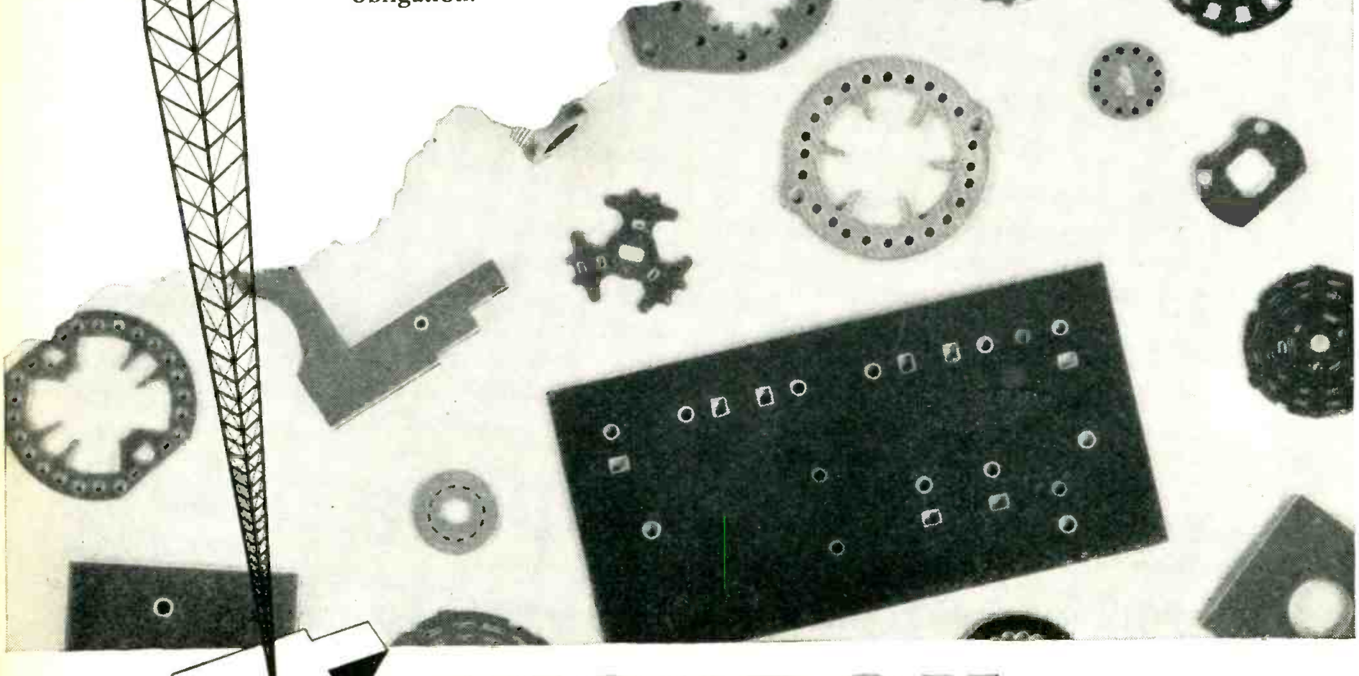
Please send me, without obligation, a copy of each of the bulletins checked:

No. 430 ☐ NAME ______
No. 440 ☐ POSITION ______
No. 422 ☐ ADDRESS ______
No. 423 ☐ ZONE No. ______ STATE ______
No. 431 ☐ OUR PRESENT OIL SUPPLIER IS ______
No. 432 ☐ (Lubricants containing **"dag"** colloidal graphite are available from major oil companies.)

T-725 an unequalled Phenolic Laminate ...AS FAR AS WE KNOW!

Superior insulation resistance, low moisture absorption and good hot punching qualities—that's INSUROK T-725—a plastic that's really worth shouting about! For parts made of INSUROK T-725 can be "sanded down" to meet very close thickness and surface parallelism requirements—yet retaining their superior insulation resistance, punching and low moisture absorption qualities, which are *unequalled by any other phenolic laminated material we know about.*

INSUROK T-725 is an improvement on T-640 and therefore has uniformly superior electrical values and mechanical characteristics. Altogether, we think it adds up to important news for those working with electronics applications. Richardson Plasticians are waiting to give you the full story. Write today—there's no obligation.



INSUROK *Precision Plastics*

The RICHARDSON COMPANY

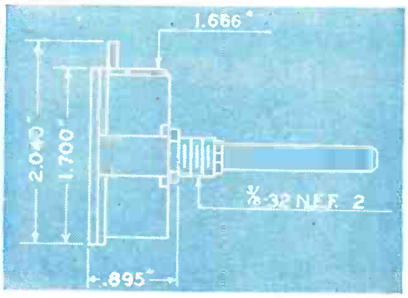
LOCKLAND, CINCINNATI 15, OHIO FOUNDED 1858 *Sales Headquarters:* MELROSE PARK, ILL.

Sales Offices NEW YORK: 75 WEST STREET, NEW YORK 6, NEW YORK
CLEVELAND: 326-7 PLYMOUTH BLDG., CLEVELAND 15, OHIO
DETROIT: 6-252 G. M. BUILDING, DETROIT 2, MICHIGAN

Factories MELROSE PARK, ILLINOIS
NEW BRUNSWICK, NEW JERSEY
INDIANAPOLIS 1, INDIANA

TREFZ

DEPENDABLE WIRE-WOUND PRODUCTS



MODEL PWW-5: A ruggedly built precision unit designed to meet Navy Spec. RE-13A-492C and Spec. JAN-R-19. Rated at 8 watts this model incorporates features which demonstrate "there is none finer." Dual units are also available (Model DPWW-5).

MODEL PWW-4: Rated at 4 watts. A competitively priced counterpart of the PWW-5 yet retaining many of the outstanding features. Its black phenolic case distinguishes it from the PWW-5. Unique one piece contact arm assembly adds stability and life to this new Potentiometer. Dual units can be furnished (Model DPWW-4).

All models can be furnished in a range 1 ohm to 150,000 ohms. Duals require 1.780" of space behind mtg. surface. Other space requirements shown above. Switches and tapered windings can be supplied.

Wartime quality wire-wound power Resistors now available in peacetime quantity to meet your immediate needs. Units ranging from 5 to 200 watts can be furnished to your specifications in either fixed or semi-variable versions.

"Hitempcote" serves as an ideal protecting cover and because of its special inorganic structure, Trefz Resistors can absorb sudden and severe overloads for a prolonged time without damage to the coating. All winding terminations are soldered to the tabs and the best of materials are used throughout.

Extreme care is used in all steps of the manufacturing cycle to avoid the possible entrance of extraneous matter which might later cause electrolytic action and final failure of the Resistor.

EXCLUSIVE SALES AGENTS

AEA

Amalgamated Electronics

ASSOCIATED

60 EAST 42nd STREET : : VAnderbilt 6-3506 : : NEW YORK 17, N. Y.

cillator tube are used in opposite arms of a bridge while small thyratrons are actuated to keep the bridge balanced by rotation of the reversible motor which also varies an inductance in series with the load. The load is closely coupled to the tank circuit with all tuning done on one slope of the first hump of the resonance curves. The load circuit is never completely tuned but always presents a capacitive reactance to the tank circuit.

• • •

Electrostatic Paint Spraying and Detearing

ELECTRONIC GEAR SERVES in the power-supply section of equipment being used in the electrodepositing of sprayed paint to achieve very uniform coatings and to reduce the waste of material from that common in ordinary spraying techniques. The same equipment can be used to detear fatty edges on pieces painted by the dip process.

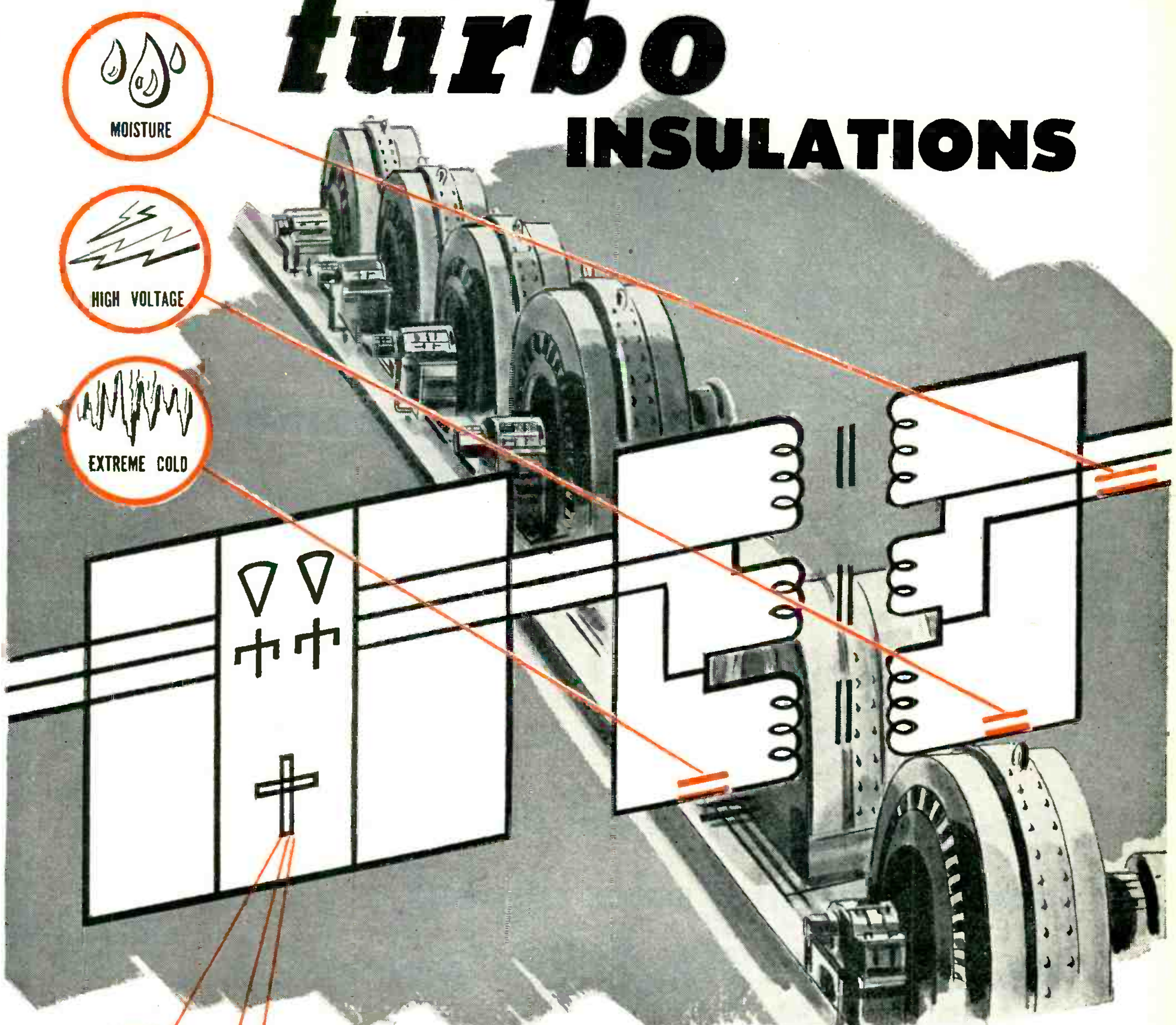
In the process, an electric field is set up around the article to be coated, the article itself being at ground potential. The field is established through a series of electrodes consisting of fine wires whose surface area is small relative to that of the piece of work.

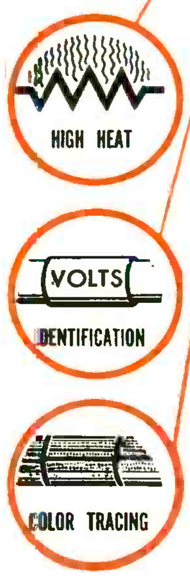
These electrodes are fed rectified a-c in the form of pulsating d-c at voltages in the order of 100,000. The current does not exceed 10 ma. In any individual case it is necessary to balance the pressures and orifices of the spray equipment against such other factors as electrode spacing and conveyor speed to gain the greatest efficiency. Specifically, the objective is to correlate the inertia of the paint particle with the intensity of the electric field through which it is moving.

Technique

For a particular setup using 100 kv, the developer of the process—Harper J. Ransburg Co. of Indianapolis, follows a rule-of-thumb formula involving No. 30 copper wires suspended vertically and spaced ten to twelve inches from each other and with the entire electrode structure eleven inches from the article. Standard spray guns

turbo INSULATIONS





TURBO insulating sleevings assure dependable functioning under adverse operating conditions. Equally important, they have the "designed in" ability to cut installation costs and reduce maintenance time. The latter factors result from three distinct characteristics. One: A full range of vivid colors that speed tracing. Two: Extra flexibility and smooth-bore for easy snaking and fishing. Three: Non-fray, non-abraiding features that simplify installation and lengthen service life.

FLEXIBLE VARNISHED OIL TUBING: offers immunity to corrosive fumes, acid, alkalis and most solvents. It is impervious to moisture and non-hygroscopic.

VARNISHED GLASS TUBING: capable of functioning in high ambient temperatures—enclosed motors, unventilated areas, and general heavy duty installations.

EXTRUDED TUBINGS: smooth wall, withstand extreme low temperature without embrittlement. Provide dependable insulation in sub-zero cold. Retains flexibility at all times.

WIRE IDENTIFICATION MARKERS: two types—sleeve type that slips directly over pipes, tubes, conductors; and tab type with flexible flag attached to sleeve. Both available in any marking.

Write today for free Specimen Board with samples and sizes of each.

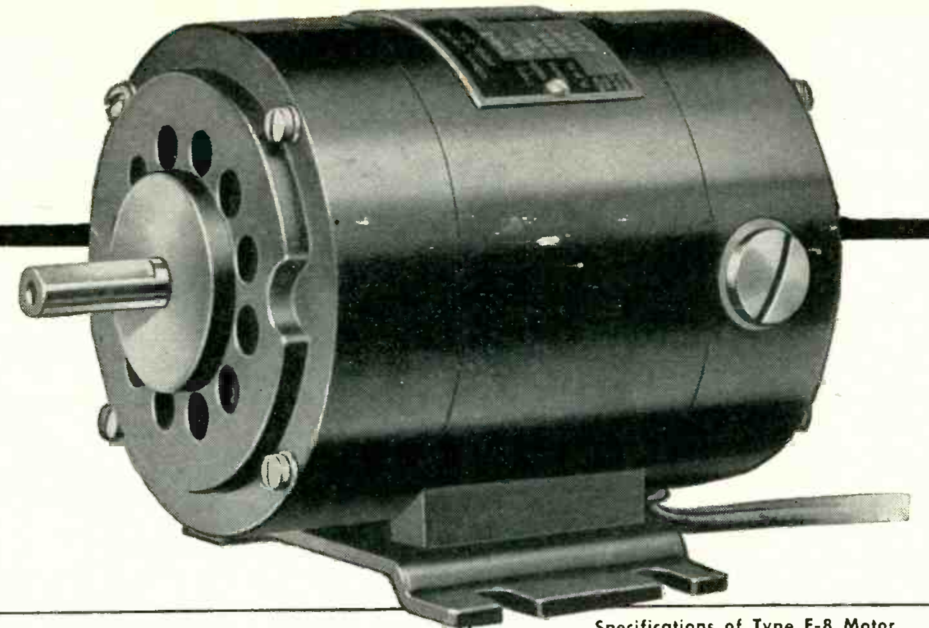
TURBO

IF IT'S TURBO IT SAFE-GUARDS

WILLIAM BRAND & CO.

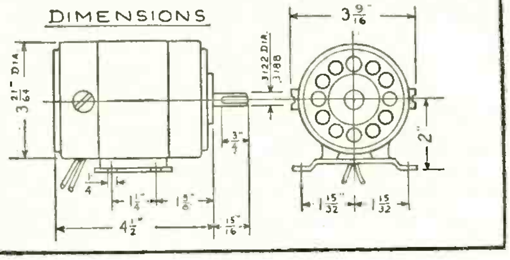
276 Fourth Ave., New York 10, N. Y. • 325 W. Huron St., Chicago 10, Ill.

OIL TUBING • PAPER AND TAPE SATURATED SLEEVING • VARNISHED CAMBRIC • MICA AND MICA PRODUCTS



115 VOLT CONTINUOUS DUTY IN 25° C. AMBIENT					
Maximum H.P.	1/12	1/16	1/25	1/35	1/50
R.P.M.	7500	5800	3800	2800	1750
Amps Input	.8	.67	.46	.38	.32
Starting Torque in % of F. L. Torque	200 min.	200 min.	200 min.	200 min.	200 min.

Specifications of Type E-8 Motor



Your new product will perform *better* and have *additional* sales appeal . . . with a dependable Oster motor

MADE IN U. S. A.

A modern, scientifically engineered motor, such as any one of many different sizes and styles made by Oster, is of prime importance in making your product perform satisfactorily.

The model E-8 Oster Motor illustrated above gives you the advantages of light weight, compactness, and dependable, trouble-free performance. Here are the details:

HOUSING — Die cast, open or totally enclosed.

FINISH — Black, baked enamel.

BEARINGS — Single or shielded ball bearings, or sleeve bearings.

BRUSHES — Furnished with metal graphite or electro graphite brushes of ample size to assure unusually long brush life. Phosphor bronze or beryllium copper brush springs.

WINDINGS — Available for operation on 12, 24 or 115 volts, in shunt, series, and split series types.

MOUNTINGS — Available for either base or flange mounting.

MODIFICATIONS — Motors can be furnished with special shaft extensions, finishes, leads, etc. Motors can also be furnished for operation in high ambient temperatures and high altitudes.

All ratings and data are approximate.

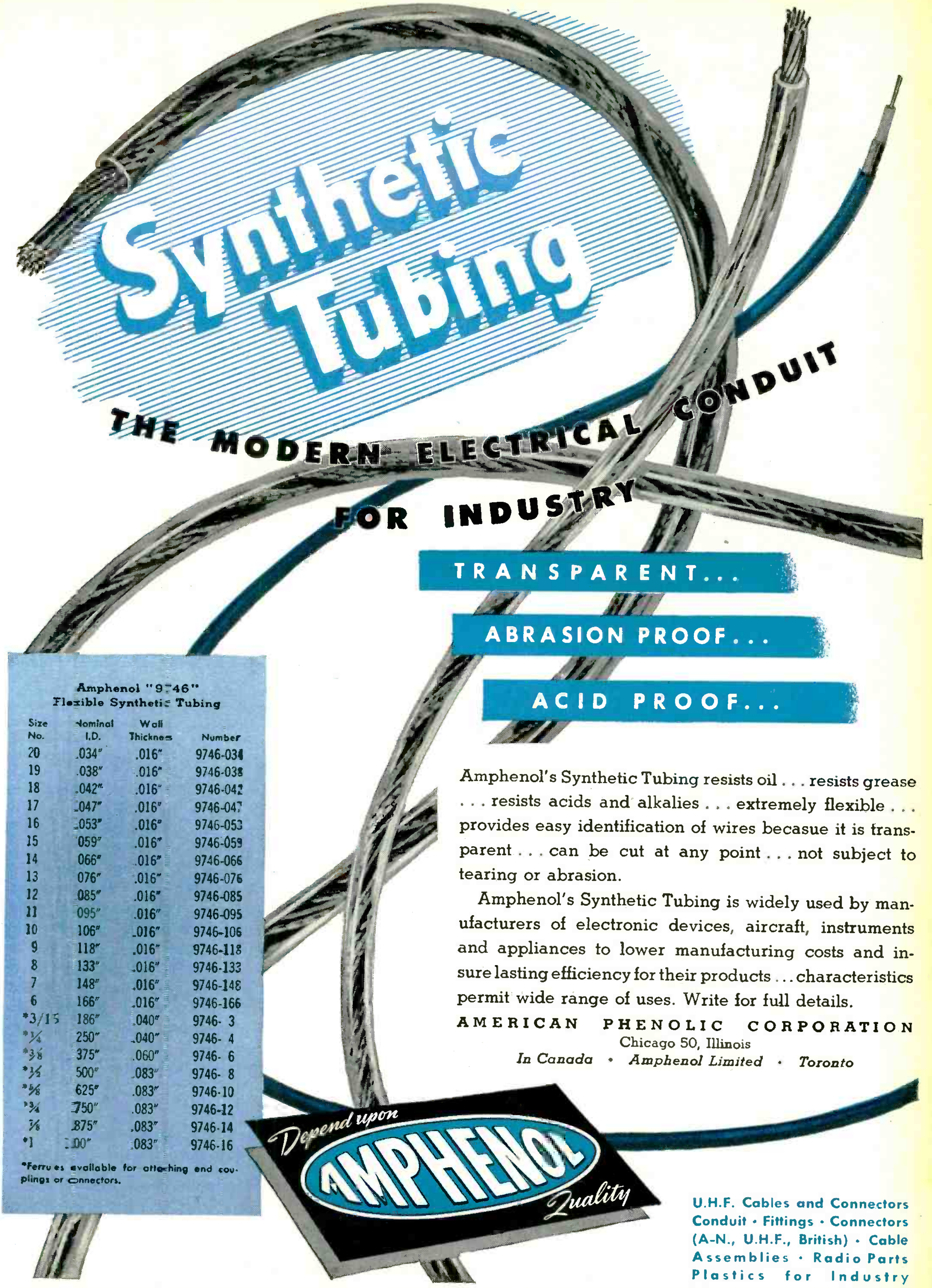
Let us help you fit this and other famous Oster Motors to your requirements.

Oster FRACTIONAL H.P. ELECTRIC MOTORS

John Oster Manufacturing Co.

DEPARTMENT L-29 • RACINE, WISCONSIN

M-29



Synthetic Tubing

THE MODERN ELECTRICAL CONDUIT FOR INDUSTRY

TRANSPARENT...

ABRASION PROOF...

ACID PROOF...

Amphenol "9746"
Flexible Synthetic Tubing

Size No.	Nominal I.D.	Wall Thickness	Number
20	.034"	.016"	9746-034
19	.038"	.016"	9746-038
18	.042"	.016"	9746-042
17	.047"	.016"	9746-047
16	.053"	.016"	9746-053
15	.059"	.016"	9746-059
14	.066"	.016"	9746-066
13	.076"	.016"	9746-076
12	.085"	.016"	9746-085
11	.095"	.016"	9746-095
10	.106"	.016"	9746-106
9	.118"	.016"	9746-118
8	.133"	.016"	9746-133
7	.148"	.016"	9746-148
6	.166"	.016"	9746-166
*3/16	.186"	.040"	9746- 3
*1/4	.250"	.040"	9746- 4
*3/8	.375"	.060"	9746- 6
*1/2	.500"	.083"	9746- 8
*5/8	.625"	.083"	9746-10
*3/4	.750"	.083"	9746-12
7/8	.875"	.083"	9746-14
*1	1.00"	.083"	9746-16

*Ferrules available for attaching end couplings or connectors.

Amphenol's Synthetic Tubing resists oil . . . resists grease . . . resists acids and alkalies . . . extremely flexible . . . provides easy identification of wires becasue it is transparent . . . can be cut at any point . . . not subject to tearing or abrasion.

Amphenol's Synthetic Tubing is widely used by manufacturers of electronic devices, aircraft, instruments and appliances to lower manufacturing costs and insure lasting efficiency for their products . . . characteristics permit wide range of uses. Write for full details.

AMERICAN PHENOLIC CORPORATION
Chicago 50, Illinois
In Canada • Amphenol Limited • Toronto

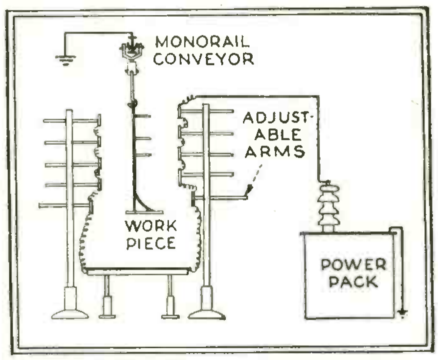
Depend upon **AMPHENOL** *Quality*

U.H.F. Cables and Connectors
Conduit • Fittings • Connectors
(A-N., U.H.F., British) • Cable
Assemblies • Radio Parts
Plastics for Industry

are used with atomizing pressure of about 10 psi and fluid pressure of one psi. They can be phototube controlled if desired.

Objects being coated do not necessarily have to be made of electrically conductive material, both wood and pottery parts having been satisfactorily handled. As an example of uniformity of coverage, it is possible to coat all sides of a part without turning it toward the source of the spray, the particles of paint which pass around the sides of the object turning in flight like homing pigeons and striking the rear.

For use as a tear-removing unit, the electrode structure is replaced



For production of electrostatic field in paint-spraying operation, an adjustable arrangement like this accommodates various sizes of articles. For detearing, the polarity of the field is reversed

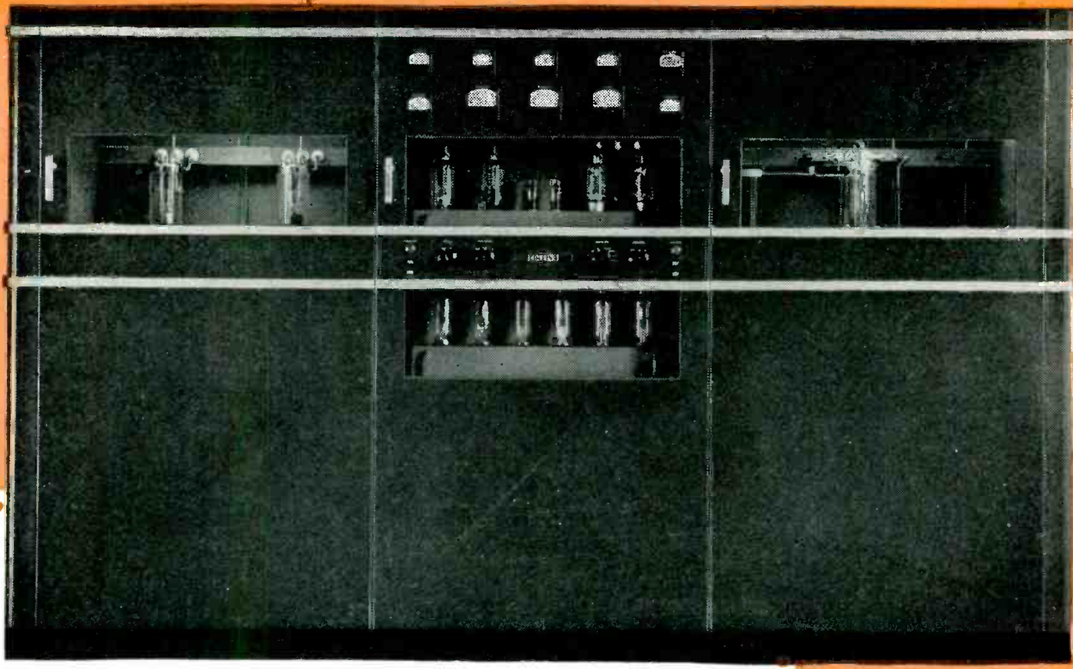
with a heavy grid and the dipped parts are stripped of surplus paint by reversal of polarity. This makes it possible for the paint chemist to formulate his finishes without regard to fatty edges and tears and thus use a wider selection of materials. Spark and consequent fire hazard in the use of the gear in explosive paint atmospheres is so small in a proper installation that AFMIC (American Factory Mutual Insurance Co.) investigators pronounce it to offer no serious problem in that regard.

• • •

Brazing Operations in Transmitter Tube Assembly

ANODE BRAZING and soldering operations in transmitter-tube manufacturing are doubly critical because hidden flaws in brazed or soldered joints can be the cause of

The New Collins 21A, 5 kw Broadcast Transmitter



Fulfilling the Tradition of Collins Quality Leadership

The 21A is a thoroughly developed 5 kw AM broadcast transmitter, and an excellent example of characteristically superior Collins engineering and construction.

Based on sound, well-proved principles of design, the 21A has been completely modernized within recent months. New components of improved design, with longer life and higher safety factors than were previously available, assure reliable continuous operation.

The response curve is flat, within ± ½ db. from 30 to 10,000 cycles. Reduced power to 1 kw is obtained by instantaneous lowering of plate voltages, permitting uninterrupted program transmission.

We will be glad to send you detailed information regarding the 21A, other Collins transmitters, the 12Y remote amplifier, the 12Z four channel remote amplifier and Collins high quality studio equipment. Collins Radio Company, Cedar Rapids, Iowa; 11 West 42nd Street, New York 18, N. Y.

The Collins 12Y Remote Amplifier

A one channel remote amplifier for unattended operation from a 115 volt a.c. power source, the 12Y provides the advantages of quick set-up, small size, light weight, high fidelity, simple operation, utmost reliability and low cost. It is practically hum free due to the removal of the isolation transformer, which is in the power cable.

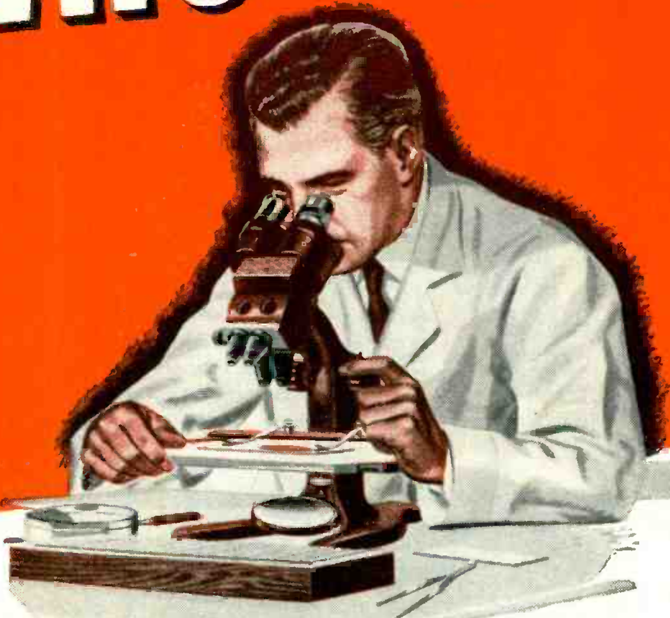
FOR BROADCAST QUALITY, IT'S... COLLINS

COLLINS EQUIPMENT IS SOLD IN CANADA BY COLLINS-FISHER, LTD., MONTREAL.

BUY MORE BONDS

AUTO-LITE

Electrical Wire AND Cable



The Proof of Sound Engineering

Many years of experience in meeting the need of the users of wire in many industries, laboratory research and a continuing effort to develop the finest manufacturing methods and devices—this has made Auto-Lite the quality line of wire and cable. There is a full range of sizes, shapes and materials for every wiring need.

Should new designs present unusual problems for wire in your product, take advantage of this Auto-Lite engineering experience. Just write to

THE ELECTRIC AUTO-LITE COMPANY

Wire and Cable Division

PORT HURON, MICH. SARNIA, ONT.

TUNE IN THE AUTO-LITE RADIO SHOW STARRING DICK HAYMES — SATURDAYS 8:00 P. M. ON C. B. S.

heartbreaking anode failure during final tube performance tests. Whenever anode failure occurs in final test, hundreds of machine-hours and scores of man-hours (invested in intricate glass working and tube assembly) are forfeited at the last minute.

At the Radio Tube Division of Federal Telephone and Radio Corp., Clifton, N. J., both rejections and time have been saved by ingenious adaptations of gas-air combustion in replacement of conventional oxy-gas techniques at two vital points of manufacture. First, open rings of special ceramic-cell gas burners have been adapted to silver-braze the heavy copper collar on the flared anodes. Second, an unusual gas-fired furnace serves to keep both the finned-radiator-assembly and the anode of the finished tube uniformly at proper temperature for

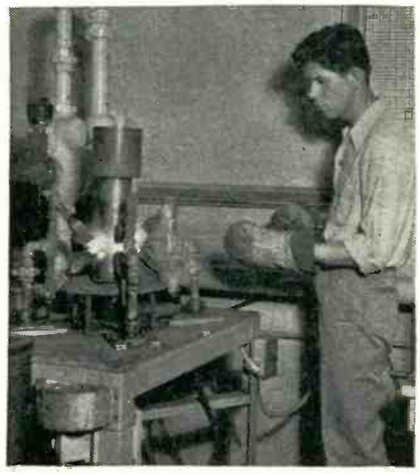


FIG. 1—Flared copper anodes of high-power transmitting tubes are joined to a seating ring by flowing silver alloy wire into the joint

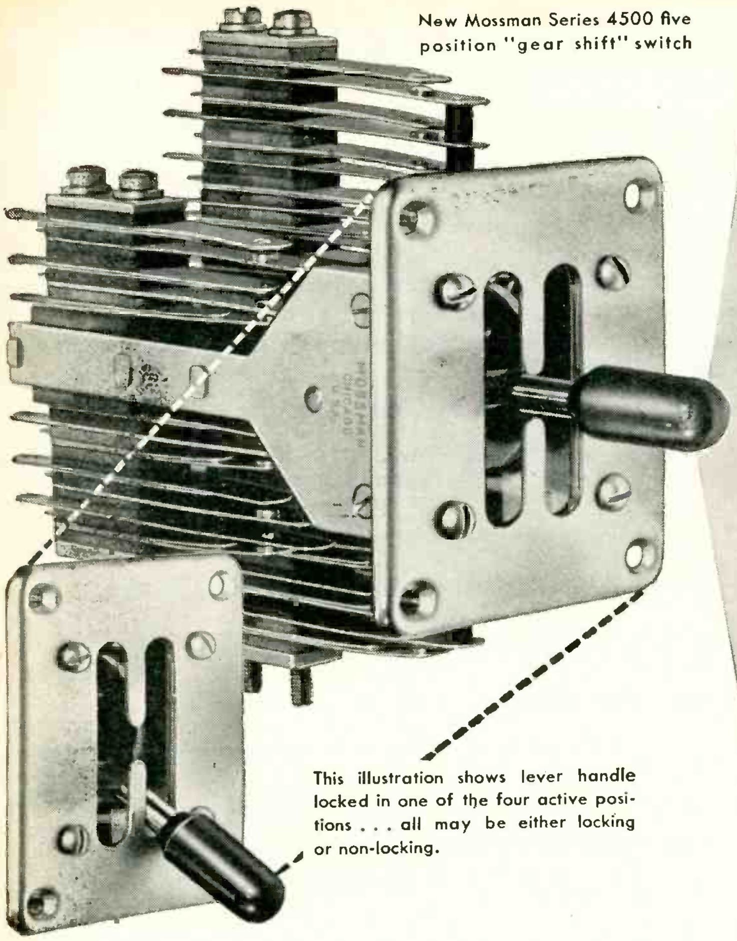
long periods while cadmium or other solder is being puddled and flowed for perfect bonding of the two elements into one assembly.

Should an air pocket develop, undetected, in either joint, a localized concentration of heat in that vicinity during final tube test will cause the tube to fail.

Anode Collar Brazing Technique

In Fig. 1 is illustrated the method of joining the seating ring to the flared copper anode by flowing silver alloy wire into the joint during rotation at a temperature of 1200 F. The flared anode is set on a splined

New Mossman Series 4500 five position "gear shift" switch



This illustration shows lever handle locked in one of the four active positions . . . all may be either locking or non-locking.

This MOSSMAN "Gear Shift Switch" Adds Choice of Five Positions to Unusual Circuit Flexibility . . .

A five position heavy duty lever switch . . . the new Mossman Series 4500 . . . has been developed to meet new and unusual requirements for precision switching.

This Series 4500 Switch is built of the same high grade materials specified by the U. S. Navy. A rigidly braced, heavy brass frame supports a chromium plated latch plate and spring-actuated piston, in which a roller is mounted clevis fashion. Axles, stop pins and piston are stainless steel. Plated phosphor bronze springs have spun-in heavy duty silver contacts.

Contact ratings are: Standard Heavy Duty—3/16" diameter, fine silver, 10 amperes; Extra Heavy Duty—5/16" diameter silver alloy, 20 amperes; both 110 volts A.C. (non-inductive).

The Series 4500 Switch provides the same unusual flexibility of circuit arrangements which have enabled Mossman Switches to meet exacting demands of circuit control. It has four independent contact spring pile-ups, each of which is actuated either locking or non-locking. Contact assemblies are built up from standard forms. They may be "make", "break", "break-make", or single pole double throw open neutral.

In all positions except the center or neutral position, the action may be locking or non-locking. The switch always locks in the center position. A special feature is that the Series 4500 Switch is not provided with fixed stops. Action of the different positions may be changed by inserting or removing stop plates beneath the escutcheon. A special safety latching feature is also available.

This new switch is typical of Mossman engineering to meet new and unusual requirements with the best in precision switching components. Where desired, Mossman Switches may be supplied with special housings, wiring and other features to meet your requirements.

Mossman engineers are located in principal cities to cooperate with you on special switching problems. Write us for the name of your nearest Mossman representative.

Applications for MOSSMAN Series 4500

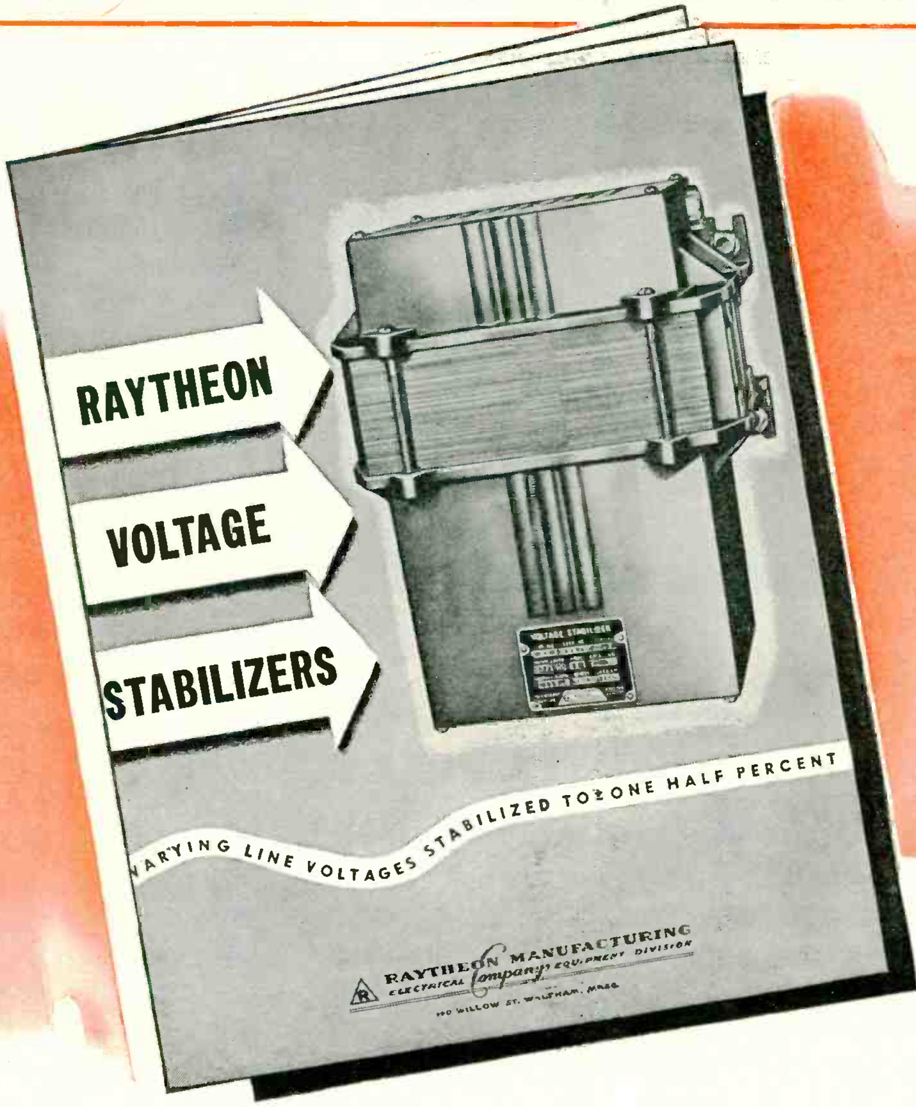
- Safety selective switching
- Emergency transfer of spare equipment
- Equalization of multi-generator operation
- Hoist control
- Crane control
- Motor starting, stopping, reversing

DONALD P. MOSSMAN, Inc., 612 North Michigan Avenue, Chicago 11, Illinois

MOSSMAN

"Electrical "Components

HERE'S THE FULL STORY



SEND FOR IT TODAY...

IN A DETAILED, 8-page bulletin now available, Raytheon Manufacturing Company tells the complete story about the dependable Raytheon Voltage Stabilizers. These trouble-free magnetic-type units . . . with no moving parts to get out of order . . . stabilize AC from ordinary voltage sources to within plus or minus a half percent, throughout their full rating.

The bulletin includes such useful information as electronic applications, performance features, principles of operation, operating characteristics, graphs, specifications of the three immediately available designs, cased, uncased, and endbell, and a price list.

We urge you to send for your copy promptly. Ask for Bulletin DL48-537, and address your request to Raytheon Manufacturing Company, Electrical Equipment Division, Waltham 54, Mass.

RAYTHEON
MANUFACTURING COMPANY
WALTHAM 54, MASS.

ELECTRICAL EQUIPMENT DIVISION

Excellence in Electronics

conical spindle which rotates at 15 rpm and is constantly fed with compressed air. The air escapes between the splined conical surface of the spindle and the inside of the anode-flare, thereby cooling the thin section of the flare and localizing the heat from the gas burners solely at the joint.

Each of the eight ceramic-lined burners (which are stationary around the rotating assembly) is constructed as shown in Fig. 2. A carefully regulated mixture of gas and air is supplied under pressure to each burner, and burns from the

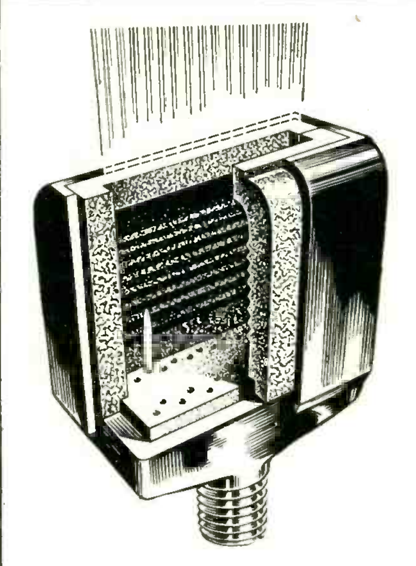


FIG. 2—Construction of a ceramic-lined burner used for heating the joint. In operation, many tiny flames issue from the ports to produce undiluted heat at the slot at top

many tiny ports in the ceramic plate deep in the interior of the ceramic cell. Thus combustion is totally confined, and the cell interior rises to white-hot temperatures. This complete surrounding of the burning gas and air with incandescent refractory surfaces tends to accelerate the combustion reaction. Consequently, only hot combustion products (undiluted by cold surrounding air) issue from the outlet slot of the burner and impinge upon the work. No flame, as such, touches anode, collar or brazing alloy.

The burners are so positioned that they fire into the joint at an angle of 45 degrees, both above and below the collar. Because of their

WESTINGHOUSE ANNOUNCES

INCREASED RATINGS

FOR THE POWERFUL

WL 473

RF POWER AMPLIFIER, CLASS C

Key down conditions per tube without amplitude modulation

Typical Operating Conditions—110 mc. Max.

Plate Volts, D. C.	3500
Plate Current, D. C. Amps.	1.0
Grid Volts, D. C. fixed or	−300
Grid Resistor, Ohms	1950
Grid Volts, Peak RF	555
Grid Current, D. C. Ma.	155
Driving Power, Watts	85
Power Output, Watts	2550

Exhaustive tests made by Westinghouse electronic tube engineers with the WL 473 have resulted in new and higher ratings that broaden its field of usefulness in the FM broadcast and induction heating fields.

The frequency rating has been increased to 110 mc for RF power amplifier service in FM broadcasting. The DC plate voltage has been increased to 5000 volts for RF power oscillator and amplifier service below 60 mc in RF heating, with a resulting increase of 20% in power output.

Write for additional data to your nearest Westinghouse office or Electronic Tube Sales Department. Westinghouse Electric Corporation, Bloomfield, N. J.

RF POWER OSCILLATOR, CLASS C

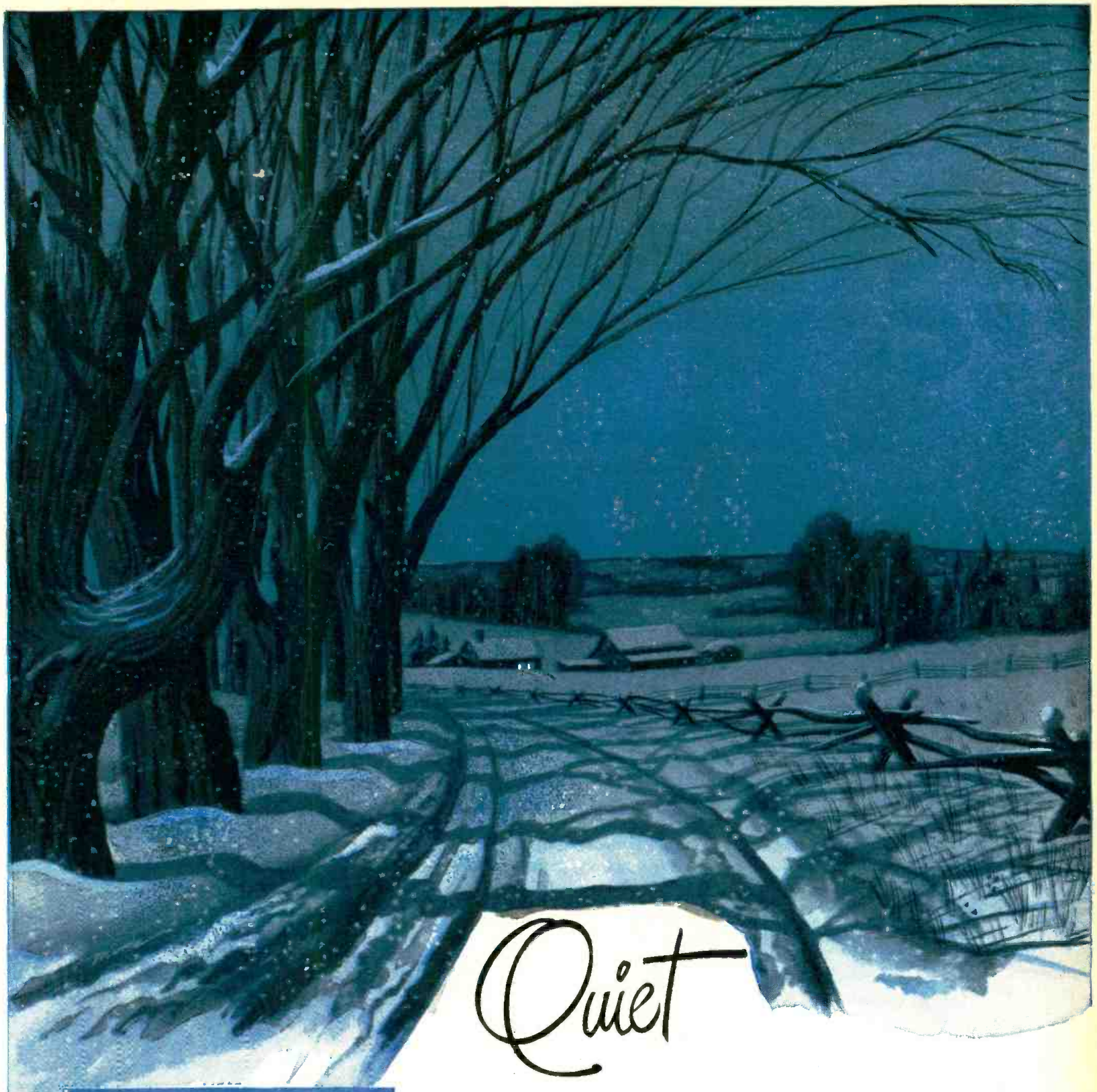
Key down conditions per tube without amplitude modulation

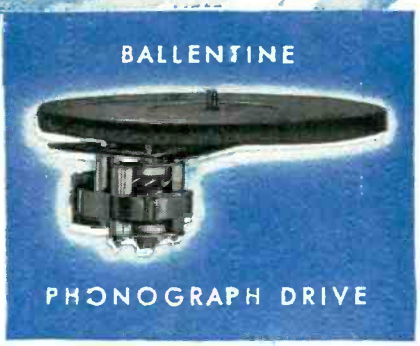
Typical Operating Conditions—60 mc. Max.

Plate Volts, D. C.	5000
Plate Current, D. C. Amps.	1.0
Grid Volts, D. C.	−850
Grid Resistor, Ohms	4000
Grid Volts, Peak RF	1200
Grid Current, D. C. Ma.	210
Power Output, Watts	3900

TUNE IN: John Charles Thomas, Sunday, 2:30 P. M., EST—NBC
Ted Malone—Mon. through Fri., 11:45 A. M., EST—ABC

Westinghouse *Electronic Tubes at Work*





The Ballentine Phonograph Drive is designed for just one purpose—to provide a reliable mechanism with the least possible background noise or rumble.

The high degree of perfection achieved by the Ballentine Phonograph Drive is the result of *precision dynamic balance,* excellence of design, rigid adherence to close tolerances plus modern manufacturing methods and equipment.

Send today for descriptive folder on the Quiet BALLENTINE Phonograph Drive.

RUSSELL ELECTRIC COMPANY

364 W. HURON STREET, CHICAGO 10, ILL.

Manufacturers of

BALLENTINE PHONOGRAPH DRIVE

close spacing to the work during the heating period, they must be racked back radially from the work for purposes of loading and unloading. The shutter-like mechanism for this withdrawal of the burners during loading and unloading can be seen at table-top level in the drawing.

Fluxing is by brush with Handy-flux. Gas consumption is at a rate of approximately 130,000 Btu per hour. The gas-air supply to the burners is carbureted with air in a Selas combustion controller (of 3500 cu ft of mixture per hour capacity) which incorporates its own blade-type positive displacement compressor. Total fuel input to the burners is visually metered through a Flo-scope so that exactly reproducable combustion conditions may be assured from braze to braze.

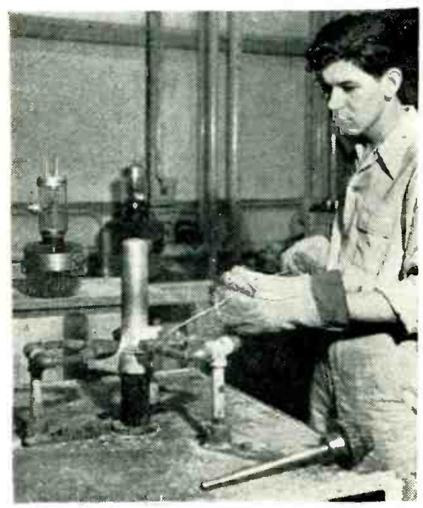
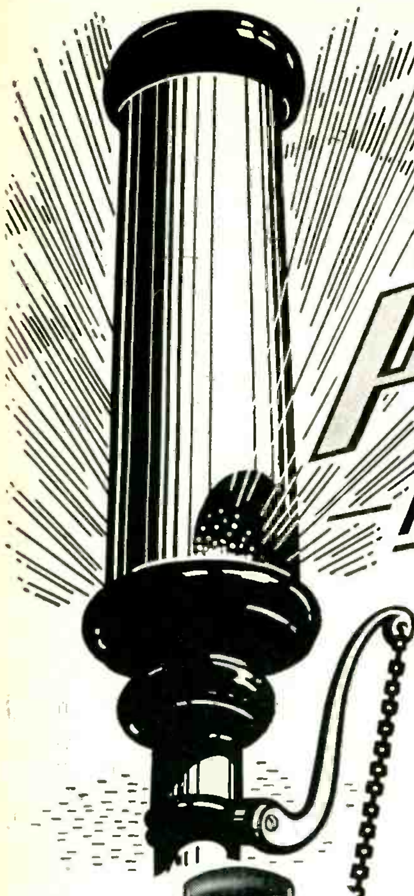


FIG. 3—Anodes for small air-cooled transmitting tubes are brazed with a smaller number of burners

After a braze is completed and the joint frozen, the assembly is placed in cold water, not only for cooling and flaking away excess flux, but to limit crystal growth in the copper anode.

The set-up was designed by Federal's Tube Division in cooperation with Selas Corporation of America, manufacturers of the gas-air mixing and combustion equipment involved. A similar arrangement shown in Fig. 3 is employed for the smaller size anodes.

Flexibility of both brazing tables is important because Federal manufactures no less than 75 different



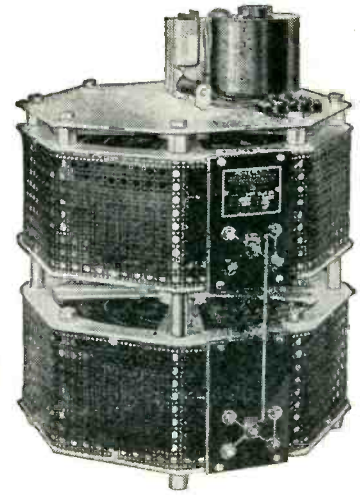
PRIORITIES NO LONGER NECESSARY

You Can Now Purchase SECO Products on Unrated Orders

To obtain any SECO product is now an easy task. By merely calling or mailing your order to the factory results in prompt shipment of the correct voltage control apparatus for your particular application. Your order does not have to wait its turn because a higher priority job has pushed it aside.

The majority of the standard POWERSTAT variable transformers are carried in stock for immediate shipment. For instance; if a smooth continuously adjustable output voltage is required from a 115 volt line, POWERSTAT type 116 is available with an output range of 0 to 135 volts. Its current rating is 7.5 amperes.

For control of POWERSTATS from push-button stations or automatic controllers, motor-driven POWERSTATS are offered in the same capacities as manually-operated units. Only a few days is necessary to make delivery of any standard model.



SECO'S increased production of SECO Automatic Voltage Regulators means that the unequalled performance of the SECO Regulator in maintaining a constant output voltage regardless of variations in input voltage or output load current is available for all requirements in the range of 1 to 100 KVA.

When space is limited or the atmosphere is hazardous, Oil-cooled POWERSTATS can be run at increased ratings with no danger involved.

Whether production testing or laboratory use is the demand, the VOLTBOX a-c power supply provides an ideal portable source of variable voltage. Regulated and unregulated models are obtainable from stock.

Send for Bulletin LE

SUPERIOR ELECTRIC COMPANY

410 LAUREL STREET, • • • BRISTOL, CONNECTICUT


DIAMOND
Stampings
Years of extensive engineering experience—modern facilities, precision equipment, and an organization of skilled designers and fabrication experts—enable George K. Garrett Company to offer a remarkably complete service in metal stampings for every industrial purpose.
Our completely equipped stamping department, together with heat-treating and finishing departments, will turn out—to your exact specifications—any quantities of stampings from steel, aluminum, alclad, brass, monel metal, stainless steel, copper and other metals. Prompt deliveries on large or small orders are assured.
Your particular problem or requirements will receive our immediate attention!
GEORGE K. GARRETT CO., INC.
1421 CHESTNUT STREET, PHILADELPHIA 2, PA.
ARMY E NAVY
DIAMOND PRODUCTS

transmitter tubes from 50 watts to 200 kw in size. About eight different anode types are involved, varying in wall thickness from 0.060 to 0.500 inch. All anodes are of cold-worked oxygen-free copper, and each anode is individually checked under the metallograph for maximum grain size.

Although the primary virtue of the procedure described is that trouble-free joints are easily obtained without skilled labor and at low fuel costs, it is interesting to observe that it is now possible to complete a braze within $1\frac{1}{2}$ minutes which formerly took over 20 minutes by manual oxy-gas torch methods.

