4th ANNUAL BUYER'S DIRECTORY

Radio Engineering

SEPTEMBER, 1936

VOL. XVI NO. 9

DESIGN • PRODUCTION • ENGINEERING

- Broadcast Receivers
- Auto-Radio Receivers
- Electric Phonographs
- Sound Recorders
- Sound Projectors
- Audio Amplifiers
- P-A Equipment
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The Journal of the Radio and Allied Industries

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RADIO ENGINEERING

REG. U. S. PATENT OFFICE

W. W. WALTZ • Editor

CONTENTS FOR SEPTEMBER

FEATURES

DEPARTMENTS

VOL. XVI *Member Audit Bureau of Circulations* NO. 9

COVER ILLUSTRATION

REPRODUCTION OF A PHOTOGRAPH WHICH WAS TRANSMITTED OVER THE PHILCO TELEVISION SYSTEM. THE INTERLACED SCANNING LINES ARE PLAINLY VISIBLE IN THE ENLARGED INSET. (See page 9)

PUBLISHED MONTHLY by the

BRYAN S. DAVIS • President SANFORD R. COWAN • Advertising Manager

JAS. A. WALKER • Secretary A. B. CARLSEN • Circulation Manager

BRYAN DAVIS PUBLISHING CO., Inc. 19 East 47th St., NEW YORK CITY *Telephone PLaza 3-0483*

CHICAGO OFFICE—608 S. Dearborn St.—C. O. Stimpson, Mgr. Telephone: Wabash 1903

CLEVELAND OFFICE—10515 Wilbur Ave.—J. C. Munn, Mgr. Telephone: Republic 0905-J

MELBOURNE, AUSTRALIA—McGill's Agency

WELLINGTON, NEW ZEALAND—Te Aro Book Depot

Entered as second class matter August 26, 1931, at the Post Office at New York, N. Y., under Act of March 3, 1879. Yearly subscription rate $2.00 in United States and Canada: 25 cents per copy. $3.00 in foreign countries; 35 cents per copy.

Editorial

THIS MONTH

IT WOULD BE INTERESTING to know just what kind of a reaction took place when our readers first noticed the front cover illustration. We'll venture a bet that there was more than one pair of eyebrows lifted in surprise—and, perhaps, even in anticipation. But the anticipation must be short-lived—there isn't any more! Believe it or not, there is a sound reason for the display of pulchritude; it provides an excellent demonstration of the quality of present-day television. Incidentally, the lady's name is Jean Muir.

We have written in the not distant past that regeneration, properly controlled, would provide some of the answers to better quality radio reception. RCA has taken the plunge, and the result is well worth noting. The details of the inverse-feedback system, which is effective in reducing speaker resonances and cutting down the overall harmonic distortion, will be found discussed in sufficient detail to enable other engineers to "go and do likewise." And, it might be a smart idea.

The continuation of the mathematical analysis of loudspeakers will tie in nicely with the feedback material as it gives, in greater detail, the "why" of speaker resonance.

At least one answer to the problem of how to provide a means of accurately tuning an auto radio is shown. The circuits are simple and, as the author indicates, inexpensive. Something along this line ought to do away with the need for a tuning indicator.

COMPRESSION

ONE OF OUR pet peeves centers about the way in which programs are "man-handled" before they leave the broadcast studios. We'll agree that in a great majority of cases, the fault is not that of the operator in the control room, although often enough to be noticeable, there will be a sudden—and vast—change in level which is obviously the result of some engineer's momentary distraction.

Aside from these pure "boners," the most objectionable feature of manually-monitored programs is the gradual decrease in level which invariably precedes a loud passage that the control room man knows is coming. Due to the fact that the smartest of humans has an appreciable reaction time, the control room naturally anticipates the peaks in the program, with the result mentioned above. The obvious answer is the use of volume compression circuits in place of manual monitoring. Properly adjusted, these should be able to hold the programs within the same limits now supposedly imposed.

From the receiver manufacturer's angle, automatic compression would certainly permit the use of expanders in the receivers. And if you don't think that this would add to sales appeal, just take some time to listen to the "oh's" and "ah's" with which the public greets demonstrations of volume-expanded phonograph reproduction.

It would seem that the broadcasters and the receiver people might accomplish a lot by getting together on a few technical matters.

BUYERS DIRECTORY

THE FOURTH ANNUAL RADIO ENGINEERING Buyers Directory, is included in this issue. This directory, which is complete in so far as parts and materials suppliers are concerned—and within limits imposed by the suppliers themselves, some of whom literally had to be coaxed to furnish us with the necessary information—is, we believe, the only one of its kind.

We know definitely that this directory is used; there is rarely a week that passes without a call requesting a copy, or, especially at this time of the year, asking how soon the new directory will be available.

To a casual observer, this directory may seem to be stereotyped and of interest solely on those occasions when one needs the name of a supplier quickly. But, examine a few of the points which are most evident to those of us who make up the directory.

In past years the most noticeable changes were those in personnel of the various companies; these changes ran as high as forty percent. This year, personnel has steadied—so much so that it is doubtful if the net change is more than fifteen percent.

Another point of interest is the number of new companies that have made their advent since last September; and the number of concerns that have failed to make the grade is less than before.

We aren't economists, but these few offhand observations seem definitely to indicate a healthy condition in the industry, a condition which, it is to be hoped, may continue indefinitely.

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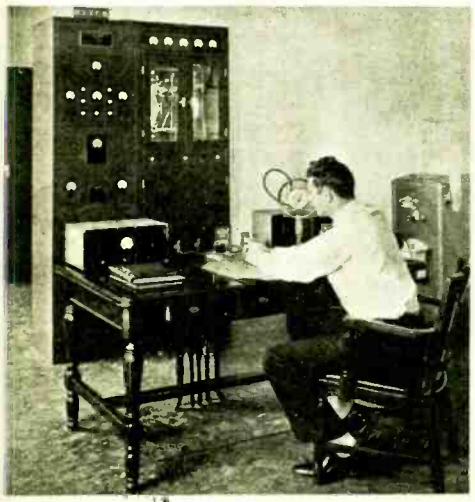

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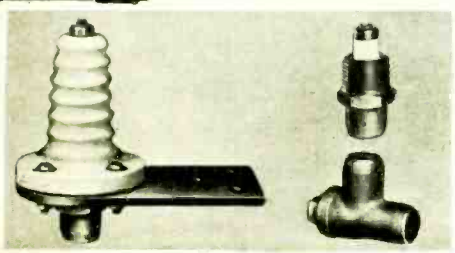

National Newark and Essex Bank Building. Showing location of transmitter and antenna connected by ISOLANTITE COAXIAL TRANSMISSION LINE.

In the rapidly developing technique of radio communication engineers recognize the coaxial transmission line as the most efficient means of conducting radio frequency energy from point to point and from transmitter to antenna.

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RADIO ENGINEERING

FOR SEPTEMBER, 1936

PHILCO TELEVISION

Unknown to Most People, Philco Has Been Conducting a Long Series of Experiments on Television. Their System, Which Is Described Below, Was Shown Publicly on Aug. 11

AS WE MENTIONED on our editorial page last month, the Philco Radio & Television Corporation gave a demonstration of their television system on August 11.

The accompanying illustrations indicate only slightly the extent to which Philco has progressed with television. While stressing that television is not yet commercially feasible, A. F. Murray, in charge of Philco's development work, pointed out the features of the system to the guests who witnessed the demonstration. A portion of Mr. Murray's remarks are quoted below.

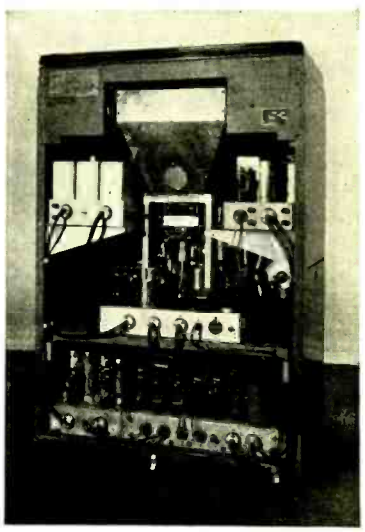
"The job of transmitting television signals of sufficient strength to give usable high-definition pictues at a distance of at least 7 miles, was not an easy one on the ultra-high frequencies used for television. The newest ideas in u-h-f transmitters, antennas and transmission lines were tested. Considerably more power was required at the transmitter to cover the desired distance than sound broadcast experience would indicate.

"One of the most difficult problems to be solved was the modulation of the transmitter by the very high video frequencies (generated by scanning) necessary for high-definition television pictures. It is a relatively easy matter in a sound transmitter to modulate from 30 to 10,000 cycles, but when the upper limit of the modulation band is pushed to 2.4 megacycles the problem of constructing amplifiers and modulators appears at first insurmountable. The solution was the invention of a new and unique type of modulation which is being used by Philco.

"Concurrently, ultra-high-frequency radio receivers (42-86 mc.) were being developed to faithfully reproduce these high modulating frequencies necessary for clear, high-definition pictures. Receivers for the accompanying sound were also developed so that the apparatus necessary to receive a television program (sound and picture) could be placed in an ordinary console.

"With all of the units of a complete system developed and operating satisfactorily, field tests were ushered in on December 23, 1935 by a one-hour program reproduced at a distance of 7 miles from the transmitter. This demonstration was witnessed by a number of Philco executives. It showed the system lacked many desirable features. Nevertheless, the results were sufficient-

Philco television receiver.



The "works."

Television control room.

ly promising to warrant pushing development work with greater speed. The engineers once again concentrated on the weaker links of the system, to remove the cause of weakness and to improve the picture. Subsequent demonstrations made at frequent intervals (to Philco executives and their guests) showed rather slow but steady progress up to that point where scheduled programs were broadcast nightly by Philco covering Philadelphia on 51 mc. (picture) and 54.25 mc. (sound). These were started June 18, 1936.

"The electrical specifications for The Philco System are given briefly in tabular form.

Channel width.....	6 mc.
Spacing between television and sound carriers	3.25 mc approx.
Polarity of Transmission	Negative
Number of lines....	345
Number pictures per second	60 interlaced
Aspect ratio	4:3
Percentage of television signal devoted to synchronizing	20%
Synchronizing signal.	Narrow vertical
Carrier frequency of picture transmitter.	51 mc
Carrier frequency-sound transmitter ..	54.25 mc.

"These specifications agree with the standards recommended by the RMA at a recent hearing before the FCC, that is, except the number of lines. As soon as our equipment can be changed we will conform with the new suggested standard of 440-450 lines. This matter of having one television standard for the U.S.A. is very important. It will be appreciated by every future television user.

"It naturally enhances interest in the demonstration which you are to see to know the conditions under which it is given and, briefly, how the equipment functions. The logical starting point is the studio, where the television signal is generated. The studio is located in our main laboratories, C and Tioga Streets. A camera employing a Philco camera tube generates by electrical scanning, voltages corresponding to the light and shade of the television picture which is focused by a lens on the signal plate of the tube. This signal is amplified in cascaded stages in the control room until it has sufficient amplitude to modulate the u-h-f transmitter. Mixed with this television signal, in the proper proportions, are synchronizing and blanking impulses. These control at the various television receivers in the field, the movement of the electron beam in the picture tubes and place around two sides of the picture a black border.

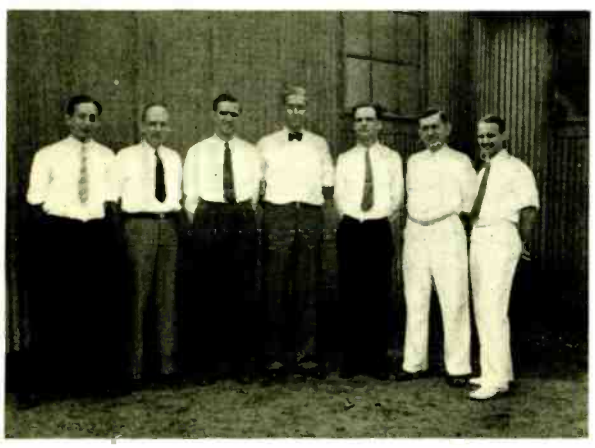
Making television tubes.

To pick up the sound accompanying the picture the studio is equipped with microphones and associated equipment, which permits transmission of high fidelity sound from our u-h-f sound transmitter operating on a frequency spaced 3.25 mc. above the television carcier wave. Further description is unnecessary since there is nothing unusual about the sound channel.

"Motion picture film, when passed through a specially-built projector, is transmitted by flashing pictures intermittently into the so-called 'electric eye,' or camera tube. This projector is designed so that the film and its sound track is moved at a speed of 24 frames per second, for satisfactory sound, and at the same time 30 frames per second are transmitted to secure 60 interlaced pictures per second. You will see this machine later.

"For outdoor television scenes the camera is placed on a motion picture tripod and motion picture technique is used in its operation.

"The latest experimental model of cabinet which is being demonstrated today comprises a sound and television receiver tuning over the frequency range of 42-86 mc. For flexibility these receivers are separately tuned, although it is easy to secure single knob control. The number of control knobs, you will notice, is only slightly more than on the usual sound receivers. These are not difficult to operate. Our field tests have shown that inexperienced persons can adjust the knobs to secure satisfactory pictures. The deflecting chassis is the name given the unit which incorporates the synchronizing and deflecting equipment. The power supply units are placed at the bottom of the cabinet. The total number of tubes used is 36."



Philco television engineers. H. Branson, P. J. Konkle, P. J. Bingley, A. F. Murray (Engineer-in-Charge), W. N. Parker, S. F. Essig, N. S. Bean.

INVERSE-FEEDBACK CIRCUITS FOR A-F AMPLIFIERS*

The Unpleasant "Blasting" Often Noticed When Pentode Tubes Are Used in the Output Stage of a Receiver, and Which Is Due Partly to the High Plate Resistance of These Tubes, Can Be Reduced by Feeding Back, in the Proper Phase Relation, a Portion of the Output Voltage. This "Inverse Feedback" Likewise Effects a Material Reduction in the Harmonic Content of the Output.

WHEN POWER OUTPUT and distortion characteristics of the final stage of an a-f amplifier are to be determined, it is customary to replace the loudspeaker by a fixed resistance of suitable value. Actually, a loudspeaker does not present the same impedance to an output tube at all audio frequencies. At the resonant frequency of the speaker, which is usually less than 100 cycles, the impedance of the speaker is high and resistive. At higher frequencies, the impedance of the speaker increases with frequency, because the voice coil has inductive reactance. Unless the variable effects of such a load are reduced by a low-resistance output tube, low frequencies "hang-over" and are accentuated by resonance effects in the speaker; high frequencies are accentuated by the rising impedance characteristic of the speaker.

The internal resistance (r_p) of an output tube shunts the plate load (Z_L). When r_p is appreciably less than Z_L, large variations in load impedance do not appreciably affect the output voltage, because the variable load impedance is shunted by the comparatively low resistance of the output tube. Hence, when a low-impedance triode is used in the output stage, the effects of the variable speaker impedance are reduced. When the internal resistance of the output tube is high compared to the load impedance, the effects of variable speaker impedance may seriously impair quality. This latter condition exists when tetrode- or pentode-type output tubes are used without compensating circuits. This paper describes the characteristics of two such circuits: (1) the familiar resistance-capacitance filter, which compensates for high-frequency effects, and (2) inverse-feedback circuits, which minimize the effects over the entire audio-frequency range.

*This material furnished through the courtesy of RCA Manufacturing Corp., RCA Radiotron Division.

Resistance-Capacitance Filter

Because the load impedance of a dynamic speaker acts like an inductance and resistance in series at frequencies higher than the resonant frequency of the speaker, a suitable resistance-capacitance filter, connected as shown in Fig. 1, can be used to compensate for the variable reactance of the load. Resistance (R) in Fig. 1 is made equal to the load impedance into which the output tube(s) should work; capacitance (C) is adjusted to give a frequency characteristic which is substantially flat over a desired frequency range.

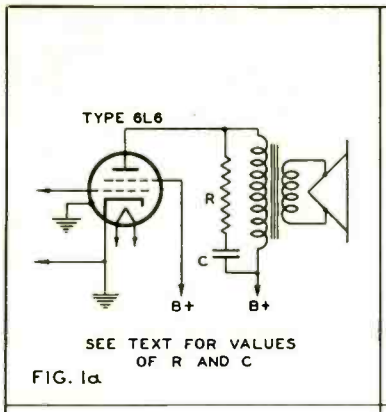
When R and C are determined in this manner, considerable power may be dissipated in R, especially at the high audio frequencies. For this reason, it may be desirable to increase R and C until a suitable balance between high-frequency compensation and power loss is obtained. The effects of speaker resonance are not reduced by the filter method of compensation.

Inverse-Feedback Circuits

Inverse-feedback circuits can be used to decrease distortion at the expense of power sensitivity in an a-f amplifier. Some forms of inverse-feedback circuits cause an increase in the plate resistance of a tube and others cause a decrease in this resistance. In the following discussion, two forms of inverse-feedback circuits are analyzed. The reduction in distortion can be made equal in both forms, although one increases and the other decreases the plate resistance of the tube.

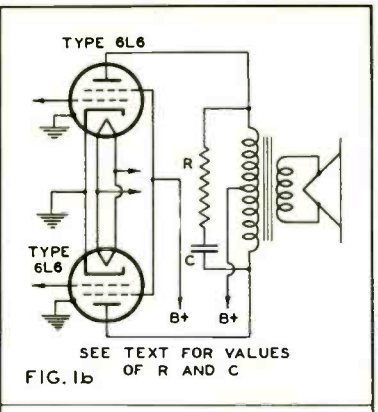
The plate resistance of a tube can be increased or decreased by feeding back to the grid circuit a portion of the alternating voltage appearing in the plate circuit. Thus, in Fig. 2, when the plate voltage is increased by an amount E by means of switch S, the control grid becomes more negative because of the increased voltage drop across the cathode resistor (R_c); this increase in negative bias reduces the plate-current change. When a signal is applied to the input and the battery (E) is replaced by a suitable load, the effect of the unby-passed cathode resistor is to increase the internal resistance of the tube as measured at the terminals of the load; therefore, the shunting effect of the tube on the load is decreased.

