SEPTEMBER, 1935

Radio Engineering

DESIGN • PRODUCTION • ENGINEERING

- Broadcast Receivers
- Auto-Radio Receivers
- Electric Phonographs
- Sound Recorders
- Sound Projectors
- Audio Amplifiers
- P-A Equipment
- Electronic Control Devices
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- Television Apparatus
- Loudspeakers
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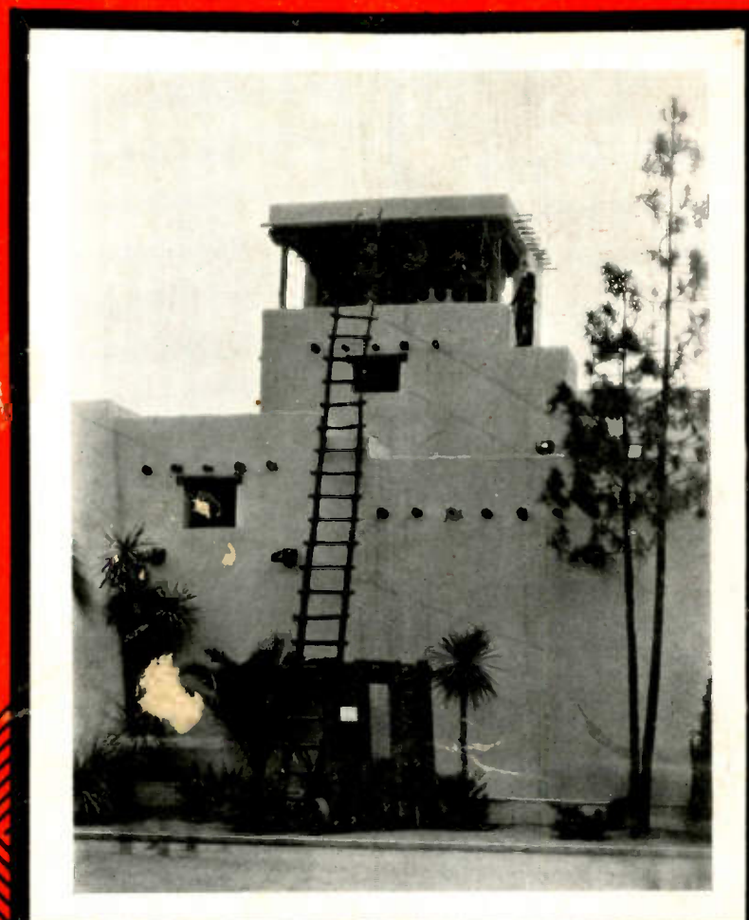
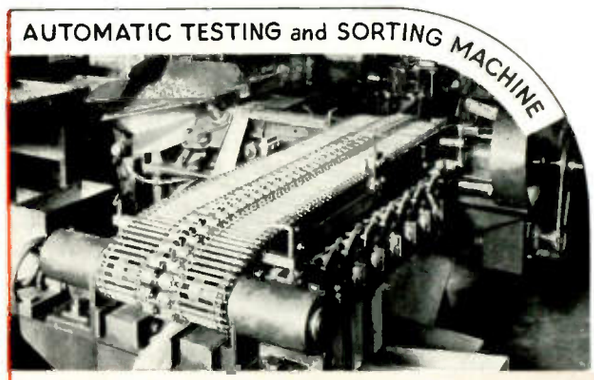
- Tubes
- Photocells



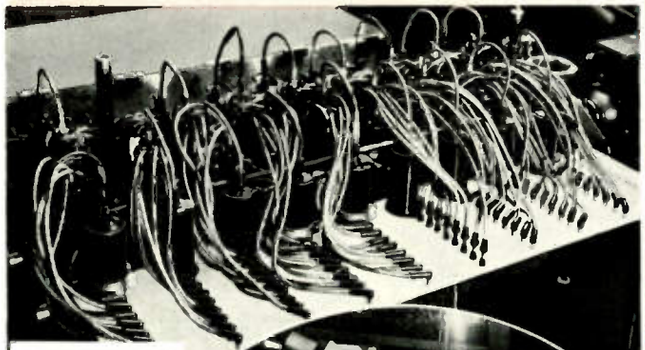
The Journal of the Radio and Allied Industries

VOL. XV NO. 9

A little more accuracy



• MUCH BETTER RESULTS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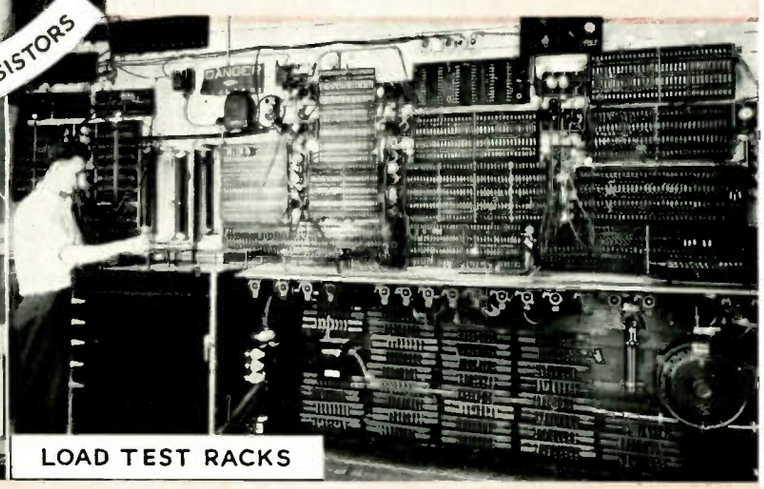
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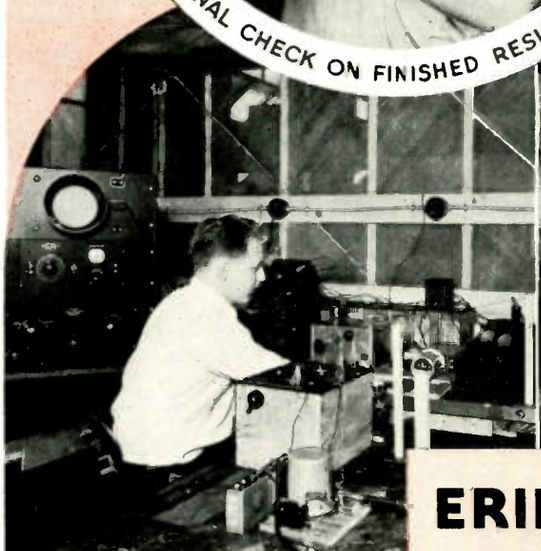
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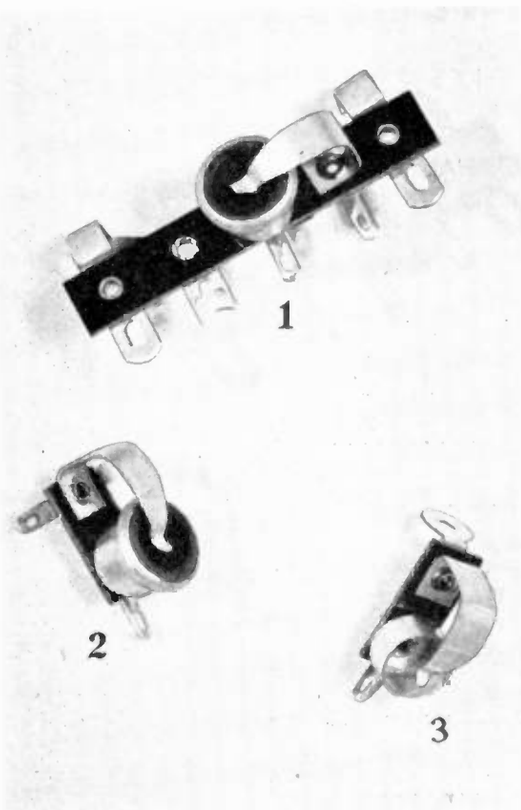

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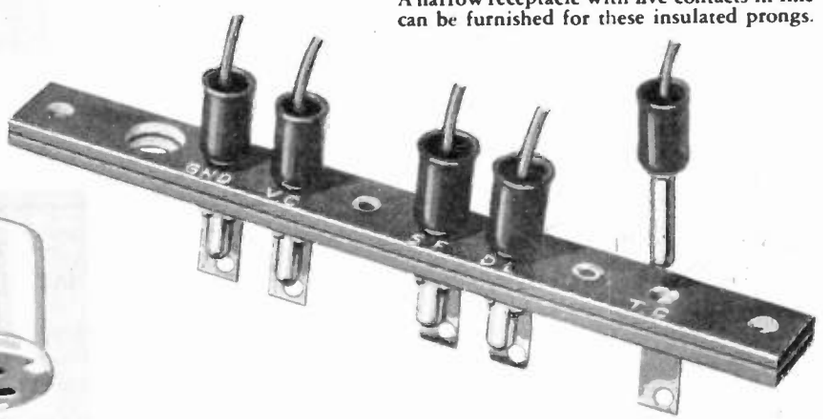

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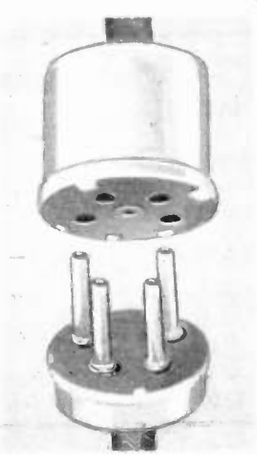

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CONTENTS FOR SEPTEMBER

COVER ILLUSTRATION

THE LOUDSPEAKER CLUSTERS BEFORE BEING COVERED ON TOP OF THE "HOLLYWOOD HALL OF FAME BUILDING." AT THIS POINT SOUND IS DISTRIBUTED WIDE RANGE TO AN ARC OF 180°.

(See Article on Page 19)

FEATURES

VOL. XV NO. 9

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EDITORIAL

RECEIVER DESIGN

RECEIVER DESIGN does not end with the chassis. For that matter, the design factors that meet the eye of the potential purchaser are quite often more important than circuit features.

A test of fifteen all-wave receivers of the table type—all in the same price range—brought out the interesting, but not surprising, observation that one set is about as good as the next in so far as practical results are concerned. In most instances the little superiorities that showed up in the more precise laboratory tests, were not particularly apparent on listening tests.

That receivers in the medium-price range are about as much alike as peas in a pod is not surprising, in view of the fact that present-day circuits are pretty well standardized. This condition does not hold for the higher-price receivers—in this instance considerable originality is expressed in circuit design, and the "results" obtained from a group of these receivers are not on a common level, as they appear to be with the table-type set.

We cannot vouch for the authenticity of the tests referred to—we can only state that, from our own meagre examinations of medium-price table-type receivers, and from what we have heard from other sources, there is an element of truth to the assertion. Be that as it may, the fact remains that few receivers in this class are so much better than others that the results are sufficiently obvious as to influence the potential purchaser.

Perhaps a purchaser is influenced principally by advertising claims, but it is safe to say that he is also influenced by the features of the set he can readily understand and which are apparent even to the casual observer . . . features such as, appearance, ease of handling, clearness of dial markings, comprehensible waveband indicators and readings, etc. If this be so—and we have the conviction that it is—more study should be given to exterior design and to the practicability of adding auxiliaries. Because improved appearance, and the inclusion of gadgets that add to the convenience of operation, should increase the salability of a table-type receiver, they should also do the same for receivers in all price classes.

Consider appearance: Table-type cabinets are as stereotyped as the circuits of the chassis they house. The opinion seems to be that it is preferable to have cabinets similar to, rather than different from, the cabinets of other manufacturers, whereas public psychology suggests that the average man would prefer to see a bit of variety. His house or his apartment may be similar to others architecturaly, but the furnishings he selects are not copies of the furnishings in his neighbor's home. He exercises a power of choice, and he is apt to resent any restraint of this power.

We still believe that a radio cabinet should be functional in design. No serious effort has been made to develop a design expressing the actual character of a radio receiver. Yet a departure from standard cabinet construction might well capture the appeal of the public.

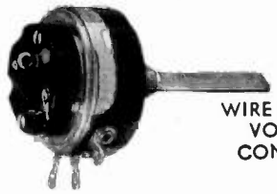
Dial design appears to be another problem. The dial should be either emphasized or subdued. To attempt to strike a happy medium between the two is to lose an effectiveness in exterior appearance. At least one manufacturer has realized that the two principal functions of a dial are, efficient operation and readability. As a result the dial has been designed to meet these requirements and, as it is necessarily large, it has been permitted to dominate the cabinet design. This comes nearer to expressing the function of a radio receiver than anything we have yet seen. It is a step in the right direction.

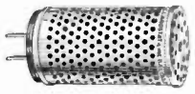
The loudspeaker or the auxiliary controls of a receiver, also hold interesting design possibilities. Were they to dominate the cabinet, rather than be subdued by it, a new note in exterior appearance could be created.

No manufacturer is helping his sales by sacrificing operating convenience. Let's see more emphasis placed on functional properties. If this is done, enhanced exterior appearance will develop as a natural thing.

CLAROSTAT'S Manufacturing Facilities

Some CLAROSTAT Products:


WIRE WOUND VOLUME CONTROLS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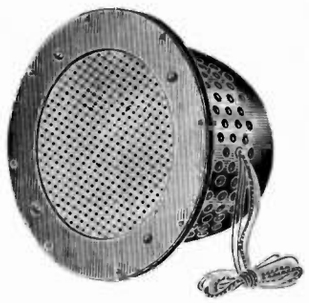
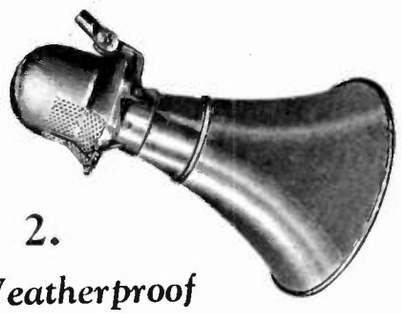


1.
BULLET SPEAKER



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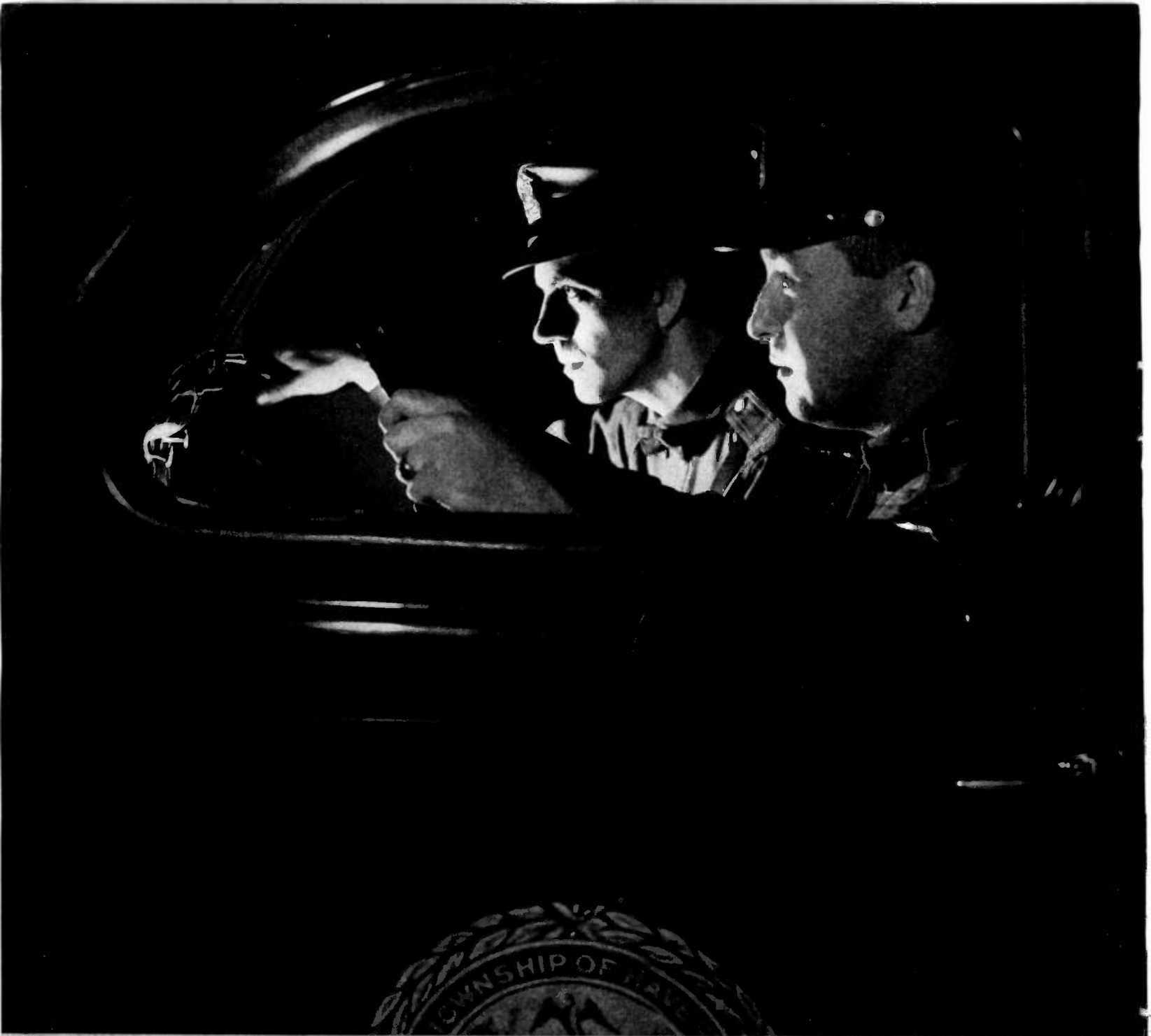

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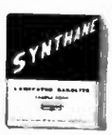

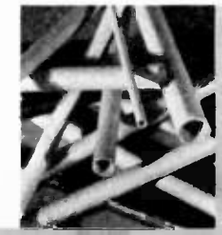

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RADIO ENGINEERING

FOR SEPTEMBER, 1935

Cathode-Circuit Degeneration

By W. D. SHEPARD

● **Relating to the realization of a rising high-frequency response in audio circuits by the control of the cathode resistor bypass capacity. Formulas are provided.**

AMONG THE REQUIREMENTS of a good audio amplifier, as generally set forth, is the condition that the response over a certain range of frequency shall be uniform, or as commonly stated, that the frequency characteristic shall be flat. For many applications this is ideal, but conditions exist where it is desirable to modify the characteristic in various ways. As an example of this intentional departure from uniform response, we have the tone control, by means of which reproduction may be made as unnatural as the tastes of the listener may dictate. In many cases, however, a departure from linearity is introduced for the purpose of compensating for deficiencies in speakers, lines, or other apparatus, or to minimize the effects of poor acoustics in an auditorium. For such purposes, a variety of filters and networks have been used. Most of these have been given a fair amount of attention by various publications, but the control of bypass capacity across the cathode-biasing resistor, frequently used to obtain a rising high-frequency response, is usually overlooked.

THE BYPASS CONDENSER

It is generally assumed that all resistances in the cathode circuit should be well bypassed in order to avoid losses due to degenerative feedback. Because of the usual low resistance employed for biasing purposes, it is necessary to use either a very large condenser or a resistance-capacity filter. We commonly meet with the statement that the use of too small a bypass condenser results in an undesirable loss of low-frequency response. As a matter of fact, the form of rising characteristic obtainable by this method finds considerable practical application, and lends itself quite readily to predetermination.

DERIVATION OF FORMULAS

In order to make clear the nature and possibilities of such circuits, it is desirable to outline the derivation of formulas suitable for purposes of design. Considering the quantities designated in Fig. 1, we may write the following three equations, all quantities in which are vectorial.

$$E = E_g + E_k \quad (1)$$

$$E_L = \mu E_g Z_L/(R_p + Z_L + Z_k) \quad (2)$$

$$E_k = \mu E_g Z_k/(R_p + Z_L + Z_k) \quad (3)$$

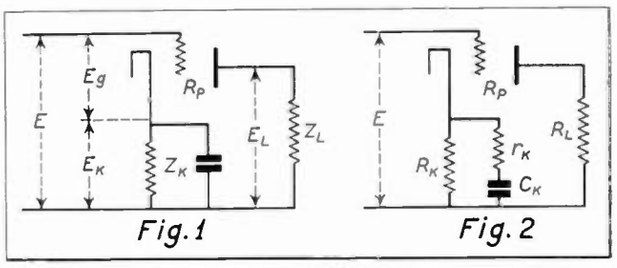
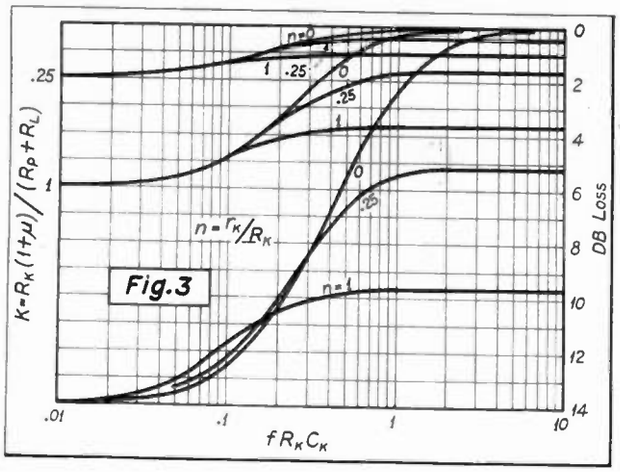


Fig. 1. Functional circuit.
Fig. 2. Circuit with resistor added in series with bypass condenser.



Curves derived from the application of equation (9).

Combining these, we obtain

$E_L = \mu Z_L E\{1 - \mu Z_k/[R_p + Z_L + Z_k(1+\mu)]\}/(R_p + Z_L + Z_k)$

The amplification, a, is then

$$a = E_L/E = \mu Z_L/[R_p + Z_L + Z_k(1+\mu)] \quad (4)$$

If, now, Z_k consists of a parallel resistance and capacity, at the higher frequencies $Z_k = 0$, and the amplification becomes

$$a_0 = \mu Z_L/(R_p + Z_L)$$

At low frequencies the bypass is ineffective, and $Z_k = R_k$. The ratio of high- to low-frequency amplification is therefore

$$a_0/a = [R_p + R_L + R_k(1+\mu) + jX_L]/(R_p + R_L + jX_L) \quad (5)$$

In the case of a resistance-coupled amplifier, this reduces to

$$a_0/a = 1 + [R_k(1+\mu)/(R_p + R_L)] \quad (6)$$

which approximates any case in which the load is principally resistive. It will be noted that certain factors, such as inter-electrode capacities, have been neglected, as the slight increase in accuracy hardly justifies the resulting complication in formulae.

EQUALIZATION

The correction or equalization obtainable may be written in db as follows:

$$db = 20 \log_{10} a_0/a \quad (7)$$

For the sake of ease in design, a set of curves may be plotted showing the variation of this quantity with frequency and circuit constants. For this purpose we write equation (4) in slightly different form, using the case of resistance coupling for simplicity.

$$a = \mu R_L/[R_p + R_L + R'_k(1+\mu) + j X'_k(1+\mu)]$$

where the equivalent series resistance and reactance of the parallel cathode resistor and condenser are

$$R'_k = R_k X_k^2/(R_k^2 + X_k^2)$$
$$X'_k = X_k R_k^2/(R_k^2 + X_k^2)$$

Writing

$$X_k = 1/2\pi f C_k$$
$$k = R_k(1+\mu)/(R_p + R_L)$$

and

$$m = X_k/R_k = 1/2\pi f C_k R_k$$

we obtain as an expression for loss

$$db = 10 \log_{10} \frac{1 + m^2(1+k)^2}{1 + m^2} \quad (8)$$

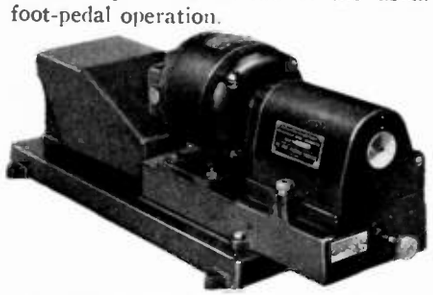
Graphs plotted by the substitution of various values for m and k in the formula indicate that certain definite values hold for frequency and amplification, dependent on circuit constants that are not easily changed. In order to afford additional control in design, a resistor is occasionally added in series with the bypass condenser, as shown in Fig. 2. The derivation for this case is entirely similar to that given above. Using $n = r_k/R_k$ for the ratio of this series resistor to the biasing resistor, the following expression may be derived.

$$db = 10 \log_{10} \frac{\{[n(n+1) + m^2] + k(n^2 + m^2)\}^2 + m^2}{[n(n+1) + m^2]^2 + m^2} \quad (9)$$

The accompanying curves result from the application of this formula. This method of calculation may be applied to a number of similar circuits. In general, the results obtained will hold quite closely for resistive circuits, and as a first approximation for some circuits involving transformers.

TWO NEW SPEEDCRAFT STRIPPER MODELS

THE WIRE STRIPPER CO., E. Cleveland, Ohio, specialists in insulated wire stripping machines, have just placed on the market two new models of their entirely redesigned Speedcraft Strippers. Both are of the rotary knife type action, but one is a semi-automatic machine with electric operation instead of the usual foot-pedal operation.



Several years of intensive study and investigation of all kinds of operating problems under actual production conditions resulted in the new design of these machines, the many new features of which have increased their efficiency and have reduced the time required for servicing the knives, etc. These machines are said to represent the greatest improvements in insulated wire strippers since the motor-driven wire stripper was introduced.

Some of the features of these new machines are as follows: A new operating head with non-breaking coil springs and properly-designed long-wear bearings for knife levers. Knives can be hand-honed without removing from the head.

A new knife setting has been perfected. Quick change guide bushings that guide the wire on center can be locked in place with a simple twist.