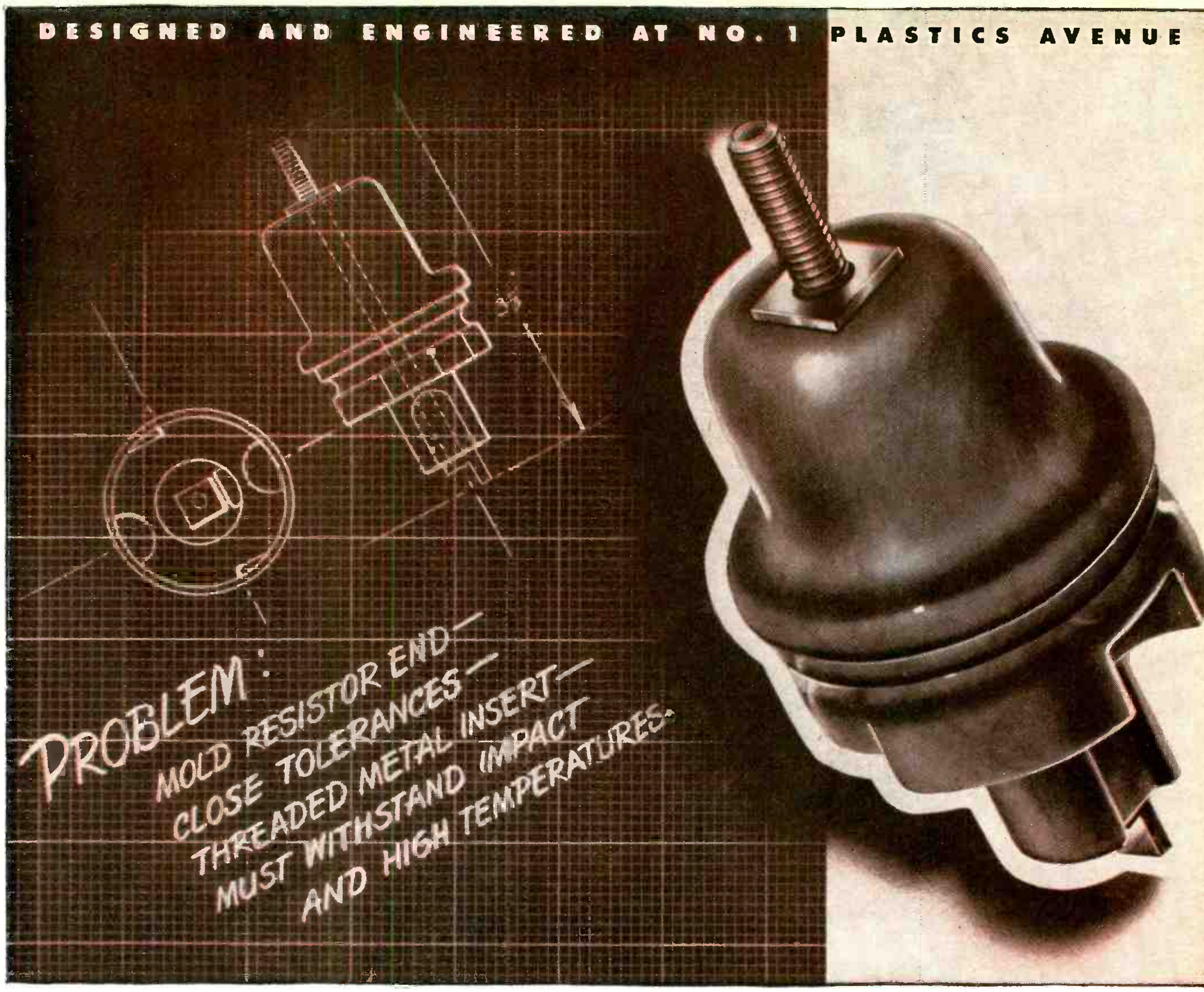
Soldering Anode Into Radiator

After an anode has been brazed to its collar, machined and welded onto the glass tube, and all internal tube construction has been completed, a final bonding of the radiator fin assembly in uniform thermal and electrical contact with the entire external anode surface must be effected.

Procedure here is delicate, exacting and vital. The steps are as follows: The radiator assembly is

FIG. 4—Lowering the tube into the radiator assembly for soldering

lowered by chain into an empty sheet-metal pot centrally located in the small gas-fired furnace shown in Fig. 4. The pot is stepped out to larger diameter above the top surface of the furnace, thereby provid-



G-E MYCALEX — FOR SAFE-CONDUCT THROUGH SHOCK AND HEAT

● Here is the end of a sealed tubular resistor unit that operates at extremely high temperatures. It forms the outside electrical connection of the unit.

Heat-resistant material designed to withstand impact had to be molded over a long threaded metal insert . . . to intricate, grooved dimensions so that a metal shell could be spun over it and held tightly in place.

These exacting specifications were met by injection-molding G-E mycalex—compound of glass and powdered mica with a unique combination of properties.

Why not investigate the possibility of specifying G-E mycalex for your own electrical components? This material is available to you in standard rods and sheets or molded to your design. For information, write to Section S-4, Plastics Divisions, General Electric Company, 1 Plastics Avenue, Pittsfield, Mass.

GE MYCALEX

G-E MYCALEX

A Unique Combination of Properties

1. High dielectric strength
2. Low power factor
3. Prolonged resistance to electrical arcs
4. Chemical stability—no deterioration with age
5. Dimensional stability—freedom from warpage and shrinkage
6. Imperviousness to water, oil, and gas
7. Resistance to sudden temperature changes
8. Low coefficient of thermal expansion
9. High heat resistance

Samples Supplied on Request

GENERAL ELECTRIC

CD46-M4

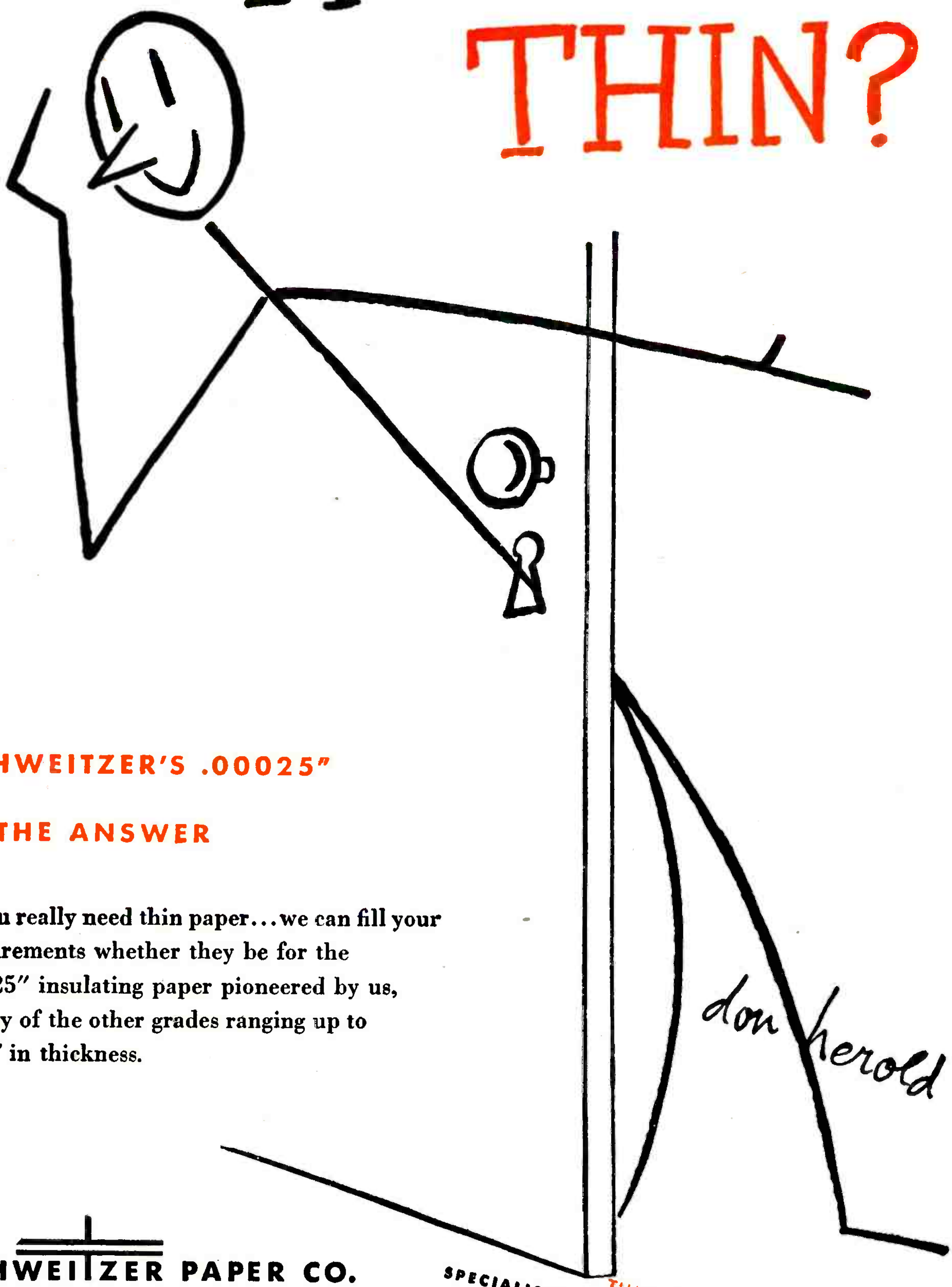
ing a ledge upon which rests a sheet metal ring for support of the radiator assembly. The pot is provided with a cover and purified-nitrogen-gas supply lines. A full hour is taken to bring the radiator slowly to heat, at which time the well within the radiator assembly is fluxed and loaded with four bars of solder. This solder melts and the anode end of the costly finished tube is slowly maneuvered down into the well. This operation is shown in Fig. 4 and 5.

It is at this point that extreme manipulative care is important (1) to prevent the entrapment of air bubbles, (2) to provide complete fluxing of both well and anode surface, and (3) to insure good wetting of all surfaces with solder. When cadmium solder is used the bonding temperature is 320 C.

FIG. 5—A weight on top of the tube maintains constant pressure to force the anode into the radiator

All in all, over 1½ hours are required after the anode has been lowered into place to flux and add approximately 1½ bars of additional solder. During this 1½ hours, weights are placed upon the top of the tube (see Fig. 5) to force the anode home. Air bubbles are caused to rise and be eliminated by working the tube with a rotary motion into the hole, and by the long period of solder flooding. After the joint is considered perfect, the furnace is

How thin is THIN?



SCHWEITZER'S .00025"

IS THE ANSWER

If you really need thin paper...we can fill your requirements whether they be for the 00025" insulating paper pioneered by us, or any of the other grades ranging up to .004" in thickness.

SCHWEITZER PAPER CO.

142 MILLER STREET, NEWARK, N. J.
Plants: Newark, Jersey City, N. J., Mt. Holly Springs, Pa.
Research Laboratories: Chrysler Bldg, New York, N. Y.

SPECIALISTS IN THIN GAUGE INSULATING PAPERS

- PRECISION WIRE WOUND RESISTORS
- WHEATSTONE BRIDGES
- RADIO & ELECTRONIC TEST EQUIPMENT
- RADAR ASSEMBLIES

Eastern Electronics Corp.

PHONOGRAPH TURNTABLE UNIT

The need at this time for large quantities of phonograph turntable assemblies has prompted us to quickly design and tool up for the immediate production of this item. Engineers will find this compact turntable meeting all of their requirements for performance. We are prepared to make immediate deliveries and suggest that purchasing agents place their orders at once before we, too, have such a backlog that we will be unable to meet your requirements promptly.

Specifications

PERFORMANCE: — Correct and uniform speed is secured through the use of a motor of ample capacity, preloaded to operate on the flattest portion of the torque-speed characteristic.

QUIETNESS: — Is assured by full-floating rubber motor mountings and rubber cushioned drive. Permanent freedom from turntable wobble is guaranteed by an extra rigid turntable, an extra long bearing and precision machining of these parts.

RELIABILITY: — The motor is fan-cooled and will operate continuously with an exceptionally low temperature rise. All bearings are of ample size and are provided with self-lubricating features.

DELIVERY: — Immediate, and cost will agreeably surprise you.

KORECT-OHM RESISTORS

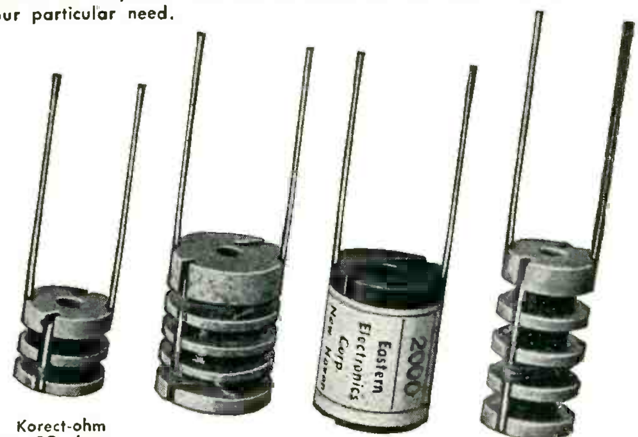
General Specifications

To insure stability Korect-ohm resistors are aged and treated to relieve strains due to winding before the final adjustment is made.

Final resistance adjustment to an accuracy of better than .1%.

TEMPERATURE COEFFICIENT. Resistors are wound with selected alloy wire having a resistance change vs. temperature of less than .08% between —55°C and +55°C. For applications where space is a factor, resistors are wound with an alloy wire having a resistivity of 650 ohms per circular mill ft. the resistance change vs. temperature of this high resistance alloy is .5% ± between —50°C and +50°C.

Many years of experience in the making and applying resistors for precision instruments and electronic equipment places us in a position to cooperate with you in supplying the right resistors for your particular need.



Korect-ohm Type CC low temperature coefficient maximum resistance 250,000 ohms.
Type NC maximum resistance 500,000 ohms.

Korect-ohm Type NA maximum resistance 1 million ohms.

Korect-ohm Type CA low temperature coefficient ranges from a few ohms to 500,000 ohms.

Korect-ohm Type CB low temperature coefficient maximum resistance 500,000 ohms.
Type NB maximum resistance 1 million ohms.

We will make special resistors to any value and tolerance.

Our regular line of resistors are available for immediate delivery.

Watch our Ads for New Items.

Eastern Electronics Corp.

41 CHESTNUT STREET, NEW HAVEN, CONN.

Boston Sales Office
11 Pemberton Square
Tel. Capitol 2425

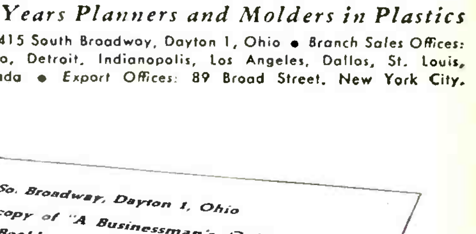
Chicago Sales Office
Bauman & Bluzat 2753 West North Ave.
Tel. Humboldt 6809

Free Offer! ...with a (small) Catch to it!

If you are a businessman with a yen to know more about plastics, you'll want your free copy of this illustrated booklet. It tells what plastics will do. It even tells what they won't do. It tells how to go about getting complete data on your project. It goes on to describe production functions from design through the finishing stages—and how to make use of them.

As for the designer, the design engineer and the professional purchaser—men who know plastics from living with 'em—there's something here for you, too. Not technical data on design or materials—which would only get the once-over-lightly treatment in a booklet like this anyway. We mean information on the kind of thinking and equipment offered by a long-established but progressive molder who would like consideration as your source of supply.

The catch? Well, after you've read it, you may want Kurz-Kasch to figure a job for you. Is that bad? We can name plenty of manufacturers who don't think so. Fill in the coupon and attach it to your letterhead. Get a free copy of "A Businessman's Guide to the Molding of Plastics"—and test *your* will power!



Kurz-Kasch

For Over 25 Years Planners and Molders in Plastics

Kurz-Kasch, Inc., 1415 South Broadway, Dayton 1, Ohio • Branch Sales Offices: New York, Chicago, Detroit, Indianapolis, Los Angeles, Dallas, St. Louis, and Toronto, Canada • *Export Offices:* 89 Broad Street, New York City.

shut off and the assembly allowed to cool and freeze slowly.

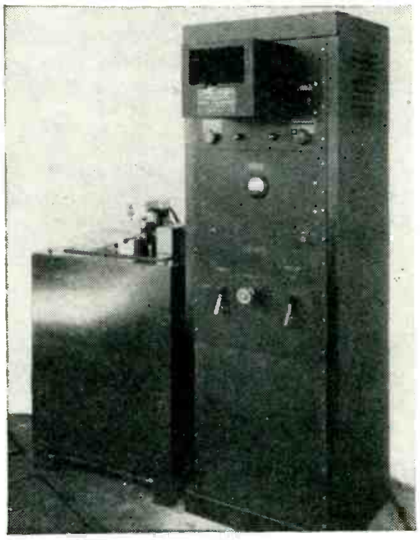
The entire sequence of operations takes about five hours. During the entire period at heat, about 20 liters per minute of purified-nitrogen-gas are forced through the space around the radiator and under the furnace pot cover. This is to minimize oxidation of the radiator fins. However, it is now felt that this protection is not sufficient to eliminate the necessity for final chemical cleaning of the radiator surface before tube shipment, and, therefore, it is intended in the future to eliminate all nitrogen purging, let corrosion take its course on the outside of the radiator-assembly, and rely on chemical cleaning entirely.

• • •

Electronic Balancer for Rotating Parts

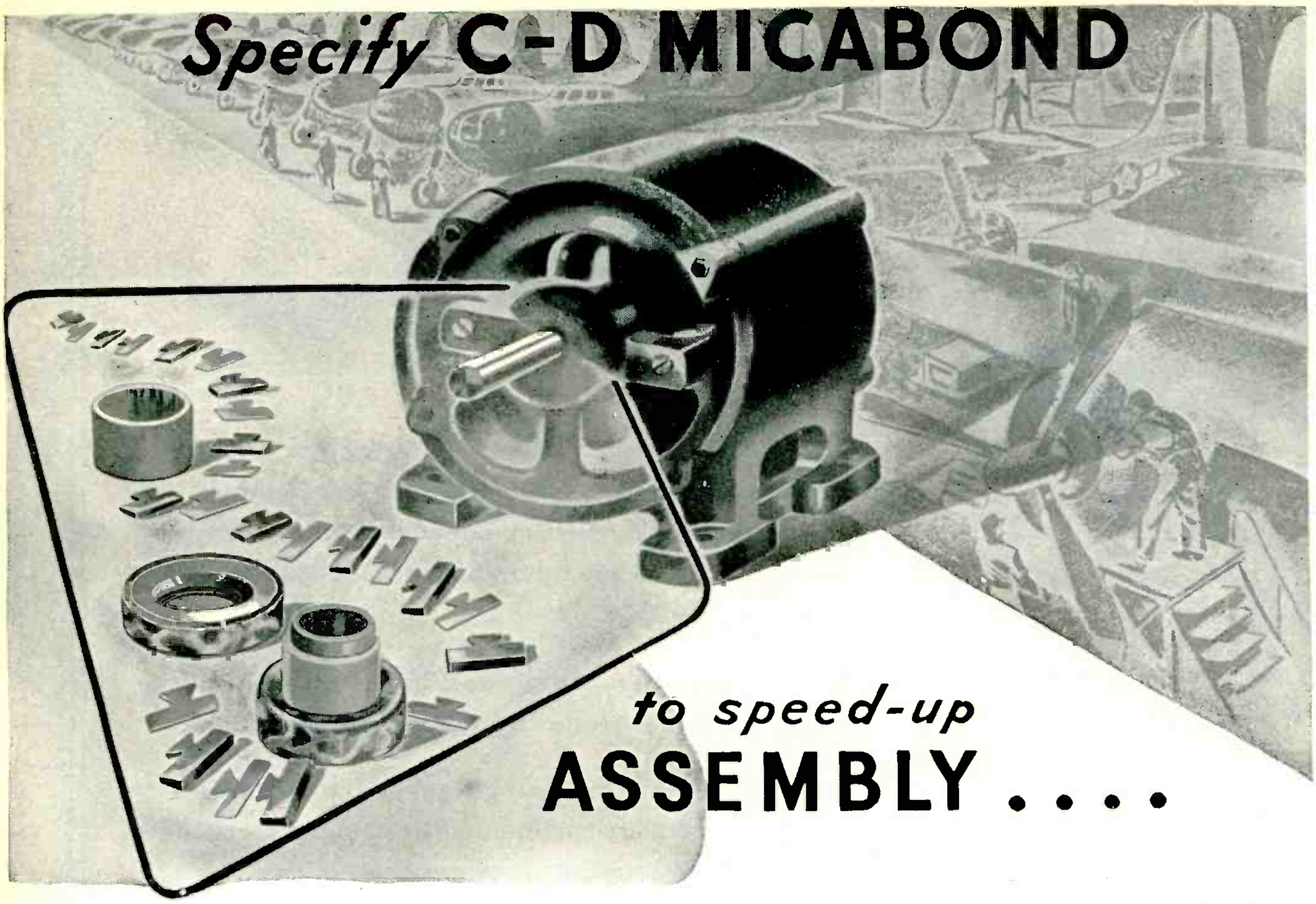
QUARTZ CRYSTAL PICKUPS, cathode-ray indication of angle and force of unbalance, and phototube speed measurement are features of the balancing machine shown in the accompanying illustration.

The rotor to be tested and corrected mounts on the unit at the left where it is brought up to speed and held there by means of compressed air driving a turbine wheel. Rotor speed is selected by a control



Parts to be balanced are mounted for test on the seismically suspended platform at left. The electronic equipment in the cabinet at right includes a c-r tube indicator and a phototube tachometer

Specify C-D MICABOND



to speed-up ASSEMBLY . . . .

ARMATURE assemblies fit when C-D MICABOND insulating rings and segments are used. They fit because C-D manufacturing standards assure close tolerance production of MICABOND materials and parts. The consistent quality and accuracy of C-D MICABOND products justifies the confidence C-D MICABOND enjoys from the many manufacturers of armatures who specify C-D MICABOND. When your electrical insulating problem dictates "mica insulation," C-D engineers will be glad to help you to design to use mica to the best possible advantage—and in its most usable form—C-D MICABOND.

KY-45

C-D PRODUCTS

The Plastics
DILECTO—A Laminated Phenolic.
CELORON—A Molded Phenolic.
DILECTENE—A Pure Resin Plastic Especially Suited to U-H-F Insulation.
HAVEG—Plastic Chemical Equipment, Pipe, Valves and Fittings.

The NON-Metallics
DIAMOND Vulcanized FIBRE
VULCOID—Resin Impregnated Vulcanized Fibre.

MICABOND—Built-Up Mica Electrical Insulation.

Standard and Special Forms
Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

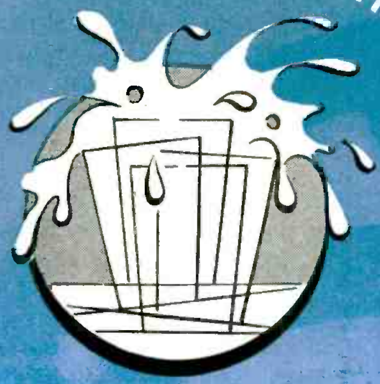
Descriptive Literature
Bulletin GF gives Comprehensive Data on all C-D Products. Individual Catalogs are also Available.

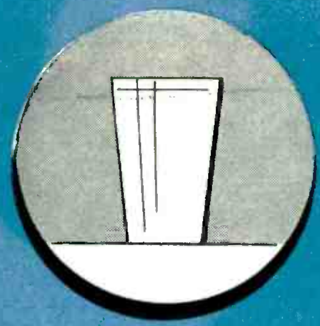
DISTRICT OFFICES
NEW YORK 17 • CLEVELAND 14 • CHICAGO 11
SPARTANBURG, S. C. • SALES OFFICES IN PRINCIPAL CITIES
•
WEST COAST REPRESENTATIVES
MARWOOD LTD., SAN FRANCISCO 3
•
IN CANADA:
DIAMOND STATE FIBRE CO. OF CANADA, LTD., TORONTO 8

Continental-Diamond FIBRE COMPANY

Established 1895.. Manufacturers of Laminated Plastics since 1911—NEWARK 16 • DELAWARE

VIBRATION & IMPACT





ABSORBED . . .

with BARRY *engineered* shock and vibration mountings

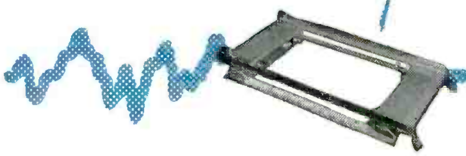
Sensitive communication and industrial electronic equipment needs the full protection of Barry *Engineered* shock and vibration control.

Barrymounts, engineered to the application, have already proved themselves in war for shipboard, mobile and airborne applications. Now, they are ready to prove themselves commercially in airborne and marine electronics, mobile radio and train communications, portable test and industrial control equipment.

Delicate tube filaments, precise measuring instruments and other critical components live longer and perform better when *whole installations* are isolated by Barrymounts. By using them intelligently on electronic units, your equipment can achieve competitive superiority.

Barry engineers are experts in the highly specialized fields of vibration isolation, impact absorption, and the correction of torsional vibration conditions. If faced with product or production problems involving the control of these conditions—call in a Barry vibration engineer at once. There is no obligation.

TYPE AVA* VIBRATION ABSORBER



ONE OF THE BARRYMOUNTS FOR USE ON

Aircraft Equipment	Radio & Radar Apparatus
Sound & Signal Systems	Industrial Electronics
Meters & Instruments	Portable Test Equipment

*The mount that meets Navy Spec. No. 16V1 (RE)

BARRY *engineered*

SHOCK & VIBRATION CONTROL

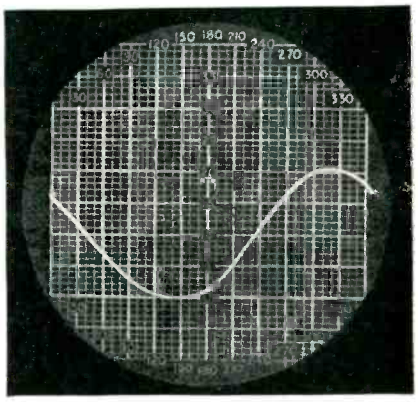
L. N. BARRY COMPANY
173 SIDNEY STREET
CAMBRIDGE 39, MASS.

WAR-TESTED FOR PEACE

at the upper right of the right-hand unit with standard speeds of 900, 1200, 3000, 3,600, 4250, 6000, 7200, 8500, and 12,000 rpm. Actual speed is indicated on a meter.

Mechanical tachometer connections are obviated by a system comprising a phototube excited by the drive wheel and responding to the number of blackout impulses per minute. The meter reads from 0 to 200 percent.

The revolving rotor is supported in a rigid frame which is deflected no more than a few millionths of an inch even at the highest unbalance possible. Unbalance forces are transmitted to load-sensitive capsules incorporating quartz-crystal disks and there translated into piezoelectric voltages. Amplified



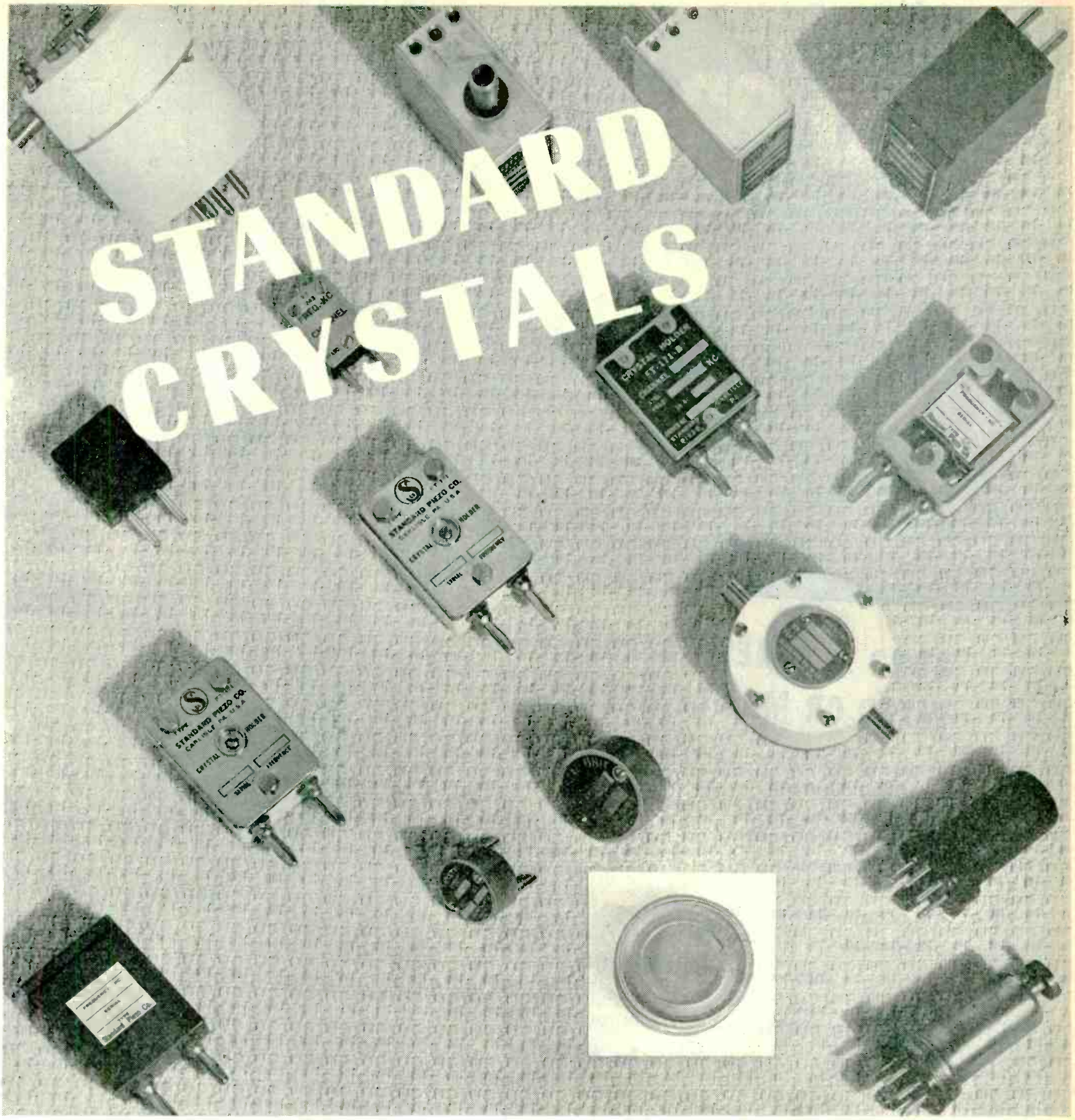
Sine-wave trace obtained on the screen of the cathode-ray tube of the Electrodynascope

through suitable electronic circuits, these voltages appear on the screen of the recessed cro tube where they can be expressed as ounce-inches or in depth of drilled or milled hole necessary for correction.

Either single-plane unbalance or that in two planes can be indicated, the planes being chosen by the positioning of the two pickup capsules into the planes where it is convenient to make the necessary corrections. Milling cutters or other correction tools can be mounted directly on the balancing platform so the rotor can be corrected and then rechecked without the necessity of its removal from the equipment.

Interpreting Trace

A typical oscilloscope trace is illustrated. It exhibits a sine-wave



Every day more STANDARD crystals are being used for general *Airline, Police, Broadcast, Aircraft, Amateur* and *Commercial* uses.

Now the modern STANDARD *MIDGET* is available for your particular problem.

Write, wire or phone us your needs so our engineering group and production facilities can be placed at your disposal.

STANDARD's new, up-to-date catalogue is yours for the asking.

The inset STANDARD *MIDGET* is shown actual size. Background pictures other popular STANDARD types.

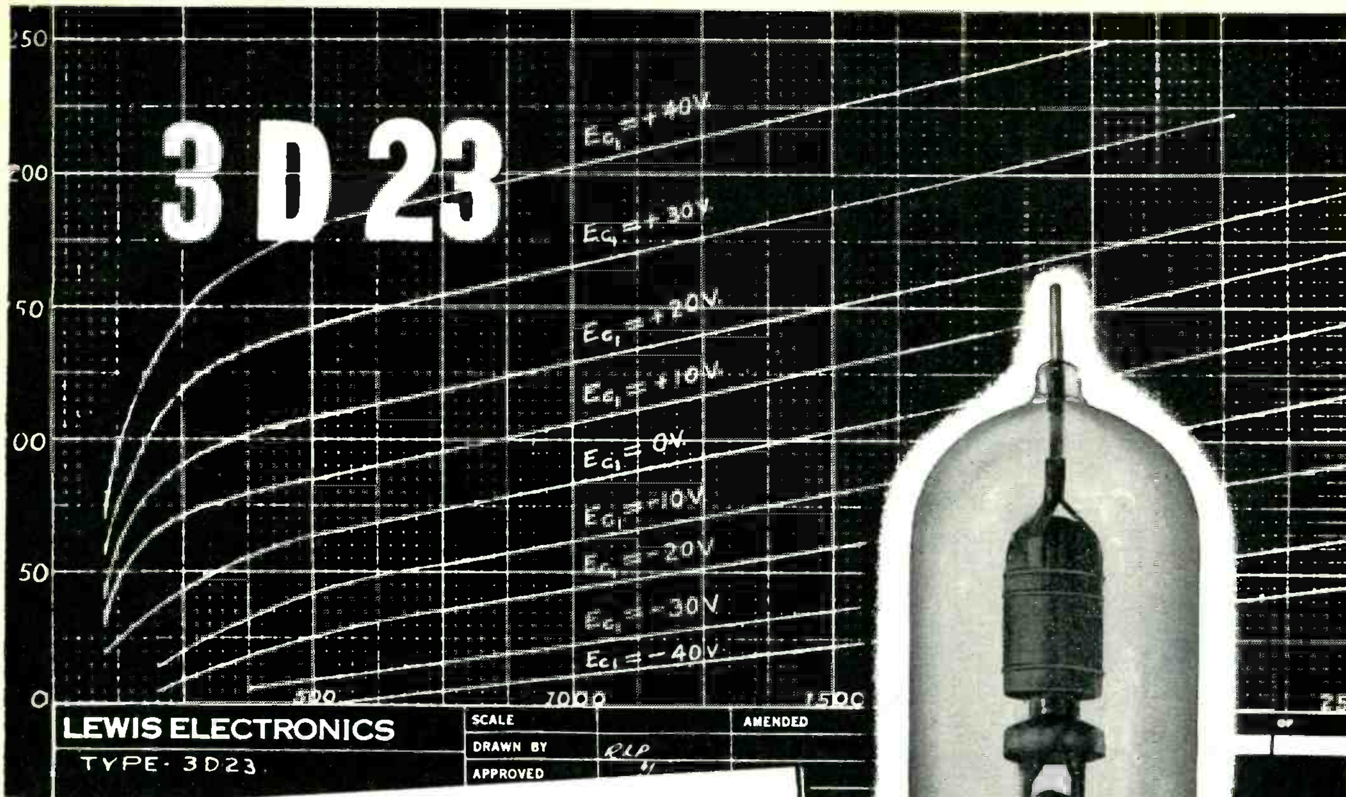
STANDARD PIEZO COMPANY

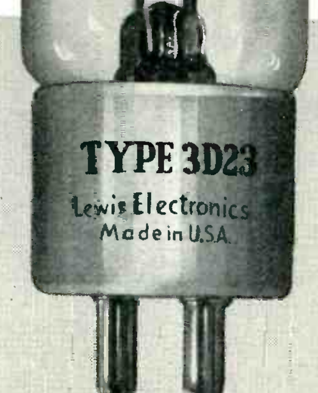
Established 1936

Quartz Crystals and Frequency Control Equipment

Office and Development Laboratory

SCRANTON, PA. — CARLISLE, PA., P. O. BOX 164 — CARLISLE, PA.





3D23 ... A NEW TETRODE FOR FIXED OR MOBILE OPERATION

Filament Voltage	6.3 AC or DC Volts
Filament Current	3.0 Amperes
Amplification Factor	65
Mutual Conductance	2750
Plate Dissipation	35 Watts
Medium 4 Pin Ceramic Base	
Maximum Power Output	130 Watts
Approximate Driving Power	4.5 Watts

Inter-Electrode Capacities:

Input to Plate . . . . .2 MMFD
Input, 6.5 MMFD — Output, 1.8 MMFD

Frequency Limits as Power Amplifier:

Full Power Input	250 MCS
Half Power Input	400 MCS

LICENSED UNDER R. C. A. PATENTS
List Price $10.

Catalog sheets and tubes ready for distribution!

Lewis at Los Gatos

A manufacturing organization . . . the pride of an entire community . . . with an electronic engineering background of 20 years experience! *Plus* a war-born performance record of meeting huge production demands and exacting technical requirements—on time and economically!

EQUIPPED and READY to produce YOUR TUBES under YOUR BRAND name!

Lewis ★ ELECTRONICS
LOS GATOS · CALIFORNIA

"You can't argue with a PRESTO RECORDING

...because

Presto gives it to you straight!"

"There's nothing like a Presto Recording for honest criticism of your work," says Ray Bloch whose Orchestra and Chorus provide the musical portion of so many network shows. "Our programs are recorded on Presto equipment because we know we can depend on Presto's fine reproduction and fidelity to musical tones. When we play back the recording, we're practically hearing our own live performance!"

Major broadcasting stations feel the same way about Presto's high quality work—and add that Presto is rugged as well as efficient, remaining in perfect operating condition over long periods without adjustment. Schools, colleges and business organizations, too, prefer Presto equipment because it's so simple to operate. Write for complete information.

PRESTO

RECORDING CORPORATION

242 West 55th Street, New York 19, N.Y.

Walter P. Downs, Ltd., in Canada

WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT AND DISCS

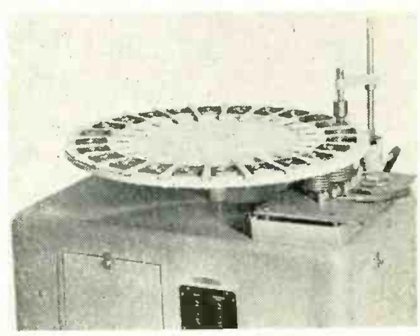
indication whose highest ordinate, in this case 20.5, represents the amount of unbalance and whose lowest peak is read on the abscissa scale as 150 deg. This reading provides the angle at which correction is to be made relative to a fixed pointer and a protractor on the driving head.

Because of the rigid mounting of the rotor, unknown inertia and dynamic forces are negligible and indications are not affected by the mass or mass distribution of the balancing table. The calibration of the unit remains constant for all weights of rotors within the capacity of the machine according to engineers of Gyro-Balance Corp., the manufacturers. Use of a cro screen for indication makes it possible to detect as distortions of the sine wave those forces which do not arise from unbalance—for instance, bearing defects.

Vibration insulation of the machines makes it possible to mount them on any kind of floor. The entire balancing platform assembly is on a heavy concrete base seismically suspended in a light outer frame, an arrangement which stops transmission of forces in both directions.

• • •

AUTOMATIC ELECTRONIC BRAZING



Used in the brazing of metal assemblies, this twenty-four-station circular indexing carrier permits the completion of one piece each twelve seconds. The operator merely loads the stations as they come around empty, ejection being performed by the vertically-operating mechanism which follows the three water-cooled induction coils. The carrier can be applied to any "S" Corrugated Quenched Gap Co. electronic generator rated between 5 and 100 kw

PULSING DRIVE

is a small, simple, rugged device for highly accurate remote positioning and may be used with any reversible motor. It offers a precise control of the extent of motion, as well as direction of rotation, far surpassing the limits of ordinary toggle or two button switches. These units find wide application in precise tuning of radio and television transmitters and receivers as well as in diversified types of industrial equipment.

CONTINUOUSLY VARIABLE CONTROLS

provides a means of continuously positioning a remote load through one or many revolutions. The load may be moved forward, backward or stopped in any position with high accuracy. Any movement of the control knob results in a corresponding movement of the load. Types available include synchronous, non-synchronous, low or high torque with or without automatic scanning. Accuracy to 1/100 of a degree is possible.

SPOT TUNER

makes it possible to rotate a remote shaft to any one of six to ten predetermined positions. Push button selection is provided for each position. All positions are easily and quickly adjustable to any point within the 180° control range. This system is particularly applicable to high precision tuning of radio and television equipment. Accuracies to one part in 18,000 are entirely feasible.

MULTI-REVOLUTION SELECTORS

remotely rotate a load to any one of several spots through from one to a number of revolutions. Push buttons are provided for all positions. Positions are easily adjustable to any desired location through the range of the unit. These controls permit extreme accuracy in positioning the load. Accuracies to one part in 1,000,000 are not uncommon.

DUAL CONTROLS

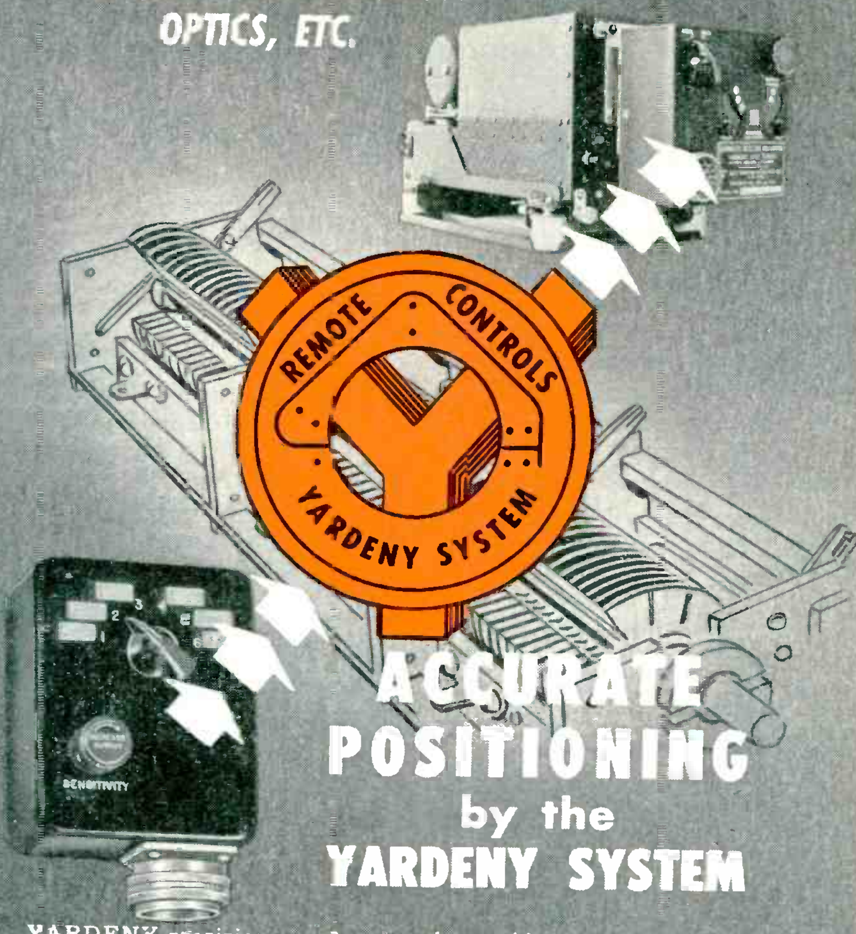
combine the features of the continuously variable control with those of the automatic selectors. The control head is provided with a knob for continuous positioning of the load. Any movement of the knob is followed by a corresponding movement of the load. In addition, a bank of push buttons permits automatic positioning of the load to a number of preset locations. These load positions may be easily adjusted and re-located to any point within the range of rotation.

MISCELLANEOUS

YARDENY devices include those for many other applications, one or more of which may solve your specific requirements.

ELECTRICAL REMOTE CONTROL

COMMUNICATION . . . INDUSTRIAL . . . AIRCRAFT . . . MARINE . . . TELEVISION . . . OPTICS, ETC.



ACCURATE POSITIONING by the YARDENY SYSTEM

YARDENY precision remote controls provide a means of accurately positioning or moving a load which is remotely located from the operator. Positioning accuracies as high as one part in a million are attained. Although this remarkable accuracy is an outstanding feature of YARDENY controls, they are simple, rugged and dependable. All are practically immune to temperature change, extreme shock, vibration or severe usage—with dependability proved through extensive use by the Armed Forces.

Basic components of YARDENY systems are the torque-delivery unit—an electric motor—and a control head. These control devices are applicable to present standard equipment as accessories, or may be engineered into future plannings as an integral part of the assembly. Merely outline your specifications and required quantities for complete collaboration. Appointments or demonstrations are by request, and you incur no obligation.

YARDENY ENGINEERING CO.

105-107 CHAMBERS STREET, NEW YORK 7, N. Y.

YARDENY LICENSEES: SELF WINDING CLOCK COMPANY, INC., AMERICAN TYPE FOUNDERS, INC., MASTER CONTROLS, INC., C. D. & I., INC.

TUBES AT WORK

Pulse Modulation in Army Equipment

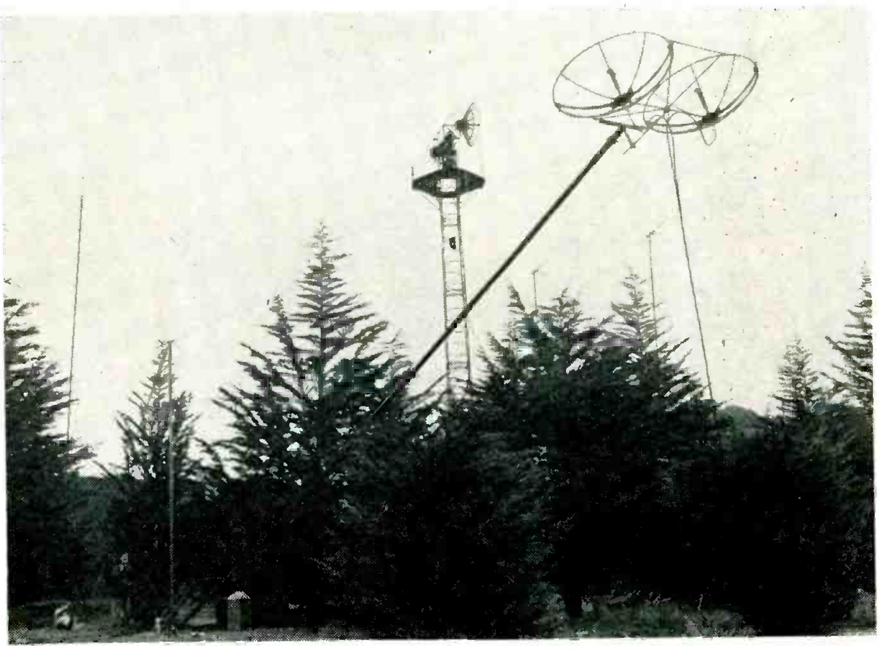
AT A RECENT DEMONSTRATION staged by Signal Corps Engineering Laboratories, two equipments shown used pulse-position modulation, a new method of modulation whose war-time application has been kept secret. One of these, radio set AN/TRC-6, is the first practical tactical radio equipment of this type developed.

To obtain a multi-channel radio relay system for the Army, it was necessary to use telephone terminal equipment. When development of the AN/TRC-6 was undertaken in 1943 it was decided to include in the equipment the multi-channel facilities desired, but without the use of extra telephone equipment. The result was a set which employs pulse-position modulation with time division multiplexing.

In pulse-position modulation, the pulse which transmits the intelligence repeats at a regular rate so that periodic sampling of the intelligence to be transmitted takes place. When the intelligence is applied, the pulse's time of occurrence is correspondingly varied in position and time.

In radio set AN/TRC-6, eight separate pulses are used and the time of occurrence of each is varied in accordance with the intelligence transmitted from one of eight separate channels. No two pulses are allowed to occur at the same time, they are interlaced. Thus, eight telephone circuits are available for simultaneous use. Each of these may be connected to conventional telephone lines. If desired, as many as ninety-six telegraph circuits can be substituted for the eight telephone circuits available.

According to the Army, radio set AN/TRC-6 provides transmission which is as quiet and distortionless as the best commercial telephone circuits available, and it is subject to very little static or atmospheric disturbance because of its use of pulse modulation and the choice of radio frequency.



Transmitting and receiving antennas of the Army radio set AN/TRC-5, the 1,400-mc multi-channel equipment using pulse-position modulation, are raised with the help of a jury mast. The 4,900-mc antennas of the AN/TRC-6 ppm set appear at center.—U. S. Army Signal Corps photo

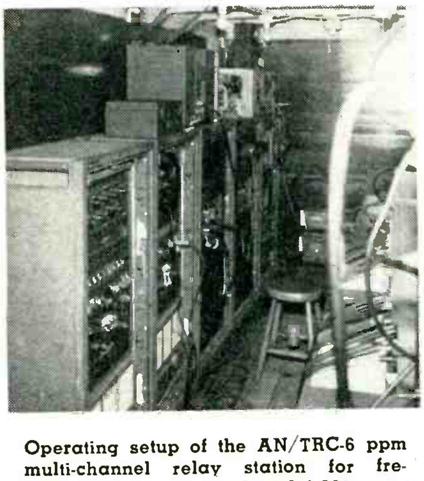
The AN/TRC-6 operates in the frequency range between 4,300 and 4,900 megacycles. The equipment is usually carried in a 2½-ton truck. Because of its size and complexity the equipment is not intended for use in forward areas but is used between armies and army groups and from army groups to rear areas.

Used In Europe

The equipment was introduced into the European theater in December 1944. When more equipment arrived in April, circuits were installed between several army groups. As the Third Army advanced into Germany constant communications between it and the 12th Army Group were maintained over nearly 300 miles, using two terminals and three relay stations.

In the Pacific, radio set AN/TRC-6 has seen only limited use in Hawaii, but it is expected that a number of these sets will be used in the occupation zones.

A second set, the AN/TRC-5, performs functions identical to those of the AN/TRC-6 but operates at



Operating setup of the AN/TRC-6 ppm multi-channel relay station for frequencies between 4,300 and 4,900 mc—U. S. Army Signal Corps photo

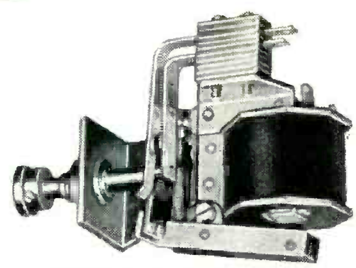
THERE'S A JOB FOR

Relays BY GUARDIAN

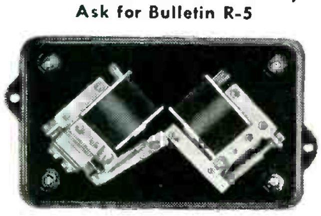
Induction heating costs less, is more dependable and easier by the electronic method. Safer, too, even with inexperienced hands, when protected from improper operation by quality relays such as the Guardian Series 90 Interlock Relay and the Series L-500 Overload Relay.

Series 90 Interlock Relay locks mechanically from an electrical impulse and unlatches or resets from another such impulse. Combinations up to DPDT available with 12½ amp. contacts rated at 110 v., 60 cycles, non-inductive load. Coil resistances up to 10,000 ohms. For AC or DC operation.

Series L-500 Overload Relay, manual reset, protects DC circuits against abnormal current surges where current conditions are constant. Contacts can take severe overloads undamaged, cannot be reset during overload. Rated for 1500 watts on 110 v., 60 cycle, non-inductive AC.



Series L-500—Overload Relay
Ask for Bulletin R-5



Series 90—Interlock Relay
Ask for Bulletin 21

Consult Guardian wherever a tube is used—*however*—Relays by Guardian are NOT limited to tube applications but may be used wherever automatic control is desired for making, breaking, or changing the characteristics of electrical circuits.

GUARDIAN G ELECTRIC
1625M W. WALNUT STREET CHICAGO 12, ILLINOIS
A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY

designs of

DISTINCTION

In medieval times discriminating knights journeyed to Toledo, Spain, to obtain hand-wrought blades of steel. Only the famed guildsmen of Toledo could produce the flawless metal from which they fashioned graceful foils and swords of sleek beauty.

For hundreds of years these proud guildsmen stamped their guild marks or signatures on their creations.

A few firms today still preserve that spirit of craftsmanship. You find it in the plants of Detrola Radio. That is why the "guild mark" of Detrola Radio on a radio receiver, record changer or other electronic instrument is a guarantee of production quality. The world's finest merchants, and their customers recognize the value of this mark.

DIVISION OF INTERNATIONAL DETROLA CORPORATION DETROIT 9, MICHIGAN

1,350 to 1,450 megacycles. It is somewhat smaller than the AN/TRC-6, and also provides eight telephone circuits. Production of this set had just started when the war ended.

Tests in California

In May 1945 the Chief Signal Officer directed that the Signal Corps Engineering Laboratories conduct comparative tests of radio relay equipment in California. The project was assigned to Coles Signal Laboratory, Red Bank, New Jersey.

The equipment being tested consists of two f-m sets and the two ppm sets mentioned above. Comparative tests are being made that are expected to help solve problems of anomalous propagation, operation and maintenance, the maximum number of relay stations that permits satisfactory communication and the effects of aircraft flying the path between stations.

• • •

New PTM System Handles 24 Conversations per Carrier

RADIOTELEPHONE CIRCUITS utilizing pulse time modulation and permitting 24 two-way conversations at the same time on a single uhf carrier wave, have been set up on an experimental basis over an 80-mile circuit from the headquarters building of International Telephone and Telegraph Corp. in lower Manhattan to Telegraph Hill near Hazlet, New Jersey, then to the Federal Telecommunications Laboratories at Nutley, New Jersey, and back to lower Manhattan. Eight-foot diameter parabolic reflectors are used to beam the 1,300-mc carrier, and also serve for reception since ptm permits alternate transmitting and receiving from the same antenna.

As previously described in Pulse-Time Modulation, ELECTRONICS, p. 100, Jan. 1945, the pulse-time method of modulation operates by emitting short pulses of high-frequency radio energy. These pulses are of constant amplitude, and are all of the same carrier frequency. Modulation is effected by transmitting a synchronizing or marker pulse followed by signal pulses at intervals varied at a

The green light in metals... Revere has them NOW

Revere knows well how precious to the nation each of these post-war days can be, and how crippling to industry and employment could be a shortage of essential metals. That is why, since V-J Day, Revere has been in full production for peace.

Fortunately, Revere metals can serve the needs of creating as well as those of destroying, can make as fine bathroom fixtures as bomb fuses, as excellent radiators for automobiles as for half-tracks. No difficult reconversion problems have stifled the outpouring of Revere metals.

Revere copper, brass, bronze, aluminum, magnesium, steel, are ready *now*, are already busy in thousands of plants helping shorten the period of reconversion for industry and for the nation.

We are able and eager to do more. One inevitable result of Revere's war effort has been that not only our ability to produce, but our ability to give service, have been expanded many times. Revere research has probed further and deeper. Revere Technical Advisors are armed with greater knowledge and experience. New methods, metals and machines may save precious time or cut all-important cost for users of our metals.

In all these ways Revere is ready *now* to serve the manufacturing and building industries to help you prove *immediately* that America is even greater in peace than she proved to be in war. In the same way Revere is ready to serve home owners with its building products which are stocked by Revere Distributors in all parts of the country.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices: 230 Park Avenue, New York 17, N. Y.

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y.

Sales Offices in principal cities, Distributors everywhere

Revere District Sales Offices are located in the following cities:

Atlanta, Ga.	Boston, Mass.	Buffalo, N. Y.
Cincinnati, O.	Cleveland, O.	Dallas, Texas
Dayton, O.	Grand Rapids, Mich.	Hartford, Conn.
Houston, Texas	Indianapolis, Ind.	Los Angeles, Calif.
Milwaukee, Wis.	Minneapolis, Minn.	New York, N. Y.
Philadelphia, Pa.	Pittsburgh, Pa.	Providence, R. I.
St. Louis, Mo.	San Francisco, Calif.	Seattle, Wash.

The Revere Office nearest you is at your service.

Listen to the Human Adventure on the Mutual Network every Sunday evening, 9 to 9:30 P. M., Eastern Time.

Complete Metal Parts Fabrication Facilities

OLYMPIC

..collaboration from the blueprint to final delivery!