The a-c voltage developed across an unby-passed cathode resistor is in opposite phase to the input-signal voltage in a single-tube amplifier; hence, the



SEE TEXT FOR VALUES OF R AND C

FIG. 1a



SEE TEXT FOR VALUES OF R AND C

FIG. 1b

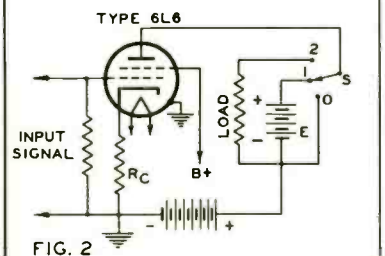


FIG. 2

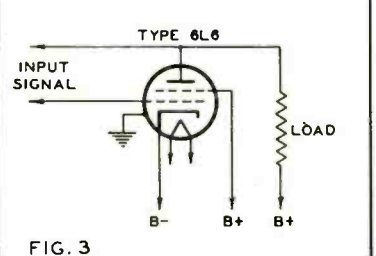


FIG. 3

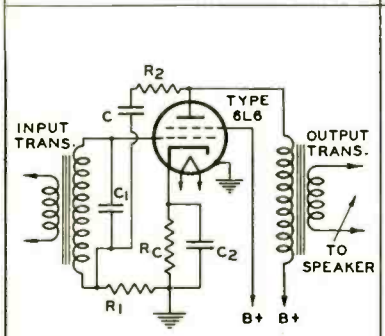


FIG. 4a

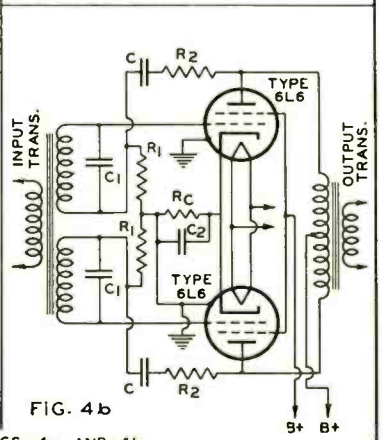


FIG. 4b

VALUES FOR FIGS. 4a AND 4b

R_C = CATHODE RESISTOR

C_2 = CATHODE-RESISTOR BY-PASS CONDENSER

	10% INVERSE FEEDBACK		16.6% INVERSE FEEDBACK	
R_1 =	5000 OHMS	10000 OHMS	8330 OHMS	16660 OHMS
R_2 =	45000 OHMS	90000 OHMS	41670 OHMS	83340 OHMS
C =	0.1 μf OR LARGER	0.1 μf OR LARGER	0.1 μf OR LARGER	0.1 μf OR LARGER
C_1 =	SEE TEXT	SEE TEXT	SEE TEXT	SEE TEXT

circuit is degenerative. The effects of degeneration in a single-tube amplifier are to reduce distortion and power sensitivity; the power output is also somewhat reduced due to power dissipated in the cathode resistor. The fractional loss in power output is R_c/R_L, where R_c is the value of the cathode resistor and R_L is the value of the load resistance plus the cathode resistance. The input signal required for rated output with degeneration is approximately

$$E_d = E_o \{1 + [g_m R_c/ (1 + R_L/r_p)] \}$$

where E_o is the input signal required for rated output without degeneration, and g_m is the grid-plate transconductance of the tube at the operating point. The distortion with degeneration is approximately

$$D_d = D_o /\{1 + [g_m R_c/ (1 + R_L/r_p)] \}$$

where D_o is the distortion without degeneration. For example, when the bypass condenser was removed from the cathode circuit of a typical single-tube amplifier using a type 6L6 tube, the distortion was reduced to approximately one-half its former value; the required input-signal voltage was doubled, and the power output was reduced by approximately 10 per cent. No other changes in circuit constants were made.

The cathode-resistor by-pass condenser should not be removed from over-biased push-pull circuits having a single cathode resistor for both tubes because the alternating plate currents of each tube do not cancel in this resistor; the resulting harmonic components of current cause an increase in distortion. The cathode-resistor by-pass condenser may be removed from over-biased push-pull circuits when each tube has its own resistor. However, the advantages of low tube resistance are not obtained.

When the entire load resistance is common to the plate and the cathode circuit, as shown in Fig. 3, a positive increment in plate voltage causes the same increment in grid voltage. Therefore, the internal resistance of the tube decreases. As in the circuit of Fig. 2, the feedback voltage, which is the entire voltage developed across the load, is in opposite phase to the input-signal voltage. It follows that this circuit is also degenerative. When the circuit of Fig. 3 is used, the internal resistance of the tube, the distortion, and power sensitivity of the amplifier are reduced; the power output and efficiency are not changed.

The circuit of Fig. 3 alters the normal characteristics of the amplifier in such a manner that the output tube acts as though it were a low-resistance triode. The amplifier has all the advantages of a triode, plus the high efficiency obtainable from a good tetrode or pentode. In addition, the circuit may be made flexible enough to permit the tube characteristics to be changed in steps from those of a tetrode or pentode to those of a low-resistance triode.

The circuits of a practical single-tube and of a push-pull amplifier using partial inverse feedback to reduce the internal impedance of the tube are shown in Figs. 4a and 4b, respectively. Resistors (R_1) and (R_2) and condenser (C) are connected in series; the combination is connected from the plate of each tube to ground. Nearly all the a-c voltage developed across the load appears across R_1 and R_2 when the capacitance of C is high. Of this voltage, that due to $R_1/(R_1 + R_2)$ is applied in series with the input-signal voltage; this ratio is defined as the percent degeneration (n). With any percent degeneration, the tube acts as though its normal internal resistance (r_p) were shunted by a resistance $1/(n\,g_m)$, where g_m is the transconductance of the tube. The input signal required for rated output is approximately

$$E_d = E_o \{1 + [n\,g_m R_L/(1 + R_L/r_p)] \}$$

where E_o is the input signal required for rated output without inverse feedback. The distortion with inverse feedback is approximately

$$D_d = D_o/\{1 + [n g_m R_L/(1 + R_L/r_p)]\}$$

where D_o is the distortion without inverse feedback. The transconductance of the tube is not changed by the addition of this type of degeneration.

The cathode resistor (R_c) has the same value with and without inverse feedback, because electrode voltages are not changed when this circuit is used. Also, the load impedance into which the tube operates should not be changed when inverse feedback is added. The load resistance that is optimum without degeneration is also optimum with degeneration. Therefore, in order to use inverse feedback in some receivers, it may be necessary only to install R_1, R_2, and C.

Circuit Precautions

Although the inverse-feedback circuits of Figs. 4a and 4b offer certain advantages, the following precautions should be observed in the design and use of these circuits in order to avoid the possibility of instability, oscillation, or a marked divergence from expected results.

(1) A conventional resistance-coupled input circuit cannot be used with this type of degenerative circuit, because the input-signal voltage must be in series with the feedback voltage for proper operation.

(2) It may be desirable to connect small fixed condensers (C_1) across each secondary of the input transformer in order to avoid the possibiltiy of oscillation due to leakage inductance and shunt capacitance in the input-transformer circuit. It is advisable to determine by test whether or not these condensers are necessary.

(3) The blocking condensers (C in Figs. 4a and 4b) should be placed between R_1 and R_2, as shown. When placed between R_2 and plate, the circuit may oscillate because of the capacitance of C to grid.

(5) It might appear that the primary of the output transformer could be tapped at the proper point or that a tertiary winding could be used to obtain the necessary feedback voltage. Attempts to use such schemes may be unsuccessful because of phase shifts due to leakage inductance.

(5) This type of circuit is not suitable for use in amplifiers that are designed for grid-current operation, because the relatively high values of R_1 cause appreciable grid-circuit distortion.

Results of Operating Tests—Circuit of Fig. 4b

Inverse feedback reduces this power sensitivity of an amplifier. In circuits having this feature it is, therefore, desirable to use an output tube that has high power sensitivity in order to obtain normal power output with reasonable signal voltage. For this reason, the 6L6 tube is well-suited for use in this type of circuit. Preliminary tests indicate that the shunting effect on a speaker load by two type 6L6 tubes with 10 percent degeneration is comparable to that which can be obtained by two low-resistance triodes in a similar circuit without degeneration. At the same time, the power sensitivity of the 6L6 amplifier is approximately twice that of the triode amplifier and the inherently high efficiency of the type 6L6 tube is retained. In one test, a push-pull amplifier using two type 6L6 tubes without degeneration was set up under the following typical operating conditions: plate voltage, 400 volts; screen voltage, 300 volts; grid bias, —25 volts; plate-to-plate load, 6600 ohms. With a peak grid-to-grid signal of 50 volts, the power output was approximately 34 watts at 2 percent distortion. When 10 percent degeneration was added, using the circuit of Fig. 4b, an output of 34 watts was obtained from the tubes at the grid-current point with approximately 1 percent distortion; grid current flowed with a peak grid-to-grid signal of 130 volts. No changes were made in electrode voltages or circuit constants.

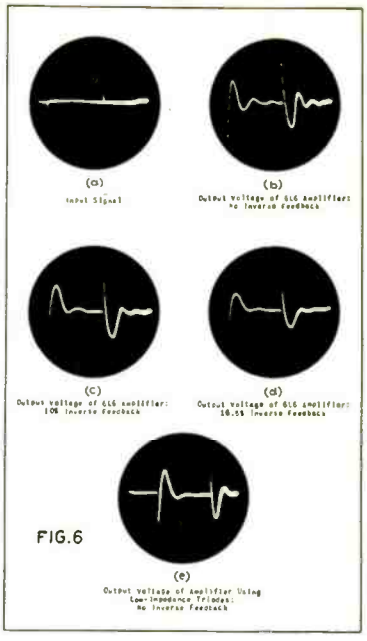


FIG. 6

The frequency characteristics of a typical amplifier with and without inverse feedback and with several values of shunt condensers for the same signal input are shown in Fig. 5. These curves indicate that the rise in power output at the resonant frequency of the speaker decreases and the high-frequency response flattens considerably when this form of degeneration is used. The effect of the shunt condensers on frequency response is small, because the secondaries of the input transformer have low impedance.

An interesting set of oscillograms which indicate the damping action of an inverse-feedback circuit are shown in Fig. 6. A short-impulse signal, shown in Fig. 6a, was fed to the grids of a push-pull amplifier. The output tubes were connected to a loudspeaker through an output transformer; the voice coil of the speaker was connected to a cathode-ray oscillograph in order to observe and to photograph the waveform of the voice-coil voltage. The slowly decaying output voltage in a 6L6 amplifier without degeneration is shown in Fig. 6b; the more rapid decay with 10 percent degeneration is shown at (c). A slight improvement is obtained by using 16.6 percent degeneration, as shown at (d). The output of a similar amplifier using low-impedance triodes is shown at (e).

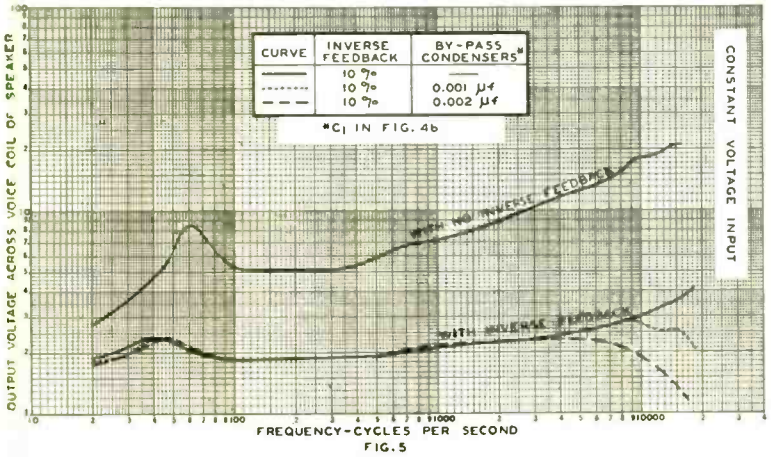


FIG. 5

© Farnsworth Television, Inc. Photos

THE FARNSWORTH TELEVISION RECEIVER

ALTHOUGH DEVELOPMENT WORK is still in progress, Farnsworth Television, Inc., has felt justified in releasing the preliminary details of their television receiver. The fundamental schematic diagram appears on the opposite page.

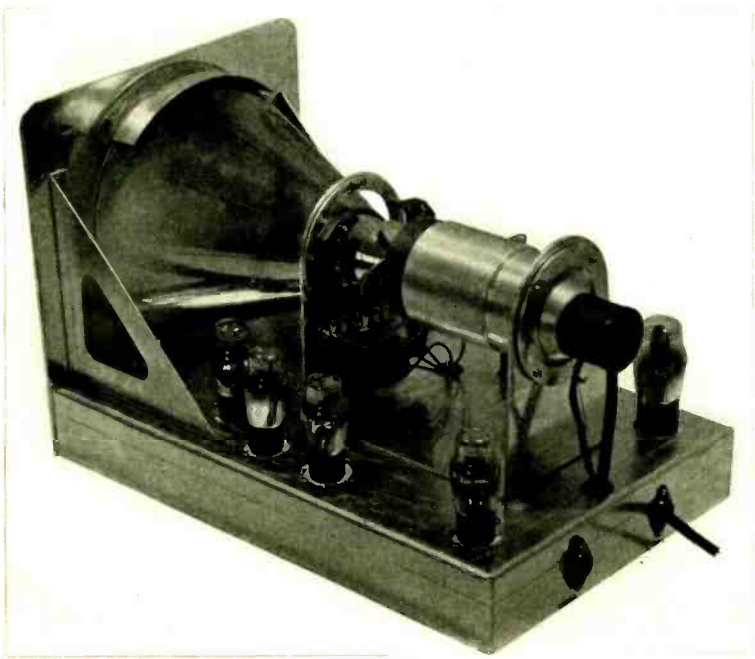
At first glance, the receiver circuits appear to be more or less conventional. In any event, the sound channel may be considered entirely so, except, as in the case of the video channel, for the high intermediate frequency employed. The use of the so-called "acorn" tubes in the sound channel is likewise on the unconventional side.

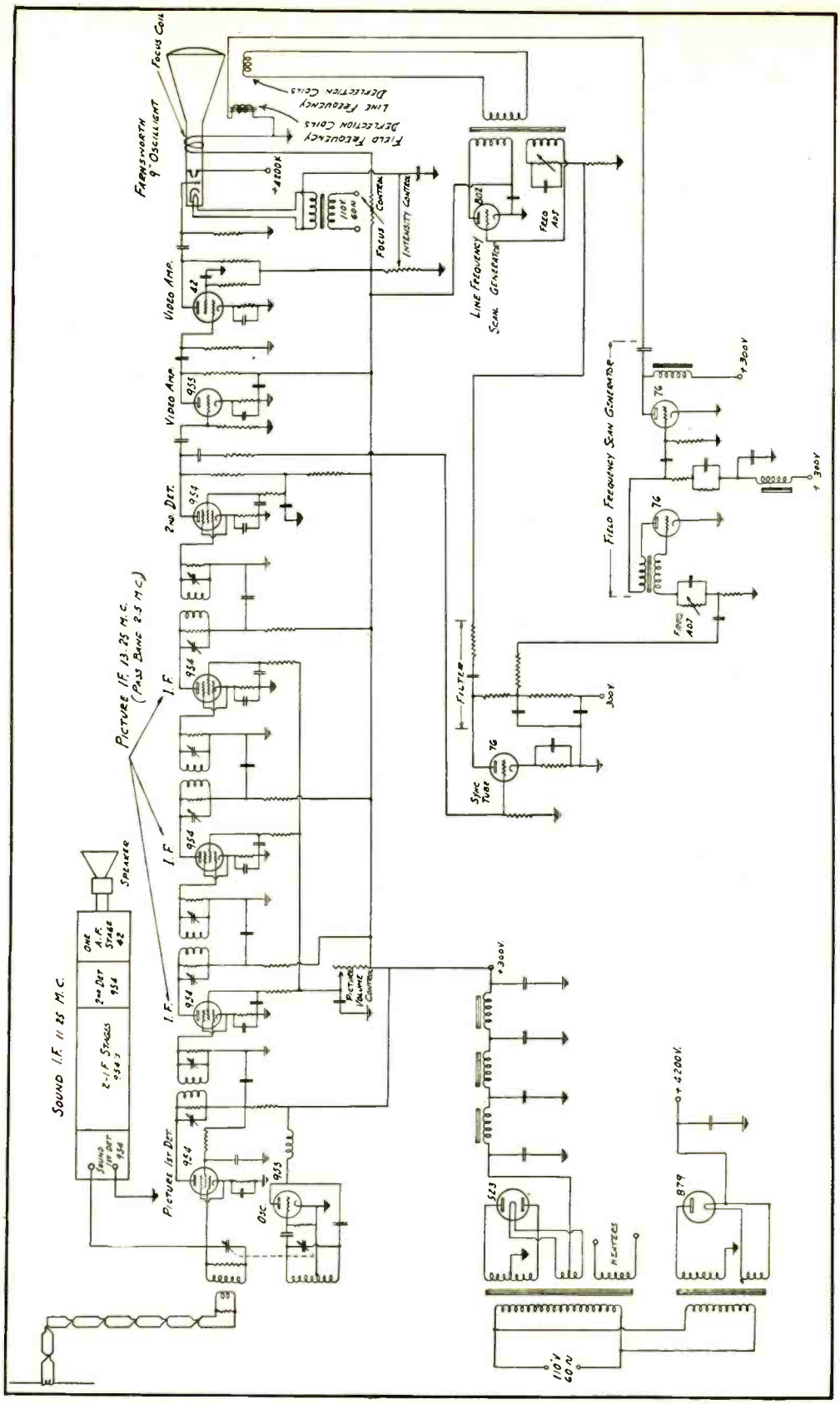
It is immediately apparent from the diagram that the same oscillator functions to supply two intermediate frequencies—one, at 11.25 mc, for sound and the other, at 13.25 mc, for picture.

Presumably, the requisite bandwidth for reasonably high audio quality can be obtained by the usual tuned-circuit i-f transformers, without the use of band-widening resistances such as will be seen shunted across the video i-f transformers. Crystal filters for intermediate frequencies as high as 13.25 mc are not entirely feasible at the present state of the art, although the beautifully sharp cut-off of these filters, along with their nearly square response characteristics should offer an ideal solution to this problem if they could be built to function at these high frequencies—but more research work is necessary. Resonant line filters may have same possibilities as i-f coupling elements.

It is of interest to note the high degree of smoothing necessary for the video circuit B-voltage supply. While figures are not available, it is probably reasonable to assume that the three-section power supply filter gives an attenuation in excess of 70 db to frequencies of 120 cycles and above.

It will be seen in the accompanying illustration of the rear of the receiver that it is built on three chassis. At the top is the Oscillight unit, the middle shelf holds the sound receiver and the remaining parts of the circuit along with the loudspeaker occupy the bottom compartment.