A hinged cover that has just one thumbscrew makes the operating head instantly accessible. Also, no chips fall into the mechanism; they all fall clear of it.

On the semi-automatic model (the one illustrated) there is still easier operation, less fatigue, greater speed and larger production.

A new bulletin has been issued describing these and the other types of wire strippers which the company manufactures. It will be sent free on request.

•

RADIO BOOSTER CLUB

At a regular meeting of the Radio Booster Club, Southern California Branch No. 1, on August 5th, the following officers were elected:

President, J. T. Hill; Vice-President, J. J. Perlmuth; Secretary-Treasurer, Harry A. Lasure; Directors, Carl Stone and Don Wallace.

The Radio Booster Club is composed of Radio Manufacturers Agents and other executives engaged in the distribution of parts, sets, and accessories, with the object of close co-operation among its members, and between manufacturers, wholesalers and dealers for the general betterment of the radio industry.

The address of the Secretary, Mr. H. A. Lasure, is 1406 South Grand Ave., Los Angeles, Calif.

Operation of the 6L7 as a Mixer Tube

THE 6L7 IS A 6.3-volt metal-shell tube intended for use as a mixer (first detector) in superheterodyne receivers, although its characteristics enable it to perform other functions. It is the purpose of this article to discuss operation of the 6L7 as a mixer, the discussion being based on data collected in the RCA Radiotron Laboratories.

The pentagrid-converter tube now in general use is a good frequency-converting device at medium radio frequencies. When a tube of this type is operated at frequencies higher than 15 or 20 megacycles, however, its conversion conductance is substantially less than that in the standard broadcast band, even though the oscillator voltage is maintained at a satisfactory value throughout the frequency range of the receiver. The cause of this decreasing conversion conductance with increasing frequency has been traced to an undesirable effect produced by space-charge coupling between oscillator and signal grids. This phenomenon is inherent in the operation of this type of tube and is serious when the ratio of signal frequency to intermediate frequency is very large.

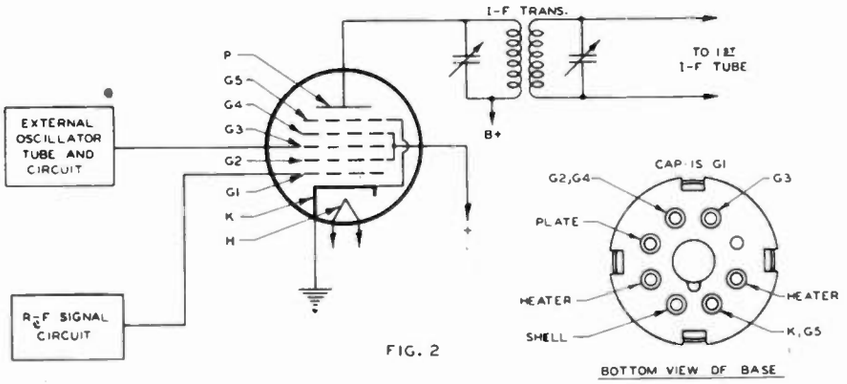


FIG. 2

Connections of 6L7 as a mixer.

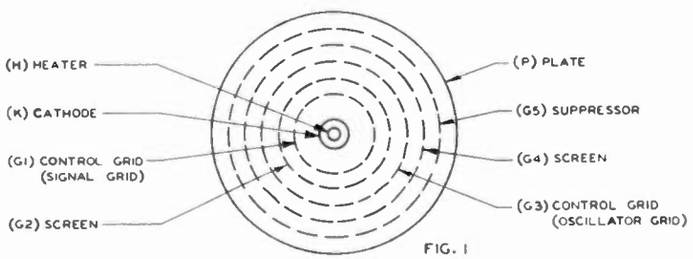


FIG. 1

Relative position of electrodes of the 6L7 tube.

PENTAGRID-CONVERTER SHORTCOMINGS

Variations in potential of the oscillator grid of a pentagrid converter modulate the electron stream from the cathode. These cause corresponding variations in the space charge surrounding the signal grid. If the intermediate frequency is low compared to the signal frequency, so that the impedance of the signal circuit is appreciable at oscillator frequency, this varying space charge will cause a voltage of oscillator frequency to be developed across the signal circuit. This generated voltage will be 180° out of phase with the oscillator-grid voltage when the oscillator frequency is higher than that of the signal circuit; it will be in phase with the oscillator-grid voltage when the oscillator frequency is lower than that of the signal circuit. Since the oscillator is usually adjusted for the higher-frequency setting in order to obtain a reasonably high tuning ratio, the combined effect of the oscillator-frequency voltages on the two grids is to reduce the conversion conductance of the tube. This effect increases with frequency because of: (1) the increasing ratio of signal frequency to intermediate frequency, and (2) the increasing value of L/C as the receiver is tuned toward the high-frequency end of a band. The use of a separate oscillator tube coupled to the normal oscillator grid does not reduce this space-charge variation phenomenon, because, as previously pointed out, this effect is inherent in the operation of pentagrid converter tubes.

SECOND DISADVANTAGE

A second disadvantage of operating a pentagrid converter tube at high radio frequencies is the shift in oscillator frequency which occurs when the signal-grid bias is varied. This frequency shift is due to a trans-conductance be-

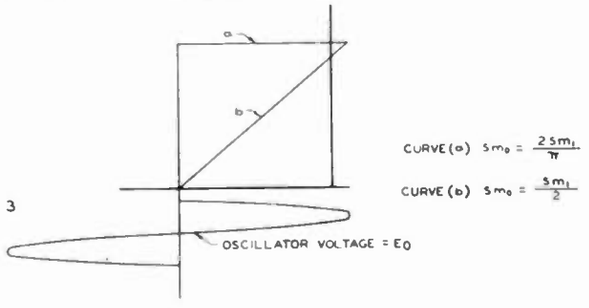


FIG. 3

Functional curves of 6L7.

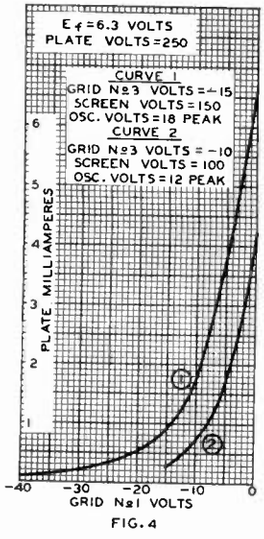


FIG. 4

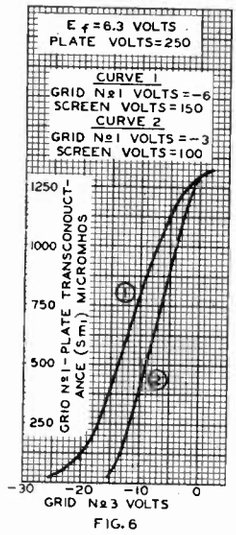


FIG. 6

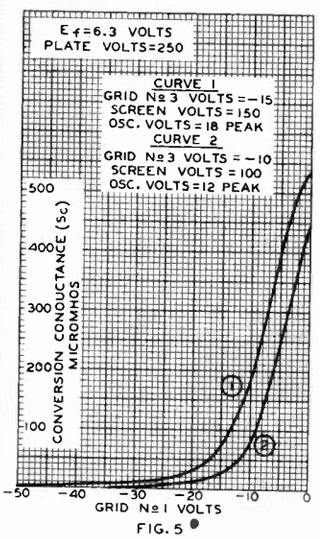


FIG. 5

Average characteristics of 6L7.

tween signal grid and oscillator anode. The use of a separate oscillator tube coupled to the normal oscillator grid will eliminate this undesirable characteristic.

Both of these high-frequency effects may be greatly minimized, with a consequent increase in gain, by replacing the pentagrid converter with an r-f amplifier pentode whose suppressor is connected to an external oscillator. However, the plate impedance is so low and the oscillator-voltage requirements are so high as to prohibit the use of this system in many receivers. These disadvantages may be overcome by increasing the amplifying action of the suppressor; a screen interposed between suppressor and plate will maintain the plate resistance at a satisfactory value.

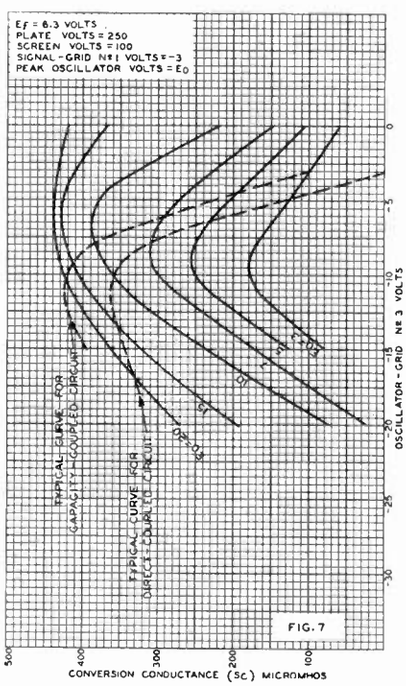


FIG. 7

Operation characteristics.

A further refinement may be made by inserting a grounded suppressor between plate and oscillator screen. This hypothetical tube, which is substantially the new 6L7, thus requires five grids for good mixing at high radio frequencies.

DETAILS OF 6L7

Fig. 1 shows the relative positions of the elements of the 6L7. The tube consists, as may be seen, of a heater, a cathode, five concentric grids, and a plate. Grid No. 1, which is nearest the cathode, is one of two control grids. It is of the remote cut-off type and, because the r-f signal to be converted is applied between it and cathode as shown in Fig. 2, may be referred to as the signal grid. The remote cut-off characteristic of this grid minimizes r-f distortion and cross-modulation effects when its bias is under the control of the avc system. Grid No. 2 serves the same purpose as the screen in a conventional tetrode; it accelerates the electrons toward the plate and reduces the G_1-G_3 capacitance to a small value. (The numerical subscript denotes the grid number.) Grid No. 3, interposed between screens G_2 and G_4, is the second control grid of the tube and has a sharp cut-off characteristic. This grid may be referred to as the oscillator grid, because the output of the external oscillator is connected to it. Grid No. 4 is another screen; it increases the plate resistance of the tube, reduces the G_3-P capacitance, and functions similarly to the screen in a conventional tetrode: G_2 and G_4 are connected together internally. Grid No. 5 is a suppressor; it is connected to the cathode internally and serves to limit the effects of a secondary emission from the plate; because of the suppressor, it is possible to operate the tube at low plate voltages.

THEORY OF OPERATION OF 6L7 AS A MIXER

The manner in which the 6L7 produces an intermediate-frequency component of plate current when it is connected to operate as a mixer may be described as follows:

An r-f signal applied to G_1 modulates the electron stream by virtue of the G_1-P transconductance (s_{m_1}). The r-f component of the plate current is, therefore, $E_g s_{m_1}$, where E_g is the signal voltage. The oscillator voltage applied to G_3 varies s_{m_1} between zero and a maximum, s_{m_1} being maximum at the peak positive potential of G_3 and minimum at the peak negative potential of G_3. Thus, regardless of the manner in which s_{m_1} varies, there is an alternating component of s_{m_1} having the same frequency as that of the oscillator. If the signal is represented by $E_g \cos \omega t$ and the component of s_{m_1} at oscillator frequency is represented by $s_{m_0} \cos \rho t$, the instantaneous plate current will be:

$$I_p = E_g s_{m_0} \cos \omega t \cos \rho t = \frac{E_g s_{m_0}}{2} [\cos(\rho + \omega)t + \cos(\rho - \omega)t]$$

where ω is the angular velocity of the signal and ρ that of the oscillator; s_{m_0} is the peak value of the alternating component of s_{m_1} having the same frequency as that of the oscillator. The difference-frequency, or i-f, component of this plate current is

$$I\ (i\text{-}f) = \frac{E_g s_{m_0}}{2} \cos(\rho - \omega) \qquad (1)$$

Thus, it is seen that the i-f component of the plate current increases directly with signal strength and with s_{m_0}.

If I (i-f) is to be a maximum for a

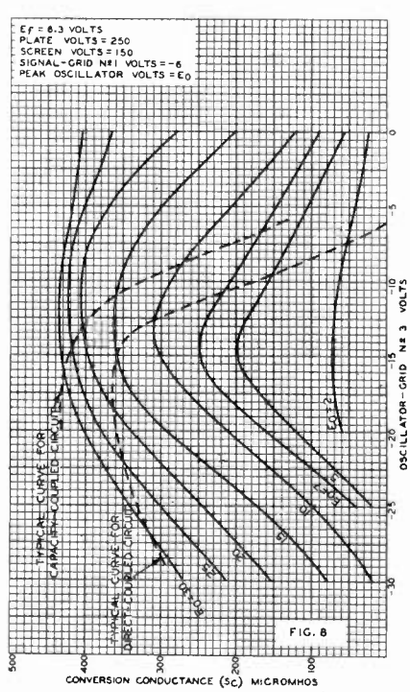


FIG. 8

Operation characteristics.

given signal strength, then s_{m1} must be varied by the oscillator in such a manner that s_{m0} is a maximum. The ideal relation between s_{m1} and E_{c3} for maximum s_{m0} is shown by curve (a) of Fig. 3; for this case,

$$s_{m0} = \frac{2\ s_{m1}\ (\text{max.})}{\pi}$$

If the relation between s_{m1} and E_{c3} is linear, as shown by curve (b), then,

$$s_{m0} = \frac{s_{m1}\ (\text{max.})}{2}$$

The conversion conductance (s_c) of a mixer tube is defined as

$$s_c = \frac{I\ (i\text{-}f)}{E_g},$$

so that Eq. (1) becomes

$$s_c = \frac{s_{m0}}{2}$$

For curves (a) and (b) of Fig. 3, then, s_c is as follows:

Curve (a)

$$s_c = \frac{s_{m1}\ (\text{max.})}{\pi}$$

Curve (b)

$$s_c = \frac{s_{m1}\ (\text{max.})}{4}$$

CHARACTERISTICS OF 6L7

The table of characteristics (Table I) recommends for a given plate voltage of 250 volts two screen voltages, 100 and 150 volts. Although the space-charge phenomenon discussed previously is very small in the 6L7, it has been found that electrons repelled by the oscillator grid during its negative voltage excursions enter the vicinity of the signal grid and cause a current to flow in that circuit. At high radio frequencies, where this effect is appreciable, the signal-grid bias must be increased to —6 volts to prevent the flow of this current. The screen voltage may be raised to 150 volts in order to compensate for the consequent decrease in conversion conductance. For all-wave receivers, it is preferable to maintain the screen voltage at 150 volts and the minimum signal-grid bias at —6 volts in all bands.

Fig. 4 shows the relation between plate current I_b and E_{c1} for the two recommended values of screen voltage. Grid No. 1 is seen to have a remote-cut-off characteristic so that it may readily be controlled by the avc system. Fig. 5 shows the relation between conversion conductance (s_c) and E_{c1} for the same two values of screen voltage. These curves show how the gain of the converter stage varies with avc voltage. The variation of s_{m1} with E_{c3} is depicted in Fig. 6. The actual variation of s_c with E_{c3} for different oscillator voltages is shown in Figs. 7 and 8; these families of curves are probably the most interesting from an application standpoint.

TABLE I

Heater Voltage (a-c or d-c)	...	6.3	Volts
Heater Current	...	0.3	Ampere
Plate Voltage	...	250 max.	Volts
Screen Voltage (Grids No. 2 and No. 4)	100	150 max.	Volts
Signal-Grid Voltage (Grid No. 1)	—3	—6 min.	Volts
Oscillator-Grid Voltage (Grid No. 3)	—10	—15	Volts
Peak Oscillator Voltage (Min.)	12	18	Volts
Plate Current	2.4	3.3	Ma
Screen Current (Grids No. 2 and No. 4)	6.2	8.3	Ma
Conversion Conductance	350	350	Micromhos
Signal-Grid Voltage for Conversion Conductance of 5 Micromhos	—30	—45	Volts
Plate Resistance	Greater than 1		Megohm
Maximum d-c Resistance in G_3 Circuit	50000	50000	Ohms
Direct Interelectrode Capacitances (Approx.):*			
Grid No. 1 to Plate	0.0005 max.		mmfd
Grid No. 1 to Grid No. 3	0.12		mmfd
Grid No. 1 to All Other Electrodes	8.5		mmfd
Grid No. 3 to Plate	0.25		mmfd
Grid No. 3 to All Other Electrodes	11.5		mmfd
Plate to All Other Electrodes	12.5		mmfd

* Shell connected to cathode.

Considering only the solid-line curves for the moment, it is seen that the optimum value of s_c increases rapidly with small oscillator voltages and slowly for larger voltages. It is also well to note that the highest values of s_c are obtained when the oscillator voltage is much higher than the bias; of course, current then flows in the G_3 circuit of the 6L7. Because of the shape of the high oscillator-voltage curves in the region of $E_{c3} = 0$ comparatively constant gain may be expected within this region from the converter stage for varying oscillator voltages. Practically, this means that, for nearly constant bias on the oscillator grid, the conversion gain will remain substantially constant as the oscillator frequency is varied over a given tuning band. The minimum oscillator voltage in any tuning band, therefore, should be large enough to give nearly maximum s_c.

COUPLING CIRCUITS

The foregoing analysis is based on the assumption that the oscillator voltage is obtained independent of E_{c3}. Although this condition may be realized with some sircuits, it is more practical to use either of the coupling circuits shown in Figs. 9 and 10. In the circuit of Fig. 9, G_3 of the 6L7 connects to ground through a 50000-ohm resistor; it also connects to the grid of the oscillator tube through the blocking condenser C. The voltage developed across the grid leak of the oscillator tube, therefore, appears across R and modulates the electron stream to produce the i-f component of plate current. If the oscillator voltage applied to G_3 is high, rectification takes place in the G_3 circuit, just as in a diode, and a rectified

(*Continued on page* 16)

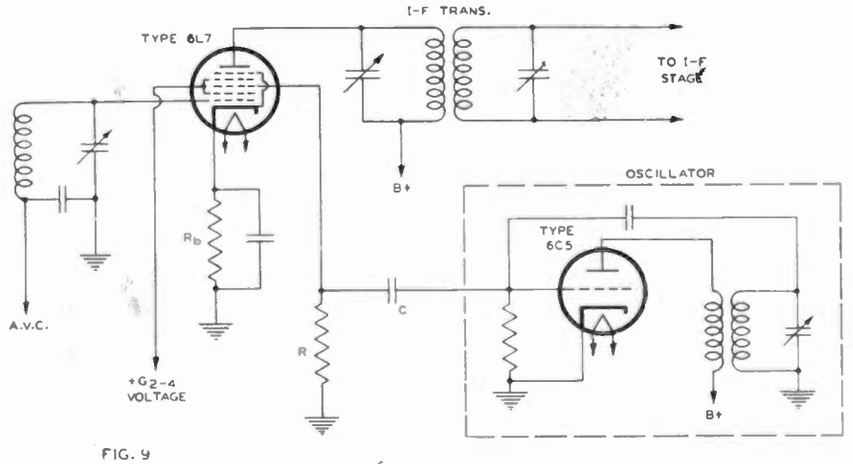


FIG. 9

R_b = {350 OHMS FOR E_{C1} = −3; 500 OHMS FOR E_{C1} = −6}
R = 50000 OHMS (MAX.)
C = 100 μμf

Coupling circuit for 6L7 in which the total bias on G_3 is a function of the oscillator voltage.

The Cathode-Ray Oscillograph

PART II (Continued from June issue)

By WILLIAM F. DIEHL
Engineering Department RCA MANUFACTURING CO., Inc.

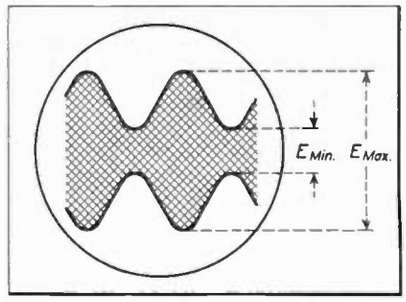


Fig. 28. R-F modulated at 1000 cycles. Timing axis supply: 500-cycle saw-tooth. Percent modulation = $\frac{\text{E Max.} - \text{E Min.}}{\text{E Max.} + \text{E Min.}} \times 100.$

MODULATION ANALYSIS

THE CATHODE-RAY oscillograph is invaluable for analyzing the waveform of a modulated radio-frequency transmitter. Fig. 27 illustrates one method of measuring percent modulation. In this case the modulated r-f output of the transmitter is applied to the vertical plates of the cathode-ray oscillograph either directly or through the amplifier, depending on the frequency range. In using this method neither the timing axis oscillator nor the horizontal amplifier are required, the instrument functioning as illustrated in Fig. 12-B (Part 1).

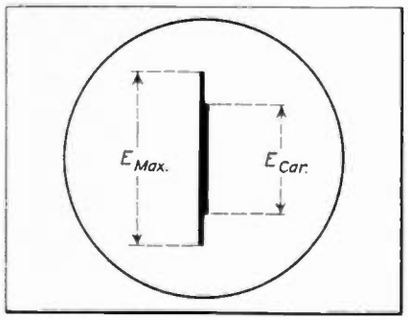


Fig. 27. No timing axis supply. Percent modulation = $\frac{\text{E Max.} - \text{E Car.}}{\text{E Car.}} \times 100.$

A second method of measuring percent modulation is illustrated in Fig. 28. In this method the modulated r-f is applied to the vertical plates of the oscillograph either directly or through the amplifier (depending on the frequency range) and the timing axis oscillator is set to a frequency corresponding to the modulation frequency, or a sub-multiple thereof. The number of complete cycles appearing on the screen will then be equal to the modulation frequency divided by the frequency of the timing axis oscillator. Figs. 29, 24 (Part 1), 30 and 31 illustrate 25-, 50-, 75- and 100-percent modulation, respectively. Fig. 32 illustrates over-modulation.

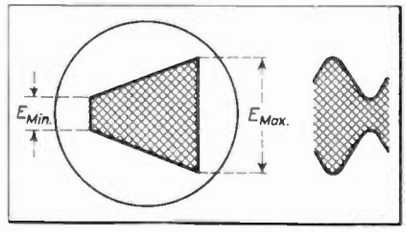


Fig. 33. Modulating signal as timing axis supply. Percent modulation = $\frac{\text{E Max.} - \text{E Min.}}{\text{E Max.} + \text{E Min.}} \times 100.$

A third method of measuring percent modulation is illustrated in Fig. 33. In

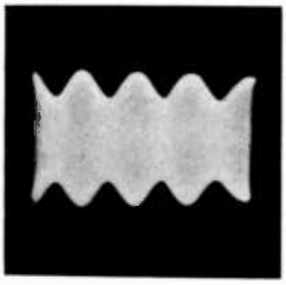


Fig. 29. A 60,000-cycle carrier modulated at 400 cycles, 25% modulation.

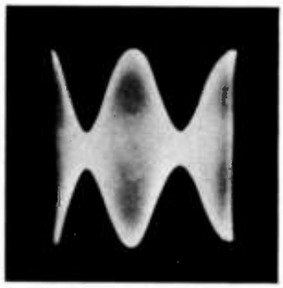


Fig. 30. A 60,000-cycle carrier modulated at 400 cycles, 75% modulation.

Fig. 31. A 60,000-cycle carrier modulated at 400 cycles, 100% modulation.

Fig. 32. Modulated carrier showing over-modulation.

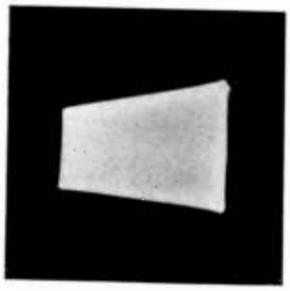


Fig. 34. Showing 25% modulation.

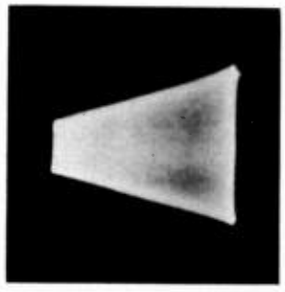


Fig. 35. Showing 50% modulation.

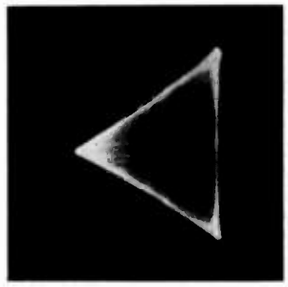


Fig. 36. Showing 100% modulation.

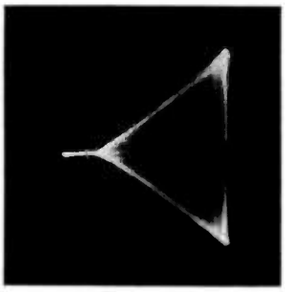


Fig. 37. Showing over-modulation.

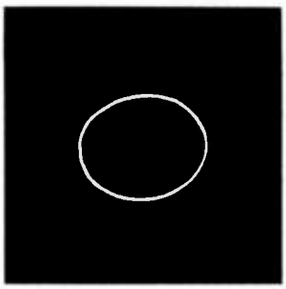


Fig. 39. Carrier only. Zero modulation.

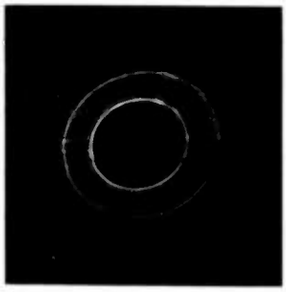


Fig. 40. Showing 25% modulation.

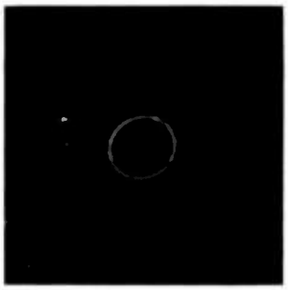


Fig. 41. Showing 50% modulation.