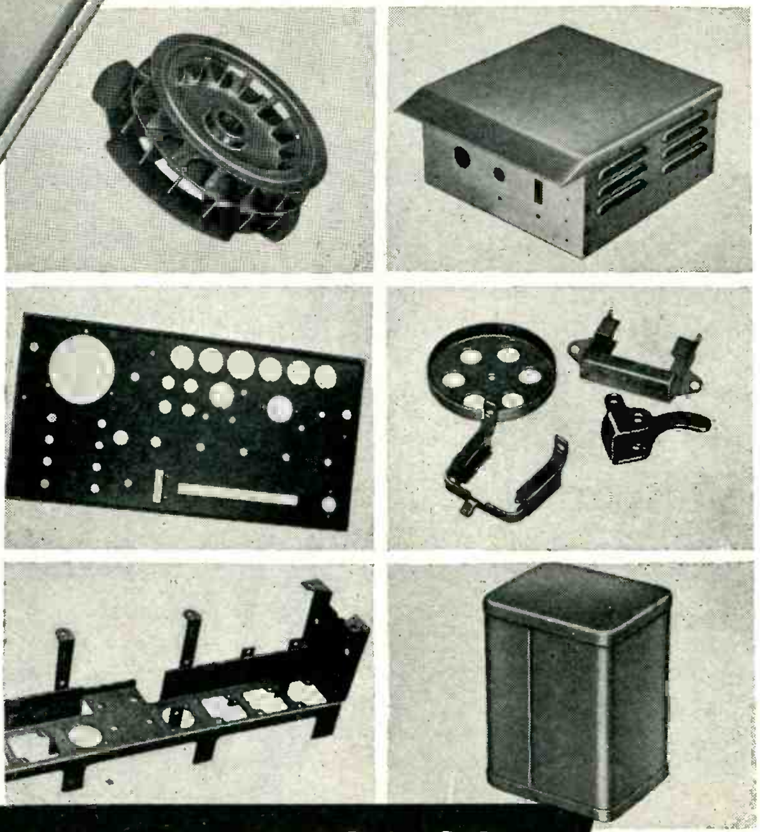
Eliminate costly overhead—OLYMPIC can be your metal parts fabrication department! Difficult or involved components — seemingly impossible to fabricate—are regularly produced by OLYMPIC. Every phase of production reflects the experience and skill of specialization in the field — finer finish, closer dimensional accuracy, prompt deliveries.

MODERN ENGINEERING, DESIGNING AND PRODUCTION FACILITIES FOR ALL PRECISION METAL PARTS FABRICATION

LOW-COST OLYMPIC FABRICATIONS PERMIT A COMPETITIVE PRICE BASIS FOR FINAL PRODUCT SALE

Lower unit cost is the big advantage at OLYMPIC. Also, close engineering and design consultation permit various production short-cuts and efficiencies. Inquiries are invited, and will be treated in strict confidence. Descriptive literature is available

WRITE TODAY!



OLYMPIC TOOL & MFG. CO.
INCORPORATED
39 CHAMBERS STREET NEW YORK 7, N. Y.

FOR THE COMPLETE SERVICE SHOP

RCP TESTERS

These two instruments represent RCP's engineering foresight in meeting the broad requirements of today's testing—anticipating tomorrow's. Greater than ever in technical perfection—th make testing easier, speedier—more accurate.

TUBE, BATTERY & SET TESTER

Model 805

For direct testing of all acorn, and regular receiving tubes. Complete leakage test under rated voltages for all electrolytic condensers. Regular resistance test for electro-static condensers at high voltage. Tests all popular sizes of radio batteries, under rated load.

Low-range ohmmeter is back-up, low-drain type. Medium-range ohmmeter is powered by self-contained battery; high range ohmmeter operates from plug-in line supply. Tests separate sections of multi-purpose tubes. Hot inter-element short and leak tests of individual elements. Separate tests for noise, hum and intermittents. Built-in "Rolindex" tube chart. With high voltage test leads in sturdy wood case, with removable cover.

SIGNAL GENERATOR

Model 705

Constancy of calibration and output, plus high frequencies, are offered in this Signal Generator. Model 705's range is from 95 kc. to 100 Mc. Fundamental frequencies are continuously variable from 95 kc. to 25 Mc. in 5 bands. Calibration is accurate to 2% per band through broadcast band, within 3% for high frequency bands.

Other features: Planetary drive condenser—direct reading calibration; output—modulated or unmodulated. Self-contained modulation 400c. or 1000c. sine wave, available for external use. A 5-step attenuator controls output. Automatic shorting of coils not in use, individual shielding of r-f circuits, overall steel case, chassis and panel. Fused line supply.

OUR COMPLETE LINE OF STANDARD TEST INSTRUMENTS IS DESCRIBED IN CATALOG NO. 128, SENT PROMPTLY ON REQUEST

RADIO CITY PRODUCTS COMPANY, INC.

127 WEST 26th STREET — RCP — NEW YORK CITY 1, N. Y.

Manufacturers of Precision Electronic Limit Bridges—Vacuum Tube Voltmeters—Volt-Ohm-Milliammeters—Signal Generators—Analyzer Units—Tube Testers—Multi-Testers.

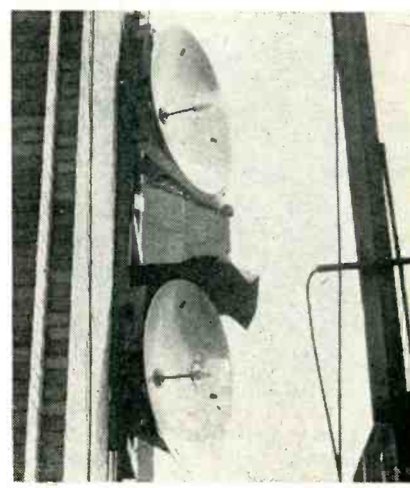
rate corresponding to the audio frequency of the signal being broadcast.

Since the transmitted wave is intermittent and not continuous, it is possible to operate the transmitter and adjacent receiver at the same frequency by including suitable time-delay circuits in the receiver and by making it insensitive while the transmitter pulse is being emitted.

Sequence of Pulses

The present system uses a single marker pulse followed by 24 signal-pulses for the 24 channels, the entire sequence being repeated at a rate of 8,000 pps. Without modulation, the entire 25 pulses are evenly spaced in time. If a signal is applied to Channel No. 1, the No. 1 signal pulse will occur slightly sooner or later in the first sequence cycle than its no-signal position. The bandwidth now in use is 3 mc.

The marker pulse synchronizes the receiver with the transmitter,



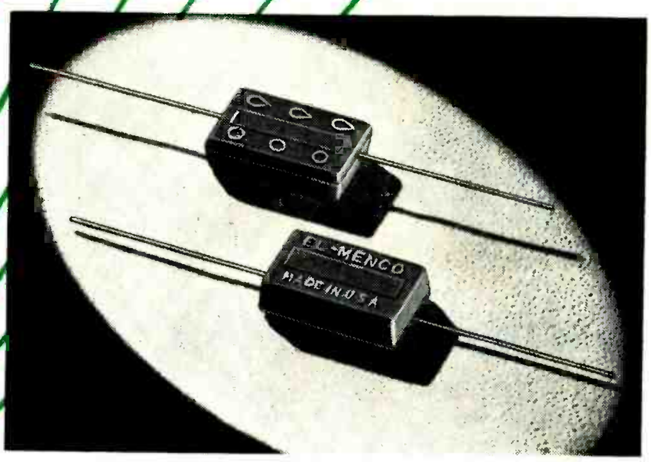
Antennas for receiving and transmitting ptm signals on 1200 megacycles are installed on the IT&T Corp. building at 67 Broad Street, New York City

so that the receiver will examine the input on each of the 24 channels in sequence, at the same rate of speed and repetition as the transmitter. Each audio channel is actually sampled or interrupted 8,000 times per second, but these interruptions occur at such high speed that they are not audible to the listener.

Requirements for the design of pulse-time modulation relay stations are much less critical than for

TOWARD NEW HORIZONS

Tested and proved in every important theatre of war, El Menco Capacitors will soon be serving with equal merit in the products of peace. Insure the correctness of this important part of your post-war product by specifying El Menco Capacitors.



Write on your firm letterhead for catalog.

El-Menco

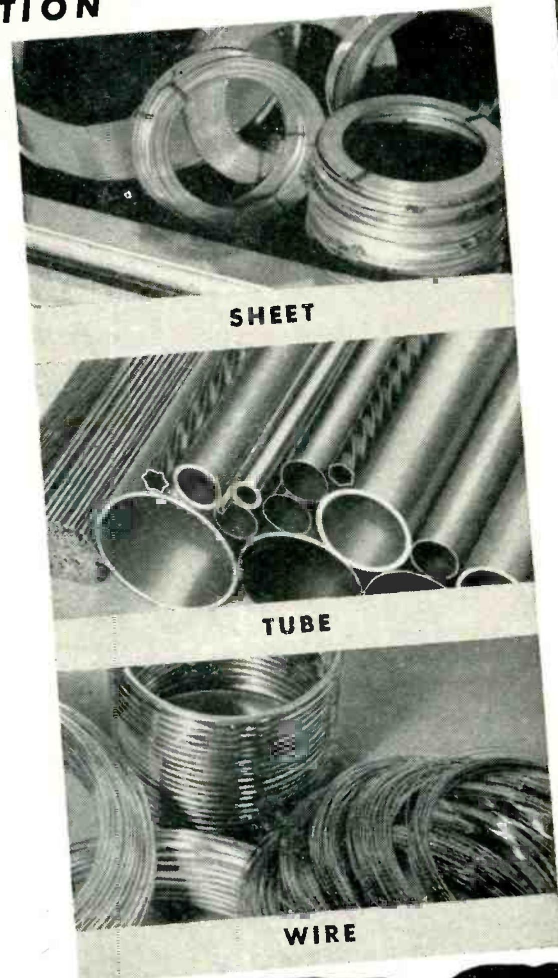
CAPACITORS

Molded Mica — Mica Trimmer

THE ELECTRO MOTIVE MFG. CO.
WILLIMANTIC, CONNECTICUT

When You NEED—

BETTER CORROSION RESISTANCE
HIGHER ELECTRICAL CONDUCTIVITY
LONG-LIVED OPERATION
PLUS ECONOMY



General Plate LAMINATED METALS

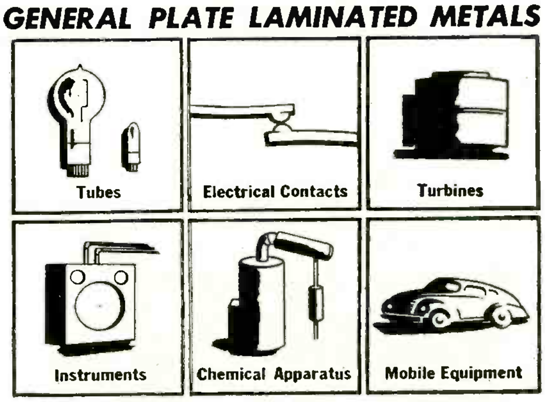
are your answer

Manufacturers and designers of peacetime products who want exceptional performance characteristics, long operating life and low overall cost of materials should investigate and become familiar with the advantages offered by General Plate Laminated Metals.

These combinations of precious metals permanently bonded to low cost base metals give you the performance of solid precious metals yet cost slightly more than the base metal itself. For instance, your designs call for high corrosion resistance . . . General Plate sheet, wire and tube meet the requirements with a thin layer of silver. In contacts, a lamination of silver at the actual point of contact gives the desired high electrical conductivity costing a fraction over the base metal.

Whether it's a redesigned pre-war product or an entirely new item, plan to use General Plated Laminated Metals. They'll save you money, improve performance and assure long life. They are available in combinations of precious metals to base metals or base to base metal laminations. New laminated combinations developed since the war are also available. Our engineers are available for consultation. Write for information today.

Where to use
GENERAL PLATE LAMINATED METALS

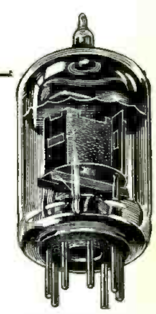


General Plate Division

of Metals & Controls Corporation

50 Church St., New York, N. Y.; 205 W. Wacker Drive, Chicago, Ill.; 2635 Page Drive, Altadena, California; Grant Bldg., Pittsburgh, Pa.
ATTLEBORO, MASSACHUSETTS

more efficient ... in miniature



ACTUAL SIZE

The old quill was picturesque but it lacked the compactness, convenience and dependability of our modern fountain pen. Its development was the usual evolution. Changes and reduction in size made for greater efficiency. The same took place in the development of the modern miniature electronic tube.

While the reduced size of TUNG-SOL Miniatures alone warrants a preference for them, their greater efficiency has resulted in their general adoption, especially for high frequency circuits. Smaller elements make them more rigid. Shorter leads result in lower lead inductance. TUNG-SOL Miniatures have low capacity and high mutual conductance.

The TUNG-SOL interest in electronics is the development and production of more efficient electronic tubes. Equipment manufacturers are invited to consult with TUNG-SOL engineers on problems of circuit planning and tube selection. Consultation is always confidential.

TUNG-SOL

vibration-tested

ELECTRONIC TUBES

ARMY E NAVY

TUNG-SOL LAMP WORKS INC., NEWARK 4, NEW JERSEY

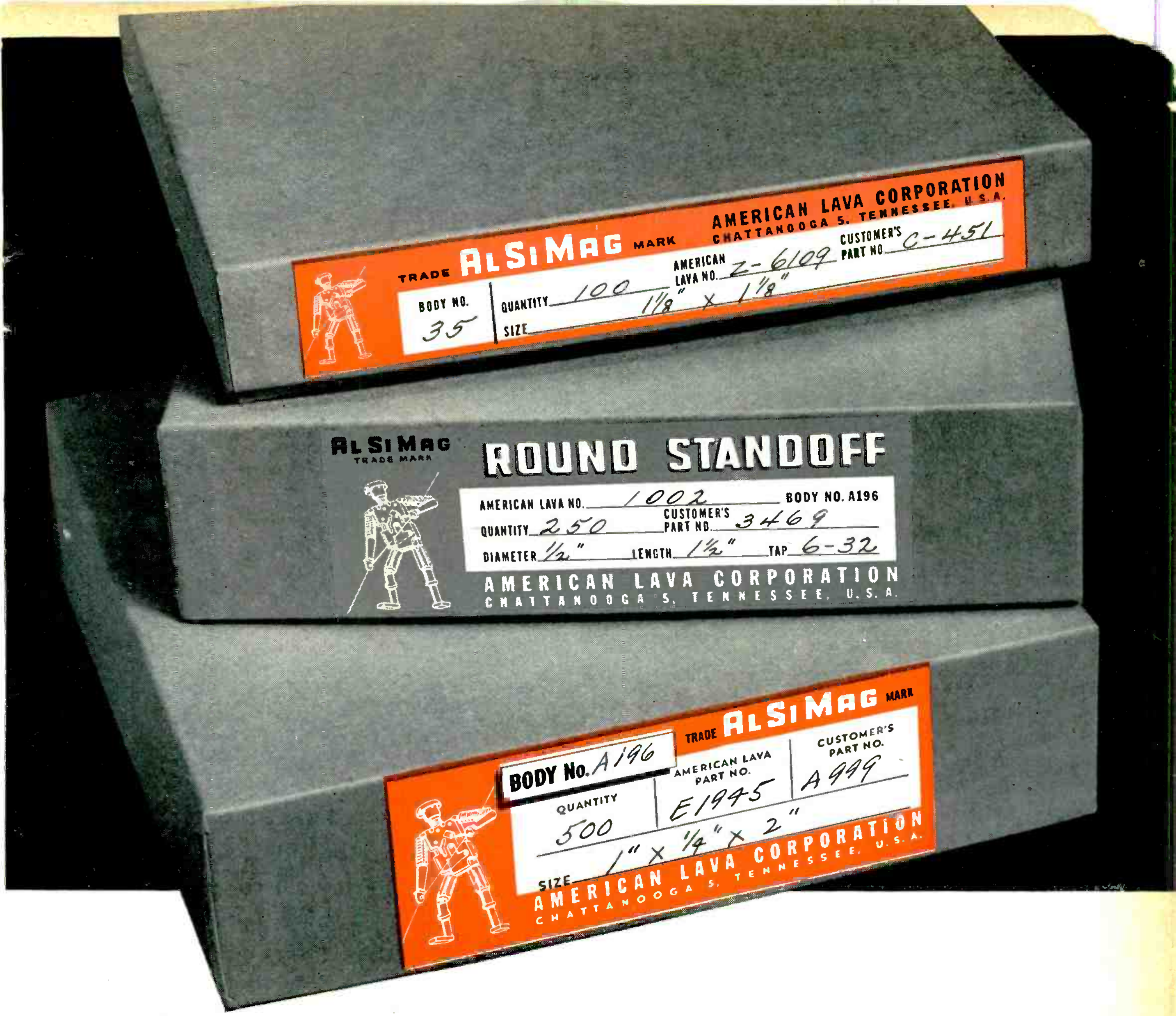
Also Manufacturers of Miniature Incandescent Lamps, All-Glass Sealed Beam Headlight Lamps and Current Intermittors other methods of modulation since only the spacing of the pulses is important. The pulse shape need not be exactly reproduced and this permits most of the tube noise to be eliminated merely by clipping the bottoms and peaks of the received pulses. Cross-talk from adjacent channels is completely eliminated because only one channel is actually on the air at one time. Another advantage of the system is the fact that telephone dialing and bell-ringing operations can be easily effected since it is feasible to transmit direct current for these functions without additional equipment.

Cyclophon Provides Electronic Switching

Placing of 24 two-way voice channels on a single carrier is accomplished by a new cathode-ray tube called a cyclophon, which rotates a cathode-ray beam in sequence to each of 24 dynodes that feed the 24 channels. The beam makes 8,000 complete revolutions per second, with the result that signals forming the sound are put into receivers so fast that the human ear cannot distinguish any intervals between them, thereby making for exact duplication of speech or music.

The electronic time selection devices at both the sending and the receiving stations operate in perfect unison to avoid cross-talk and other confusion. This is accomplished by transmission of a synchronization pulse at the beginning of each cycle so both time selection devices start off together.

The stations both send and receive, changing from one to the other with lightning speed. So rapid are the changeovers effected that they are not noticeable in a two-way telephone conversation, even if the two parties talk at the same time. Each vibration of the vocal cords is transmitted as 6 to 12 separate pulses, with the tube circuits and the human ear together filling in the gaps between pulses at the receiving end. The audible results which ptm present to the ear can be compared with visual effects which the motion picture presents to the eye. Although the screen in a motion picture theater



MARK OF QUALITY

The new AlSiMag labels represent a new convenience in parts identification for our customers. But more than that, they are the mark of insulators made to the highest known standards of quality.

Rely on AlSiMag—the foundation of *quality* equipment in the electronic and electrical field.

AlSiMag Steatite Ceramic Insulators are custom-made to your specifications. High speed production is usually possible with pressed and extruded parts. Inquiries are invited.

ALCO has been awarded for the fifth time the Army-Navy "E" Award for continued excellence in quantity and quality of essential war production.

AMERICAN LAVA CORPORATION
CHATTANOOGA 5, TENNESSEE

43RD YEAR OF CERAMIC LEADERSHIP


KEN-RAD
Little Giant MINIATURE TUBES
Better than ever
● Power-packed Ken-Rad Miniature Tubes have contributed much to the success of portables and other compact radio units . . . Now important added facilities assure still finer tube performance . . . Through Ken-Rad's effort top-quality tubes, built steadily better, will continue to meet the highest requirements of designers and manufacturers of electronic equipment.
Write for your copy of "Essential Characteristics" the most complete digest of tube information available.
KEN-RAD
DIVISION OF GENERAL ELECTRIC COMPANY
OWENSBORO, KENTUCKY

is completely dark much of the time that a film is being shown, the eye is not quick enough to detect the dark intervals.

The present system is the logical outgrowth of the pioneering efforts of the I.T.&T. companies, dating back to 1931 with the Dover-Calais microwave communication system and the first multi-channel voice communication circuits between Scotland and Ireland. The entire sending apparatus can be made to occupy a cabinet only three feet high and covering a floor space 20 inches square, and containing fewer tubes than the average home radio. The receiver cabinet is similar in size and number of tubes.

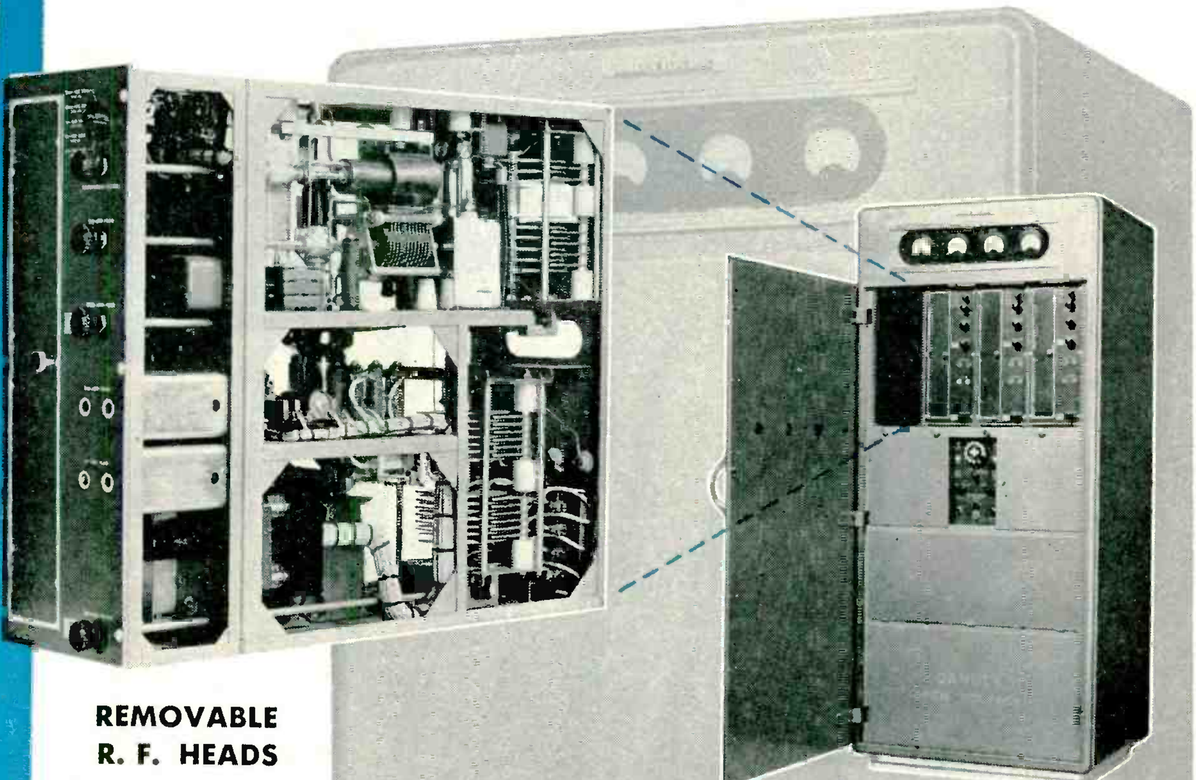
Advantages and Applications

A special advantage claimed for ptm is the reduction of static, cross-talk and other noises in the reception as compared to other radio systems—a-m and f-m. This is due to the fact that these systems use the whole radio wave but ptm can filter out all but a small portion of the wave and the time position of the pulses remains unchanged. Wave distortion therefore has a much smaller effect. This feature permits the widespread use of repeater stations, where a transmission is picked up and retransmitted to another station. The noise does not accumulate in the relayed message. The repeater stations are required approximately every 30 miles, but operate automatically and require no attendants. The clarity of reception obtained is valuable in radio and television broadcasting. Of especial significance is the fact that it makes possible the transmission of many music programs simultaneously over the system.

With the new system it will be possible to dial long distance numbers directly, say from New York to San Francisco, without going through long distance operators as in the present telephone system. Ptm may therefore find use advantageously in radio-telephone systems for railroads, taxi companies, etc—in fact, any application where multi-channel operation, versatility, and clarity of reception are desired.

The ptm system is also applicable

Wilcox Type 99A Transmitter



REMOVABLE R. F. HEADS

All radio frequency circuits are included in the 2—20 Mc. R.F. head shown above. All connections to the transmitter cabinet are by means of plugs and receptacles.

A medium power transmitter, designed particularly for aeronautical service. Equally adaptable to other fixed services. Check these features for their application to your communication problems:

★ Four transmitting channels, in the following frequency ranges:
125—525 Kc. Low Frequency.
2— 20 Mc. High Frequency.
100—160 Mc. Very High Frequency.
Other frequencies by special order.

★ Simultaneous channel operation, in following maximum combinations:
3 Channels telegraph.
2 Channels telephone.
1 Channel telephone, 2 Channels telegraph.

★ Complete remote control by a single telephone pair per operator.

★ 400 Watt plus carrier power.

★ Low first cost. Removable radio frequency heads are your protection against frequency obsolescence.

★ Reliability backed by two years of engineering research, one year of actual field operation.

★ Available with all-steel, or wood pre-fabricated transmitter house complete with primary power, antenna, and ventilation fittings.

★ Not a "post-war plan," but a field-tested transmitter now in production.

An inquiry on your letterhead outlining your requirements will bring you complete data.

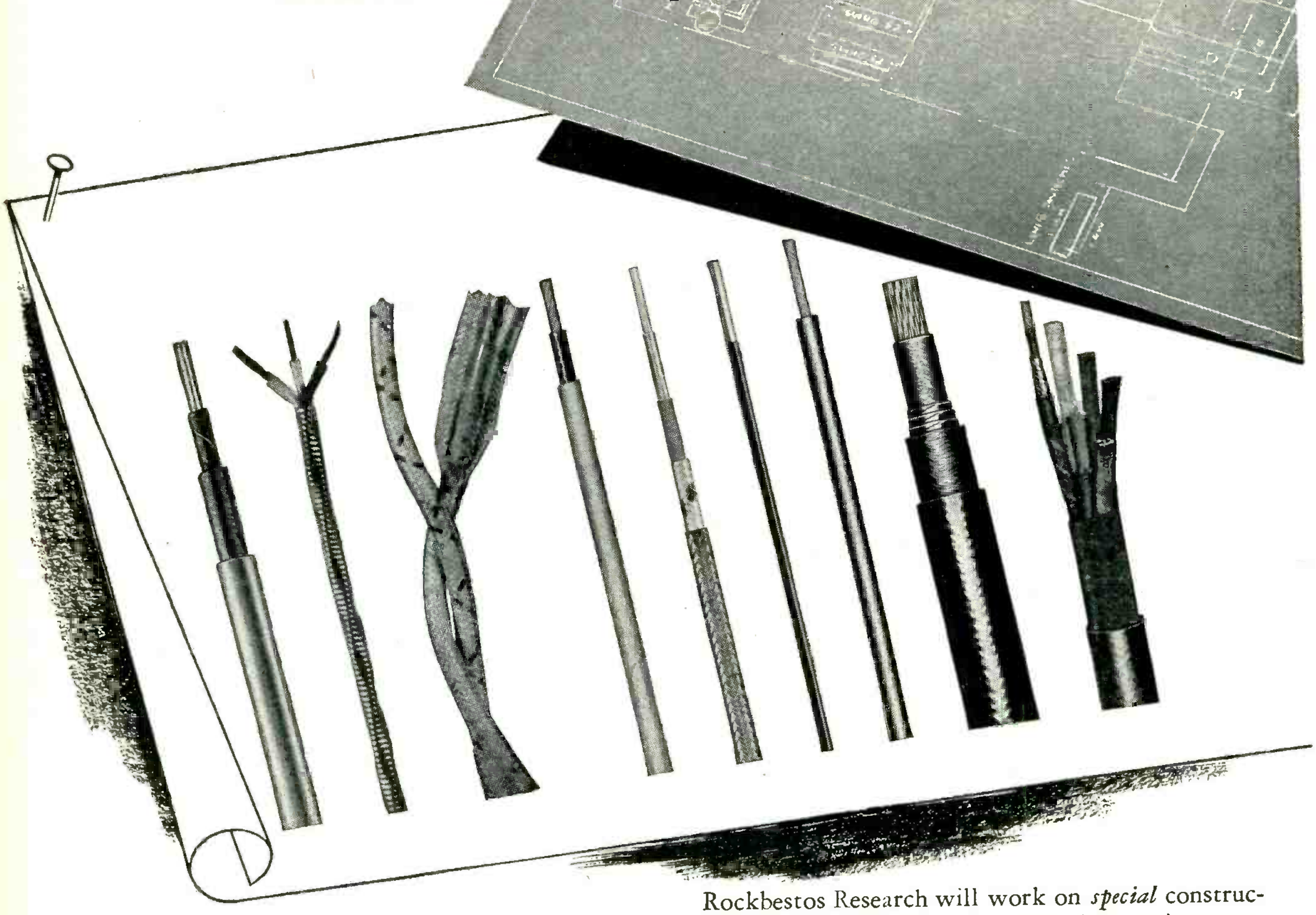
WILCOX ELECTRIC COMPANY, INC.

Manufacturers of Radio Equipment

Fourteenth and Chestnut · **Kansas City, Missouri**

Formula FOR PREVENTING WIRE-FAILURES

Match Wire Specs to Product Plans



125 Permanently Insulated Rockbestos Wires, Cables and Cords give trouble-free performance

To protect your product from wire-failures, the simplest formula is to avoid all trouble starters by wire-planning and using wire that meets every performance requirement.

Typical insulation destroying factors in service that can not always be avoided are high ambient temperatures, aging and ozone oxidation, moisture, alkalies, solvents, overloads, cracking caused by vibration and abrasion, fungus, oil, grease and corrosive fumes.

Whether your product is entirely new or a redesigned pre-war item, you'll find that *permanently insulated* wires, cables and cords provide performance protection that cuts wire-failures, service calls and factory returns to practically zero.

Rockbestos *permanently* insulated wires, cables and cords are available in 125 standard constructions... all resistant to heat, flame, moisture, cold, oil, grease and other destructive elements.

Rockbestos Research will work on *special* constructions where standards won't meet the requirements.

Phone, wire or write for complete information, wire engineering assistance or samples to nearest district office or:

ROCKBESTOS PRODUCTS CORPORATION
429 Nicoll Street, New Haven 4, Conn.

A 400°F. WIRE—
NEW ROCKBESTOS FIREWALL CONSTRUCTION

War-developed Rockbestos High-Temperature Wire—*with a maximum operating temperature of 400°F.*—designed for jet propelled plane applications and circuits to hot-wing de-icers, fire detectors and extinguishers, and air conditioning and heating units where baking temperatures destroy ordinary insulation. Under continuous operation at rated temperature it retains its original dielectric strength and inherent resistance to heat and flame, and *progressively improves* in its resistance to moisture and abrasion. Now available for these and other severe applications. Write for complete information and samples.

BUY VICTORY BONDS!

ROCKBESTOS RESEARCH

Solves Difficult Wiring Problems

NEW YORK BUFFALO CLEVELAND LOS ANGELES PITTSBURGH
CHICAGO ST. LOUIS SAN FRANCISCO SEATTLE PORTLAND, ORE.

For Quick Visual Indication

Investigate the Unique Characteristics of G-E Neon Glow Lamps

THE unique characteristics of General Electric Neon Glow Lamps recommend them for a variety of uses in radios and electronic devices . . . as indicators, voltage regulators, pilot lights and test lamps.

The uses described at right are typical. If you think G-E Neon Glow Lamps can be useful to you, write or phone the address below. Experienced General Electric Lamp Engineers will be glad to discuss your problems with you.

NE-51 For general indication, such as showing existence of potential across various parts of electrical circuits.

NE-17 Indicator and pilot light lamp that flashes to show condition of B-battery in portable radios. Frequency of flashes decreases as battery runs down.

NE-48 (also N-E 16). Indicator lamps. Special volt-ampere characteristics of these lamps indicate use as voltage regulators. Screw base lamp available as NE-45.*

*NE-16 meets JAN-1A specifications for 991. Special marking JCG-991 supplied for small extra charge.

CONSIDER THESE ADVANTAGES

1. **Distinctive orange-red glow — no colored cover glass needed.**
2. **Dependable performance and long life — rated at 3,000 hours.**
3. **Very low current consumption — less than ½ milliampere for smallest lamp.**
4. **Variety of sizes and wattages.**
5. **High resistance to vibration, shock.**
6. **Normally usable on a-c or d-c.**
7. **Screw base lamps for 105-125 v. circuits; similar lamps available with bayonet bases, but external resistance required.**
8. **Produce practically no heat.**
9. **Nearly flat volt-ampere characteristics.**
10. **Insensitive to voltage variations above critical value.**

ORDER NO.	NE-2	NE-51	NE-17	NE-48	④ NE-16	NE-45	NE-30	NE-32	NE-34	NE-36	NE-40	NE-42
Watts, Nominal	1/25	1/25	③	¼	¼	¼	1	1	2	2	3	3
Volts (Circuit)	105-125	105-125	③	105-125	105-125	105-125	105-125	105-125	105-125	105-125	105-125	105-125
Starting Voltage ① AC / DC	65 / 90	65 / 90	③	65 / 90	— / ⑤	65 / 90	60 / 85	60 / 85	60 / 85	60 / 85	60 / 85	60 / 85
Base	★Unbased (Wire Terminals)	★S. C. Bay. Min.	★D. C. Bay. Cand.	★D. C. Bay. Cand.	★D. C. Bay. Cand.	Cand. Screw	Medium Screw	★D. C. Bay. Cand.	Medium Screw	★Sk. D. C. Bay. Cand.	Medium Screw	★Sk. D. C. Bay. Cand.
Maximum Overall Length	② 1 1/16″	1 3/16″	1½″	1½″	1½″	1⅝″	2 1/16″	2″	3 5/16″	3¾″	3 5/16″	3¾″
List Price (plus tax)	$.08	$.10	$.45	$.35	$.42	$.40	$.40	$.45	$.50	$.55	$.60	$.65

① Applies to lamp when new.
② Glass part; wire terminals extend additional 13/16″.
③ Designed for DC flashing operation in RC circuit.
④ Meets JAN-1A specifications for 991. Special marking JCG-991 supplied at small extra charge.
⑤ Designed for 67-87 Volts D.C. (D.C. operating voltage at 1.5 milliamperes, 53-65 volts).
★ All Bayonet Base Lamps Need External Resistance.

For further information, write address below for Bulletin 7100

NELA SPECIALTY DIVISION, LAMP DEPARTMENT

GENERAL ELECTRIC

1 Newark Street, Hoboken, N. J.

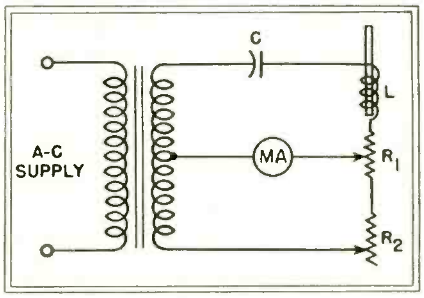
to the transmission of color television with sound on the same channel. If used for radio broadcasting, it would make possible the simultaneous transmission of twelve different programs from the same station.

• • •

Testing Coils for Shorted Turns

A SIMPLE and useful instrument for the rapid testing of coils is shown in the accompanying schematic. Reactance of the search coil L is balanced by capacitance C. Exact balance of the bridge is obtained with the resistor R_2; resistor R_1 being in the mid position.

The instrument is then adjusted for a-c supply by varying R_1 until a standard reading is obtained on



Circuit of simple coil testing unit capable of detecting a single shorted turn of 40-gage copper wire. The coil is placed over projecting core of inductor L

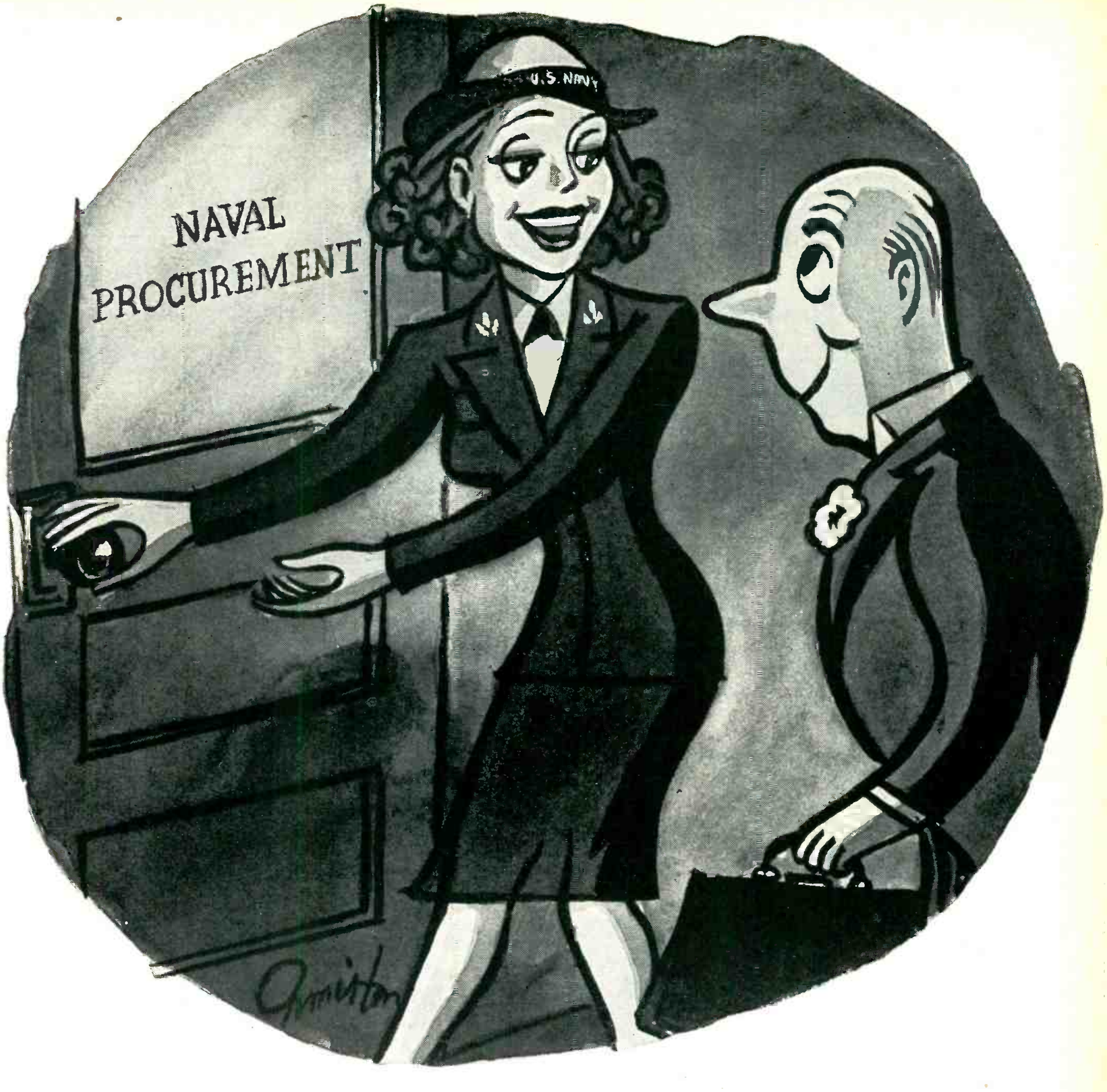
the rectifier-type milliammeter MA. The coil to be tested is placed over the projecting iron core of the search coil and if short-circuited turns are present the normal deflection of the meter will change.

It is claimed by the designers that a single short-circuited turn of 40-gage copper wire can be detected. This is an extreme case since in most bad windings two or more layers are shorted, hence there is usually considerable deflection. The tester is produced by Banner Electric Co., Hoddesdon, Hertfordshire, England.

• • •

Electronic Antenna-Analyzer

MATHEMATICAL COMPUTATIONS involved in the location and arrange-



This is not the kind of WAVE GUIDE we supply . . .

DE MORNAY
BUDD *inc.*

EQUIPMENT
FOR
97% OF ALL
RADAR SETS

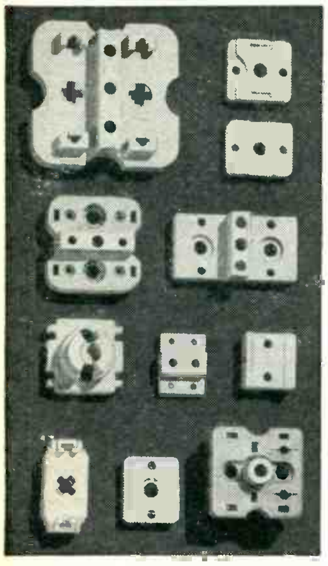
but we are recognized as experts on wave guides and other transmission line equipment in the micro-wave field. Now that the Radiation Laboratory at M.I.T. has closed shop, we invite all members of the electronic industry to visit our Micro-Wave Research Division. We are the *only organization* offering the services of one of the finest and most completely equipped ultra high frequency labs to the entire electronic industry. Inquiries on your RF problems are invited. Write "MWR" Division.

DE MORNAY-BUDD, INC., 475 GRAND CONCOURSE, NEW YORK, N. Y.

WAVE GUIDES • DIRECTIONAL COUPLERS • MIXERS
CO-AXIAL STUB SUPPORTED LINES • ROTATING JOINTS
R. F. BENCH AND FIELD TESTING EQUIPMENT • AMPLIFIERS
MODULATORS • I. F. STRIPS • ANTENNAE

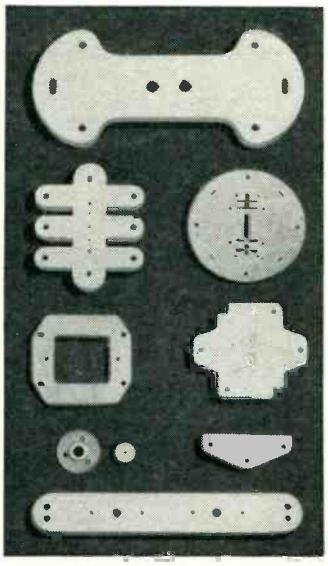
STUPAKOFF

CERAMIC INSULATORS FOR YOUR PRODUCTS



PADDER AND TRIMMER BASES

Padder and trimmer bases that are mechanically strong, dimensionally accurate, and electrically stable, keep assembly lines flowing, minimize breakage in production and in use, insure consumer satisfaction. STUPAKOFF combines mass production with laboratory precision. Exacting control extends from scientific testing of raw material through final packing. STUPAKOFF engineers are at your service.



TUBE PARTS

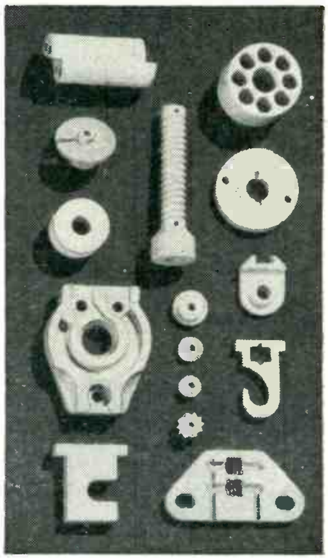
From the day when the first STUPAKOFF ceramic heater insulator was produced for the first A. C. radio tube, the name STUPAKOFF has been a synonym for quality in the field of radio ceramics. Adherence to specification tolerances, both mechanical and electrical, and to the proper material for the specific application are integrated in every STUPAKOFF product.

RESISTOR PARTS

STUPAKOFF produces precision-made ceramic resistor parts as rods, plain or threaded; as tubes, plain or threaded; as winding forms for *all* types of resistors; and metallized for solder-sealed resistors. STUPAKOFF ceramics are dense and sturdy, vitrified to withstand moisture, resistant to vibration and thermal shocks.

ELECTRIC APPLIANCE CERAMICS

STUPAKOFF insulators are planned to meet the demands of assembly line production and to endure the rigorous usage requirements, thus minimizing field failures and service calls. Made vitrified, dense, non-hygroscopic or porous as required. Made to withstand sudden temperature changes without fracturing. Engineered to suit the job.



★ BUY VICTORY BONDS ★

ARMY E NAVY "FOR GREAT ACHIEVEMENT"

STUPAKOFF CERAMIC AND MANUFACTURING CO., LATROBE, PA.

Products for the World of Electronics

RADIO MANUFACTURERS ASSOCIATION RMA MEMBER

ment of directional-antenna towers are quickly performed by the Antennalyzer, a new piece of computing equipment developed at RCA Laboratories and shown in operation in Fig. 1.

Using 52 electron tubes, the gear

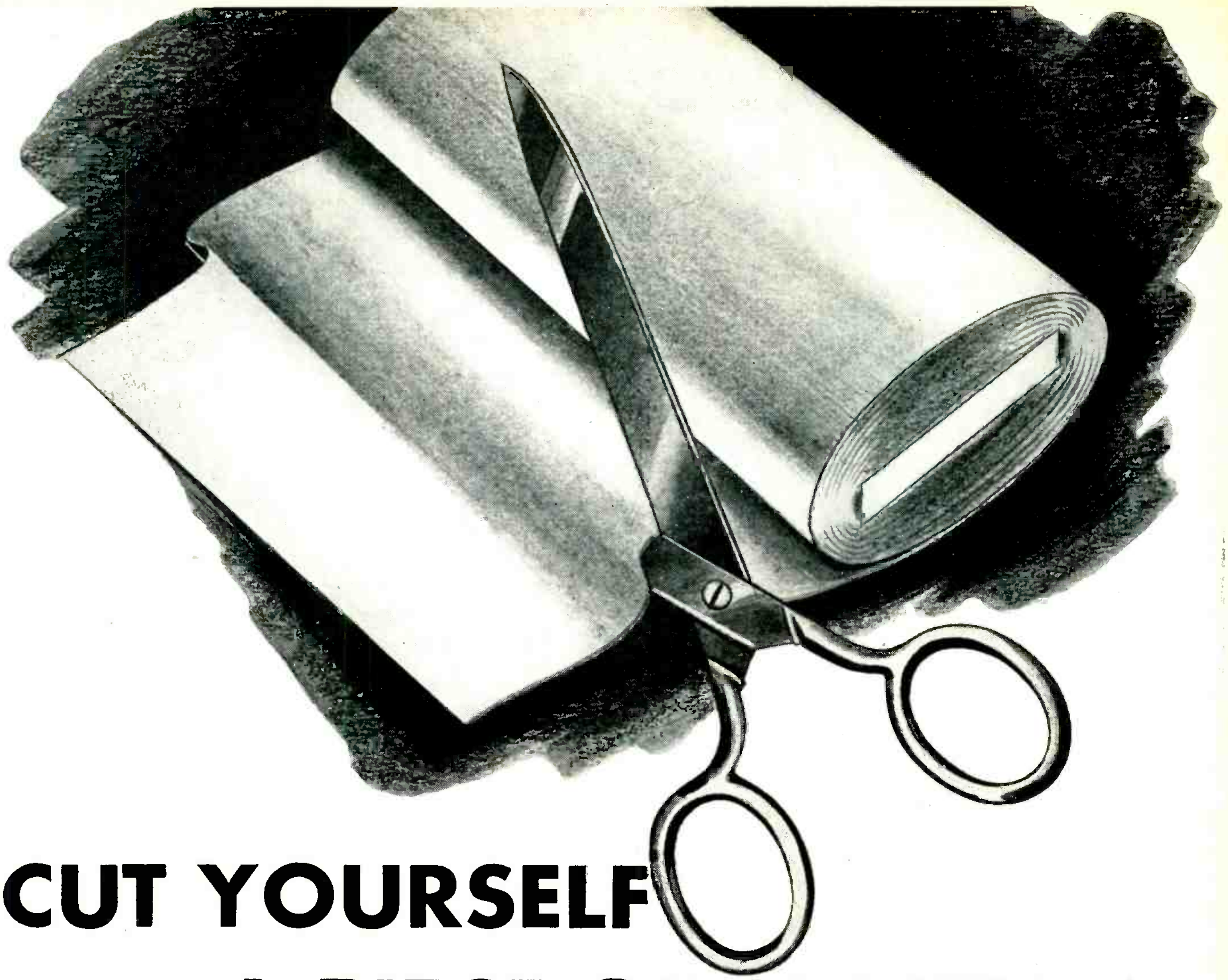
Fig. 1—An RCA technician manipulates the controls of the Antennalyzer which solves the mathematics of directional antenna-array design

is adjusted until the pattern on a c-r screen reproduces the desired field of the projected transmitter. Corresponding dial readings provide data on the location of towers and give all the electrical parameters connected with the overall design of the array.

A rear view of the equipment is shown in Fig. 2. Mathematically, its operation in the case of a five tower array depends on solution of the equation

$$F = KI_A \sqrt{\begin{aligned}&\Big\{1 + M_B \cos\left(\alpha_B + \tfrac{2\pi d_B}{\lambda}\cos[\phi-\theta_B]\right) + M_C \cos\left(\alpha_C + \tfrac{2\pi d_C}{\lambda}\cos[\phi-\theta_C]\right)\\&+ M_D \cos\left(\alpha_D + \tfrac{2\pi d_D}{\lambda}\cos[\phi-\theta_D]\right) + M_E \cos\left(\alpha_E + \tfrac{2\pi d_E}{\lambda}\cos[\phi-\theta_E]\right)\Big\}^2\\&+ \Big\{M_B \sin\left(\alpha_B + \tfrac{2\pi d_B}{\lambda}\cos[\phi-\theta_B]\right) + M_C \sin\left(\alpha_C + \tfrac{2\pi d_C}{\lambda}\cos[\phi-\theta_C]\right)\\&+ M_D \sin\left(\alpha_D + \tfrac{2\pi d_D}{\lambda}\cos[\phi-\theta_D]\right) + M_E \sin\left(\alpha_E + \tfrac{2\pi d_E}{\lambda}\cos[\phi-\theta_E]\right)\Big\}^2\end{aligned}}$$

where F is field strength in direction of angle ϕ, M is current ratio in each tower relative to tower A, α is phase angle of each tower current, d is spacing from a reference point of each tower, λ is frequency of transmission, ϕ is angle whose function is used to plot field



CUT YOURSELF A PIECE OF *PLASTIC*

Most plastics are hard. Have to be sawed and machined. Imagine, then, a plastic that handles as easily as any ordinary cloth. Sheer and pliant. Or coarse as burlap, if you prefer it that way, and still pliant. Not a cloth — not a plastic, but a happy combination of both, *Holliston Processed Cloths* may be water-proof, mildly resistant to common acids, and certain styles will withstand moderate heat. Because of these and certain interesting dielectric and acoustic properties they're a challenge to your ingenuity.

Research and development men are going to think up a lot of new uses for *Holliston Processed Cloths*, thereby solving knotty problems that now confront them. Wherever possible, we'll be glad to assist with samples for testing, specifications and suggestions.

Got a Problem? — Ask our Research Department.

The HOLLISTON MILLS, Inc.

Processors of Cloth for Special Purposes

NORWOOD, MASSACHUSETTS

Sales Agents in Principal Cities

Cloth Bound

A cloth bound book is bound to be kept — bind your

CATALOG — SALES MANUAL — INSTRUCTION BOOK, ETC.

in HOLLISTON Book Cloth — durable, impressive, hard-to-soil, easy-to-clean.

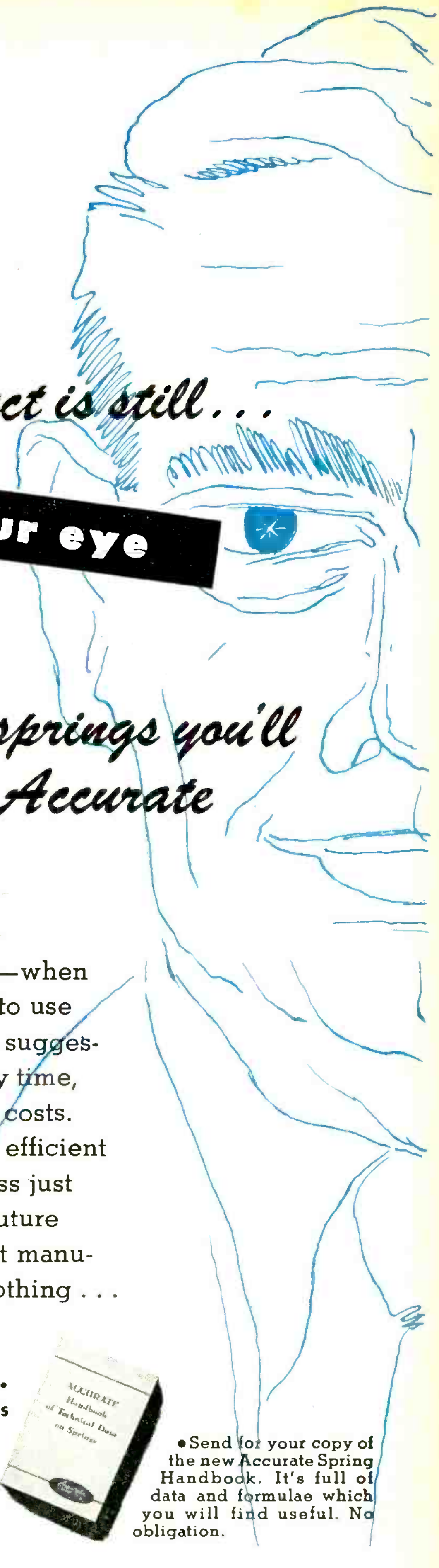
Write for samples.
Consult your printer.

SPECIAL FINISH

HOLLISTON special finish cloths meet special needs —

TRACING CLOTH — PHOTO CLOTH — RUBBER (PROCESSING) CLOTH — BOOK CLOTH — SHADE CLOTH — SIGN CLOTH — TAG CLOTH.

Cloth combined with special compounds, filled, impregnated, coated — to form a material with characteristics of a plastic and the flexible strength of a woven fabric.



WHILE *your new product is still . . .*

a gleam in your eye

THEN *. . . discuss the springs you'll need with Accurate*

it's a good way to save time, trouble and money

• Often, when we know all the influencing factors—when we know how and why and where you are going to use springs—we can make helpful suggestions. These suggestions may improve your product, shorten assembly time, increase spring efficiency and perhaps cut spring costs.

We don't say we can work miracles. But . . . the efficient use and application of spring power is our business just as well as is their manufacture. In planning your future products, ask us about the springs *before* you start manufacturing—in confidence, of course. It costs you nothing . . . and may pay you well.

ACCURATE SPRING MANUFACTURING CO.
3830 West Lake Street **Chicago 24, Illinois**

Accurate Springs

SPRINGS
WIRE FORMS
STAMPINGS

• Send for your copy of the new Accurate Spring Handbook. It's full of data and formulae which you will find useful. No obligation.

strength of system, θ is azimuth angle of each tower with respect to a reference line.

Field tests and calculations which formerly required weeks can now be executed in a matter of minutes. The Antennalyzer adds and subtracts angles, looks up trigonometric functions, adds numbers, squares them, and ends by taking the square root. Radiation patterns can be converted from rectangular to polar coordinates at the flick of a switch.

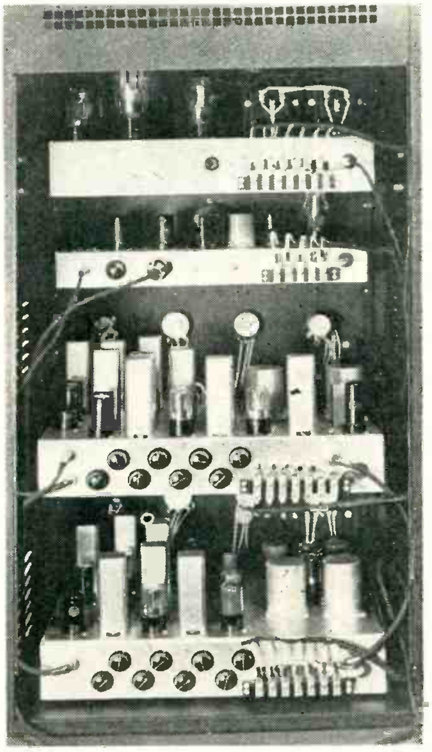


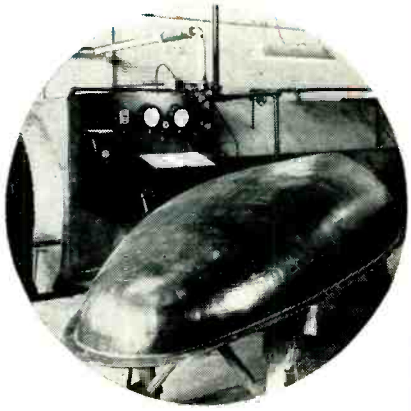
Fig. 2—Rear view of analyzer. Entire gear includes 52 electron tubes, reduces work of weeks to a few minutes

• • •

German Magnetic-Tape Recorder

USING TISSUE-THIN plastic-base tape impregnated with iron oxide, a recording and playback unit developed in Germany has a flat frequency response from 50 to 8000 cps with only a slight falling-off up to 12,000. Manufactured by the E. E. G. Magnetophon Co., the device was reported by *Broadcasting*.