FUNDAMENTAL SCHEMATIC DIAGRAM OF THE FARNSWORTH TELEVISION RECEIVER

OPTICAL PATHS FOR TRANSMISSION AT ULTRA-HIGH FREQUENCIES

by

R. D. RETTENMEYER*

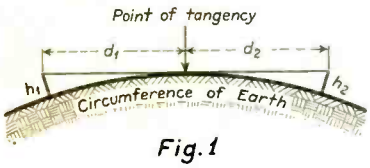
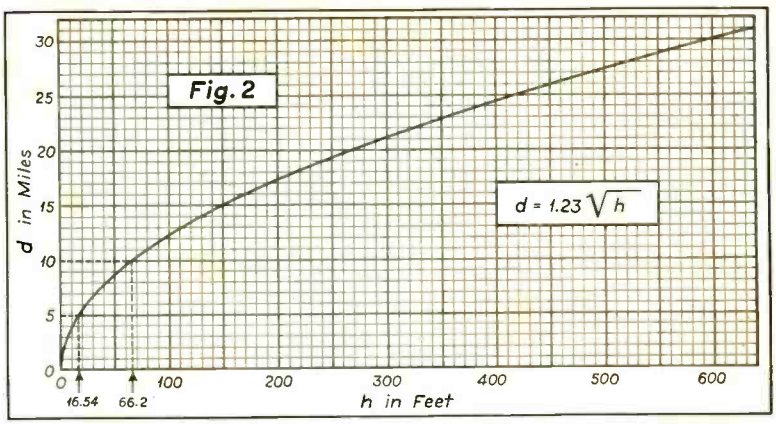


Fig. 1



EXPERIENCE indicates that centimeter waves and even those of a meter or so in length, travel in straight lines similar to light. Assuming this to be true, transmission can be expected between two antennas as long as there is a clear optical path between them. And, in general, this does represent the limit of transmission for such waves.

Let us consider a transmitting antenna of height h_1 (Fig. 1). Now a straight line d_1 to the point of tangency with the earth will be the limit of the optical path. However, if a receiver antenna of height h_2 is erected over the horizon so that a straight line can be drawn between the tops of the two antennas and the point of tangency, this line $(d_1 + d_2)$ will represent the new optical path of limiting transmission.

It is well known that for short distances, say one hundred miles or so, the following approximate relation holds:

$$d_1 = 6500\sqrt{h_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where d_1 and h_1 are both in feet. Or,

$$d_1 = \frac{6500}{5280}\sqrt{h_1} = 1.23\sqrt{h_1} \quad \ldots\ldots\ldots (2)$$

if d_1 is in miles and h_1 in feet. This latter equation is plotted in Fig. 2.

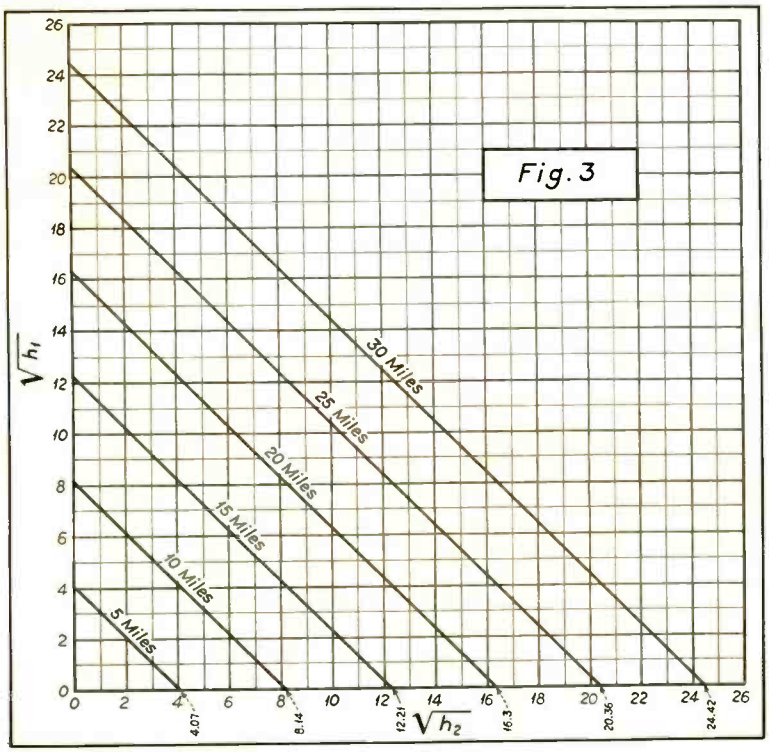
Now from equation (2) we have

$$h_1 = \frac{d_1^2}{(1.23)^2} = \frac{d_1^2}{1.51} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

Fig. 3 is a plot of equation (3):

At a distance of five miles (Fig. 2) we find h to be 16.54 feet. Now the square root of 16.54 is 4.07, and a straight line, in Fig. 3, between 4.07 on the horizontal axis and 4.07 on the vertical axis represents the square root of the antenna height for an optical path of five miles over a spherical earth.

From the foregoing, the receiver antenna height for a given transmitting antenna can be determined for any optical path. As an example, let $h_2 = 100$. The square root of 100 is 10. Then for a 15-mile path (Fig. 3) $\sqrt{h_1} = 2.20$ and $h_1 = 4.84$ feet. Similarly, for a 20-mile path $\sqrt{h_1} = 6.4$, and $h_1 = 40.96$ feet. If desired, of course, the axes can be plotted directly in feet.



*Editor, COMMUNICATION & BROADCAST ENGINEERING.

THE SHOW GOES ON

Radio broadcasting stations, where an interruption is fatal, depend upon SYNTHANE laminated bakelite. While on the receiving end, radio sets in millions of homes function better, more dependably through its use. • SYNTHANE, the same dependable insulation that makes uninterrupted transmission and reception possible, can contribute the same reliability to your product.

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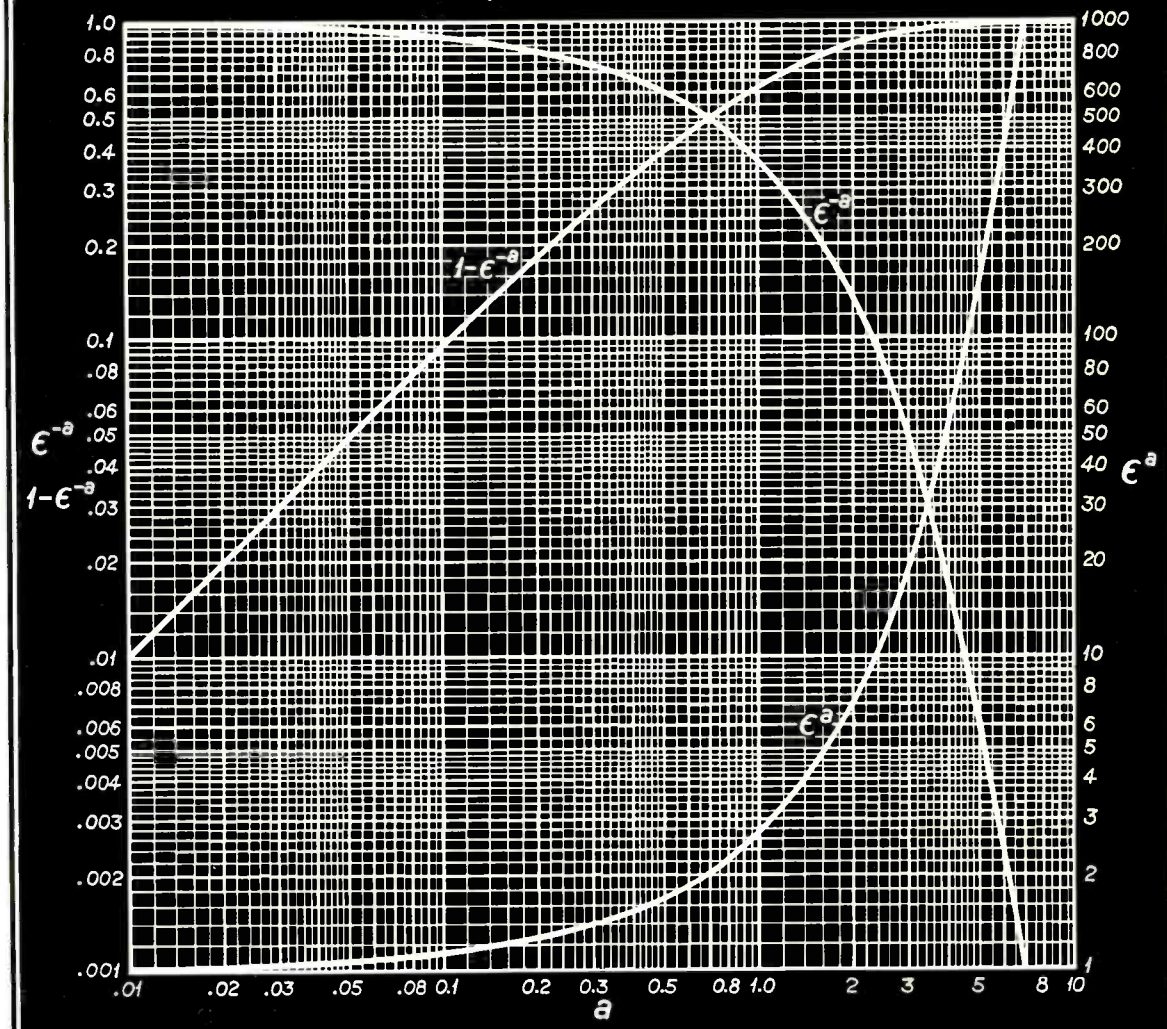
•• Curves of Exponential Functions ••



• Some Uses of Exponential Function Curves •

Charging condenser: $i_c = \frac{E}{R}\epsilon^{-\frac{t}{CR}}$ Discharging condenser: $i_c = -\frac{E}{R}\epsilon^{-\frac{t}{CR}}$

$E_c = E\left(1-\epsilon^{-\frac{t}{CR}}\right)$ $E_c = E\epsilon^{-\frac{t}{CR}}$

Growth of current in an inductance: $i_L = \frac{E}{R}\left(1-\epsilon^{-\frac{Rt}{L}}\right)$ $E_L = E\epsilon^{-\frac{Rt}{L}}$

• Hyperbolic Functions •

$\text{Sinh } a = \frac{\epsilon^{a}-\epsilon^{-a}}{2}$ $\text{Cosh } a = \frac{\epsilon^{a}+\epsilon^{-a}}{2}$ $\text{Tanh } a = \frac{\epsilon^{a}-\epsilon^{-a}}{\epsilon^{a}+\epsilon^{-a}}$

Where a is in radians

AN AUTOMATIC SENSITIVITY TUNING SYSTEM

by A. W. BARBER*

MANY METHODS OF tuning automatic volume control equipped radio receivers are available, but still many receivers have no provisions for indicating exact resonance. Since the quality of reception may be greatly impaired by incorrect tuning, the conclusion must be that the present tuning indicating means are either expensive or unsatisfactory. If this be the case then, an inexpensive indicator and one which may be used under special circumstances would seem desirable. The present system is very inexpensive and is particularly applicable to special cases such as automobile radio receivers.

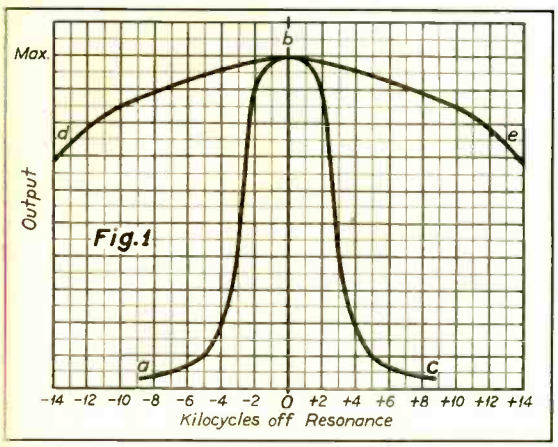


Fig.1

During the early days of broadcasting, tuning was done entirely by ear. The method was satisfactory since the volume of output accurately followed the degree of tuning and the sharper the tuned circuits were, the sharper the variation of output with tuning was. With the advent of automatic volume control the situation changed. The true sharpness of resonance is obscured in an automatic volume controlled receiver since the output tends to remain constant over a wide range of input levels as the receiver is tuned through resonance. The more effective the control system the greater is the obscuring of true resonance.

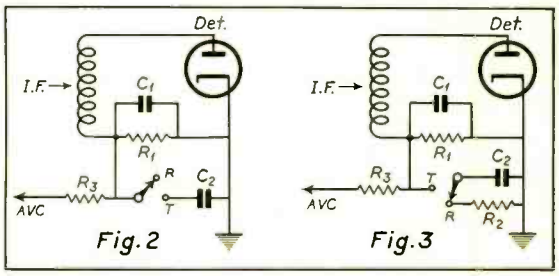


Fig.2

Fig.3

In order to make tuning of automatic volume controlled receivers possible various devices have been used. Meters operating on the cathode current of the controlled tubes, neon lamps operating from the unregulated screen voltage, and finally automatic tuning means have been resorted to. These all add to the receiver cost and in many cases are not entirely satisfactory. The result has been that an increasing number of receivers are being manufactured and sold with no tuning aids provided.

In cases where receiver costs must be held at a minimum the need for tuning aid is not necessarily reduced, but it certainly would be desirable to use one which would add very little expense. In the case of automobile receivers as was pointed out recently in a RADIO ENGINEERING editorial the tuning means should not be visual to take the driver's eyes from the road for even an instant. The system to be described is one which re-

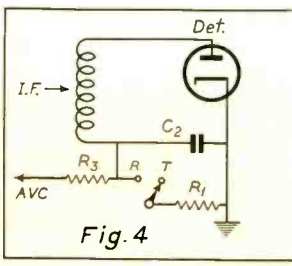


Fig.4

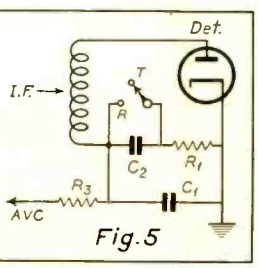


Fig.5

*Consulting Engineer.

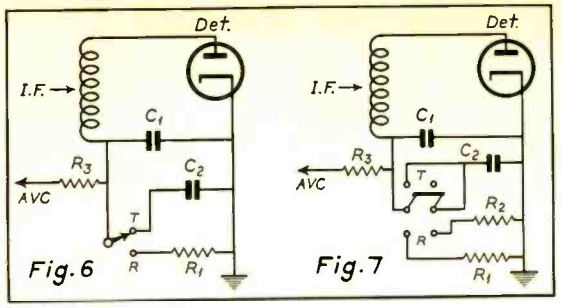


Fig. 6 Fig. 7

stores the apparent selectivity of the receiver to its actual selectivity during tuning. This restored selectivity enables the operator accurately to tune the receiver by ear which, after all, is perhaps the most natural way. In addition the extra expense of this tuning system is so small that it should be possible to apply it to even the most inexpensive receiver, to the advantage of the user in operation and the manufacturer in sales appeal. Furthermore it would not increase the hazard in tuning of automobile radio receivers while driving.

Briefly, the system of tuning to be described consists in permitting the automatic volume control voltage to build up to normal value for the station being tuned in and then "fixing" the control voltage. With the control voltage thus held constant the station may be accurately tuned in by ear, since under this condition the apparent selectivity of the receiver becomes its true selectivity.

Fig. 1 shows a curve "abc" of the selectivity of a radio receiver. When this receiver is tuned to a signal by ear its selectivity will apparently be as shown by curve "dbc" if the receiver is equipped with automatic volume control. While the true resonance point is difficult to locate on curve "dbc," the receiver fidelity will suffer and distortion will result from unequal sideband acceptance if true resonance is not located. The present "fixation" system, however restores the apparent selectivity to the true selectivity and the receiver may be easily and accurately tuned by ear by adjusting to maximum output.

Fig. 2 shows an avc detector with an input coil receiving voltage from an intermediate-frequency amplifier. The normal avc load circuit consists of resistor R_1 by-passed by condenser C_1. The control voltage drop generated across the load circuit passes through a decoupling resistor R_3 to the usual control points in the carrier amplifier. A switch is shown which in position R maintains the normal avc conditions suitable for receiving. The switch when thrown to T for tuning, connects a condenser C_2 across the normal avc load circuit and thereby increases its time constant. If the time constant is increased sufficiently, the control voltage across $C_1 + C_2$ will build up through the low diode resistance to a maximum value on tuning through a station. This maximum value will be a function of the signal strength of the station and the voltage will fall very slowly upon tuning beyond the station. The receiver sensitivity thus becomes essentially fixed at a value consistent with the strength of the desired signal and the receiver selectivity is restored making it easy to tune in the station by ear. Practically, C_1 may be 100 mmfd, R_1 1 megohm and C_2 10 mfd. With the switch turned back to the "receive" position the avc follows normal signal fading variations while in the "tune" position the avc voltage will fall only 10 percent in 1 second.

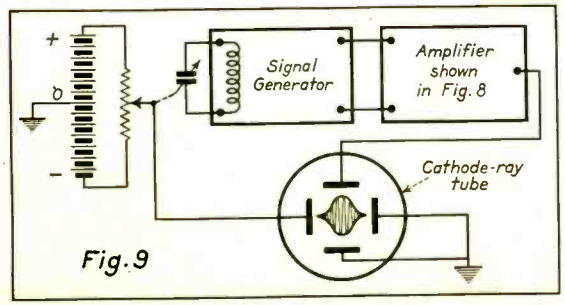


Fig. 9

Fig. 3 shows a system similar to that of Fig. 2, but with the addition of a resistor R_2. This resistor is connected across the fixation condenser C_2, when the switch is in the "receive" position, for the purpose of discharging it. The discharge of condenser C_2 may be desirable, since if a strong station is tuned in, a large voltage is built up across C_2 and if it is not dissipated before attempting to tune in a weaker station, the receiver sensitivity will be so reduced that the weaker station will not be heard. The value of R_2 is not critical and may be almost anything from zero up to about 100,000 ohms. About 10,000 ohms seems a good value as it eliminates clicking on condenser discharge and at the same time quickly discharges the condenser rendering the system ready for tuning again.

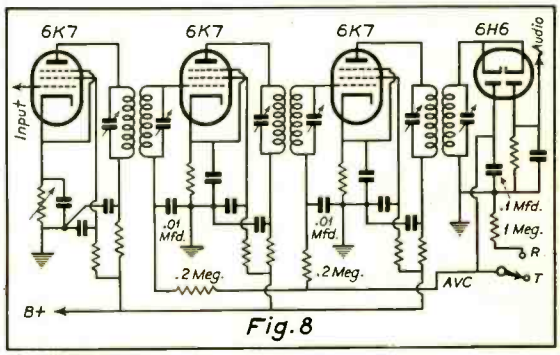


Fig. 8

Fig. 4 shows a simplified circuit in which C_2 R_1 forms the normal receiving position detector load and R_1 is opened for tuning fixation. With R_1 open the effective discharge resistance across C_2 is the maximum possible and C_2 may be greatly reduced in size while retaining the fixation function. The discharge path with R_1 open consists of leakage through C_2, controlled tube grids and other connected circuits. Practically this discharge path may have an effective resistance of the order of 50 to 100 megohms and C_2 may be from 0.02 to 0.25 mfd. In this circuit R_1 may be from 0.1 to 1 megohm.