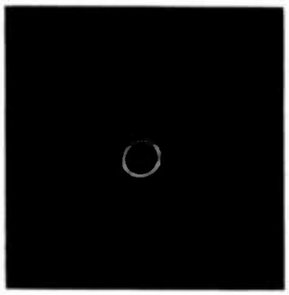


Fig. 42. Showing 75% modulation.

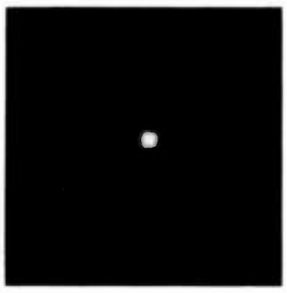


Fig. 43. Showing over-modulation.

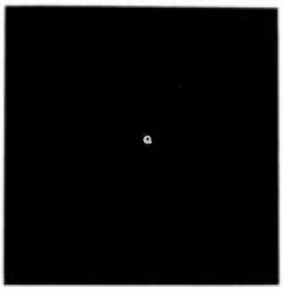


Fig. 44. Showing 100% modulation.

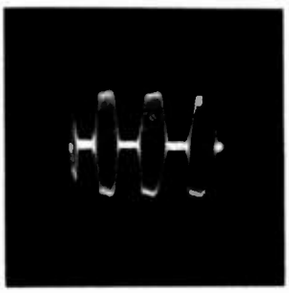


Fig. 45. Tone-modulated. Overmoculated due to over-loading and insufficient r-f grid excitation.

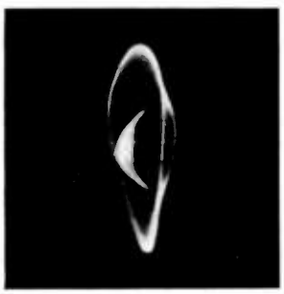


Fig. 46. Modulated trapezoid showing extreme phase distortion.

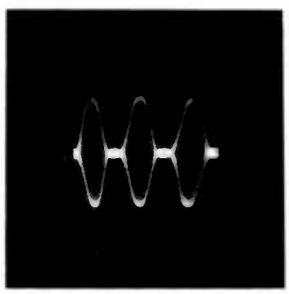


Fig. 47. Overmodulation with a-f distortion on positive peaks due to overloading.

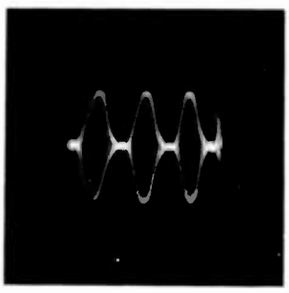


Fig. 48. Tone-modulated. Overmodulation but with reserve a-f to maintain good waveform on positive peaks.

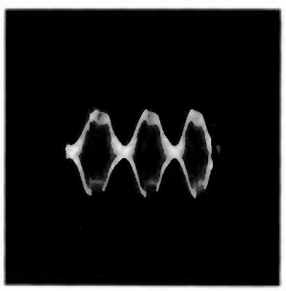


Fig. 49. Tone-modulated. Tank circuit of modulated stage detuned from resonance, showing phase distortion.

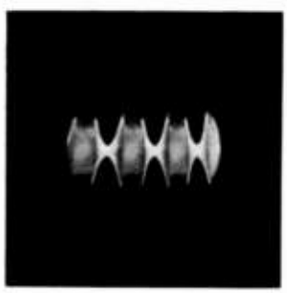


Fig. 50. Tone-modulated. Inadequate r-f excitation to modulated stage.

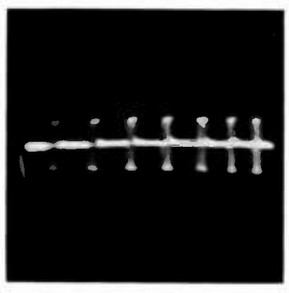


Fig. 51. Modulated tone out-out of facsimile equipment.

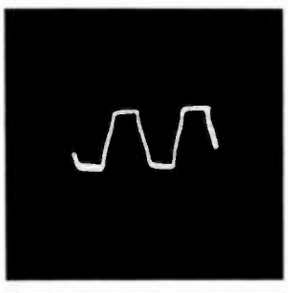


Fig. 52. Output of small "square-wave" alternator.

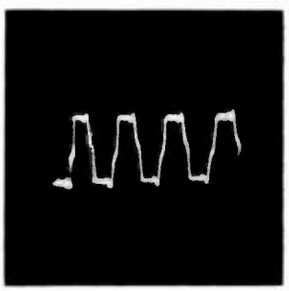


Fig. 53. Output of small "square-wave" alternator; third harmonic removed.

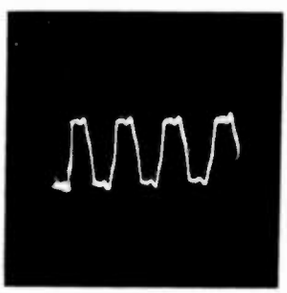


Fig. 54. Output of "square-wave" alternator with fundamental and fifth harmonic present.

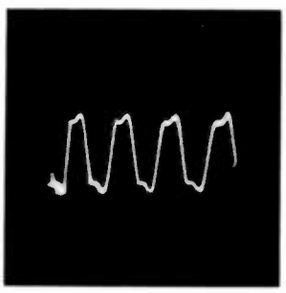


Fig. 55. Output of "square-wave" alternator with fifth and higher harmonics removed; fundamental and third present.

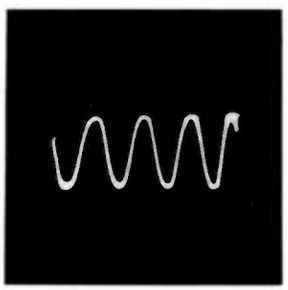


Fig. 56. Output of "square-wave" alternator; practically all harmonics filtered out, leaving fundamental only.

Fig. 57. Composite wave of 60-cycle pickup and commutator ripple.

this case the modulated r-f is applied to the vertical input, while the modulation frequency is applied to the horizontal input either directly or through an amplifier, depending on the sensitivity required. Since the modulation frequency may be obtained from the output of any stage of the modulator, the gain control on the horizontal amplifier may be used effectively to adjust the horizontal width of the image. Figs. 34, 35, 23 (Part 1) and 36 illustrate 25-, 50-, 75- and 100-percent modulation, respectively. Fig. 37 illustrates over-modulation.

A fourth method of measuring percent modulation is illustrated in Fig. 38. In this case the modulated r-f is applied to both the vertical and the horizontal deflecting plates, but by means of a phase-splitting circuit, the horizontal input is arranged to be 90 degrees out of phase with the vertical input. Fig. 39 illustrates the carrier only (zero modulation), while Figs. 40, 41, 42 and 43 illustrate 25-, 50-, 75- and 100-percent modulation, respectively. Fig. 44 illustrates over-modulation.

The cathode-ray oscillograph may also be used in conjunction with a radio receiver to determine the modulation characteristics and to check the percent modulation of a distant transmitter.

For this application, a high-fidelity receiver is employed and a separate shielded stage of i-f incorporated which feeds the vertical plates of the oscillograph directly. This separate stage of i-f is connected in the receiver as a branch circuit ahead of the second detector so that the characteristics of the receiver are unaltered. This separate i-f stage is required in order to increase the i-f amplifier output to a value sufficient to give a full-scale vertical deflection on the screen of the oscillograph. In most cases the modulated envelope can be viewed by properly adjusting the timing axis oscillator. However, since the modulation frequency is varying during the program, more accurate results can sometimes be instantaneously observed by disconnecting the timing axis oscillator and applying the audio output of the receiver to the horizontal input—using the Trapezoid Figure. A receiver equipped with cathode-ray oscillograph. as described, should prove of great service to station owners, managers and chief engineers, where it is desirable to monitor the transmitter from their home or other remote point and at the same time compare the characteristics of their own transmitter with the characteristics of transmitters on the same or other carrier frequencies.

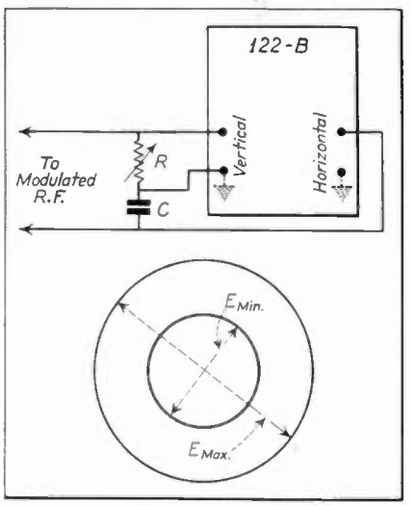


Fig. 38. When very near to 100% modulation, the inner circle, while extremely minute, will be open in the center. At exactly 100% modulation, the inner circle will simply be a spot which will increase in intensity with overmodulation.

DISTORTION*

Various forms of distortion are illustrated in Figs. 45, 46, 47, 48, 49 and 50.

Fig. 51 illustrates the modulated tone output of a facsimile equipment, while Figs. 52 to 56, inclusive, illustrate the waveform of a square-wave alternator, the output of which has been filtered to remove certain harmonics.

Fig. 57 shows a composite wave: i. e., 60-cycle pickup. superimposed on commutator ripple.

*Reference. Waller QST March, 1934. Figs. 45 to 50 inclusive.

(*To be continued*)

THE 6L7 AS A MIXER TUBE

(*Continued from page* 13)

current will flow through R; the d-c component of this current produces a d-c voltage across R which contributes to the fixed bias developed by R_b. Thus, the total bias on G_3 is a function of the oscillator voltage.

In the circuit of Fig. 10, the d-c and a-c components of the voltage developed across R by the oscillator tube are applied to G_3; the d-c component of this voltage plus the fixed voltage across R_b equals the total bias on G_3. If the peak value of the a-c component of the oscillator voltage is greater than this total bias, rectification will occur in the G_3 circuit of the 6L7; the total bias Ec_3 will thus be augmented. For these considerations, it is clear that, once the voltage drop across R_b is fixed, the variation of s_c with Ec_3 depends on the type of coupling circuit and the characteristics of the oscillator used. The dotted curves of Figs. 7 and 8 show the variation of s_c with total grid bias for two typical circuits of the type shown in Figs. 9 and 10. The flat portion of each curve is of greatest importance to the set designer, since it determines the minimum oscillator voltage required for nearly maximum conversion conductance. The minimum oscillator voltage in each waveband in the receiver should be great enough to secure nearly maximum conversion conductance; any further increase in oscillator voltage, such as may be obtained when tuning from the low- to the high-frequency end of any band, will not materially change the gain of the converter stage.

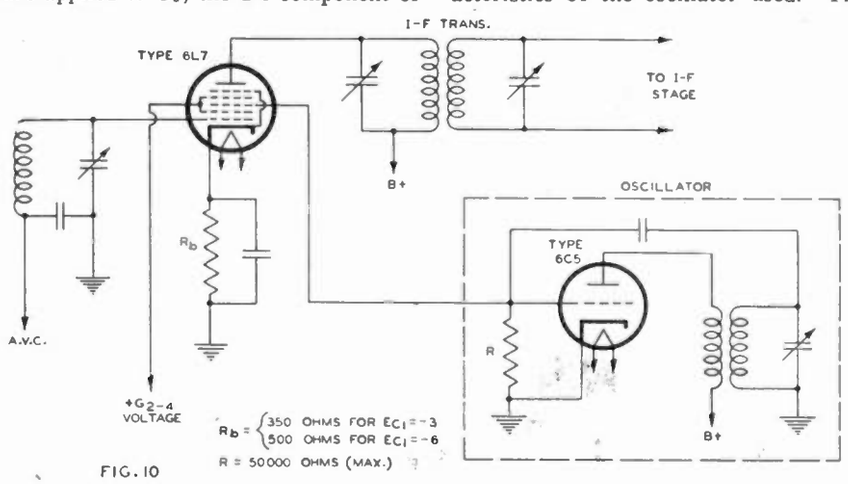


FIG. 10

A 6L7 coupling circuit in which the total bias on G_3 is augmented by the a-c component of the oscillator voltage.

Consideration should be given to the G_3 input capacitance which shunts the tuned circuit of the oscillator through the oscillator-grid condenser. The oscillator coils and padding circuit should be so designed that the desired tuning range can be covered with this capacitance in the circuit. The use of but part of the voltage developed across the oscillator coil, the connection of G_3 to the plate instead of to the grid of the oscillator, or the use of the circuit of Fig. 9 with a smaller value of C, will lower the effects of this capacitance.

Foreign Radio Markets

BY ANDREW W. CRUSE

Chief, Electrical Division, U. S. DEPARTMENT OF COMMERCE

AUSTRIA

NEGOTIATIONS AMONG Austrian radio manufacturers are reported to have made considerable progress recently toward the establishment of a radio cartel in Austria. It is believed that the cartel may become effective by August 15.

It is proposed to confine production to certain types of apparatus and equipment, thus reducing production costs. No price increases are expected as a result of the new cartel, which will endeavor to stop price cutting and to fix production contingents for individual plants. A special endeavor of the new cartel will be the promotion of radio exports, which, although increasing in quantity, have declined relatively from 30% of total sales three years ago to 10% of total sales this year. (*Gardner Richardson, Commercial Attache, Vienna.*)

BRAZIL (BAHIA)

The development of the radio market in Bahia has been progressing during the past two and one-half years.

The people of Bahia are naturally fond of music. Up to a few years ago one was certain to find phonographs in the most surprising places, such as small, dark rooms where the negroes or poorer natives lived; today radios are as frequently found in the same places. There is very little information available regarding the development of the radio market in Bahia, but it is understood that the first radio imported was an American battery set in 1924. From 1924 to 1928 there were practically no radios imported into Bahia, and it was not until 1930 that any measurable interest was shown in radio. The first broadcasting station was founded in 1925, the second in 1930, and the third in 1934. All of these stations use medium waves.

According to the local laws, all radio sets should be registered. On June 30, 1935, the Telegraph and Post Office department had registered only 1,086. It is estimated, however, that there are between 3,500 and 4,500 sets in Bahia.

The market for radios has been very good during the past two years in Bahia, especially when it is considered that over 80 percent of the people are of the black race and can buy only the bare necessities of life. It is true that the high rate of exchange has hindered the importations during the past few months, but the retailers state that the market is still good and they are looking forward to increased sales. There seems to be an increased demand for all-wave table models of 7 to 9 tubes.

Most of the radios are sold on time, with down payments ranging from 10 to 30 percent with the rest payable in monthly installments of from 10 to 18 months. Most dealers do not charge interest for the first 10 months, but for longer periods a charge of 6 percent is made. (*Vice Consul Lee Worley, Bahia.*)

CANADA

Radio manufacturers' sales to dealers in June registered an increase of nearly 500 units over the previous month and list value of sales increased 8½ percent. This is entirely accounted for by improved movement of battery sets, particularly dual-wave units, sales of which increased by more than 500 units. The sale of alternating-current models was smaller than in the previous month. Demand for automobile sets also fell slightly.

Projected production in the industry for the third quarter is placed at 70,203 units, a considerably higher manufacturing rate than set for June. Output of a-c chassis will be chiefly dual-wave and all-wave models, each in excess of 22,000 units. Only 4,554 standard band sets are forecast.

Demand for all-wave battery sets has been relatively light recently, but it is significant that in the third quarter production schedule manufacture of nearly 5,000 of these units is projected. It is also significant that jobbers' inventory and projected production of automobile sets is only 500 greater than sales reported in June. (*Asst. Trade Commissioner Avery F. Peterson, Ottawa.*)

IRISH FREE STATE

According to official figures there were 69,500 licensed receiving sets in the Irish Free State on June 30, 1935, as compared with 54,000 in October, 1934, 45,000 in December, 1933, and 30,000 in December, 1932.

POLAND

The annual congress of the "Union Internationale de Radio Diffusion" was held in Warsaw from June 18 to 29. Representatives from 22 European countries and from European offices of two American broadcasting companies participated in the conference.

It was announced at the conference that the number of radio listeners had increased during the last year to about 200 millions at the beginning of June, as against 180 millions a year previously.

Among the more important resolutions passed at the conference was one inviting national and international radio organizations of all countries and continents to participate in the inter-continental conference of 1936, to discuss the organization of a World Radio Federation.

On the initiative of the "Polskie Radio," the Union decided to create a new series of lectures, which would establish contact between leading representatives of science, literature and art, and the listeners of all broadcast stations belonging to the Union. The selection of speakers as well as of subject would be made with the cooperation of national and international academic institutions.

It was further agreed that a concert of students' choirs from all countries belonging to the Union would be organized on October 27. The Union resolved to take part in the work of the newly organized International Union for Promotion of the Workers' Recreation, the Institute for Intellectual Cooperation in Paris, and the International Film Educational Institute in Rome.

The delegates discussed the technical development of the Union's laboratory and of the Central Bureau for Wave Measurement, in Brussels. It was reported that the wave stability of the European broadcast stations had considerably improved during the last 10 years, and that the former fluctuations, which in some cases were as high as 1000 to 3000 cycles, had been reduced to one cycle.

The Congress approved the text of a resolution on the Berne-Rome Convention concerning copyright, to be presented at the Conference in Brussels in 1936. (*Commercial Attache Clayton Lane, Warsaw.*)

SWITZERLAND

Switzerland has six broadcast stations: Beromunster, Basel Bern, for the German part of Switzerland, Sottens and Geneva for French Switzerland, and Monte Ceneri for Ticino, the Italian canton, all under the control of the Federal Post and Telegraph Department. For German Switzerland the three stations alternate in giving programs and

the same is true of Sottens and Geneva for French Switzerland. With three principal languages, French, German, and Italian, one national broadcast station would not meet the needs of this country, as continuous broadcasting in all three languages is required. No commercial broadcasting is permitted in Switzerland and no use is made of this medium for advertising or political propaganda.

As a result of the severe import restrictions established in 1932, Swiss producers have been able to fill about one-half of the demand. Some domestic firms have put on the market a fairly satisfactory product. It cannot be said, however, that Switzerland really has a radio industry of its own, since the manufacturers are still largely dependent on foreign parts, notably Philips. Most of the cabinets are now made in Switzerland.

Imports of Radios and Parts

Prior to 1933 radios and parts were not classed in customs statistics separately from telephones and telegraph parts, and therefore the statistics as to imports of radios in previous years can only be estimated. The figures for imports from the United States, however, are considered substantially correct in the earlier years, because it is understood that this country did not import American telephones and telegraph apparatus.

Imports have steadily declined since 1932 under the severe Government restrictions and American trade has especially suffered in this curtailment. In the boom year of 1931, when trade was unfettered, American radios represented one-third of the total value of imports, and probably over one-half in the actual number of sets, as many small radios were imported at that time from the United States. In 1932 American trade shrank one million francs. The following year it dropped again by more than two-thirds. In 1934 it had declined to about one-tenth of the total trade, and during the first six months of the current year the value of American radios was only 9 percent of the total imports.

Import Restrictions

On April 1, 1933, the first restrictive measures on radio imports were taken by increasing the duty on radios and parts from 60 to 200 francs for 100 kilograms gross weight. Although this was an increase of over 300 percent, it was not a serious handicap for the sale of American radio sets, as a duty of 2 francs per kilo is only a minor factor in the final sale price of American radios. which have always been sold for several times the American retail price. The principle of large sales and small profit has not been practiced in the radio business. There have always been too many dealers in the field and they have had to figure on a large margin of profit on each transaction to pay expenses, and this system flourishes under monopolistic conditions.

Further Restrictions

Notwithstanding the high duty and the quota restrictions, it was found that at the end of 1933 large numbers of small radios were still being imported, with resulting severe competition to native production, and on January 1, 1934, a new restrictive measure was imposed the effect of which was practically to bar further importation of small and miniature sets from the United States. This new measure provided that, while the quotas are still dependent upon weight, it was arbitrarily arranged that each radio or chassis would be considered to weigh 12.5 kilograms in other words, eight chassis imported by a dealer would reduce his contingent by 100 kilograms. It did not matter whether the chassis weighed more or less than 12.5 kilograms. only eight units could be imported for 100 kilograms of quota contingent. In the case of a radio with a cabinet, the weight was arbitrarily fixed at 16 kilograms, which meant that the Swiss dealer could bring in six of these units for a contingent of 100 kilograms.

In 1934 Switzerland imported 49,236 kilograms of radio products from the United States. About 25 percent of this total was probably tubes and other radio parts imported by dealers and Swiss manufacturers. After this deduction the figures indicate a total of about 37,000 kilograms for sets, and averaging seven sets to each 100 kilograms, the total number of American sets imported in 1934 approximates 2,600. Actual sales of American sets in 1934 are estimated between 4,000 and 5,000 sets, the difference representing radio sets imported by dealers in previous years. Judging by the imports of the first six months of 1935, imports for the current year will probably not much exceed 2,000 sets.

Radio Tubes and Prices

Radio tubes are also subject to quota restrictions, being treated in the same way as radio sets and parts. The Federal Department of Economics, in apportioning the import allotments at the beginning of the year, deducts 10 percent from the quota granted to each dealer as a reserve to apply to tubes and other parts. If the importer does not utilize this reserve for the importation of tubes and accessories he is allowed to use it up at the end of the year for the importation of sets and chassis. Importers apparently have had no difficulty in filling their need for tubes, as the 10 percent reserve is adequate to cover the requirements of sets imported. However, it is not possible for a dealer to specialize in the sale of tubes because of the 10 percent limitation. Consequently, the dealers in radio sets provide the replacement tubes for their customers. The customs duty on tubes and accessories is the same as for radio sets.

The retail prices of tubes vary little between the different makes, but as American tubes cost less the dealers can make a greater margin of profit on the American tubes. Whereas the profit on the Philips and Telefunken tubes ranges from 33⅓ to 40 percent, the American product yields a gain of from 60 to 80 percent. It is apparent, therefore, that dealers prefer to sell American goods and are only restrained by quota restrictions and threats of litigation. (*Consul General A. C. Frost, Zurich.*)

UNITED KINGDOM

British Television Notes

The following report, which has just been received from Mr. Henry E. Stebbins, Assistant Trade Commissioner, in the office of the Commercial Attache in London, is to me most interesting. Here we have a picture of the stage being set for the inauguration of high-definition television in England. The atmosphere is becoming tense, "The air is still filled with rumors," efforts are being made to calm the nerves of the radio manufacturers and the motion picture interests, both of which have been jittery over the possible effect on their business ever since the publication of the report of the Television Committee in January of this year. Only the actual presentation of the proposed television programs from the Alexandra Palace transmitters of E. M. I. and Baird will clarify the situation and answer the questions now being asked regarding the future of television for entertainment. I can only repeat what I have said before, and that is, that, in my opinion. after having seen both the Baird and E. M. I. systems in operation, *I feel that the entire future of British television depends entirely upon the ability of the British Broadcasting Corporation to present programs which will be enthusiastically received by the public.* Technically, both the transmitting and receiving equipment is adequately satisfactory to introduce this service at this time, but the unknown factors are—program material and program presentation. Will the novelty of this new art be sustained after the novelty has worn off? We, in the United States, can learn many valuable lessons which may later save us many dollars by patiently watching this development of the British television picture.

Mr. Stebbins is very well qualified to

(*Continued on page 21*)

An "A-F Broadcast Chain"

THE OFFICIAL public-address system of the California-Pacific International Exposition now open in Balboa Park, San Diego, California, is a complete Western Electric System possessing many features not heretofore attempted on an installation of this scope and size. In effect it is the exact counterpart of a radio broadcast chain with the exception that the releasing stations are audio frequency instead of radio frequency.

BROADCASTING STUDIOS

The system was engineered and installed by the C. C. Langevin Company, of California, and it is operated under their supervision. It in-

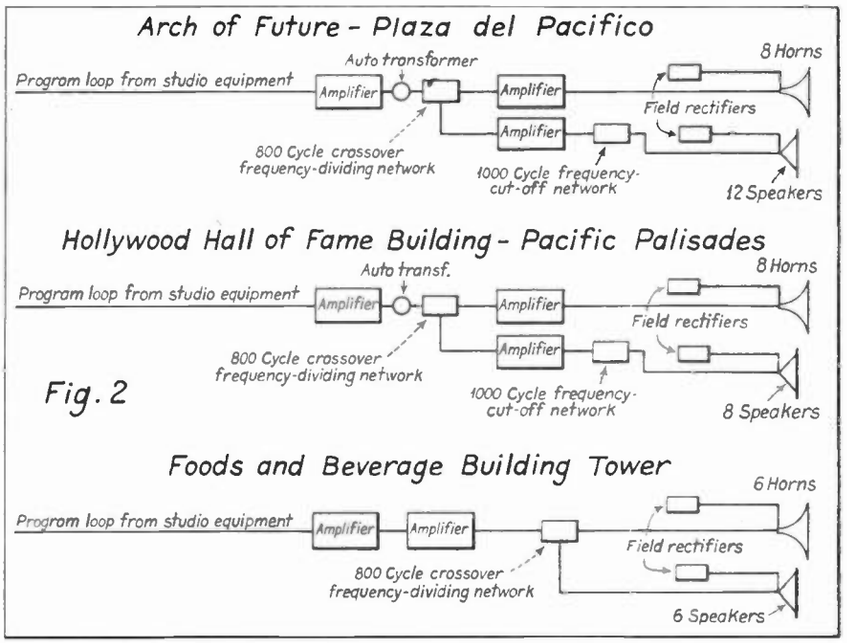


Fig. 2

Block diagrams of the amplifier and wide-range loudspeaker equipment in the Arch of the Future, Hollywood Hall of Fame and the Foods and Beverage Building tower.