Recording tape costs three dollars a roll and runs for about twenty minutes. The material is



Plastics progress sails along *on molded hulls*

Co-Ro-Lite, a Durez-resin-impregnated sisal fiber, has been noted as a plastic material of tremendous strength with unusual adaptability to large moldings. That the Columbian Rope Company, producers of Co-Ro-Lite should successfully develop a sailing boat with a hull molded of this material seems a logical step forward in plastics progress . . typifies the foresight and progressiveness of the industry as a whole.

The development of this Co-Ro-Lite sailboat is an outgrowth of the Columbian Rope Company's wartime experience in making large moldings such as jettison tanks, glider noses, and engine nacelles. The experience gained in molding these items seemed to be applicable to fashioning a strong lightweight sailboat hull.

Molding The Hull

To mold the hull, a thick blanket of rope fibers was first cut into a rough shape resembling the finished boat. This blanket was then mechanically dusted in a vibrator machine with a powdered Durez phenolic resin to the extent of 50 to 55% content. This combination was then bag-molded into the finished hull. The deck was molded separately but in a similar manner.

The inherent properties such as durability, moisture resistance, and impact strength which the Durez resin used for this purpose possesses, combined with the tremendous strength of sisal fibers, make a lightweight hull of unusual durability... a hull with no ribs or internal bracing.

Many Advantages

In addition to the production economies which Co-Ro-Lite effects, this Durez-resin-impregnated sisal fiber sailboat has no seams to be caulked. Furthermore, the monocoque construction provides a boat which does not have to be worked over each season, aside from painting, and offers a clean interior with no ribs to catch dirt. Besides this, submersion tests conducted in Florida waters prove this plastic boat resists penetration by barnacles and other growth.

Competent Assistance Available

The Co-Ro-Lite sailboat is but one of many highly successful developments in which Durez phenolic plastics were used.

As specialists in the production of the versatile phenolics for the past quarter century, Durez technicians have acquired a rich background of successful product development work. The benefits which this background and a wealth of proved data can provide are available to you and your custom molder at all times. Durez Plastics & Chemicals, Inc., 3211 Walck Road, North Tonawanda, N. Y.

DUREZ

PHENOLIC RESINS

- MOLDING COMPOUNDS
- INDUSTRIAL RESINS
- OIL SOLUBLE RESINS

PLASTICS THAT FIT THE JOB

Model 201

The Time-Tested, Reliable

VIBROTEST

Insulation Resistance Tester

Since 1938 VIBROTESTS have proven the soundness of this modern method of testing insulation resistance. Superbly engineered, ruggedly built, this pioneer instrument in CRANKLESS INSULATION TESTING offers the utmost in usefulness and value.

VIBROTEST

Is Thoroughly Modern—

No hand cranking, no leveling, no shocks to the operators. Wide range 0-200 megohms covering values usually encountered in general testing, are instantly available from a self-contained power source providing a constant potential of 500 Volts D.C.

Available in this one compact instrument are a convenient Ohmmeter scale as well as A.C. and D.C. voltage ranges up to and including 600 volts full scale. Other models with 1,000 volts D.C. potential also available.

Many Other VIBROTESTS

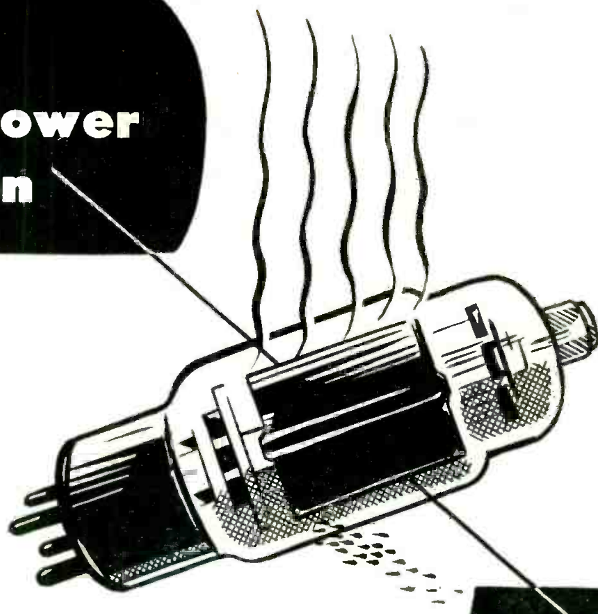
are designed for specific uses involving unusual ranges or operating conditions. WRITE for full information at your earliest opportunity.

Engineering Service Representatives in All Principal Cities

ASSOCIATED RESEARCH, Incorporated

**223 So. Green St.
Chicago 7, Ill.**

4 TIMES greater power dissipation



with SPEER GRAPHITE ANODES

- **SPEER GRAPHITE . . . 70 WATTS**
- **MATERIAL "A" . . . 16 WATTS**
- **MATERIAL "B" . . . 14 WATTS**

(based on comparison at 510°C)

How much power will a transmitting or rectifying tube safely handle? That largely depends on the ability of the anodes to dissipate the heat of operation. And *that* in turn depends on the anode material.

Tubes with SPEER Graphite Anodes, tested at the temperature at which all anodes begin to show red color, dissipated 70 watts—a dissipating value *4 times higher* than the average of two other widely used anode materials tested in identical tubes. SPEER Graphite Anodes rated *3½ times better* than the second best material. This greater heat dissipating value of SPEER Graphite Anodes greatly lessens the possibility of tube damage due to warping and fusing.

Graphite's native properties, and the manufacturing techniques that give SPEER Graphite Anodes their high radiating emissivity and high thermal conductivity, also effect the other advantages listed at right. Whether you make or use tubes, if they have SPEER Graphite Anodes—you can count on consistently uniform performance *throughout life* of your tubes. Write for details now.

DO YOU KNOW SPEER GRAPHITE ANODES?

- Increase allowable plate power dissipation.
- Lower temperatures of associated tube parts.
- Withstand severe overloads.
- Defy warping.
- Prevent hot spots of fused holes.
- Minimize bulb darkening and insulator leakage.
- Improve degassing qualities.
- Decrease gas troubles.
- Enhance tube appearance.
- Provide precise anode dimensions.
- Produce uniform tube characteristics.
- Retain original dimensions in service.
- Maintain normal tube characteristics.
- Allow wide latitude of anode design.

CHICAGO • CLEVELAND • DETROIT
MILWAUKEE • NEW YORK • PITTSBURGH

manufactured by I. G. Farben. Three heads are used on the machine, one for erasing, one for recording, and one for playback. In the rare case of tape breakage, repairs are quickly made with a chemical supplied for the purpose.

American engineers who have checked the gear indicate that it excels conventional recordings in dynamic range, absence of noise, and ease of editing as well as frequency response. Life seems unlimited, some of the recordings having been used at Radio Luxembourg since 1941 with no sign of deterioration.

• • •

Crystal Oven Anticipates Temperature Changes

CAPABLE OF UNDERGOING the rigorous conditions of military service from the points of view of temperature range and rough service, a new thermally regulated quartz crystal oven has been designed for airborne radio equipment by engineers of Federal Telephone and Radio Corp. In operation, it actually anticipates changes in ambient temperature before they reach the crystal. Basically, it consists of an inner Bakelite chamber to hold the crystals, an insulating air chamber surrounding the Bakelite one and containing heating coils and a limiting thermostat, and an outside Bakelite cover. The unit is $1\frac{3}{16}$ in. square and $2\frac{1}{8}$ in. high, including the standard 11-pin base upon which it is mounted. It holds one to three plated type of crystals or one or two of the pressure-mounted type, yet it occupies about one-fifth the space required for the previously manufactured ovens.

The working parts of the oven are as shown in the cutaway drawing. The inside Bakelite chamber *A* holds the crystals *B*, and is surrounded by a casing *C* of conductive material. An air space *D* surrounds this chamber and acts as an insulator between the outside atmosphere and that of the chamber *A*, since the temperature of the air in *D* is raised or lowered by the thermostatically controlled heater *E*. The thermostat *F* is of the bimetal type which closes on lowered temperature and is usually adjusted to

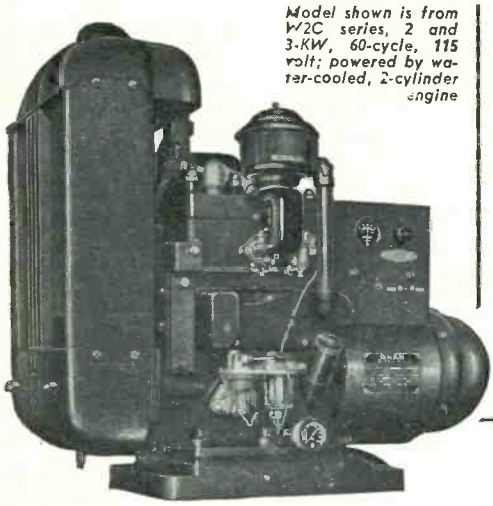
ELECTRICITY

FOR ANY JOB —ANYWHERE

★ ONAN ELECTRIC GENERATING PLANTS supply reliable, economical electric service for electronics applications as well as for scores of general uses.

Driven by Onan-built, 4-cycle gasoline engines, these power units are of single-unit, compact design and sturdy construction. Suitable for mobile, stationary or emergency service.

Model shown is from W2C series, 2 and 3-KW, 60-cycle, 115 volt; powered by water-cooled, 2-cylinder engine



ELECTRIC PLANTS
Onan
POWER AND LIGHT FOR EVERY NEED

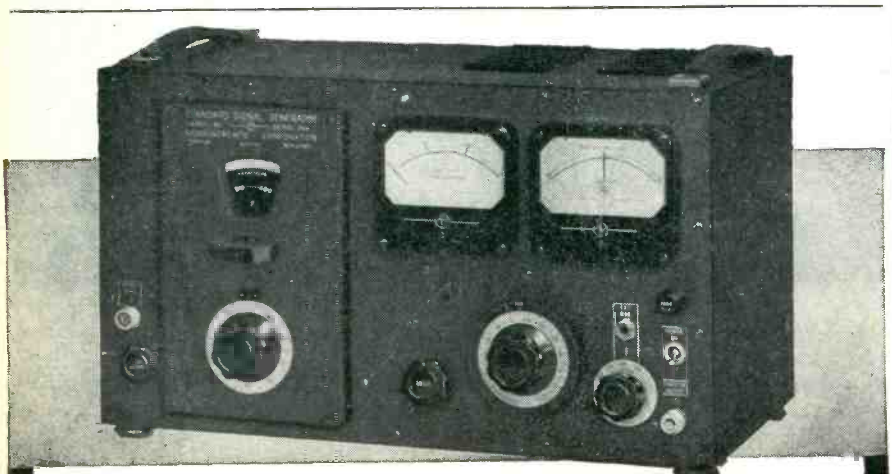
"Models range from 350 to 35,000 watts. A.C. types from 115 to 660 volts; 50, 60, 180 cycles, single or three-phase; 400, 500, and 800 cycle, single phase; also special frequencies.

D. C. types range from 6 to 4000 volts.

Dual voltage types available.

Write for engineering assistance or detailed literature".

D. W. ONAN & SONS 3270 Royalston Ave. Minneapolis 5, Minn.



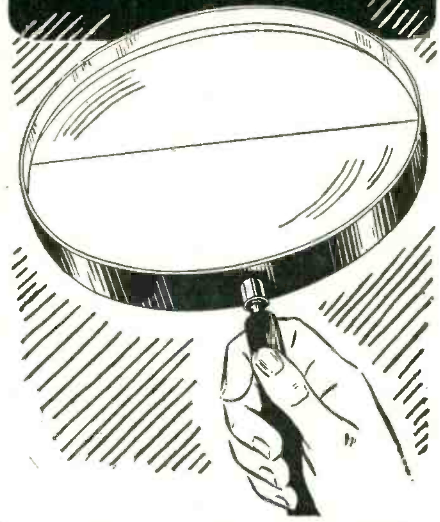
STANDARD SIGNAL GENERATOR Model 80

SPECIFICATIONS:

CARRIER FREQUENCY RANGE: 2 to 400 megacycles.
OUTPUT: 0.1 to 100,000 microvolts. 50 ohms output Impedance.
MODULATION: A M 0 to 30% at 400 or 1000 cycles internal.
Jack for external audio modulation.
Video modulation jack for connection of external pulse generator.
POWER SUPPLY: 117 volts, 50-60 cycles.
DIMENSIONS: Width 19", Height 10¾", Depth 9½".
WEIGHT: Approximately 35 lbs. PRICE—$465.00 f.o.b. Boonton.
Suitable connection cables and matching pads can be supplied on order.

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

WIRE SO FINE IT MUST BE *Magnified* TO BE SEEN



WOLLASTON PROCESS

Wire as small as

$\frac{1}{100,000}$ OF AN INCH IN DIAMETER

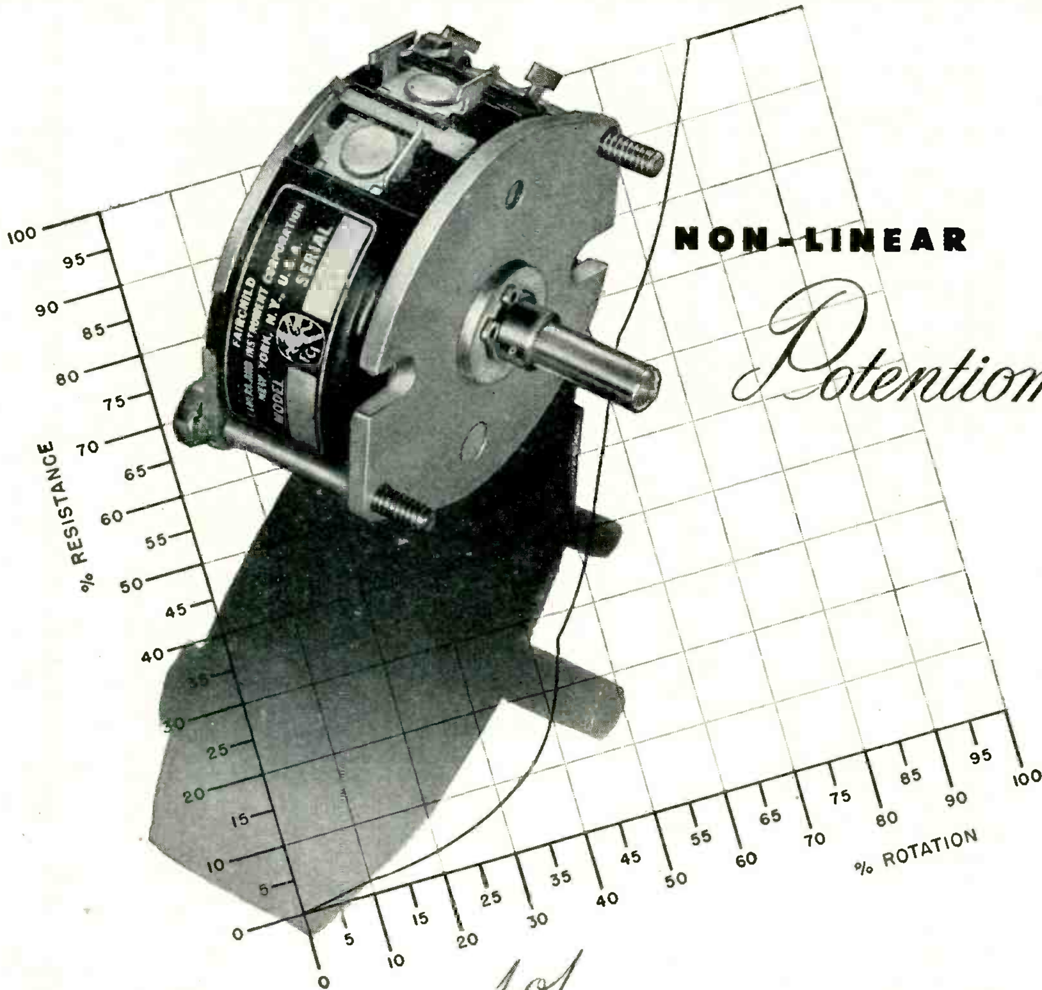
. . . available in Platinum and some other Metals

.00001" is less than 1/30 the diameter of the smallest wire die commercially available. Yet our Wollaston Process wire (drawn in a silver jacket) closely meets your specifications for diameter, resistance and other characteristics.

•

This organization specializes in wire and ribbon of smaller than commercial sizes and closer than commercial tolerances. *Write for List of Products.*

SIGMUND COHN & CO.
SINCE 1901
44 GOLD STREET NEW YORK 7



NON-LINEAR *Potentiometer*

operating accuracy within 1% of plotted performance

Look to the Fairchild *non-linear* Potentiometer for unexcelled accuracy. War born—to meet the never-before-attained accuracy required of T attenuators in airborne, electronic lead computing gunsights—it proved its accuracy in battle.

Industry is now offered the full advantages of this war-time development. It eliminates intricate, space-consuming, expensive mechanical cams and linkages and electrical units—used with or without linear potentiometers.

Fairchild's *non-linear* Potentiometer offers these excellent design possibilities: Small size—being 1⅝" in diameter, $\frac{25}{32}$" thick, with shaft diameter optional, but usually ¼"... high 'linearity'—ability to follow a plotted curve of resistance versus rotation within an error of 1% or less at any point on the curve ... great flexibility for reproducing almost any desired curve.

For further information address: *New York Office:* 475—10th Avenue, New York 18; *Plant:* 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.

CONSIDER THESE APPLICATIONS

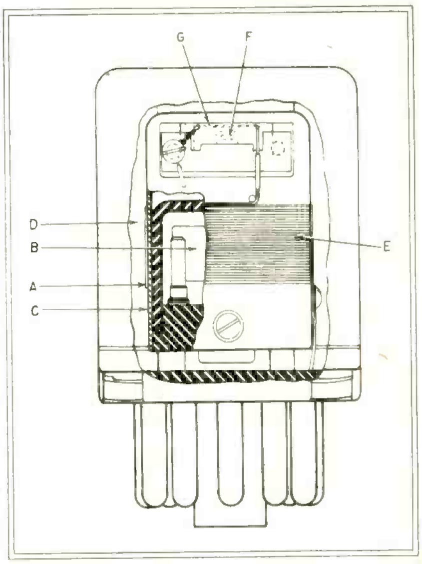
Fairchild non-linear Potentiometers can be adapted industrially to: instruments for process control, motor drives . . . computing and analyzing instruments and equipment . . . electronic heating . . . electro-medical equipment . . . aircraft and ship radio transmitter control rooms . . . AM, FM and television transmitter controls . . . recording, transcription and public address sound equipment . . . telephone long lines, etc.

Fairchild **CAMERA AND INSTRUMENT CORPORATION** a temperature of approximately 75 C.

An important feature of the oven is the trigger wire *G* placed in close proximity to the thermostat and connected in series with the heater. This wire raises the temperature of the thermostat as the heater is turned on, causing the thermostat to open without waiting for the heat to be conducted to the thermostat through the air space *D*. Such action prevents overshooting and makes for uniform temperature in the air space *D*.

Anticipating Action

Operation of the thermostat is an intermittent opening and closing of the switch, producing heat pulses in the main heater *E*. The pulses range from 10 per minute at minus 40 C to 1 per minute at plus 70 C. By this type of pulsating action, air



Cutaway view of the crystal oven for aircraft radio equipment that anticipates temperature changes

in the insulating chamber *D* is more rapidly heated whenever the ambient temperature drops and conversely it is less rapidly heated when the ambient rises, thus acting upon the insulating air in such a manner that temperature changes are anticipated before they reach the oven.

The oven is designed to operate over an ambient temperature range of minus 40 C to plus 70 C with the frequency drift not exceeding plus or minus 0.001 percent. At five

When the Factory says "No" ...We Say "YES!"

One of the biggest questions in the minds of most business men today is "when can we have the completed new products ready for consumer sale?"

Every meeting of the new-product planning board is sure to find the "factory" being pressed by the sales department's "when?".

You Can't Blame the Factory!

It would take more than a Houdini to extricate production lines from the hang-overs of war-time schedules which linger with us. Certain departments must yet be kept on some military production.

So when the factory manager says "no" to your pressure for a delivery promise, why not suggest to him that he isolate the parts or assemblies that are likely to cause the delays—and turn a good sub-contractor loose on them?

Let Lewyt Do It

For over fifty years we've been pinch-hitting for other manufacturers . . . producing parts or assemblies for them and dove-tailing our assembly lines into their production schedules.

We have developed techniques and shortcuts that enable us to work wonders with the calendar. Maybe we can help you beat the delivery date—and save you some money in the process, too!

At any rate it won't hurt to find out why some of America's leading industries have decided that it is a good policy, when facing a bottleneck in the plant, to "Let Lewyt Do It".

★ ★ ★

Write on your business stationery for 48-page book, "Let Lewyt Do It"—the story of the Lewyt organization in pictures. Lewyt Corporation, 62 Broadway, Brooklyn 11, N. Y.

Lewyt

FOR MORE THAN 50 YEARS A CONTRACT MANUFACTURER . . . EXPERTLY STAFFED TO PRODUCE COMPLETE ELECTRONIC AND MECHANICAL ASSEMBLIES, COMPONENT PARTS, SUB-ASSEMBLIES AND METAL PRODUCTS, TO THE MOST EXACTING REQUIREMENTS

BUY VICTORY BONDS

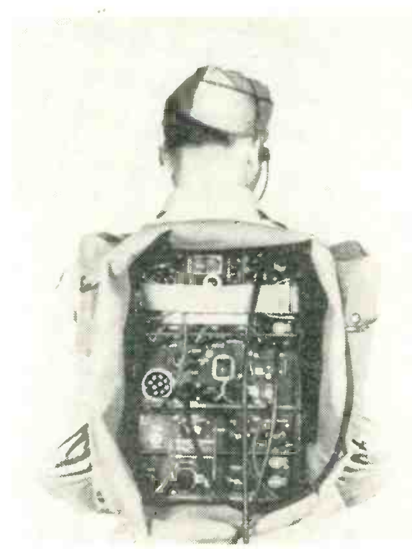
megacycles this would mean plus or minus 50 cycles, and with properly cut crystals the oven will operate to considerably less than half this tolerance. The actual total temperature deviation of the oven is one degree, and the temperature swing at any one ambient does not exceed three degrees.

The heater was designed to operate on 24 volts a-c or d-c. However, it was found that the oven is efficient at lower voltages when the temperature range is limited to a point where the heater will not operate continuously. Power consumption varies from one watt at 6 volts to approximately 14 watts at 24 volts. From five to eight minutes are required to enable a cold oven at minus 40 C to warm up sufficiently to provide stabilized frequency.

• • •

Piggieback Transceiver

ORIGINALLY DEVELOPED as a small receiver-transmitter combination for airborne troops, the SCR 694, as illustrated, is credited with being one of the most versatile units



Twenty pounds of transmitter-receiver in the single case of model SCR 694. At the right is the battery pocket, jumper-connected. With cover in place, the set is watertight enough to float without damage

ever sponsored by the Army Signal Corps. Infantry, artillery, amphibious, and Navy forces have found useful tasks for it as well.

The receiver is a sensitive 6-tube

ANSCO Gets Better Color Prints with G-E Voltage Stabilizer

● *Illumination of unvarying brightness* is essential for processing color prints and transparencies. A slight change in the voltage supplied to the lamp, used in exposing and printing, changes its color temperature and content, and makes accurate, uniform printing of color values difficult.

Ansco's San Francisco Laboratories, as part of their research to simplify color printing for amateur photographers, have found that the G-E voltage stabilizer is a substantial aid in assuring correct illumination.

This small, compact, automatic device, which can be connected to any 115-volt plug outlet, provides a constant power supply regardless of line-voltage fluctuations up to ± 15 per cent.

CONSTANT VOLTAGE may add new accuracy to your precision jobs, too

● On almost every precision job where electricity is used, a closely held voltage supply adds speed or accuracy, or decreases rejects. In addition, it protects delicate instruments, tools and electronic tubes from sudden overvoltages, and increases the reliability and life of such equipment.

If you are a user or manufacturer of such apparatus as radio transmitters, testing equipment, X-ray machines, other electronic devices, motion-picture projectors, and precision photographic equipment, it will pay you to investigate the benefits of G-E voltage stabilizers. They can be used as an accessory to present equipment or built into new, redesigned products to add salability.

These small, compact units are available in ratings from 50 to 5000 va. On circuits where the voltage may vary from 95 to 130 or 190 to 260 volts, they automatically provide a constant 115- or 230-volt output. Because they have no moving parts, the need for maintenance is practically nonexistent. Ask for Bulletin GEA-3634A for complete information. *General Electric Company, Schenectady 5, N. Y.*

Buy all the BONDS you can — *and keep all you buy*

GENERAL ELECTRIC

403-81-5205

A Name to Look for on Electrical COILS and Transformers

GRACOIL

"One Good Turn - or a Million"

Famous for years as COILS by DOYLE

LAYER-WOUND COIL

RELAY COIL

Be sure that the coil you buy bears the trademark name — "GRACOIL", for only then can you know that you have the best in electro-magnetic windings. Every "GRACOIL" is wound to the specified number of uniform turns from precision-gauged wire. Every "GRACOIL" is fully insulated, thoroughly impregnated, and properly laminated when supplied as a complete transformer. The most rigid inspections and tests make sure that each "GRACOIL" is worthy of the name it bears.

If your design calls for a special electro-magnetic application, let competent "GRACOIL" engineers make specific recommendations for you. Write today!

LOW VOLTAGE TRANSFORMER

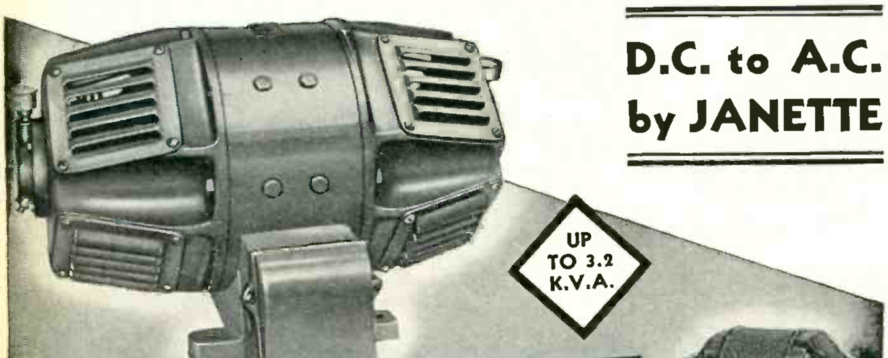
GENERATOR FIELD COIL

THE GRAMER COMPANY

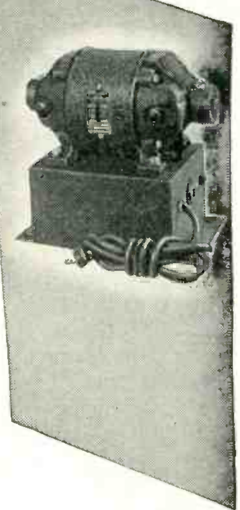
Electrical Coils and Transformers

2736 N. PULASKI RD., CHICAGO 39, ILL., U. S. A.

D.C. to A.C. by JANETTE



D.C. TO A.C. CONVERTERS



Electronic and Gaseous Tube Devices can be operated from direct current power by means of a rugged Janette converter. When used with sound devices, specially designed filters discriminating enough to filter out unwanted noises and to minimize conducted radio noise voltage, can be furnished.

For nearly a quarter of a century Janette converters have given dependable service under varied climatic conditions in all parts of the world.

If you have a D.C. to A.C. requirement and want a reliable, high quality converter **you can safely specify a Janette.**

Janette

Ask for Bulletin 13-25

Janette Manufacturing Co. 556 W. Monroe St. Chicago 6, Ill.

Special CRYSTAL OFFER

100 KC.

Wartime Production Methods And Improved Technique Enable Us To Offer A Limited Quantity Of The New Improved XL 100 Standard Frequency Crystal At A Reduced

NET COST OF $7.10

Latest design insures accurate and stable operation in frequency standard, monitors and frequency meters.

IMMEDIATE DELIVERY

Purchase direct from your local radio distributor or if not in stock order direct from factory.

NO PRIORITY REQUIRED

VALPEY

Crystal Corp.

CRAFTSMANSHIP IN CRYSTALS SINCE 1931
HOLLISTON, MASSACHUSETTS

An Unusual Service

for PRECISION *Sub-contracting*

ATLAS . . . with its highly technical staff of 400 engineers, machine and product designers and toolmakers, is now in position to offer the services of its personnel and complete machine and assembly sections to a few manufacturers who require precision sub-contracting of radar units, instruments or other types of difficult assemblies.

We have undertaken and successfully produced many "secret" components for war plants and with that experience have something to offer you that goes far beyond the abilities of the normally "good" plant.

Here is what we can do for you:

I Provide complete engineering service for new projects . . . finish your partially completed work.

II Design and build all tooling for production (either in your plant or ours).

III Produce, assemble and test intricate, precise units or products on sub-contract.

IV Design and build high speed automatic special machines for any type of production.

On request we will send you the Atlas brochure which explains in detail all of our services and pictures the modern engineering, machine and assembly sections of our plant. If you desire quick action, telephone or telegraph for a consultation with one of our key men. It is quite probable that we can lift "a load off your shoulders onto ours".

An Award for  *Precise Production*

ATLAS TOOL & DESIGNING CO.
ATLAS METAL STAMPING CO.
Castor & Kensington Aves., Phila. 24, Pa.

unit that operates a loudspeaker. It has a built-in calibration oscillator which supplies a standard for tuning, and a netting control which facilitates adjusting both the transmitter and receiver to exactly the same frequency. A sensitivity control allows operation of the receiver near another transmitter without blocking. Both the receiver and transmitter operate on a-m signals and cover a frequency range of 3.8 to 6.5 mc.

The radio units, without the panel cover, are moistureproof and fungusproof, being, therefore, extremely efficient and stable for use in tropical climates.

For vehicular operation the radio is powered by a vibrator supply which functions from a 6-, 12-, or 24-volt source. This feature affords flexibility, which allows the radio to be installed in motor vehicles, tanks, and planes. For field use the radio is powered by a new type of hand generator with chain drive.

The transmitter provides phone, cw or mcw operation. It has a power output of 25 watts, an approximate range of 65 miles with a whip antenna in a vehicle, and a range of several hundred miles when a long wire antenna is used.

• • •

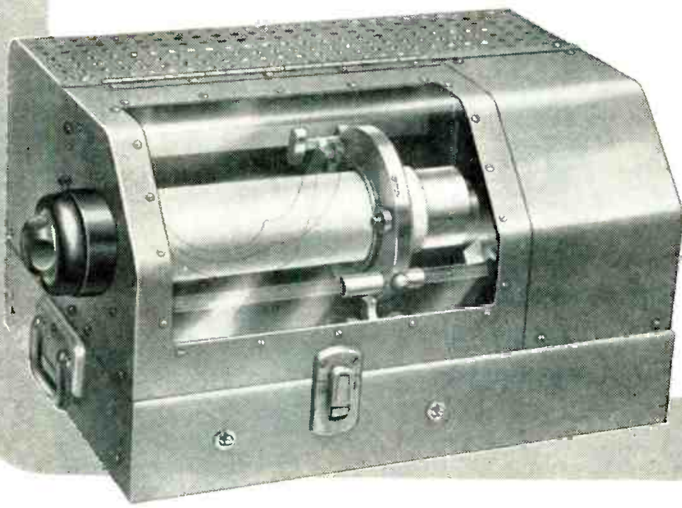
Audio Design for Battery-Powered Receivers

To DESIGN RECEIVERS capable of high efficiency over a long operating range of battery voltage, Sylvania Electric Products suggests the use of tubes optimized for low voltage conditions. Such types include the 1LB4, 1LD5, 1LC6, and 1LC5. Portable receivers present the alternatives, for battery economy, of using a maximum supply of 45 v or using a 90 or 67½-v battery allowed to fall below the usual end-of-life voltage.

Considering the design of an audio section using a 1LD5 resistance-coupled to drive a 1LB4, since the optimum values of load and bias resistors differ for the three operating conditions, and since it is not practical to change these values in service, compromise values must be selected to give satisfactory operation over the desired voltage range. Figure 1 shows the effect on power

NEW!

Sweep-Balance Recorder



✓ **PLOTS CURVES OR SETS OF CURVES OF TWO FUNCTIONAL VARIABLES.**

✓ **PRODUCES A PERMANENT RECORD.**

Now you can record many types of relationship with new speed and accuracy. Obtain permanent inkless records of such functions as *viscosity vs. temperature . . . speed vs. torque . . . angle vs. light emission . . . volts vs. amperes.*

A complete picture of the required information is automatically and quickly produced without chance of error due to human element. As many as 1000 related points visually recorded in three minutes' time. Up to six variables can be traced simultaneously as a function of a common seventh, making multiple testing simple.

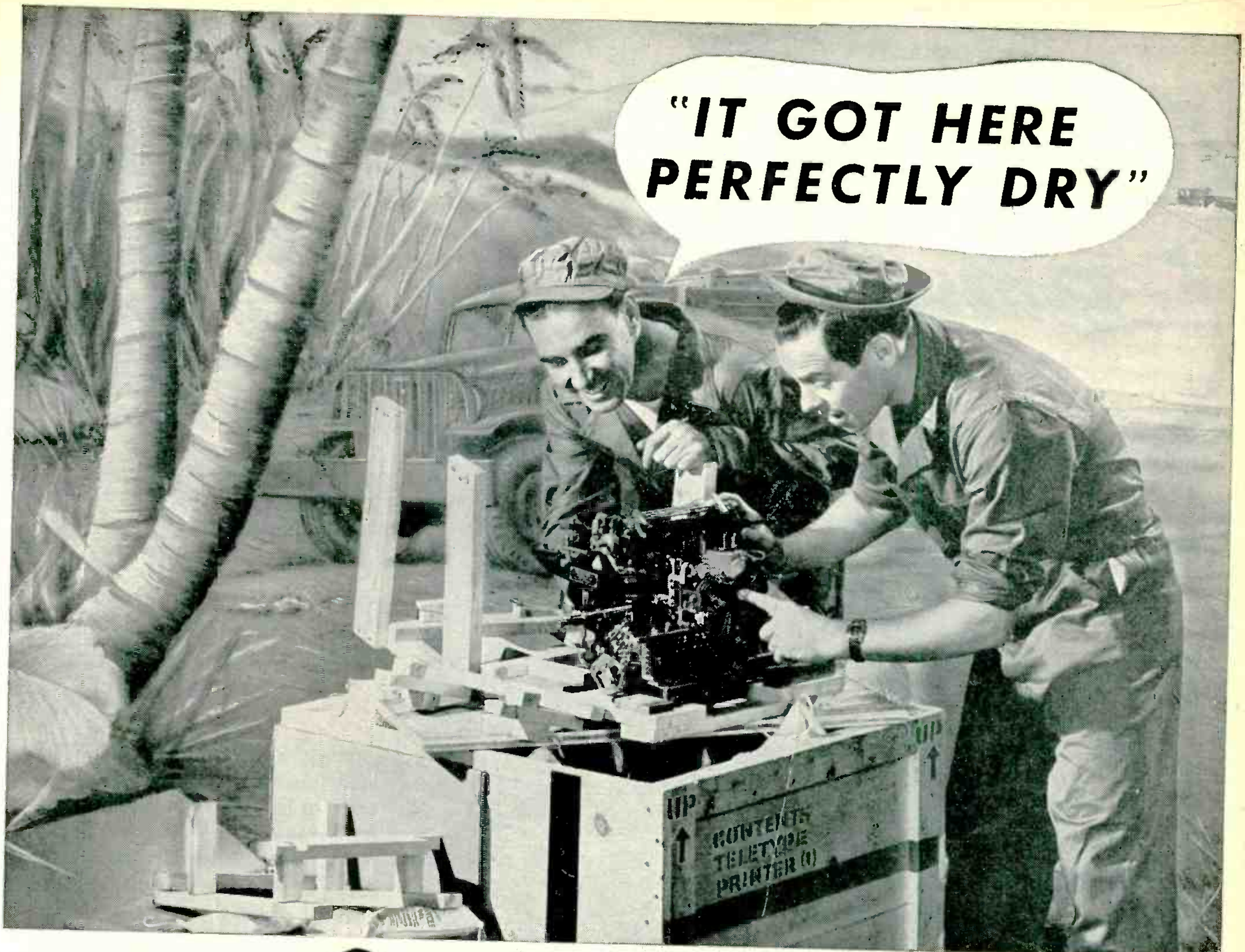
For example, three samples of oil can be tested at one time, for *viscosity vs. temperature,* with each test permanently recorded.

The Sweep-Balance X-Y Recorder is readily adapted for recording any magnitude which can be transformed into an electrical signal. Adaptation to a multitude of recording problems is simple. Often, only the pick-ups (for temperature, pressure, humidity, etc.) may have to be changed to meet specific applications.

Outline your production or laboratory testing requirements by letter. They will have the prompt attention of our engineers. Great American Industries, Inc., Connecticut Telephone & Electric Division, 406 Britannia Street, Meriden, Connecticut.

Connecticut

ELECTRICAL EQUIPMENT



JAY CEE SILICA GEL

PROTECTS TELETYPE* EQUIPMENT FROM MOISTURE DAMAGE . . .

Yes . . . this Teletype printer arrived "perfectly dry" . . . thanks to Jay Cee Silica Gel—which is protecting innumerable over-seas shipments of delicate machines, instruments and weapons from moisture damage.

A few small cotton bags containing this ideal drying agent are enclosed in the box or carton with the equipment. The phenomenal power of Jay Cee Silica Gel to absorb the atmospheric moisture within the container prevents rust or corrosion in transit. Jay Cee Silica Gel is also used in packages of foods, fabrics, chemicals, and other products. Moreover, it has wide application in the air conditioning, refrigeration, and chemical industries. Jay Cee Silica Gel is clear white; passes a rigid section test, meets exacting Government specifications; is strictly a quality product.

JOBBERS WANTED—A few excellent Jay Cee Silica Gel sales territories are still open to jobbers. Write for details.

* Registered trade-mark

JOLIET CHEMICALS, LTD.
INDUSTRY AVENUE
JOLIET, ILLINOIS

output of changes in load and bias resistances. The data shown are with the maximum signal which gives 10 percent total distortion.

Values selected for best average performance, considering the plate current drain, are 1500 ohms for

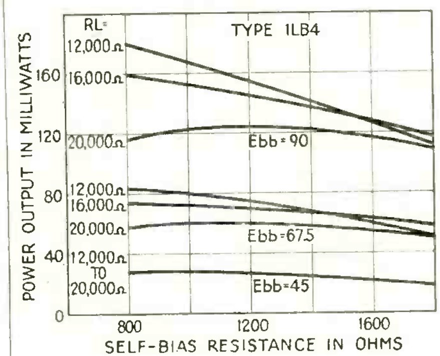


Fig. 1—Plot of effect on power output of changes in load and bias resistance for type 1LB4 tube

biasing, and 12,000 to 16,000 ohms load. As shown by the curves, the value of load resistance becomes less important at the lower voltage but the lower values of bias resistance cause a disproportionate increase in current drain for a small additional power output. Values of output power shown include that lost in the output transformer, as the test circuit used a choke having 100 ohms resistance which approached ideal conditions.

Filament voltage was maintained

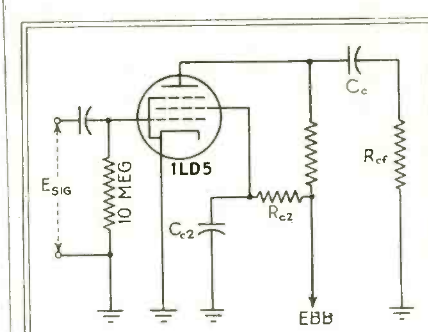
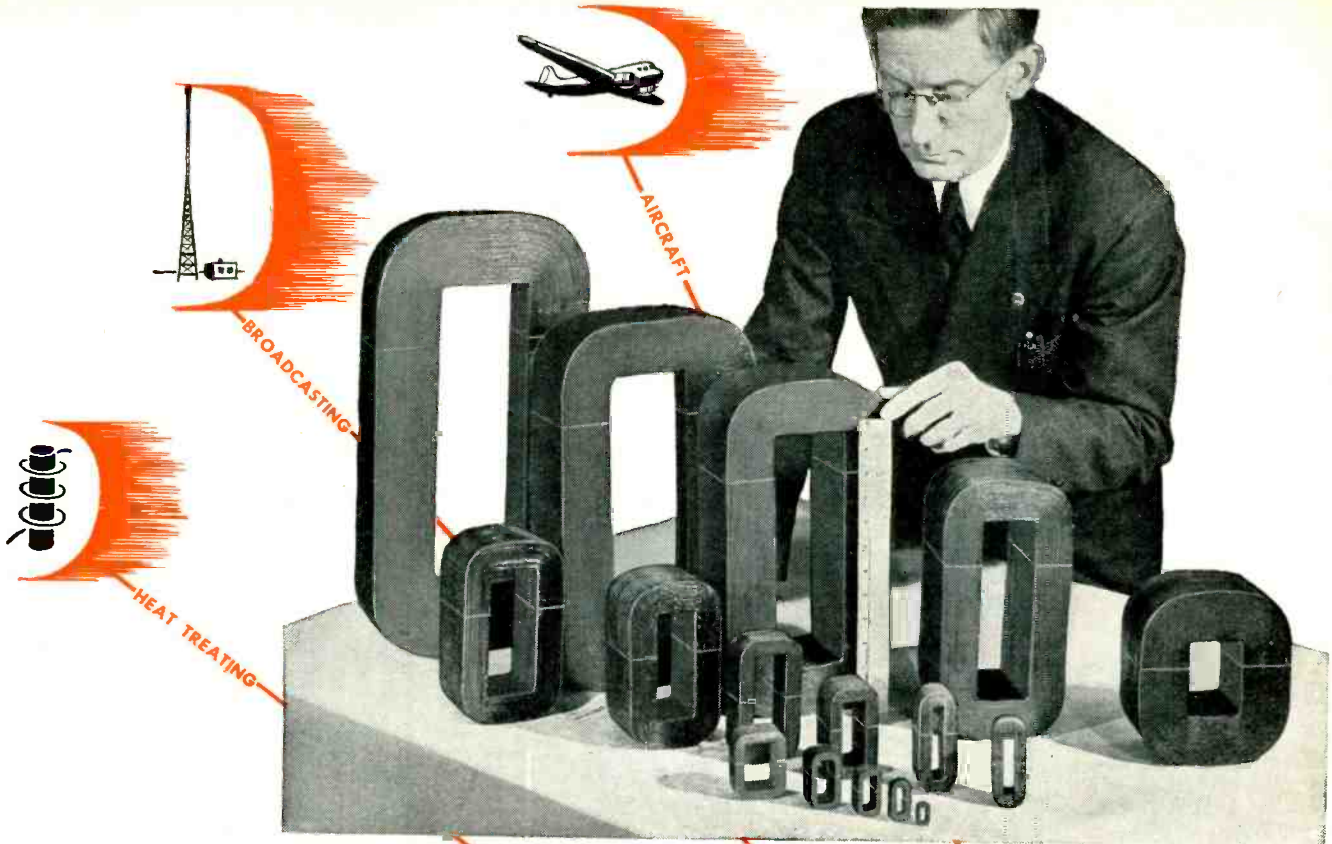


Fig. 2—Circuit used with formulas in text to calculate by-pass capacitor values by rapid method

at 1.4 volts so another variable would not be introduced.

Audio Bypass Values

The circuit in Fig. 2 relates to a short-cut method of calculating



Where can you use this HIGH-PERMEABILITY, easier-to-assemble CORE?

The answer probably is: "In many transformer designs." Two-piece Hipersil* electromagnetic cores open up new horizons in electronic products . . . are available in an almost unlimited range of sizes. These easy-to-assemble cores—which increase flux-carrying capacity as much as ⅓—release designers from the limitations of ordinary silicon steel in many fields of application. Some of these are:

1. Commercial broadcast equipment transformers for AM, FM and television.
2. Induction heating equipment transformers.
3. Aircraft transformers for radio, radar and 400-cycle power.
4. Industrial electronic control device transformers.
5. Specialty transformers up to 50 kva.

Smaller size, lighter weight and wider range of linear response contribute to the superior performance of Hipersil cores. Five different thicknesses of laminations range from 29 gauge for 60 cycle applications down to 1 mil for high-frequency requirements. Laminations of this tissue thinness are grain orientated to give the exceedingly low losses and high permeability at high flux densities which are characteristic of other thicknesses of Hipersil.

Westinghouse application engineers can help you check the possible benefits obtainable with Hipersil. Consult your representative or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

*Registered trade mark

J-70465

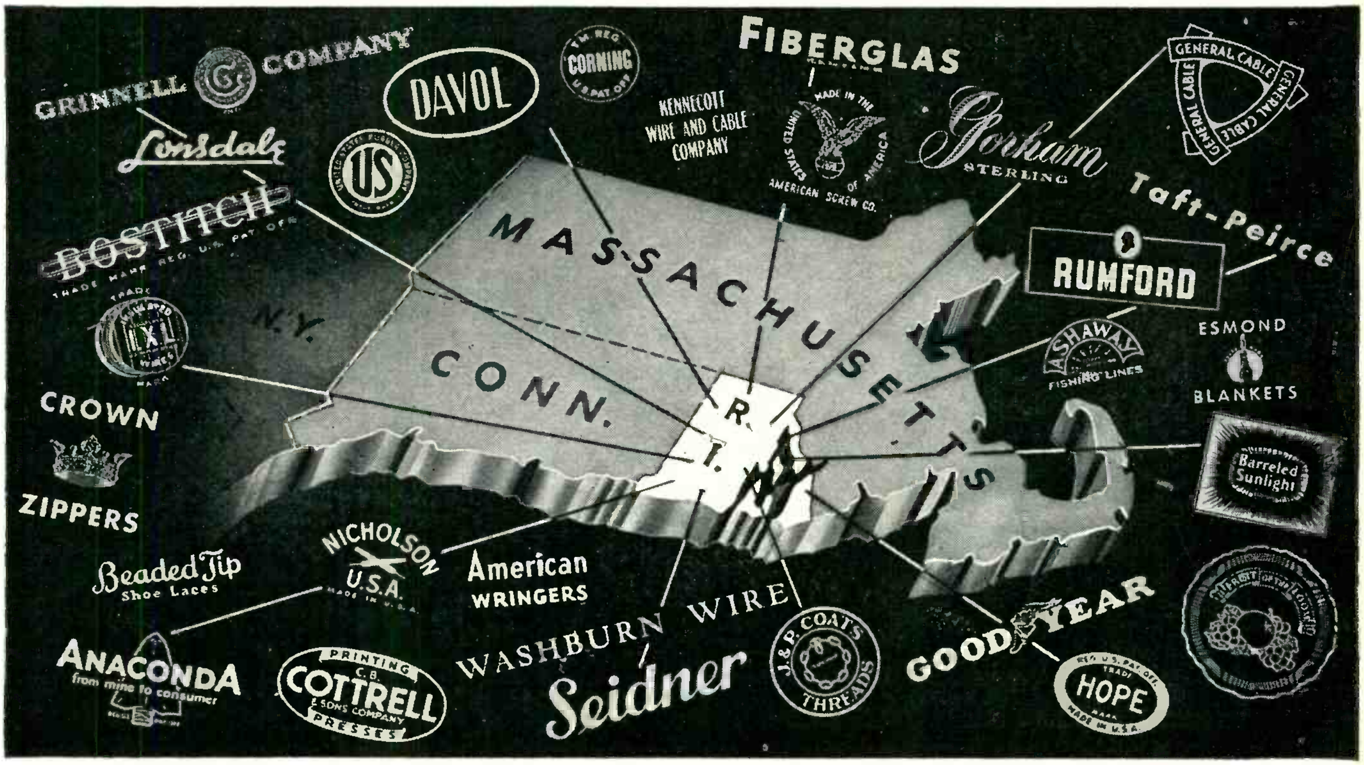
Hipersil Type "C" Cores come ready assembled, in two segments per loop. They eliminate tedious time-consuming "stacking" of separate laminations . . . permit quick, economical assembly with coils and stamped metal bases by means of steel straps. Cast mountings and assembly bolts can be dispensed with.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

HIPERSIL

Southern New England . . .
where industries grow great



FOR over 150 years, Southern New England's *first manufactures*—firearms, clocks, copper and brass—have been growing more and more famous.

Products of other industries which followed have won wide acceptance, too . . . such as Rhode Island's paint, rubber goods, wire, cable, tools, textiles, glassware, piping, packaged foods, silverware, machines.

That's because Southern New England has lived from the start in an atmosphere of inventiveness, progress and opportunity, and manufacturers—quick to sense its value—have come by the hundreds to join those already established.

The result is that Southern New England today is the greatest industrial area per square mile in the world.

The skill of her people—"know-how", if you please—goes back for generations.

And, what is equally important, so does the understanding, sympathetic attitude of the whole community, for it realizes that it owes its growth to industry.

Furthermore, Southern New England has always been closest to the richest markets of America and Europe. Today there are 58,000,000 domestic customers alone for Southern New England's goods who live within 500 miles, to say nothing of the vast foreign trade that will be served through Southern New England's own seaports during the peacetime era ahead.

We believe there is a place for *your* new or expanding business in Southern New England.

A place for your family, too . . . because Southern New England is a region just as inviting for good living as it is for manufacturing.

A full-color booklet is yours for the asking: *Southern New England For Tomorrow's Industry"*. Get your copy by writing to P. E. Benjamin, Manager of Industrial Development, The New Haven Railroad, 80 Federal Street, Boston 10, Massachusetts.

This is one of a series of advertisements presenting the industrial advantages of Southern New England.

THE NEW HAVEN R.R.

Serving **SOUTHERN NEW ENGLAND** *with a network of rail and highway transportation that puts every manufacturer* "ON THE MAIN LINE."

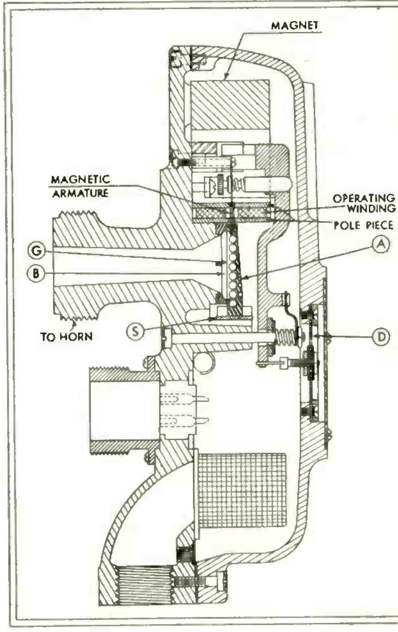
the values of bypass capacitors C_{C2} and C_C. Depending mainly upon the frequency characteristics required and where the low-frequency limit is f_1, $C_{C2} = (1.6 \times 10_6)/(f_1 R_{C2})$ μf and $C_C = (1.6 \times 10^6)/(f_1 R_{Cf})$ μf. This method is quite rapid and gives conservative values with a loss from incomplete bypassing less than one percent. Capacitor size can be halved where economy is essential unless stages are cascaded and highest quality is required.

• • •

Modulated-Air Super Speaker

APPLYING THE PRINCIPLES by which the human larynx uses vibrating vocal cords to modulate air flow from the lungs, a super-power loudspeaker substitutes an air compressor and a modulating air valve.

As shown in an accompanying illustration the unit was given tests which showed a coverage up to four miles under favorable conditions. Messages spoken in a whisper were audible as far as a mile through high noise levels. It has been heard as far as 18 mi.



Fluid-flow unit in cross-section. Identification of parts is in the text. Modulation of compressor-supplied air is accomplished at interface G

This particular model operates at 20 to 25 psi of air and dissipates 15 to 20 w of audio power. Higher pressures produce greater outputs

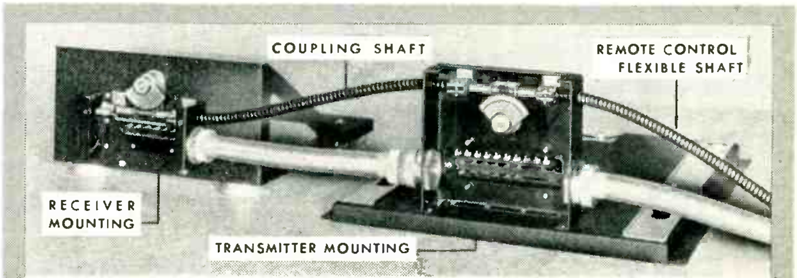
"COUPLING"

with S. S. WHITE FLEXIBLE SHAFTS aids Electronic equipment design

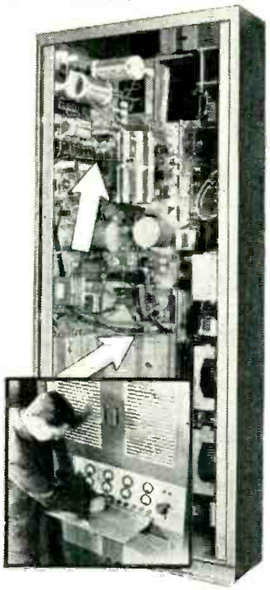
COUPLING *the external remote control shafts to the tuning elements, as in this radio receiver, damps vibration, thus preventing vibration-created noise from being communicated to the sensitive receiving circuit. It also eliminates any need for precise mounting and alignment of the tuning elements and gives complete freedom in their location.*

"Coupling" is the use of comparatively short lengths of S. S. White flexible shafting inside of equipment, or from one unit to another, as distinguished from the longer external remote control applications.

The examples illustrated, show three ways in which coupling can be used to advantage in electronic equipment design.



In this radio telephone equipment the tubes in both the transmitter and receiver must be transferred in steps by means of switches from one pre-set tuning circuit to another. The illustration shows how COUPLING made this possible with a single remote control.



COUPLING *elements which require operational adjustment to their control knobs—as in this broadcast transmitter — makes it possible to place both the elements and the knobs wherever desirable to simplify wiring, to facilitate assembly, to conserve space, to make servicing convenient and to centralize controls at an easy-to-reach point.*

When properly applied, COUPLING with S. S. White shafts provides any required degree of sensitivity and operates as smoothly and easily as a direct connection. A wide range of shaft sizes and physical characteristics is available.

S. S. White engineers have helped work out many such applications and their cooperation is yours also, without obligation.

SEND FOR THIS FLEXIBLE SHAFT HANDBOOK

The subject of flexible shafts and their application is completely covered in this 256-page volume. A free copy will be mailed to you, if you will write for it on your business letterhead and mention your position.

ARMY E NAVY

S.S.WHITE INDUSTRIAL DIVISION

THE S. S. WHITE DENTAL MFG. CO.

DEPT. E, 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS AIRCRAFT ACCESSORIES
MOLDED PLASTICS
MOLDED RESISTORS FLEXIBLE SHAFT TOOLS

One of America's AAAA Industrial Enterprises

AN 3155
POWER RHEOSTAT

AN 3155-50—50 WATT

AN 3155-25—25 WATT

Totally enclosed in accordance with Army-Navy specifications (AN-R-14A).

Permanently sealed in dust-proof, corrosion-proof metal cases.

Smooth control, rugged and thoroughly dependable under the most severe service conditions—shock, vibration, humidity, heat, cold, and altitude.

Hardwick, Hindle is proud of the excellent performance of these power rheostats on thousands of planes flying in every theatre of war under all climatic conditions. And they will prove to be invaluable in innumerable post-war applications.

Let us send you technical data and detailed information on these and many other rheostats and resistors with H-H exclusive features.

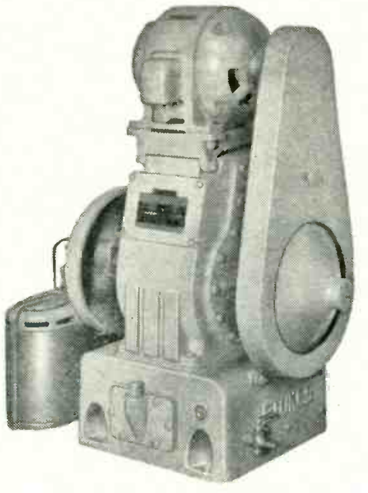
Write today for our new catalogue.