There may be some distortion generated by the circuit of Fig. 4 due to the long time constant of the avc load if the audio detector is connected to the same circuit. Fig. 5 shows a circuit in which this distortion may be eliminated although the generated avc voltage would be reduced. Suitable components are R_1 100,000 ohms, C_1 100 mmfd and C_2 0.1 mfd.

The components of Fig. 6 may have the same values as those of Fig. 5 with improved results. Fig. 6 is perhaps the best combination of simplicity and efficiency of all the circuits shown.

Fig. 7 is a more complicated circuit in which C_1 R_1 forms the normal avc load circuit. C_2 is the fixation condenser and R_2 is the resistor for discharging condenser C_2 between tuning intervals. This circuit employs a double-pole double-throw switch.

(*Continued on page 29*)

PLASTIC APPLICATIONS IN RADIO

by J. DELMONTE

PLASTIC MATERIALS HAVE found widespread application in the field of radio because of their desirable electrical and mechanical characteristics, and the attractive appearance which they lend to the finished product. The large variety of plastic materials does not afford an easy selection for the radio manufacturer. Consequently, it is proposed to trace briefly the outstanding developments of the plastics industry in this paper, at the same time placing emphasis upon those products which are of greatest interest to the radio industry.

Dr. Baekeland, in 1907, invented a group of phenol resinoids which have been known to industry as "Bakelite." At the expiration of the basic patents, and with the more recent developments, the plastic output in America has almost doubled in the last five years. Plastics are being rapidly absorbed by every field of industry.

Broadly speaking, plastics are of organic origin, a combination of hydrogen, oxygen, nitrogen, carbon, and others. Some of the more important materials are classified in Table I, listing the typical radio applications. The list does not make a pretense at being complete, as a number of plastic products not of immediate interest to the radio world are not included.

Groups I, IIc, and III of Table I are thermo-plastic, that is to say they are rigid under ordinary temperatures, but under excessive heat and pressure they will deform. Groups IIa and IIb are thermo-setting, inasmuch as in their production they become permanently infusible and undergo complete physical and chemical changes.

Molded Plastics

In discussing the applications and the properties of plastic materials, it is often convenient to divide them into two categories, laminated and molded, indicative of the method of manufacture. The molded products, as Table I shows, are used quite extensively in radio parts particularly those subject to the public gaze. A few years ago whenever the question of wood *versus* molded plastic cabinets arose, the wood panels were favored because on altering the design, the cost of writing off the dies did not have to be considered as for the plastics. However, with the modernistic trend in interior decorating becoming more pronounced, some radio manufacturers have found it economical to use molded cabinets of phenol resin, enhanced by brightly colored urea dials and knobs. A light buffing operation after molding yields a product with a high sales appeal. For special small quantity units, laminated plastic panels are comparable with the plywood construction. With molding compositions at a low cost per pound, the economy of molded parts is realized when one considers that careful finishing operations necessary for wood panels are eliminated completely.

Molding of plastic products is accomplished generally at pressures of 2,000 to 8,000 pounds per square inch, and at temperatures in the neighborhood of 300° F. Special cold molding operations for natural resins are conducted at high pressure and heated after molding. To the basic synthetic resin are added various fillers which give to the finished product its physical and chemical char-

TABLE I

Typical Plastic Applications in the Radio Field

Origin	*Applications*	*Typical Trade Name (U. S.)*
Cellulose Derivatives		
Cellulose Nitrate	Dials	Celluloid, Pyroxylin
Cellulose Acetate	Dials, insulation, recording discs	Fibestos, Plastecele
Synthetic Resins (Phenol-Formaldehyde)		
Molded	Cabinets, knobs, dials, instrument cases, bushings, plugs, receptables	Bakelite, Durez
Laminated	Coil forms, panels, tube bases, insulating washers, fabricated parts	Micarta, Synthane, Textolite, Formica
Cast	Small special parts	Catalin, Marblette
Synthetic Resins (Urea-Formaldehyde)	Radio cabinets, dials, knobs, etc., requiring color	Beetle, Plaskon
Synthetic Resins (Miscellaneous)		
Styrol	Low-loss high-frequency insulation, insulating varnish, coil forms and condenser insulation	Viotron
Vinyl Resigns	Recording discs	Vinylite
Glyceryl Phthalic Anhydrides	Molded parts, insulating varnishes, coil impregnating liquids	Glyptal
Natural Resins		
Petroleum Derivatives, Rosin, Pitch, Asphalt, Shellac	Impregnating materials, battery cases, etc.	Cetec, Thermoplax

RADIO PARTS OF LAMINATED PLASTIC, WITH POLISHED SHEETS AND TUBES. (*Synthane Corp.*)

acteristics. Consequently, in specifying a molded plastic material, it is of prime importance to indicate which properties are of cardinal significance. The fillers are grouped as follows:

Wood Flour Filled Plastic—This filler exhibits good electrical characteristics. Bases for radio tubes, switch plates, high dilelectric strength insulators, headphones, and microphones are radio parts using this particular plastic. It is probably the most widely used molded plastic composition. Among other properties is the possibility of incorporating metal inserts at the time of molding. This plastic machines quite easily.

Fabric Filled Plastic—This molded composition is noteworthy in its ability to resist high impact without failure, with a shock resistance 2 to 20 times better than the common wood flour type.

Mica-filled Plastic—Excellent low loss characteristics are imparted to the plastic by powdered mica. Power factors as low as 0.6% at 1,000 kc. have been reported for this type, as compared with the 3.5 to 10% for the ordinary wood-flour filled types. As it machines poorly, the coil forms are usually molded with the grooves for the wires.

Asbestos-filled Plastic—For parts experiencing high temperatures, certain asbestos filled plastics are suitable for temperatures up to 500° F. For the majority of other plastics, the maximum safe temperature is in the neighborhood of 250-300° F.

Various other fillers, as graphite, chalk, rottenstone, etc., are added to bring out specific characteristics. For superior electrical qualities, vacuum dried fillers have proved feasible.

The absorption of water by some of the plastics will alter their primary characteristics, hence in some installations it is important to select a plastic with a low moisture absorption. This property is brought out in Table II, which tabulates the physical and chemical qualities of the more important plastics.

Laminated Plastics

The laminated plastics make use of the fact that the majority of synthetic resins are supplied in liquid form which, dissolved in a thinner, impregnates a fabric or paper base. On the application of heat and pressure to several layers of the impregnated base, hard plastic sheets are obtained which exhibit excellent dielectric properties and high mechanical strength. By using a semi-circular mold and a mandrel it is possible to obtain laminated plastic tubes, which are described below. For general insulating purposes, the laminated plastic has no rival. A large variety of small radio parts, some of which were stamped from laminated sheet stock are illustrated herein. The sheet thicknesses are available in .010 inch up to several inches, and the finish from dull to glossy. The laminated plastics can be adapted to all radio physical requirements as they may be: sawed, sheared, punched, turned, blanked, engraved, riveted, drilled, reamed, ground, and polished. In this connection, it is interesting to note that laminated plastics have been made into gears which have given long, satisfactory service.

The various grades of laminated plastics as applied to the radio industry are listed herein, with their qualities, as defined by the NEMA:

1. Grade X is a craft paper base laminated plastic. It is suitable for general machining and electrical purposes.

2. Grade XP, a paper base laminated plastic, fulfills

TABLE II

Approximate Characteristics of Plastic Materials for Radio Parts

Material	*Weight lb./cu in*	*Tensile Strength psi*	*Water Absorption % in 24 hrs.*	*Dielectric Strength volts/mil*	*PF% at 10⁶ cycles*	*Dielectric Constant at 10⁶ cyc.*
Cellulose Acetate	.047	4,000- 6,000	3.0	600- 800	6.0	...
Phenol-molded Wood Filler	.053	6,000-11,000	0.2 to 0.6	300- 500	4-15	...
Phenol-molded Fabric Filler	.050	6,500- 7,000	1.0	200- 400	5-10	...
Phenol-molded Mica Filler	.070	6,000- 7,000	.002	650- 700	0.75	...
Phenol-molded Asbestos Filler	.070	5,000-10,000	.01—.03	200- 400	5-10	...
Phenol-lamin. Grade X	.050	12,500	3.0	500- 700	4.2	5.0
Phenol-lamin. Grade XP	.050	10,000	2.0	400- 600	4.2	5.0
Phenol-lamin. Grade XX	.050	8,000	1.3	500- 700	4.5	5.5
Phenol-lamin. Grade LE	.050	9,000	1.2	300- 500	4.5	5.0
Styrol Resin	.038	6,000- 7,500	0	500-1,000	.035	...

LAMINATED PLASTIC PARTS — NOTE THE GEAR WHEEL.

(*Synthane Corp.*)

difficult punching operations on cold stock up to 3/32 inch thickness.

3. Grade XX, a rag paper base laminated plastic, exhibits the best electrical characteristics under varying climatic conditions. It has a very low moisture absorption.

4. Grade LE, a fine weave fabric base laminated plastic, has good electrical characteristics, and better mechanical characteristics than those exhibited by the paper base products. It punches and machines easily.

There are several other grades of laminated plastics, but the ones listed above are of greatest interest to the radio industry. They are furnished in natural brown or black, but other colors may be had upon special orders.

The surface finish of the laminated plastic is quite important to the moisture absorption behavior. A finished surface, with the thin resinous layer removed, will absorb considerably more water than a smoothly finished surface. The desirability of low moisture absorption is manifested in such a piece of radio equipment as the variable condenser with laminated plastic insulator blocks supporting the plates. With the increase of water absorption the power loss through the plate supports will increase with time, rendering the unit unsuitable. The high power factor ratings of certain plastics limit their application to condensers. The electrical characteristics of various laminated plastics are given in Table II.

Permanently Thermo-plastic Resins

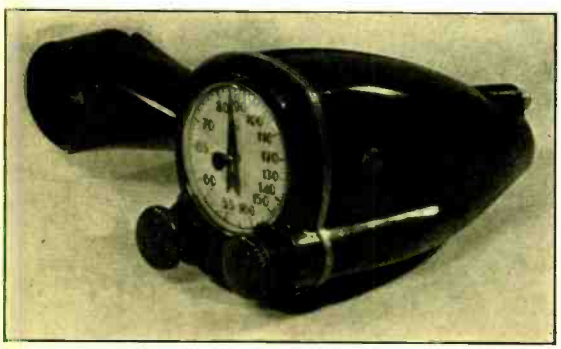
Cellulose acetate and styrol resins are the most important of the thermo-plastic resins (i.e. those which soften above a certain temperature) insofar as the radio industry is concerned. Cellulose acetate is a clear, water-white resin (which may be rendered translucent by various dyes or pigments) suitable for radio dials. It is not inflammable, like its predecessor, "Celluloid." Cellulose acetate has a high dielectric strength, and within the past year its utilization for insulating purposes has been increasing. It possesses another physical advantage, as does styrol, inasmuch as it may be converted into a viscous liquid suitable for "injection-molding," which is analogous to die-casting of metals. The parts may be thus produced at a rapid and economical rate.

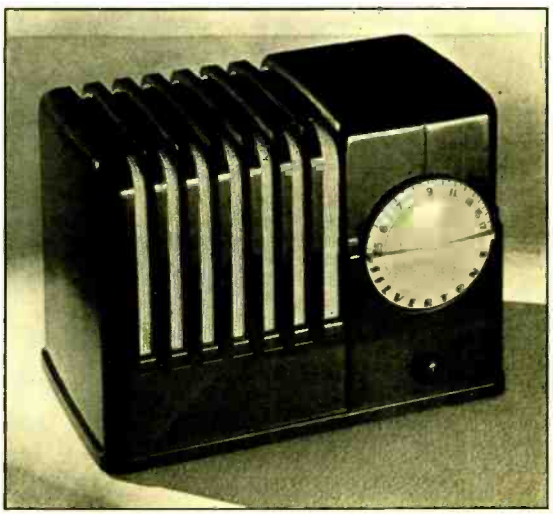
The styrol resin has found its greatest application on radio parts requiring low power loss at very high frequencies. It has practically zero water absorption, and hence retains its excellent properties despite changes in humidity. The specific gravity of 1.04 makes styrol resin one of the lightest of all plastics. In dielectric qualities, it is surpassed only by fused quartz.

To facilitate the radio engineer in his choice of plastic materials for radio parts, Table II has been compiled from manufacturers' data. The values are approximate.

LEFT—RECEIVER CABINET MOLDED IN ONE PIECE.—(*General Plastics.*)

BELOW—REMOTE CONTROL HOUSING FOR AUTO RADIO.—(*Bakelite Corp.*)





THEORY OF THE LOUDSPEAKER
AND OF MECHANICAL OSCILLATORY SYSTEMS

Part III

by HANS RODER*

THE FORCE WHICH is exerted upon a conductor of length *l*, suspended in a magnetic field having an induction of B volt sec/cm² and carrying a current of i amperes is

$$f = Bli \text{ watt sec/cm} = Bli\ 10^7 \text{ dynes.} \quad \ldots\ldots (19)$$

This force is utilized in the electrodynamic loudspeaker for moving a diaphragm in order to convert electrical into acoustical energy. As a rule, a magnet structure is used which is magnetized by d-c current and has an annular airgap. The diaphragm is made of paper in form of a truncated cone, to make it most rigid. On its apex, it carries the voice coil which extends into the airgap.

It may at this point be mentioned that the validity of the theory brought forward in previous discussions is limited to a certain frequency range. The lower limit is given by the frequency of mechanical resonance of the oscillatory system, or rather by a slightly higher frequency. At resonance frequency, the cone excursion becomes so large, as to extend into the region where the edge and spider stiffness becomes non-linear. The upper limit is represented by the frequency where the cone ceases to vibrate as a stiff piston; i.e., with phase and excursion equal on all points of the diaphragm. This frequency is from 350 to 500 cycles, depending on cone type and size.

In a later section, these limitations will be discussed in more detail.

Fundamental Equations and Equivalent Network

The external force, equation (19) which acts upon the voice coil is counteracted by the forces of inertia, friction and compliance:

$$f = m\frac{d^2x}{dt^2} + r\frac{dx}{dt} + \frac{1}{c}x = Bl.i \quad \ldots\ldots (20)$$

where[1]

m....total mass. Consists of: diaphragm mass + voice coil and collar mass + air mass m_a;
c....resulting compliance of edge plus spider;
r....acoustical radiation resistance, plus friction if any;

r and m_a from equations (13 and 14), respectively; values are to be multiplied by 2, because both sides of the diaphragm are exposed to air.

Equation (20) describes the displacement x of the cone in terms of the *electrical current* i. In order to find the relation between cone displacement and the driving voltage e, we must remember that an emf will be induced in the voice coil because it is moving in a magnetic field. This emf is

$$e_r = Bl.\frac{dx}{dt} \text{ volts}$$

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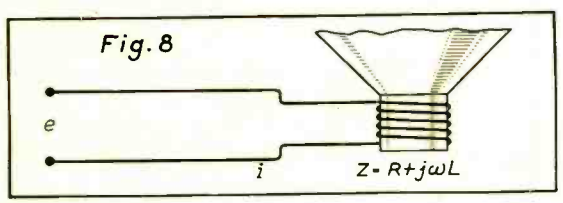
Fig. 8



The voice-coil circuit contains resistance and self-inductance. We can write for the equilibrium of instantaneous voltages:

$$L\frac{di}{dt} + Ri + e_r = e; \text{ or}$$

$$L\frac{di}{dt} + Ri + Bl\frac{dx}{dt} = e \quad \ldots\ldots (21)$$

We want to solve for the steady state solution in case of a sinusoidal driving voltage e. Because the magnitudes L, R, B, m, c, r are all supposed to be constant, also i and x must be sinusoidal time functions.

We may thus write:

$$e = E\varepsilon^{j\omega t}$$
$$i = I\varepsilon^{j\omega t}$$
$$x = x_o\varepsilon^{j\omega t}$$
$$v = \frac{dx}{dt} = j\omega x_o\varepsilon^{j\omega t} = v_o\varepsilon^{j\omega t}$$

We substitute into equations (20) and (21) and obtain:

$$v\left(r + j\left(\omega m - \frac{1}{\omega c}\right)\right) = BlI \quad \ldots\ldots (22)$$

$$j\omega LI + RI + Blv = E \quad \ldots\ldots (23)$$

Elimination of I yields v in terms of E:

$$v\left(r + j\left(\omega m - \frac{1}{\omega c}\right)\right) + \frac{B^2l^2}{R + j\omega L} = E\frac{Bl}{R + j\omega L}, \quad (24)$$

while the elimination of v yields:

$$I\left(R + j\omega L + \frac{B^2l^2}{r + j\left(\omega m - \frac{1}{\omega c}\right)}\right) = E \quad \ldots\ldots (25)$$

The equations (22), (24) and (25) are the *fundamental equations* for the electro-mechanical system which is represented by the loudspeaker.

The equations (22 and 23) can conveniently be represented by the vector diagrams as shown in Fig. 9. We obtain a voltage diagram for the electrical circuit and a force diagram for the mechanical circuit.

Equivalent Network

Inspection of equation (25) reveals a striking similarity of this equation with the expression obtained for the primary current in a two-mesh network (two coupled circuits).