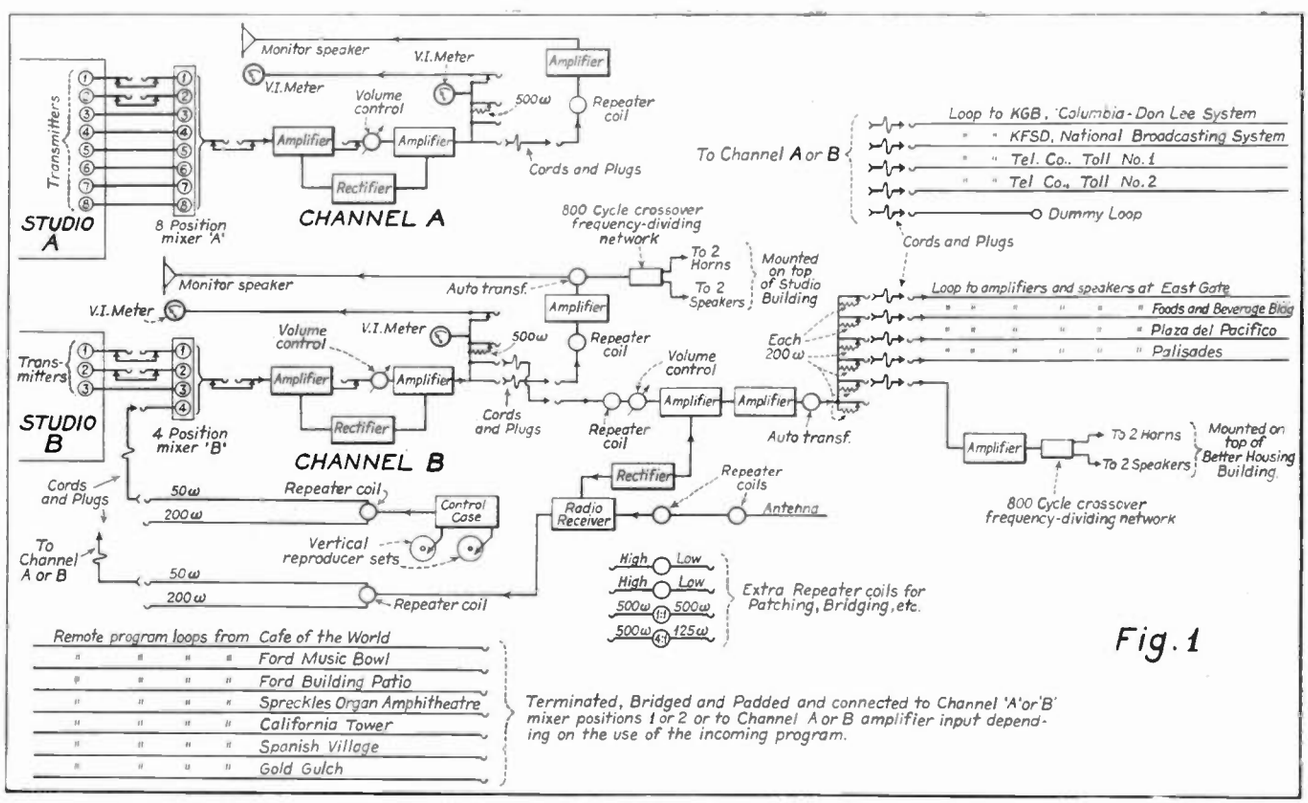
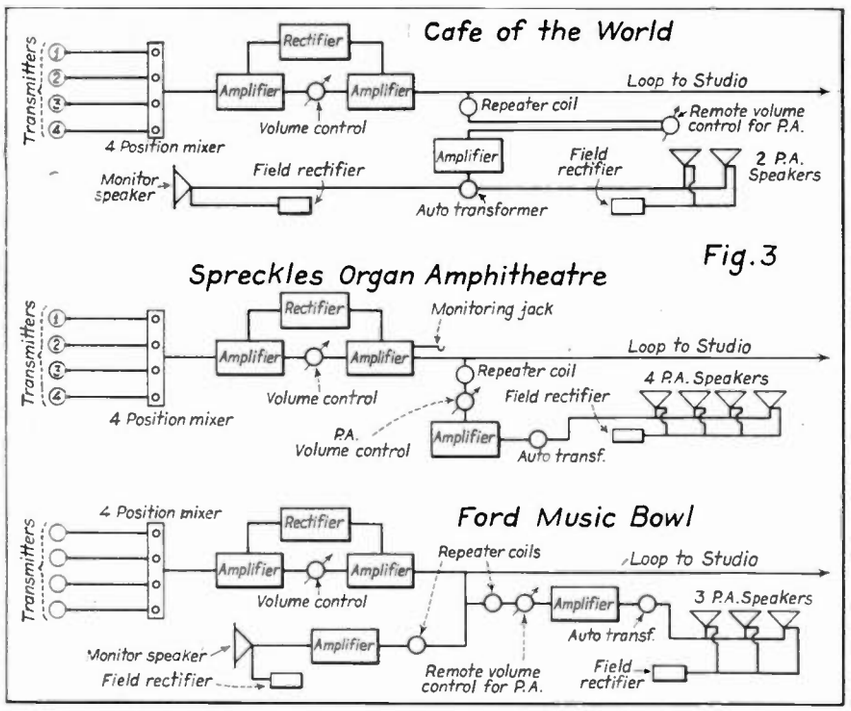


Fig. 1

Block-diagram of the central distribution system, the heart of the audio-frequency broadcast chain.



Block diagrams of remote pickup equipment in Cafe of the World, Spreckles Organ Amphitheatre and Ford Music Bowl.

cludes two broadcasting studios, Studio A and Studio B, especially constructed, of the live and dead end type, and each having its own speech-input equipment, together with a bridged monitor amplifier. The output of these studios is fed into the main control room for distribution either to any of the broadcast stations or to either the National Broadcasting or Columbia Broadcasting chains.

Also installed in the main control room is reproducing equipment which makes it possible to play records over any or all of the various loudspeaker audio stations. In addition to this, program loops are brought in from many points throughout the grounds. At these points remote programs are picked up, amplified and sent over the loops to the main control room, from which place they are routed either to the ether or over audio channels within the grounds.

SEVEN "AUDIO" STATIONS

There are seven audio broadcast stations which supply both announcements and music to practically every square yard of the Exposition grounds. Five of these stations are wide-range set-ups, the speaker banks consisting of horn projectors equipped with moving-coil units for the higher frequencies and dynamic loudspeakers equipped with baffles to cover the low-frequency end of the audio spectrum. The division of frequency between the middle and high range, and the low range, occurs at 800 cycles.

The other two audio stations are largely intended for use as individual public-address stations and originating points. These two stations are located at the Organ Amphitheatre and at the Ford Bowl. Permanent remote-control equipment is installed for picking up programs from the Cafe of the World, the Ford Music Bowl and the Patio of the Ford Building, as well as the Spreckles Amphitheatre. From these locations programs are regularly picked up and broadcast both over the air and over the audio chain within the grounds.

PROGRAM LOOPS

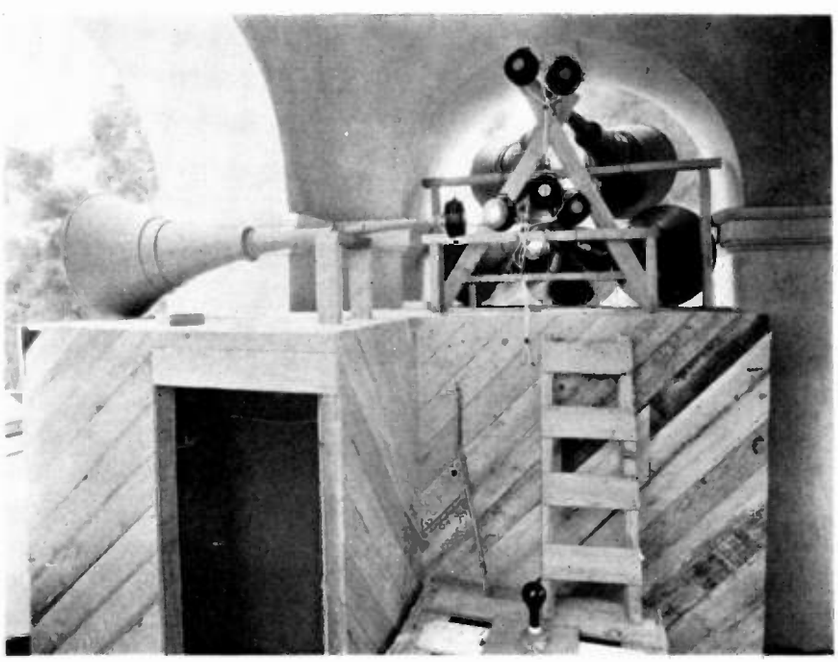
In addition to these permanent pickup points, there are some twelve or fourteen others from which programs are occasionally picked up. Program loops and private telephone loops are permanently installed at these spots, but portable pickup equipment is installed only when programs are to originate there. All incoming program loops as well as outgoing loops are grouped in a number of patching strips whereby any incoming program, either from a remote position or from Studio A or B, or from the transcription equipment, can be transmitted to any one or all of the loudspeaker audio stations.

In addition to the above sources of programs, a radio receiver is installed so that radio programs may likewise be transmitted over any of the channels.

It will be noted from the accompanying block diagrams that wide-range equipment is used throughout. The program amplifiers and monitoring amplifiers in every instance are of the latest type.

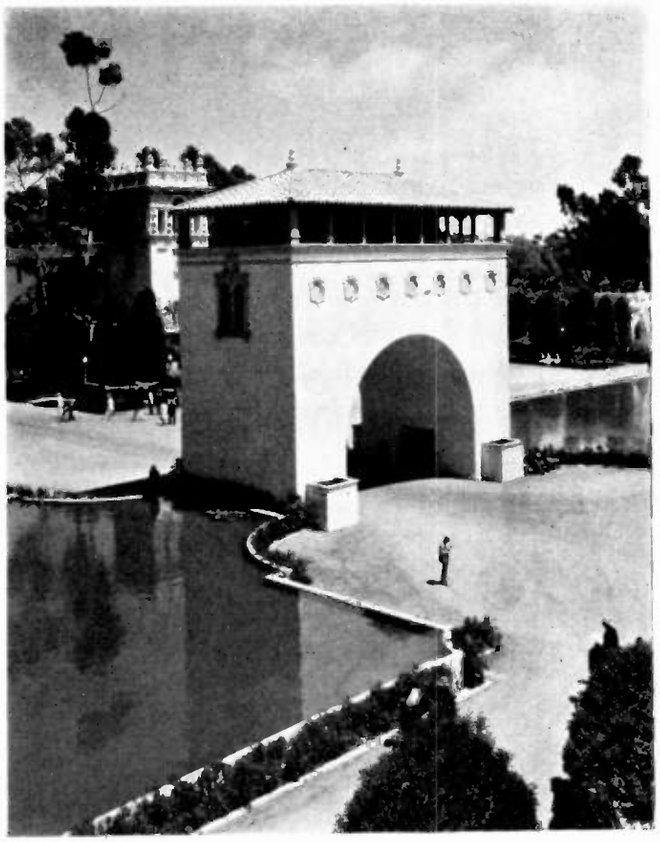
FREQUENCY-DIVIDING SYSTEM

In the case of the audio stations, the program is fed over loops into an inter-



A rear view of the loudspeaker clusters installed in the tower of the Foods and Beverage Building. The low-frequency speakers are installed underneath the horns in the enclosed structures. The insides of these structures are acoustically treated to prevent resonance.

mediate amplifier, which in turn feeds the power amplifier. In the case of two of the stations, one in the Arch of the Future in the Plaza del Pacifico and the other on top of the Hollywood Hall of Fame Building, a slightly different frequency-dividing arrangement is utilized. More audio power is required at these stations. The incoming loop feeds an amplifier, and an 800-cycle dividing network is fed by this amplifier through an auto transformer. The high-frequency end of this dividing network then leads into a power amplifier, the output of which supplies the high-frequency speakers. The low-frequency end of this network is likewise fed into an amplifier which supplies the low-frequency speakers through a 1000-cycle, low-pass filter. The object of the filter is, of course, to limit high-frequency harmonics generated in the low-frequency amplifier should the overload point be approached at any time.



VICTORY ARCH IN THE PLAZA DEL PACIFICO. Within this arch are located twelve speaker units working with eight exponential horns; also twelve low-frequency units. Sound is distributed in four directions.

LAYOUT OF SYSTEM

The accompanying block diagrams give the entire layout. In Fig. 1, in the upper left-hand corner is shown the equipment installed in Studio A. Directly below it, that in Studio B. Directly below Studio B are the various remote program loops incoming into the main control room. In the top right-hand corner of Fig. 1 are shown the outgoing loops to both Columbia and the National Broadcasting Company, as well as to the Telephone Company Toll. Directly below that are shown the loops to the various audio loudspeaker stations within the grounds. All jacks shown, together with patch cords, are located altogether in four patch bays.

Fig. 2 shows the block diagrams of the audio stations at three locations.

Fig. 3 shows the equipment at three remote radio pickup stations.

Programs at the Exposition start at 10 A. M. and conclude at 11 P. M. There are no quiet periods. The procedure of operation is exactly the same as in chain broadcasting. Change-overs are made to the second with the usual cues and announcements.

The management of the Exposition, as well as the Associated Oil Company which has sponsored this system, have actually received thousands of complimentary comments, both written and oral, about the system.

FOREIGN RADIO MARKETS

(*Continued from page* 18)

observe television developments for us in England. He accompanied me on all my visits to the various laboratories during my stay in connection with this subject. He knows the engineers who are doing the work—he knows the manufacturers who are making the receiving equipment—he knows the people at B. B. C. who will present the programs.

While the General Post Office is still considering the tenders of Baird Television Co., Ltd., and the Electrical and Musical Industries, Ltd., for the construction of the two stations to be erected at the Alexandra Palace, the air is still thick with rumors as to how far and how soon the public broadcast of television will progress. Each company directly interested in television is handling its affairs in its own particular way with little or no reference to each other.

Although it is now known that the Alexandra Palace, London, has been definitely chosen as the site of the high-definition television station for the London area, and that two different systems are to be given an opportunity of demonstrating their capabilities, it is important that the facts in regard to television should be clearly presented. Otherwise there is likely to be a good deal of disappointment; there is also danger that an imperfect realization of the true position may have an adverse effect on the manufacture and sale of sound-broadcasting receivers in the immediate future.

The two systems to be tried at the Alexandra Palace will be the Baird, using 240 lines, 25 picture traversals and 25 complete frames per second, and the Marconi-E. M. I., with 405 lines, 25 pictures, interlaced to give 50 frames each 202½ lines per second. Schemes for ultra short-wave, high-definition television services have been based on the belief that radiation on wavelengths below eight meters have optical characteristics. There is, however, reason to doubt whether this assumption is fully justified. Experiments made by the Marchese Marconi in the Mediterranean first suggested that the range of ultra-short waves was a good deal greater than the limit of optical visibility. Now it seems that British Post Office engineers are picking up and resolving the Berlin television transmissions and that these have even been received in Buenos Aires. The theory of propagation of radio waves would appear to be still in need of revision—whether another ionized layer above the Appletin is at work, or whether there is some other cause for the distant reception of ultra-short waves has yet to be ascertained. Whatever the reason may be, it is evidently necessary to discover its nature and the manner in which it may be expected to affect reception on ultra-short wavelengths before it will be safe to proceed with the erection of a number of transmitters using the same wavelength—a scheme which seemed quite practicable heretofore.

Purchasing Guide

The following pages contain information which it is believed will be of value to executives, engineers and purchasing agents. The companies listed are recognized sources of supply whose products thru past and present acceptance and use by the radio and allied industries, have achieved a reputation for merit and satisfactory performance.

In presenting this information, Radio Engineering assumes no responsibility for omissions. We have tried to give comprehensive and accurate information. We have tried to make the information usable and as complete as possible. If we have unintentionally overlooked or omitted information, we'll be only too glad to have it brought to our attention and will make any needed additions in a following issue of the publication.

For the purpose of brevity and convenience, the listings are grouped in rather broad classifications which include groups of related materials or components. See Index below.

INDEX

OUR READERS ARE CORDIALLY INVITED TO COMMUNICATE WITH US AT ANY TIME CONCERNING PRODUCTS WHICH THEY ARE INTERESTED IN PURCHASING. WE WILL BE GLAD TO GIVE PROMPT, UNBIASED INFORMATION REGARDING SOURCES OF SUPPLY.

Broadcasting and Public Address Equipment Amplifiers, Attenuators, Crystals, Decade Boxes, Microphones, Mixers, Radio Towers and Miscellaneous Equipment

ALLOY TRANSFORMER CO. (See page 32)

136 Liberty St., New York City. Equalizers, Chokes.

AMERICAN BRIDGE CO.

Pittsburgh, Pa. Radio Transmitter Towers.

AMERICAN MICROPHONE COMPANY

Los Angeles, Calif. Microphones of All Kinds. New York Office: 27 Park Place, N. Y. C.

AMERICAN TRANSFORMER COMPANY

175 Emmet Street, Newark, N. J.
Date of Organization: 1900.

PRODUCTS

Standard and Special Transformers for Audio, Plate, Filament, Power and Modulation Circuits; Audio and Filter Reactors; Transformers and Reactors for use in Laboratories and with Special Electronic Devices; Power Distribution and Special Industrial Transformers; Testing Sets for Oil, Paper, Cable and Insulation; Spot Welding Machines.

EXECUTIVES

Thomas M. Hunter.....President and Sales Manager
J. L. Schermerhorn.....Vice President
Walter Garlick.....Engineer in Amplifier Design
A. A. Emlen.....Engineer, Dry-Type Transformer Design
J. R. Gaston.....Engineer, Oil-Immersed Transformer Design
F. H. Canfield.....Advertising Manager
E. H. Bard.....Purchasing Agent

AMPERITE CORPORATION

561 Broadway, New York, N. Y.

PRODUCTS

Current and Voltage Regulators; Velocity Microphones; Pre-Amplifiers; Microphone Stands.

EXECUTIVES

President.....Elliot Leeds
Vice-President....Wm. Ruttenberg
Chief Engineer...Samuel Ruttenberg
Purchasing Agent....Murray Simon
Advertising Mgr.....Furman Gold

BRANCH OFFICES OR REPRESENTATIVES

W. S. Trinkle, Philadelphia, Pa.
S. B. Darmstader, Chicago, Ill.
D. C. Wallace, Long Beach, Calif.
E. K. Seyd, Hartford, Conn.
J. W. McCarthy, Cedar Rapids, Iowa.
R. R. Bean, Seattle, Washington.
N. W. Kathrinus, St. Louis, Mo.
H. B. Parke, Pittsburgh, Pa.
R. W. Mitscher, Buffalo, N. Y.

ASTATIC MICROPHONE LABORATORY, INC.

40 Hubbard Road, Youngstown, Ohio.

PRODUCTS

Crystal Microphones, Contact Micropohnes, Phono. Pickups, and Cardiaphones.

EXECUTIVE

President.....F. H. Woodworth
General Mgr.....C. E. Semple, Jr.
Vice President, Engineering....C. M. Chorpening

BRANCH OFFICES OR REPRESENTATIVES

C. C. Baines Sales Co., 4107 River Park Drive, Louisville, Ky.
R. L. Cooper, 3917 Morrell Ave., Kansas City, Mo.
Merton A. Dobbin, 407 Postal Bldg., Portland, Oregon.
B. J. Fitzner Company, 153 E. Elizabeth St., Detroit, Mich.
M. E. Foster Company, 601 Cedar Lake Road, Minneapolis, Minn.
General Engineers, 2201 Laws Street, Dallas, Texas.
Walter V. Gearhart, Volunteer Bldg., Atlanta, Ga.
L. H. Jackman, 2043 E. 77th St., Cleveland, Ohio.
D. R. King, King Sales Co., 2203 W. Clyborn St., Milwaukee, Wis.
Conrad R. Strassner, 1764 N. Fairfax, Los Angeles, Calif.
James H. Southard, 420 Market Street, San Francisco, Calif.
Wesley S. Scharp, 67 W. 44th St., New York, N. Y.
G. O. Tanner, 1104 Standard Life Bldg., Pittsburgh, Pa.

EXPORT

C. O. Brandes, 5716 East Euclid Ave., Cleveland, Ohio.

AUDAK COMPANY

500 Fifth Ave., New York City. Pickups.

BEACON MICROPHONE CO.

590 Sumner Street, Akron, Ohio. Microphones.

BELL SOUND SYSTEMS, INC.

61 E. Goodale St., Columbus, Ohio. Portable P-A Equipment.

BLAW-KNOX CO.

Pittsburgh, Pa. Radio Towers.

BLILEY ELECTRIC COMPANY

237 Union Station Bldg., Erie, Pa.

PRODUCTS

Piezo-Electric quartz crystals, holders and ovens for transmitters, receivers, monitors and standards.

EXECUTIVES

President.....F. D. Bliley
General Manager...F. Dawson Bliley
Sales Manager.....G. E. Wright
Chief Engineer.....C. C. Collman
Advertising Mgr.....A. K. Shenk

BRUNO LABORATORIES

20-22 West 22nd Street, New York, N. Y.

PRODUCTS

Velocity Microphones and Broadcast Equipment for Studio, Public Address, Sound Picture Recording Studio, Police Radio and Facsimile Applications.

BRANCH OFFICES OR REPRESENTATIVES

Chicago, Ill.
Philadelphia, Pa.
Boston, Mass.
San Francisco, Calif.
Los Angeles, Calif.

BRUSH DEVELOPMENT CO.

E. 40th & Perkins Ave., Cleveland, Ohio.

PRODUCTS

Microphones; Loudspeakers; Tweeters; Headphones; Crystal Elements; Special Consulting Work.

EXECUTIVES

President.....A. L. Williams
Vice-President.....C. B. Scott

BRANCH OFFICES OR REPRESENTATIVES

A. H. Baier, Cleveland, Ohio.
C. C. Baines Sales Co., Louisville, Ky.
A. F. Blinn, Hollywood, Calif.
R. L. Cooper, Kansas City, Mo.
M. A. Dobbin, Portland, Ore.
The Foster Co., Minneapolis, Minn.
Walter V. Gearhart Co., Atlanta, Ga.
King Sales Co., Milwaukee, Wis.
W. S. Scharp, New York, N. Y.
James H. Southard, San Francisco, Calif.
General Engineers, Dallas, Texas.
H. E. Walton, Detroit, Mich.
Brush Crystal Products, Toronto, Ontario.

EXPORT

C. O. Brandes, Export Manager.

BUD SPEAKER CO.

1112 Jackson Street, Toledo, Ohio—Microphones.

THE ALLEN D. CARDWELL MANUFACTURING CORP.

Factory and Sales Offices—81 Prospect Street, Brooklyn, N. Y.
Established 1920

PRODUCTS

Variable and Fixed (air and oil dielectric) Condensers for Receivers, Transmitters; Telegraph Equipment; Relays; Line-Voltage Regulators; Duralumin Work, Welding, Folding in all its branches.

EXECUTIVES

President.....Allen D. Cardwell
Sales Mgr.....C. M. Sherwood
Production Mgr.....William Smith
Chief Engineer....Allen D. Cardwell
Advertising Mgr.....C. M. Sherwood

EXPORT

Ad. Auriema, Inc., 116 Broad Street, New York, N. Y.

CARRIER MICROPHONE CO.

525 S. Commercial Street, Inglewood, Calif. Microphones.

CLOUGH-BRENGLE CO. (See page 32)

1134 W. Austin Ave., Chicago. Amplifiers, P-A Equipment.

S. H. COUCH CO., INC.

North Quincy, Mass. Amplifiers.

DOOLITTLE & FALKNOR

1306 W. 74th Street, Chicago, Ill. Frequency Monitors, B. C. Equipment.

EASTERN MIKE-STAND CO.

56 Christopher Avenue, Brooklyn, N. Y. Microphones and Stands.

EASTERN RADIO SPECIALTY CO.

1845 Broadway, New York City. Radio-Telephone Monitors.

ELECTRIC SPECIALTY CO.

Stamford, Conn. Dynamotor Power Supplies for Aircraft.

FEDERAL TELEGRAPH CO.

200 Mt. Pleasant Avenue, Newark, N. J. Transmitting Tubes.

FEDERATED PURCHASER

25 Park Place, New York City. P-A Equipment.

FOX SOUND EQUIPMENT CORP.

3120 Monroe Street, Toledo, Ohio.

PRODUCTS

Theatre Sound Equipment, Electrodynamic Units, Fox Aluminum Horns, Portable P-A Systems, Aircraft Equipment, High-Fidelity Theatre Reproducers, Special Apparatus.

EXECUTIVES

President.....John Kendricks
General Mgr.....Horace N. Rowe

EXPORT

Ad. Auriema, Inc.

Broadcasting and Public Address Equipment (Continued)

GATES RADIO & SUPPLY COMPANY
Main Office and Factory—Quincy, Illinois.

PRODUCTS

Broadcast Station Apparatus, Public-Address Equipment, Centralized Sound Apparatus, Talking Picture Equipment and other Apparatus in the Sound Communication Field.

EXECUTIVES

Gen. Mgr. & Chief Eng.....P. S. Gates
Asst. Eng. Charge Production..P. L. Tourney
Secretary.....C. B. Gates
Comptroller.....T. Otto

GENERAL ELECTRIC CO.
Schenectady, New York.

GENERAL RADIO COMPANY
30 State Street, Cambridge, Mass.

PRODUCTS

Radio and Electrical Laboratory Apparatus and Accessories.

EXECUTIVES

President.....Melville Eastham
Vice-President.....E. H. Locke
General Mgr.....H. H. Richmond
Sales Mgr.....C. T. Burke
Chief Engineer..Melville Eastham
Production Mgr.....E. H. Locke
Purchasing Agent.W. H. Sherwood
Advertising Mgr.....J. M. Clayton

BRANCH OFFICES OR REPRESENTATIVES

M. T. Smith, General Radio Co., 90 West St., New York City. The C. C. Langevin Company, 274 Brannan Street, San Francisco, Calif.

HAMMARLUND MANUFACTURING COMPANY, INC.
424 West 33rd Street, New York City.
Established for over a quarter of a century.