HARDWICK, HINDLE, INC.
RHEOSTATS and RESISTORS
SUBSIDIARY OF
THE NATIONAL LOCK WASHER COMPANY
ESTABLISHED 1886
Newark 5, N. J., U. S. A.

QUALITY CONTROL OF MICA

FORD RADIO & MICA CORP.
Joseph J. Long, President
538 63rd Street,
Brooklyn 20, N. Y.
Telephone:
Windsor 9-8300
Established 1917

Stokes MICROVAC Pumps
HEART OF HIGH VACUUM SYSTEMS



- Higher Vacuum (in the low micron range)
- High volumetric efficiency
- Low power requirement
- Complete discharge of air —no re-expansion
- Continuous dehydration of oil — no moisture to re-evaporate
- Discharges sudden slugs of liquid without injury
- Easily accessible, non-corrosive discharge valve
- Rugged, compact, simple construction
- Long life . . . negligible maintenance.
- Five sizes—from 10 to 235 cu. ft. per min.

Stokes VACUUM GAUGES
(Patented McLeod Type)
Are Always Accurate

- Require no calibration
- Rapid readings
- Simple to operate—just tip and read
- Two models (AA) 0 to 5000 microns—(BB) 0 to 700 microns, with readings to 1/10 micron.

F. J. STOKES MACHINE CO.
6046 Tabor Road Philadelphia 20, Pa.

Stokes *High Vacuum*
PUMPS • GAUGES • EQUIPMENT

PARTS FABRICATED BY ROGERS

KAYPAR fuel pump protector

KAYGREY radio dust cover

KAYGREY magneto insulator

KAYGREY formed insert

DURO motor slot cell

DUROK capacitor can liner

BAYRU packing list protector

INDUSTRY hands this ROGERS-BORD to its customers in ever-increasing quantities. Made exclusively for Bakelite Corporation and identified as BAKELITE molding plastic BM-9725, it is a high-strength thermo-setting plastic used for a multitude of products requiring extra ruggedness.

While ROGERS does no plastic molding, its complete Fabricating Division helps molders by producing BM-9725 blanks of correct weight and thickness and proper shape for easier molding. ROGERS has thus simplified production of many kinds of high-strength plastic articles.

And, as shown in the panel above, other ROGERS-BORDS—plastic and non-plastic—can be formed, drawn, punched and shaped by ROGERS into a wide range of components.

To learn more, check and mail:

- ☐ Send me the ROGERS EXHIBIT BOX, containing fabricated parts and samples of Rogers-Bord.
- ☐ Have a Rogers representative bring samples and fabricated parts.
- ☐ We are enclosing blueprint for suggestions and quotation.

COMPANY ....

ADDRESS ....

NAME ....

ROGERS CORPORATION
Formerly
The Rogers Paper Manufacturing Co.
107 Mill St., Manchester, Conn.

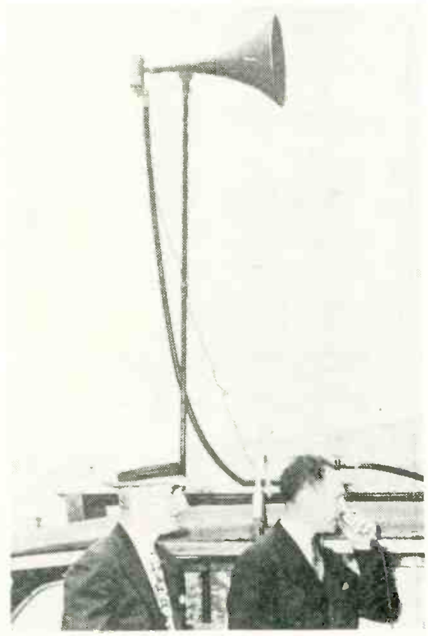
*BAKELITE BM-9725
PRODUCTION STEPS

MANUFACTURING	FABRICATING BY ROGERS	MOLDING
Phenolic resin and cellulose fiber sheets.	Sheets blanked to molders' requirements.	Knife handle molded from blanks.

CREATORS AND FABRICATORS
ROGERS
FIBROUS AND PLASTIC MATERIALS

but with an accompanying rise of harmonic distortion. At 100 ft on the axis of baffle, the speaker shows intensities of 120 db for voice and 130 db for signal.

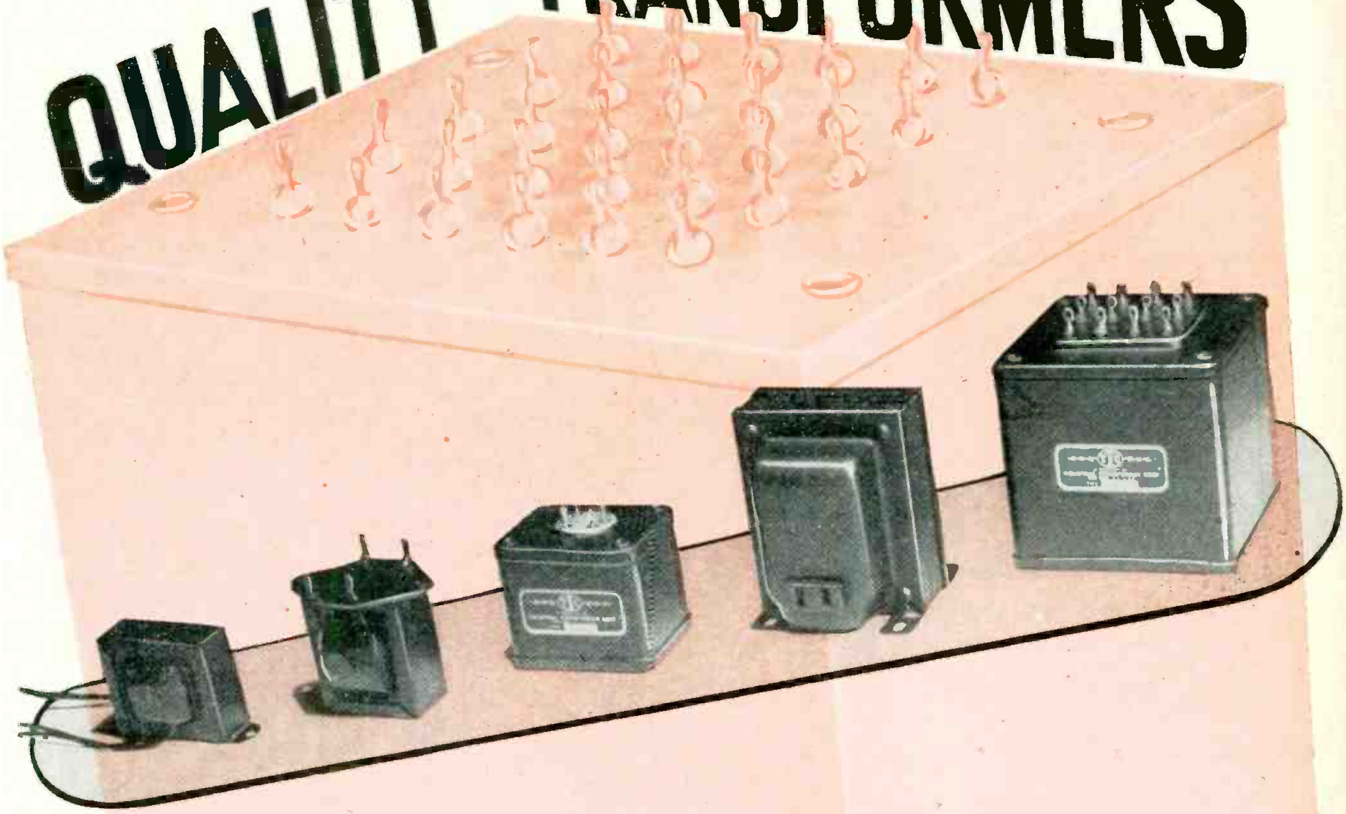
In the section drawing of the design developed by General Electric engineers, the manner in which air flow is modulated can be seen. Air, entering through the bottom connection, passes through a filter. Its further progress toward the horn depends upon the device illustrated at *A*. This consists of a slot-



Super-speaker is tested by Inspector F. E. Burns of the New York City police department and H. L. Perdiue of GE. Intelligence has been projected as far as 18 mi. under ideal conditions

ted armature and a facing plate *B* which are in contact along face *G* at zero pressure. The armature is driven by the fields established around the coil shown immediately above and pivoted on the torsion spring marked *S*. A pressure equalizing arrangement is based on diaphragm *D* and the connected linkage so that the mean value of the gap at *G* is established by the pressure of the air. In operation, the gap never closes completely as that would result in an unbearable mechanical chatter. Linear response is achieved by the separate modulation of air streams coming through 34 0.006-in. slits and control is exercised with extremely small armature movements—only 0.0006 in. at 25 psi.

QUALITY TRANSFORMERS



There are ITC TRANSFORMERS to meet YOUR Specifications

Power, Volstats, voltage regulating, step-up and step-down, plate, filament, audio, input, interstage, output, modulation driver, Microphone, Line, Mixing Transformers, Audio Reactors . . . . .

Our expert Engineering staff and years of experience in developing and manufacturing transformers has established an unexcelled reputation for Dependability and Quality.

Inquiries Invited

INDUSTRIAL TRANSFORMER CORP.

2540 BELMONT AVENUE, NEW YORK, N. Y.

PLASTICON* CAPACITORS

Can you use a 10,000 VOLT PLASTICON 1/8 the size of a corresponding paper capacitor?

Because of the 4400 volt per mil breakdown voltage of the Plasticon film dielectric, high voltage Plasticons are smaller, lighter and more economical than paper capacitors.

*Plasticons—plastic film dielectric capacitors

Condenser Products Company
1375 NORTH BRANCH STREET
CHICAGO 22, ILLINOIS

THE CONNECTICUT CABLE CORPORATION

Now in Peacetime Production

OFFERS TO THEIR OLD AND NEW CUSTOMERS

PROMPT DELIVERY

OF ALL TYPES OF

Electric Cord Sets

Manufactured to commercial specifications or customer's individual requirements.

- EXTENSION CORDS
- HEATER CORDS
- HARNESSES
- LAMP CORDS
- RADIO CORDS
- CUSTOM MOLDED SETS

All wires engineered and manufactured in our own plant. Our prices are truly competitive. We solicit your inquiries regardless of quantity.

THE CONNECTICUT CABLE CORPORATION
JEWETT CITY • CONNECTICUT

RESISTORS
CONDENSERS
CONTROLS • WIRE
TRANSFORMERS • CABLE
HEADPHONES
RELAYS • SWITCHES
SOLDERING IRONS
BATTERIES • TUBES
TOOLS

RIGHT OFF THE SHELF!

Radio-Electronic Parts and Materials . . .

Dalis carries an outstanding stock—most items right off the shelf—or Dalis go-gets them for you . . .

IN A HURRY!

Dalis Service

'Phone, wire, or write . . .

H. L. DALIS Inc

Wholesale Distributors
RADIO-ELECTRONIC SUPPLIES & PARTS
17 Union Square
NEW YORK 3, N. Y.
Phones: ALgonquin 4-8112-3-4-5-6-7

THE ELECTRON ART

Analysis of Cathode Follower

EQUIVALENT CIRCUITS for input and output impedance and equations for the gain of a cathode follower are derived by C. N. Jeffery in the *A.W.A. Technical Review*, March 1945. It is assumed that the input signal is small enough to ensure linear operation and that grid-cathode conductance due to transit-time and dielectric loss is negligible.

Input Impedance

Symbols are identified in Fig. 1 and Table I. From conventional circuit analysis the input impedance is found to be

$$Z_{in}' = [r_pZ_1/(r_p + Z_1)] + Z_{gk} + g_mZ_{gk}[r_p\,Z_1/(r_p + Z_1)] \tag{1}$$

The equivalent circuit for input impedance is that of Fig. 2.

At low frequencies where interelectrode and distributed reactances are considerably greater than resistances in parallel with them the equivalent circuit is that of Fig. 3A. The conditions represented in

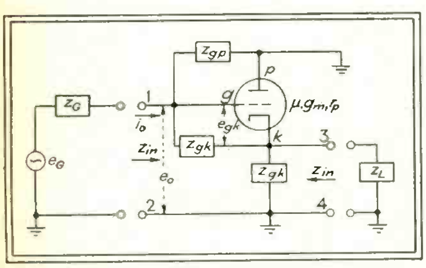


Fig. 1—Terms and symbols used in text. Inter-electrode capacitances are understood to be a part of the various impedances

this circuit are that the grid-cathode bias is obtained through R_{gk} to a tap on R_{ke}, this tapped portion being small enough compared to R_{ke} to be neglected; and that x is the ratio of the effective output load to the normal output impedance, $1/g_m$ (a fact to be deduced later). This circuit indicates that

Table I—Cathode Follower Circuit Symbols

Z_{gp} —	Grid-plate impedance (assumed to be $-j/\omega C_{gp}$)
Z_{gk} —	Grid-cathode impedance, a capacitance $-j/\omega C_{gk}$ which may be shunted by resistance R_{gk}
Z_{ke} —	Cathode-earth impedance, normally resistor R_{ke} considerably greater than $1/g_m$, shunted as discussed
Z_G —	Internal impedance of generator of emf e_G connected to terminals 1, 2
Z_L —	Impedance of load connected to terminals 3, 4
Z_1 —	Z_L, Z_{ke} in parallel
Z_2 —	Z_G, Z_{gp} in parallel
Z_3 —	Z_L, Z_{ke}, r_p in parallel
Z_{in}' —	Input impedance without Z_{gp} in parallel
Z_{in} —	Input impedance with Z_{gp} in parallel

input resistance is increased, particularly if x is large. In practice the load is generally a resistance of the order $1/g_m$, thus the input resistance is $2R_{gk} + 1/g_m$.

At high frequencies where interelectrode reactances are much less than their associated resistances, if the load is capacitive the equivalent circuit is that of Fig. 3B. The negative resistance term may produce oscillation if the generator and input impedances combine to form a resonant circuit. The negative resistance can be neutralized by a series resistance whose value is

$$R_s = \frac{(1/g_m)\,(C_3C_{gk}/C_{gp}^2)}{1 + (\omega^2/g_m^2)\,(C_3 + C_{gk} + C_3C_{gk}/C_{gp})^2} \tag{2}$$

Because there will be some damping by the tuned circuit, the required grid stopper resistance is less than this value. From Eq. 2 it can be seen that R_s decreases

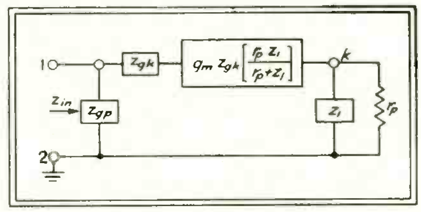
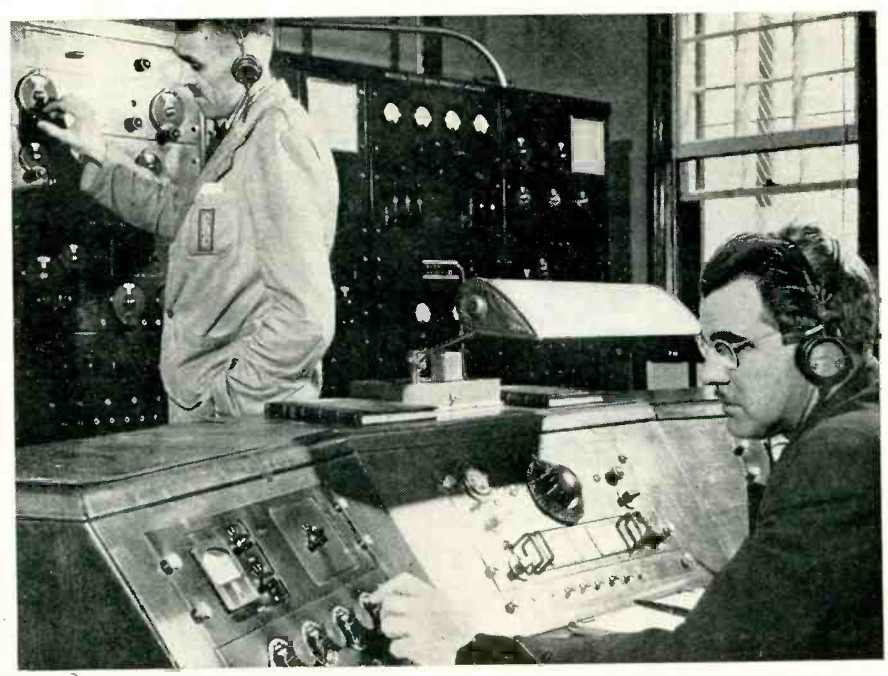


Fig. 2—Generalized equivalent input circuit of cathode follower

with increasing frequency therefore parasitic oscillations at high frequencies require only a small grid stopper.

Some control may be exercised over C_3 which should be kept low. An example arose in practice: Out-

CANADIAN MONITORS



Master control desk at CBC listening post near Ottawa. A Marconi diversity short-wave receiver in the background covers the frequencies from 5 to 25 Mc. Two operators patrol the air lanes 16 hours a day

RAY-O-VAC CAN HELP YOUR POST-WAR PICTURE

IF YOU ARE A RADIO MANUFACTURER

If dry batteries are required in your products, be sure to look to Ray-O-Vac. Ray-O-Vac batteries are designed and built to deliver more hours of service. It is this extra capacity that insures greater consumer satisfaction for your product. Take no chances — specify Ray-O-Vac.

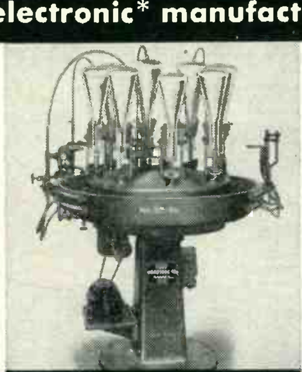
The "know how" that has solved innumerable problems of radio power for our armed forces is at your service in our Commercial Engineering Dept. to aid in planning your products powered by dry cells.

RAY-O-VAC BATTERIES

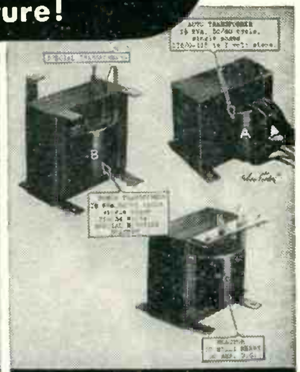
RAY-O-VAC COMPANY, MADISON 4, WISCONSIN

EISLER EQUIPMENT
..complete and diversified for every phase of electronic* manufacture!

(A) No. 600-KC3P, 50 KVA Press Type Spot Welder, 3 Spots, Air Operated, 18" Throat—a high production unit.



(B) No. 57-8L New Eisler 8 head type Tipless Sealing Machine. Adaptable for all types and sizes of bulbs.



(C) EISLER Special Transformers and Reactors — high or low voltage; air cooled, oil immersed or uncased.

The CHAS. EISLER line of specialized electronic tools, machines and devices is complete and diversified. Included are innumerable types of welders — spot, seam, butt, rocker, arm, pneumatic and special types. Also included are hundreds of devices for vacuum tube manufacture — glass tube cutters, slicers, stem and sealing machines as well as an all-inclusive line of transformers for every industrial and general need.

* EISLER serves 99% of American vacuum tube producers today. Write for completely illustrated catalog.

CHAS. EISLER
EISLER ENGINEERING CO.
751 SO. 13th STREET (Near Avon Ave.) NEWARK, NEW JERSEY

MADE BY *Engineers* FOR *Engineers*

CORWICO

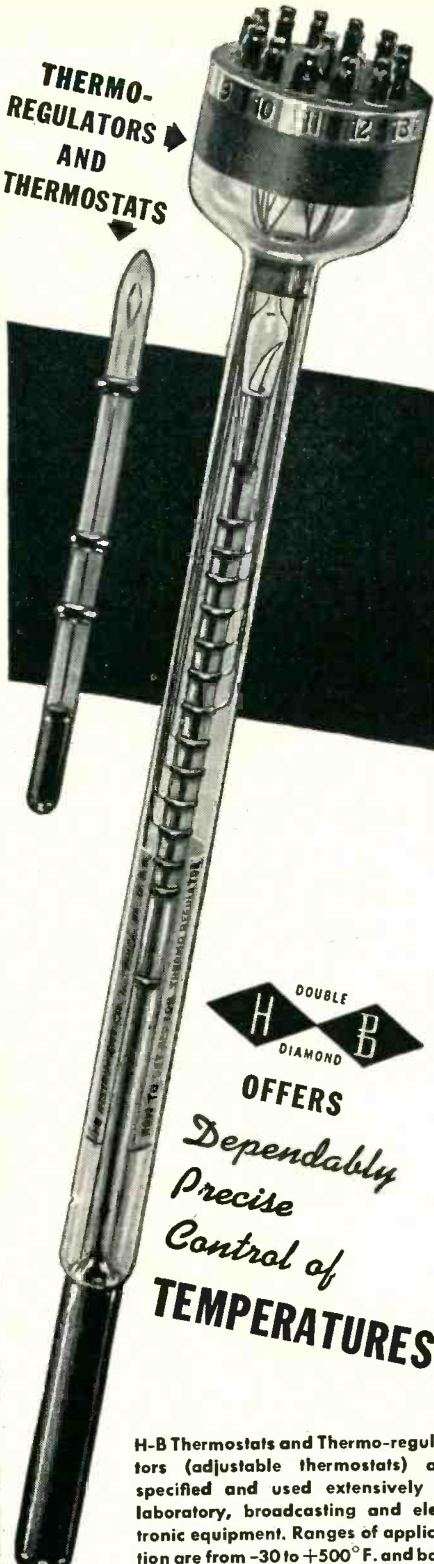
WIRES

JOB AHEAD!

. . . and we are equal to it!
Each day we'll be shipping
MORE for civilian use

cornish
WIRE COMPANY, INC.
15 Park Row, New York City, New York

THERMO-REGULATORS AND THERMOSTATS



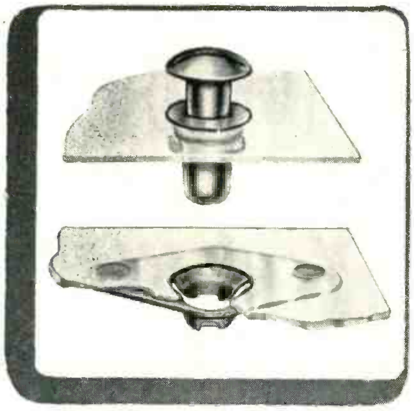
DOUBLE H B DIAMOND

OFFERS *Dependably Precise Control of* **TEMPERATURES**

H-B Thermostats and Thermo-regulators (adjustable thermostats) are specified and used extensively in laboratory, broadcasting and electronic equipment. Ranges of application are from -30 to +500° F. and both straight and angle types are available. Temperatures can be maintained with these instruments to an accuracy of a fraction of a degree. Many shapes and sizes now available for shipment. Write for Blue Book No. 4 . . . For more than 27 years, H-B has been producing specialized precision instruments in large and small quantities for the measurement and control of temperature. Relays, thermometers, manometer tubes and other H-B units are standard in the field. Call on us for assistance in your problems.

H-B INSTRUMENT COMPANY
2524 No. Broad Street, Philadelphia 32, Penna.

FASTEN IT FASTER WITH A SIMMONS FASTENER



QUICK-LOCK

SIMPLIFIES ACCESS PANEL ASSEMBLIES. A 90° turn locks and unlocks it in a jiffy. QUICK-LOCK requires no special tools. Flexible mounting and tapered stud makes it ideal for assembling curved sheets and insures tight fit when locked. Stud is self-ejecting when unlocked. Minimum deflection is assured—only initial loads are carried by helical spring. Solid supports take increased loads. Let QUICK-LOCK solve your problems.

SPRING-LOCK

ONE-PIECE BLIND FASTENER. Inexpensive one-piece assembly speeds-up blind installation...requires no nuts, receptacles, lock washers or threading. SPRING-LOCK is self adjusting for various material thicknesses. Locks and unlocks with a quarter turn...can be permanently installed as blind rivet...cannot work loose from vibration. Locks with high initial load without deflection.

LOCK NUT

DOUBLE DUTY—LOCK NUT and STOP NUT. An all-purpose safety nut that reduces assembly time. One end of safety ring engages nearest serration on bolt thread. 7 Serrations provide 14 locking positions per revolution. Serrations can be cut by simple broaching operation in a fraction of the time required to drill cotter pin hole. Can be used as stop nut without serrated thread for close adjustment.

WRITE FOR SAMPLES

SIMMONS FASTENERS

SIMMONS FASTENER CORPORATION, 1750 No. Broadway, Albany 1, N.Y.

put of a cathode follower was connected to a long cable. On disconnecting the cable load oscillation in the cathode follower commenced due to the large capacitance of the unterminated cable.

If the cathode-earth impedance is effectively a resistance R_3 of value

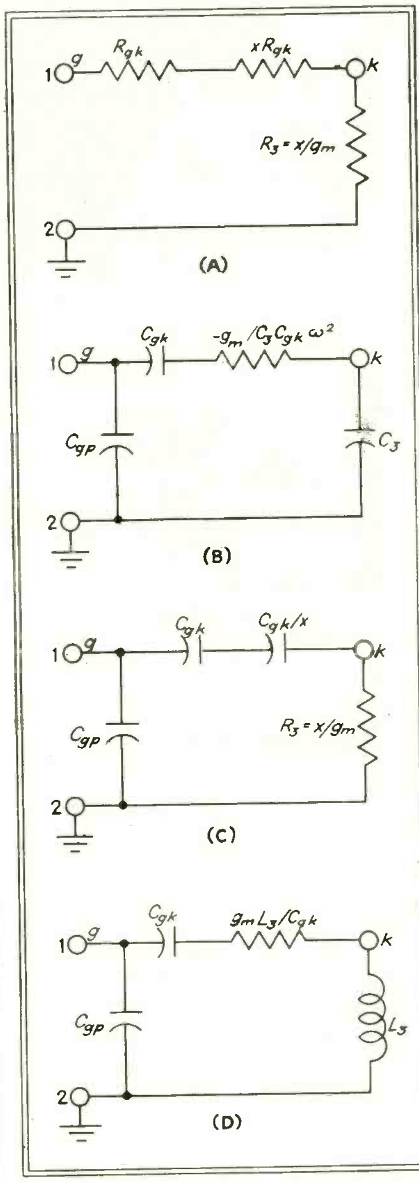
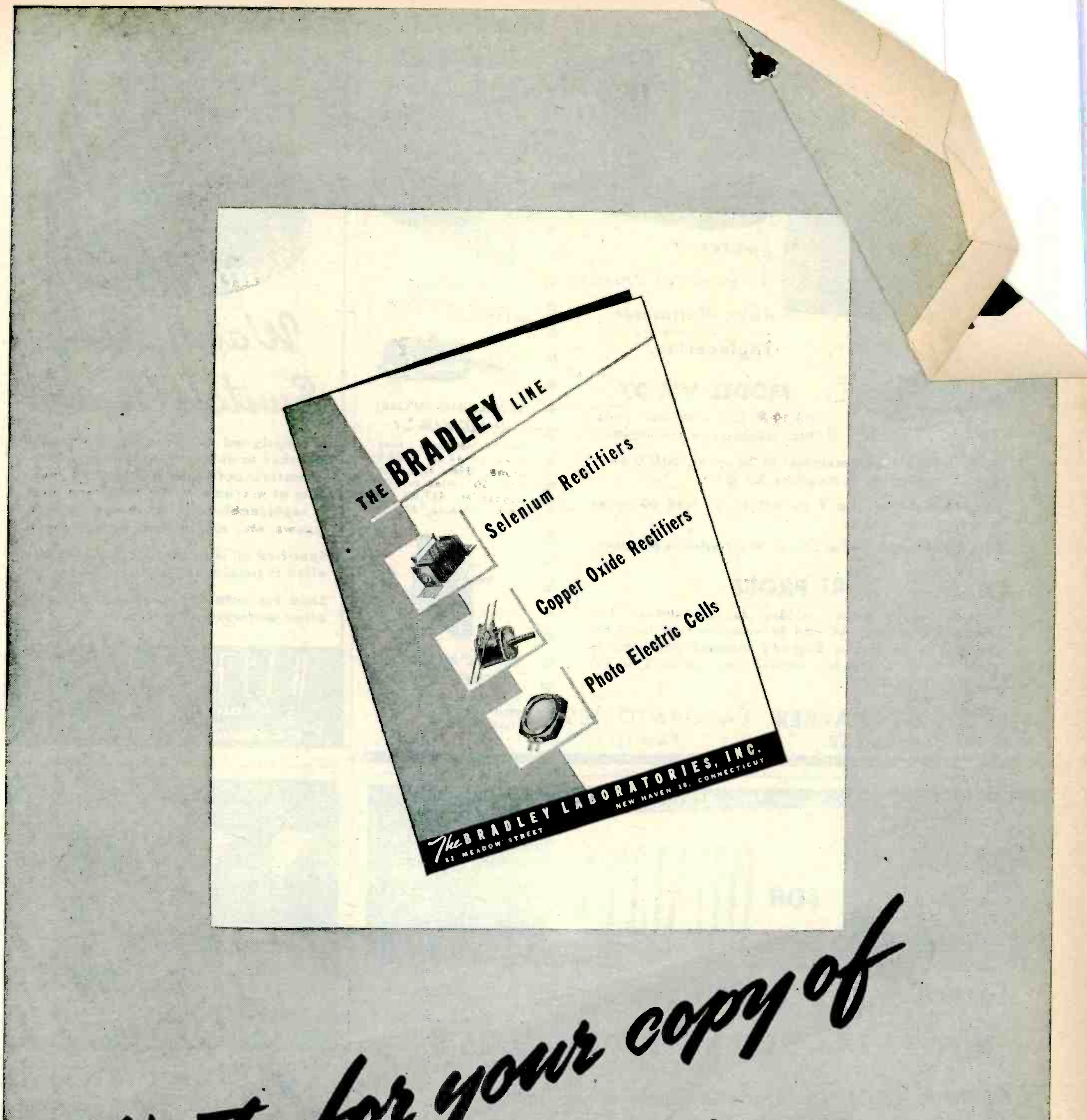


Fig. 3—Cathode follower input circuits for (A) low frequency, (B) capacitive load, (C) resistive load, and (D) inductive load

x/g_m, the equivalent circuit is that of Fig. 3C, which is also the equivalent circuit for low frequencies where grid bias is obtained by returning the grid resistor to a bias battery. If the grid-earth network is reduced to a parallel R-C, the resistance is

$$R_p = R_3 + (1 + x)^2/R_3C_{gk}^2\omega^2 \qquad (3)$$



THE BRADLEY LINE
Selenium Rectifiers
Copper Oxide Rectifiers
Photo Electric Cells
The BRADLEY LABORATORIES, INC.
82 MEADOW STREET
NEW HAVEN 10, CONNECTICUT

IMMEDIATE DELIVERIES

VACUUM TUBE VOLTMETER

RF — AC — DC

The result of 10 years of Vacuum Tube Voltmeter Engineering.

MODEL VM-27

1-3-10-30-100 volts full scale
Peak response, r.m.s. calibration.

HIGH IMPEDANCE—4 megohms at 50 cycles, 60,000 ohms at 100 megacycles. 7 megohms for d-c.

ACCURATE—Better than 2 percent on d-c and 60 cycles thru 50 megacycles.

SELF-CONTAINED—115 or 230 volt 50-60 cycle line operation.

RF PROBE

Interchangeable probe included for convenience and efficiency in making AC and RF measurements. Input capacity 5 micro farads. Ruggedly mounted 6H6 tube in balanced circuit. Complete voltmeter with probe $150 net f.o.b. Flushing, N. Y.

ACCESSORIES

To increase VM-27 range to 1000 volts.

10X AC MULTIPLIER MODEL ACM-27

Input impedance even greater than probe alone. Flat response from 20 cycles to 200 megacycles. $17.00 net f.o.b. Flushing, N. Y.

10X DC MULTIPLIER MODEL DCM-27

5 megohms input resistance. $8.00 net f.o.b. Flushing, N. Y.

ALFRED W. BARBER LABORATORIES
34-06 Francis Lewis Blvd. Flushing, N. Y.

Waterproof Switch Covers

are designed to cover certain toggle switches so as to make them completely waterproof without impairing freedom of movement. The Neoprene boot is replaceable without removing nuts, screws, etc., and without special tools.

Specified on many Navy items. Installation is simple, and cost moderate.

Send for catalog describing this and other waterproofing items.

WATERPROOF
ELECTRIC COMPANY
70 E. VERDUGO AVE., BURBANK, CALIF.

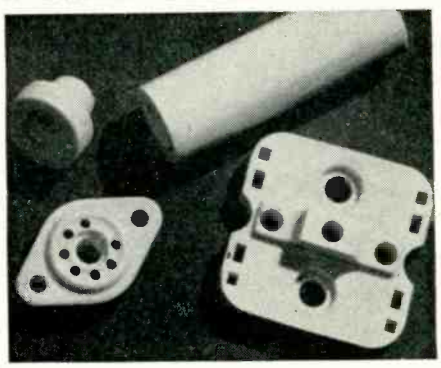
RADELL-BUILT PRODUCTS

• It is easy to recognize the marks of superior craftsmanship in Radell-built electronic products. With a broad basic knowledge and advanced production skill, Radell Corporation is a versatile organization specializing in the assembly and sub-assembly of highest quality electronic products.

COMPLETE FACILITIES FOR AUDIO WORK

RADELL CORPORATION

6323-37 Guilford Avenue, Indianapolis 5, Indiana



Lavite STEATITE CERAMIC

Properties and Characteristics of Our LAVITE S1-5 Steatite Ceramic Body

Compressive Strength	96,000 lbs. per square inch
Tensile Strength	7,200 lbs. per square inch
Flexural Strength	10,500 lbs. per square inch
Modulus of Rupture	20,000 lbs. per square inch
Dielectric Strength	235 volts per mil
Dielectric Constant	6.42 } Frequency of 1 megacycle
Loss Factor	2.90 } Frequency of 1 megacycle
Power Factor	.446 } Frequency of 1 megacycle
Bulk Specific Gravity	2.664%
Density (from above gravity)	0.096 lbs. per cubic inch
Hardness (Mohr scale)	7.0
Softening Temperature	2.350°F.
Linear Coefficient of Expansion	8.13×10^{-6}
Moisture Absorption (ASTM D-116-42-A)	0.009%

Makers of electrical and radio apparatus destined for war service are finding in LAVITE the precise qualities called for in their specifications . . . high compressive and dielectric strength, low moisture absorption and resistance to rot, fumes, acids, and high heat. The exceedingly low loss-factor of LAVITE plus its excellent workability makes it ideal for all high frequency applications.

We will gladly supply samples for testing.

D. M. STEWARD MFG. COMPANY
Main Office & Works: Chattanooga, Tenn.
Needham, Mass. Chicago Los Angeles

21 STAR ★ FEATURES

21 NEW!

21 MODERN!

Ready Now ... the New 1946 EASTERN AMPLIFIERS

21 DIFFERENT!

QUALITY performance is the keynote of the new 1946 21-Star-Feature series of Eastern Amplifiers. Each model contains the many built-in features exclusively listed as Eastern developments and innovations.

The 21 Star Features include the new Eastern's *AMPLITUBE, a unique circuit component, insuring constant operation under all conditions—Eastern's *UNICABLE construction, eliminating the troubles associated with old-fashioned "floating" components—Eastern's *ROTO-VUE scale dials—Eastern's "Coded Cable Wiring Harness"—and many other Eastern contributions to "Soundest Sound" values. And back of this 1946 picture stands Eastern's well-known policy of *"Ethical Engineering."*

For complete information and price list—for the first edition of our 1946 Catalog—write today! Eastern Amplifier Corporation, 794 E. 140th St., New York 54, N. Y.—Dept. 11F.

ARMY E NAVY

EASTERN AMPLIFIERS

*U.S. Reg'n Applied For

The damping effect of this on a tuned circuit is less in the case of a triode than for a pentode.

If the cathode follower load is inductive, the equivalent circuit is that of Fig. 3D.

Output Impedance

From analysis of the equivalent circuit, the general output circuit of a cathode follower is reduced to that of Fig. 4. At low frequencies where in normal practice $R_{ke} > 1/g_m$, $\mu > 1$ or $r_p > 1/g_m$, and provided $R_G > R_{gk}$ the output is a resistance $1/g_m$ and the circuit reduces to that of Fig. 5A.

In Fig. 5B where the generator impedance is a capacitance C_G the input capacitance is increased. If the generator impedance is an inductance L_G and the frequency is such that the equivalent input impedance is also inductive (L_{in} is L_G and C_{gp} in parallel as in Fig. 5C), the shunting term can be either zero, negative, or positive depending on the ratio f/f_o where f_o is the resonant frequency of the series circuit L_{in}, C_{gk}. If L_{in} is very large, oscillations can occur due to the negative resistance term.

If the input is a tuned circuit of dynamic resistance R_d the equivalent circuit is that of Fig. 5D. If Z_{ke} is capacitive, resonance can occur in the cathode circuit, but can be prevented by making the cathode impedance more resistive or inductive or by damping the input circuit. If it is essential that the output impedance be as nearly as possible a resistance $1/g_m$, then R_d at the highest operating frequency is restricted to very low values.

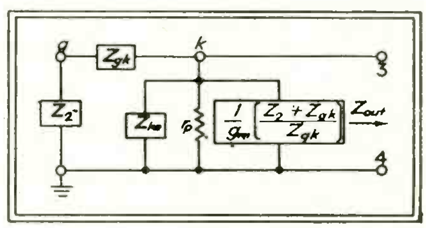
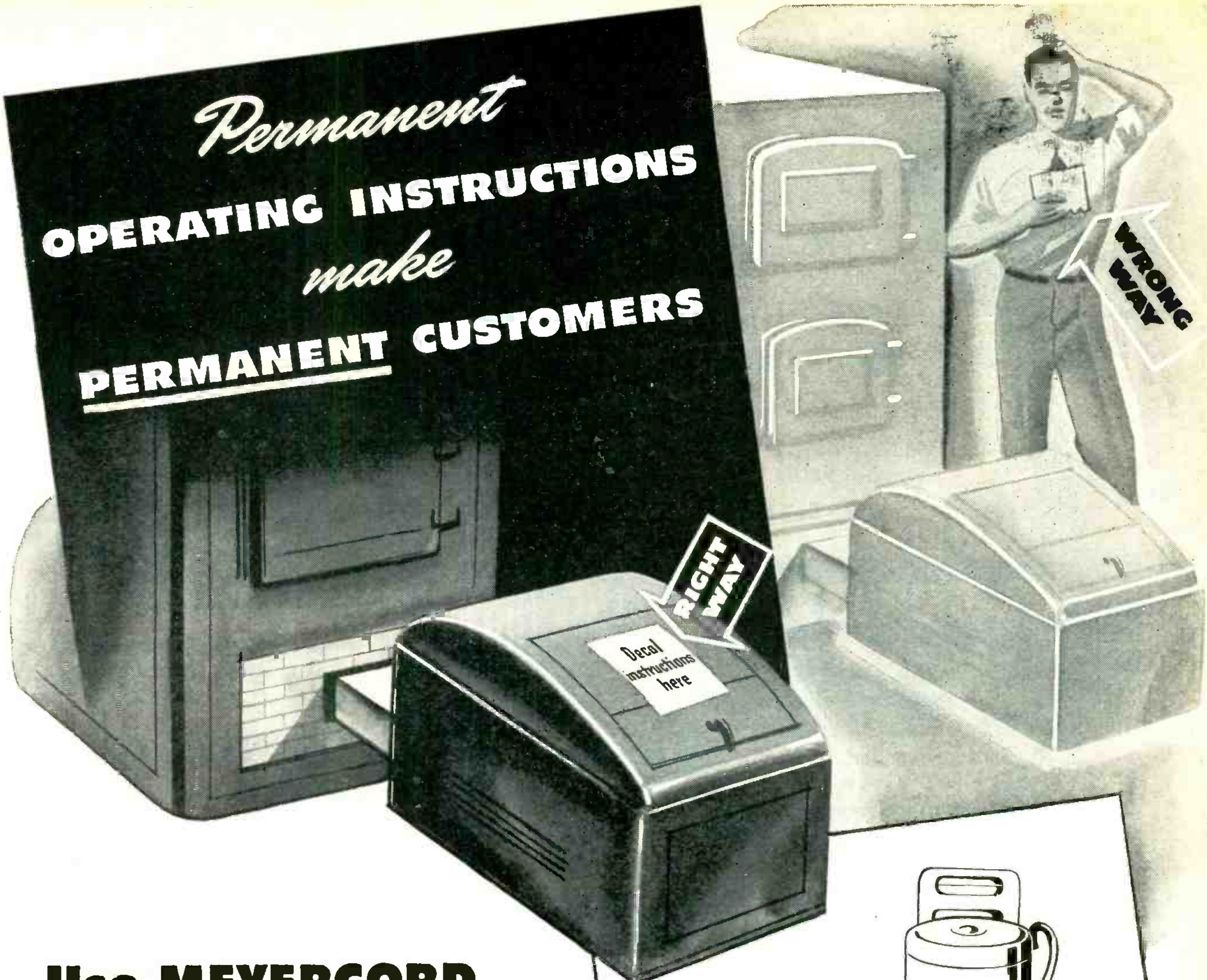


Fig. 4—Generalized equivalent output circuit of cathode follower

Gains

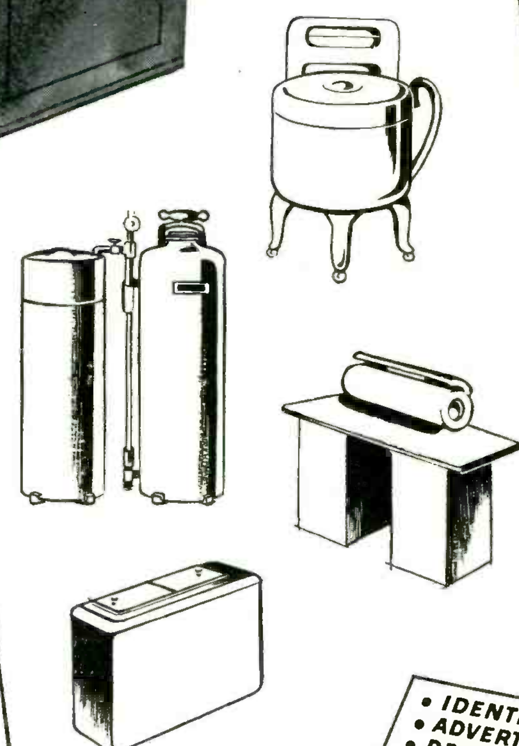
Two types of gain will be con-



Use MEYERCORD DECAL Name Plates

Home equipment ruined annually in America through ignorance of operation and maintenance reaches a staggering total. The unnecessary reflection on manufacturers' reputations is equally costly. Keep your product in use . . . from one owner to another . . . with Meyercord Decal instructions. They can be produced in any size, design and number of colors for fast, lasting application *to any commercial surface.* No rivets, bolts or screws required. Rigid tests prove their resistance to abrasions, temperature extremes, moisture, acids and vibration. Investigate Meyercord Decals for your product instructions. Free technical and designing service. Please address inquiries to Dept. 9-11.

Bring the Boys Back with Victory Bonds

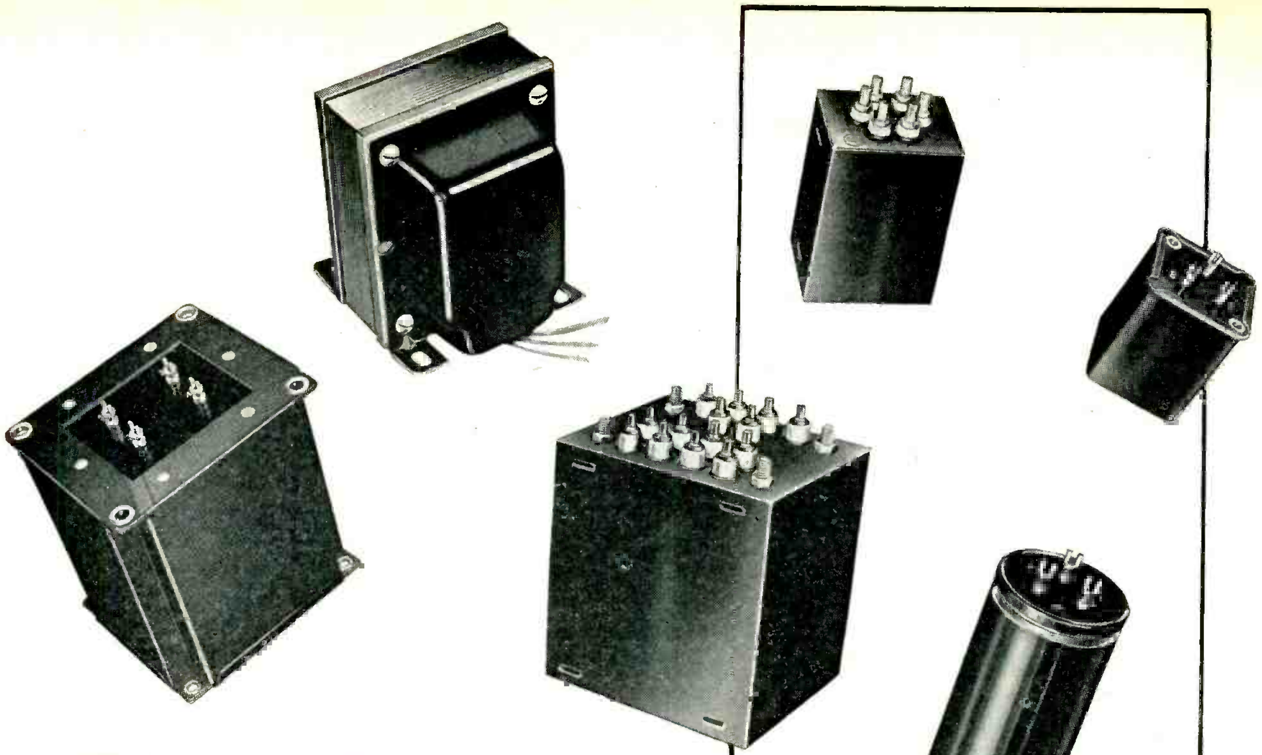


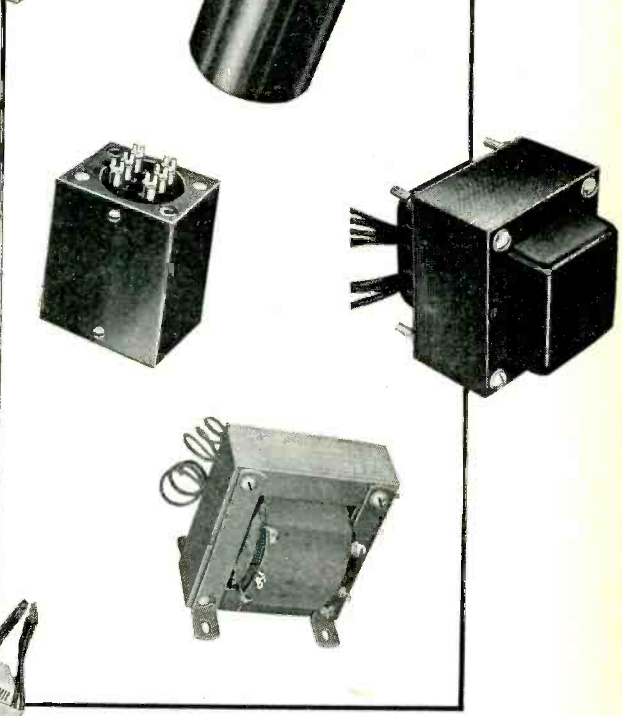
• IDENTIFY
• ADVERTISE
• DECORATE
your products with
MEYERCORD DECALS

THE MEYERCORD CO.

World's Largest Decalcomania Manufacturers

5323 WEST LAKE STREET • • • CHICAGO 44, ILLINOIS



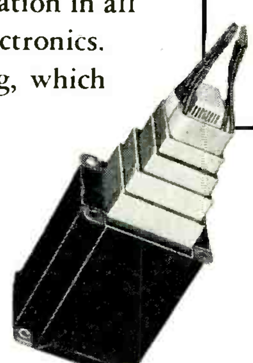


They **LOOK** *like other transformers*

BUT— the difference is in *performance* — exceptional FREED performance.

Built into every transformer are the specialized engineering techniques in design and production that mark the name FREED. Soundly constructed to withstand long and severe usage, FREED transformers are completely dependable for every application in all fields of communications and electronics.

FREED specialized engineering, which pioneered shock proof construction, hermetic sealing and many more outstanding improvements, is available to help solve your transformer problems. Why not take advantage of it?



Wave Filters
Audio Systems
Carrier System Components
Phase Shift Devices
Special Bridge Circuits
Supersonic Frequency Components
Supersonic Frequency Systems

FREED TRANSFORMER CO.

FREED TRANSFORMER CO.

72 E. SPRING STREET, NEW YORK 12, N.Y.

sidered; the stage gain—defined as the ratio of output voltage to grid-earth voltage; and the overall gain—defined as the ration of output to generator input voltages.

The stage gain is

$$\left|\frac{v}{e_0}\right| = \left|\frac{1 + 1/g_m Z_{gk}}{1 + (1/\mu) + (1/g_m Z_{gk}) + 1\, g_m Z_1}\right| \quad (4)$$

The overall gain is

$$\left|\frac{v}{e_0}\right| = \left|\frac{[Z_{gp}/(Z_{gp} + Z_G)]\cdot[1 + 1/g_m Z_{gk}[}{1 + \frac{1}{\mu} + \frac{1}{g_m Z_{gk}} + \frac{1}{g_m Z_1} + \frac{Z_{gp}\cdot(r_p + Z_1)Z_G}{(Z_G + Z_{gp})r_p Z_1 g_m Z_{gk}}}\right| \quad (5)$$

For low frequency operation Z_{in} is very large thus the stage gain is

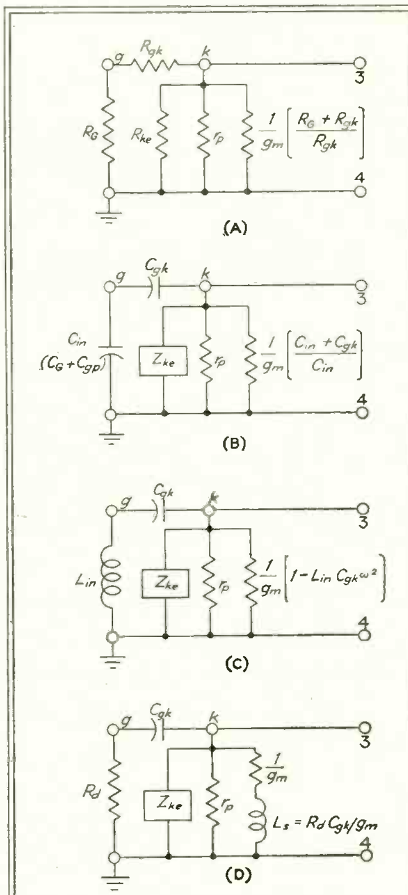


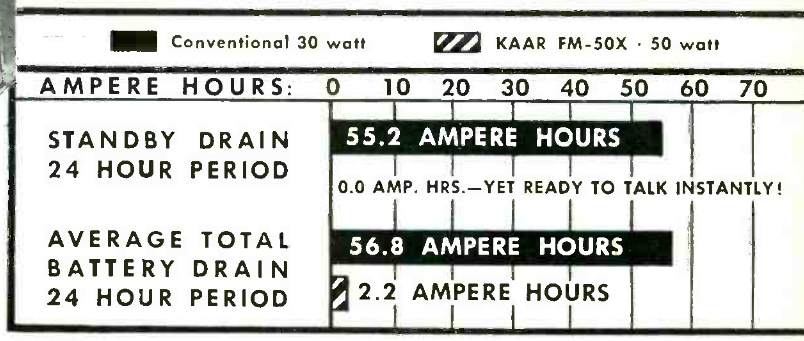
Fig. 5—Cathode follower output circuits for (A) low frequency, (B) capacitive input, (C) inductive input, and (D) resistive input

used. Normally Z_{gk} and Z_1 are considerably greater than $1/g_m$ and if $\mu \gg 1$, the stage gain tends toward unity. If in addition $Z_1 = 1/g_m$, the stage gain is $\frac{1}{2}$.

At high frequencies the input impedance must be considered. Normally the cathode follower is de-

Compare the actual battery drain!*

NORMAL BATTERY DRAIN OF A CONVENTIONAL TRANSMITTER AND KAAR FM-50X EQUIPPED WITH INSTANT-HEATING TUBES



*** CHART BASED ON TYPICAL METROPOLITAN POLICE USE**

(140 Radiotelephone-equipped cars operating three shifts in city of 600,000 population.)

MESSAGES ORIGINATED BY CARS	904
MESSAGES ACKNOWLEDGED BY CARS	932
TOTAL TRANSMISSIONS PER CAR	13
AVE. LENGTH OF TRANSMISSION	15 sec.
AVE. TRANSMITTING TIME 24 HOURS	3 min. 15 sec.

KAAR mobile FM-50X transmitter gives you 20 watts more output with only 1/25th usual battery drain!

KAAR engineers—who pioneered the instant-heating AM radiotelephone—have now, through the use of instant-heating tubes, made 50 and 100 watt *mobile* FM transmitters practical! Thus you gain greater power and range—along with a tremendous reduction in battery drain!

With instant-heating KAAR equipment standby-current is zero—yet the moment you press the button microphone you are on the air. Contrast this with conventional emergency transmitters, over 90% of which operate with the filaments "hot" during stand-by. Since sturdy instant-heating tubes eliminate this great waste of energy without slowing the handling of messages, KAAR 50 and 100 watt transmitters can be operated from the standard ignition battery!

100 WATT MOBILE FM!

The KAAR FM-100X is identical to the FM-50X, except for the final amplifier. It puts 100 watts into a standard 34 ohm non-inductive load and is ideal for county and state police use. It requires no special batteries, wiring, or generator changes.

ADDITIONAL FEATURES

A new system of modulating the phase modulator tubes in KAAR FM transmitters provides excellent voice quality. Note that the equipment is highly accessible, and only two types of tubes are used. Frequency range: 30 to 44 megacycles.

Write today for free bulletin describing KAAR FM transmitters in detail. It's ready now!

KAAR ENGINEERING CO.

PALO ALTO CALIFORNIA

Export Agents: FRAZAR AND HANSEN · 301 Clay St · San Francisco, Calif.

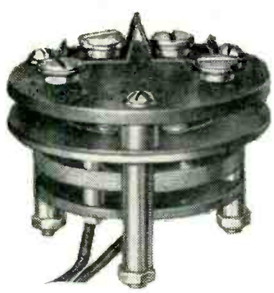
"When Ordering Please Mention Electronics"

Type C-7220 Precision Snap Switch 12 amps. 30 Volts D. C., 125 Volts A. C.

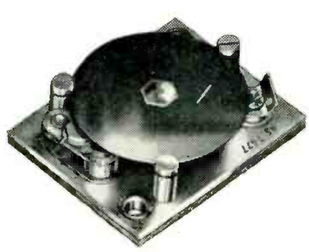
Type C-2851 Thermostat. For such use as Roughing Controls on Outer Crystal Ovens.

Type RT Thermostat. Adjustable Temperature Control.

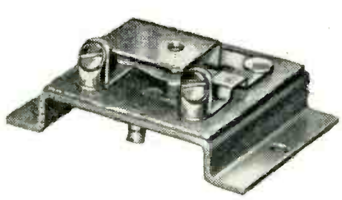
Type C-6363
Switch Circuit Breaker



Type ER Series. Ambient Compensated Time Delay Relays.



Type B-3120 Thermostat and Heater, Crystal Dew Point Control.



Type C-4351 Thermostat. Used for Tube Warming, Tube Cooling, High Limit Controls, etc.

KLIXON Snap-Acting CONTROLS

REQUIRE NO BABYING

in control or protection applications

No sir! You don't have to baby or coddle Klixon snap-acting controls when you use them for such applications as motor and transformer overheat protection, electrical circuit overload protection, thermal time delays and temperature control for radio equipment. These compact, sturdy, light-weight controls "snap" the circuit wide open with a quick break or snap it close to a solid make no matter how often they operate. The actuating element, a foolproof, time-tested Spencer Thermostatic Disc, eliminates toggles, magnets and other complicated parts that tend to wear and get out of order . . . always assures dependable performance regardless of position of mounting, vibration, motion and altitude.