The term

$$\frac{B^2l^2}{r + j\left(\omega m - \frac{1}{\omega c}\right)}$$

[1]Equation (20) is written in form of a "magnitude equation" (and so will be also all following equations). It permits the use of any system of units for numerical calculations, the only requirement being that all magnitudes be measured in units of the *same* system, either of the electrical or mechanical system. If, for instance, in equation (20) mechanical units are used on the left-hand side, then the force Bli must be expressed in dynes, and vice versa. The conversion is most readily performed by means of the conversion table (Table I, Part I).

represents the coupled-in impedance which is reflected from the mechanical circuit into the electrical circuit. If we express

B ....in Volt sec/cm²

l ....cm

r, ωm and $\frac{1}{\omega c}$ in Watt sec²/cm²

$$\left(\text{whereby } 1\ \frac{\text{erg sec}}{\text{cm}^2} = 10^{-7}\ \text{Watt sec}^2/\text{cm}^2\right)$$

then

$$\frac{B^2 l^2}{r + j\left(\omega m - \frac{1}{\omega c}\right)} \qquad \frac{\text{Volt}^2\ \text{sec}^2}{\text{cm}^4} \qquad \frac{\text{cm}^2\ \text{cm}^2}{\text{Watt sec}^2}$$

has the dimension of electrical ohms. Vice versa, in equation (24), the term

$$\frac{B^2 l^2}{R + j\omega L}$$

has the dimension of mechanical ohms and represents the impedance reflected from the electrical into the mechanical circuit. This fact permits us to draw the network of Fig. 10 as the equivalent network of the electro-mechanical system. The network consists of two meshes coupled by a "transformer" which has no primary and secondary stray impedance and whose mutual inductance is equal to Bl. In the primary circuit we have electrical ohms and electrical current; in the secondary circuit we have mechanical ohms instead of electrical ohms and velocity instead of current. The transformer takes care of the proper transformation from electrical into mechanical ohms and vice versa. It can readily be seen that equation (23) is obtained when writing down the expression for the balance of voltages in the primary circuit. The analogous consideration for the balance of forces in the secondary will yield equation (22).

The transformer in Fig. 10 has the peculiar feature of transmitting d-c because its mutual reactance is independent of frequency. This is in perfect agreement with the fact that d-c through the voice coil will produce a displacement of the voice coil, whereby the force exerted upon the voice coil is counterbalanced by the restoring force developed by the spring c.

Referring to equation (22) we see that resonance will occur in the mechanical circuit if $\omega m = \frac{1}{\omega c}$.

If the current through the voice coil is constant, the amplitude will be

$$x_0 = \frac{1}{\omega_0}\,\frac{Bl}{r}.$$

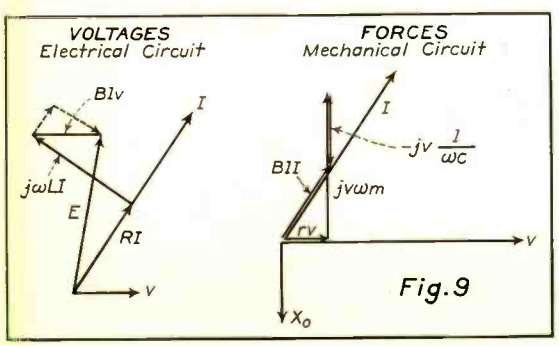


Fig. 9

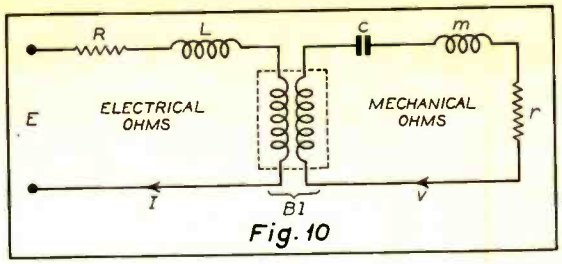


Fig. 10

Because r is small, the amplitude of excursion would become very large, if it were not for the fact that for large excursions the compliance of the spider and of the edge become non-linear. The result is that under these conditions non-linear distortions are produced in the sound output. In case of a pentode driver, the voice coil current is practically constant for constant grid input voltage, because R_p is very much greater than the tube load impedance.

Considering now equation (24) for constant voltage E, we find for the displacement at mechanical resonance ($R >> \omega L$ in practice at low frequencies):

$$j\omega x_0 \left(r + \frac{B^2 l^2}{R}\right) = E\,\frac{Bl}{R}.$$

Because $\frac{B^2 l^2}{R} >> r$, the excursion is very materially reduced. This case is approximately given for a triode driving stage.

We conclude from this that a triode driver stage will be less liable to produce excessive non-linear distortions in the region of mechanical resonance than a pentode driver stage.

According to equation (22) mechanical resonance occurs when $\omega m = \frac{1}{\omega c}$. The mass m represents the total mass associated with the mechanical oscillatory system; it consists of three portions: the mass of the cone, the mass of the collar plus the voice coil, and the mass of the air (accession to inertia). The effect of the last term depends upon the type of baffle used. With no baffle at all the air "circulation" effect is very large. In other words, as the diaphragm pushes forward, the air in front of the diaphragm simply flows into the space back of the diaphragm thus preventing the generation of excess pressure. Hence, the frequency of the mechanical resonance will depend upon the type of baffle used for the loudspeaker. A loudspeaker mounted in a finite baffle will resonate at a somewhat higher frequency than when mounted into an infinite baffle. With radio cabinets, effects are somewhat obscured due to compression (i.e., horn) effects in the cabinet cavity. When speaking of the mechanical resonance frequency of a loudspeaker, it should be stated, with what kind of baffle the resonance frequency was measured.

Acoustical Output and Efficiency

The electrical power required for driving a loudspeaker is in all practical cases supplied by a vacuum tube amplifier. For matching the voice-coil impedance to the tube load impedance a transformer is used. If we assume this transformer to be an ideal transducer with transformation ratio n, we have (see Fig. 11):

$$I = nI_0$$

$$E_p = nE$$

The tube will look into an impedance

$$Z_o = E_p / I_o$$

for which we have from equation (25):

$$Z_o = n^2 \left(Z_1 + \frac{B^2 l^2}{z_2} \right) \quad \ldots\ldots\ldots\ldots (26)$$

wherein

$Z_1 = R + j\omega L$ = primary circuit impedance,

$z_2 = r + j \left(\omega m - \frac{1}{\omega c} \right)$ = secondary circuit impedance.

When considering the values obtained for Z_1 and z_2 in practical cases, then it is readily found that—at frequencies above the frequency of mechanical resonance—the reflected-in impedance B^2l^2/z_2 is very small in comparison with Z_1. In the term Z_1, itself, only the magnitude R is of importance in the frequency range we consider. (For most loudspeaker designs, the frequency where ωL becomes equal to R, is above 1500 cycles.) Thus, equation (26) reduces to

$$Z_o = R_o = n^2 R ,$$

where R is the voice-coil resistance. Introducing the "loading factor" α with

$$R_p = \alpha R_o ,$$

we obtain

$$I_o = \frac{E_o}{R_p + R_o} = \frac{E_o}{R_p} \frac{\alpha}{1+\alpha} .$$

Substituting this into equation (22) we get

$$v\, z_2 = Bll = Bln I_o = \frac{E_o}{R_p} n\, Bl \frac{\alpha}{1+\alpha}$$

$$v\, z_2 = \frac{Bl}{\sqrt{R}} E_o \sqrt{\frac{\alpha}{R_p}} \frac{1}{1+\alpha} \quad \ldots\ldots [2] \quad (27)$$

$$v = \frac{Bl}{\sqrt{R}} \sqrt{\frac{\alpha}{R_p}} \frac{E_o}{(1+\alpha) z_2 + \frac{b^2 l^2}{R}}$$

The *acoustical power* radiated by the diaphragm is rv^2, hence

$$P_{acoustical} = rv^2 = \frac{r}{|z_2|^2} \frac{B^2 l^2}{R} \frac{\alpha}{R_p (1+\alpha)^2} E_o^2 \quad \ldots\ldots (28)$$

Before discussing this result let us derive an expression for the efficiency. We find from an inspection of equation (25):

1—the power dissipated in R is I^2R,

2—the power converted into acoustical energy is

$$I^2 B^2 l^2 \frac{r}{|z_2|^2}$$

3—the total power supplied to the voice coil is

$$I^2 \left(R + B^2 l^2 \frac{r}{|z_2|^2} \right) .$$

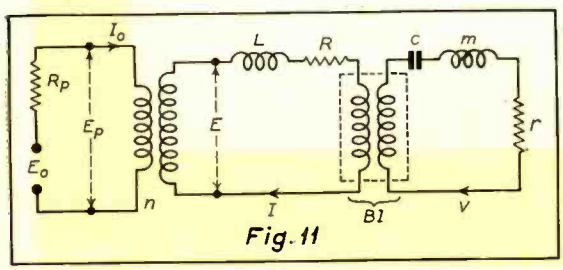


Fig. 11

Hence the *efficiency* becomes,

$$\text{efficiency} = \frac{\text{acoustical output}}{\text{electr. input to voice coil}} =$$

$$\frac{\frac{r}{|z_2|^2} \frac{B^2 l^2}{R}}{1 + \frac{r}{|z_2|^2} \frac{B^2 l^2}{R}} \quad \ldots\ldots [3] \quad (29)$$

For practical loudspeakers, the term $\frac{r}{|z_2|^2} \frac{B^2 l^2}{R}$ is small—usually from 2 to 8% and can be neglected in comparison with 1. We then have the following approximate expression for the efficiency:

$$\text{efficiency} = \frac{r}{|z_2|^2} \frac{B^2 l^2}{R} \quad \ldots\ldots (30)$$

We shall now discuss the various factors which are contained on the right-hand side of equations (28) and (30):

A—The term

$$\frac{\alpha}{R_p (1+\alpha)^2}$$

in equation (28) solely *depends upon the tube* and upon the conditions under which it is operated. The factor α, i.e., the ratio of plate resistance over load resistance is chosen by the designer of the output amplifier from considerations of distortions, plate dissipation, power handling capacity, for the output tube used. This term bears no relation to the loudspeaker design.

B—The term

$$\frac{B^2 l^2}{R}$$

appears in the equations (28) and (30). It has an important significance. The resistance of the voice coil is

$$R = \frac{l}{sq}$$

where l is the length of the wire (cm), q its cross section (cm^2) and s its conductivity (mho/cm). Thus

$$\frac{B^2 l^2}{R} = sB^2 V \quad \ldots\ldots (31)$$

where $V = ql$ = total volume of voice-coil wire (cm^3). Now we have to remember that the magnetic energy P_m, stored in a volume element dV equals

$$dP_m = \frac{1}{2} \int HB \, dV,$$

if H is the field strength and B the induction of the magnetic field. In case H and B are constant throughout the whole volume V we have

$$P_m = \frac{1}{2} \frac{1}{\mu_o} B^2 V \text{ (Joules)} \quad \ldots\ldots (32)$$

because $\mu_o H = B$.

μ_o = permeability of the vacuum $= \frac{4\pi}{10} 10^{-8}$ henry/cm

[2] This expression is somewhat in error at the frequency of mechanical resonance, due to the approximation made above. The exact expression, valid also at resonant frequency, is

[3] This is not the "absolute efficiency" as defined by IRE (1933 Standardization Report, p. 164). The term "absolute efficiency" as defined there has little physical significance and should be discarded.

Substitution of (32) into (31) yields

$$\frac{B^2l^2}{R} = 2\mu_o s P_m \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (33)$$

Equation (33) shows that $\frac{B^2l^2}{R}$ depends upon the conductivity of the voice-coil wire material, and upon the *magnetic energy contained in the volume occupied by the voice-coil wire*. As long as B^2V and s are constant, it does not matter whether R is large or small. The magnetic energy is solely a consequence of the *magnet structure design*: the weight and quality of the iron, the field coil copper weight, field coil shape, air-gap dimensions and clearances required between voice coil and pole faces.

C—Finally, the term

$$\frac{r}{|z_2|^2},$$

which appears in (28), (29), and (30) is made up as follows

$$\frac{r}{r^2 + \left(\omega m - \frac{1}{\omega c}\right)^2}.$$

All magnitudes appearing in this fraction depend (for a given baffle) upon diaphragm properties exclusively: diaphragm diameter, weight of diaphragm, weight of voice coil plus collar, and edge-plus-spider-compliance.

At frequencies greater than the resonance frequency, r^2 can be neglected versus

$$\left(\omega m - \frac{1}{\omega c}\right)^2, \text{ and } \frac{1}{\omega c} \text{ versus } \omega m.$$

Thus we have approximately

$$\frac{r}{|z_2|^2} = \frac{r}{(\omega m)^2} = \frac{r}{\omega^2 (m_{air} + m_{cone} + m_{voice\ coil})^2} \quad \ldots\ldots\ldots\ldots (34)$$

The cone mass, m_{cone}, is proportional to D^2. We substitute the values for r and m_{air} from (13) and (14) and find:

$$\frac{r}{|z_2|^2} = \frac{k_1 D^4 \omega^2}{\omega^2 (k_2 D^3 + k_3 D^2)^2}$$

where k_1, k_2, and k_3 are constants. The voice-coil mass is usually insignificant versus $m_{air} + m_{cone}$; it was, therefore neglected. The result finally becomes:

$$\frac{r}{|z_2|^2} = \frac{k_1}{(k_2 D + k_3)^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (35)$$

It is seen from this relation that loudspeakers with large diaphragms have less sensitivity and efficiency than those with smaller diaphragms (provided magnet structure and voice coil are equal). This conclusion has been confirmed by experimental results. The explanation is, that, with increasing diameter, the cone velocity decreases faster—on account of the increased air loading—than the radiation resistance r will increase. This indicates that the recent trend to larger loudspeaker sizes is a step in the wrong direction as far as loudspeaker efficiency is concerned.

The voice-coil wire volume, V, in equation (31) and the voice-coil mass, appearing in (34), are, of course, directly proportional. Therefore, the terms

$$\frac{B^2l^2}{R} \text{ and } \frac{r}{|z_2|^2}$$

are not wholly independent. However, in most practical designs, the voice-coil mass is only a small fraction of the total diaphragm mass; consequently the effect of voice-coil mass upon $\frac{r}{|z_2|^2}$ is small. For high-frequency horn-type loudspeakers, however, the voice-coil mass may represent a large fraction of the total diaphragm mass.

(To be continued)

AN AUTOMATIC SENSITIVITY TUNING SYSTEM

(Continued from page 16)

In Fig. 8 is shown an intermediate-frequency amplifier followed by a double diode detector for generating avc and audio voltages. The fixation circuit is the same as was shown in Fig. 4. This circuit was set up using the constants shown and oscillograms of its operation were made. The method of making the oscillograms is shown in Fig. 9. A source of direct current was connected through a potentiometer to the horizontal deflection plates of the cathode-ray tube. The potentiometer shaft was ganged with a vernier frequency control condenser of a signal generator. The output of the signal generator was connected to the input of the amplifier of Fig. 8 and the amplifier output was fed to the vertical deflection plate of the cathode-ray tube. Rotation of the potentiometer thus moved the cathode-ray tube spot horizontally across the screen and varied the frequency of the signal generator. The main frequency control of the generator was adjusted so that when the cathode-ray tube spot was in the center of the screen, the generator frequency corresponded to the resonant frequency of the amplifier under test. The resulting cathode-ray tube pattern was photographed as shown in Fig. 10. The left-hand patttern shows the amplifier output as the

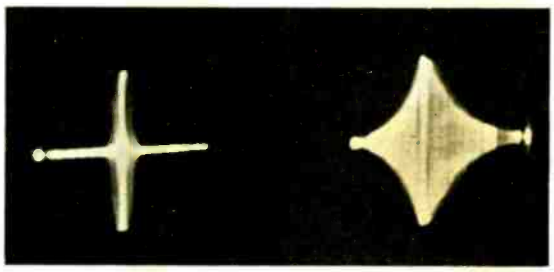


Fig. 10

potentiometer was varied back and forth at a rate corresponding to a normal tuning speed and with the avc circuit normal. The right-hand pattern shows the result of throwing the switch of Fig. 8 to the tune or fixation position. It will be evident from these curves how broad the normal avc receiver is to manual tuning and how the apparent selectivity is greatly increased by the fixation circuit making accurate tuning easy.

It is felt that the system which has been described forms a suitable tuning means for avc radio receivers. Its simplicity and low cost should recommend it for use in even very inexpensive receivers. Since it is an audible tuning system it should be useful in cases where visual tuning is not feasible such as in the case of automobile radio receivers.

RMA NEWS

MILWAUKEE PLAN TO PROHIBIT AUTOMOBILE RADIO IS POSTPONED

Introduction of an ordinance in the Milwaukee city council to prohibit automobile radio was followed promptly by opposition from RMA and Milwaukee jobbers and dealers and further consideration of the proposed ordinance has been postponed at least until October. If revived or reintroduced the ordinance will be vigorously opposed by RMA, the automotive and also the auto trade, broadcasters', motorists' organizations and others.

The Milwaukee Police Department sponsored the ordinance in the city's anti-noise campaign. Police Chief Laubenheimer of Milwaukee also believes that automobile radio is a hazard, distracts attention of drivers, and frequently causes accidents although the overwhelming judgment of state and municipal authorities, especially in the absence of any accident anywhere directly attributable to automobile radio, is that it is a safety factor, reduces driving speed, keeps drivers alert and actually tends to reduce traffic accidents.

Introduction of the police ordinance in Milwaukee July 20 was followed promptly by vigorous action from RMA. All RMA members and also Wisconsin radio and automotive interests opened preliminary attack on the ordinance. However, under technical rules of the Milwaukee council, the ordinance was blocked for three months, at least until October.

In addition to the proposed ban on automobile radio, making operation (not installation) of radio sets a misdemeanor with fines from $1 to $25, the proposed Milwaukee ordinance would prohibit operation of sound trucks, loudspeakers, public-address systems, etc., on vehicles, in addition to automobile radio.

The RMA will follow closely all developments in connection with the ordinance when its further consideration may be resumed next October. No such regulation or restriction of automobile radio has been adopted by any state or city and similar legislation proposed in Connecticut and St. Louis was killed after their officials received complete information regarding automobile radio and after organized opposition led by RMA.

EXPORTS INCREASE IN MAY JUNE AND FISCAL YEAR

American exports of radio during the fiscal year ending June 30 totaled $26,176,153, an increase of 3.76 percent over the fiscal year of 1935, according to RMA compilations of official reports of the United States Bureau of Foreign and Domestic Commerce. The greatest increase was 6.18 percent during the last six months ending June 30 over the similar period of 1935.

The table gives the detailed statistics compiled by RMA from the Government reports.