PRODUCTS

Midget condensers, Midline and Straight Line capacity types; dual Midget condensers, all types; transmitting condensers; standard Midline condensers; flexible couplings; short-wave and ultra-short-wave coil forms and kits; Isolantite sockets; tube shields; "air-tuned" I-F transformers and oscillator units; heavy duty transmitting chokes; high impedance and shielded R-F chokes; adjustable padding condensers. Midget trimming condensers and equalizers. Comet "Pro" Superheterodyne receivers for high frequency and all frequency coverage. Other special units are Western Union Call-boxes and other precision devices.

EXECUTIVES

President.....Oscar Hammarlund
Treasurer.....Joseph Lush
Sales Mgr..Lloyd A. Hammarlund
Asst. Sales Mgr.....A. E. Stevens
Production Mgr..H. B. Macartney
Chief Engineer.....D. K. Oram
Publicity Director...Lewis Winner

BRANCH OFFICES OR REPRESENTATIVES

1438 North 13th Street, Philadelphia, Pennsylvania.
55 Kilby Street, Boston, Massachusetts.
9 South Clinton Street, Chicago, Illinois.
159 East Elizabeth Street, Detroit, Michigan.
1400 West 25th Street, Cleveland, Ohio.
945 East Pico Street, Los Angeles, California.
1264 Folsom Street, San Francisco, California.
917 South West Oak Street, Portland, Oregon.
Box 4101, Station "A," Dallas, Texas.

EXPORT

Rocke International Co., 15 Laight Street, New York City.
White Radio Co., Canadian Representative, 41 West Avenue, North, Hamilton, Ontario, Canada.

HARVEY RADIO LABS.
12 Boylston St., Brookline, Mass. High-Frequency Equipment.

HEINTZ AND KAUFMAN, LTD.
311 California Street, San Francisco, California. Transmitting tubes.

INT'L BROADCASTING EQUIPMENT CO.
3112 W. 51st Street, Chicago, Ill. Frequency Monitors—Amplifiers.

THE INT'L DERICK & EQUIPMENT CO.
890 Michigan Ave., Columbus, Ohio. Radio Towers.

JENKINS & ADAIR, INC.
3333 Belmont Avenue, Chicago, Ill. Monitors—Microphones, etc.

KELLOGG SWITCHBOARD & SUPPLY CO.
1066 W. Adams Street, Chicago, Ill. Microphones.

KENYON TRANSFORMER CO., INC. (See page 32)
840 Barry St., New York City. Equalizers, Chokes, Etc.

LEAR DEVELOPMENTS, INC.
125 W. 17th St., New York City. Aircraft Equipment.

MACY ENGINEERING CO.
1452 39th St., Brooklyn, N. Y. Directional Baffles.

MEYER KOULISH CO., INC.
64 Fulton St., New York City. Recording Needles, Stylii.

MORLEN ELECTRIC CO.
100 Fifth Avenue, New York City.

PRODUCTS

Amplifiers and P-A Equipment.

MIRROR RECORDING CORP.
58 W. 25th Street, New York City. Aluminum Discs.

D. W. ONAN & SONS
503 Royalston Ave., Minneapolis, Minn. Power Plants.

OPERADIO MFG. CO.
St. Charles, Ill. Amplifiers—Sound Equipment.

PHILCO RADIO & TELEVISION CORP.
Philadelphia, Pa. Amplifiers, Sound Equipment.

B. A. PROCTOR CO., INC.
17 W. 60th Street, New York City. Recording Equipment.

PRESTO RECORDING CORP.
139 W. 19th Street, New York, N. Y.

PRODUCTS

Recording Equipment—Instantaneous. Amplifiers, Tuners, Playback Machines. Chemically Coated Disc for Instantaneous Recording.

EXECUTIVES

President.....Sol Sholes
Vice-President.....M. M. Gruber
Electrical Engineer..George Saliba
Advertising Mgr.....S. Sholes

EXPORT

W. J. Witte, 1878 Manuela Pedroza, Buenos Aires, Argentina.
Export inquiries direct to main office in New York City.

RACON ELECTRIC CO., INC. (See page 30)
52 E. 19th Street, New York City. P-A Equipment.

RADIO INSTRUMENT CO.
22 Wooster Street, New York City.

PRODUCTS

Oscilloscopes, Oscillators.

RADIO RECEPTOR CO., INC.
106 Seventh Avenue, New York City.

PRODUCTS

Microphones, P-A Equipment.

THE RADIART CORP.
Shaw Avenue, Cleveland, Ohio. Amplifiers.

RADIOTONE RECORDING COMPANY
6103 Melrose Ave., Hollywood, Calif.

PRODUCTS

Portable Recorders, Studio Recorders, Acetate Recording Discs, Cutting, Stylii and Reproducing Needles, Recording Amplifiers.

EXECUTIVES

President.....W. H. Snow
General Mgr.....F. H. Brown
Chief Engineer.....W. H. Snow
Production Mgr..C. E. Butterworth

EXPORT

Ad Auriema, Inc., 116 Broad Street, New York, N. Y.

RADIO TRANSCEIVER LABS.
86-27 115th Street, Richmond Hill, N. Y. Transceivers.

RAYTHEON PRODUCTION CORP.
DELTA DIVISION
Newton, Mass. Rectifiers.

RAWSON ELECTRICAL INSTRUMENT CO.
School Street, Cambridge, Mass. Meters.

RCA MANUFACTURING CO., INC. (See page 34)
RCA RADIOTRON DIVISION

RCA MANUFACTURING COMPANY, INC.
RCA VICTOR DIVISION
Camden, N. J.

PRODUCTS

Radio Receivers; Radio-Phonograph Combinations and Records. Sound Reinforcement and Centralized Sound Systems. Radio Communication Equipment for Naval, Merchant Marine, Commercial, Aviation and Police Service. Photophone Sound Motion Picture Equipment for Recording and Reproducing Portable and Stationary. Industrial and Laboratory Equipment. Radio Parts and Antenna systems; 16 millimeter Amateur Sound Movie Cameras; Portable Projection Equipment for Home and Industrial Use; Electrical Transcriptions for Broadcasting; Sound Trucks; Slide-Film Projectors; Multiple Antenna Systems for apartment houses, hotels and business buildings.

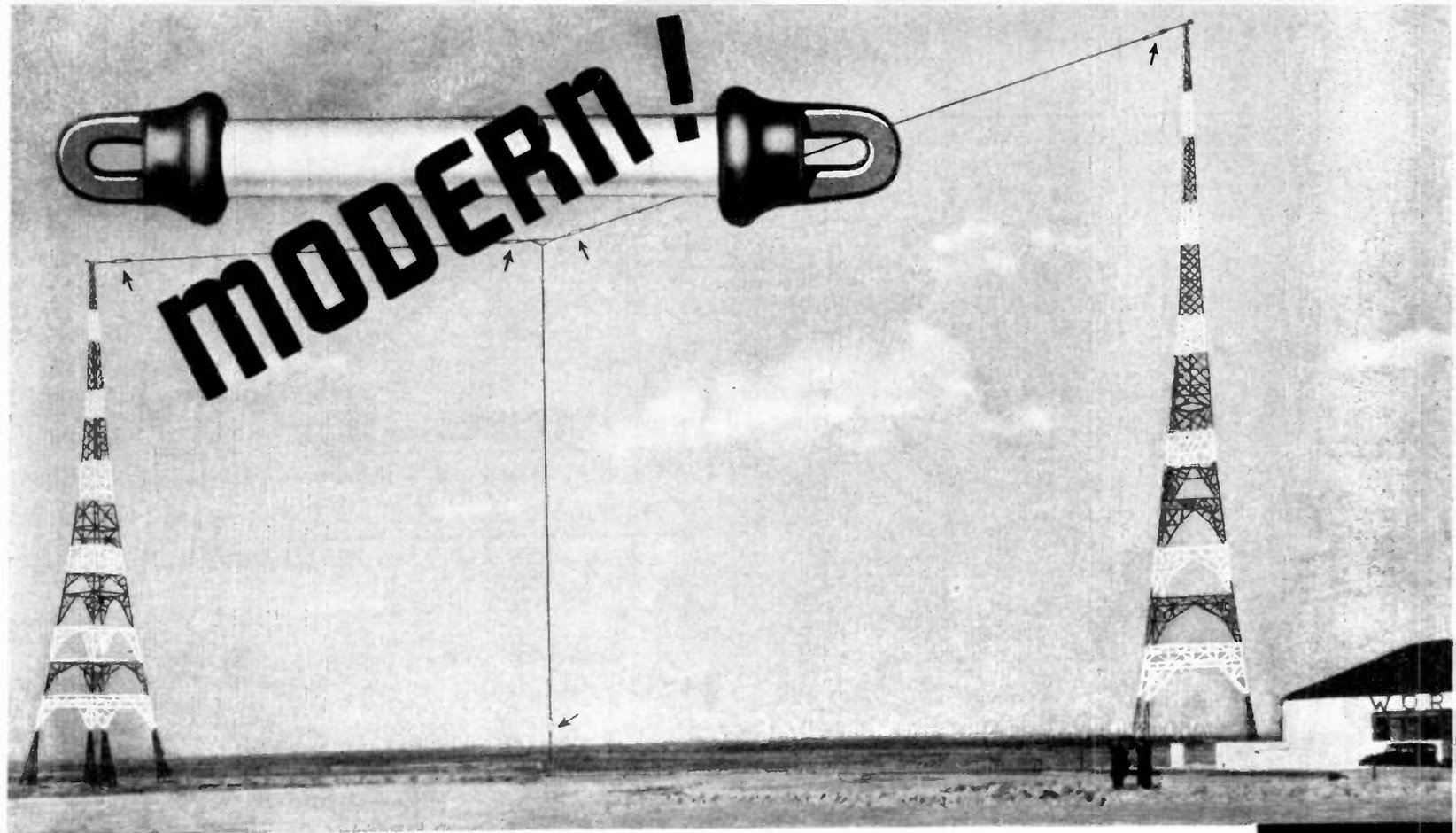
EXECUTIVES

Chairman.....David Sarnoff
President.....E. T. Cunningham
Executive Vice-President.
G. K. Throckmorton
Asst. to President.
G. K. Throckmorton
Vice-President in Charge of Engineering and Research.
Lewis M. Clement

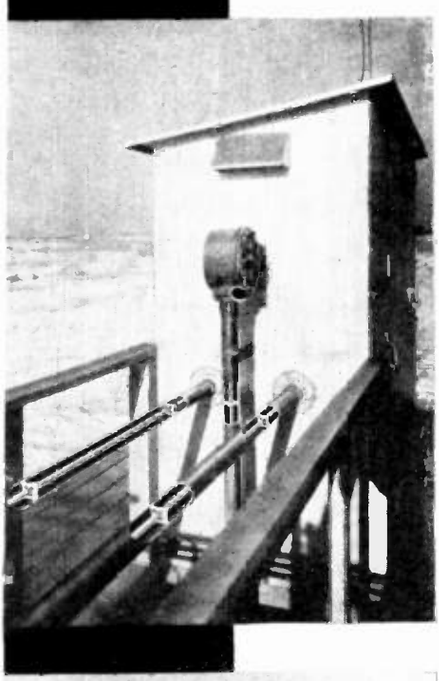
REMLER COMPANY, LTD.
2101 Bryant Street, San Francisco, Calif.
Transmitting Equipment—Microphones.

SCIENTIFIC RADIO SERVICE
124 Jackson Avenue, University Park, Hyattsville, Md. Crystals.

SHALLCROSS MFG. CO.
Collingdale, Pa.
Testing Equipment—Attenuators, Decades, etc.



Panorama of WOR 50KW Broadcast Station



ISOLANTITE PLAYS AN IMPORTANT ROLE IN THE MODERN BROADCAST TRANSMITTER

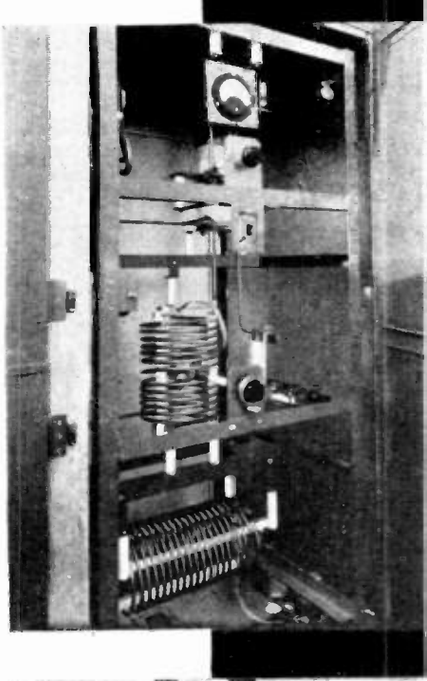
The 50KW Transmitter recently built by Western Electric for Station WOR employs ISOLANTITE liberally.

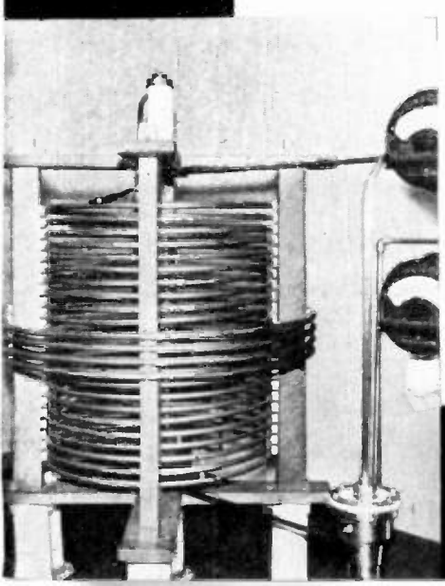
In this up-to-date station are strain insulators, concentric transmission line spacers and end seals, stand-offs, switches, shafts, inductance supports, power and rectifier tube supports, condenser cases, pedestals and many other parts of ISOLANTITE.

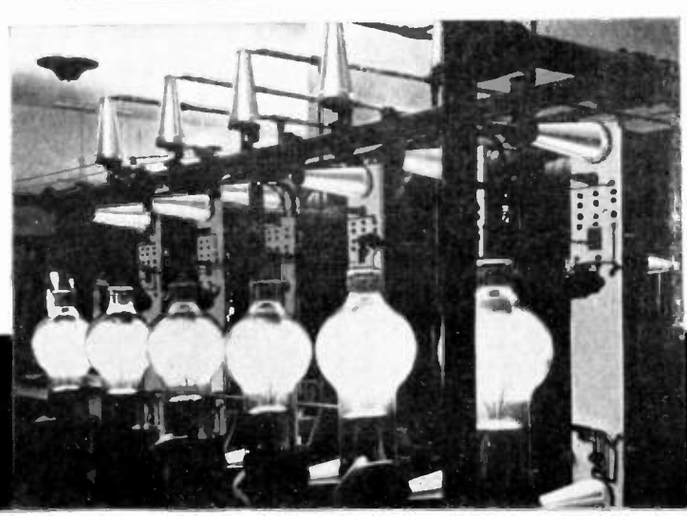
To improve your equipment, specify ISOLANTITE insulation. ***Isolantite Inc., 233 Broadway, New York, N. Y. Factory at Belleville, N. J.***

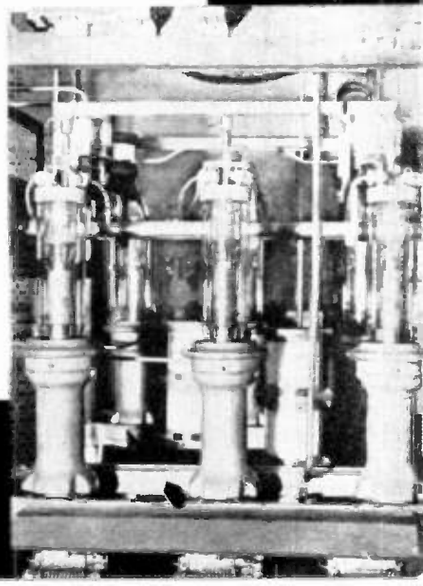
Represented by GRAYBAR ELECTRIC CO.

Isolantite
CERAMIC INSULATORS









Broadcasting and Public Address Equipment (Continued)

SHURE BROTHERS COMPANY
215 West Huron Street, Chicago, Illinois.

PRODUCTS

General Purpose Diaphragm and High-Fidelity (Wave-Equalized) Sound-Cell Type Crystal Microphones; General Purpose and High-Fidelity (Wave-Equalized) Condenser Microphones; Single- and Double-Button Carbon Microphones (Voice to High Quality types); Power Supplies; Pre-Amplifiers; Microphone Stands and Accessories; Mixing and Input Transformers; Microphone Cable.

EXECUTIVES

President.....S. N. Shure

BRANCH OFFICES OR REPRESENTATIVES

R. R. Bauman, 2168 Ann Arbor St., St. Paul, Minn.
W. T. Croysdill, 966 Lafayette Ave., Buffalo, N. Y.
Howard P. Hardnsty, 356 East Grand Blvd., Detroit, Mich.
R. C. James, c/o Northwestern Agencies, 3rd Ave. & Vine St., Seattle, Wash.
Leonard C. Kohn, 422 Wilkinson Bldg., Omaha, Nebraska.
S. K. MacDonald, 217 Riggs Bank Bldg., Washington, D. C.
H. B. Parke, 508 Third Ave., Pittsburgh, Pa.
F. Edwin Schmitt, 136 Liberty St., New York, N. Y.
O. H. Smith, 215 W. Huron St., Chicago, Ill.
J. A. Wherry, 424 Camp Street, New Orleans, La.
L. M. Wood, Wood & Anderson Co., 915 Olive St., St. Louis, Mo.
J. P. Kay, Kay Sales Co., 314 S. Cincinnati, Tulsa, Oklahoma.
Clawson, care Harry W. Gebhard, 55 Kilby St., Boston, Mass.
Henry W. Burwell, 393 Peachtree St., N. E., Atlanta, Ga.
C. H. Dolfuss, Jr., Film Exchange Bldg., 21st St. & Payne Ave., Cleveland, Ohio.
W. Bert Knight, 115 W. Venice Blvd., Los Angeles, Calif.
J. Earl Smith, P. O. Box 1805, Dallas, Texas.
A. C. Simmonds, 218-228 Front St., E., Toronto 2, Ontario, Canada.

EXPORT

Through own Export Department.

SOUND ENGINEERING CORP.
412 N. Leavitt Street, Chicago, Ill. Amplifiers.

SOUND SYSTEMS, INC.
1311 Terminal Tower, Cleveland, Ohio.

PRODUCTS

Amplifiers; Pre-Amplifiers; P. M. Speakers; Crystal Microphones; Automatic Turntables; Complete Sound Systems for schools, hospitals, and hotels; Portable Systems for all types of work; Aluminum Trumpets; Electro-Dynamic Units; Excitors.

EXECUTIVES

President.....Edward L. Gove
Vice-President.....C. A. Hyde
General Mgr.....K. J. Banfer
Sales Mgr.....P. R. Baus
Chief Engineer....E. K. Ackerman
Production Mgr.....A. Korb
Purchasing Agent....K. J. Banfer
Advertising Mgr.....P. R. Baus

BRANCH OFFICES OR REPRESENTATIVES

Wesley W. S. Scharp, 67 West 44th Street, New York City.
J. H. Southard, 420 Market Street, San Francisco, Calif.

EXPORT

C. O. Brandes, Export Manager, 5716 Euclid Ave., Cleveland, Ohio.

STROMBERG-CARLSON TEL. MFG. CO.
Rochester, New York. Sound Equipment—Amplifiers.

THOMASTON LABS., INC.
220 W. 42nd Street, New York City. Microphones.

TRUSCON STEEL CO.
Youngstown, Ohio. Radio Transmitting Towers.

TURNER COMPANY
700 3rd Avenue, Cedar Rapids, Iowa. Microphones.

UNITED ELECTRONICS CO.
42 Spring Street, Newark, N. J. Transmitting Tubes.

UNITED TRANSFORMER CORP. (See Page 32)
72-78 Spring Street, New York City.

UNIVERSAL MICROPHONE COMPANY, LTD.
424 Warren Lane, Inglewood, Calif.

PRODUCTS

Microphones—all types for broadcasting, amateur and sound uses.

EXECUTIVES

President.....James R. Fouch Advertising Mgr.....Ralph L. Power

THE WEBSTER COMPANY
3827 W. Lake Street, Chicago, Ill. Amplifiers.

WEBSTER ELECTRIC COMPANY
Racine, Wisconsin. Amplifiers, Pickups.

WESTERN ELECTRIC COMPANY, INC.
195 Broadway, New York City.

Founded in 1869. Since 1882 it has been the manufacturer of communication apparatus for the Bell Telephone System. Its research and engineering are conducted by the renowned Bell Telephone Laboratories. The Company has three principal manufacturing plants located at Chicago, Ill., Baltimore, Md., and Kearny, N. J.

PRODUCTS

Radio broadcasting transmitting equipment. Police radio-telephone transmitting equipment. Marine radio-telephone equipment. Aviation communication equipment. Point-to-point radio-telephone equipment. Speech input equipment. Microphones (carbon button, condenser, dynamic types). Vacuum tubes and photo-electric cells. Public address equipment. Music reproducing systems. Program distribution systems. Radio frequency distribution systems. Radio frequency monitoring equipment. Telephone systems, apparatus and cable. Railway Train Dispatching Equipment. Vacuum thermocouples, cathode ray oscillographs. Audiometers, hearing aids, electrical stethoscope. Talking picture equipment.

WESTINGHOUSE ELEC. & MFG. CO.
E. Pittsburgh, Pa. Broadcast Equipment.

WESTON ELEC. INST. CORP. (See page 34)
Newark, N. J. Meters.

WHOLESALE RADIO SERVICE CO.
100 Sixth Avenue, New York City. Amplifiers.

Coils and Coil Forms
Radio Frequency
(For Chokes, Speaker Coils, etc., see listings under Transformers)

ALADDIN RADIO INDUSTRIES, INC.
4049 Diversey Avenue, Chicago.

PRODUCTS

Radio Coils.

COILS, INC.
1229 Chapman Street, Providence, R. I.

ELECTRICAL WINDING CORP.
22-26 Wooster Street, New York City.

PRODUCTS

Radio Coils.

EXECUTIVE

President.....Benjamin Vilkemerson

FERROCART CORP.
1229 RCA Building, New York City.

GENERAL MANUFACTURING CO.
8066 S. Chicago Avenue, Chicago, Ill.

EDWIN I. GUTHMAN & CO., INC.
1036 W. Van Buren Street, Chicago, Ill.

PRODUCTS

Radio Coils, Chokes, Oscillators, I-F Transformers, R-F Amplifier and Antenna Coils.

EXECUTIVES

President.....Edwin I. Guthman
Vice-Pres.....Seymour Rothschild
General Mgr...Edwin I. Guthman
Sales Mgr.....B. J. Funk
Chief Engineer.....I. L. Glerum
Production Mgr.....W. Roberts
Purchasing Agent, Seymour Rothschild
Advertising Mgr.....J. B. Rubin

BRANCH OFFICES OR REPRESENTATIVES

P. Saftler, 27 Warren St., New York City, N. Y.
M. Friedman, 6030 Christian St., Philadelphia, Pa.
The Heimann Co., 2142 Berkeley St., St. Paul, Minn.
L. H. Jackman, 2043 E. 77th St., Cleveland, Ohio.
R. Smith, 912 Commerce St., Dallas, Texas.
G. O. Tanner, 600 Grant St., Pittsburgh, Pa.
R. A. Adams, 9440 Dexter St., Detroit, Mich.
Geo. D. Norris, 303 E. Pike St., Seattle, Wash.

EXPORT

M. Simons & Son Co., 25 Warren St., New York City, N. Y.

HAMMARLUND MFG. CO. (See page 24)
424 W. 33rd Street, New York City.

MEISSNER MFG. CO.
522 S. Clinton Street, Chicago, Ill.

SICKLES COMPANY
300 Main Street, Springfield, Mass.

PRODUCTS

Radio Coils.

BRANCH OFFICES OR REPRESENTATIVES

Edward Spiegler, 254 West 31st Street, New York, N. Y.
Harry Gerber, 94 Portland Street, Boston, Mass.
P. Mack, 1603 So. Michigan Ave., Chicago, Ill.
G. O. Tanner, 345 Fourth St., Pittsburgh, Pa.

UNIVERSAL WINDING CO.
Boston, Mass.

PRODUCTS

Coil Winding Machines.

EXECUTIVES

President.....R. A. Leeson
Vice-president.....E. O. Smith
Sales Mgr.....R. Leeson, Jr.
Purchasing Agent....F. C. Potter
Advertising Mgr...R. L. Chisholm

BRANCH OFFICES OR REPRESENTATIVES

Charlotte, N. C.
Atlanta, Ga.
Philadelphia, Pa.
New York City, N. Y.
Utica, N. Y.
Springfield, Mass.
Providence, R. I.

Condensers, Fixed. Dry Electrolytic, Wet Electrolytic, Mica and Paper

ACME WIRE COMPANY (See page 38)
New Haven, Connecticut. Paper Condensers and Condenser Parts.

AEROVOX CORPORATION
80 Washington Street, Brooklyn, N. Y.

PRODUCTS

All Types of Condensers.

CONDENSER CORP. OF AMERICA
259 Cornelison Avenue, Jersey City, N. J. All types.

CORNELL-DUBILIER CORP.
4377 Bronx Boulevard, New York City.

PRODUCTS

Oil Condensers; Mica Condensers; Dry Electrolytic Condensers; Wet Electrolytic Condensers; Power Factor Condensers; Paper Tubular Condensers; Paper Bypass Condensers; Paper Filter Condensers; Transmitting Condensers; Automobile Radio Condensers.