Klixon controls are available in many standard types to meet most control and protection requirements. Our engineers will help you with your problems. Write for complete information, today.

SPENCER THERMOSTAT COMPANY, ATTLEBORO, MASS.

KLIXON

signed to feed a resistive load of value $1/g_m$, Z_{gk} and Z_{gp} are usually capacitive, and if $\mu \gg 1$, the stage gain becomes $|(1 + j\omega_{gk}/g_m)/(2 + j\omega C_{gk}/g_m)|$. The overall gain can similarly be reduced to a simpler expression.

Conclusions

It is difficult to define a figure of merit for comparing valves to be used in cathode follower circuits. However the following requirements are required at the higher frequencies: low output impedance for connection to concentric cable or low-impedance network (g_m high).

Output impedance independent of generator (input) impedance (C_{gk} low).

Freedom from oscillation if cathode impedance becomes capacitive, as from removing the load at the end of a transmission line connected to the cathode follower ($g_m/C_{ke}C_{gk}$ high).

High input resistance when output is correctly terminated (g_m/C_{gk}^2 high).

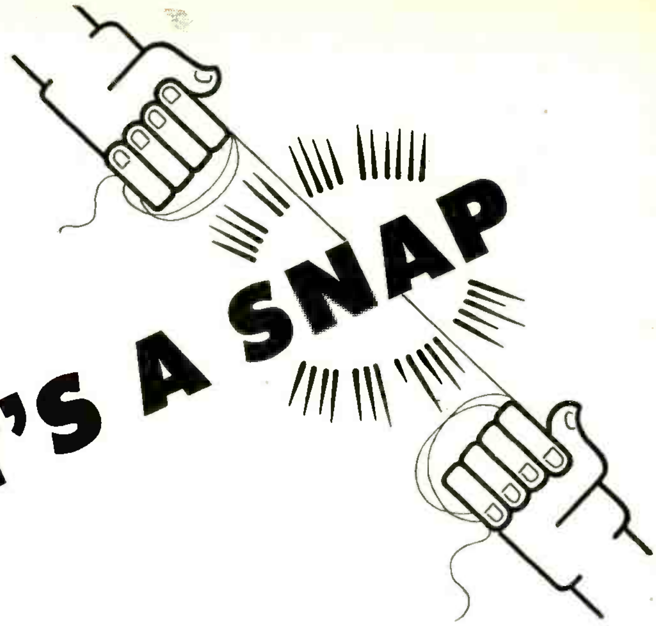
From these requirements a tentative figure of merit of $g_m/C_{ke}C_{gk}^2$ is suggested. Applying this figure of merit to typical valves indicates that the triode is approximately 50 percent better that the pentode.

Where input capacitance is important C_{gk} should be considered. If this parameter is included in the figure of merit, the triode is 25 percent better than the pentode. For additional material on cathode followers the reader is referred to Lockhart, C. E. writing in *Electronic Engineering* **15**, 287; **15**, 375, and **16**, 21 (1942-1943).

• • •

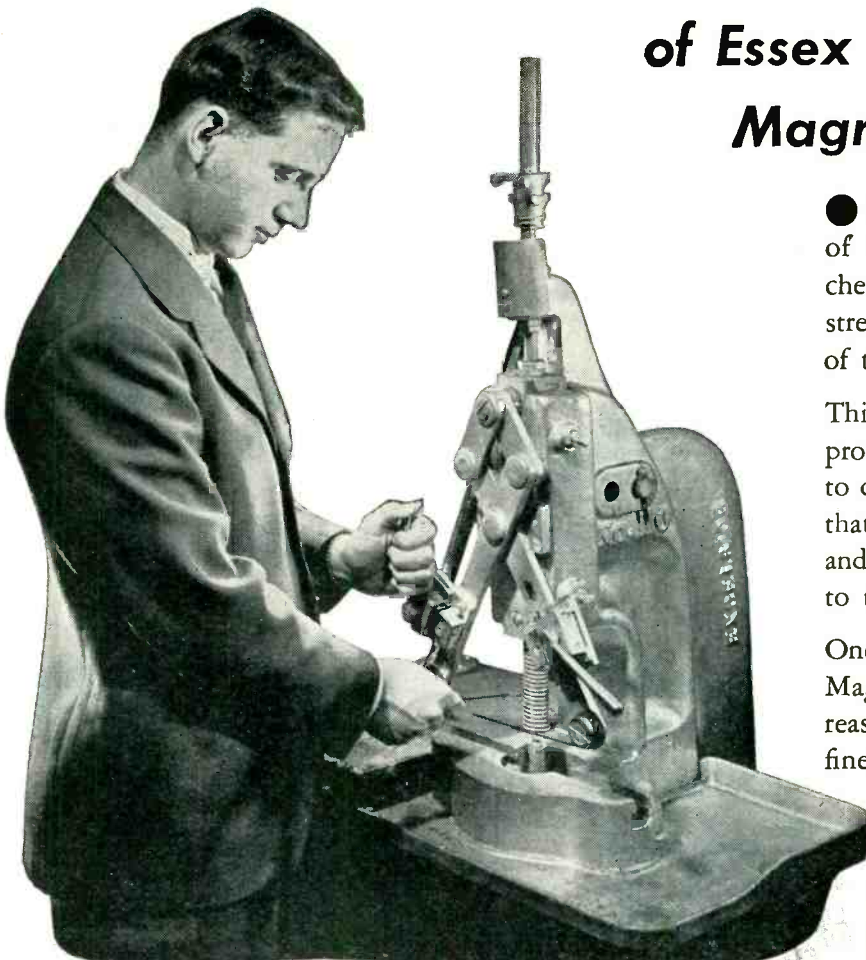
Sensitive Gas Relay Tube

THE TELEION, a multi-electrode gas tube for amplification of pulse signals, is described in *Wireless World* (Iliffe & Sons Ltd., London) for August 1945 by J. Reiss from information given by the inventor M. S. Lalewicz. The tube—suitable for amplification of weak d-c pulses such as those derived from phototubes in high speed telegraph transmitters or from the detector of a receiver in such a communication



IT'S A SNAP

—to prove the "skin" value of Essex *EXTRA-TEST* Magnet Wire



● Before it leaves the plant, every spool of Essex Magnet Wire, #10 and finer, is checked with the *snap test*—a sudden, rapid stretch or elongation to the breaking point of the copper.

This *snap test* enables Essex engineers to prove the "skin" value (toughness, adhesion to copper, and flexibility of the enamel) so that the wire will wind into tight places and around sharp corners without damage to the film.

One more reason for Essex *Extra-Test* Magnet Wire's middle name—one more reason why it is specified so consistently for finer coil winding.

WIRE SX PRODUCTS

ESSEX WIRE CORPORATION
FORT WAYNE 6, INDIANA


For Smallest
Precision Parts and
Intricate Timing Gears
depend on
Tel-air
Consider the smallness required of some of the most important precision parts! Timing gears, bomb fuzes, hundreds of "big little" components of aircraft, comparable to the size of a tiny tack! Yet on their sturdiness and microscopic accuracy depend the success of the entire mechanism.
On the perfection of such parts Tel-air has built a special and unexcelled reputation. "Tel-air means accuracy" is proverbial thruout precision manufacture.
TODAY IS NONE TOO SOON to familiarize yourself with the exceptionally complete facilities, and the years of specialized engineering experience available to you in Tel-air. And tooling of toughest steels and newest alloys is a fine art here.
Where surpassing precision and longest dependability are essential objectives in your product—present or post-war—you can not afford to take chances. Make sure with Tel-air!
Teleoptic Directional Signals for the highway are made to the same standards of accuracy and dependability.
WITHOUT ANY OBLIGATION ON YOUR PART — bring your problem to Tel-air engineers, for immediate attention.
And remember—PROMPT DELIVERY is a basic rule with Tel-air.
On the Highway it's
Teleoptic
T. M. REG.
In the Air it's
Tel-air
T. M. REG.
THE TELEOPTIC CO.
1251 MOUND AVENUE
RACINE, WISCONSIN
Write for Profusely Illustrated Catalog showing typical Tel-air Parts. It will save you time and money.

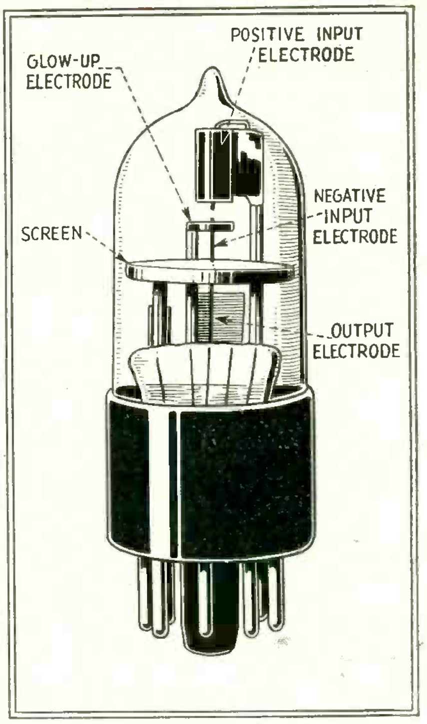


Fig. 1—Addition of a screen disk to separate input and output electrodes, and a glow-up electrode to maintain a pilot discharge produces a high-speed, sensitive relay amplifier tube

circuit, in sensitive relay circuits, and in decreasing the fly-back time of time-base circuits—is illustrated in Fig. 1.

Operating Characteristics

The screen serves to limit the passive glow to the input portion of the tube. At a critical input current the gas discharge extends

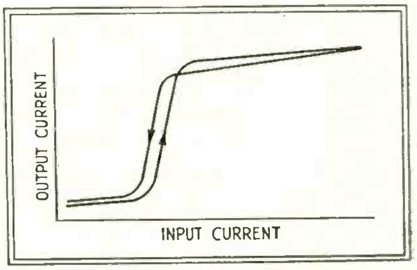


Fig. 2—Relative input-output characteristic of the Teleion indicates how, at a critical point on the characteristic, a small decrement in the input produces a large change in the output

through the screen into the region of the output electrode, if the input is increasing; or withdraws from the output electrode region, if the input is decreasing as shown in Fig. 2.

By maintaining a constant gas

108 SERIES *Amplifiers*

WITH MOUNTING ACCESSORIES

TYPE 108-B two-stage Amplifier provides transformer input impedances for either 30 or 250 ohms with nominal output impedance 500 or 8 ohms. Variable gain 65/105 db. with electronic volume control. Frequency response better than ±1 db. 30/16,000 c.p.s. Power output +43 V.U. (20 watts) with less than 5% RMS harmonic content. Noise level full gain 56 db. below full output.

THE 108 SERIES consist of four different amplifiers available simply by changing one or two small input panels on the master chassis. Except for these input panels all amplifiers have the same transmission characteristics. Input impedance, gain and noise level depending on types listed below.

These units are designed for the highest type audio service having gain-frequency characteristics better than ±1 db. 30/16,000 c.p.s. Power output +43 V.U. (20 watts) with less than 5% RMS harmonic content.

TYPE 108-A two-stage Amplifier provides transformer input for either 600 ohm or bridging. 600 ohm input fixed gain 61 db. Bridging input variable gain 6/46 db. Noise level 68 db. below full output.

TYPE 108-B as illustrated and described above.

TYPE 108-C combines the input channels of the 108-A and 108-B Amplifiers. Channel 1—600 ohm input variable gain 20/60 db. Bridging input variable gain 2/42 db. Channel 2—high gain 30/250 ohm input variable gain 62/102 db. with electronic volume control. Noise level 56 db. below full output.

TYPE 108-D two-channel each 30/250 ohm input. Either channel variable gain 62/102 db. with electronic volume control. Noise level 56 db. below full output.

MOUNTING ACCESSORIES

TYPE 202-A Wall Mounting Cabinet permits universal installation of 108 Series Amplifiers to any flat surface. Well ventilated and designed for maximum accessibility, servicing and convenience of installation. Standard aluminum gray finish.

TYPE 9-A Modification Group permits 108 Series Amplifiers to mount on standard 19" telephone relay racks. Occupies 7" rack space. Allows servicing from front of rack. Standard aluminum gray finish.

The Langevin Company

INCORPORATED

SOUND REINFORCEMENT AND REPRODUCTION ENGINEERING

NEW YORK
37 W. 65 St., 23

SAN FRANCISCO
1050 Howard St., 3

LOS ANGELES
1000 N. Seward St., 38

HAVE YOU AN ELECTRONIC *Problem?*

If your product requires heavy duty filter reactors, swinging reactors, or plate transformers, write us for quotation.

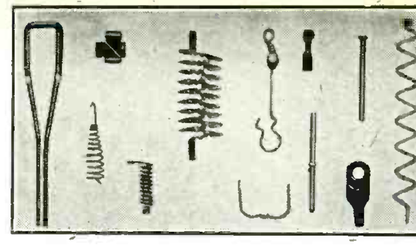
We are already booking orders for next year! First come—first served!

DONGAN ELECTRIC MFG. CO.
2977 Franklin   Detroit 7, Mich.

DONGAN TRANSFORMERS

The Dongan Line Since Nineteen-Nine

We Invite Inquiries

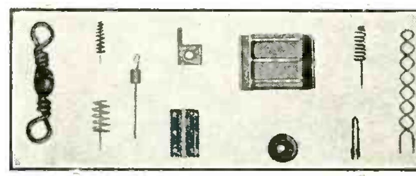


SMALL PARTS

Filaments, anodes, supports, springs, etc. for electronic tubes. Small wire and flat metal formed parts to your prints for your assemblies. LUXON fishing tackle accessories, double pointed pins, fine sizes wire straightened. Inquiries will receive prompt attention.

ART WIRE AND STAMPING CO.

227 High St.   Newark 2, N. J.



The WINSLOW line includes Wheatstone, Kelvin, Varley, Murray, Limit and Megohm bridges.

WINSLOW megohmmeters are available in ranges to 1000 megohms at 500 volts.

Winslow ELECTRIC MEASURING AND TESTING INSTRUMENTS

AIRCRAFT THERMOCOUPLES, IGNITION TEST SETS, INSULATION TEST SETS, BRIDGES, MEGOHMMETERS, POTENTIOMETERS, TACHOMETERS, VACUUM GAUGES.

The WINSLOW line of portable electrical instruments for measuring direct currents, alternating currents, resistance, temperature, speed, vacuum and insulation, etc., are attractively housed, convenient to use. All are ruggedly constructed to maintain accuracy under severe usage. Special design precautions are incorporated for complete immunity to dust, dirt and moisture. A complete line of rare and base metal thermocouples for all industrial and laboratory applications is included as well as all accessories—switches, leads and meters. Write for details today—no obligation of course.

THE WINSLOW CO.
9 LIBERTY ST., NEWARK 5, N. J.

ELECTRONICS *to your order!*

Veterans of pre-war and wartime electronics, we serve aviation, marine and related companies to C. A. A. and F. C. C. standards. Ask us . . .

To DESIGN, DEVELOP and MANUFACTURE . . .

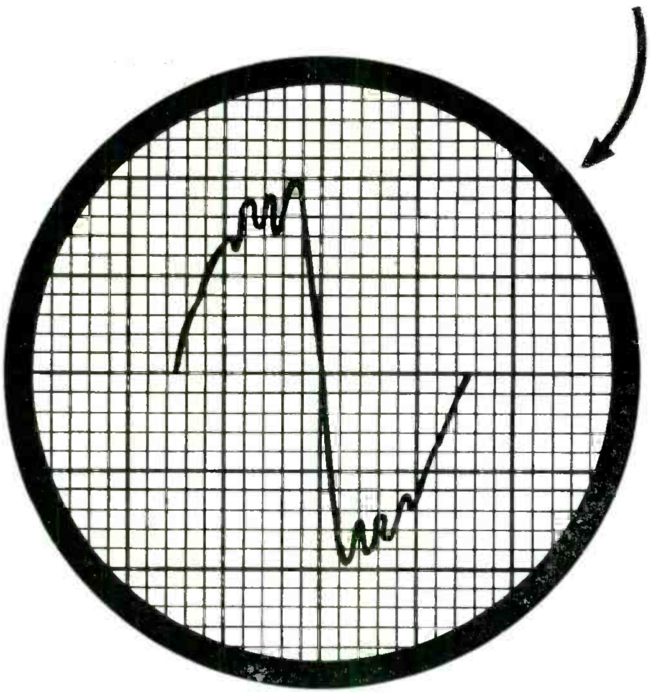
Radio Receivers and Transmitters
Industrial Electronic Equipment
Airport Radio Control Equipment
Marine Radio Telephone Equipment

Your inquiries will receive immediate action

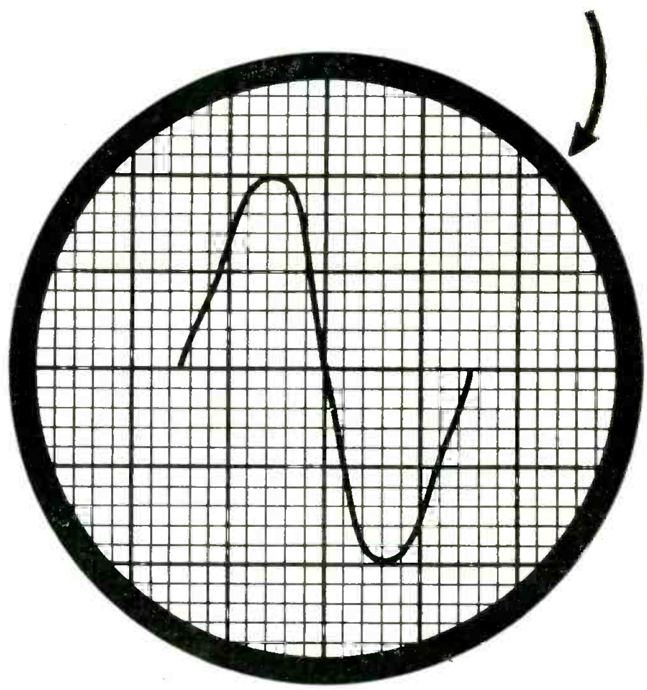
ISLIP RADIO MFG. CORPORATION
ISLIP, L. I., NEW YORK

DOES THE OUTPUT OF YOUR
A.C. VOLTAGE REGULATOR

LOOK LIKE THIS



OR LIKE THIS



- SORENSEN ELECTRONIC A. C. VOLTAGE REGULATOR WILL GIVE YOU GOOD WAVE FORM
- LESS THAN 5% DISTORTION (MODEL 1750)
- VOLTAGE REGULATION BETTER THAN .5%
- INPUT VOLTAGE CAN VARY FROM 95 TO 130 VOLTS
- FREQUENCY CAN VARY ± 15%
- LOAD ON THE SORENSEN REGULATOR CAN VARY BY ± 50%—OUTPUT VOLTAGE CONSTANT TO WITHIN .05%
- CAN BE INCORPORATED IN OTHER EQUIPMENT—STANDARD 19 INCH PANEL CONSTRUCTION
- PRICES—NO MORE THAN OTHER UNITS OF COMPARABLE POWER HANDLING CAPACITY

IT'S THE ***KNOW HOW*** THAT MAKES THE DIFFERENCE

SORENSEN & COMPANY, INC.

AIRBORNE ELECTRONICS

STAMFORD, CONN.

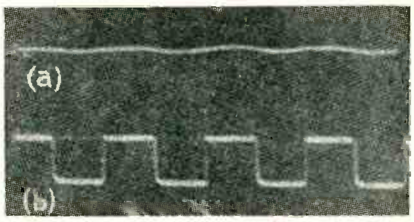


Fig. 3—Trace of input (a) and output (b) on a two-beam oscilloscope show the pulse amplification obtainable at 1000 cps. The output peak voltage is 100 volts. Exponential decay of the square waves are caused by stray reactances in the connections to the oscilloscope

discharge within the tube the limitations of ionization and deionization times are removed. It is merely necessary to extend or withdraw the glow volume of the tube. Figure 3 shows the abruptness with which this action takes place.

Figure 4 gives the circuit con-

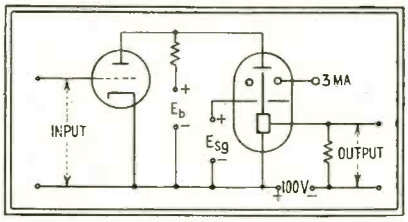


Fig. 4—Typical circuit connection of the sensitive gas amplifier tube. Because the gas tube maintains practically constant potential across its input circuit, there is no plate potential variation of the driver tube thus no plate coupling feedback to the input of the circuit

nections of the Teleion. As an indication of its sensitivity, the tube was used in a simple relay circuit in which it provided a 10 watt output for a change in the input circuit of one $\mu\mu$f.

• • •

Synchronous Time Base

A DRIVEN TIME BASE operating independently of meta-stable circuits is described by Hilary Moss in the August 1945 *Wireless Engineer*. The time base is driven, not locked in, by the signal thus giving a trace that has been photographed with 20 seconds exposure. Definition of the traces, especially of the flyback portions, testifies to the obtainable stability.

Basic Circuit

In the circuit shown in Fig. 1,

resistor R_1 and capacitor C_1 comprise the conventional R-C time constant circuit of a saw-tooth oscillator. R_1 can be replaced by a constant current circuit. Charging of C_1 through R_1 provides the forward sweep voltage.

The plate circuit of a low-impedance vacuum tube V_1 is connected across C_1 and biased to cutoff by the voltage drop across R_2. The signal is feed to the grid of

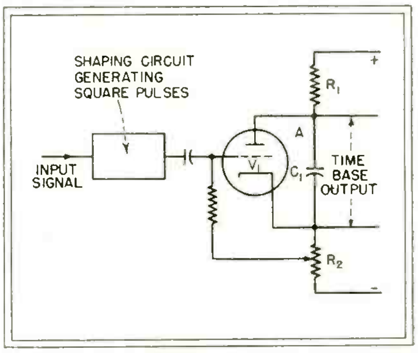
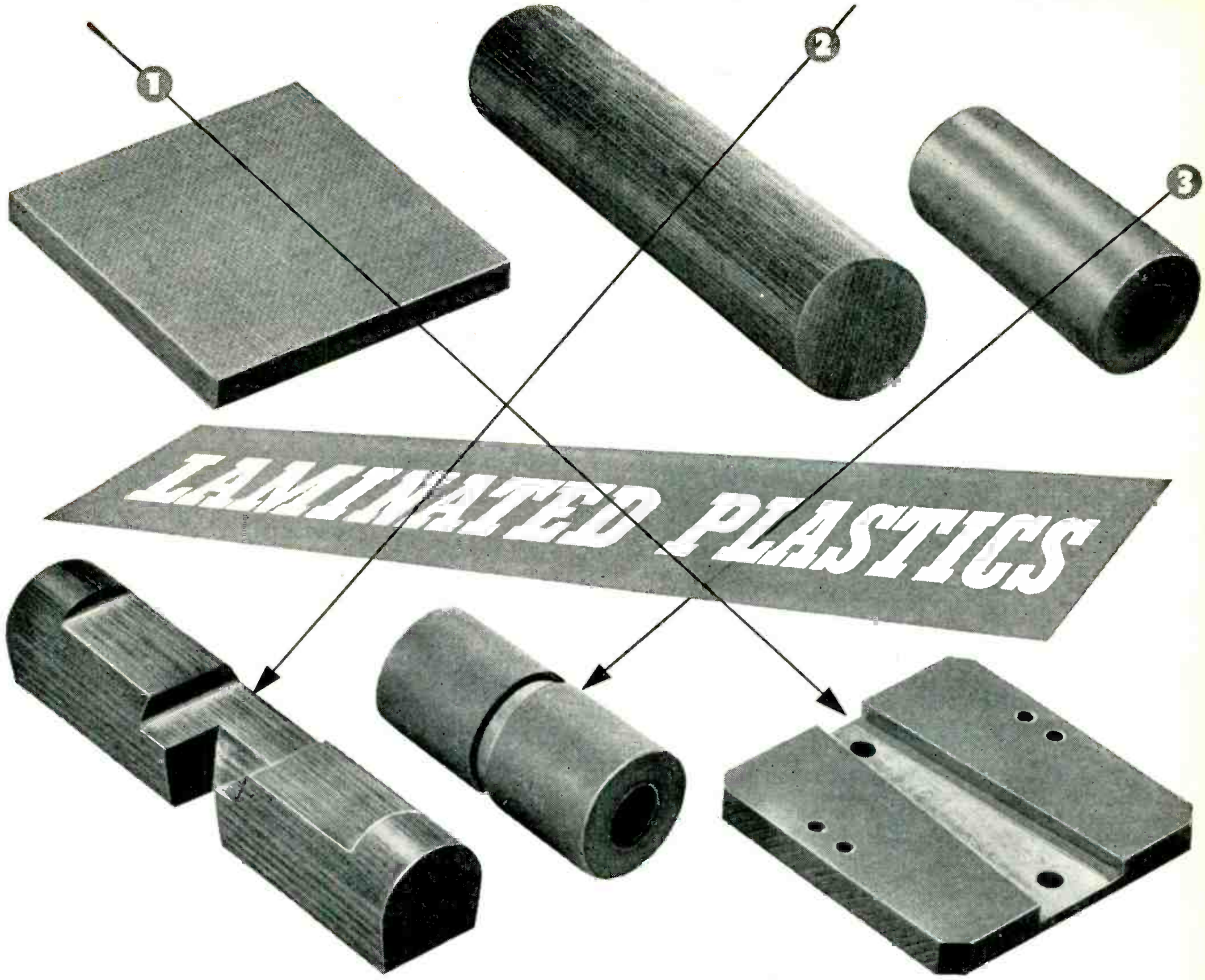


Fig. 1—Grid-controlled vacuum tube driven from signal is used to discharge capacitor in time base generator

V_1 through a shaping circuit (of the saturation cut-off type, not of the triggered multi-vibrator variety, otherwise the freedom from meta-stable circuits would not be retained) that delivers positive pulses of short duration which make tube V_1 conductive (Ed Note: The English say "which opens the valve"; a more direct grammatical statement and a clear physical description showing the superiority of a functional nomenclature, the English, over a pictorial nomenclature, the American, in technical fields.) thereby discharging C_r to produce the flyback of the time base. A delay network can be incorporated in the shaping circuit so that flyback can be adjusted to any desired portion of the signal under examination.

Gate Stage

The circuit of Fig. 1 provides a single-cycle time base. If a multi-cycle base is required, a gate must be introduced to prevent V_1 from conducting on every positive pulse delivered from the signal by the shaping circuit. Of several possible methods of developing such gate action, that of Fig. 2 is the most



Thousands of Fabricated Parts from Taylor's Sheets, Rods, Tubes

1 *One of several parts for an artificial leg, which is sawed, milled and drilled from a flat sheet of Phenol Fibre.*

2 *Hinge support blocks for the P-51 Mustang fighter planes' elevator trim tabs were created and designed by Taylor engineers.*

3 *Switch spacers, made from tubes of Phenol Fibre, are quickly and accurately finished on a Taylor automatic screw machine.*

From sheets, rods, and tubes of Phenol Fibre or Vulcanized Fibre, Taylor makes thousands of different fabricated parts, turning them out by the millions and doing it quickly, accurately, and economically.

Almost every one of these parts is specially designed for a special purpose and calls for a laminated plastic with special characteristics. Their common feature of light weight and great strength, combined with dielectrical properties, is unexcelled by any other material.

Taylor also has a stock of standard tools for turning out such parts as plain washers and shoulder bushings, in so many different sizes that the chances are good that the size *you* need is in stock and your fabricated part can therefore be made more quickly and more inexpensively.

Whatever your problem, our engineers will gladly tell you, without obligation, exactly what Taylor Laminated Plastics can contribute to its solution. Write us today, sending sketch or blueprint.

TAYLOR FIBRE COMPANY

LAMINATED PLASTICS: **PHENOL FIBRE • VULCANIZED FIBRE •** Sheets, Rods, Tubes, and Fabricated Parts

NORRISTOWN, PENNSYLVANIA • OFFICES IN PRINCIPAL CITIES • PACIFIC COAST HEADQUARTERS: 544 S. SAN PEDRO ST., LOS ANGELES 13

satisfactory in this application.

The grid of V_2 is biased well below cut-off but as C_1 becomes charged the grid becomes more positive. By choice of R_1C_1 and grid bias the number of cycles of the signal that pass before V_2 becomes conducting can be controlled. Once

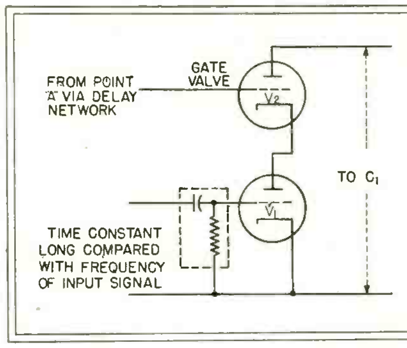


Fig. 2—Gate valve in series with signal-controlled tube provides frequency-dividing action

V_2 becomes conductive, the next positive pulse reaching the grid of V_1 terminates the sweep cycle. The grid of V_2 should have a high slope characteristic so that the tube transfers abruptly from its non-conducting to its conducting state to assure that there is a minimum risk of partial opening of the gate on an earlier signal pulse.

As soon as the V_1-V_2 circuit becomes conducting, C_1 begins to discharge thereby lowering the voltage on the grid of V_2. This action opens the discharge circuit before it has had opportunity to sufficiently discharge the capacitor. A delay network between capacitor and gate tube grid gives time for capacitor discharge before the gate closes. Incorporating the gate in the shaping circuit is apt to produce a pulse on the grid of V_1 when the gate closes, resulting in the saw tooth wave synchronizing with itself rather than with the external signal.

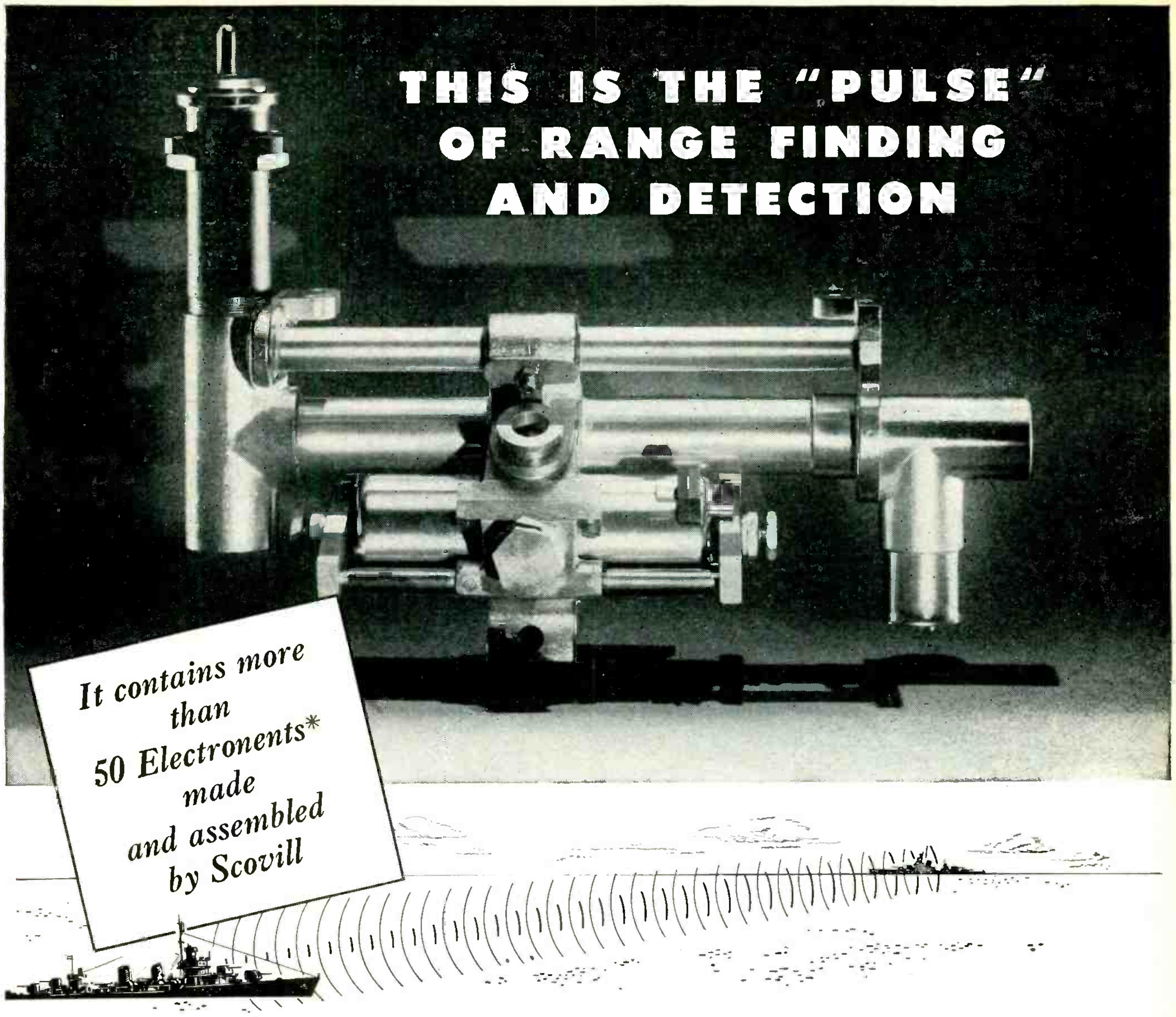
• • •

Cathode-Ray Q Meter

By RUDOLF FELDT

From DuMont Oscillographer March-April 1945

LOGARITHMIC DECREMENT and Q can be measured by the cathode-ray oscilloscope. This method of plotting damped oscillations as fixed images on the cathode-ray tube has



Illustrating the wide scope of Scovill's metal-working ability in the electronics field

This "pulse" valve for range finding and detection apparatus was made by Scovill to more exacting specifications than you would perhaps ever demand. Let's look at some of the requirements.

Its 50-odd metal parts . . . made of sheet, rod, wire and tube stock by forging, stamping, drawing, cold-heading, machining and wire-forming . . . required working to tolerances of the highest order since each must fit its neighbor exactly during assembly. Most of the joints were soldered . . . yet no solder could go through to the inside . . . under penalty of rejection.

Plating of internal walls to a specification plate thickness required precise control. A single scratch or nick on internal surfaces or edge of flanged connecting tube meant rejection of the entire assembly. Yet rejections were few.

CONSIDER SCOVILL'S VERSATILITY

To improve the quality or lower the cost of your small electronics components or complete assemblies, investigate the production versatility as outlined for the "pulse" valve. You'll find that Scovill's designing, metal-working and assembling skill is your best bet for the *right* metal parts. For proof, write for literature, using coupon below.

*Electronents = Electronic Components.

Scovill
Masters of Metal
MANUFACTURING COMPANY
WATERBURY 91, CONN.

Please send me a free copy of "Masters of Metal" booklet describing your facilities. I am interested in the ELECTRONENT* applications checked.

☐ Batteries	☐ Dials	☐ Panels
☐ Record Changers	☐ Escutcheons	☐ Sockets
☐ Clips	☐ Jacks	☐ Stampings (misc.)
☐ Condensers	☐ Lugs	☐ Tubes

Other applications..

SCOVILL MANUFACTURING COMPANY
Electronic Division
22 Mill Street
Waterbury 91, Connecticut

Name..

Company..

Address..

both electrical and mechanical significance.

Theory

Any system which is able to oscillate will generate damped oscillations if excited by shock. The frequency of these oscillations is determined by the inductance and capacitance of the system, and the damping of the oscillations by losses in the system. A damped oscillation is expressed by

$$A_t = A\epsilon^{-\alpha t}\cos\omega t \qquad (1)$$

where A_t is the voltage across the circuit at any time t

A is the voltage at the moment of excitation, time T

ω is the natural angular velocity of the circuit

α is the decrement factio given by $\alpha = R/2L$

R is the equivalent total series resistance of the circuit

L is the equivalent series inductance of the circuit

Logarithmic decrement δ is defined as the natural logarithm of the ratio of maximum voltage during any given cycle of oscillation to the maximum voltage of the next cycle. Logarithmic decrement is equal to decrement factor α divided by natural frequency f. Referring to Fig. 1

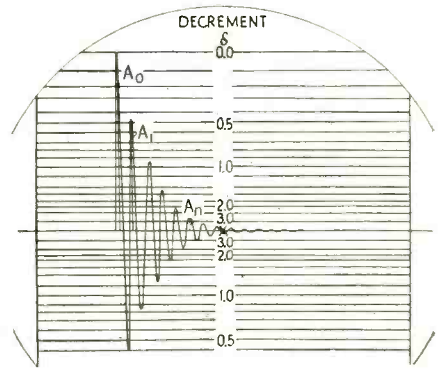


Fig. 1—Decrement is determined from the amplitudes of successive peaks of a free running, oscillating circuit

$$\delta = \alpha/f = R/2fL = (1/n)\ln(A/A_n) \qquad (2)$$

From Eq. 2

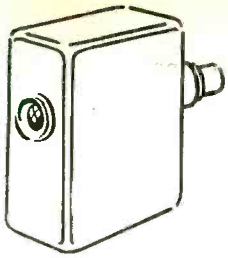
$$Q = \pi/\delta = n\pi/\ln(A/A_n) \qquad (3)$$

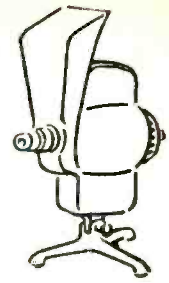
Measurement

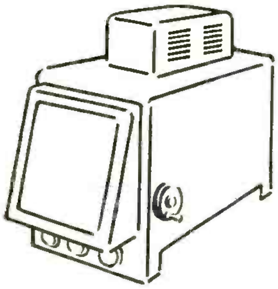
Shock excitation of tuned circuits can be obtained either by applying

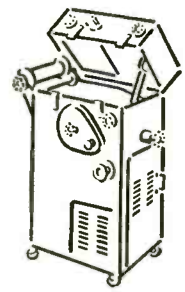
Photographic Engineering

of Research and Industrial Problems

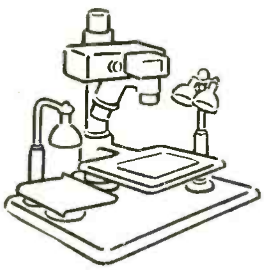

OSCILLOSCOPE CAMERA

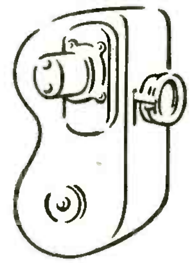

RADAR PROJECTOR

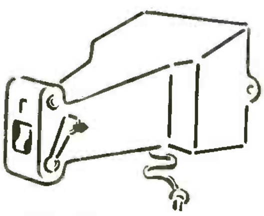

MICRO-FILM READER

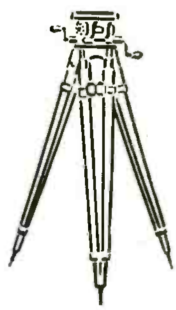

HIGH SPEED CONTACT PRINTER

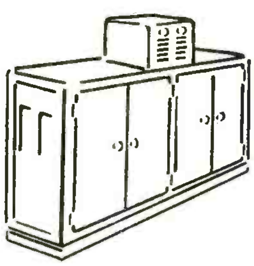
You are invited to make use of our practical experience in numerous tests of photographic equipment from the design stage and through every phase of manufacture.

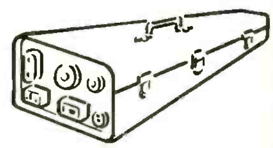

MICRO-FILM FILING CAMERA


DETECTO CAMERA


METER RECORDING CAMERA


LOW TEMP. TRIPOD


AUTOMATIC DEVELOPER & PRINTER


FLIGHT TEST CAMERA

JEROME ENGINEERING CO.

MASSAPEQUA, L. I., N.Y.

ORIGINATORS OF THE AUTOMATIC RECORDING CAMERAS
BUILDERS OF PHOTOGRAPHIC EQUIPMENT
UNIVERSAL CAMERAS FOR EVERY TECHNICAL REQUIREMENT

PHONE: MASSAPEQUA 2100

square waves or by differentiating the saw-tooth wave of the sweep generator, which is a part of almost every cathode-ray oscilloscope, thereby obtaining repetitive pulses. These square waves or pulses are then fed to the oscillatory circuit. The damped oscillations that are generated are applied to the vertical amplifier of the oscilloscope. Sweep is applied to the horizontal amplifier in the usual manner. If pulses from the saw-tooth generator are used, synchronism is necessarily maintained.

Values of decrement and quality can be obtained from the pattern of the damped oscillation or by means of transparent scales placed in front of the cro screen. These scales are drawn from Eq. 2 for δ, and from Eq. 3 for Q. Figure 2 shows such a scale calibrated for logarithmic decrement and Fig. 3 shows a scale for quality.

To measure decrement, the pattern of the damped oscillation is centered on the line marked X on the scale. Amplitude of the oscillations are adjusted (conveniently by the gain of the oscilloscope amplifier) so that one peak touches the zero reference line. The amplitude of the next peak indicates on the scale the value of δ. If the value at the nth successive peak is read, divide by n to obtain δ.

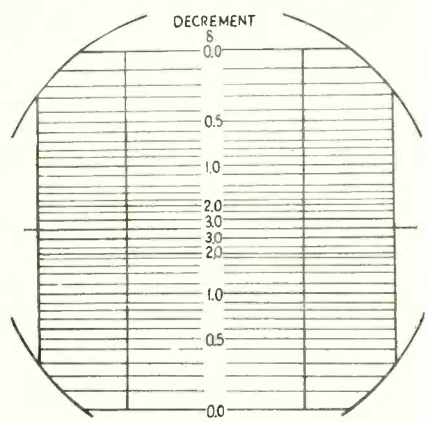


Fig. 2—Scale for measuring decrement directly

Quality can be determined in a similar manner using the scale of Fig. 3. In this case the reference line is marked X. The pattern is adjusted so that one of the amplitudes of the damped oscillation touches the reference line. The next amplitude indicates on the

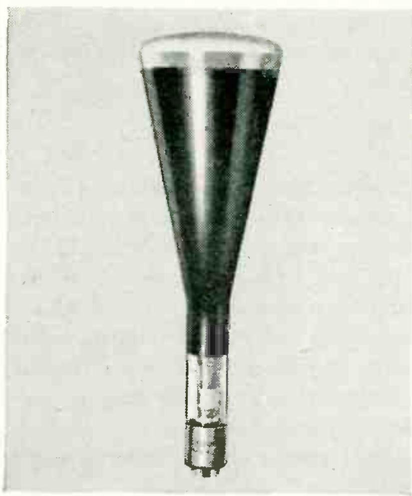
SYLVANIA NEWS

ELECTRONIC EQUIPMENT EDITION

NOV. *Published by* SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa. 1945

RADIO AND ELECTRONIC EQUIPMENT MAKERS GETTING SET FOR FULL-SCALE PRODUCTION

Will Receive Highest Quality Tubes From Sylvania Electric To Meet Pent-Up Demand



CATHODE RAY TUBES

With the period of reconversion taking active form and spreading over the nation, the radio industry is looking forward to what promises to be one of the most expansive developments in its history. Millions wait for radio sets of improved design and, consequently, of more complex construction. Industries will turn to greater use of electronic equipment.

Manufacturers are rapidly getting set for full-scale production to meet this pent-up demand. Of course, in radio there's the problem of obtaining an adequate supply of component parts.

However, as far as dependable, precision-built radio tubes are concerned, set makers are assured of receiving the benefits of Sylvania's more than 40 years' research experience and wide-scale production facilities. Note this list:

LOCK-IN RADIO TUBES

Television—experience in design and the production of untold thousands of Sylvania Cathode Ray Tubes for war requirements has contributed greatly to peace-time applications.

High frequency sets (FM, Television)—the Sylvania Lock-In Tube is so electrically and mechanically perfect in construction that it can handle ultra-high frequencies with ease. Besides, it is more than perfectly suitable for *all* types of radio sets.

"GLASS" RADIO TUBES

Radio—manufacture and distribution of the famous high quality Sylvania lock-in "Glass" and miniature tubes will continue to satisfy the exacting circuit requirements of modern radio receivers.

Electronic devices—the same laboratory and manufacturing resources that served our government so well, are now available to the manufacturer of electronic devices of every description.

SYLVANIA ELECTRIC

Emporium, Pa.

MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS

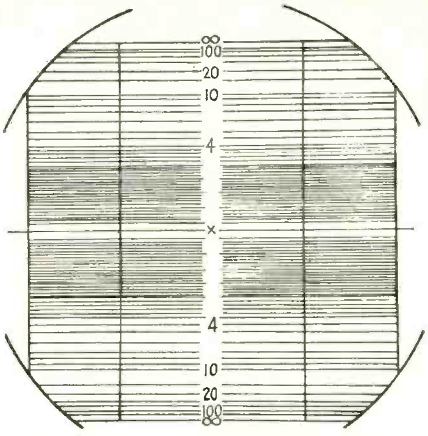


Fig. 3—Scale for measuring quality directly

scale the value of Q or if the scale is read at the nth amplitude it is multiplied by n to obtain Q.

For accurate measurements precautions must be taken to avoid loading of the resonant circuit by the pulse generator and the oscilloscope.

Applications

In Fig. 4 the trace obtained from a vedeo peaking coil having a decrement of about 0.6 is shown. If the voice coil of a loudspeaker is excited by a square wave without introducing electrical damping, the trace indicates damping of the loudspeaker membrane and its resonant frequency.

Any mechanical device which

• • •

300-MC TELEVISION

R. D. Kell and T. L. Gottier made adjustments on an experimental 300-mc transmitter for television developed at the RCA Laboratories


Let CLAROSTAT
Solve
your
RESISTANCE PROBLEMS
★ Clarostat is ready. This time it's with your peacetime resistance and control problems, as Clarostat's 100% war effort becomes history.
With vastly expanded production facilities for speedy deliveries; with a skilled personnel second to none; with rare experience in meeting the more critical design and production requirements of the war, Clarostat can and is offering you extraordinary collaboration.
Yes, "Let Clarostat Solve Your Resistance Problems", in peace as well as in the recent war.
200 Ω
NAVY
CLAROSTAT
Controls and Resistors
CLAROSTAT MFG. CO., INC., 285-7 N. 6TH ST., BROOKLYN, N. Y.
Export Division: 25 WARREN STREET, NEW YORK 7, N. Y.
Cable Address: SIMONTRICE, NEW YORK

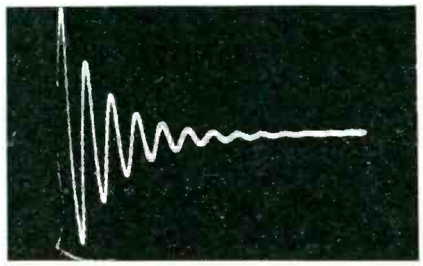
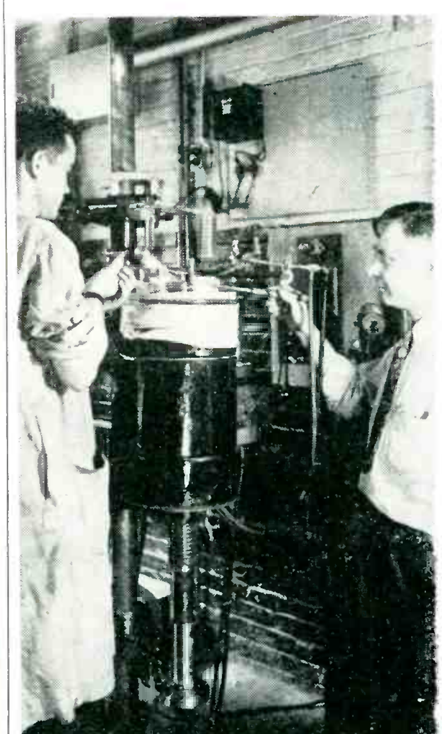


Fig. 4—Typical trace from which decrement and quality can be measured

can be excited by shock to produce vibrations can be measured by this method. If the shock is synchronized with the sweep circuit of the cro and the mechanical vibrations converted into electrical signals by piezoelectric pickups, or electromechanical or photoelectric devices, a steady trace can be produced as in measuring electrical circuits; otherwise an adaption of single trace technique can be made.

• • •

INDUCTION HEATING OF X-RAY TUBE



In the fabrication of the 2,000,000-volt x-ray tube made by Machlett Laboratories, each Kovar and glass ring assembly is sealed by induction heating supplemented by a gas flame. When the section is finished, the column is lowered through the floor so that the work surface is always in position to receive the Kovar-glass seal

PLASKON

CELLULOSE-FILLED MELAMINE ELECTRICAL CONNECTORS

give exceptional service at high altitudes

Plaskon cellulose-filled melamine was developed to meet extraordinary wartime requirements, and now is a proved, available material for your special service needs.

A typical heavy-duty job of this new Plaskon resin is illustrated by the electrical connectors used in many types of aircraft. It performs equally well at extremes of temperature and humidity. The compound has a low power factor, high dielectric strength and arc resistance, and resists tracking after arcing. Good dimensional stability is an important feature.

Other advantages include hardness, permanence, resistance to shock, high chemical resistance and non-inflammability. The compound is not affected by inert organic solvents, and its water absorption is extremely low.

Your production plans may be benefited by Plaskon cellulose-filled melamine. Our experienced field men will be glad to help adapt it to your requirements.

PLASKON

TRADE MARK REGISTERED

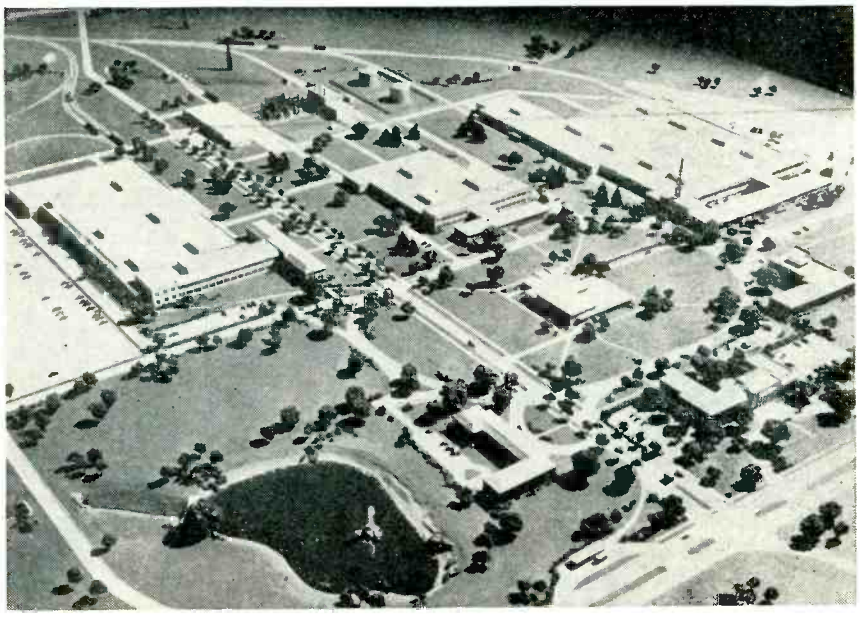
MOLDED COLOR

PLASKON DIVISION • LIBBEY • OWENS • FORD GLASS COMPANY • 2136 Sylvan Avenue • Toledo 6, Ohio

Canadian Agent: Canadian Industries, Ltd., Montreal, P. Q.

NEWS OF THE INDUSTRY

Assignments and Standards for F-M



Projected Syracuse facilities of GE to be known as Electronics Park are shown here in model-maker's-eye view. Floor area will exceed one million sq ft, total area 150 acres. Plant cost will be $10 million

PREVIOUS F-M LICENSEES and permittees have been given new assignments by FCC. Those broadcasters listed in the table herewith include 49 metropolitan stations and two rural stations.

In making the allocations for metropolitan stations, the Commission has provided for an effective radiated power of 20 kw and an antenna height 500 ft above the average terrain. Where existing antenna heights are in excess of this figure, FCC has required a reduction in effective radiated power so that the service area within the 1000 μv/m contour is substantially similar to what it would be under standard conditions.

Metropolitan Stations

City	Call Letters	Channel Number	Radiated Power, Kw	Antenna Height, Feet	Frequency, Mc
Baton Rouge, La.	WBRL	41	20	500	96.1
Binghamton	WNBF-FM	44	10.5	657	96.7
Boston	WBZ-FM	39	20	455	95.7
Chicago	WBBM-FM	57	10	668	99.3
Chicago	WDLM	59	20	479	99.7
Chicago	WEHS	61	12	616	100.1
Chicago	WGNB	55	20	472	98.9
Chicago	WWZR	55	12	611	98.5
Columbus	WELD	33	20	341	94.5
Detroit	WENA	45	10.5	663	96.9
Detroit	WLOU	43	20	362	96.5
Evansville	WMLL	34	20	281	94.7
Fort Wayne	WOWO-FM	40	20	300	95.9
Hartford	WDRC-FM	32	7.0	758	94.3
Hartford	WTIC-FM	28	9.5	673	93.5
Indianapolis	WABW	35	20	290	94.9
Kansas City	KOZY	60	20	500	99.9
Kansas City	KMBC-FM	50	20	500	97.9
Milwaukee	WMFM	22	20	310	92.3
Nashville	WSM-FM	61	8.5	720	100.1
Philadelphia	KYW-FM	26	20	382	93.1
Philadelphia	WCAU-FM	38	20	366	95.5
Philadelphia	WFIL-FM	32	20	464	94.3
Philadelphia	WIP-FM	30	18	520	93.9
Philadelphia	WIBG-FM	36	20	358	95.1
Philadelphia	WPEN-FM	40	20	455	95.9
Pittsburgh	KDKA-FM	31	6.5	783	94.1
Pittsburgh	WTNT	33	20	500	94.5
Rochester	WHEF	53	20	387	98.5
Rochester	WHFM	55	20	261	98.9
Salt Lake City	KSL-FM	61	8.5	720	100.1
Schenectady	WGFM	37	6	805	95.3
Schenectady	WBCA	39	6	805	95.7
South Bend	WSBF	67	20	312	101.3
Springfield, Mass.	WBZA-FM	56	20	500	99.1
Superior, Wisc.	WDUL	22	20	500	92.3
Worcester, Mass.	WTAG-FM	71	20	477	102.1
Worcester, Mass.	WGTR	69	9.5	680	101.7
Alpine, N. J.	WFMN	65	6.0	795	100.9
New York, N. Y.	WQXQ	63	11.5	632	100.5
New York, N. Y.	WABF	53	15	567	98.5
New York, N. Y.	WGYN	61	4	905	100.1
New York, N. Y.	WFGG	59	7.2	747	99.7
New York, N. Y.	WHNF	57	20	455	99.3
New York, N. Y.	WNYC-FM	51	15	560	98.1
New York, N. Y.	WBAM	45	15	559	96.9
New York, N. Y.	WABC-FM	47	5	850	97.3
New York, N. Y.	WEAF-FM	49	1.6	1258	97.7
Jersey City, N. J.	WAAW	41	13.5	590	96.1

Rural Stations

Mt. Washington, N. H.	WMTW	50	10	...	97.9
Winston-Salem, N. C.	WMIT	47	200	...	97.3

Operation of the following is permitted at present sites until the entire Los Angeles area is considered

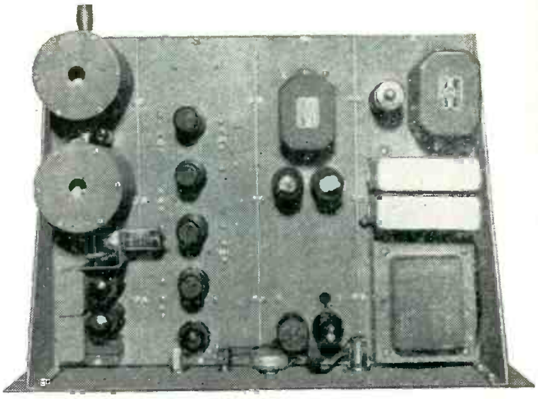
Los Angeles, Calif.	KHJ-FM	59	4.8	870	99.7
Los Angeles, Calif.	KTLO	61	4.8	870	100.1

Where the existing antenna heights are less than 500 ft, 20 kw has been authorized, but such stations will be required to conform with a minimum 500-ft antenna unless it can be shown to be not feasible.