RMA BOARD TO MEET

A meeting of the RMA Board of Directors during September is being arranged by President Leslie F. Muter. Reports will be received from several Association committees which have been unusually ac-

RADIO EXPORTS FISCAL YEAR 1936

Month	Total	Receiving Sets		Receiving Tubes		Components	Loud Speakers		Other Accessories	Transmitting Apparatus
	Value	*Number*	*Value*	*Number*	*Value*	*Value*	*Number*	*Value*	*Value*	*Value*
July 1935	$1,712,739	38,102	$964,793	444,119	$185,807	$383,478	13,177	$30,710	$37,543	$110,408
August	2,051,579	44,896	1,167,141	515,653	223,010	449,990	12,511	34,349	37,319	139,770
September	2,143,756	50,275	1,255,867	677,081	284,727	433,601	15,491	39,945	51,409	78,207
October	2,714,113	63,552	1,659,892	667,185	307,320	504,103	27,751	51,882	38,057	152,859
November	2,892,778	74,982	1,959,569	614,595	276,070	433,349	23,928	50,748	51,720	121,322
December	2,261,351	54,148	1,546,312	523,213	237,613	336,275	10,804	25,524	25,991	89,636
6 Months	$13,776,316	325,954	$8,553,574	3,441,846	$1,514,547	$2,540,796	103,662	$233,158	$242,039	$692,202
January 1936	$2,039,522	46,951	$1,243,672	491,354	$227,822	$280,027	12,382	$29,802	$35,037	$223,163
February	1,828,844	45,383	1,145,272	535,780	225,738	271,841	15,244	28,631	39,556	117,806
March	2,229,717	58,595	1,330,100	928,827	382,930	363,035	17,705	35,050	40,163	78,439
April	2,104,065	46,046	1,221,688	648,955	277,425	401,976	20,907	45,127	37,201	120,648
May	2,191,353	45,071	1,073,249	639,876	268,260	596,202	31,809	63,134	48,698	141,810
June	2,006,336	39,460	863,221	647,596	277,037	522,116	40,378	83,983	43,689	216,290
6 Months	$12,399,837	281,506	$6,877,202	3,892,388	$1,659,212	$2,435,197	138,425	$285,726	$244,344	$898,156
12 Months	$26,176,153	607,460	$15,430,776	7,334,234	$3,173,759	$4,975,993	242,087	$518,884	$486,383	$1,590,358

RADIO EXPORTS FISCAL YEAR 1935

July 1934	$2,179,147	34,909	$1,030,693	961,546	$469,491	$462,966	15,453	$40,270	$43,827	$131,900
August	2,040,412	41,067	1,096,674	625,719	306,865	422,901	7,968	22,751	64,982	126,259
September	1,856,501	41,878	1,138,948	469,509	214,501	358,147	15,554	37,199	50,340	57,366
October	2,378,592	57,678	1,454,593	648,326	291,953	437,442	20,640	50,062	51,556	92,986
November	2,780,569	77,844	1,906,271	600,778	274,221	428,808	18,235	35,171	49,647	86,451
December	2,313,561	60,170	1,644,801	465,835	197,480	295,259	14,716	32,657	37,737	105,627
6 Months	$13,548,782	313,546	$8,271,980	3,771,713	$1,754,511	$2,405,523	92,566	$218,110	$298,089	$600,569
January 1936	$1,989,429	43,898	$1,172,129	481,668	$219,237	$292,903	11,047	$25,522	$33,371	$246,267
February	1,920,395	46,470	1,262,556	403,141	183,602	260,854	10,500	28,441	35,616	149,326
March	2,106,562	47,693	1,251,486	457,008	210,010	412,559	14,100	44,633	43,367	144,507
April	1,989,663	47,980	1,250,530	551,280	236,028	331,275	8,595	20,134	50,957	100,739
May	1,892,551	41,302	1,078,377	673,606	281,941	349,964	27,615	55,279	38,306	88,684
June	1,779,272	35,912	903,639	579,511	236,903	385,607	23,975	52,227	45,452	155,444
6 Months	$11,677,872	263,255	$6,918,717	3,146,214	$1,367,721	$2,033,162	95,832	$226,236	$247,069	$884,967
12 Months	$25,226,654	576,801	$15,190,697	6,917,927	$3,122,232	$4,438,685	188,398	$444,346	$545,158	$1,485,536

tive during the summer period and new projects for the fall and winter months will be planned by the RMA Board.

EXCISE TAX COLLECTIONS FOR JUNE AND FISCAL YEAR

June 1936 collections of $422,696.37 by the U. S. Internal Revenue Bureau of the 5 percent excise tax on radio and phonograph apparatus brought total federal tax collections for the fiscal year 1935-36 to $5,075,270.82, an increase of 40 percent over $3,624,904.31 collected during the previous fiscal year of 1934-35. These figures do not include large additional federal excise taxes on automobile sets and radio automotive accessories, and reflect increased business of the radio industry during the past fiscal year.

The 5 percent excise tax collections last June were 111.5 percent over the collections for June 1935, apparently due to belated tax settlements closing the accounts with the Government for the fiscal year.

Detailed figures on radio and phonograph tax collections, not including substantial additional taxes collected on automobile radio sets and accessories but not segregated in the Government report of automotive taxes, are given herein:

Fiscal Year 1935-36		*Fiscal Year* 1934-35	
July	$146,320.19	July	$92,007.81
August	319,331.10	August	229,681.76
September	339,382.47	September	305,291.91
October	643,440.02	October	280,699.11
November	571,479.61	November	462,638.47
December	730,002.69	December	568,117.99
Total 6 Months	$2,749,956.08	Total 6 Months	$1,938,437.05
January	$601,144.68	January	$398,177.40
February	423,673.38	February	193,467.30
March	336,043.04	March	350,334.03
April	321,006.84	April	253,066.45
May	220,750.43	May	291,536.71
June	422,696.37	June	199,885.37
Total 6 Months	$2,325,314.74	Total 6 Months	$1,686,467.26
Total Fiscal Year	$5,075,270.82	Total Fiscal Year	$3,624,904.31

MAY 1936 LABOR INDICES

Seasonal activity was a primary factor in a 14.2 percent increase in radio factory employment in May 1936, according to the latest labor report of the U. S. Department of Labor, Bureau of Labor statistics, and compared with May 1935, employment in radio and phonograph factories was 28.2 percent higher. The May 1936 employment index figure was 215.4 percent compared with the three-year official average of 1923-25, while the April index figure was 188.6.

Radio factory payrolls in May 1936 were 20.3 percent above the previous month of April, and 39.7 percent above May 1935. The May index figure was 141.9 percent compared with the three-year official average.

Average weekly earnings in radio factories last May were $20.42, compared with $19.36 during the previous month of April, an increase of 5.3 percent, and average weekly earnings during May were 9.2 percent above those of May 1935.

Average hours worked per week in radio factories last May were 38.2 hours compared with 35.5 hours during the previous month of April, an increase of 7.2 percent and they were 13.8 percent above those of May 1935.

Average hourly earnings during May of radio factory employees were 53.5 cents, compared with 54.6 cents during the previous month, a decrease of 1.7 percent, and they were 4.4 percent less than average hourly earnings in May 1935.

ARGENTINE IMPORT CONCESSION

The Argentine Government has announced import concessions, through exchange rates, on imports of American radio tubes and some miscellaneous parts and accessories but the concessions are not applicable to complete receiving sets or loud speakers. According to a report received by the Department of Commerce from the American Trade Commissioner at Buenos Aires, the Argentine Government modified its regulations, providing favorable exchange to an additional list of American merchandise including radio tubes and certain parts and accessories. These American radio products formerly were not accorded "prior import permits," compelling such imports to be financed by the less favorable "free" exchange rate, which included a surcharge. Under the new regulations radio tubes and certain accessories, excluding complete sets and loud speakers will, whenever possible, be accorded "prior import permits," making possible their importation at the more favorable "official" instead of the current "free" exchange rate. Needs of the Argentine radio manufacturing industry for the American tubes and accessories is believed to be the basis of the Argentine concession.

CANADIAN SALES IN JUNE

Canadian manufacturers during June 1936, sold 7,078 AC sets with a list value of $649,560; 3,647 battery sets valued at $264,321 and 1,907 automobile receivers valued at $114,085, according to figures received by RMA through the cooperation of the Canadian RMA. Canadian inventories on June 30 were 18,267 AC sets; 11,249 battery sets and 1,572 automobile sets. Projected production of Canadian manufacturers for the quarter ending September 30 next was reported to be 67,937 AC sets, 25,388 battery sets and 2,027 automobile chassis, a total projected production for the third quarter of 95,352 sets.

BROADCASTERS AND RMA PREPARE FOR FCC HEARING

Broadcasters and also RMA are preparing for another hearing, scheduled for October 5, of the Federal Communications Commission at Washington on allocation and also interference problems. Broadcasters will attend in great numbers as the principal subject of the Commission's inquiry is reallocation of frequencies in the 550-1600 KC band. Prevention of interference with this band is another important subject affecting the manufacturing industry and specific subjects of interest to manufacturers and RMA are practicable standards of receiver selectivity and fidelity.

The manufacturing subjects on the agenda of the Commission are being studied by the RMA engineering division, of which Dr. W. R. G. Baker of Bridgeport, Connecticut, is chairman and also Virgil M. Graham of Emporium, Pennsylvania, chairman of RMA standards section, and Dr. L. F. C. Horle. They held a preliminary meeting at New York August 14 to prepare for presentation of the RMA recommendations at the Washington hearing in October.

FOREIGN NEWSPAPERS USE U. S. SHORT-WAVE PROGRAMS

Foreign listening to short-wave programs of American stations has been given great impetus, according to reports received by the U. S. Department of Commerce, through the American short-wave program service provided by the RMA. This was inaugurated about June 1, the RMA programs of American short wave stations being distributed by the Department of Commerce to all of its representative abroad.

Many foreign newspapers in some of the larger European cities are now using American short-wave programs daily and the new program service, provided by RMA and distributed by the Government, promises to become as popular and as established a feature in the foreign press as the foreign short wave programs now are in leading American daily newspapers. If anything, interest in and use of short wave radio is greater in Europe than in the United States, in the opinion of many Government officials abroad. Benefits to American relations abroad as well as stimulus to foreign trade are results cited by officials.

BOOK REVIEW

HANDBOOK OF ENGINEERING FUNDAMENTALS, edited by O. W. Eshbach, published by John Wiley & Sons, Inc., New York. First edition. 1081 pages. Price $5.00.

The publishers state in their preface to this latest addition to the engineering handbook series, "In making plans for new editions . . . . it soon became clear that engineering science and practice had developed to such an extent that handbooks were growing beyond all practical bounds. They had become both bulky and inconvenient and contained much duplicated material." With these sentiments we are in hearty accord. The term "handbook" has all too often come to mean a book that not even the hardiest engineer would attempt to carry further than across the office.

With this thought in mind, the publishers have divided the so-called handbook into sections; the book being discussed is one of these sections, dealing entirely with theory and mathematics applicable to any branch of engineering.

There are thirteen sections in the book, each prepared by an acknowledged authority. Without attempting to discuss each section, this reviewer would like to point out that the portion devoted to mathematics is perhaps as complete as any he has even seen; it compares favorably with many of the books which are supposed to give a comprehensive view of the subject.

The make-up of the entire book is convenient; we are especially impressed by the section- and page-numbering method used. The indexing is unusually complete.

News Of The Industry

BAKELITE BOOKLET

The seventh edition of "Bakelite Molded," an informative publication showing and describing various applications of molded bakelite, has just been made available by the Bakelite Corp., 247 Park Avenue, New York, N. Y.

— RE —

POLYIRON DATA SHEET 536

The Aladdin Radio Industries, Inc., 466 West Superior Street, Chicago, Ill., has announced a new bulletin on the technical characteristics of their products. Included in the bulletin are data on circuits and recommended combinations of tubes for use with the various components manufactured by this company.

— RE —

PLASTICS COMPETITION CLOSES

Attesting to the growing importance of plastics in practically every branch of industry, the first annual Modern Plastics Competition closed Sept. 5 with almost a thousand products entered in this international contest to promote development of these chemically-made materials.

The products competing must have been designed and put on the market during the year ending August 15th, and are classified in three groups—industrial, style and decorative. Each group will receive three cash awards, and will have its own board of judges made up of competent authorites in engineering, architectural, style and fashion field. The judges expect to finish their work and announce the awards about the 15th of September.

A tabulation of the entries shows more products competing in the industrial group than in the other two classifications, largely due to the application of plastics in electrical, radio and aeronautical engineering during the past year.

— RE —

REYNOLDS PLASTIC OPENS N. Y. OFFICE

Rapidly growing demand for Reynolds Molded Plastics causes the Reynolds Spring Company of Jackson, Michigan to open a sales office in New York City. The new office, under the direction of Herbert S. Reynolds, Jr., is located at 90 West Street. Telephone Rector 2-8563. Mr. Reynolds, long connected with the factory at Jackson, Michigan, has ample facilities to handle all inquiries, to aid in the development of plastic applications, and to care for the customers' interests promptly.

Other Reynolds sales offices are located at Rochester, N. Y., Cleveland, Detroit, Chicago, St. Louis, Milwaukee and Minneapolis.

— RE —

DR. WESTON DEAD

Dr. Edward Weston, famous scientist and inventor, who established the first factory in America for the exclusive manufacture of indicating electrical instruments, died at his home, Montclair, N. J., on August 20. Among the many honors which had been given to him in recognition of his pioneering work, were: the presidency of the AIEE (in 1888), the medal of the Franklin Institute, and honorary degrees from several universities.

IRE ROCHESTER FALL MEETING

The annual Rochester Fall Meeting of the Institute of Radio engineers has been scheduled for November 16, 17, and 18. The meetings will be held at the Sagamore Hotel, Rochester. The RMA Engineering Division is co-operating with the IRE, and advance reports indicate that this meeting will continue to uphold the high standards set in the past. The complete program will be announced in these pages as soon as it is available.

— RE —

GENERAL CABLE CATALOG

A new bulletin, SS2, on Super Service Portable Cable, is being distributed by the General Cable Corporation, White Plains, N. Y. Copies may be obtained from the company by writing to them at the address given.

— RE —

CORNELL-DUBILIER MOVES

Cornell-Dubilier Corporation announces the removal of their plant and general offices to South Plainfield, N. J. All future correspondence and orders should be addressed to the new location.

A special catalogue has been issued by the Cornell-Dubilier Corporation covering the new reduced prices recently announced for their line of "Dwarf-Tiger" condensers.

This catalogue lists the entire line of this series, together with catalogue numbers, and shows both the old and new price schedules. This catalog, No 132A, will be mailed to those requesting it from the Cornell-Dubilier Corporation, 1000 Hamilton Boulevard, South Plainfield, New Jersey.

— RE —

ATLAS CATALOG

A new catalog, describing their line of wire-wound tubular resistors, has been issued by the Atlas Resistor Co., 423 Broome Street, New York, N. Y.

— RE —

TECHNICAL DATA ON DIPPING BASKETS

A bulletin giving technical information on the various alloys used for dipping baskets, has been issued by The C. O. Jelliff Mfg. Corp., Southport, Conn. The bulletin contains valuable data on the resistance to corrosion shown by the metals.

— RE —

KAHN JOINS STANDARD TRANSFORMER

Jerome J. Kahn, president of the Standard Transformer Corporation, announces the appointment of Eugene Carrington as Sales Manager of the Distributor's Division of the firm.

— RE —

UNIT REPRODUCERS' N. Y. OFFICE

In order to more capably handle the increasing demands of manufacturers, jobbers and dealers, the Unit Reproducers Mfg. Company has established a New York City office located at 1472 Broadway.

DEUTSCHMANN CAMPAIGN

Tobe Deutschmann Corporation of Canton, Mass., announces a new advertising and sales promotional campaign to promote the sales of a new line of electrolytic condensers. This campaign is addressed to the entire radio field, with special emphasis upon jobbers and service men.

— RE —

LAYTEX BULLETIN

The United States Rubber Products, Inc., 1790 Broadway, New York, N. Y., is issuing a new handy manual—"Laytex, The New Dielectric in Communication and Control Wires and Cables"—for use by engineers, contractors and designers when specifying wire and cable installations for signal and control service.

The manual gives detailed information, graphs and tables indicating the characteristics and proper uses of the various types and gauges of "U. S." Laytex insulated communication tables, fire alarm and police signal cables, supervisory control cables, telephone cable, outside telephone wire, inside telephone wire, and emergency telephone wire.

— RE —

FOX THEATRES SIGN FOR RCA SERVICE

The National Agency Corporation, headed by Spyros Skouras, president, has completed arrangements with the Photophone Division of the RCA Manufacturing Company, whereby the sound reproducing equipment in more than three hundred Fox controlled theatres in the middle west and west will be serviced by RCA engineers.

— RE —

MILLS JOINS FRANKLIN TRANSFORMER

Franklin Transformer Mfg. Co., 607 Twenty-second Avenue, N. E., Minneapolis, Minn., announces the appointment of H. L. Mills as sales manager of the transformer division.

— RE —

SHALLCROSS CATALOG

A new complete loose leaf catalogue giving characteristics and specifications of precision wire wound resistors, decade resistance boxes, bridges, test equipment and switches, is now available. Write Dept. V-1, Shallcross Mfg. Co., Collingdale Penna.

— RE —

SYLVANIA SETS SAFETY RECORD

H. W. Zimmer, factory manager of the Emporium plant of Hygrade Sylvania Corporation is proudly exhibiting Merit and Honor awards won by Sylvania employees groups in the 1935 Accident Prevention Contest conducted by the Pennsylvania Department of Labor and Industry. Manhours worked by participating employees during the period of the contest totalled 2,823,550 with but 540 hours of lost time due to accidents.

(*Continued on page* 47)

BUYERS DIRECTORY

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 Recording and Miscellaneous Equipment

AALLOY TRANSFORMER CO. (See page 48)
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 CO. (See page 48)
175 Emmet Street, Newark, N. J.

AMPEREX ELECTRONIC PRODUCTS, INC.
79 Washington St., Brooklyn, N. Y.

PRODUCTS

Transmitting and Therapeutic Tubes.

AMPERITE CORPORATION (See page 42)
561 Broadway, New York, N. Y.

PRODUCTS

Current and Voltage Regulators; Velocity Microphones; Preamplifiers; Microphone Stands; Transformers.

EXECUTIVES

President.....Elliot Leeds — Chief Engineer...Samuel Ruttenberg
Vice-President....Wm. Ruttenberg — Purchasing Agt....Wm. Ruttenberg
Advertising Mgr.....H. J. Gold

BRANCH OFFICES OR REPRESENTATIVES

S. K. Wallace, Lutz, Fla.
S. B. Darmstader, 520 No. Michigan Ave., Chicago, Ill.
J. U. McCarthy, 1768 Laurel Ave., St. Paul, Minnesota.
E. K. Seyd, 184 Sigourney St., Hartford, Conn.
E. P. Scott, 1836 Euclid Ave., Cleveland, Ohio.
W. S. Trinkle, 1438 No. 13th St., Philadelphia, Pa.
Don. C. Wallace, 4214 Country Club Drive, Long Beach, Calif.
R. R. Bean, 202 Smith Tower Annex, Seattle, Wash.
J. B. Fitzner, 153 E. Elizabeth St., Detroit, Mich.
N. W. Kathrinus, 3916 Potomac St., St. Louis, Mo.
H. B. Parke, 508 3rd Ave., Pittsburgh, Pa.
H. B. Segar, 601 Ellicott Sq., Buffalo, N. Y.