EXECUTIVES

President.....O. Blake — Sales Mgr.....L. Adelman
Vice-President.....Wm. Dubilier — Chief Engineer.....Wm. Bailey
General Mgr.....H. Beyer — Purchasing Agent.....J. Roth

BRANCH OFFICES OR REPRESENTATIVES

115 W. Venice Blvd., Los Angeles, Calif.
761 Cole St., San Francisco, Calif.
2319 Second Ave., Seattle, Washington.
2317 Calumet Ave., Chicago, Ill.
763 Tacoma Ave., Buffalo, N. Y.
31 Main Street, Cambridge, Mass.
220 Riggs Bank Bldg., Washington, D. C.
907 American Bank Bldg., Pittsburgh, Pa.
2126 Lee Road, Cleveland, Ohio.
2007 Calumet Ave., Toledo, Ohio.
Fourth and Keo Way, Des Moines, Iowa.
526 N. Vandeventer Ave., St. Louis, Mo.
316 Ninth Street, N. E., Atlanta, Ga.
918 Union Street, New Orleans, La.
137 S. Montclair St., Dallas, Texas.

EXPORT

Rocke International Electric Co., 15 Laight St., New York, N. Y.

CONTINENTAL CARBON, INC.
13912 Lorain Avenue, Cleveland, Ohio.

CURTIS CONDENSER CORP.
3088 W. 106th Street, Cleveland, Ohio.

PRODUCTS

Electrolytic Condensers for Radio, Telephone and Motor Starting purposes.

EXECUTIVES

President.....J. T. Curtis — Production Mgr.....Cecil Curtis
Purchasing Agent.....E. J. Weil

BRANCH OFFICES OR REPRESENTATIVES

J. J. Perlmuth, 225 E. Pico St., Los Angeles, Calif.
W. W. Boyd, 9 S. Clinton St., Chicago, Ill.
D. M. Kasson, 140 Washington St., New York, N. Y.

EXPORT

R. de Pasquale, 135 Liberty St., New York, N. Y.

DUMONT ELECTRIC CO., INC.
455 Broome Street, New York City.

MAGNAVOX CO., LTD.
2131 Bueter Road, Fort Wayne, Ind. All types.

P. R. MALLORY & CO.
3029 E. Washington Street, Indianapolis, Ind. All types.

MICAMOLD RADIO CORP.
1087 Flushing Avenue, Brooklyn, N. Y. All types.

THE MUTER COMPANY
1255 So. Michigan Avenue, Chicago, Illinois.

PRODUCTS

Candohm Armored Wire Wound Resistors for set manufacturers; Muter Certified Resistance Bridge; Interference Filters; Midget Knife Throw Switches; Resistance Indicator; Voltage Safety Regulator; 32-Volt "A" Battery Eliminator; Telaire Thermometer-Hygrometer.

EXECUTIVES

President.....Leslie F. Muter — Production Engineer.C. M. Kraemer
Vice President.....A. A. Dailey — Production Mgr..Joseph C. Nasturski
General Manager..Leslie F. Muter — Purchasing Agent.....A. A. Dailey
Sales Manager.....J. R. Scanlan — Advertising Mgr.....M. A. Berry
Research Engineer.....K. E. Rollefson

BRANCH OFFICES OR REPRESENTATIVES

L. Freed, 145 W. 45th Street, New York, N. Y.
F. W. Churchill, 923 Belmont Ave., Collingswood, N. J.
L. J. Smith, 425 E. Pico St., Los Angeles, Calif.

EXPORT

S. Ginsbury, 57A Blvd. Botanique, Brussels, Belgium.

SEVISON MAGNETO ENG. CO.
379-401 Phillips Avenue, Toledo, Ohio.

PRODUCTS

Small paper condensers.

SOLAR MFG. CORP.
599-601 Broadway, New York City.

PRODUCTS

Wet and Dry Electrolytic Condensers; Paper Condensers; Mica Condensers; Trimmer and Padding Condensers; Elim-O-Stats; Condenser Testers.

EXECUTIVES

President.....Otto Paschkes — Chief Engineer.....Paul Hetenyi
Vice-President.....Paul Hetenyi — Production Mgr.....J. A. Poitras
Sales Mgr.....W. C. Harter — Purchasing Agent...George Sexton
Advertising Mgr.....Sylvan Wolin

SPRAGUE SPECIALTIES CO.
No. Adams, Massachusetts. All types.

SANGAMO ELEC. CO.
Springfield, Illinois. Mica Condensers.

TOBE DEUTSCHMANN CORP.
Canton, Massachusetts. Paper Condensers, Filters, etc.

Condensers, Variable

ALLEN D. CARDWELL MFG. CO. (See page 23)
81 Prospect Street, Brooklyn, N. Y.

DEJUR-AMSCO CORP.
95 Morton Street, New York City.

GENERAL INSTRUMENT CO.
225 Varick Street, New York City.

GENERAL RADIO CO. (See page 24)
30 State Street, Cambridge A, Mass.

HAMMARLUND MFG. CO. (See page 24)
424 W. 33rd Street, New York City.

OAK MFG. CO.
711 W. Lake Street, Chicago, Ill.

PRECISE MFG. CO.
254 Mill Street, Rochester, N. Y.

RADIO CONDENSER CO.
Davis Street & Copewood Avenue, Camden, N. J.

RELIANCE DIE AND STAMPING CO.
1260 Clybourne Avenue, Chicago, Ill.

SCOVILL MFG. CO.
Waterbury, Conn.

UNITED SCIENTIFIC LABS.
510 Sixth Avenue, New York City.

Insulation, Molded and Laminated (Molding Powders)

BAKELITE CORPORATION
247 Park Avenue, New York, N. Y.

PRODUCTS

Plastic Materials, including Transparent Resins, Molding Materials, Laminating Materials, Baking Type Varnishes, Lacquers, Cements, and Enamels, Synthetic Resins for Air-Drying Finishes, Resinoids for Bonding Abrasive Products and for Waterproofing Fabrics.

BRANCH OFFICES OR REPRESENTATIVES

Main Office—247 Park Avenue, New York.
Research and Office—230 Grove Street, Bloomfield, N. J.
Plant and Office—River Road, Bound Brook, N. J.
Office—7016 Euclid Avenue, Cleveland, Ohio.
Office—43 East Ohio Street, Chicago, Illinois.
Office—410 Asylum Street, Hartford, Connecticut.

CONTINENTAL DIAMOND CO.
Newark, Delaware.

FORMICA INSULATION CO.
4614 Spring Grove Avenue, Cincinnati, Ohio.

GENERAL ELECTRIC CO.
Schenectady, New York (Textolite)

GENERAL PLASTICS, INC.
North Tonawanda, N. Y. Durez.

MICA INSULATOR CO.
200 Varick Street, New York, N. Y.

PRODUCTS

Built-Up Mica Plate (Micanite) for transformers and the like; Raw Mica, Fabricated Parts, such as Condenser Films, Tube Supports, etc.; Varnished Fabric and Paper; Varnished Cambric Tubing; Laminated Bakelite Sheets, Tubes, Rods and Fabricated Parts.

EXECUTIVES

President.....M. A. Chapman — Vice President.....C. H. Bell
Purchasing Agent.....Q. F. Jardine

BRANCH OFFICES OR REPRESENTATIVES

Mica Insulator Co., Sales and Executive offices, 200 Varick Street, New York, N. Y.
Mica Insulator Co., Branch Offices in Chicago and Cleveland.
Electric Specialty Co., San Francisco, Los Angeles, and Seattle.
Ebbert & Kirkman, Birmingham, Alabama.
New York Insulated Wire Co., Boston, Mass.
D. M. Fraser Co., Ltd., Toronto, and Montreal.

NAT'L VULCANIZED FIBRE CO.
Wilmington, Delaware.

Insulation, Molded and Laminated (Continued)

RESINOX CORPORATION
Sales Offices—Terre Haute, Indiana.

SYNTHANE CORPORATION
Oaks, Pa. (near Philadelphia)
Organized in 1928
New plant constructed and production started during March 1929.

PRODUCTS
Synthane Laminated Bakelite; Sheets; Rods; Tubes; Fabricated Parts; Silent Stabilized Gear Material; Synthane Radioform Tubing; Synthographic Process for making parts. The Synthane Corporation will furnish, or on demand fabricate, Laminated Bakelite for the following: Coil Forms for Broadcast and Short-Wave Coils; Coil Forms for Transformer Coils (power or audio); Terminal Strips for connection blocks; Plug Bases for Speaker Connections; Antenna Switch or Plug Plates with markings stamped or printed; Trimmer Condenser Bases; Fixed Condenser Bases; Strips for winding Resistance Coils; Panels and Subpanels; Insulating Washers and Bushings; Gears; Fuse Bases; Dial Light Mountings; Tuning Dials; Light Diffusing Discs; Plug and Pin Bases; Forms for Mounting R-F Choke Coils; Short-Wave Switch Stator and Rotor Mountings; 4-, 5-, 6-, 7-, and 8-Prong Tube Sockets; Loudspeaker Plug Sockets; Volume Control Strips for Resistance Coils; Insulated Arms; Bases for Volume or Tone Controls; Heat Resisting Bakelite Strips; Loudspeaker Coil Forms; Voice Coil Bobbins; Speaker Spiders; Terminal Strips; Field Coil Separators; Condenser Stator Brackets, Washers, Bases, Bakelite Tops, Insulating Washers for Metal-Tube Control Grid.

EXECUTIVES
President.....R. R. Titus
Vice-President and Secretary.....Jacob B. Rittenhouse
Chief Engineer.....S. W. Place

BRANCH OFFICES OR REPRESENTATIVES
Synthane Corporation is represented in all the principal cities in the country. Immediate and personal service on a national scale is a feature of this organization.

EXPORT
Export shipments largely to Europe and Asia are handled through the New York and San Francisco offices.

WESTINGHOUSE ELEC. & MFG. CO.
E. Pittsburgh, Pa. (Micarta)

WILMINGTON FIBRE CO.
Wilmington, Del.

Resistors, Controls and Rheostats
Fixed and Variable Resistances, Carbon and Wire-Wound-Volume and Tone Controls, Voltage Regulators, Suppressors, Etc.

AEROVOX CORP. (See page 27)
80 Washington St., Brooklyn, N. Y.

ALLEN-BRADLEY COMPANY
126 West Greenfield Avenue, Milwaukee, Wisconsin.

PRODUCTS
Fixed Radio Resistors, Spark Plug Suppressors, Bradleyometers, and other Variable Resistors, Filament Rheostats, Adjustable Grid Leaks, Relays, and a complete line of Industrial Electric Controlling Apparatus, such as Motor Starters, Controllers, Contactors, Relays, etc.

EXECUTIVES
President.....Lynde Bradley
Vice President...Harry L. Bradley
General & Sales Mgr..F. F. Loock
Chief Engineer.....G. O. Wilms
Purchasing Agent...Theron Childs
Production Mgr.....R. Whitmore
Advertising Mgr...A. H. Fensholt

BRANCH OFFICES
In all leading cities.

EXPORT
Rocke International Electric Corp.,
15 Laight Street, New York, N. Y

AMPERITE CORP. (See page 23)
561 Broadway, New York City.

CENTRALAB
900 East Keefe Avenue, Milwaukee, Wisconsin.

PRODUCTS
Variable Resistors and Fixed Resistors manufactured primarily for radio service. Power Rheostats.

EXECUTIVES
President.....E. R. Stoekle
Vice-President.....H. E. Osmun
General Mgr.....J. D. Wanuig
Sales Mgr.....H. E. Osmun
Advertising Mgr.....H. E. Osmun
Chief Engineer.....E. R. Stoekle
Production Mgr.....C. L. Nadon
Purchasing Agent.....A. C. Rohde

CLAROSTAT MANUFACTURING COMPANY
285 N. Sixth Street, Brooklyn, N. Y.
Established in 1928, succeeding the American Mechanical Labs.

PRODUCTS
Wire Wound Volume Controls, Potentiometers, Fixed Resistors, Ballast Resistors, Tone Controls, Hum Controls, Flexible Resistors, Noise Suppressors — Composition Element Volume Controls, Potentiometers, Tone Controls — Compression Type Rheostats — Fractional Horse Power Motor Speed Controls.

EXECUTIVES
President.....John J. Mucher
Controller.....Victor Mucher
Chief Engineer.....George Mucher
Production Mgr...Stephen Mucher

BRANCH OFFICES OR REPRESENTATIVES
L. G. Cushing Co., 9 S. Clinton Street, Chicago, Ill.
A. M. Baehr, 1400 W. 25th Street, Cleveland, Ohio.
B. L. Moore, 191 Starin Avenue, Buffalo, N. Y.
J. J. Perlmuth, 225 E. Pico Street, Los Angeles, Calif.
W. I. Otis, 905 Mission Street, San Francisco, Calif.
J. M. Cartwright, 1349 Vincon Avenue, Memphis, Tenn.

EXPORT
M. Simons & Son, 25 Warren Street, New York City.

CONTINENTAL CARBON, INC.
Lorain Avenue, Cleveland, Ohio. Resistors and Suppressors

CHICAGO TELEPHONE SUPPLY COMPANY
(H. H. Frost, Inc.—Sales Division)
1142-1228 W. Beardsley Avenue, Elkhart, Ind. Volume Controls.

ELECTRAD, INC.
175 Varick Street, New York City. Resistors, Suppressors and Controls.

ERIE RESISTOR CORPORATION
644 W. 12 Street, Erie, Pa.

PRODUCTS
Fixed and Variable Carbon Resistors, Molded Carbon Resistors and Molded Carbon Suppressor Resistors.

EXECUTIVES
President.....G. P. Fryling
Vice-President.....G. R. Fryling
Purchasing Agent....C. M. Emery
Chief Engineer.....B. B. Minuium
Sales Mgr.....W. H. Fryling
Production Mgr.....H. C. Sherk
General Manager.....H. C. Sherk

BRANCH OFFICES OR REPRESENTATIVES
W. S. Block, Jr., 15 E. 26th Street, New York City, N. Y.
E. F. Mills Co., 205 W. Wacker Drive, Chicago, Ill.

EXPORT
Erie Resistor of Canada, Ltd., 49 Bathurst Street, Toronto, Canada.
Erie Resistor, Ltd., Carlisle Road, London, England.

GLOBAR CORP.
Niagara Falls, New York.

HARDWICK, HINDLE, INC.
40 Hermon Street, Newark, N. J. Wire-wound.

INTERNATIONAL RESISTANCE CO.
2100 Arch Street, Philadelphia, Pa.

PRODUCTS
I.R.C. Fixed and Variable Resistors, I.R.C. Volume Controls and Potentiometers, I.R.C. Motor-Radio Suppressors, I.R.C. Precision Wire Wound Resistors, I.R.C. Heavy Duty Power Wire Wound Resistors, Metallized Resistors.

EXECUTIVES
President.....Ernest Searing
Vice-President.....Fred D. Williams
Sales Manager..Daniel J. Fairbanks
Chief Engineer.....Jesse Marsten
Production Mgr...M. W. Weiscopf
Purchasing Agt.....M. J. Bethany
Advertising Mgr.....Dan. J. Fairbanks

BRANCH OFFICES OR REPRESENTATIVES
Dallas, Texas.
Cleveland, Ohio.
Buffalo, New York.
Chicago, Illinois.
Detroit, Michigan.
Cedar Rapids, Iowa.
Boston, Mass.
Philadelphia, Pa.
San Francisco, Calif.
Denver, Colorado.
Portland, Oregon.
St. Louis, Missouri.
New Orleans, La.
Atlanta, Ga.
Kansas City, Mo.
New York City, N. Y.
Pittsburgh, Pa.

EXPORT
International Resistance Co., Ltd., Toronto, Canada.
International Resistance Co., London, England.
International Resistance Co., Copenhagen.
International Resistance Co., France.
International Resistance Co., Italy.
Other Offices in Australia, New Zealand, South America, Mexico and most countries.

LYNCH MANUFACTURING CO., INC.
405 Lexington Avenue, New York City.

P. R. MALLORY & CO. (Yaxley Div.)
3029 E. Washington Street, Indianapolis, Ind.

MICAMOLD RADIO CORP.
1087 Flushing Avenue, Brooklyn, N. Y.

THE MUTER CO. (See page 27)
1255 S. Michigan Avenue, Chicago, Ill.

OHIO CARBON COMPANY
12508 Berea Road, Cleveland, Ohio.

OHMITE MFG. CO.
627 N. Albany Avenue, Chicago, Ill.

PRECISION RESISTOR CO.
334 Badger Avenue, Newark, N. J.
(Continued on page 30)

Resistors, Controls, Rheostats, Etc. (Continued)

(*Continued from page 28*)

PRODUCTS

Wire-wound Resistors exclusively.

EXECUTIVES

Production Manager.....A. H. Melick

SHALLCROSS MFG. CO.

700 Parker Avenue, Collingdale, Pa. (Wire-wound).

SPEER RESISTOR CORP.

St. Marys, Pennsylvania

STACKPOLE CARBON CO.

Tannery Street, St. Marys, Pennsylvania.

PRODUCTS

Carbon Radio Resistors, Suppressors, Volume and Tone Controls. Carbon, Graphite and Metal Brushes for Motors, Generators, Slip-Rings, Magnetos and Distributors. Carbon, Copper-Graphite and Silver-Graphite Contacts. Welding and Battery Carbons, Graphite Anodes for Electrolytic Cells and Electrodes for Electric Furnaces. Carbon Crucibles and Carbon Specialties.

EXECUTIVES

President.....H. C. Stackpole
Chief Engineer.....J. V. Dobson
Vice President & Gen. Mgr., H. S. Conrad
Production Manager A. A. Haberberger
Sales Manager.....H. S. Conrad
Purchasing Agent.....L. F. Joyce

BRANCH OFFICES OR REPRESENTATIVES

Arthur C. Beckert, 1512 Durand Street, Saginaw, Michigan W. S.
J. R. Benge, Otis Bldg., Rm. 709, 16th and Sampson Streets, Philadelphia.
C. O. Benson, 1413 Dobson Street, Evanston, Ill.
Ingram Ferguson Co., 4452 Cass Avenue, Detroit, Mich.
A. T. Kelly, 522 Hyde Avenue, Ridgway, Pa.
Wm. C. Laing, 626 Broadway, Cincinnati, Ohio.
I. H. Lewis, 106 Orange Avenue, Cranford, N. J.
H. A. Merris, 19450 Shrewsbury Drive, Detroit, Mich.
G. W. Milld, 508 Broome Street, New York City.
Electrical Specialty Co., 1575 Folsom Street, San Francisco.
H. Weissinger, 1805 Spring Garden Street, Philadelphia, Pa.
Joseph Sprung, 225 Varick Street, New York City.
Electrical Specialty Co. of Southern Calif., Los Angeles.

SOLAR MFG. CORP. (See page 27)

599 Broadway, New York City.

TECH LABORATORIES

703 Newark Avenue, Jersey City, N. J. Resistors, Volume Controls.

S. S. WHITE DENTAL MFG. CO.

10 East 40th Street, New York City.

PRODUCTS

Molded Resistors; Flexible Shafting for Remote Controls.

WARD LEONARD ELECTRIC CO.

Mt. Vernon, New York.

WIRT COMPANY

5221 Greene Street, Philadelphia, Pa.

Sockets, Dials, Switches, Jacks, Plugs, Escutcheons, Nameplates, Binding Posts, Knobs, etc.

THE D. L. AULD COMPANY

5th Avenue and 5th Street, Columbus, Ohio

ALDEN MANUFACTURING CO.

Campello Station, Brockton, Mass.

BASTIAN BROS. CO.

1600 N. Clinton Avenue, Rochester, N. Y.

BEST MANUFACTURING CO.

1200 Grove Street, Irvington, N. J.

CINCH MANUFACTURING CORPORATION

2335 W. Van Buren Street, Chicago, Ill.

CROWE NAME PLATE & MFG. CO.

1749 Grace Street, Chicago, Illinois.

PRODUCTS

Tuning Units, Escutcheons (Embossed and Etched), Remote Controls (Auto Radio), Grills and Metal Trim for Cabinets, Dials and Scales. Nameplates (metal), Radio Cabinets (metal).

EXECUTIVES

President.....E. C. Coolidge
Purchasing Agent...G. C. Hass
Radio Sales Manager....Winslow C. Goodwin

THE H. H. EBY MFG. CO.

2066 Hunting Park Avenue, Philadelphia, Pa.

EDDIE MFG. CO.

9 W. Illinois Street, Chicago, Ill.

GENERAL RADIO CO. (See page 24)

30 State Street, Cambridge, A, Mass.

INSULINE CORP. OF AMERICA

23 Park Place, New York City.

PRODUCTS

Radio Parts—Sockets, Jacks, Phone Plugs, Short-Wave Coils, etc.

EXECUTIVES

President.....Samuel J. Spector
Production Mgr...B. Z. Moskowitz
Chief Engineer.....Alex G. Heller
Purchasing Agent....H. H. Smith
Advertising Mgr.....S. J. Spector

HOWARD B. JONES

2300 Wabansia Avenue, Chicago, Ill.

KAY PRODUCTS OF AMERICA, INC.

1036 Bedford Avenue, Brooklyn, N. Y.

PRODUCTS

Remote Controls and Dials for Auto Radio and Home Receivers.

EXECUTIVES

President.....J. Heller
Sales Mgr.....L. P. Karlin
General Mgr.....I. P. Karlin
Chief Engineer.....N. A. Karlin

P. R. MALLORY CO. (Yaxley Div.)

Indianapolis, Ind.

THE MUTER CO. (See page 27)

1255 S. Michigan Avenue, Chicago, Ill.

OAK MANUFACTURING CO.

711 W. Lake Street, Chicago, Ill.

SORENG-MANEGOLD CO.

1901 Claybourne Avenue, Chicago, Ill.

D. L. VAN LEUVEN

410 E. 15th Street, New York City. Meter Dial Scales.

Speakers and Headphones (Dynamics, Magnetic, Crystal Types)

BEST MANUFACTURING CO.

1200 Grove Street, Irvington, N. J.

BRUSH DEVELOPMENT CO.

E. 408 Perkins Avenue, Cleveland, Ohio

ALBERT W. FRANKLIN MFG. CORP.

137 Varick Street, New York, N. Y.

PRODUCTS

Sockets for all tubes; Switches; Terminal Insulation Strips.

EXECUTIVES

President.....Albert W. Franklin
Chief Engineer.....A. Bredesen
General Mgr.....A. W. Franklin
Production Mgr.....E. V. Gluck
Purchasing Agent.....M. R. Pearlman

EXPORT

Rocke International Electric Co., 15 Laight St., New York, N. Y.

C. F. CANNON CO.

Springwater, New York.

CHICAGO TEL. SUPPLY CO. (H. H. Frost, Inc.)

Elkhart, Indiana. Headphones.

ELECTROPHONE CORP.

Philadelphia, Pennsylvania.

JENSEN RADIO MFG. CO.

6601 S. Laramie Avenue, Chicago, Ill.

MAGNAVOX CO., LTD.

Fort Wayne, Indiana

MORLEN ELECTRIC CO. (See page 24)

100 Fifth Avenue, New York City.

OPERADIO MFG. CO.

13th & Indiana Street, St. Charles, Ill.

OXFORD RADIO CORPORATION

350 W. Huron St., Chicago, Illinois.

PRODUCTS

Electro-Dynamic and Magnetic Loudspeakers.

EXECUTIVES

President.....Paul H. Tartak
Ass't Sales Mgr..Jerome S. Gartner
General Manager..Paul H. Tartak
Purchasing Agt..Alexander M. Arnt

BRANCH OFFICES OR REPRESENTATIVES

W. S. Scharp, New York, N. Y.
Stanley Wallace, Lutz, Florida.
W. Pray, Boston, Mass.
R. I. Campion, Dallas, Texas.
R. W. Mitscher, Buffalo, N. Y.
J. P. Kay, Tulsa, Oklahoma.
L. H. Jackman, Cleveland, Ohio.
I. I. Aaron, Milwaukee, Wis.
J. O. Olsen, Pittsburgh, Pa.
L. E. Jacques, University City, Mo.
Martin Friedman, Philadelphia, Pa.
R. C. Merchant, Detroit, Mich.
Don H. Burcham, Portland, Ore.
Southern Sellers, New Orleans, La.

PHILCO RADIO & TEL. CORP.

Philadelphia, Pennsylvania.

RCA MFG. CO. (See page 24)

Camden, New Jersey.

RACON ELEC. CO., INC.

52 East 19th Street, New York City.

(*Continued on page 32*)

Speakers and Headphones (Continued)

(*Continued from page 30*)

PRODUCTS

Loudspeaker Horns, Electro-dynamic Horn Units, Dynamic Cone Speakers, Public-Address Equipment.

EXECUTIVES

President.....A. I. Abrahams
Sales Mgr.....C. J. Brown
Chief Engineer....A. I. Abrahams
General Mgr.....Samuel Davis
Production Mgr.....S. Davis
Purchasing Agent.A. I. Abrahams
Advertising Mgr.....C. J. Brown

BRANCH OFFICES OR REPRESENTATIVES

Philadelphia, Pa.
Boston, Mass.
Tampa, Florida.
Louisville, Ky.
St. Paul, Minn.
Los Angeles, Calif.
San Francisco, Calif.
Denver, Colo.
Seattle, Wash.
Chicago, Ill.
Saginaw, Mich.
St. Louis, Mo.
Buffalo, N. Y.

THE ROLA COMPANY

2530 Superior Avenue, Cleveland, Ohio.

PRODUCTS

Loudspeakers for all kinds of receiving sets and public-address equipment.

EXECUTIVES

President.....B. A. Engholm
Vice-President.....H. S. Tenny
Sales Mgr.....L. Golder
Chief Engineer.....B. A. Engholm
Purchasing Agent.....K. Phillips

BRANCH OFFICES OR REPRESENTATIVES

205 East 42nd Street, New York, N. Y.

EXPORT

Ad Auriema, Inc., 116 Broad Street, New York, N. Y.