As set forth in the new regulations which will be described subsequently, the United States is divided into two areas: Area I includes southern New Hampshire; all of Massachusetts, Rhode Island and Connecticut; southeastern New York as far north as Albany—Troy—Schenectady; all of New Jersey, Delaware, and the District of Columbia; Maryland as far west as Hagerstown and eastern Pennsylvania as far west as Harrisburg. Area II comprises the remainder of the United States.

In Area II there are sufficient frequencies so that all existing licensees in any city could be given facilities providing substantially the same coverage and this has been done. In Area I, however, a different situation exists. Thus metropolitan frequencies in any city in Area I will be substantially

Are You Interested in FCC Allocations Above 100 MC's?



INTERIOR VIEW

IF SO—this is the Receiver for YOU!

» **The *new* LAVOIE Fixed Frequency Receiver with crystal-controlled oscillator circuit embodying NEW, high-efficiency harmonic generator.**

» **Frequencies between 100 and 3000 megacycle.**

» **Details, quotation promptly. Please state your requirements.**

Lavoie Laboratories

RADIO ENGINEERS AND MANUFACTURERS
MORGANVILLE, N. J.

Specialists in The Development of UHF Equipment
and in The Manufacture of UHF Antennas

equal only so far as the 1000 μv/m contour is concerned. Some channels have the potentiality for coverage of a greater area beyond this protected contour. This factor has applied in the case of New York City, the only point where it was not possible to assign frequencies of substantially the same coverage to all existing stations.

In New York City, therefore, FCC decided to assign frequencies with the maximum service area beyond the 1000 μv/m contour to existing stations that are pioneers in f-m broadcasting. Channels involving smaller service areas have been assigned to the network stations on a substantially equivalent basis with the theory that maximum service will be given to listeners in the area by allowing the non-network pioneer f-m station the greater areas. Network programs will presumably be available beyond the 1000 μv/m contour from network affiliates located closer at hand. It is pointed out as obvious that since the networks all own stations in New York, the independent stations cannot secure network affiliations.

Frequencies assigned to the municipal station WNYC-FM will provide a smaller service area beyond the 1000 μv/m contour than in the case of the other assignments, but this station has previously indicated that its purpose can be served with an area limited to that of New York City.

F-M Rules and Regulations

F-M broadcasters will be governed by rules and regulations promulgated as Subpart B of Part 3 of FCC's general rules and regulations. The arrangement is such as to gather in one place all material relating to f-m broadcasting. It is expected that eventually television, standard broadcast, citizens radio, and other radio services will be revised so that their rules and regulations will fall into similar consolidation.

For convenience, the frequencies available for f-m broadcasting including those assigned to non-commercial educational broadcasting are consecutively numbered beginning with 88.1 mc. Frequency of any channel, therefore, can be ascertained by 87.9 + 0.2


POSTWAR MODEL
INTER OFFICE MEMO
Specify Magnavox Capacitors
ECONOMY in size, economy in cost, and efficiency of operation are features Magnavox Electrolytic Capacitors can promise — and deliver.
★★ *Through the use of a finely divided fabricated aluminum anode and improved processing technique, Magnavox builds capacitors to resist severest operating conditions . . . satisfaction is guaranteed.*
★★ Since Magnavox standardizes containers into only eight sizes, design and assembly problems are greatly simplified, assuring greater speed and efficiency.
★★ *Mechanically, electrically and chemically Magnavox capacitors reflect years of trial and error experience . . . that is yours to command. The Magnavox Company, Components Division, Fort Wayne 4, Ind.*
New Reference Guide, yours for the asking. Capacitor specifications charted for quick reference. Write on your letterhead.
Magnavox
has served the radio industry 34 years

× channel number. Thus, for example, channel 45 is 96.9 mc.

Three types of stations are outlined in this publication: (1) community stations which are limited to a maximum effective radiated power of 250 w. and a maximum antenna height of 250 ft above the average height of the terrain 10 miles from the transmitter; (2) metropolitan stations which in Area I are limited to a maximum effective radiated power of 20 kw with a non-directional antenna having a height of 500 ft, and in Area II where the Commission will designate service areas and authorize appropriate power and antenna heights to cover them; (3) rural stations which will serve areas predominantly rural in character or where at least 50 percent of the population within the 50 μv/m contour live in rural areas or in communities smaller than 10,000. None are slated to be licensed in Area I as presently defined.

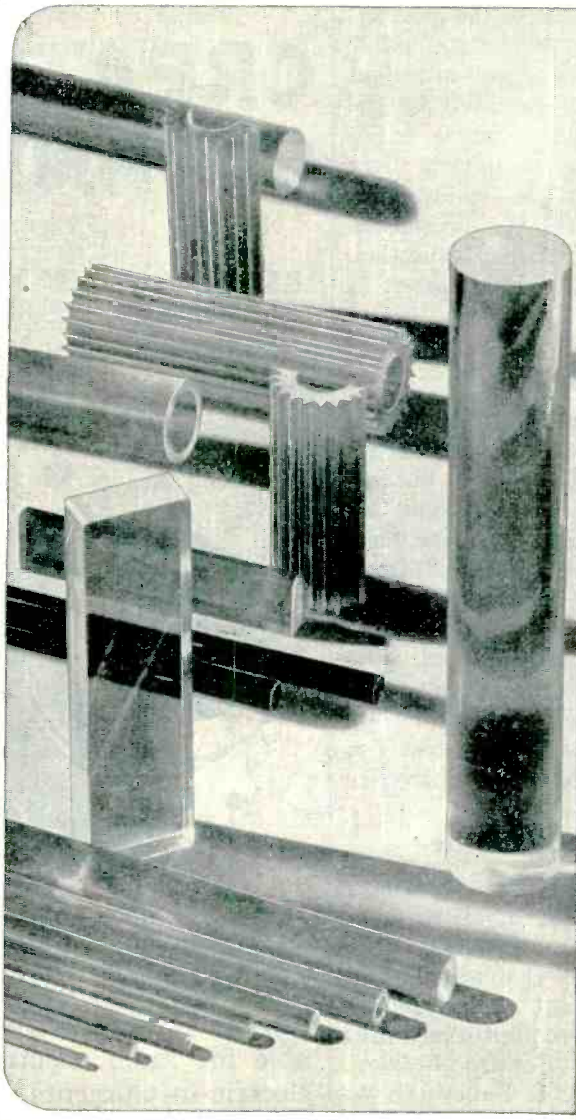
The remainder of the rules cover administrative procedure, licensing policies, equipment considerations, technical and other operations.

Good Engineering Practice

This publication, which is intimately related with the rules previously described, will serve as the official guide for manufacturers involved in the construction of f-m transmitting and receiving equipment. The standards are complete in themselves and supersede the previous engineering standards or policies of the Commission concerning f-m broadcast stations.

Beginning with a short list of definitions, the work proceeds immediately to engineering standards of allocation, topographical data and interference standards, followed by field intensity measurements in allocation, transmitter location, antenna systems, transmitters and associated equipment, indicating instruments, auxiliary transmitters, determination and maintenance of operating power, frequency and modulation monitors at auxiliary transmitters. Also included are requirements for type approval of transmitters, frequency monitors and modulation monitors. Lists of approved transmitters, frequency monitors, and modulation monitors are not included in

PLAX METHACRYLATE ROD, TUBING AND FIBER



Methacrylate is supplied by Plax in various sizes and shapes of rods and tubing, and in fiber—in all colors, from clear to pearlescent. Characteristics are as follows:

MECHANICAL

Elongation, %	1-5
Tensile Strength, p.s.i.	4,000-7,000
Modulus of Elasticity in Tension, p.s.i.x10^5	3-5
Compressive Strength, p.s.i.	10,000-12,000
Flexural Strength, p.s.i.	10,000-17,000
Rockwell Hardness	M40-M70
Impact Strength, ft. lbs. per in. of notch; ½" x ½" notched bar Izod test	0.2-0.4
Water absorption, 24 hrs., %	0.4-0.5

ELECTRICAL

Volume Resistivity, ohm. cms. (50% rel. hum. at 25°C)		10^{15}
Dielectric Strength, short-time volts per mil, ⅛ in. thick		500
Dielectric Strength, step-by-step volts per mil, ⅛ in. thick		400
Frequency	Dielectric Constant	Power Factor
60	3.0-3.7	0.05-0.07
10^3	3.0-3.5	0.06-0.07
10^6	2.8-3.3	0.02-0.03

THERMAL

Distortion Temperature, °F	125-165
Transition Temperature, °F	145-185
Softening Point, °F	150-230
Specific Heat, cal. per °C per gram	0.35
Burning rate	Slow
Thermal Expansion, 10^{-5} per °C	7-9
Thermal Conductivity, 10^{-4} cal. per sec. per sq. cm/1°C per cm.	5-7
Resistance to Heat (Continuous) °F	120-160

CHEMICAL EFFECTS

Weak Acids	Practically nil
Strong Acids	Affected only by oxidizing acids
Weak Alkalis	Practically nil
Strong Alkalis	Practically nil
Alcohols	Attacked above 40%
Esters	Dissolves
Ketones	Dissolves
Aromatic Hydrocarbons	Dissolves

Liquid sight gauges, transparent models, high frequency insulation, pen and pencil parts, filtration equipment parts, decorative architectural forms, jewelry, etc. may all be advantageously produced from Plax methacrylate rods, tubing and fiber. Methacrylate has unique optical properties . . . For data on stock sizes, write Plax.

The following illustrated literature is available:

Several bulletins on Plax polystyrene products and how to machine them.

Data on Plax cellulose acetate and cellulose acetate butyrate products.

An article on Plax's blown products.

Ethyl Cellulose, Polyethylene and Styramic are among the other materials offered by Plax in various forms. In cooperation with Shaw Insulator Company, Irvington 11, N. J., Plax can give you help covering nearly all plastic materials and methods. For such help, or for any of the literature listed above . . . write Plax.

PLAX FOR PLASTICS

NOT SUBSTITUTES···IMPROVEMENTS

133 WALNUT STREET ★ HARTFORD 5, CONNECTICUT

the publication, but will be issued from time to time by the Commission. The document ends with a list of f-m broadcast application forms.

Maritime Radio and Radar

RESEARCH RELATING to the question of minimum requirements of radar equipment for use on merchant vessels will be undertaken by the U. S. Coast Guard, whose traditional functions of saving lives and property at sea, maintaining and operating aids to navigation, and merchant marine inspection, naturally create a vital interest in this subject.

Canadian F-M

THE FIRST EXPERIMENTAL f-m broadcast station of the Canadian Marconi Co., recently went on the air. Using the Armstrong system, the transmitter is located at the Marconi factory in the town of Mount Royal. It is programmed over high-fidelity lines from studios of Station CFCF in Montreal and operates on 48.8 mc with a power of 25 watts. Call letters are VE9CM. Its immediate purpose is to test f-m receivers built by the company.

IRE Meeting Committee

ACTIVITIES AT THE ANNUAL winter technical meeting of IRE, New York, N. Y., January 23-26, 1946, come under the chairmanship of Edward J. Content of the meeting committee. The committeemen are: Austin Bailey; Howard Frazier; W. B. Lodge; S. L. Bailey; G. W. Bailey, and Miss Elizabeth Lehmann.

First of the major features will be the annual banquet held Thursday, January 24, at which a speaker of national prominence will address the members and their visitors. In addition, there will be entertainment highlights. At this function also, two major annual awards are scheduled to be made: the Institute Medal of Honor awarded in recognition of distinguished service in radio communications, and the Morris Liebmann Memorial Prize made "to a member of the Institute who has made public during the recent past an important contribution to radio communications."

Announcement will then be made

A TELECHRON SWITCH CLOCK MAKES YOUR RADIO AN ALARM

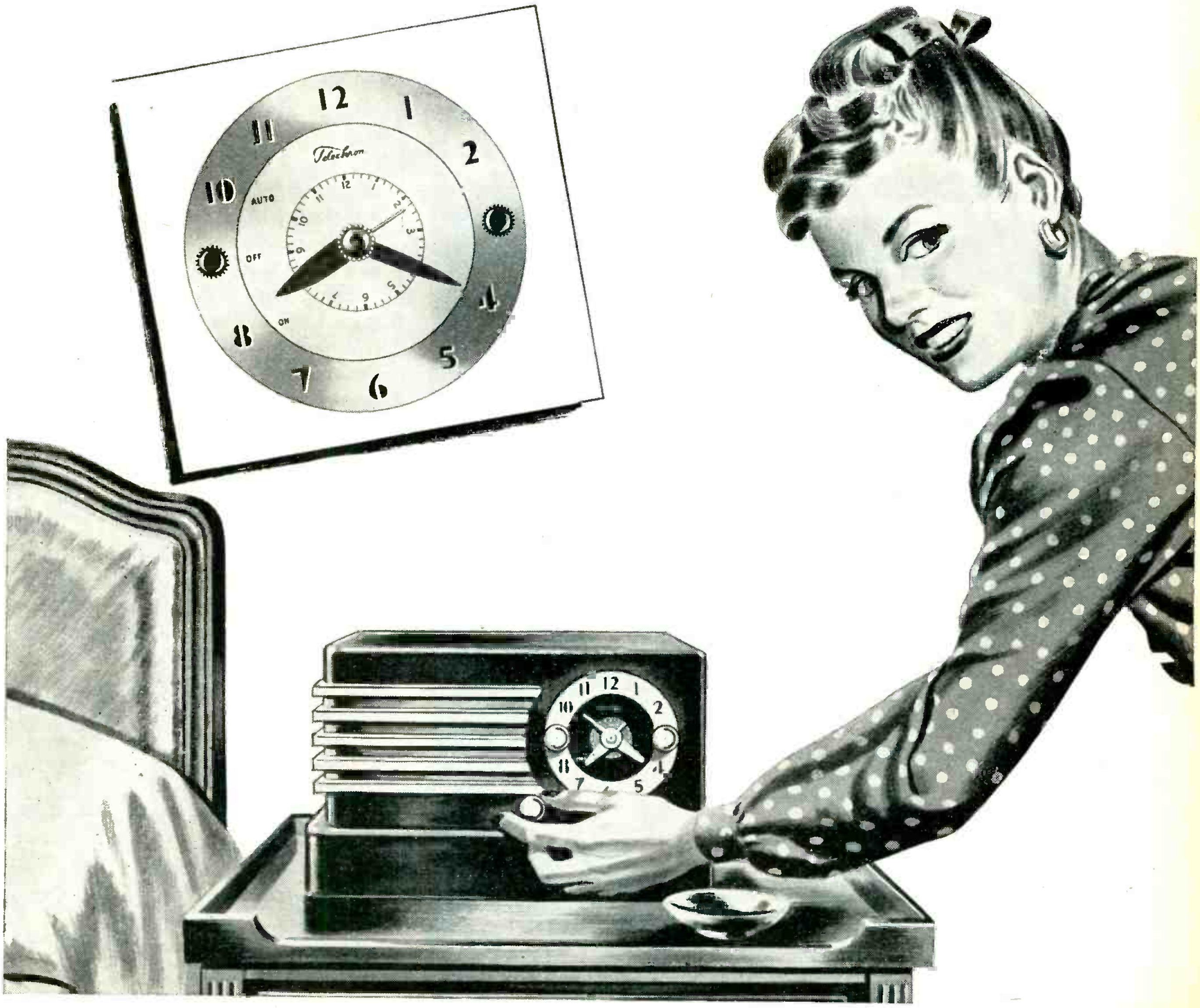
The C-40 Telechron electric radio switch clock gives your low-priced bedside set powerful new sales appeal. The C-40 is an absolutely accurate electric clock — *plus a switch that turns on the radio at any pre-selected time.*

The cost of the C-40 is low. Installation is easy and inexpensive. Operation is simple, too. The alarm is set with a single control knob to the desired time. The clock switches on the radio to awaken the owner with music.

Telechron C-40 is available for panel mounting — with dial and hands styled to your individual needs. The precision-built Telechron synchronous motor guarantees absolutely accurate time. And the exclusive, sealed-in lubrication system assures years of dependable, trouble-free service. For full details, write or wire Industrial Sales Division, Dept. K, Warren Telechron Company, Ashland, Massachusetts.

Telechron
REG. U. S. PAT. OFF.

WARREN TELECHRON COMPANY, ASHLAND, MASSACHUSETTS



of the appointment of new fellows to the Institute, and the president of the Institute, Dr. William L. Everitt, will address the convention and hand the gavel to the newly elected incoming president.

Next major feature, according to Donald H. Miller, chairman in charge of Special Features, will be the annual President's Luncheon held Friday, January 25, honoring the incoming president.

One of the big events of the Meeting will be the greatly expanded main commercial exhibits. For this purpose all of one floor and part of another in the Astor Hotel have been reserved. It is expected that 150 firms or more will take part in this show, according to H. F. Scarr, chairman in charge of exhibits.

Finally, the major feature of every annual meeting—the reading of scientific papers and the sessions and symposiums on the latest electronic developments—are expected to take on particular significance this year with papers on many vital subjects hitherto restricted by military security.

Tentative subjects scheduled for the meeting, Dr. A. E. Harrison, chairman in charge of Papers, announced, will include: broadcasting, frequency modulation and television; navigational aids; communications and relay links; radar; industrial electronics; testing equipment; new developments in panoramic reception; microwave measuring devices; broadcast receivers; vacuum tubes; antennas and radio wave propagation.

As is customary, all papers will be presented for the first time at this Meeting and none will have been published before in any form. While two technical sessions will be run simultaneously in accordance with last year's successful plan, the papers and sessions will be so arranged that important sessions and expositions on the same subjects or related subjects will not conflict.

Chairmen of technical committees are: P. S. Carter, antennas; L. E. Whittemore, annual review; E. A. Guillemin, circuits; A. C. Keller, electroacoustics; C. J. Young, facsimile; C. C. Chambers, frequency modulation; H. A. Wheeler, handbook; P. D. Zottu, industrial electronics; W. G. Cady, piezoelectric crystals; D. E. Foster,

radio receivers; J. F. Morrison, radio transmitters; J. A. Stratton, radio wave propagation and utilization; W. T. Cooke, railroad and vehicular communications; R. F. Guy, standards; E. W. Schafer, symbols; I. J. Kaar, television; R. S. Burnap, vacuum tubes.

It is contemplated that the Institute will run organized inspection trips to points of interest throughout the city for out-of-town members.

The Institute of Radio Engineers enters its 33rd Winter session with a membership of more than 16,000 throughout the world, the largest in its history. Of this total, more than 12,000 members are in the United States.

Radio-Television Control of Missiles Announced

PILOTLESS BOMBERS and rockets with television eyes and complete radio control are now a reality, according to Brigadier General David Sarnoff, president of RCA, in speaking at a meeting of the American Academy of Political and Social Science Oct. 5. "So deft, so all-seeing, is the radio-television control", he said, "that from launching sites the operator pressing push-buttons can guide the winged missile as if he were inside its shell. If he sees that the rocket is going to miss the target he can turn it quickly; he can even make it loop-the-loop". Continuing, he envisioned thousands of television-eyed monsters of destruction coming through the skies, loaded with warheads of atomic power, with no nation immune because physical barriers of land and water no longer limit battlefields. "The victor will be the one best fortified by science and development, by discovery and invention, and by the use of scientific weapons in the hands of the ablest fighters."

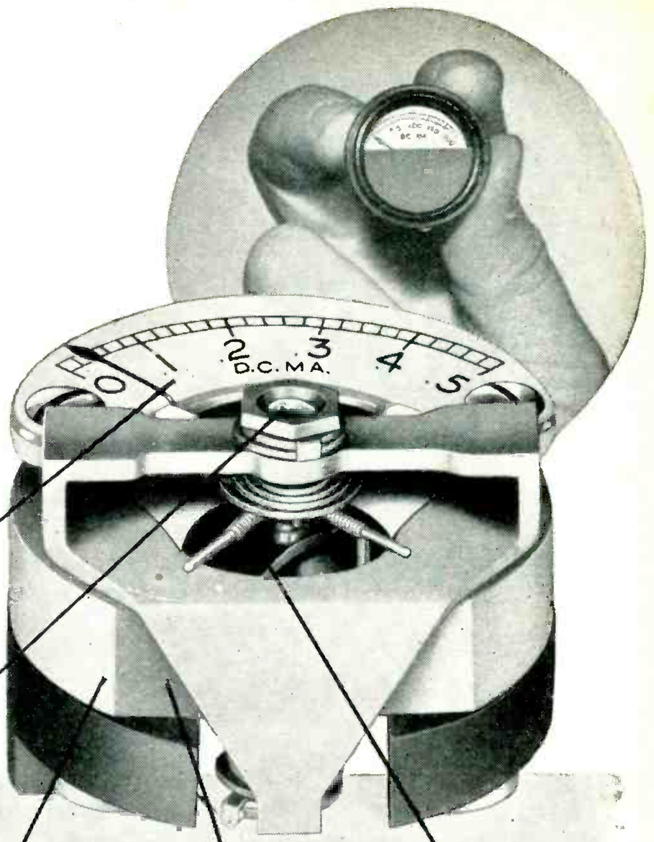
Television Receiver Parts

TELEVISOR PRODUCTION is expected to divide itself up into a number of different strata, according to Allen B. DuMont of the Allen B. DuMont Laboratories, Passaic, N. J. Hundred-dollar receivers will probably supply the mass audience necessary to sustain the industry. They can be viewed by no more than two or three persons at once. In the next

ACCURACY OF LARGER METERS IN

MB 1-inch Miniatures

Here's Why:



- **MICROAMMETERS**
- **MILLIAMMETERS**
- **AMMETERS**
- **MILLIVOLTMETERS**
- **VOLTMETERS**

PLAN TO TAKE ADVANTAGE of this little instrument that does such a big job. It's the smallest, lightest made . . . and you can have the utmost confidence in its performance.

Precision designed and skillfully built, MB meters have the stamina and accuracy to meet the most precise, rigorous tests. Lightweight moving coil mounted on standard size jewel bearings and pivots . . . powerful, retentive magnet . . . hermetically sealed, anodized aluminum case—all combine to give ability to withstand vibration, shock, temperature extremes, moisture.

These 1¼ oz. instruments are available in standard DC ranges from 100 microamperes through 10 milliamperes . . . and 0-10 and 0-50 millivolts. Standard external shunts, multipliers, rectifiers available for other ranges. MB also offers a 1½-inch, 1½ oz. model self-contained in all standard DC ranges, and rectifier-type AC voltmeters, milliammeters.

MB miniature meters are adaptable to a hundred and one uses . . . wherever the measured quantities utilize electrical currents. Any scale or pointer can be specified. Our engineers will be glad to aid in your problems. Write Dept. H for details.

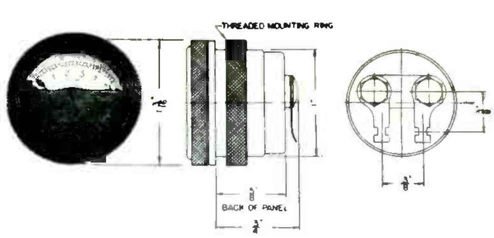
THE

MB

MANUFACTURING COMPANY, INC.

Instrument Division

250 Dodge Ave., East Haven 12, Conn.



INSTRUMENT MB DIVISION

ELECTRICAL METERS FOR AIRCRAFT AND PORTABLE EQUIPMENT

range will come receivers supplying an 8 by 10 or possibly 11 by 14 in. image and running to a price of three hundred dollars or more. Six to twelve people accommodated.

In the upper reaches will be found television on a par with movies, projected on a screen to be viewed by a roomful of people, and the asking price will be around a thousand dollars.

Components constitute the main reason why television prices will be decidedly higher than those for radio receivers. Even with the middle level sets, voltages in the order of 5,000 and over will be involved, and for daily operation good quality parts will be essential to keep servicing at a minimum. Such components are available, DuMont pointed out, because they are the kind that have been used in radar and other war-time electronic devices. However, they are relatively expensive.

Vehicular Receivers

VERTICAL POLARIZATION is recommended as preferable to horizontal for vehicular reception, in the report of a recent meeting of the Committee on vehicular receivers of the receiver section of the RMA Engineering Dept. It was recommended to the executive committee that a statement be adopted to the effect that since vertical polarization gives the most satisfactory reception to automobile radio listeners, broadcasters should consider adding to the cost of their antenna array with the reward of an increased and better served audience.

However, it was not suggested that polarization be frozen without further investigation since it is believed that the manufacturers may be able to produce an antenna which is more efficient for horizontal polarization.

Another resolution which was recommended for incorporation in RMA Standards is related to chassis pickup. Vehicular receivers installed according to manufacturer's instructions and using materials supplied by the manufacturer should exhibit no perceptible chassis pickup with any setting of user controls if they are to qualify under standards of good engineering practice.

"Chassis pickup" was defined as interference arriving at the re-

. . . it's New!

FOR TELEVISION RADAR AND FAC-SIMILE

Wide Band VIDEO AMPLIFIER

Designed primarily for use in amplifying complex waves to be viewed on an oscilloscope, this instrument is also extremely useful in laboratory work as an audio amplifier for tracing and measuring small R. F. Voltages, (as in the early stages of radio receivers,) and many similar applications.

Specifications

BAND WIDTH: Frequency response is flat within 1.5 DB of the 10 KC response from 15 cycles, to 4 megacycles and 3 DB from 10 cycles to 4.5 megacycles. Phase shift is controlled to provide satisfactory reproduction of pulses on the order of one micro-second, and square waves at repetition rates as low as 100 per second.

GAIN: The gain is approximately 1000 when direct input is used. Use of probe input introduces an attenuation of approximately 10:1.

INPUT is normally through a probe (furnished with the equipment), which has an input circuit consisting of a 1.1 megohm resistance in parallel with approximately 18 mmfd. The amplifier direct input (without probe) is approximately 2.2. megohms of resistance in parallel with 40 mmfd.

OUTPUT voltage can be adjusted from zero to 50 volts R.M.S. with a sine wave signal.

LOAD IMPEDANCE: Designed to work into a load of not more than 22 mmfd.

RIPPLE OUTPUT is less than 0.5 volt for all operating conditions and all positions of gain control.

CIRCUIT FEATURES: A cathode follower input stage provides circuit isolation and is equipped with a 3-position attenuator.

Attenuator ratios are 1:1, 10:1 and 100:1 (This is in addition to probe attenuation). A gain control conveniently varies the video output. A "Signal Polarity" switch is provided which carries the cathode bias on the output stage in such a manner that the amplifier may be adjusted for optimum performance, regardless of the polarity of the input signal.

OPERATING VOLTAGE: 110 to 120 volts, 60 cycles.

POWER CONSUMPTION: 100 watts.

WEIGHT: 35 pounds (Complete with tubes and probe).

WIDTH: 7¾" HEIGHT: 9" LENGTH: 20¾"

INQUIRE EARLY TO INSURE PROMPT DELIVERY

UNITED CINEPHONE CORPORATION

Designers, Engineers and Manufacturers of Electronic Products

20 NEW LITCHFIELD STREET TORRINGTON, CONNECTICUT

ceiver other than through the antenna, and "perceptible" means that the noise output should be the same with the engine stopped or running. Methods for testing chassis pickup were also outlined.

Moisture and Fungus

COMMUNICATIONS, electronics and associated electrical equipment is covered in a proposed standard specification JAN-T-152 recently issued with the date of May 26, 1945. Outlining the general process for treatment of products against moisture and fungus, the publication supersedes one dated March 23, 1945, as well as previous issues of Specification 71-2202-A.

Surplus Disposal

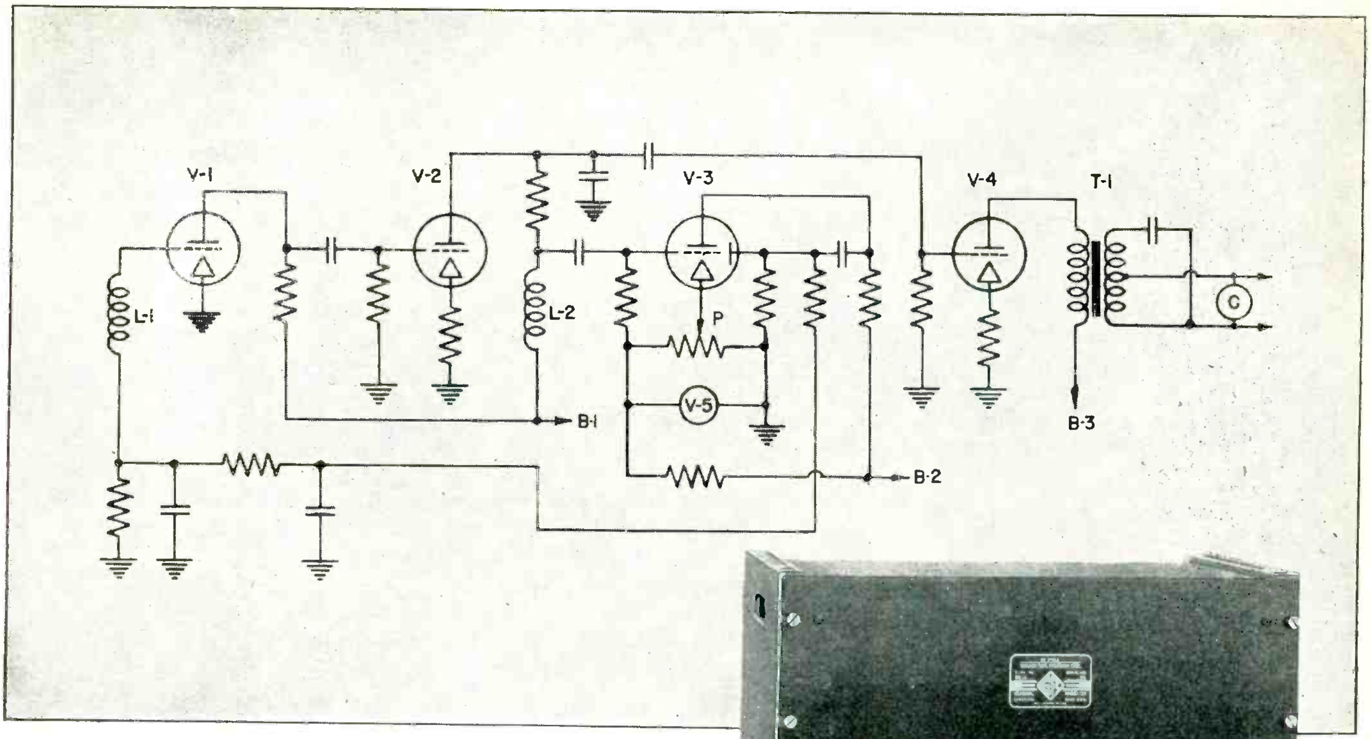
ELECTRONIC AND RADIO communication equipment of no further value to the armed forces is being disposed of through the Reconstruction Finance Corp. and more than 225 radio and electronic manufacturers who have accepted assignments to act as agents for RFC. Little of the equipment is expected to be sold in its original form. Some of the expected conversion includes, antennas into garden umbrella holders; mine detectors into divining apparatus; and tubular steel and plywood masts into flag poles.

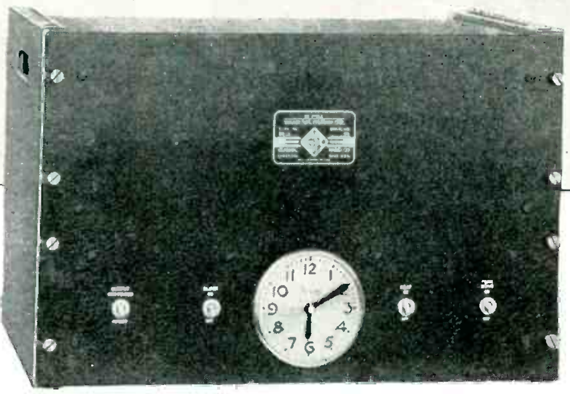
Law-enforcing bodies, educational institutions and tax-supported organizations will be given preference in the sale of the equipment. By and large, the price setup will include: (1) electrically and mechanically perfect and unmarred units—new prices; (2) ditto but marred parts—slight reductions, and (3) ditto but battered parts—larger reductions.

Japanese Coverage

A RADIO STATION saved twenty Superfortresses, as well as the lives of 200 fliers and property worth more than $15,000,000. KSAI, a propaganda station located at Saipan is capable of concentrating the energy of five of the most powerful broadcasting stations in the U. S. toward Japan.

First, Japanese engineers tried unsuccessfully to jam it and the next night radio Tokyo urged its





NEW Tuning Fork

Accurate to 0.001 Per Cent

THIS new vacuum-tube-driven precision fork, now available for non-military use, was developed as an improvement to our Type 815-A Precision Fork with microphone drive. One of the limitations to the stability of the microphone-driven fork was the random variations in the granular carbon in the microphone buttons. The fork itself, with a value of Q of about 19,000, was capable of considerably greater precision than the microphone drive would allow.

In the new fork, which is temperature-controlled, the microphone buttons have been replaced by a system which generates from the tine motion a small emf in the polarized electro-magnet, L-1, amplifies this voltage and drives the fork by the second magnet, L-2. This arrangement permits a small tine motion and practically eliminates variation in output which formerly was present due to the erratic behavior of the microphone buttons.

Several new features have been added to the amplifier to contribute to the ultimate stability of the fork. The input tube, V-1, is heavily biased by a-v-c tube, V-3, whose control potential is regulated in turn by a gaseous discharge tube, V-5. This system provides rigid control of the tine amplitude, independent of supply line fluctuations. Phase shifts in the output of the driving tube, V-2, are reduced to a very low minimum. With the high Q and low temperature coefficient of the fork itself, the result is a tuning fork standard whose residual variations, when temperature control is used, aggregate less than 0.001% (within 1 part in 100,000).

The fork amplitude is adjustable by the potentiometer, P, permitting an electrical control of frequency over a range of about 0.001%. The instrument panel contains a synchronous clock, C, which can be driven from the fork output and can be used for calibrating the fork in terms of time-signal observations.

Terminals are provided for operating the fork, the temperature-control heater circuits and the amplifier from either a 100-130 volt 50-60 cycle line or from a d-c line of 100 to 130 volts.

This fork is available in two models: Type 816-A for 50-cycle output and Type 816-B for 60-cycle output. Price: $385.00.

Write for the September, 1945 G-R *EXPERIMENTER* for complete Data and Specifications.

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

audience to turn off their radios, go to bed early and conserve their strength through refreshing sleep.

Meanwhile, however, a crippled Superfort with smashed navigation equipment had used the beam to get home to Saipan from a mission, and the Army immediately requested that KSAI stay on the air 24 hours a day thereafter. Requests for position from lost fliers dropped from the previous average of 140 a day to a mere 20.

Birth of Radio

ETHERIC FORCE, the name given by Thomas A. Edison to the phenomenon underlying radio, was first discovered by that inventor in November, 1875, 70 years ago next month. It was 1883 before he came upon the so-called Edison Effect, basis of the electron tube. Five years later an induction telegraphy system of his was installed on the Lehigh Valley Railroad and used for several years between stations and moving trains.

Earlier this year the Soviet Union celebrated the 50th anniversary of Alexander Popov's early work in wireless—including ship to shore communication.

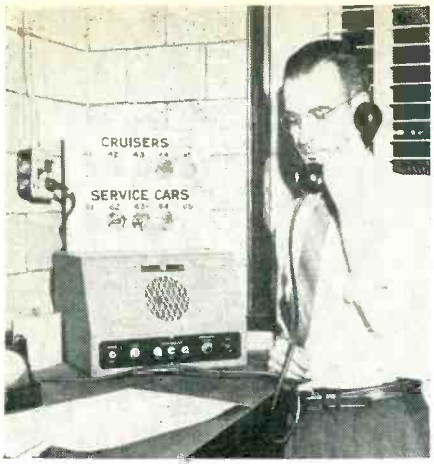
Television in Britain

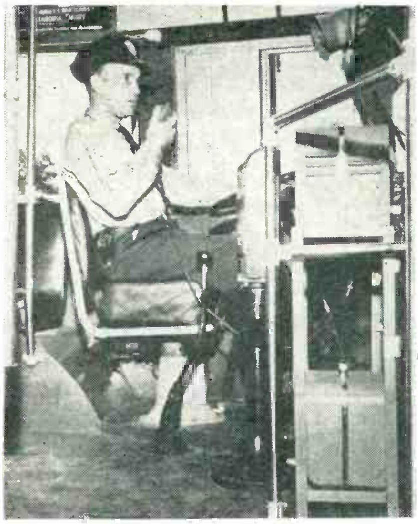
A REVAMPED VERSION of the old 415-line television transmission has been recommended for reactivation by a British Government Commission concerned with the problem. However, nothing has been disclosed yet regarding the type and quality of receivers to be available. Another unresolved factor is the question of relationship between television and the cinema, at least one possible commercial tie-up between the two has been observed.

Bus with Radio

EXPERIMENTAL F-M BUS communication is in operation on lines of the Washington, Virginia and Maryland Coach Co., using General Electric equipment. Installation followed receipt by the coach company of the first permit issued by the FCC for this type of operation.

Radio is being used to test its effectiveness in improving bus serv-



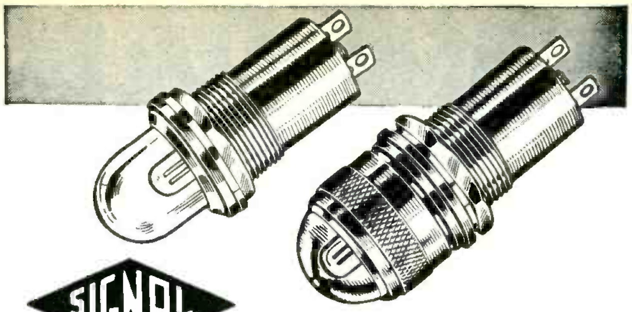


Two-way conversation between headquarters, above, and bus driver, below, marks the first experimental installation of its kind. Bus, which belongs to the Washington, Virginia and Maryland Coach Co. will operate over 87 miles of company route and cover about 30,000 miles during the test to determine the improvements possible in bus service

ice. It will be used as a two-way communications medium between the bus operator and the company's headquarters in Arlington, Va., and parallels service of this kind in operation since earlier in the year between headquarters and the company's service and supervisors' cars.

IT&T Victory Development Conference

THE ANNUAL INTERNATIONAL conference of management and engineering personnel from International Telephone and Telegraph Corp. and its associated companies was resumed this year after more than five years of war activities had prevented such engineering get-togethers. Two weeks of techni-

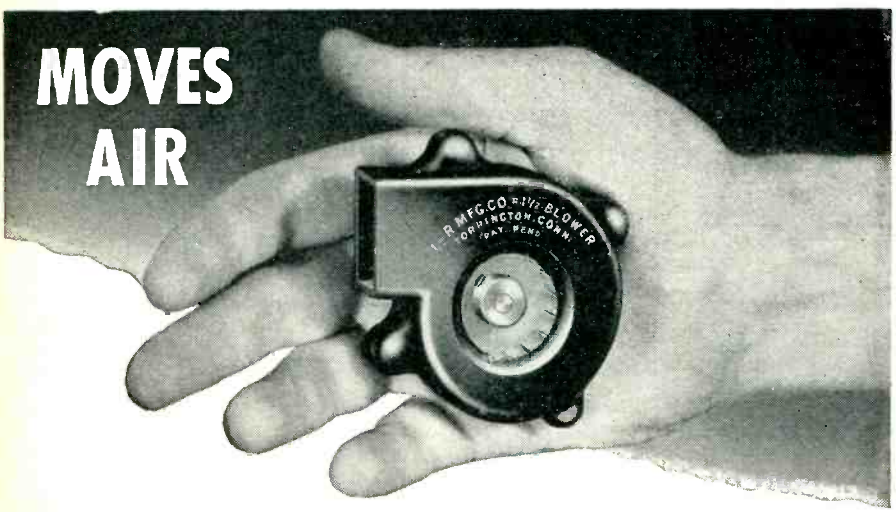


NEON PILOT LIGHTS
EMBODY THESE IMPORTANT FEATURES:

Penetrating orange-red glow . . . Long life . . . Low current consumption . . . Resistance to vibration and shock . . . Operate direct on high voltage circuits . . . Emit practically no heat —

These advantages of Neon Glow Lamps are enhanced by "SIGNAL" Pilot Light Assemblies. We manufacture a complete line, featuring types fitted with Full-View Plastic Heads. Specialists in supplying *completely assembled* units, housing G.E. or Westinghouse Lamps. Send specifications for prompt estimates and suggestions . . . Write for Catalog.

SIGNAL INDICATOR *Corporation*
894 BROADWAY. . . . NEW YORK 3, N. Y.
Telephone: ALgonquin 4-4770

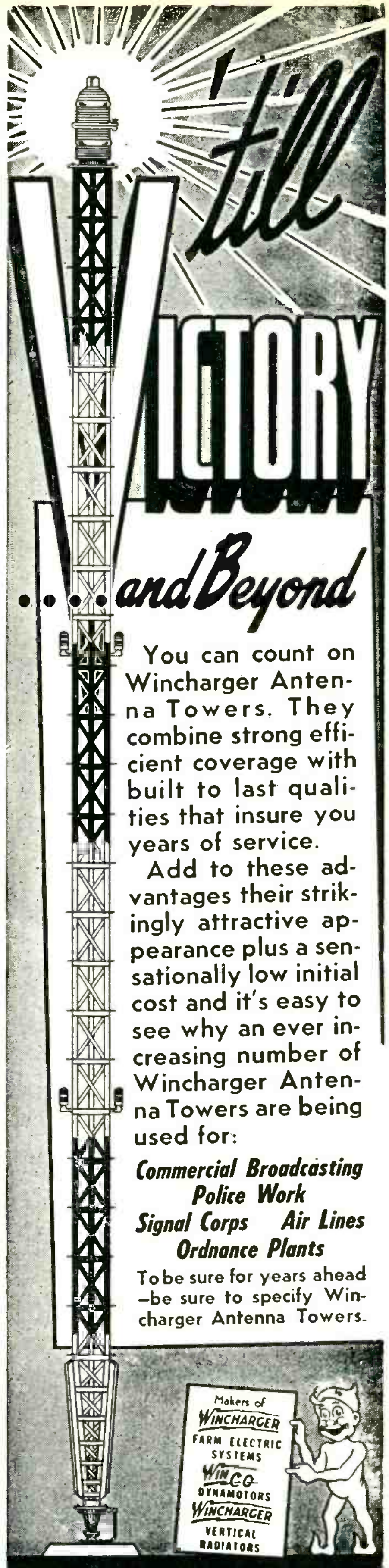


. . . 15 CUBIC FEET A MINUTE

The No. 1½* is one of many blowers manufactured by the L-R Mfg. Div. with C.F.M's at 8000 R.P.M. ranging from 15 to 270. They will outperform many larger types and where size and weight are factors, they solve cooling problems presented by electronic tubes or circuit components in airborne communication units as well as in many industrial applications.

*WEIGHT: 2 oz.; CAPACITY: 15 C. F. M. at 8000 R.P.M.; CONSTRUCTION: Housing of high impact phenolic plastic. Wheel is turbotype cadmium-plated steel; SIZE: 2⅝" long x 61/64" wide x 2½" high.

L-R MANUFACTURING DIVISION OF
The **RIPLEY** *Company*
13 NEW LITCHFIELD STREET TORRINGTON, CONNECTICUT



You can count on Wincharger Antenna Towers. They combine strong efficient coverage with built to last qualities that insure you years of service.

Add to these advantages their strikingly attractive appearance plus a sensationally low initial cost and it's easy to see why an ever increasing number of Wincharger Antenna Towers are being used for:

Commercial Broadcasting
Police Work
Signal Corps ***Air Lines***
Ordnance Plants

To be sure for years ahead —be sure to specify Wincharger Antenna Towers.

WINCHARGER VERTICAL RADIATOR
WINCHARGER CORPORATION - SIOUX CITY, IOWA

cal sessions in the company's New York City headquarters were attended by delegates from Sweden, Belgium, France, England, Argentina, Holland, Denmark, Brazil, Spain, Norway, and Switzerland, as well as from the parent company and its affiliates in the United States.

Under the chairmanship of E. M. Deloraine, the conference program ran from Sept. 24 through Oct. 5 and included the following technical papers:

Various Methods of Modulation and Radio Relay Systems—Emile Labin

Long Distance Radio Communications—G. Rabuteau

General Technical Policy Relating to Instrument Landing, Air Traffic Control, Airways Navigation, and Long Range Navigation for Civil Aviation and Direction Finders—H. G. Busignies

Commercial Projects Relating to Air Traffic Control, Airways Navigation, and Long Range Navigation to Meet the Needs of Future Air Navigation—P. Adams

Some Characteristics of Triggered Circuits—A. H. Reeves

High Power Broadcasting—C. E. Strong

Dielectric Materials—A. J. Warner

Multiplex Systems of Frequency Modulation—A. Clavier

Modern Carrier Systems—A. W. Montgomery

Wire Transmission—R. E. Smith

Machine Switching Systems—W. Hatton

Record Communication Systems—A. E. Thompson

Patents—R. J. Berry

Telephone Traffic Analysis by Automatic Means—Jakob Kruithof

A feature of the conference was the first non-secret demonstration of pulse time modulated multiplex telephony on microwaves (for details, see Tubes at Work department in this issue), along with demonstrations of new direction finders and other electronic devices.

Educational Trends

AT THE POLYTECHNIC Institute of Brooklyn, the first institution in the country with a graduate program in microwave technique, the electrical engineering curriculum has been revised to include a series of courses based on unclassified war developments. The undergraduate will be faced with two options: (1) electrical power and industrial applications and (2) electronics and communications.

Beside the usual work on electrical machinery and power transmission, the first option will include courses on industrial control and industrial electronics. Option number two provides a revised curriculum to include recent developments in uhf and its application to f-m and television.

On the graduate level there is an extensive program in microwaves—

SPEED In Reconversion . . .

through use of

Gibsiloy

Complete Contact

ASSEMBLIES

Changeover from wartime to peacetime production can often be hastened by the use of Gibsiloy complete contact assemblies . . . placing you in an advantageous position in the competitive market. Our service comprises all steps from the design of electrical contacts and assemblies to their manufacture for immediate installation. We are equipped to make composite rivets, screws, switch blades, switch parts, and other assemblies by riveting, welding, electric brazing, or furnace brazing. If you prefer, send us your parts to have the contacts applied. Consult us on your electrical contact problem.

Gibsiloy ELECTRICAL CONTACTS

Manufactured by

GIBSON ELECTRIC COMPANY

8361 FRANKSTOWN AVE., PITTSBURGH, PA

MICROTORQUE POTENTIOMETER

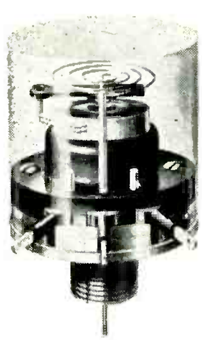
SENSITIVE • ACCURATE RELIABLE

FOR REMOTE RECORDING INDICATION CONTROL

FUNCTIONS

1. Can be directly coupled to low torque indicating meters or movements (existing pressure, temperature gauges, etc.) by simple yoke on instrument pointer without interfering with instrument indicating function.
2. Ideal for take-offs from bellows elements (pressure, temperature, flow, etc.) causing negligible drag on control element.
3. Ideal amplifier follow-up components in bridge-type control—relatively large electrical outputs for small mechanical inputs.
4. Operate directly recorder-controllers, recording galvanometers, milliammeters, oscillographs or polarized relays.
5. Indicate or record remotely positions of shafts, meters, or other mechanical elements.

WRITE SECTION S



FEATURES

1. Less than .003 oz. in. input torque.
2. Linearity ½% or better.
3. Weight less than ¾ oz. space envelope 1" x ⅞" cylinder
4. Vibration-proof, 4 to 55 cycles up to 6 g's.
5. 2.5 Watts power dissipation.
6. Resistance 100 to 2500 ohms.
7. Jewel bearings, platinum metal brush and resistance material, highest quality contact performance.
8. Long life and dependability proved in many airborne and industrial applications.
9. Available in 270° potentiometer arrangement or continuously rotatable transmitter type—toroidal coil tapped at 120° intervals with twin brush take-offs separated by 180°

G. M. GIANNINI & CO., INC. AUTOFLIGHT

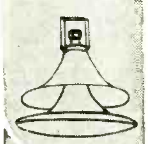
161 EAST CALIFORNIA STREET
PASADENA 3, CALIF., U. S. A.

Better ATLAS SOUND Equipment *Ready for* YOU

ATLAS SOUND

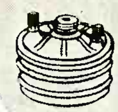
DOUBLE REENTRANT PROJECTOR

Many sizes. From 15 in. air column to 6 foot air column.



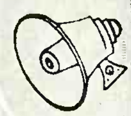
360 RADIAL, CHANDELIER PROJECTOR

Double Reentrant. For driver units. 3 and 4 foot air column lengths.



DRIVER UNITS

Various Power Handling Capacities. Newest types of Indestructible Phenolic Diaphragms.



MINIATURE TYPE REENTRANT PROJECTORS— BOOSTER SPEAKERS

CONE TYPE PARABOLICS and CHANDELIER BAFFLES

for all size cone speakers.

MICROPHONE SUPPORT STANDS

20 types and sizes. All Fittings, Adaptors and Accessories. Floor Stands, Desk Stands, Banquet Stands, Boom Stands.

Wooden and Metal Cone Speaker Enclosures, Baffles, Carrying Cases, Loud Speaker Support Stands and Brackets.

ATLAS SOUND CORPORATION

1449 39th St., Brooklyn, N. Y.

generation, transmission, reception in all phases, servo mechanisms, antennas, television, modulation circuits, and electron optics.

At New York University's College of Engineering, a normal schedule of two 16-week semesters a year has been reinstated. It supersedes an accelerated program which had been in effect since October 1943, but a full year will be required before all students will be back on normal schedule.

Wartime Radio-Radar Production

FIGURES SUPPLIED by the Radio and Radar Division of WPB reveal that the industry produced approximately $7.5 billion worth of goods during the war. Following are figures provided in an annual breakdown by WPB:

	Monthly	Total
1942		
Jan.—June	$55,000,000	$330,000,000
July—Dec.	109,000,000	654,000,000
1943		
Jan.—June	160,000,000	960,000,000
July—Dec.	200,000,000	1,200,000,000
1944		
Jan.—Dec.	223,000,000	2,676,000,000
1945		
Jan.—Aug.	200,000,000	1,400,000,000
		$7,220,000,000

Additional production, principally during the September-December period in 1941 accounts for the other $330,000,000.

Intercity-Bus Radio

A DIVISION of the National Association of Motor Bus Operators called Intercity Bus Radio Inc. is seeking permission from FCC to equip up to 100 intercity buses with two-way radio communication and to operate a central control transmitter. The 250-w central transmitter would be located in the Chicago Loop, while the buses would be equipped with 50-w transmitters and with receivers. Three additional relay receiving stations would be located in outlying sections of Chicago.

It is anticipated that the central transmitter would be able to reach buses as far distant as 75 miles. Frequency modulation would be used and operation would be on two frequencies between 30 and 44 mc.

Greyhound Corp. is undertaking the experiment in cooperation with

several other intercity lines which run into Chicago. Greyhound will install equipment on four lines, Pennsylvania, Central, Northland, and Illinois.

MEETINGS TO COME

NOV. 2; AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS; Radar Generation; Engineering Auditorium, 33 West 39 St, New York, N. Y.; H. E. Farrer, AIEE Headquarters, 33 West 39 St, New York 18, N. Y.

NOV. 8; INSTITUTE OF RADIO ENGINEERS, New York Section; Radio Pioneers' Party; Commodore Hotel, New York, N. Y.; by ticket ($6.) from E. J. Content, WOR, 1440 Broadway, New York, N. Y.

NOV. 9; AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS; Radar Reception; Engineering Auditorium, 33 West 39 St, New York, N. Y.; H. E. Farrer, AIEE Headquarters, 33 West 39 St, New York 18, N. Y.

NOV. 12-13; ROCHESTER FALL MEETING COMMITTEE, Rochester Fall Meeting; Sheraton Hotel, Rochester, N. Y.; Virgil Graham, chairman, P. O. Box 750, Williamsport, Pa.

NOV. 12-15; INTERNATIONAL MUNICIPAL SIGNAL ASSOCIATION, 50th annual meeting; Hotel La Salle, Chicago, Ill.; Irvin Shulsinger, secretary, 8 East 41st St., New York 17, N. Y.

NOV. 13; INSTRUMENT SOCIETY OF AMERICA, New Jersey Section; Instrumentation in the Industrial Power Plant by Julius G. Berger, consulting engineer; Essex House, Newark, N. J.

NOV. 14; AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS; Survey of the Servomechanism Field, by Gordon S. Brown, professor, Massachusetts Institute of Technology; Room 301, Pupin Hall, Columbia University; H. E. Farrer, AIEE Headquarters, 33 West 39 St, New York 18, N. Y.

NOV. 16; AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS; Radar Indication; Engineering Auditorium,

Here's that New TRIPLETT 625-N

●

Long Scale, Wide Range Volt-Ohm-Milliammeter

DIRECT READING OUTPUT LEVEL DECIBEL RANGES
−30 to +3, +15, +29, +43, +55, +69 DB

TEMPERATURE COMPENSATED CIRCUIT FOR ALL CURRENT RANGES D.C. MICROAMPERES
0-50 Microamperes, at 250 M.V.

D.C. MILLIAMPERES
0-1-10-100-1000 Milliamperes, at 250 M.V.

D.C. AMPERES
0-10 Amperes, at 250 M.V.

OUTPUT READINGS
Condenser in series with A.C. Volts for output readings.

ATTRACTIVE COMPACT CASE
Size: 2½" x 5½". A readily portable, completely insulated, black, molded case, with strap handle. A suitable black, leather carrying case (No. 629) also available, with strap handle.

LONG 5" SCALE ARC
For greater reading accuracy on the Triplett RED •DOT Lifetime Guaranteed meter.

SIMPLIFIED SWITCHING CIRCUIT
Greater ease in changing ranges.

DOUBLE SENSITIVITY D.C. VOLT RANGES
0-1.25-5-25-125-500-2500 Volts, at 20,000 ohms per volt for greater accuracy on Television and other high resistance D.C. circuits.
0-2.5-10-50-250-1000-5000 Volts, at 10,000 ohms per volt.

A.C. VOLT RANGES
0-2.5-10-50-250-1000-5000 Volts, at 10,000 ohms per volt.

OHM—MEGOHMS
0-400 ohms (60 ohms center scale)
0-50,000 ohms (300 ohms center scale)
0-10 Megohms (60,000 ohms center scale)

Write for descriptive folder giving full technical details.

Triplett ELECTRICAL INSTRUMENT CO., Bluffton, Ohio

STAR Makes More Than Just STEATITE

Find Out Now About

STAR CERAMICS

There are many kinds for special uses, such as applications calling for resistance to electricity, heat, moisture, chemicals or weathering agents. There are more than a score of formulas in actual production at one time in our factory.

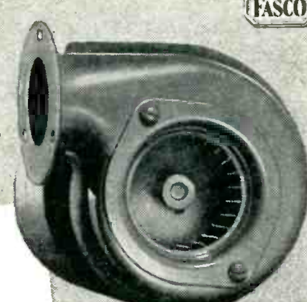
Send for "A Brief Survey of Technical Characteristics of Molded Ceramic Products." It is right to the point.

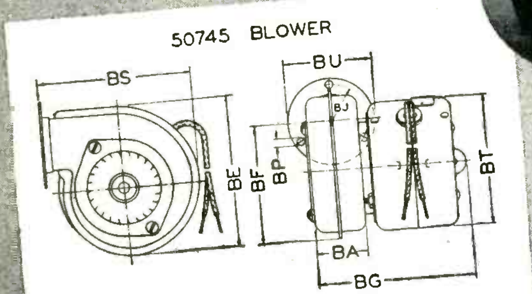
★

The **STAR PORCELAIN CO.**
Electronics Dept.
Trenton 9, N. J.

FASCO

Little Blowers do BIG Jobs efficiently...quietly





MODEL 50745

Typical applications of these small (15 to 100 C.F.M.) Blowers are air distribution in confined spaces such as: cooling radio and other electronic equipment; forced draft; exhausting fumes and gases. Write for Bulletin 3A-14 today.