ASTATIC MICROPHONE LABORATORY, INC.
40 Hubbard Road, Youngstown, Ohio.

PRODUCTS

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

EXECUTIVES

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 5th Ave., New York, N. Y.

PRODUCTS

Electric Pickups and Turntables; Electro-acoustic Apparatus.

EXECUTIVES

President.....Maximilian Weil — Vice-President.....G. V. Sullivan

EXPORT

M. Simon & Sons Co., Inc., 25 Warren St., N. Y.

BEACON MICROPHONE CO.
390 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 — Sales Manager.....G. E. Wright
General Manager..F. Dawson Bliley — Chief Engineer.....C. C. Collman
Advertising Mgr.....A. K. Shenk

EXPORT

Pan-American Trading Company, 25 South William Street, New York, N. Y.
Frazar & Co., Ltd., 7 Front Street, San Francisco, Calif.

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

BRUSH DEVELOPMENT CO. (See page 46)
E. 40th & Perkins Ave., Cleveland, Ohio.

PRODUCTS

Sound-Cell Microphones, Tweeters, Vibration Pickups, Speakers, Headphones, Microphone Stands, Oscilloscope Units.

EXECUTIVES

President.....A. L. Williams — Chief Engineer.....C. K. Gravley
Vice-President.....C. B. Scott — Sales Manager....W. H. St. Clair
Purchasing Agent....A. J. Eamer

BRANCH OFFICES OR REPRESENTATIVES

A. H. Baier, 2015 E. 65th St., Cleveland, Ohio.
C. C. Baines Sales Co., 4107 River Park Drive, Louisville, Ky.
W. J. Berggren, 2007 S. Michigan Ave., Chicago, Ill.
R. L. Cooper, 3916 Morrell Ave., Kansas City, Mo.
M. A. Dobbin, 524 S. W. Pine, Portland, Oregon.
M. E. Foster Sales Co., 601 Cedar Lake Road, Minneapolis, Minn.
General Engineers, 4133 Shenandoah Ave, Dallas, Texas.
W. V. Gearhart Co., Volunteer Bldg., Atlanta, Ga.
King Sales Co., 2203 W. Clybourn St., Milwaukee, Wis.
G. B. Miller, 8208 Santa Monica Blvd., Los Angeles, Calif.
W. S. Scharp, 67 W. 44th St., New York, N. Y.
H. E. Walton, 2021 Stark St., Saginaw, Mich.
Brush Crystal Products, 240 King St. E., Toronto, Ontario, Canada.

BUD SPEAKER CO.
1112 Jackson Street, Toledo, Ohio—Microphones.

BURSTEIN-APPLEBEE
1012 McGee St., Kansas City, Mo.

PRODUCTS

Amplifiers and Public-Address Equipment.

THE ALLEN D. CARDWELL MANUFACTURING CORP. (See page 40)
Factory and Sales Offices—81 Prospect Street, Brooklyn, N. Y.
Established 1920

PRODUCTS

Variable and Fixed (air and oil dielectric) Condensers for Receivers, Transmitters and Therapy Apparatus; Contract Manufacturing to Specification; Stamped and Welded Aluminum and Duralumin products.

EXECUTIVES

President and Chief Engineer.....Allen D. Cardwell
Sales and Advertising Manager.....Ray L. Morehouse
Production Manager.....William Smith

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 48)
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.

FAIRCHILD AERIAL CAMERA CO., INC.
62-10 Woodside Ave., Woodside, L. I., N. Y.
Recording Equipment, Pickups.

FERRANTI ELECTRIC, INC. (See page 48)
30 Rockefeller Plaza, N. Y. C.

FEDERAL TELEGRAPH CO.
200 Mt. Pleasant Avenue, Newark, N. J. Transmitting Tubes.

Broadcasting and Public Address Equipment (Continued)

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., 116 Broad St., New York.

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

GENERAL ELECTRIC CO.
Schenectady, New York.

GENERAL RADIO COMPANY (See page 40)
30 State Street, Cambridge, Mass.

PRODUCTS

Industrial Devices; Resistors; Variable and Precision Fixed Condensers; Inductors; Frequency Standards; Broadcast Frequency Monitors; Modulation and Distortion Monitors; a-f and r-f Laboratory Oscillators; Audio-Frequency Amplifiers; Precision Bridges and Accessories; Standard-Signal Generators; Electron Oscillographs; Wave Analyzers; High-Speed Cameras; Meters; Power Supplies; Parts and Accessories.

EXECUTIVES

President.....Melville Eastham Sales Mgr.....C. T. Burke
Vice-President.....E. H. Locke Production Mgr.....E. H. Locke
General Mgr.....H. B. Richmond 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.

HAMMARLUND MFG. CO. (See pages 39, 40)
424 West 33rd Street, New York City.

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 DERRICK & 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.
840 Barry St., New York City. Transformers, Equalizers, Chokes, Etc.

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

LEHIGH STRUCTURAL STEEL CO.
17 Battery Place, New York City. Radio Towers.

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

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

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

PRODUCTS

Amplifiers and P-A Equipment.

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.

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

PRODUCTS

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

EXECUTIVES

President.....Sol Sholes Electrical Engineer..George Saliba
Vice-President.....M. M. Gruber 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 46)
52 E. 19th Street, New York City. P-A Equipment.

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

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

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

PRODUCTS

Dynamic Microphones, P-A Equipment.

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

PRODUCTS

Radiotone Instantaneous Recording Machines; Recording Amplifiers; Cutting Stylii; Radiotone Blank Acetate Recording Discs.

EXECUTIVES

President and Chief Engineer.....W. H. Snow
General Manager.....F. H. Brown

RANGERTONE, INC.
201 Verona Ave., Newark, N. J.

PRODUCTS

Recording Equipment and Supplies; Electric Organ; Electric Chimes.

EXECUTIVES

President.....H. H. Ranger Chief Engineer.....E. P. Schmidt
Production Mgr....H. B. Wattson

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

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

RCA MANUFACTURING CO., INC. (See pages 46, 50)
RCA RADIOTRON DIVISION

RCA MANUFACTURING CO., INC. (See pages 46, 50)
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 Asst. to President,
President.....E. T. Cunningham G. K. Throckmorton
Executive Vice-President, Vice-President in Charge of Engineering and Research,
G. K. Throckmorton Lewis M. Clement

REMLER CO., LTD.
2101 Bryant St., San Francisco, Calif.

PRODUCTS

Home and Auto-Radio Sets; Amplifiers; Microphones; Attenuators; Broadcast Speech Equipment; Public-Address Equipment.

EXECUTIVES

President and General Manager....E. G. Danielson
Vice-President and Sales Manager.....R. C. Gray
Chief Engineer.....H. A. Greene
Purchasing Agent.....H. H. Daniels

BRANCH OFFICES OR REPRESENTATIVES

Chicago, Ill. Salt Lake City, Utah.
St. Louis, Mo. Seattle, Wash.
Portland, Oregon Los Angeles, Calif.
Denver, Colo.

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

SHALLCROSS MFG. CO. (See pages 44, 50)
Collingdale, Pa.
Testing Equipment—Attenuators, Decades, etc.

SHURE BROTHERS COMPANY
215 West Huron Street, Chicago, Illinois.
(*Continued on page 39*)

Broadcasting and Public Address Equipment (Continued)

(Continued from page 38)

PRODUCTS

General Purpose and "Ultra" Wide-Range Diaphragm and High-Fidelity Sound-Cell Type Crystal Microphones; General Purpose and High-Fidelity Condenser Microphones; Single- and Double-Button Carbon Microphones ranging from voice to high-quality applications; Power Supplies; Preamplifiers; Microphone Stands and Accessories, Microphone Cable. Acoustic Laboratory Equipment. Engineering and Commercial Acoustic Devices.

EXECUTIVE

President.....S. N. Shure

BRANCH OFFICES OR REPRESENTATIVES

W. T. Croysdill, 98 Harvard Pl., 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.
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.
Fred Ellinger, 9 S. Clinton St., Chicago, Ill.
J. E. Muniot, 918 Union St., New Orleans, La.
L. M. Wood, Wood & Anderson Co., 915 Olive St., St. Louis, Mo.
J. P. Kay, Kay Sales Co., P. O. Box 1313, Tulsa, Oklahoma.
J. Clawson, 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.
R. M. Campion, P. O. Box 4101, Sta. A, Dallas, Texas.
Hill-Hedquist Co., Commercial Bldg., Minneapolis, Minn.
Russ Hines, 1485 Waller St., San Francisco, Cal.
G. W. Sipe, 1873 Waverly, Memphis, Tenn.
C. F. Down, 301 Travellers Bldg., Winnipeg, Canada.
A. C. Simmonds, 301 King St., E., Toronto 2, Ontario, Canada.

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.

TECH LABORATORIES

703 Newark Ave., Jersey City, N. J.

PRODUCTS

Attenuators; Volume Controls; Potentiometers; Volume Indicators; Line Equalizers; Precision Resistors (r-f); r-f Attenuators; Precision Attenuators for Laboratory Use; Faders; Fixed Pads; Decade Boxes; Decade Condensers; Special Bridges; Special Instruments; Geophysical Instruments; etc.

EXECUTIVES

Proprietor.....Magnus Bjorndal
Consulting Eng.....K. Brandt
Consulting Geophysicist.
Prof. H. Joesting
Sales Manager.....B. L. Moore
Chief Engineer..Magnus Bjorndal
Production Manager.....M. Uritis

BRANCH OFFICES OR REPRESENTATIVES

B. L. Moore, 191 Starin Ave., Buffalo, N. Y.
P. J. Burrill, 9 S. Clinton St., Chicago, Ill.
D. C. Wallace, 4214 Country Club Drive, Long Beach, Calif.
Wilcox Electric Co., 1014 W. 37th St., Kansas City, Mo.
E. Aymond, 3750 Urban Ave., Dallas, Texas.
Prof. H. Joesting, University of Alaska, Fairbanks, Alaska.

TRUSCON STEEL CO.

Youngstown, Ohio. Radio Transmitting Towers.

TURNER COMPANY

Cedar Rapids, Iowa. Microphones, P. A. Equipment

UNITED ELECTRONICS CO.

42 Spring Street, Newark, N. J. Transmitting and Therapeutic Tubes.

UNITED TRANSFORMER CORP. (See page 48)

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 CO., INC. (See pages 46 and 50)

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.

WHOLESALE RADIO SERVICE CO.

100 Sixth Avenue, New York City. Amplifiers.

Coils and Coil Machinery Radio Frequency

(For Chokes, Speaker Coils, etc., see listings under Transformers)

ALADDIN RADIO INDUSTRIES, INC.

4049 Diversey Avenue, Chicago.

PRODUCTS

Radio Coils.

COILS, INC.

229 Chapman Street, Providence, R. I.

GENERAL MANUFACTURING CO.

8066 S. Chicago Avenue, Chicago, Ill.

EDWIN I. GUTHMAN & CO., INC.

400 S. Peoria Street, Chicago, Ill.

PRODUCTS

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

EXECUTIVES

President.....Edwin I. Guthman
Vice-President....S. H. Rothschild
General Mgr.....S. H. Rothschild
Sales Mgr.....B. J. Funk
Chief Engineer.....I. L. Glerum
Production Mgr.....W. Roberts
Purchasing Agent...Walter Jones
Advertising Mgr.....B. J. Funk

BRANCH OFFICES OR REPRESENTATIVES

Perry Saftler, 27 Warren St., New York, N. Y.

HAMMARLUND MFG. CO. (See pages 38, 40)

424 W. 33rd Street, New York City.

MEISSNER MANUFACTURING CO.

Mt. Carmel, Illinois

PRODUCTS

Radio and Industrial Coils; Trimming Condensers; Padding Condensers; Litzendraht Wire; Textile Covered Wire.

EXECUTIVES

President.....J. T. Watson
Chief Engineer...J. J. O'Callaghan
Production Manager..F. B. Lester
Purchasing Agt...R. N. Treadwell
Advertising Mgr....Wm. Carduner
Vice-President & General Sales Manager....G. V. Rockey

NORWALK ENGINEERING CORP.

55 Chestnut St., S. Norwalk, Conn.

PRODUCTS

Ultra-high-frequency, Short-wave, Radio-frequency, and Intermediate-frequency Coils.

EXECUTIVES

President.....E. A. Gelein
Vice-President.....K. W. Jarvis
Chief Engineer.....R. M. Blair
Production Mgr.....E. Hobusch

SICKLES COMPANY

300 Main Street, Springfield, Mass.

Coils and Coil Machinery (Continued)

UNIVERSAL WINDING CO.
Boston, Mass.

PRODUCTS
Coil Winding Machines.

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

ACME WIRE COMPANY (See page 54)
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

AEROVOX CORPORATION (See page 42)
80 Washington Street, Brooklyn, N. Y.

PRODUCTS
Electrolytic Condensers and Paper; Wound Condensers and Mica Condensers: Oil-Filled Condensers and Transmitting Condensers; Wire-Wound Vitreous Enameled Resistors; Carbon Resistors; Resistor Mountings.

EXECUTIVES
President.....S. I. Cole
Vice-Presidents, H. E. Rhodes and S. Siegel
General Manager.....S. I. Cole
Sales Manager.....C. Golenpaul
Chief Engineer.....H. E. Rhodes
Production Manager...T. E. Abiel
Purchasing Agent.....S. Siegel
Advertising Mgr.....W. G. Many

BRANCH OFFICES OR REPRESENTATIVES
Boston, Mass.—94 Portland Street
Detroit, Mich.—4829 Woodward Avenue
Atlanta, Ga.—289 Peachtree Street, N. E.
Dallas, Texas—3716 Binkley Avenue
Chicago, Ill.—9 South Clinton Street
Cleveland, Ohio—219 Film Exchange Bldg. East 21st and Payne Avenue
Pittsburgh, Pa.—508 Third Avenue
Minneapolis, Minn.—706 Sixth Avenue South
Salt Lake City, Utah—646 East 21st Street South
San Francisco, Cal.—580 Market Street
Los Angeles, Cal.—1341 South Hope Street
Seattle, Wash.—2124 Smith Tower Bldg.
St. Louis, Mo.—377 Arcade Bldg.
Tulsa, Okla.—314 So. Cincinnati Street

EXPORT
Paris, France—71 Rue de Provence
Havana, Cuba—49 Obrapia Avenue
Wellington, New Zealand—Civic Chambers, Cuba Street
Sydney, Australia—35-43 Clarence Street
Buenos Aires, Argentina—25 De Mayo 11

CONDENSER CORP. OF AMERICA
S. Plainfield, N. J.

CORNELL-DUBILIER CORP.
1026 Hamilton Blvd., So. Plainfield, N. J.

PRODUCTS
Oil Condensers; Dykanol 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
Vice-President.....Wm. Dubilier
General Mgr.....H. Beyer
Sales Mgr.....L. Adelman
Chief Engineer.....Wm. Bailey
Purchasing Agent.....J. Roth

BRANCH OFFICES OR REPRESENTATIVES
115 W. Venice Blvd., Los Angeles, Calif.
761 Cole St., San Francisco, Calif.
2603 Third Ave., Seattle, Washington.
2317 Calumet Ave., Chicago, Ill.
91 North Drive, 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.
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.
4863 N. Woodburn St., Milwaukee, Wis.
2635 Garland Ave., Cincinnati, O.
71 Glencairn Ave., Toronto, Ont.

EXPORT
100 Varick St., New York, N. Y.

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

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

DUMONT ELECTRIC CO., INC.
514 Broadway, New York City.

ILLINOIS CONDENSER CO.
3252 North Ave., Chicago, Ill.

PRODUCTS
Complete line of Electrolytic Condensers for all purposes relating to filtering, power factor and motor starting, spark elimination and allied uses.

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.

SANGAMO ELEC. CO.
Springfield, Illinois. Mica 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 Analyzers; Elim-O-Stat Radio Noise Suppressors.

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

BRANCH OFFICES OR REPRESENTATIVES
All principal cities.

EXPORT
599-601 Broadway, New York City.

SPRAGUE SPECIALTIES COMPANY
North Adams, Mass.

PRODUCTS
Radio Condensers: Oil Paper Condensers for motor starting and running; Paper Tubular Condensers; Paper Bypass Condensers; Electrolytic Motor Starting Condensers; Wet Electrolytic Filter Condensers; Dry Electrolytic Filter and Bypass Condensers; Oil Paper Condensers; Trimmer and Padder Condensers; Power Factor Correction Condensers.

EXECUTIVES
President.....R. C. Sprague
Vice-President.....C. Shugg
General Manager...R. C. Sprague
Sales Manager.....R. C. Sprague
Chief Engineer.....P. Robinson
Production Manager....C. Shugg
Purch. Agt.....F. W. McNamara
Adv. Mgr.....L. N. Andersen

BRANCH OFFICES OR REPRESENTATIVES
S. B. Darmstader, 520 No. Michigan Ave., Chicago, Ill.
J. K. Sprague, 21 Jarvis Street, Toronto, Ont., Canada.
G. F. Petry, 501 W. Maple Ave., Merchantville, N. J.
H. W. Whitby, 1234 Mount Vernon Ave., Dayton, Ohio.
A. J. Loeb, 1836 Euclid Ave., Cleveland, Ohio.
Consolidated Sales Co., 214 W. Pico Blvd., Los Angeles, Calif.

EXPORT
W. McKim, 238 Main Street, Cambridge, Mass.

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

Condensers, Variable

ALLEN D. CARDWELL MFG. CO. (See page 37)
81 Prospect Street, Brooklyn, N. Y.

DEJUR-AMSCO CORP.
Shelton, Conn.

GENERAL INSTRUMENT CO.
Elizabeth, New Jersey.

GENERAL RADIO CO. (See pages 38, 46, 50)
30 State Street, Cambridge A, Mass.

HAMMARLUND MANUFACTURING COMPANY, INC. (See pages 38, 39)
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

(Continued on page 42)

WHAT CAN BE DONE ABOUT THIS?

PRESUMABLY IT IS news when the public tries to buy a product no one has offered for sale, and exhibits a spontaneous demand for merchandise never advertised or manufactured.

What the country seems to need is a simple, inexpensive device to tie to its radio receivers, which will enable it to record its favorite radio programs.

The writer of these lines has recently been privileged to see the correspondence, and breakdown of the correspondence, of one of the largest of radio's mail-order houses, and has been singularly impressed by the scope and persistence of the public's attempt to buy what no one has offered to sell.