STROMBERG-CARLSON TEL. MFG. CO.

Rochester, New York.

TRIMM RADIO MFG. CO.

1528 Armitage Avenue, Chicago, Ill. Headphones only.

UNITED PRESSED PRODUCTS CO.

407 S. Aberdeen Street, Chicago, Ill.

PRODUCTS

Pressed and Moulded Forms and Foundations in Paper—Cloth—Composition—Speaker Diaphragms.

EXECUTIVES

President.....Harry Raffles
Vice-President.....Frank Raffles
Chief Engineer.....Frank Raffles
Production Mgr.....Frank Raffles
Sales Manager.....Frank Raffles

EXPORT

The M. Simons & Sons, 25 Warren St., New York, N. Y.

UTAH RADIO PRODUCTS CO.

820 Orleans Street, Chicago, Ill.

VICTORY SPEAKERS, INC.

7131 East 14th Street, Oakland, Calif.

VOICE OF THE AIR CO.

730 Phillips Avenue, Toledo, Ohio.

PRODUCTS

Speaker Units and Trumpets.

WESTERN ELECTRIC CO. (See page 26)

195 Broadway, New York City.

WRIGHT-DE COSTER, INC.

2253 University, St. Paul, Minnesota.

Transformers and Chokes (Speaker Coils)

THE ACME ELEC. & MFG. CO.

1440 Hamilton Avenue, Cleveland, Ohio.

PRODUCTS

Radio Transformers; Neon Transformers; Television Transformers, Voltage Adjustors; Industrial Transformers.

EXECUTIVES

President.....G. R. Hillstrom
Vice-President.....J. A. Comstock
Purchasing Agent..J. A. Comstock
Sales Manager.....C. H. Bunch
Chief Engineer....J. A. Comstock
Production Mgr.....Wm. Raden

BRANCH OFFICES OR REPRESENTATIVES

Adolph Friedman, 220 E. 23rd St., New York, N. Y.

ALLOY TRANSFORMER COMPANY

135 Liberty Street, New York City, New York.

PRODUCTS

Audio Transformers, Power Transformers, Audio and Power Chokes, Equalizers, Castings, Laminations.

EXECUTIVES

President.....Leon J. Littmann
Sales Mgr.....James R. Long

AMERICAN TRANSFORMER CO. (See page 23)

175 Emmet Street, Newark, N. J.

CHICAGO TRANSFORMER CORP.

2626 W. Washington Boulevard, Chicago, Ill.

DONGAN ELECTRIC MFG. COMPANY

2987-3001 Franklin Street, Detroit, Michigan.

GENERAL TRANSFORMER CORP.

5025 S. Throop Street, Chicago, Ill.

THE HALLDORSON COMPANY

4500 Ravenswood Avenue, Chicago, Ill.

JEFFERSON ELECTRIC CO.

Bellwood, Illinois.

KENYON TRANSFORMER CO., INC.

840 Barry Street, New York, N. Y.

PRODUCTS

Chokes, Equalizers, Transformers and Reactors.

RCA MFG. CO., INC. (See page 24)

Camden, New Jersey.

THE RADIART CORPORATION

Shaw Avenue at 133rd Street, Cleveland, Ohio.

STANDARD TRANSFORMER CORP.

866 Blackhawk Street, Chicago, Ill.

THORDARSON ELEC. MFG. CO.

500 W. Huron Street, Chicago, Ill.

UNITED TRANSFORMER CORP.

72-78 Spring Street, New York City.

PRODUCTS

Specialty Transformers for rectifiers, battery chargers, medical instruments, lighting and signalling circuits, instruments; Dry and Oil Type Power Transformers; all grades and types Audio Transformers; Reactors; Voltage Regulators; Filters; Rectifiers; Amplifiers; Power Amplifier Kits.

EXECUTIVES

President.....I. A. Mitchell
Vice President.....S. L. Baraf

BRANCH OFFICES OR REPRESENTATIVES

Seattle, Wash.—Third Ave. at Vine St.
Boston, Mass.—94 Portland St.
St. Louis, Mo.—3800 North Grand Boulevard.
Atlanta, Ga.—316 Ninth St. N.E.
Pittsburgh, Pa.—600 Grant St.
Saginaw, Mich.—2021 Stark St.
Los Angeles, Calif.—1341 S. Hope St.
Cleveland, Ohio—2015 E. 65th St.
Dallas, Texas—2201 Laws St.
Louisville, Ky.—4107 River Park Drive.
Syracuse, N. Y.—Hotel Hilton, Segar.

Testing Instruments (For Manufacturing, Broadcasting, Service and Laboratory)

APPARATUS DESIGN CO.

Little Rock, Arkansas. Tube Testers.

ALLEN B. DU MONT LABORATORIES

542 Valley Road, Upper Montclair, N. J.

PRODUCTS

Cathode-Ray Tubes and Oscillographs, Cathode-Ray Modulation Indicators, Power Supplies, Sweep Circuits, Mercury-Vapor Discharge Tubes, and All Accessories Pertaining to Cathode-Ray Tubes and Oscillographs.

EXECUTIVES

President.....Allen B. Du Mont
Sales Manager.....H. C. Holmes

BOONTON RADIO CORP.

Boonton, N. J. Q-Meters, Etc.

BUD RADIO, INC.

1937 E. 55th Street, Cleveland, Ohio. Test Leads.

BURTON ROGERS CO.

755 Boylston Street, Boston, Mass. Oscillators, Etc.

CLOUGH-BRENGLE CO.

1134 West Austin Avenue, Chicago, Illinois.

PRODUCTS

Laboratory and Test Equipment; Radio Service Equipment; Radio-Frequency and Audio-Frequency Oscillators; Cathode-Ray Equipment; Public-Address and Theatre Amplifiers.

BRANCH OFFICES OR REPRESENTATIVES

R. A. Adams, 9440 Dexter Ave., Detroit, Mich.
Howard P. Allen, 704 Lincoln Avenue, Bellevue, Pa.
R. L. Cooper, 3916 Morrell Ave., Kansas City, Mo.
W. T. Croysdill, 966 Lafayette Ave., Buffalo, N. Y.
M. A. Dobbin, 407 Postal Building, Portland, Ore.
I. M. Forshay, 27 Park Place, New York, N. Y.
R. J. H. Gregory, 1209 Greenfield Ave., Nashville, Tenn.
W. B. Knight, 113 W. Venice Blvd., Los Angeles, Calif.
R. Hines, 761 Cole Street, San Francisco, Calif.
I. U. McCarthy, 2424 Bever Ave., Cedar Rapids, Iowa.
Mountain States Sales Co., 2610 Dexter St., Denver, Colo.
Murphy & Cota, 289 Peachtree St., Atlanta, Ga.
E. P. Scott, 3277 DeSota Ave., Cleveland, Ohio.

(*Continued on page 34*)

Testing Instruments (Continued)

(Continued from page 32)

J. E. Smith, P. O. Box 1805, Dallas, Texas.
Trade Contract Corp., 25 Huntington Ave., Boston, Mass.

EXPORT

J. Koelig, Jr., P. O. Box 2113, Havana, Cuba.
Frazer & Co., Ltd., 7 Front St., San Francisco, Calif.
S. Ginsbury, 57A Blvd. Bontanique, Brussels, Belgium.
F. M. Neckrock, 56 Woodleigh Ave., Hamilton, Ontario, Canada.
Pan-American Trading Co., 25 S. William St., New York, N. Y.
Taylor & Pearson, Ltd., Edmonton, Alberta, Canada.
Lincoln Export Co., 41 Water St., New York, N. Y.

FERRIS INSTRUMENT CORP.
Fairview Avenue, Boonton, N. J. Micro-Volters.

GENERAL ELECTRIC CO.
Schenectady, New York. Meters.

GENERAL RADIO CO. (See page 24)
30 State Street, Cambridge, A, Mass.

HICKOK ELEC. INST. CO.
10512 DuPont Avenue, Cleveland, Ohio. Tube Testers.

INTERNATIONAL RESISTANCE CO. (See page 28)
Philadelphia, Pa. Volt-Ohmmeters.

JACKSON ELECTRICAL INST. CO.
430 Kiser Street, Dayton, Ohio. Tube Tester, Etc.

KALTMAN & ROMANDER
62 Court Street, Newark, N. J. Cathode-Ray Oscilloscopes.

LAMPKIN LABORATORIES
Bradenton, Florida. Monitors.

L. & L. ELECTRIC CO.
336 Madison Avenue, Memphis, Tenn. Tube Testers. Etc.

PREMIER CRYSTAL LABS., INC.
55 Park Row, New York City. Impedance Measuring Devices.

RCA MFG. CO. (See page 24)
Camden, New Jersey.

RADIO CITY PRODUCTS CO.
28-30 W. Broadway, New York, N. Y. Radio Testing Equipment.

RADIO CONSTRUCTORS LABS.
136 Liberty Street, New York City. Signal Generators.

RADIO DEVICE MFG CO.
142 Washington Street, New York City. Condenser Testers.

RADIO INSTRUMENTS CO.
22-26 Wooster Street, New York City.

PRODUCTS
Cathode-Ray Oscilloscopes, Oscillators.

RADIO PRODUCTS CO.
145 Sunrise Place, Dayton, Ohio. Tube Testers.

RADIO RESEARCH CO., INC.
9th & Kearny Streets, N. E., Washington, D. C.
Special Instruments to Order.

RAWSON ELEC. INST. CO.
90 Windsor Street, Cambridge, Mass.
Voltmeters. Electrical Measuring Instruments, Thermocouples, etc.

READRITE METER WORKS
177 College Avenue, Bluffton, Ohio. Meters.

SHALLCROSS MFG. CO.
Collingdale, Pa. Wheatsone Bridge—Decades. Etc.

SUPREME INSTRUMENTS CORP.
Greenwood, Mississippi. Tube Testers.

THE TEST-RACK CO.
2035 E. 96th Street, Cleveland, Ohio. Test Racks.

THE TRIPLETT ELECTRICAL INST. CO.
49 Main Street, Bluffton, Ohio. Tube Testers, etc.

TRIUMPH MFG. CO.
4017 W. Lake Street, Chicago. Tube Testers.

WESTERN ELECTRIC CO. (See page 26)
195 Broadway, New York City.

WESTINGHOUSE ELEC. AND MFG. CO.
East Pittsburgh, Pa. Meters.

WESTON ELECTRICAL INSTRUMENT CORP.
614 Frelinghuysen Avenue, Newark, N. J.
(Established in 1888)

PRODUCTS
Electrical Measuring Instruments of all types and for all classes of service and "Photronic" Photoelectric Cell.

EXECUTIVES

President.....Edward F. Weston
Vice-President.....Caxton Brown
Sales Manager
H. Leigh Gerstenberger
Advertising Manager....Sidney Cassey
Chief Electrical Engineer
W. N. Goodwin, Jr.
Production Manager...R. R. Lambe
Purchasing Agent.....A. R. Briggs

BRANCH OFFICES OR REPRESENTATIVES
In all principal cities.

EXPORT
In all principal cities in all foreign countries.

Tubes—Receiving and Transmitting Photo Cells—Cathode Ray Tubes

ARCTURUS RADIO TUBE COMPANY
Newark, New Jersey

CHAMPION RADIO WORKS, INC.
90 Holten Street, Danvers, Mass.

HERMAN A. DEVRY, INC.
37 E. Wacker Drive, Chicago, Ill.

ALLEN B. DU MONT LABORATORIES (See page 32)
9 Bradford Way, Upper Montclair, N. J.

FEDERAL TELEGRAPH COMPANY, INC.
200 Mt. Pleasant Avenue, Newark, N. J.

G-M LABORATORIES, INC.
1731 Belmont Avenue, Chicago, Ill. Photo-cells.

GENERAL ELECTRIC CO.
Schenectady, New York.

GENERAL SCIENTIFIC CO.
4828 S. Kedzie Avenue, Chicago, Ill. Photo-cells.

GOLD SEAL MANUFACTURING CO., INC.
127 S. 15th Street, Newark, N. J.

HEINTZ AND KAUFMAN, LTD.
311 California Street, San Francisco.

HYGRADE SYLVANIA CORPORATION
500 Fifth Avenue, New York City.

PRODUCTS
Receiving Tubes of all Types, Incandescent Lamps.

EXECUTIVES

President.....B. G. Erskine
Chairman of the Board..E. J. Poor
Vice-President in Charge of Manufacturing.....W. E. Poor
Sales Manager (Jobber-Dealer Sales) Receiving Tubes and Incandescent Lamps..S. N. Abbott
Sales Supervisor.....C. G. Pyle
Advertising Manager, (Tubes) P. S. Ellison
Advertising Manager (Lamps) R. A. Poor
Export Manager....W. A. Coogan
Manager Equipment Sales C. W. Shaw
Chief Tube Egr.....R. M. Wise

BRANCH OFFICES OR REPRESENTATIVES
Plants located at Emporium, Pennsylvania, Salem, Massachusetts, St. Marys, Pennsylvania.
Offices located at Emporium, Pennsylvania; 500 Fifth Avenue, New York City; 10 Post Office Square, Boston, Massachusetts; 520 N. Michigan Ave., Chicago, Illinois, and 3440 South Hill Street, Los Angeles, California.

HYTRON CORP.
Salem, Mass.

THE KEN-RAD CORPORATION
Owensboro, Kentucky.

PRODUCTS
Radio Receiving Tubes; Incandescent Electric Lamps.

EXECUTIVES

President.....T. E. Sandridge
Exec. Vice-President..Roy Burlew
Vice-Pres. & Gen. Mgr., C. J. Hollatz
Chief Engineer.....G. W. Bain
Works Manager....H. S. Dunning
Purchasing Agent...C. G. Johnson
Sales Mgr.....C. C. Mathews

EXPORT
Leonard L. Minthorne Co., 116 Broad St., New York, N. Y.

NATIONAL UNION RADIO CORP.
570 Lexington Avenue, N. Y. C.

RCA MANUFACTURING COMPANY, INC.
RCA RADIOTRON DIVISION
Harrison, N. J.

PRODUCTS
RCA Radio Tubes of Glass and Sealed-in-Steel All-Metal Types, Transmitting Tubes, Cathode-Ray Tubes, and Amateur Radio Tubes.

EXECUTIVES

Chairman of the Board David Sarnoff
President.....E. T. Cunningham
Executive Vice President G. K. Throckmorton
Vice President & General Mgr., J. C. Warner
Asst. to President on Sales Judson S. Sayre

RCA MFG. CO., INC. (See page 24)
Camden, New Jersey.

RAYTHEON PRODUCTION CORP.
30 E. 42nd Street, N. Y. C.

TELEPHOTO & TELEVISION CORP.
133 W. 19th Street, N. Y. C.

TRIAD MANUFACTURING CO., InNC.
Pawtucket, Rhode Island.

TUNG-SOL RADIO TUBES, INC.
95 Eighth Avenue, Newark, N. J.

UNITED ELECTRONICS CO.
42 Spring Street, Newark, N. J.

WESTINGHOUSE ELEC. & MFG. CO.
E. Pittsburgh, Pa.

WESTERN ELECTRIC CO. (See page 26)
195 Broadway, N. Y. C.

Tube Machinery

CENTRAL SCIENTIFIC CO.
460 E. Ohio Street, Chicago, Ill.

EISLER ENGINEERING CO.
740-770 South 13th Street, Newark, N. J.

PRODUCTS

Incandescent Lamp Machinery, Radio Tube Machinery, Radio Tube Parts, Neon Tube Machinery, Neon Tube Parts and Supplies, Laboratory Equipment, Glass Working Machinery, High-Vacuum Pumps, Electric Spot Welding Machines, Oil Burners, Gas Burners, Oxygen Burners, Butt Welding Machines, Air Pressure Blowers, Ampule Exhaust Machines, Bombarders, Blast Torches, Carbonizing Machines, Electric Furnaces, Frosting Machines, Gas Boosters and Regulators, Glass Apparatus, Gas Purifiers, Motorized Drives, Hooks of all kinds, Nickel Tubes, Leadwires, Copper Clad Wire, Tungsten Wire, Wire Drawing Machines, Wire Cutting Machines, Wire Welding Machines, etc.

EXECUTIVES

President.....Charles Eisler
Chief Engineer.....Charles Eisler
Vice-President.....J. A. Morick
Purchasing Agent....J. A. Morick

THE ENGINEERING CO.
57-59 Branford Street, Newark, N. J.

PRODUCTS

All types Aluminum-Brass Bases and Caps. Combination Tungsten Welds. Products for Electronic Tubes.

INT'L MACHINE WORKS, INC.
927 Van Wagenen Place, N. Bergen, N. J.

KAHLE ENGINEERING CO.
320 Manhattan Avenue, Union City, N. J.

LEPEL HIGH FREQUENCY LABS.
39 W. 60th Street, N. Y. C.

PRODUCTS

Bombarding Apparatus, High-Frequency Coils, High-Frequency Induction Furnaces.

EXECUTIVES

President.....E. Von Lepel
Vice-President.....A. Von Lepel
General Mgr.....E. R. Capita

Tube Parts and Materials (including Wire)

THE AMERICAN BRASS COMPANY
(Waterbury Brass Good Branch)
26 Crane Street, Waterbury, Conn.

PRODUCTS

Eyelets; Radio Base Pins; Screen Grid Caps; Grommets; Soldering Terminals; Cups and Shells; Blanks and Stampings; Washers; Rivets; "Holtite" Brazing Solder.

EXECUTIVES

Vice President.....H. W. Coe
Manager.....A. W. Miner
Sales Manager.....A. L. Davis

BRANCH OFFICES OR REPRESENTATIVES

25 Broadway, New York, N. Y.
1326 West Washington Blvd., Chicago, Ill.
131 Dorrance Street, Providence, R. I.
803 Architects Building, Philadelphia, Pa.
925 Euclid Ave., Cleveland, Ohio.

AMERICAN ELECTRO METAL CORP.
Lisbon St., Lewiston, Maine.

PRODUCTS

Molybdenum and Molybdenum Tungsten Alloys in all forms—Grid Wire, Support Wire, Furnace Wire, Molybdenum Contact Rods.

EXECUTIVES

President....Dr. Paul Schwarzkopf
Vice-President.....Rudolf Lowit
General Mgr.....Rudolf Lowit

EXPORT

N. V. Molybdenum Co., Amsterdam, Holland.
Deutsche Gluehfadenfabrik, Berlin, Germany.
Metallwerk Plansee Ges.m.b.H., Reutte, Austria.
Technisches Bureau Willi Schwarzkopf, Vienna, Austria.

AMERICAN LAVA CORPORATION
1411 Williams Street, Chattanooga, Tennessee.
Established 1903.

PRODUCTS

Insulating parts for receiving tubes and broadcasting tubes. For these parts, specially treated Lava, Magnesia and Alumina, form the raw materials. Also a new ceramic insulating body to which through derivation from its constituent materials, is given the name of "Alsimag." "Alsimag" combines high dielectric strength with a low loss factor and unusual mechanical strength, while porosity tests show only 0.02 per cent absorption by weight. The coefficient of expansion at 900° C. has tested as low as 2.93 x 10—⁶. In practice "Alsimag" is being used advantageously, not only in highly specialized applications, but in all ordinary appliance work where it insures against current leakage.

EXECUTIVES

President.....Paul J. Kruesi
Production Mgr..Harold R. Smartt
Vice-President.Warren A. Jeffords
Advertising Mgr.....G. E. Richter
Sales Manager.....Gus E. Richter
Chief Engineer..Frank J. Stevens
Research Engineer.....Hans Thurnauer

BRANCH OFFICES OR REPRESENTATIVES

J. F. Morse, 80 Federal St., Rm. 223, Boston, Mass.
C. H. Carey, 1112 Merchandise Mart, Chicago, Ill.
C. E. Wistar, Newman Stearns Bldg., Cleveland, Ohio.
J. H. Mills, Globe Indemnity Bldg., Newark, N. J.
R. H. Geiser, 1123-29 Washington Ave., St. Louis, Mo.
A. P. Bartley, 163 Second St., San Francisco, Calif.
H. S. Glasby, 1107 Real Estate Trust Bldg., Philadelphia, Pa.

ART WIRE & STAMPING CO.
16 Boyden Place, Newark, N. J.

CALLITE PRODUCTS CO.
540 39th Street, Union City, N. J.

PRODUCTS

Tungsten and Molybdenum Products in shape of rods, sheet and wire filament; Tungsten and Refractory Contacts; Radio Products, Refractory Carbide Tools and Dies; Lead-in wire, Kulgrid wire, etc.

EXECUTIVES

President.....C. A. Laise
Chief Engineer.....G. Wheeler
Vice-President.....C. H. Kratt
Production Manager....M. A. Fox
General Manager.....C. A. Laise
Purchasing Agent.....Geo. Dewey
Sales Manager.....J. Kurtz
Advertising Manager....J. Storrs

EXPORT

R. G. McLeod, London, England.
Guilden Shokai, Tokyo, Japan.
Carl Bondy & Co., Vienna, Austria.

CLEVELAND WIRE CLOTH & MFG. CO.
3573 E. 78th Street, Cleveland, Ohio.

HENRY L. CROWLEY & COMPANY, INC.
1 Central Avenue, West Orange, N. J.

DRIVER-HARRIS COMPANY
Harrison, New Jersey. Alloy wires.

FANSTEEL PRODUCTS COMPANY, INC.
46 West 22nd Street, North Chicago, Illinois.

WILBUR B. DRIVER CO.
Newark, N. J.

GOAT RADIO TUBE PARTS, INC.
314 Dean Street, Brooklyn, N. Y.

PRODUCTS

Radio Tube Parts, Radio Tube Shields.

EXECUTIVES

President.....Walter Goat
Sales Mgr.....E. F. Staver
Vice-President....J. N. Mortensen
General Mgr....Edward F. Staver

BRANCH OFFICES OR REPRESENTATIVES

Fred Garner, 43 East Ohio Street, Chicago, Ill.
Frank Emmet Co., 200 N. Edgemont Ave., Los Angeles, Calif.

KING LABORATORIES, INC.
237 W. Division Street, Syracuse, N. Y.

NEWARK WIRE CLOTH COMPANY
351 Verona Avenue, Newark, N. J.

PEQUOT WIRE CLOTH CO., INC.
S. Norwalk, Connecticut.

GEORGE W. PRENTISS & COMPANY
439 Dwight Street, Holyoke, Massachusetts.

STUPAKOFF LABS., INC.
6617 Hamilton Avenue, Pittsburgh, Pa.

PRODUCTS

Filament Insulating Material; Insulated Filament Wires; Folded Filaments to Specifications; Rods, Single and Multiple Hole Cathode Insulators, Ceramic Spacers for Receiving and Power Tubes; Radio Set Insulators; Refractory Oxides; Conductive Ceramics; Thermocouple and Electric Appliance Insulators.

EXECUTIVES

President.....Semon H. Stupakoff
Vice-President.....G. S. Friesell
Sales Manager.....R. R. Sloan

BRANCH OFFICES OR REPRESENTATIVES

H. H. Reynolds—New England.

EXPORT

England, France, Italy, Germany

SUMMERILL TUBING COMPANY
Bridgeport (near Philadelphia), Pa.
Established 1899

PRODUCTS

Seamless Tubing; Mechanical Tubing Specialties; Special Tubing for Radio Industry, Aircraft; Diesel Injector Tubing; Needle Tubing; Golf and Fishing Rods, Industrial Instruments; Heat Transfer.

(Continued on page 38)

A FRANK MESSAGE
from
FEDERATED PURCHASER

WHEN choosing your wholesale source of supply, you naturally want to know something about the firm which solicits your business. What is their price policy? Do they cooperate or compete with you? Are they a large organization able to carry comprehensive stocks of standard merchandise for immediate delivery?

Federated's price policy guarantees world's lowest prices. We meet all competition.

Trade where you never overpay!

Federated does a wholesale business. No business is solicited from the general public. A set and sound equipment List Price Catalog is issued for dealer's profit protection and selling convenience.

Trade where your rights are respected!

Federated is the world's largest WHOLESALE organization with 8 branches for speedier service. Instant teletype puts stocks of all branches at your disposal. Federated's pick-up Shopping Service avoids the bother of "Splitting" orders.

Trade where you get what you want . .

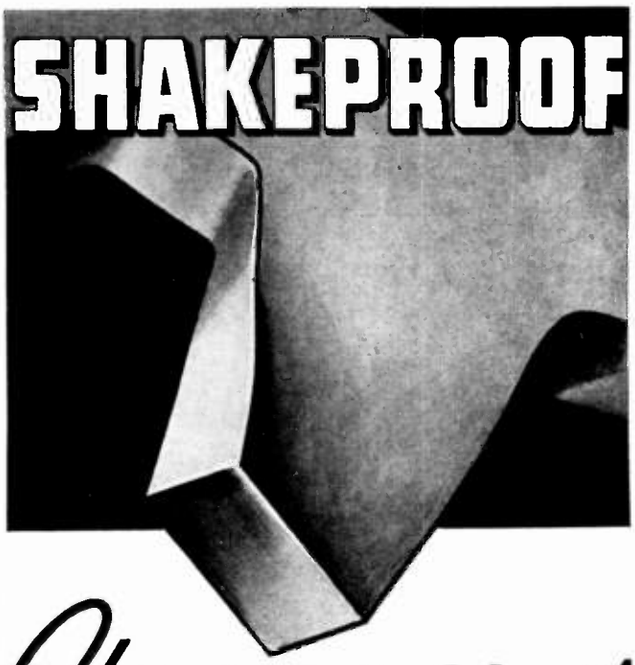
when you want it!

The Federated Creed

- ALWAYS to be the lowest priced wholesale house in the industry.
- ALWAYS to cooperate with the dealer, serviceman, amateur and experimenter.
- ALWAYS to guarantee the satisfaction of every customer by backing every product with our own name and reputation.
- ALWAYS to merit your confidence.