DIMENSION CHART

BA	BE	BF	BG	BJ	BP	BS	BT	BU
1-5/16"	3-3/16"	3"	4"	15/16"	13/64"	3-29/32"	3-11/32"	2-1/4"

F. A. SMITH MFG. CO., INC., 801 Davis St., Rochester 2, N. Y.

Pilot BLOWERS

FLEXIBLE SHAFTS

for many fields

F. W. STEWART MFG. CORP.
4311-13 RAVENSWOOD AVE.
CHICAGO 13, ILL.
WEST COAST BRANCH:
431 Venice Blvd.; Los Angeles 15, Cal.

33 West 39 St, New York, N. Y.; H. E. Farrer, AIEE Headquarters, 33 West 39 St, New York 18, N. Y.

Nov. 23; American Institute of Electrical Engineers; Radar Testing Equipment; Engineering Auditorium, 33 West 39 St, New York, N. Y.; H. E. Farrer, AIEE Headquarters, 33 West 39 St, New York 18, N. Y.

Nov. 27; Institute of Radio Engineers, Cedar Rapids Section; Oscillators, by Professor W. L. Cassell, Iowa State College; J. A. Green, secretary, Collins Radio Co., 855 35 St, N. E., Cedar Rapids, Iowa.

Dec. 12; American Institute of Electrical Engineers; Mathematical Formulations for Linear Servomechanism Systems, by Charles F. Rehberg, New York University; Room 301, Pupin Hall, Columbia University; H. E. Farrer, AIEE Headquarters, 33 West 39 St, New York 18, N. Y.

Jan. 9; American Institute of Electrical Engineers; Transient Analysis of Linear Servomechanisms, by John R. Ragazzini, professor, Columbia University; Room 301, Pupin Hall, Columbia University; H. E. Farrer, AIEE Headquarters, 33 West 39 St, New York 18, N. Y.

Jan. 18-Feb. 7; Gardner Display Co., Products of Tomorrow Exposition; Coliseum Group, Chicago, Ill. Marcus Hinson, general manager planning department, Armory, 16th and Michigan, Chicago.

Jan. 23-26, Institute of Radio Engineers, 33d Annual Winter Technical Meeting; Astor Hotel, New York, N. Y.; E. J. Content, chairman of meeting committee, WOR, 1440 Broadway, New York 18, N. Y.

WASHINGTON NEWS

Railroad Operators. The 500,000 railroad employees who are eventually expected to be involved in the operation of railroad radio equipment will not be required to have operating licenses from FCC, according to a recent rule of that body. In lieu of its waived examinations, the Commission approved a procedure where applicants will be required to pass an examination conducted by railroad examiners.

INDUSTRIAL EMPLOYMENT. At the peak of activity last spring, the radio industry had a personnel of more than 500,000, according to WPB. By July, this had fallen to 470,000. Estimates have it that 335,000 people were obtained from the prewar radio industry itself, while the rest were newcomers, many of whom are expected to go back to other pursuits in peacetime production.

COMPONENTS. WPB is predicting the possibility of 3,500,000 new radio sets for civilian use by the end of the year. Supplies of components will be ample to meet most needs of the industry, and while some items may be in short supply, there are many cases where substitutes can be used. Besides this, quantities of components can come from surplus stock and also from longer production runs made possible by the less precise specifications of civilian designs. Component supplies for military and civilian research and development laboratories have become so easy that ERSA (Electronics Research Supply Agency) is scheduled to go out of existence. Component production capacity has increased markedly during the war, as may be seen from the following table:

Component	1939 Average Monthly Production	June 1945 Deliveries
Tubes (receiving)	9,127,000*	13,117,000*
Tubes (receiving)	$2,747,000	$6,380,000
Tubes (transmitting)	27,000*	2,412,000*
Tubes (transmitting)	$189,000	$15,860,000
Transformers	$706,000	$12,090,000
Capacitors	$2,298,000	$12,023,000
Resistors	$770,000	$4,429,000

* Units

FCC ACTS

To permit:	To do this:
WSAP Portsmouth, Va.	Operate with newly installed vertical antenna.
WOMT Manitowoc, Wis.	Operate with increased power and changed transmitting equipment.
KOTA Rapid City, S. D.	Operate with changed frequency, power increase, new transmitter and directional antenna for night use, and transmitter moved.
WHNC Henderson, N. C.	Operate newly constructed standard broadcast station.
WHBC Canton, Ohio	Use formerly licensed 250-w transmitter as auxiliary.
WATX Ann Arbor, Mich.	Extend completion date of new non-commercial educational broadcast station to December 16, 1945.
WJBK Detroit, Mich.	Install composite 250-w transmitter at present site of main transmitter for auxiliary.

WLEE Richmond, Va.	Modify construction of new station to install vertical antenna and change transmitter location.
Michigan Bell Telephone Co. Detroit, Mich.	Construct experimental Class 2 coastal harbor station for ship-to-ship and ship-to-shore radio telephone communications on vhf. Frequencies will be assigned, power will be 60 w.
Illinois Bell Telephone Co. Chicago, Ill.	Same as above.
Lorain County Radio Corp. Duluth, Minn.	Same as above.

BUSINESS NEWS

SHERRON ELECTRONICS CO. Brooklyn, N. Y. is set up to provide an electronic engineering service for manufacturers having problems where electronic devices and applications may aid. It covers the complete research, design, development, and manufacturing service.

MAGUIRE INDUSTRIES INC., Bridgeport, Conn., is retooling its tommy gun plant for production of railroad radio equipment, a 6-tube home receiver, an automatic record changer and related items.

WESTERN ELECTRIC CO., New York, N. Y., supplied to the Government during the war more than 52,900 radars of 64 different types valued at more than $800 million.

PERSONNEL

NORAN E. KERSTA, former manager of NBC's television department has been discharged from the U. S. Marine Corps. He returns to the network's television department in an executive capacity.

CHARLES R. DENNY, JR., former general counsel to FCC, is confirmed in his is membership on the Commission. He is the youngest commissioner in FCC history.

RAY C. ELLIS, former director of the WPB radio and radar division, is appointed vice-president of Raytheon Mfg. Co., New York, N. Y.

No RECONVERSION in SERVICE!

Before and during the war the HENRY P. SEGEL CO. was known for its *dependable service*. Today, there will be no reconversion, no changeovers. You can count on that dependability to continue serving your best interests.

The HENRY P. SEGEL CO. has entered its 21st years of serving the New England radio, electronic and electrical market.

By every standard of performance, quality and service, you can rely with confidence on the HENRY P. SEGEL CO. and the firms it represents.

HENRY P. SEGEL COMPANY

Radio—Electronic—Electrical Manufacturers' Representatives Field Engineers

143 NEWBURY STREET
BOSTON 16, MASS.

Tels. KENmore 3012-6333-9755
In HARTFORD: Tel. 2-9859

Transformer Engineers Devoted to

RESEARCH•DEVELOPMENT

● As leaders in the field of design and development of specialized transformers, Electronic Engineering Co. has established an enviable reputation for solving the most difficult transformer applications. With complete electronic laboratories and the finest engineering talent available, Electronic Engineering Co. is devoted exclusively to the production of specialized transformers.

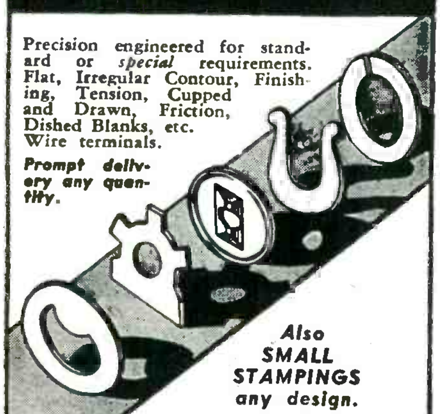
ELECTRONIC ENGINEERING CO.
3223-9 WEST ARMITAGE AVE., CHICAGO 47, ILLINOIS
"SPECIALIZED TRANSFORMER ENGINEERS"

Particular WASHERS FOR ELECTRONIC PRODUCTS

Quadriga Quality WASHERS

Precision engineered for standard or *special* requirements. Flat, Irregular Contour, Finishing, Tension, Cupped and Drawn, Friction, Dished Blanks, etc. Wire terminals.

Prompt delivery any quantity.

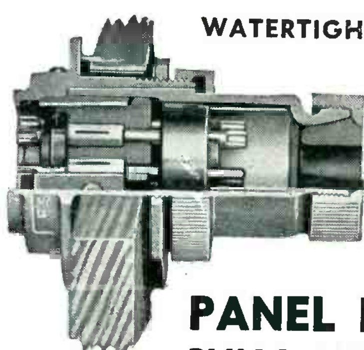


Also SMALL STAMPINGS any design.

Ask for Quadriga Catalog, Photos and valuable washer data. Send specifications for quotation.

The QUADRIGA MFG. CO.
Incorporated 1894 "Half a Century"
221A West Grand Ave., CHICAGO 10, ILL.

WATERTIGHT



PANEL MOUNTING
PLUGS AND RECEPTACLES
VIBRATION-PROOF ASSEMBLIES

For locknut or bolted style mounting to panels 1/16" to 5/8" thick. Precision built housings — light weight, ample wiring space.

Contacts fully machined, self wiping and free floating. All terminals identifed. Polarized, grounded and shielded.

Interior moulded bakelite. Moulded rubber gaskets on watertight style.

Thousands in use for vital war service.

EVERLOK AUTOMATIC LOCKING

●

FOR PORTABLE SOUND AND SIGNAL SYSTEMS 2 to 12 POLE

●

FOR POWER 10 to 200 AMP. 2, 3 & 4 POLE

Since 1902 *Please address Dept. No. H*

RUSSELL & STOLL COMPANY
EXPLOSION-PROOF, WATER-TIGHT, INDUSTRIAL LIGHTING FIXTURES AND EQUIPMENT. AUTOMATIC LOCKING "EVER-LOK" CONNECTORS
125 BARCLAY STREET • NEW YORK 7, N. Y.

HUGH S. KNOWLES, vice-president and chief engineer of the Jensen Radio Mfg. Co., Chicago, Ill., is elected president of the Acoustical Society of America.

JAMES H. MCGRAW JR., chairman of the board and president of McGraw-Hill Publishing Co. is awarded the honorary degree of

doctor of engineering, "for his achievement in behalf of science and engineering for their fullest use for all the peoples of the world," by Rensselaer Polytechnic Institute, Troy, N. Y.

Four miniature tubes are used as the full electronic complement of the proximity fuze described in detail elsewhere in this issue. The fuze includes a triode, two pentodes and a thyratron. They are being held by Roger M. Wise, vice president and chief engineer of Sylvania Electric Products, the company which made all the tubes for use in rotating projectiles. One-ounce tubes, mounted in the projectile assume a weight of 125 lb under acceleration of being fired from guns

Roy S. Kercher is appointed chief electrical engineer at Grayhill, Chicago, Ill. He was previously with the Furnas Electric Co. engaged in laboratory and experimental work.

Robert A. Millikan, 77, administrative head of the California Institute of Technology for 24 years, retires. He will continue as vice-president of the board of trustees and will assist the board president in public relations and institutional development. In 1923 he was awarded the Nobel Prize in physics for isolating and measuring the charge of an electron.

Ray H. Manson, who joined Stromberg-Carlson Co. in 1916 as chief engineer, becomes the first engineer-scientist to be president of the company during its 51 years.

He has been executive vice-president and general manager. He is succeeded by Lee McCanne, who originally joined the firm as a radio engineer.

AWARDS

Through this department Electronics pays tribute to the workers of the following concerns in the electronic field who were awarded final Army-Navy "E" burgees for excellence in production.

John E. Fast & Co.
Chicago, Ill.
Hamilton Radio Corp.
New York, N. Y.
Webster-Chicago Corp.
Chicago, Ill.
(two plants)

NEW BOOKS

You and Your Radio

By VEPA V. LAKSHMANA RAO, *Radio Engineer, Govt. of Madras, India. Addison & Co., Ltd., Madras, India,* 170 *pages, price* 5 *rupees.*

ALL ABOUT BROADCASTING, in language for the layman and with emphasis on material likely to be of interest and value to broadcast listeners. Starting with fundamentals of radio, the author traces a program from microphone to loudspeaker, gives advice on choosing a radio for use in various localities of India, gives some practical tips on home radio maintenance, and devotes two chapters to broadcasting in India and Ceylon and to rural broadcasting in India. Various types of canned programs are described, with general details of gramophone-disc recording, steel-tape recording, and celluloid-tape recording. This well-written and adequately illustrated work is the second edition, completely revised, of a book originally brought out by the author in 1942.—J.M.

• • •

Network Analysis and Feedback Amplifier Design

By HENDRIK W. BODE, *Research Mathematician, Bell Telephone Laboratories. D. Van Nostrand Co., Inc.,* 1945, 551 *pages,* $7.50.

BASIC CIRCUIT THEORY and mathematical analysis of feedback amplifiers is presented in generalized form for the design engineer. The text is self-contained for those who have had the equivalent of present-day college senior circuit and mathematics courses. The discussion is interspersed with practical circuit considerations and conclusions. Stress is laid on interpretation of circuit behavior from graphs of circuit functions.

Groundwork for the final chapters on design of absolutely-stable single-loop feedback amplifiers and illustrative examples of such amplifiers appear in the first few chapters on mesh and nodal equations for tube circuits, the complex frequency plane, a mathematical approach to feedback, and physical realizability of and Nyquist criterion for stability.

To provide completeness in the single volume, there are four chap-

A BOX TO REMEMBER when you want GOOD coils

STANWYCK R. F. COILS

AND ASSOCIATED ASSEMBLIES

There is a Stanwyck coil for every application in the Radio Frequency Spectrum—coils that have met the requirements of war and which will meet your requirements now that the war is won . . . Send for folder describing our line and facilities.

STANWYCK WINDING CO.
NEWBURGH NEW YORK

THE NEW POST WAR PORTABLE

ELECTRIC *Megaphone**

will be available soon for Ships—Towboats—Piers and all marine applications. Also Fire and Police Departments—Athletic Games—and other uses too numerous to mention.

This Megaphone gives your voice 2500 times its normal power.

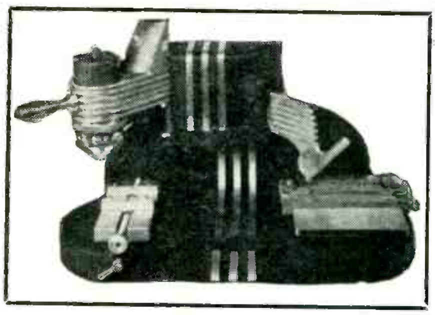
This equipment is a development of a megaphone used exclusively by U. S. Navy and Amphibious Forces and was developed, manufactured and patented by us.

—WATCH FOR ANNOUNCEMENT—

ARMY E NAVY

GUIDED RADIO CORPORATION
161 Sixth Avenue New York 13, N. Y.

* Patent No. 2,301,459—After the war any infringement of this patent will be prosecuted.



DUPLICATING and PROFILING

AUTO ENGRAVER

Accurate Engraving with Unskilled Operators

Unskilled operators will profile or accurately reproduce in smooth lines any design, number, letter, emblem, signature; on iron, brass, copper, aluminum, soft steels and all plastics. Here are some of its other uses . . .

- Drills a series of holes, or profiles small parts
- Cuts an even channel for wiring on panels. Increases accuracy and production.
- Works from original drawing or templates.
- Etches glass and similar items.
- Will not cause distortion.

For complete information on this and other models and prices write Dept. K.

AUTO ENGRAVER CO.
1776 BROADWAY, NEW YORK 19

Draftsmen Wanted

Also

Designers, Detailers, Tracers and Engineers

We are one of the largest manufacturers of a wide variety of communication and electronic equipment in the world, fully prepared and ready to go ahead with a very ambitious, expansion program as quickly as we are permitted. There will be unlimited possibilities for creative, ambitious men to advance to key positions both in research development and production field. At present, we are producing vital equipment for our fighting forces.

Good Starting Salaries — Exceptionally fine working conditions

Apply Personnel Office 8 A. M. to 5 P. M.

FEDERAL TELEPHONE & RADIO CORP.

The Mfg. unit of the International Tel. & Tel. Corp.

591 Broad St., Newark, N. J.

W M C Rules Observed

ters on impedance functions which consider design of impedance functions to provide predetermined characteristics, and physical representation of driving point and transfer impedance functions.

With this background, the author discusses the problems bearing directly on feedback amplifier design. The interdependence of real and imaginary components of network functions indicates the extent to which gain and phase-shift in the amplifier are related. The previously developed circuit theorems are applied to input and output and to interstage networks to determine their effects on attenuation and phase-shift. Circuit response is indicated by generalized response curves.

As stated before, the final chapters are concerned with design of feedback amplifiers based on the foregoing considerations and techniques. Such considerations as the effect of amplifier bandwidth on maximum permissible feedback are analysed. Application of feedback to an f-m receiver, a radio transmitter, and to a broad-band amplifier illustrate the use of the foregoing development.—F.R.

• • •

Atomic Energy for Military Applications

By Henry DeWolf Smyth, *Chairman, Department of Physics, Princeton University, and Consultant, Manhattan District, U. S. Engineers. Published by the Princeton University Press, Princeton, N. J.,* 1945, 264 *pages, paper bound* $1.25, *cloth bound* $2.00.

The official report on development of the atomic bomb with a few additions and clarifications, with the War Department release on the New Mexico test of July 1945 and an index have been printed as a public service by Princeton University.

The report is written to the engineer and executive who have a general understanding of physics and technology. Beginning with the knowledge of atomic physics reached in 1940, the report discusses organizational and technical steps taken in initiating and executing the Manhattan Project, and credits the men associated with management and research in the development of atomic power

sources. A chapter is devoted to electromagnetic separation of uranium isotopes. The text is illustrated by line drawings and an insert of photographs of the Oak Ridge and Hanford Engineering Works and of the test explosion in New Mexico.—F.R.

A General Account of the Development Methods of Using Atomic Energy for Military Purposes Under the Auspices of the United States Government, 1940 - 1945

By H. D. SMYTH, *Published by the U. S. Government Printing Office, and for sale by the Superintendent of Documents, Washington* 25, *D. C.*, 182 *pages*, $0.35.

THE TEXT of the official report, as written at the request of Major General L. R. Groves and originally distributed in a limited edition to official authorities, has been reprinted for public distribution.

• • •

Business Executive's Guide

By J. K. LASSER. *McGraw-Hill Book Co., New York 18, N. Y., 252 pages, $3.00.*

A CHECK LIST governing all phases of typical transactions in small and medium-size business ventures. A thorough compilation, it reaches down to the level of what to do in budgeting, filing, buying supplies, printing, collecting accounts, building an efficient organization, creating customer good will and good employee relations, dealing with banks, buying and selling businesses, avoiding frauds and embezzlements, controlling salesmen's expenses, securing credit information, checking business insurance, planning office layouts, and cutting down office expenses. The author is well known for his book, "Your Income Tax."—J.M.

• • •

Practical Supervision

By PALMER J. KALSEM, *Engineering Educational Department, The Glenn L. Martin Co. McGraw-Hill Book Co., Co. New York, 18, N. Y., 186 pages, $2.00.*

DETAILED INSTRUCTIONS on how the industrial supervisor can get the most out of those under him, with a special chapter on how to cope with women in industry and maintain maximum production. The

basis for this book is a series of supervisory training bulletins, and the many effective cartoons from these are included in the book. Highly recommended for all engineers hoping to advance into responsible executive positions, whether in the office, shop, or drafting room. The human-interest approach and the humorous but pointed illustrative treatment make interesting at-home reading—a painless way to study the principles of good supervision.—J.M.

• • •

Training for Supervision in Industry

By George H. Fern, *Director, Michigan State Board of Control for Vocational Education. McGraw-Hill Book Co., New York, 18, N. Y., 188 pages, $2.00.*

A TEXTBOOK MANUAL aimed at guiding the supervisor in his own self-improvement and upgrading, helping the prospective supervisor, and helping conference leaders to get results. Human relations receive major attention because to many workers the supervisor is the company and by his actions the company is judged. Other topics covered include accident prevention, women in industry, starting the new worker, and job analysis.—J.M.

• • •

How to Train Your Assistants

By Richard W. Wetherill. *National Foremen's Institute, Deep River, River, Conn., 16 pages, $0.25.*

ILLUSTRATED BOOKLET presenting a five-step formula for allowing overburdened foremen and supervisors to do more work with less effort by training assistants to solve their own problems where possible. The formula is the result of fifteen years experience in training men and women, and gets practical results in nearly all cases.—J.M.

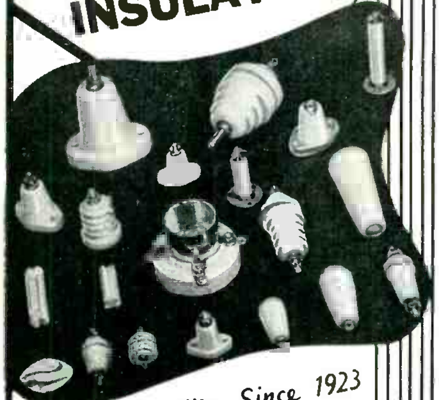
• • •

What the Foreman Needs for Success

National Foremen's Institute, Deep River, Conn., 16 pages, $0.25.

CARTOON-ILLUSTRATED booklet contrasting an army sergeant's responsibility to his men with the factory foreman's similar responsi-

CERAMIC PORCELAIN & STEATITE INSULATORS



Quality Since 1923

MANUFACTURERS OF RADIO HARDWARE *and* ANTENNAS

Also Carrying a COMPLETE LINE of WIRES, CABLES *and* HOOK-UP WIRES

Inquiries Invited!

BIRNBACH

BIRNBACH RADIO CO., Inc.
145 HUDSON ST. NEW YORK, 13, N. Y.

ARMY E NAVY

FARRAND OPTICAL CO., INC.

Engineers, Designers and Manufacturers

PRECISION OPTICS, ELECTRONIC AND SCIENTIFIC INSTRUMENTS.

BRONX BLVD. AND EAST 238TH STREET, NEW YORK 66, N. Y.

★

The Farrand Optical Co. plant is recognized as one of the finest equipped modern optical and precision instrument factories in the world, and is staffed by a group of outstanding technical and scientific personnel.

Technical Facilities—Engineering; consulting; design; research; development and manufacture of PRECISION OPTICS, ELECTRONIC AND SCIENTIFIC INSTRUMENTS.

Manufacturers of—Precision Optical Components for television, photographic, electronic and scientific instruments—Projection Screens for television, motion picture and visual education—Special Cameras—Television Projection Lenses—Periscopes—Telescopes—Telephotoscopes—Rangefinders—Gun Fire Control Apparatus—Shop and Toolmakers Microscopes—Optical Comparators—quartz Monochromators—Spectrometers—Spectrographs—Spectrophotometers — Fluorometers—Electron Microscopes—Electron Recording Devices and Amplifiers.

RAWSON A. C. MULTIMETERS

TYPE 502A
Accuracy 1%

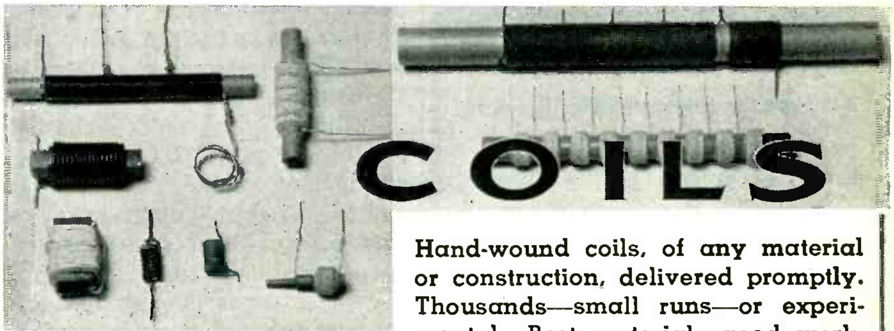
Readings from 2 ma. to 3 amperes on 6 ranges, and .06 volts to 1000 volts on 8 ranges. Uses internal thermocouple. No waveform or frequency errors below 5000 cycles.

The word MULTIMETER is our copyrighted trade mark. *Write for Bulletins.*

We also supply
Regular D.C. Meters
D.C. Multimeters
Fluxmeters
Electrostatic Voltmeters

Special apparatus built to order

RAWSON ELECTRICAL INSTRUMENT COMPANY
111 POTTER ST. CAMBRIDGE, MASS.
Representatives
CHICAGO NEW YORK CITY



COILS

Hand-wound coils, of any material or construction, delivered promptly. Thousands—small runs—or experimental. Best material—good workmanship. Send prints or specifications for quotation. State delivery requirements.

BITTERMANN ELECTRIC CO.
50 Henry St. Brooklyn, N. Y.
TRiangle 5-4767
"If It's a COIL—We'll Make It"

SAFETY DOOR INTERLOCK SWITCH

An inexpensive, dependable safety device that *breaks* power circuits when access doors are opened. Protects personnel, guards equipment. Particularly suitable for radio transmitters, television receivers, X-ray and therapeutic machines, fire doors and burglar alarms. For details write: *Electronics Department, General Electric, Schenectady 5, New York.*

GENERAL ELECTRIC
164-D3

bility to provide leadership that will hold up the spirit and morale of his men. Three main steps in learning to handle various personalities are outlined: (1) Adjust your own personality; (2) Know your workers; (3) Lead properly. A good refresher for supervisors. —J.M.

• • •

Transmission Lines, Antennas and Wave Guides

By Ronald W. P. King, Harry Rowe Mimno, *and* Alexander H. Wing, *all of Harvard University. McGraw-Hill Book Co., Inc.*, 1945, 347 *pages*, $3.50.

From experience in training commissioned officers in new uhf applications of electronics, the Cruft Laboratory faculty has prepared this descriptive text. The treatment employs a minimum of mathematics, chiefly trigonometry and complex algebra. For the most part the discussion concerns the physical behavior and practical uses of representative uhf circuits. Information and concepts are summarized in graphs and line drawings. At the end of the book there are problems with answers.

Among specific topics on transmission lines likely to be of especial interest are: means of suppressing even harmonics and suppressing the third harmonic; impedance matching by quarter- and half-wave sections and by either single or double stubbing; construction and use of a circle diagram for calculating stub lengths and positions.

Distribution of current and voltage on antennas is explained, with illustrations for a variety of antenna elements. Methods of feeding the different types of elements are described, with the purpose of each. Phasing and coupling of parasitically excited arrays are shown. The section concludes with determinations of the fields of antenna arrays, and mention of the familiar antenna systems.

In the chapter on wave guides the behavior of guides and the modes in which they can operate are analysed descriptively. From the understanding so acquired, methods of driving guides and the configurations of cavities are developed.

The last chapter on wave propagation describes briefly the principal factors affecting wave propagation.—F.R.

NEW SOLDERING GUN

THE SPEED IRON*

Patent Applied For

100 Watts   115 Volts   60 Cycles

Soldering Heat in 5 Seconds

Wherever you have a soldered joint in radio, electrical or electronic repair and service work, the Speed Iron will do the job faster and better.

The transformer principle gives high heat—in 5 seconds—after you press the trigger switch. Convenient to hold with a pistol grip handle, the compact dimensions of this new soldering tool permit you to get close to the joint. The copper loop soldering tip permits working in tight spots. The heat is produced by the high current flowing through the soldering tip—permitting direct and fast transfer to the soldered connection.

If you want to save time on soldering jobs with a tool that is ready to use in 5 seconds, get a Speed Iron today. See your radio parts distributor or write direct.

*T.M. Reg U. S. Pat. Off.

WELLER MFG. CO.
DEPT. E-1 • EASTON, PA.

Test Insulation the Modern Way with a MODEL B-5 MEGOHMER

VARIOUS NEW MODELS AND RANGES

NEW BATTERY-VIBRATOR TYPE

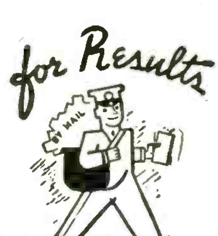
No more tiresome cranking of a hand-driven generator . . . Entirely self-contained, steady test potential of 500 volts DC, available at the touch of a switch. Direct reading in insulation resistance.

HERMAN H. STICHT CO., INC.
27 PARK PLACE   NEW YORK, N. Y.

WRITE FOR BULLETIN No. 430E

WHAT MAKES A MAILING CLICK?

for Results



McGRAW-HILL
DIRECT MAIL LIST SERVICE

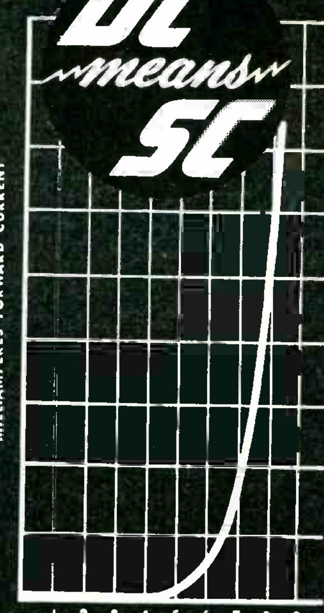
Advertising men agree . . . the list is more than half the story. McGraw-Hill Mailing Lists, used by leading manufacturers and industrial service organizations, direct your advertising and sales promotional efforts to key purchasing power.

In view of present day difficulties in maintaining your own mailing lists, this efficient personalized service is particularly important in securing the comprehensive market coverage you need and want. Investigate today.

McGraw-Hill Publishing Co., Inc.
DIRECT MAIL DIVISION
330 West 42nd Street   New York, 18, New York

NUMBER SIX OF A SERIES

DC means SC



STATIC CHARACTERISTICS OF UNFORMED PLATE

DC means SC . . . Selenium Control. The forward threshold of Selenium plates falls naturally at .6 volts per plate. Use this characteristic as a Control Element. A DC circuit...fed by fluctuating battery voltage . . . can be controlled at 1.2 maximum voltage by connecting 2 Selenium plates in series. Selenium rectifier plates can be manufactured to close electrical tolerances. One of the many reasons why DC means SC . . . Selenium Control. If you use DC, get the facts on SC!

SEND FOR BULLETIN

SELENIUM CORPORATION of AMERICA
1719 WEST PICO BOULEVARD
LOS ANGELES 15, CALIFORNIA
EXPORT DIVISION: FRAZAR & HANSEN
301 CLAY STREET, SAN FRANCISCO, CALIFORNIA
IN CANADA: BURLEC LTD., TORONTO 13, ONTARIO, CANADA

BACK TALK

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment on articles which have been published in Electronics

Atomic Ache

GENTLEMEN:

REQUIRED READING for the editors of ELECTRONICS: their own editorial in the June 1940 issue which goes:

▶ "WOLF . . . Lately there have been new announcements of the energy available when, and if, certain nuclei are smashed—enough to run a big threestacker liner across the Atlantic at 40 knots and all that sort of thing. We are getting a bit blasé about all these predictions. No one as yet has supplied atomic energy to push a dead fly across a frictionless surface. Atomic energy always seems to be one jump ahead of the scientists—they always need a bigger jimmy, and having got the jimmy the vision of releasing the energy is just as bright but is only delayed a bit in time."

A. S. CLARKE
Washington, D. C.

[Ouch!—Ed.]

• • •

At Home Abroad

DEAR SIR:

DURING THE LAST two years, I have been a design engineer at the Admiralty Signal Establishment of

517

CONTACTS

FOR THE FIELD OF ELECTRONICS

the Royal Navy in Britain producing radar equipment for the fleet, and have just recently returned.

ELECTRONICS magazine, as you only too well must know, is very much in demand overseas especially in such establishments as this. We could manage to get just one copy per month and to circulate it adequately some three to four hundred of us put our names on the circulation list.

I can tell you the poor thing looked like just a pile of reference sheets by the time it got around; needless to say it was in circulation for a good eight months before we had all seen it. The only way we could get any permanent information from it was to have photostat copies made of each useful and relevant article; those copies were certainly very much in demand. Will the day come when ELECTRONICS is easily available!

Being the only American on the staff, I was continuously being asked to interpret words, terms, and advertisements. I found the experience very interesting.

ROBERT L. WOLTZ
Wichita, Kan.

[The day has come; ELECTRONICS is back on a normal circulation basis.—Ed.]

• • •

GRID PROJECTION

The 813 transmitting tube has two grids which must be perfectly aligned. At North American Philips, light is projected on the tube mount and then focussed on a ground-glass plate. The 20-to-1 enlargement produced shows whether or not one grid is exactly behind the other

SEARCHLIGHT SECTION

EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

UNDISPLAYED RATE:
15 cents a word, minimum charge $3.00. (See ¶ on Box Numbers.)
POSITIONS WANTED (full or part-time salaried individual employment only), 1/2 above rates.
PROPOSALS, 50 cents a line an insertion.

INFORMATION:
BOX NUMBERS in care of any of our New York, Chicago or San Francisco offices count 10 words additional in undisplayed ads.
DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED—RATE PER INCH:
The advertising rate is $7.50 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.
AN ADVERTISING INCH is measured 7/8 inch vertically on one column, 3 columns—30 inches—to a page. E.

NEW ADVERTISEMENTS received by 10 A. M. November 7th will appear in the December issue, subject to limitation of space available.

POSITION VACANT

WANTED: ENGINEERS with experience in Audio Circuit work for engineering development on hearing aids and associated devices. Experience on hearing aids not actually necessary. Apply to Chief Engineer Zenith Radio Corporation, 6001 W. Dickens Avenue, Chicago 39, Illinois, giving details of education, age and experience. These positions offer excellent opportunities for interested personnel.

EMPLOYMENT SERVICE

SALARIED POSITIONS $2,500-$25,000. Reconversion is creating lifetime opportunities now. This thoroughly organized confidential service of 35 years' recognized standing and reputation carries on preliminary negotiations for supervisory, technical and executive positions of the calibre indicated, through a procedure individualized to each client's requirements. Retaining fee protected by refund provision. Identity covered and present position protected. Send only name and address for details. R. W. Bixby, Inc., 278 Delward Bldg., Buffalo 2, N. Y.

POSITIONS WANTED

CHEMIST-CHEMICAL Engineer. Two degrees. Five years industrial experience in research, development, sales-service on materials for electrical and electronic application—dielectrics, resistors, capacitors, ceramics, etc. Broad experience training, proven ability, excellent references. Desires responsible position in research and development or technical sales. PW-937, Electronics, 330 W. 42nd St., New York 18, N. Y.

INDUSTRIAL PHYSICIST, Ph.D., extensive experience in development and production of electronic tubes, gas discharge tubes, and other vacuum devices desires appropriate position. PW-938, Electronics, 520 N. Michigan Ave., Chicago 11, Ill.

HIGH VACUUM Engineer. Three years industrial experience in the electronic and high vacuum fields. Desires position connected with development or application aspects of these fields with organization interested in high vacuum work. Graduate EE. PW-939, Electronics, 330 W. 42nd St., New York 18, N. Y.

ELECTRO-MECHANICAL Engineer, Army officer desires permanent position upon discharge. Engineering executive and organization director with experience in design, operation and research in electronics, radar, radio, refrigeration and cold storage, air conditioning, diesel and steam power equipment and electrical and other power machinery. Salary $6000.00 to $10000.00 depending upon location. References furnished upon request. PW-940, Electronics, 330 W. 42nd St., New York 18, N. Y.

POSITIONS WANTED

ELECTRONIC ENGINEER and physicist, B.S. in E.E., 3 years experience at Cal Tech in design, laboratory and field development, and production of electronic equipment under war research contract, desires research and design position, preferably in electro-therapy. Paul G. Thiene, Jr., 728 S. Arroyo Blvd., Pasadena 2, Calif.

MICROWAVE ENGINEER Sc.M. in E.E. M.I.T.,—Seven years experience in microwaves, velocity modulation tube design, and radar, laboratory field, and executive experience; presently employed; desires permanent position in research or development with aggressive company preferably on West Coast. PW-941, Electronics, 330 W. 42nd St., New York 18, N. Y.

ENGINEER, GOOD technical and supervisory experience background with leading radio and telephone manufacturers and government in circuit design, production test equipment, quality control, inspection management, field engineering service. PW-942, Electronics, 520 N. Michigan Ave., Chicago 11, Ill.

EXECUTIVE ENGINEER with legal training now employed by large corporation in east desires position in middle west or south. Experienced in research, production, patent prosecution all phases including foreign (registered U. S. patent office), agreements, and administrative problems in mechanical-electrical arts. Inventions. Age 38, $10,000 per annum. PW-943, Electronics, 330 W. 42nd St., New York 18, N. Y.

RADIO ENGINEER, Harvard graduate, leaving army, desires position with American firm in China, or in preparation for going to China later. Experience: one year directional antenna design, antenna impedance measurement, and field strength calculation and measurement; 4 years airborne radar. Speaks fluent French; studying Chinese. PW-944, Electronics, 330 W. 42nd St., New York 18, N. Y.

ELECTRONICS ENGINEER, M.S. communication engineering, industrial executive, assistant professor physics, experienced research development radar, circuits, quartz crystals. Available immediately. PW-924, Electronics, 330 W. 42nd St., New York 18, N. Y.

RADIO ENGINEER. Interested in V.H.F. development, particularly multi-channel telegraph operation over V.H.F. radio links. (see page 237 August Electronics.) Recently returned from 3 years in charge of V.H.F. development section of British Admiralty. Desires position with company who might be interested in developing new ideas for V.H.F. communication. PW-936, Electronics, 68 Post Street, San Francisco 4, Cal.

MEXICO

EXECUTIVE ENGINEER

20 years experience in electronics and radio, including five published original research projects, locating in Mexico City. Will handle, on a retainer basis, investigation negotiations; supervise application or manufacture of electronic products in Mexico. Or, will consider an engineering or managerial position in charge establishment or operation of plant.

PW-946, Electronics
621 So. Hope St., Los Angeles (14) Calif.

CAPITAL NEEDED

Well Known Electronic Engineer forming Corporation to do Electronic Engineering, Manufacturing, Selling. Will release 50% of stock to one individual or organization who will provide capital and assistance in manufacturing and/or selling products.

BO-929, Electronics
520 North Michigan Ave., Chicago 11, Ill.

FOR SALE

Controlling Stock Interest

in well known transformer manufacture. Excellent opportunity to enter this active business

BO-876, Electronics
330 West 42nd St., New York 18, N. Y.

FOR SALE

Private Trade School, fully equipped to handle 300 students. Licensed by State and approved for Veteran training under provisions of G. I. Bill. School now provides complete class and laboratory instruction in Electricity, Radio, Industrial Electronics and Television. Located in Mid-West.

FS-928, Electronics
520 North Michigan Ave., Chicago 11, Ill.

ADDITIONAL POSITIONS VACANT ADS
on pages 509, 522, 523 & 524
SELLING OPPORTUNITY ADS
on page 524

OPENINGS FOR TELEVISION ENGINEERS

Design experience in the development of television cameras, terminal equipment or transmitters. State experience and salary desired.

Apply in person or in writing to:

Personnel Department

RAYTHEON Manufacturing Co., Inc.

COMMUNICATIONS DIVISION

60 E. 42nd St. New York 17, N. Y.

Senior Engineer

We are completing the development work on several important new products and require the services of a seasoned

Electronic Engineer

from the Greater Boston area as a permanent addition to our organization.

STEVENS ARNOLD CO.
22 Elkins St., South Boston, Mass.

Chief Engineer or Senior Engineer

New York radio and television manufacturer, expanding very fast requires man with several years thorough experience in design and production of home radio receivers. Not a temporary but a permanent opportunity. Still have substantial military work; also very substantial home set orders throughout U. S. A. and abroad. High pay.

TELEVISION MFG. CORP.
Seventh Ave., New York 11

DIRECTOR OF ENGINEERING

Smaller firm with national organization and established postwar business in electronic, audio and electro-acoustic fields has opening for engineer in charge of development and design. Salary $6,000 to $8,000. Must have engineering degree and practical experience. Design of audio and electro-acoustic systems.

Replies confidential. State education, experience record, patents, etc. Photograph if available.

P-894, Electronics
520 North Michigan Ave., Chicago 11, Ill.

WANTED

Research Design and Development Engineers

For large capacitor plant located in Southeastern Massachusetts.

Post-War opportunities for qualified engineers.

Write letter giving full details of experience, training, and salary expected.

Applicants will be hired in accordance with the Area Stabilization Plan.

P-892, Electronics
330 West 42nd St., New York 18, N. Y.

WANTED

Production Engineers

One or more electronic production engineers for large British group of companies, splendid opportunity for real producers, minimum contract period two years. Reply to P-890, Electronics, 330 West 42nd St., New York 18, N. Y., giving full details, experience, college education and salary required.

WANTED

ENGINEERS

Opportunities are offered by an expanding, progressive engineering organization to first-class Development, Communication and Radio Engineers with extensive prewar experience. Write:

Maguire Industries, Inc.
Electronics Division, Personnel Department,
342 West Putnam Ave., Greenwich, Conn.

WANTED

Production Engineers

One or more electronic production engineers for large British group of companies, splendid opportunity for real producers, minimum contract period two years. Reply to P-931, Electronics, 330 West 42nd St., New York 18, N. Y., giving full details, experience, college education and salary required.

WANTED

SENIOR DEVELOPMENT ENGINEER

Large Midwest manufacturer has immediate openings in domestic radio and television receiver development for two Senior Radio Project Engineers and one Mechanical Engineer. Confidential inquiries respected.

P-813, Electronics
520 North Michigan Ave., Chicago 11, Ill.

WANTED

PHYSICIST OR ENGINEER

Experienced in x-ray tube manufacture, high vacuum technique and degassing of metals. Please state education experience and salary desired. Reply.

P-932, Electronics
520 North Michigan Ave., Chicago 11, Ill.

Permanent Employment Executive Engineer

Leading eastern manufacturer of electronic equipment requires graduate E. E. with project engineering experience to be responsible for administration of all engineering and research. Immediate and post-war opportunity.

P-871, Electronics
330 West 42nd St., New York 18, N. Y.

WANTED

Assistant Chief Engineer

Midwest radio manufacturer requires an engineer to assume complete supervision of household and auto radio receiver development. Extensive prewar experience in above lines imperative. Television receivers will be in our line. All inquiries confidential.

P-814, Electronics
520 North Michigan Ave., Chicago 11, Ill.

Export for Profit

Roburn Agencies, Inc. have represented leading manufacturers of radio and electrical equipment, parts and accessories, in world-wide markets since 1935. Extensive facilities relieve you of all export headaches – correspondence, advertising, sales, finance, packing and shipping. A few additional clients seeking experienced, reliable representation are invited. Write for information on Profits Through Exports.

Roburn Agencies, Inc.
115E Fulton Street New York 7, N. Y.

NATIONAL DISTRIBUTION AVAILABLE

For Manufacturers who make products suitable for sale to radio and electronic jobbers. We have a complete sales staff for national and export distribution. Reply with samples or description of products.

RA-870, Electronics
330 West 42nd St., New York 18, N. Y.

CHINA - PHILIPPINES - MALAYA
INDIA - SOUTH AFRICA - MEXICO

Our Technical Department Is Ready to Assist You In Building A Market For Your Radio and Electronic Equipment, Instruments, And Technical Products In These Areas

We Offer:

1. "On The Spot" representation from our own Branch Offices throughout the world.
2. "Know How" gained from over 50 years experience in the Export markets gained as exclusive representatives for leading American Manufacturers.
3. Engineers who talk your language and the customers' language.
4. Export business on a domestic basis to you.

For further information write:

TECHNICAL DEPARTMENT

GETZ BROS. & CO.

64 Pine St. San Francisco 11, Calif.

furnished through your bank.

WANTED

RESEARCH ENGINEERS

Prominent Radio Receiver Manufacturer located in Midwest has immediate openings for two research men with prewar development experience in the radio receiver or television field. Confidential inquiries respected.

P-815, Electronics
520 North Michigan Ave., Chicago 11, Ill.

Sales Manager Wanted

Well established, progressive radio parts manufacturing company, situated in Southern California, having national distribution, requires a Sales Manager. Must have real executive ability. Several years experience in sales department of radio parts manufacturing company or equivalent background essential. This is a splendid opportunity for a man capable of handling the supervision of the activities of agents and salesmen, assisting in the development of new markets and the design of new items, handling correspondence and contacts with jobbers and manufacturers throughout the country, etc. Reply

SW-930 (Agency) Electronics
68 Post St., San Francisco 4, Calif.

LEGAL NOTICE

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

Of Electronics, published Monthly at Albany, New York, for October 1, 1945.

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

Before me, a Notary Public in and for the State and county aforesaid, personally appeared J. A. Gerardi, who, having been duly sworn according to law, deposes and says that he is the Secretary of the McGraw-Hill Publishing Company, Inc., publishers of Electronics and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the name and address of the publisher, editor, managing editor, and business manager is: Publisher, McGraw-Hill Publishing Company, Inc.; Editor, Keith Henney; Managing Editor, W. W. MacDonald; Business Manager, Wallace B. Blood; all of 330 West 42nd St., New York 18, N. Y.

2. That the owner is: McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York City. Stockholders holding 1% or more of stock: James H. McGraw, James H. McGraw, Jr., James H. McGraw, Jr., Curtis W. McGraw and Edwin S. Wilsey, Trustees for: Harold W. McGraw, James H. McGraw, Jr., Donald C. McGraw, Curtis W. McGraw, all of 330 West 42nd Street, New York City; Edwin S. Wilsey and Curtis W. McGraw, Trustees for James H. McGraw, 3rd, Madison, New Jersey; Curtis W. McGraw, 330 West 42nd Street, New York City; Donald C. McGraw, 330 West 42nd Street, New York City; Mildred W. McGraw, Madison, New Jersey; Wilson C. Laucks, Spruce and Canal Sts., Reading, Pa.; Grace W. Mehren, 73 No. Country Club Dr., Phoenix, Ariz.; Margaret Stump, 1418 Rose Virginia Rd., Wyomissing Park, Reading, Pa.

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

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

J. A. GERARDI, Secretary
McGRAW-HILL PUBLISHING COMPANY, INC.

Sworn to and subscribed before me this 20th day of September, 1945.

[SEAL] ELVA G. MASLIN

(My commission expires March 30, 1946.)

LINES WANTED

BY

Manufacturers Representative

For sale to Electrical, Hardware and specialty Jobbers and Manufacturers in Ill., Ind. and Wis. Over 15 yrs. experience. Can handle a major line or several smaller ones. Thorough knowledge of electrical industrial applications. Large acquaintance in trade.

RA-945, Electronics
520 North Michigan Ave., Chicago 11, Ill.

SALES REPRESENTATION WEST COAST

If you are a manufacturer of electrical or electronic equipment for industrial applications, let our staff of experienced engineering consultants represent your products on the west coast. Address

RA-934, Electronics
68 Post St., San Francisco 4, Calif.

To EMPLOYERS who advertise for MEN:

THE letters you receive in answer to your advertisements are submitted by the applicants with the hope of securing the position offered.

Frequently when there are many applicants, the only letters acknowledged are those of the most promising candidates. Others may not even receive the slightest indication that their letters have been received, much less considered. These men often become discouraged, will not respond to future advertisements, and sometimes even question their bona fide character.

Every advertisement printed in the searchlight section is duly authorized.

It will help to keep readers interested in this advertising if you will make it a practice to acknowledge every application received, even if you merely return the letters of unsuccessful applicants marked, "Position filled, thank you." If you don't care to reveal your identity, you might mail them in plain envelopes.

This suggestion is made in a spirit of friendly co-operation between employers and the men replying to Positions Vacant advertisements.

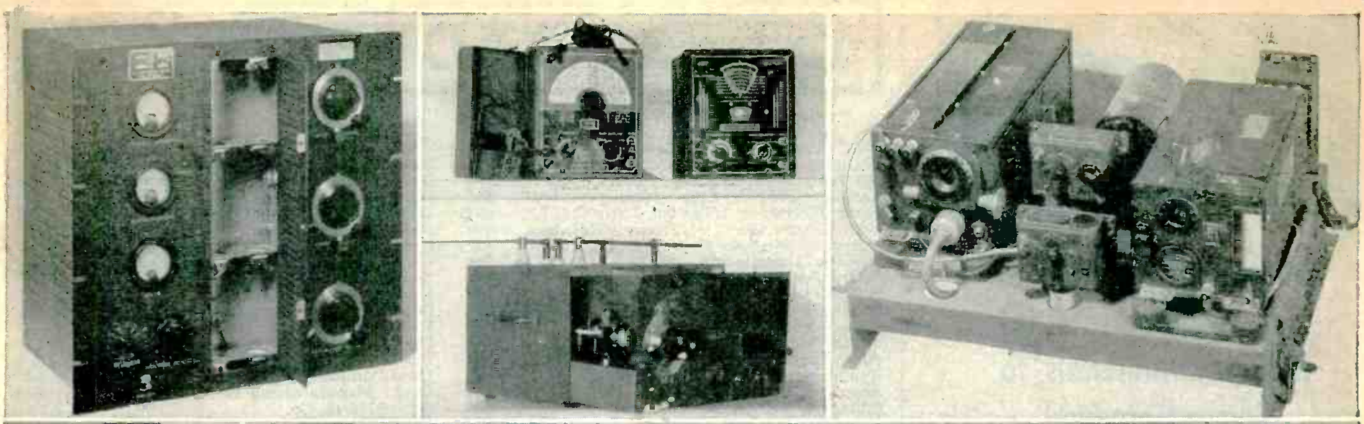
Departmental Staff

McGRAW-HILL PUBLISHING CO., INC.

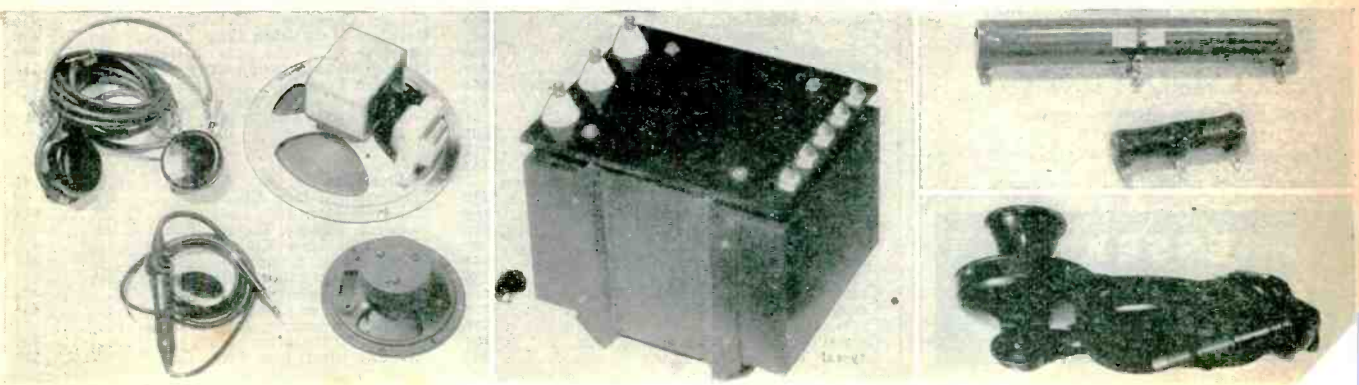
★

"Put yourself in his place"


Switches
Shown above are a few of the many types of micro-switches, toggle switches, knife switches, rotary switches, band switches, etc., now available through the Hallicrafters Co., Chicago, agent for the Reconstruction Finance Corporation under contract SIA-3-24.
Other radio and electronic components such as resistors and condensers are also available in large quantities. Send the coupon for further details.
hallicrafters RADIO
THE HALLICRAFTERS CO., AGENT FOR RFC UNDER CONTRACT SIA-3-24
MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT
THESE VALUABLE ITEMS Available Now
or very soon. Write, wire or phone for further information.
• head phones • test equipment • component parts • marine transmitters and receivers • code practice equipment • sound detecting equipment • vehicular operation police and command sets • radio beacons and airborne landing equipment.
COPYRIGHT 1945 THE HALLICRAFTERS CO.
CLIP THIS COUPON NOW
RFC DEPARTMENT 317, HALLICRAFTERS
5025 West 65th Street • Chicago 38, Illinois
☐ Send further details and price on Switches and component parts
☐ Send listings of other available items
Especially interested in
NAME
ADDRESS
CITY ZONE
STATE



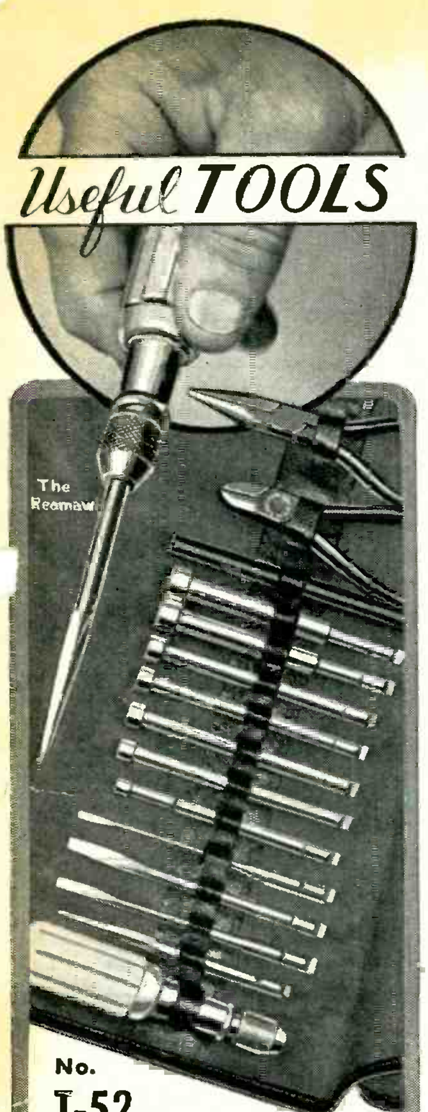

New shipments arriving weekly!
Vast quantities of Government-owned material . . . every conceivable type of—
RELEASED TELEPHONE AND
ELECTRONIC
END EQUIPMENT • COMPONENTS • TEST EQUIPMENT



INDEX TO ADVERTISERS

ADVERTISER'S INDEX

(Continued)



No.
T-52 SPINTITE SET.

Chuck Type Handle with Reamawl, 3 Screw Drivers, 7 SPINTITES, Insulated Neutralizing Alignment Wrench, and 2 Pliers, all in a Leatherette Roll. . . .

A Positive need in every RADIO, HOME and ELECTRICAL SHOP.

A Fascinating, Fast-Moving Item for thousands of stores. Your good jobber has it. . .

Send for Catalog No. 141 picturing a full line of Automobile, Aircraft and Radio Tools.

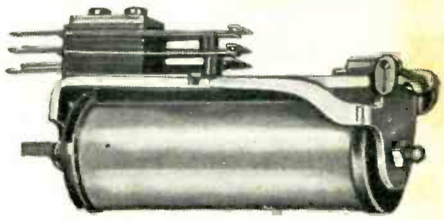
WALDEN WORCESTER WRENCHES

...S WALDEN, INC.
...EWSBURY STREET
...R, MASSACHUSETTS

ADVERTISER'S INDEX

(Continued)

THE STANDARD TELEPHONE TYPE RELAY



Built by CONTROL CORPORATION, long experienced in the application of Relays.

OPTIONAL FEATURES:

1. Double Arm
2. Delayed Operate or Release
3. Varnish Impregnated Coil
4. Tropicalization Treatment
5. Export Pack
6. Removable Cover
7. Plug and Socket Mounting

Inquiries and orders given prompt, courteous attention.

WRITE — WIRE — PHONE

CONTROL CORPORATION

718 CENTRAL AVENUE

Phone Granville 8897

MINNEAPOLIS 13, MINN.

JONES 2400 SERIES PLUGS and SOCKETS

P-2406-CCT

A new series of Plugs and Sockets designed for highest electrical and mechanical efficiency. Improved Socket Contacts provide 4 individual flexing surfaces which make positive contact over practically their entire length.

S-2406-SB

The Contacts on both Plugs and Sockets are mounted in recessed pockets greatly increasing leakage distance, increasing voltage rating. Molded BM 120 Bakelite insulation. Plug and Socket contacts are silver plated. The finished appearance of this series will add considerably to your equipment.

The 2400 Series are interchangeable with all units of the corresponding No. 400 Series.

Send today for general catalog No. 14 listing and illustrating our complete line of Plugs, Sockets and Terminal Strips.

HOWARD B. JONES COMPANY
2460 W. GEORGE ST. CHICAGO 18