FEDERATED PURCHASER INC.

NEW YORK — 25 Park Place
CHICAGO, ILL. — 1331 So. Michigan Ave.
ATLANTA, GA. — 546 Spring St. N.W.
PITTSBURGH — 343 Blvd. of the Allies
NEWARK, N. J. — 224 Central Ave.
PHILADELPHIA — 120 North 7th St.
BRONX, N. Y. — 534 E. Fordham Rd.
JAMAICA, L. I. — 92-26 Merrick Rd.



This twisted tooth
IS AN EXCLUSIVE SHAKEPROOF FEATURE

ONLY Shakeproof can give you the positive and powerful locking action of the multiple twisted tooth design. When you turn a nut down on a Shakeproof Lock Washer, you get a different kind of action than is possible by any other locking method. Each twisted tooth bites into both work and nut surfaces and the spring tension of the twisted tooth forces the biting edges in deeper as vibration trys to loosen the nut. That's why a nut locked with Shakeproof is *really* locked and why vibration—no matter how severe—will never loosen it. Prove this on your own product and in your own shop—send for free testing samples today!

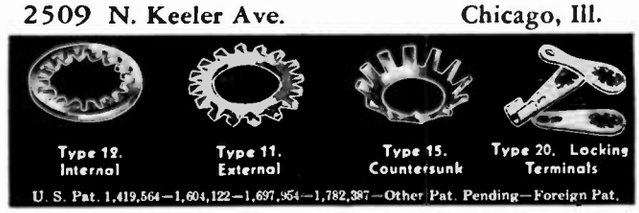
NEW CATALOG
Send for your free copy

Just off the press—our new 1935 catalog tells you how to solve your locking problems. Also illustrates and explains other patented Shakeproof products—a truly valuable book—send for your free copy today!

SHAKEPROOF
Lock Washer Company

Distributors of Shakeproof Products
Manufactured by Illinois Tool Works

2509 N. Keeler Ave. Chicago, Ill.



U. S. Pat. 1,419,564—1,604,122—1,697,954—1,782,387—Other Pat. Pending—Foreign Pat.

Tube Parts and Materials (Continued)

(*Continued from page 36*)

SUPERIOR TUBE CO.
Norristown, Pa. Seamless Tubing.

SWEDISH IRON & STEEL CORPORATION
17 Battery Place, New York City.

PRODUCTS

SVEA METAL Ribbon and SVEA METAL. Wire for internal vacuum tube parts such as Plates, Getter Cups, Screens, Grids, Mica Strapping, Welds, Lead-Ins, etc. Also Electrode Shells for Neon Lights; Non-Magnetic Iron for Core Parts, Armatures, etc., in Relays, Loudspeakers, Switches, Signals.

EXECUTIVES

President.....Victor H. Todd
Vice-President.....Harold C. Todd
Sales Manager.....John W. Upp, Jr.
Chief Engineer.....Lauren L. McMaster, Jr.

BRANCH OFFICES OR REPRESENTATIVES

29 South LaSalle Street, Chicago, Ill.
66 Rutledge Street, Brooklyn, N. Y.

EXPORT

R. G. McLeod, Ltd., 30 Gordon Street, London, W. C. 1, England.
Ad Auriema, Inc., 116 Broad Street, New York City. (General export except Great Britain and Canada.)

Wire—Antenna, Hook Up, Magnet, etc.

ACME WIRE COMPANY
New Haven, Connecticut.

PRODUCTS

Condensers and Condenser Parts, Magnet Wire, Coils (Litz), Varnished Insulations (Cambric, Paper, Silk) and Aerial Wire.

EXECUTIVES

President.....T. G. Nee
General Mgr.....T. G. Nee
Sales Mgr.....H. B. Bassett
Chief Engineer.....J. G. Kries
Production Mgr.....C. G. Ives
Advertising Mgr.....H. B. Bassett
Purchasing Agent.....C. J. Schnelle

ANACONDA WIRE & CABLE CO.
20 N. Wacker Drive, Chicago, Ill.

AMERICAN ENAMELED MAGNET WIRE CO.
Port Huron, Michigan.

BENTLEY, HARRIS MANUFACTURING CO.
Hector & Lime Streets, Conshohocken, Pa.

BELDEN MANUFACTURING COMPANY
4647 W. Van Buren Street, Chicago, Ill.

CORNISH WIRE COMPANY, INC.
30 Church Street, N. Y. C.

ESSEX WIRE CORPORATION
37 Manchester Avenue, Detroit, Mich.

ELECTRO-METALS, INC.
1880 E. 40th St., Cleveland, Ohio.

GENERAL CABLE CORPORATION
420 Lexington Avenue, New York City.

HOLYOKE COMPANY
720 Main Street, Holyoke, Mass.

LENZ ELECTRIC MANUFACTURING CO.
1751-1757 North Western Avenue, Chicago, Ill.

PRODUCTS

Push Back Wire, Indoor Aerial, Auto-Radio Cable, Microphone Cable, Short Wave Lead-In, Shielded Wires and Cables, Speaker and Head Set Cords, Battery and Speaker Extension Cable, Flexible Rubber-Covered Lead-in Wire.

EXECUTIVES

President.....J. Mayo Lenz
Vice President.....Phillip C. Lenz
Secretary.....Harry F. Racine
Sales Mgr.....Raymond G. Zender

BRANCH OFFICES OR REPRESENTATIVES

C. H. Anderson, Box 307, Fort Madison, Iowa.
H. W. Burwell, 413 Le Bron Ave., Montgomery, Ala.
R. M. Campion, Box 4101, Station A, Dallas, Texas.
J. M. Cartwright, 1288 Vinton Ave., Memphis, Tenn.
M. A. Dobbin, 407 Postal Bldg., Portland, Oregon.
Frank A. Emmet, 741 S. Burnside Ave., Los Angeles, Calif.
H. P. Hardesty, 356 E. Grand Blvd., Detroit, Mich.
S. K. MacDonald, 217 Riggs Bank Bldg., Washington, D. C.
W. T. McGary, 3800 N. Grand Ave., St. Louis, Mo.
E. H. Pratt, 4110 E. 51st Terrace, Kansas City, Mo.
W. F. Seeman, 763 Tacoma Ave., Buffalo, N. Y.
H. F. Smith, 259-265 West 14th St., New York, N. Y.
G. O. Tanner, 345 Fourth Ave., Pittsburgh, Pa.
Trade Contact Corp., 25 Huntington Ave., Boston, Mass.
F. C. Valentine, 4337 Drury Lane, Fort Wayne, Indiana.

PHELPS DODGE COPPER PRODUCTS CORP.
(Inca Manufacturing Division)
Fort Wayne, Indiana.

JOHN A. ROEBLING SONS CO.
Trenton, New Jersey.

SPARGO WIRE COMPANY
Rome, New York.

Wire—Resistance

DRIVER-HARRIS CO.
Harrison, New Jersey.

WILBUR B. DRIVER CO.
Newark, N. J.

HOSKINS MANUFACTURING CO.
Detroit, Michigan.

GEORGE W. PRENTISS AND CO.
Holyoke, Mass.

Wire Strippers

THE WIRE STRIPPER COMPANY
1729 Eastham Avenue, E. Cleveland, Ohio.

PRODUCTS

Speedcraft Semi-Automatic Knife-Type Wire Stripper; Speedcraft Foot-Pedal Knife-Type Wire Stripper; Brush-Type Wire Stripper; Bar Cleaning Stripper.

EXECUTIVES

President.....Frank Larned

MISCELLANEOUS EQUIPMENT (See Index, Page 22)

Antennae, Interference Filters, Etc.

BIRNBACH RADIO CO. INC.
145 Hudson Street, New York City.

ARTHUR H. LYNCH, INC.
227 Fulton Street, New York City.

PORCELAIN PRODUCTS, INC.
Findlay, Ohio.

RIVARD MANUFACTURING CO.
1014 Madison Avenue, Toledo, Ohio.

TECHNICAL APPLIANCE CORP.
27-26 Jackson Avenue, Long Island City, N. Y.

Auto-Radio Vibrators

ELECTRONIC LABORATORIES, INC.
122 W. New York St., Indianapolis, Indiana.

PRODUCTS

Vibrators and Vibrator Power Supplies.

EXECUTIVES

President.....Norman R. Kevers
Vice-President..Wm. W. Garstang
Chief Engineer.....Wm. W. Garstang

Cabinets and Cabinet Ornaments

CROWE NAMEPLATE & MFG. CO. (See page 30)
1749 Grace Street, Chicago, Ill.

THE EXCEL WOODCRAFT CORP.
Columbus Road at Leonard St., Cleveland, Ohio.

PRODUCTS

Wood Radio Cabinets

EXECUTIVES

President.....Carl Soros
Sec. & Treas.....A. A. Kest

Ceramics

AMERICAN LAVA CORP. (See page 36)
1411 William Street, Chattanooga, Tenn.

THE COLONIAL INSULATOR CO.
Akron, Ohio

PRODUCTS

Electrical and Heat Resisting Porcelain; Porcelain Forms for Dipped Rubber Goods.

EXECUTIVES

President.....Jas. R. Hemphill
Secretary.....R. W. Hemphill
Treasurer.....W. H. Motz

BRANCH OFFICES OR REPRESENTATIVES

1800 Grace Street, Chicago, Illinois.

HENRY L. CROWLEY & COMPANY, INC.
1 Central Avenue, West Orange, N. J.

ISOLANTITE, INC.
343 Cortlandt Street, Belleville, N. J.

PRODUCTS

Specialty Ceramics of all kinds, Strain Insulators, Standoffs, Spacers.
(*Continued on page 40*)

Ceramics (Continued)

Bushings, Washers, Coil Bodies, Radio Tube Bases and Parts. Trimmer
(*Continued from page 38*)
and Padder Bases. Radio-Frequency Concentric Transmission Lines and Accessories, Resistor Tubes, Oil Burner Ignition Insulators and Assemblies, Thread Guides, Chemical Tower Packing, Ceramic Valves and Nozzles for chemical uses.

EXECUTIVES

President.....W. D. Waltman
Vice-President.....R. S. Bicknell
General Manager....R. S. Bicknell
Sales Manager.....H. G. Beebe
Chief Engineer.....N. H. Snyder
Production Mgr.....Paul Mouraud
Purchasing Agent..E. J. W. Riess
Advertising Mgr.....H. G. Beebe

BRANCH OFFICES OR REPRESENTATIVES

New York Sales Office, 233 Broadway, New York, N. Y.
C. E. White, Bulkley Building, Cleveland, Ohio.
Graybar Electric Co., 420 Lexington Ave., New York City.

Diaphragms for Speakers

HAWLEY PRODUCTS COMPANY
St. Charles, Illinois.

MASLAND MANUFACTURING CORP.
Amber & Willard Streets, Philadelphia, Pa.

UNITED PRESSED PRODUCTS CO. (See page 32)
407 S. Aberdeen Street, Chicago, Ill.

Felt

AMERICAN FELT COMPANY
315 Fourth Ave., New York, N. Y.

T. R. BRAWLEY FELT CO., INC.
279 20th Street, Brooklyn, N. Y.

PRODUCTS

Felt Feet for the Radio Receiver, and other Felt Products.

FELTERS COMPANY
210 South Street, Boston, Mass.

WESTERN FELT WORKS
4115 Ogden Avenue, Chicago, Ill.

Flexible Shafting

THE S. S. WHITE DENTAL MFG. CO. (See page 30)
10 East 40th Street, N. Y. C.

Foil

THE JOHNSTON TINFOIL & METAL CO.
6106 S. Broadway, St. Louis, Mo.

REYNOLDS METAL CO., INC.
541 W. 25th Street, N. Y. C.

Fuses

LITTELFUSE LABORATORIES
4507 Ravenswood Avenue, Chicago, Illinois.

PRODUCTS

Instrument Fuses; High-Voltage Fuses (Radio); Radio-Receiver Fuses; Aircraft Anti-Vibration Fuses; Fuse Mountings; Neon Potential Fuses; Neon Pocket Testers; Neon Pilot Lights; Neon Dead Fuse Indicators.

EXECUTIVES

General Mgr.....E. V. Sundt
Production Manager.....B. Kollath

BRANCH OFFICES OR REPRESENTATIVES

David F. Tobias, 30 Church Street, New York City.
Electrical Apparatus Co., 10 High Street, Boston, Massachusetts.

FOREIGN DISTRIBUTORS

Exclusive distributors in every principal country.

Graphite

ACHESON COLLOIDS CORPORATION
1635 Washington Ave., Port Huron, Michigan.

PRODUCTS

"Aquadag" Colloidal Graphite (in water). "Oildag" Colloidal Graphite (in oil). "Castordag" Colloidal Graphite (in castor oil), "Glydag" Colloidal Graphite (in glycerin). "Prodag" Semi-Colloidal Graphite (in water), and "Varnodag" Colloidal Graphite (in phenolformaldehyde varnish).

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Vice-Pres. & Gen. Mgr., Geo. R. Siegrist
Advertising Mgr.....Edw. A. Bodine
Sales Mgr.....M. W. Reynolds
Tech. Director...R. Szymanowitz
Purchasing Agent...L. H. Miller

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Laminations and Stampings

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1100 E. Twenty-Third Street, Indianapolis, Ind.

PRODUCTS

Permanent Magnets, Dies, Tools, Metal Stampings, and Laminations.

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Vice-President.....R. J. Owen
Secretary & Treas..O. H. Skinner
Production Mgr.....E. R. Piercy

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E. I. DUPONT COMPANY
Parlin, N. J.

GENERAL PLASTICS, INC.
N. Tonawanda, New York.

MASS & WALDSTEIN CO.
438 Riverside Avenue, Newark, N. J.

THE ZAPON COMPANY
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ZOPHAR MILLS, INC.
587 Court Street, Brooklyn, N. Y.
Founded 1846.

PRODUCTS

Wax Compounds; Wax Saturators; Sealing Compounds; Compounds for Coils, Transformers and Condensers.

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Vice-President.....C. W. Gramm
Purchasing Agent...E. C. Zolkoski
Sales Mgr.....J. J. Blank
Technical Dept.....A. Saunders
Production Mgr.....A. Saunders
General Mgr.....H. J. Blank

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Otto E. Pfannkuch, Devon, Conn.
C. E. White & Co., Cleveland, Ohio.
Electrical Specialty Co., San Francisco, Calif.
Electrical Specialty Co. of Southern Calif., Los Angeles, Calif.

EXPORT

No direct agents—sell through export brokers.

Lugs and Terminals

CINCH MANUFACTURING COMPANY
2339 W. Van Buren Street, Chicago, Ill.

CLAROSTAT MANUFACTURING CO.
285 N. 6th Street, Brooklyn, N. Y.

F. R. ZIERICK MANUFACTURING COMPANY
70 E. 131st Street, New York City.

Metals

Aluminum

ALUMINUM CORP. OF AMERICA
New Kensington, Pa.

FAIRMONT ALUMINUM COMPANY
Fairmont, W. Virginia.

Phosphor Bronze and Nickel Silver

PHOSPHOR BRONZE SMELTING CO.
2200 Washington Avenue, Philadelphia, Pa.

RIVERSIDE METAL COMPANY
Riverside, New Jersey.

Brass and Copper

AMERICAN BRASS CO. (See page 36)
Waterbury, Conn.

THE BALTIMORE BRASS COMPANY
Wicomico and Ostend Streets, Baltimore, Md.

Nickel

INTERNATIONAL NICKEL CO.
67 Wall Street, New York City.

Steel

THE AMERICAN ROLLING MILL CO.
703 Curtis Street, Middletown, Ohio.

PRODUCTS

"Armco" Electrical Sheet Steel (All Grades). "Armco" Ingot Iron and "Armco" Steel—Sheets—Strip—Plate—Coils. "Armco" Stainless Steel—Sheet—Strip—Plates.

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President.....Charles R. Hook
Vice-President.....W. W. Sebald
Vice-President and Gen. Mgr.....C. W. Verity
Sales Manager...G. F. Ahlbrandt
Chief Engineer.....E. N. Millan
Purchasing Agent.....N. Ebersole
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BRANCH OFFICES OR REPRESENTATIVES

All principal cities.

EXPORT

The Armco International Corporation.

SWEEDISH IRON & STEEL CORP. (See page 38)
17 Battery Place, New York City.

Mica

WILLIAM BRAND & COMPANY
268 Fourth Avenue, New York City.
FORD RADIO MICA CO., INC.
830 Fourth Avenue, Brooklyn, N. Y.
MICA INSULATOR CO.
200 Varick Street, New York City.

Motors, Motor Generators, Turntables and Record Changers

BALDOR ELECTRIC CO.
4353 Duncan Street, St. Louis, Mo.
BODINE ELECTRIC COMPANY
2264 W. Ohio Street, Chicago, Ill.
ELECTROMATIC RECORD CHANGER CORP.
2212 S. Paulina Street, Chicago, Ill.
ELECTRIC SPECIALTY CO.
211 South Street, Stamford, Conn.
GENERAL ELECTRIC CO.
Schenectady, New York.
THE GENERAL INDUSTRIES COMPANY
Elyria, Ohio.
JANETTE MANUFACTURING COMPANY
556 W. Monroe Street, Chicago, Ill.
THE OHIO ELECTRIC MFG. CO.
5900 Maurice Avenue, Cleveland, Ohio.

PIONEER GEN-E-MOTOR CORP.
466 West Superior Street, Chicago, Illinois.

PRODUCTS

Dynamotors; "B" Eliminators; D-C to A-C Converters; Gas-Engine Genemotors; Wind-chargers.

EXECUTIVES

President.....D. E. Bright Chief Engineer.....Harry Goldberg

SOUND APPARATUS CO.
150 W. 46th Street, New York City.

RCA MFG. CO., INC. (See page 24)
Camden, New Jersey.

WESTERN ELECTRIC COMPANY (See page 26)
195 Broadway, New York City
WESTINGHOUSE ELEC. & MFG. CO.
E. Pittsburgh, Pa.

Oil Tubing, Saturated Sleeving, Varnished Cloth

BENTLEY HARRIS MFG. CO.
Conshohocken, Pa.
WILLIAM BRAND & CO.
268 Fourth Avenue, New York, N. Y.

Paper for Condensers

C. H. DEXTER & SONS CO., INC.
Windsor Locks, Connecticut.
PETER J. SCHWEITZER, INC.
Newark Avenue and Virginia Streets, Elizabeth, N. J.
FRED C. STRYPE
140 Lafayette Street, N. Y. C.

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CHICAGO PAPER TUBE COMPANY
137 S. Albany Avenue, Chicago, Ill.
CROSS PAPER PRODUCTS COMPANY
2595 Third Avenue, N. Y. C.
THE PAPER TUBE COMPANY
1718 Damen Avenue, Chicago, Ill.

Relays

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1033 W. Van Buren Street, Chicago, Ill.
J. H. BUNNELL & CO.
215 Fulton Street, New York City.
STRUTHERS-DUNN, INC.
139 Juniper Street, Philadelphia, Pa.
WARD, LEONARD ELECTRIC CO.
Mt. Vernon, New York.

WESTON ELEC. INST. CORP. (See page 34)
Frelinghuysen Avenue, Newark, N. J.

Screws

PARKER-KALON CORPORATION
Factories and Sales Headquarters, 190-198 Varick Street, New York City.

Shielding

GOAT RADIO TUBE PARTS, INC. (See page 36)
314 Dean Street, Brooklyn, N. Y.

HAMMARLUND MANUFACTURING CO. (See page 24)
424 W. 33rd Street, New York City.

SCOVILL MANUFACTURING CO.
Waterbury, Connecticut.

Solder and Soldering Irons

ELECTRIC SOLDERING IRON CO.
342 West 14th Street, New York City.

PRODUCTS

Green Label and Industrial Soldering Irons. Solder Pots.

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Secretary.....Jack Hanebury
General Mgr.....L. P. Young
Chief Engineer.....L. P. Young
Production Mgr.....Jack Hanebury
Sales Mgr.....L. P. Young

GARDINER METAL COMPANY
4820 S. Campbell Ave., Chicago, Illinois.

PRODUCTS

Dipping Alloys; Acid-Core Solder; Flux-Filled Solder; Rosin-Core Solder; Self-Fluxing Solder.

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Vice-President.....F. W. Murray
Sales Manager.....J. C. Shaw
Chief Engineer.....A. F. Sternad
Production Mgr.....H. J. Gardiner
Advertising Mgr.....J. C. Shaw

KESTER SOLDER COMPANY
4201 Wrightwood Avenue, Chicago, Ill.

RUBY CHEMICALS CO.
56 McDowell St., Columbus, Ohio. Solder.

STA-WARM ELECTRIC CO.
508 N. Chestnut Street, Ravenna, Ohio

PRODUCTS

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Vice-President.....E. J. Smith
General Mgr.....J. Edwin Jensen
Chief Engineer....P. L. Warmuth

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Newark Avenue, Elizabeth, N. J.

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NATION-WIDE SERVICE

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PRODUCTS

Lock Washers, Nuts, Locking Terminals, Self-Locking Set Screws, Tapping Screws, Spring Washers, Special Stampings.

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General Mgr.....F. W. England
Sales Manager..Jack M. Gribbie
Chief Engineer....Carl G. Olson
Production Mgr....John Biesnick
Purchasing Agent..Fred Hassell
Advertising Mgr...J. M. Gribbie

WROUGHT WASHER MANUFACTURING CO.
2203 South Bay Street, Milwaukee, Wis.

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Washers of all types, including: Standard Washers, Riveting Washers, Lock Washers, Cup Washers, Counter-Sunk Washers, Finishing Washers, Shim Washers, Expansion Plugs, etc. Washers made from all materials.

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General Mgr.....E. Caldwell
Sales Mgr.....W. F. Disch
Chief Engineer.....C. R. Dowdy
Production Mgr.....J. A. Holzer
Purchasing Agent.....C. H. Disch
Advertising Mgr.....C. R. Crabb

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CANDY & COMPANY, INC.
2515 W. 35th Street, Chicago, Ill.
GENERAL CEMENT MFG. CO.
Rockford, Ill.
ZOPHAR MILLS, INC. (See page 40)
Court, Lorraine and Creamer Streets, Brooklyn, N. Y.

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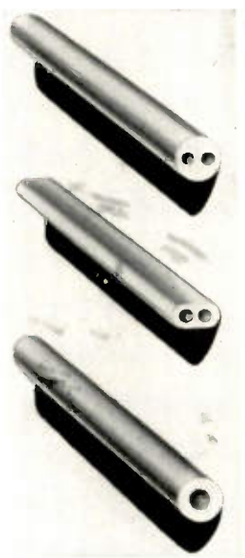

In the newer short wave and ultra short wave receivers the use of this ceramic is destined to play an important part, because of its lower losses and also because it does not "cold flow" or bend.

ELECTRICAL CHARACTERISTICS

Dielectric Constant at 3000 K. C.		6.
Power Factor at 1000 KCS—50 MCS		.08 — .04%
Loss Factor at 1000 KCS—50 MCS		.48 — .24
Volume Resistivity ohms per CC:	20°C	10^{14} — 10^{15}
	300°C	10^{10}
	600°C	4.10^{7}
Porosity		Nil

MECHANICAL PROPERTIES

Tensile Strength: lbs. per sq. in.	8,000
Compressive Strength: lbs. per sq. in	120,000
Modulus of Rupture: lbs. per sq. in.	18,000
Impact bending strength: ft. lbs. sq. in.	1.6—2.1
Thermal expansion between 20° . . . 650°C:	6.2—6.8. $.10^{-6}$
Softening Temperature °C:	1440

Use this Alsimag (Steatite) body 196 for your short wave sets and get the experience which you will need for television.

Can your engineers afford NOT to specify this Steatite body Alsimag 196 for your ceramic parts?

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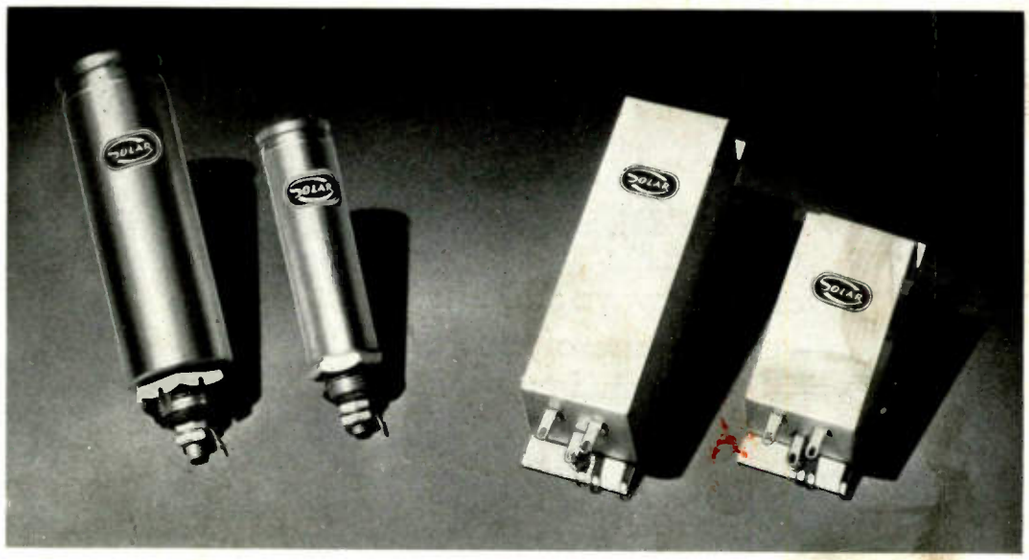

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Solar Type GEP Capacitors Offer Remarkable Compactness

SOLAR Engineers have perfected methods whereby greater capacity in electrolytic condensers is now obtained through increase in effective surface area without increasing overall foil size. This improved construction exhibits thorough reliability, both in the field and in laboratory tests.

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