To be sure, there are numerous makes of recorders. They are not made in mass production. They are seldom simple to operate, seldom small in size, never mounted in cabinets suited to the home, and cost, as a rule, several hundred dollars. One instrument, not too satisfactory, is available in the order of eighty dollars, and is about the least expensive made today.

Cellulose acetate blanks cost as much or more, size for size, than finished commercial records available in any music store.

Keeping a record of Gracie Allen, or of Stoopnagle and Budd, still presents too many difficulties and too much cost to a public palpitating to do that very thing as soon as the industry will make it reasonably possible.

A substantial percentage of the correspondence bearing on this matter expresses perplexity at the cost and complication of the only equipment available. Inquirers point out that a recorder is essentially a phonograph working backward, that if "wows" are objectionable in a recording turntable they are equally objectionable in a phonograph turntable, that a cutting head need not differ materially from a reproducing head, that a worm drive made in any quantity ought to cost nearer ten cents than ten dollars, and in general, how come?

What appears to be wanted is something in the order of a short-wave converter, not too large nor too expensive, housed in a suitable box, readily connected, say in parallel to the voice coil of the loudspeaker, and easy to operate. The size of the spontaneous demand would appear to indicate that a substantial proportion of all the receivers in America could be so equipped, if the apparatus were available and merchandised as thoroughly as is radio itself.

The demand is not confined to home use. Business men inquire occasionally

(*Continued on page* 43)

Condensers, Variable (Continued)

(Continued from page 40)

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.

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.

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.

FRANKLIN FIBRE-LAMITEX CORP.
Wilmington, Del.

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.

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

Etab. Sylvan Ginsbury, S. A., Brussels.

TAYLOR & CO., INC.
Norristown, Penna.

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 40)
80 Washington St., Brooklyn, N. Y.

ALLEN-BRADLEY COMPANY (See page 58)
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 37)
561 Broadway, New York City.

CENTRALAB
900 East Keefe Avenue, Milwaukee, Wisconsin.

PRODUCTS

Variable Resistors; Volume and Tone Controls; Composition Fixed Resistors; Wave Change Switches; Socket Contacts.

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

BRANCH OFFICES OR REPRESENTATIVES

T. B. Hunter, 160 E. Illinois St., Chicago, Ill.
W. S. Scharp, 67 W. 44th St., New York, N. Y.

EXPORT

British Centralab, Ltd., Kilburn, N. W. 6, London, England.
French Centralab Co., 118 Avenue Ledru-Rollin, Paris XI, France.

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.

(Continued on page 44)

WHAT CAN BE DONE ABOUT THIS?

(*Continued from page* 41)

as to the availability of electric equipment to take the place of the office dictating machine. Police and detective organizations who desire legal records of conversations are represented, and there is a scattering of industrial and scientific demand indicating a desire to record non-human sounds of various kinds, if it can be done efficiently and cheaply. Schools and amateur entertainers ask how much it will cost to make records for transcription through small local broadcasting stations, who are willing to donate time only at odd moments when no other program is available.

Curiously, some who are aware of present-day requirements of disc recordings, are under the misapprehension that they can meet their needs more simply and inexpensively with film and photo-cell.

These remarks are based on a study of a breakdown of inquiries extending over a period of a year and a half, and originating in every part of the country. Many of the letters indicate not only a strong desire for the equipment, but annoyance at finding it is not available in the type and price class anticipated.

AIR EXPRESS BOOMS IN YEAR'S FIRST HALF

VAST GAINS in air express shipments and revenues were registered in the first six months of 1936, the month of June, with approximately 45,000 shipments, breaking all records, and revenue for the half-year 75 percent higher than that of the contract air lines during the first half of 1935. Total shipments for the six months period were 212,635, according to a report just issued by Air Express Division of Railway Express Agency.

Printed matter, mostly advertising, showed the highest gain, with 9,450 shipments in July alone, an increase of 300 percent over July of last year, while 5,000 electrotypes, air-expressed in that month, represented an 80 percent gain, and radio rose sharply to 2,700 shipments for the month of July.

Shipments of checks between correspondent banks averaged 2,000 per month, while an average of 2,000 shipments of certificates and other valuable papers was carried between brokers and bond dealers. Significant of improving conditions was a tremendous increase in shipments of printed matter between investment bankers and security dealers.

Production films and newsreel negatives and prints showed a gain of 130 percent over last year, with 6,500 shipments during July.

Resistors, Controls, Rheostats, Etc. (Continued)

(Continued from page 42)

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.

PRODUCTS
Resistors, Suppressors and Controls.

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

PRODUCTS
Carbon Resistors; Insulated Carbon Resistors; Auto Radio Suppressors; Molded Plastic Knobs; Molded Plastic Dials; Molded Plastic Bezels.

EXECUTIVES
President.....G. P. Fryling — Chief Engineer.....B. B. Minnium
Vice-President.....G. R. Fryling — Production Mgr....E. H. Mulcahy
General Manager.....H. C. Sherk — Purchasing Agent..C. M. Emery
Vice-Pres. & Sales Mgr...W. H. Fryling

BRANCH OFFICES OR REPRESENTATIVES
W. S. Block, Jr., 15 E. 26th Street, New York City, N. Y.
E. E. Mills Co., 205 W. Wacker Drive, Chicago, Ill.
Consolidated Sales Co., 243 W. Adams Blvd., Los Angeles, Calif.
W. Neelon, Buffalo, N. Y.

EXPORT
Erie Resistor of Canada, Ltd., 49 Bathurst Street, Toronto, Canada.
Erie Resistor, Ltd., Carlisle Road, The Hyde, London, N.W.9, England.
J. E. Canetti & Cie—16, Rue d'Orleans, Neuilly (Seine), France.

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

INTERNATIONAL RESISTANCE CO.
401 N. Broad Street, Philadelphia, Pa.

P. R. MALLORY & CO. (Yaxley Div.) (See pages 40, 46, 58)
3029 E. Washington Street, Indianapolis, Ind.

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

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.

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.

SHALLCROSS MFG. CO. (See pages 38, 50)
700 Parker Avenue, Collingdale, Pa. (Wire-wound).

SPEER CARBON 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. COPR. (See page 40)
599 Broadway, New York City.

TECH LABORATORIES (See page 39)
703 Newark Avenue, Jersey City, N. J.

S. S. WHITE DENTAL MFG. CO.
10 East 40th Street, New York City.

WARD LEONARD ELECTRIC CO. (See page 58)
Mt. Vernon, New York.

WIRT COMPANY
5221 Greene Street, Philadelphia, Pa.

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

AMERICAN PHENOLIC CORP.
500 S. Throop Street, Chicago, Ill.

AMERICAN RADIO HARDWARE CO.
476 Broadway, New York.

THE D. L. AULD COMPANY
5th Avenue and 5th Street, Columbus, Ohio

ALDEN MANUFACTURING CO.
715 Center St., Brockton, Mass.

BASTIAN BROS. CO.
1600 N. Clinton Avenue, Rochester, N. Y.

CINCH MANUFACTURING CO.
2335 W. Van Buren St., Chicago, Ill.

PRODUCTS
Tube Sockets, Soldering Lugs, Terminal Strips, Plugs, Etc.

EXECUTIVES
President.....A. W. Kimbell — Chief Engineer.....C. L. Knutson
Vice-President.....W. G. Roby — Production Manager..A. C. Peters
Purchasing Agt..J. C. Macdonnell — Sales Manager.....J. J. Steffen
Advertising Manager.....D. T. Campbell

BRANCH OFFICES OR REPRESENTATIVES
In all principal cities.

EXPORT
Cinch Mfg. Co., 31 Ames St., Cambridge, Mass.

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

CONTINENTAL-DIAMOND FIBRE CO.
Wilmington, Del.

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.

A. W. FRANKLIN MFG. CO.
160 Varick St., New York City

PRODUCTS

Laminated Sockets; Trimmer Condensers; Terminal Strips.

EXECUTIVES

President.....A. W. Franklin

EXPORT

Ad. Auriema, Inc., 116 Broad St., New York City.

GENERAL RADIO CO. (See pages 38, 40 and 50)
38 State Street, Cambridge, A. Mass.

INSULINE CORP. OF AMERICA
23 Park Place, New York City.

HOWARD B. JONES
2300 Wabansia Avenue, Chicago, Ill.

KAY PRODUCTS OF AMERICA, INC.
3901 Queens Blvd., Long Island City, N. Y.

P. R. MALLORY CO. (See pages 40, 44 and 58)
Indianapolis, Ind.

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. (See page 37)
E. 408 Perkins Avenue, Cleveland, Ohio.

CHICAGO TEL. SUPPLY CO. (H. H. Frost, Inc.)
Elkhart, Indiana. Headphones.

CINAUDAGRAPH CORP.
Stamford, Conn.

PRODUCTS

Permanent Magnet Speakers.

President and Chief Engineer.....J. S. Hoyt
Vice-President and General Manager.....H. W. Hanwell
Director of Sales.....D. D. O'Brien

BRANCH OFFICES OR REPRESENTATIVES

Chicago, Ill.
Philadelphia, Pa.
San Francisco, Cal.
Los Angeles, Cal.
Seattle, Wash.
Detroit, Mich.
Toledo, Ohio
Toronto, Ont.

EXPORT

100 Varick St., N. Y. C.

CONTINENTAL MOTORS CORP.
12801 E. Jefferson Ave., Detroit, Mich.

PRODUCTS

Tiny Tim Portable Gas-Electric Lighting Plant & Battery Charger 6-volt 200- watt; Perm-O-Flux Permanent Magnet Dynamic Speaker; Kleen-Aire Portable Type Air Conditioner.

EXECUTIVES

President.....W. R. Angell
Vice-President.....J. Reese
General Manager....W. R. Angell
Vice-President and Sales Manager.....B. F. Tobin
Chief Engineer.....I. B. Serge
Production Manager.....L. Rich
Purchasing Agent...F. Gallagher
Advertising Manager.....A. Wild

FOX SOUND EQUIP. CORP.
3120 Monroe Street, Toledo, Ohio

JENSEN RADIO MFG. CO.
6601 S. Laramie Avenue, Chicago, Ill.

MAGNAVOX CO., LTD.
Fort Wayne, Indiana

OPERADIO MFG. CO.
13th & Indiana Street, St. Charles, Ill.

OXFORD-TARTAK RADIO CORPORATION
350 W. Huron St., Chicago, Illinois.

PHILCO RADIO & TEL. CORP.
Philadelphia, Pennsylvania.

RCA MFG. CO. (See pages 38 and 46)
Camden, New Jersey.

RACON ELEC. CO., INC. (See page 38)
52 East 19th Street, New York City.

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

THE ROLA COMPANY
2530 Superior Avenue, Cleveland, Ohio.

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.

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.

QUAM-NICHOLS CO.
Chicago, Ill.

WESTERN ELECTRIC O. (See pages 39 and 50)
195 Broadway, New York City.

WRIGHT-DE COSTER, INC.
2253 University, St. Paul, Minnesota.

Transformers, Chokes and Speaker Coils

AALLOY TRANSFORMER COMPANY (See page 37)
135 Liberty Street, New York City, New York.

PRODUCTS

Power Transformers, Transmitting Audio and Power Transformers, Audio Transformers, Audio, Filter Chokes, Special Coils, Field Coils.

EXECUTIVES

President.....Leon J. Littmann
Vice-President....Alton D. Miller
General Manager...Monroe Strom
Sales Manager.....Al Benton
Chief Engineer.....Jerry Kriz
Advertising Mgr...James R. Long

THE ACME ELEC. & MFG. CO.
1444 Hamilton Avenue, Cleveland, Ohio.

PRODUCTS

Radio Transformers; Neon Transformers; Television Transformers, Voltage Adjustors; Industrial Transformers; Chokes; Insulation and Spark Plug Testers.

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 Manager..Wm. Radon

(Continued on page 48)

NEWS OF THE INDUSTRY

(*Continued from page 34*)

MEISSNER MOVES TO NEW PLANT

The Meissner Mfg. Co., coil manufacturers, have just completed moving the entire organization to Mt. Carmel, Illinois. The increased floor space and the new buildings permit the use of the most modern production methods and will enable the Meissner Mfg. Co. to take care of their increased business.

— RE —

PLANT EXPANSION OF DETROIT REX PRODUCTS COMPANY

Because of the great increase in demand for Detrex Degreasers by the metal working and finishing industries, the Detroit Rex Products Company, 13005 Hillview Avenue, Detroit, Mich., has had to seek additional quarters and increase their manufacturing facilities.

New equipment is now being purchased and installed to facilitate the production and delivery of both standard and special designs of Detrex Degreasers.

— RE —

RAYTHEON APPOINTEE

Mr. D. T. Schultz, vice-president and treasurer of Raytheon Production Corporation, announces the appointment of Mr. Earl S. Dietrich as manager of distributors' sales. Mr. Dietrich's headquarters will be at the New York office of the Raytheon Company, 420 Lexington Avenue, New York City. He will operate under the general supervision of the general sales manager of Raytheon, Mr. Edgar S. Riedel, whose headquarters will continue at the Chicago office of the Raytheon Company, 445 Lake Shore Drive, Chicago, Illinois.

— RE —

CLINICS TO SHOW LATEST WELDING PRACTICE FOR NON-FERROUS ALLOYS

Latest developments in welding practice for non-ferrous alloys will be demonstrated at two clinics to be held in Cleveland, Ohio, and Buffalo, N. Y., during September. Included will be practical examples and demonstrations of the latest methods of electric and oxy-acetylene welding and brazing on Monel, aluminum, nickel copper, brass, bronze, Inconel, and nickel-clad steel.

The clinic at Cleveland will be conducted by welding engineers of The International Nickel Comany, The Aluminum Company of America, and the Revere Copper and Brass Company. It will be held in the warehouse of Williams and Company, Inc., 1748-56 East 22d Street, on September 18 and 19.

At Buffalo, the clinics will be held on September 25 and 26 in the warehouse of Whitehead Metal Products Company of New York, Inc., 254 Court Street. It will be under the auspices of The International Nickel Company, The Aluminum Company of America, and The American Brass Company.

Somewhat similar clinics have been planned for Montreal and Toronto in October.

(*Concluded on page 53*)

Transformers, Chokes and Speaker Coils (Continued)

(Continued from page 46)

BRANCH OFFICES OR REPRESENTATIVES

A. M. Baehr, 1400 W. 25th St., Cleveland, O.
Ray T. Perron, 211 Winthrop St., Taunton, Mass.
Adolph Friedman, 220 E. 23rd St., New York City.
H. Glenn Johnston, G.M.C. Bldg., Detroit, Mich.
O. E. Rosche, 740 N. Plankinton, Milwaukee, Wisc.
F. C. Somers, 2004 Grand Ave., Kansas City, Mo.
Geo. D. Norris, 307 Noll St., Seattle, Wash.
J. I. Menkin, 524 W. Van Buren St., Chicago, Ill.

EXPORT

The Leonard L. Minthorne Co., 116 Broad St., New York City (Radio only).

AMERICAN TRANSFORMER COMPANY (See page 37)

175 Emmet Street, Newark, N. J.

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

CHICAGO TRANSFORMER CORP.

2626 W. Washington Boulevard, Chicago, Ill.

DONGAN ELECTRIC MFG. COMPANY

2987-3001 Franklin Street, Detroit, Michigan.

FERRANTI ELECTRIC, INC. (See page 37)

30 Rockefeller Plaza, New York, N. Y.

PRODUCTS

Transformers; Chokes; Inductors; Power Supplies; Low and High Power Audio Equipment; High Q Coils; Filters; Radio Frequency Voltmeters, A.C./D.C. Test Sets; Phase Rotation Indicators; Clip-On Ammeters, etc.

EXECUTIVES

President.....V. Z. de Ferranti
Vice-President.....A. B. Cooper
Sales Manager.....W. R. Spittal
Chief Engr.....P. F. Bechberger
General Mgr.....W. R. Spittal
Purchasing Agt....E. M. Benners

ASSOCIATED COMPANIES

Ferranti Limited, London, England.
Ferranti Electric Limited, Toronto, Canada.

FRANKLIN TRANSFORMER MFG. CO.

607-609 22nd Ave., N.E., Minneapolis, Minn.

PRODUCTS

Radio Receiving Power and Audio Transformers Original Equipment and Replacement; Audio Transformers and Power Transformers; Filter Reactors, etc., for public address; Amateur and Broadcast Equipment.

EXECUTIVES

President.....G. L. Pugh
Production Mgr...F. Heidenreich
General Manager.....H. L. Mills
Chief Engineer.....H. L. Mills
Purchasing Agent.....L. Proulx
Advertising Mgr.....M. J. Konier

BRANCH OFFICES OR REPRESENTATIVES

All principal cities.

EXPORT

C Q Radio, 38 South Frederick St., Dublin, Ireland (British Isles).
Jose H. Rodreques, P. O. Box 1964, Rio De Janeiro, Brazil.
Cape Electrical & Radio Co., 22 Brug St., Cape Town, South Africa.

GENERAL RADIO COMPANY (See page 38)

30 State Street, Cambridge, A, Mass.

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.

RCA MFG. CO., INC. (See page 38)

Camden, New Jersey.

STANDARD TRANSFORMER CORP.

866 Blackhawk Street, Chicago, Ill.

THORDARSON ELECTRIC MFG. CO.

500 W. Huron St., Chicago, Ill.

PRODUCTS

Iron Core Transformers and Chokes for Radio and Neon Tube Lighting.

EXECUTIVES

President.....C. H. Thordarson
General Manager....D. MacGregor
Chief Engineer.....M. Heald
Export Manager....C. A. Lohman
General Sales Manager....C. P. Cushway

UNITED TRANSFOMER CORP. (See page 39)

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)

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, Analyzers, etc.

CLOUGH-BRENGLE CO. (See page 37)

1134 W. Austin St., Chicago, Ill.

PRODUCTS

R. F. Signal Generators, A. F. Beat Oscillators, Cathode-Ray Oscillographs, Volt-Ohmeters, Analyzers, Power Level Indicators.

EXECUTIVES

President.....Kendall Clough
Production Mgr.....R. T. Brengle
Sales Manager.....John S. Meck
Chief Engineer.....Kendall Clough
Purchasing Agent.....I. Borg
Advertising Mgr.....John S. Meck

BRANCH OFFICES OR REPRESENTATIVES

All principal cities.

ALLEN B. DU MONT LABORATORIES (See page 50)

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

BRANCH OFFICES OR REPRESENTATIVES

J. H. Hill Sales Co., 821 W. Olympic Blvd., Los Angeles, Calif.
J. J. Backer & Co., 109-11 Bell St., Seattle, Wash.
G. K. Brown Co., 538 Polk St., San Francisco, Calif.
H. H. Reynolds, 36 Cherry St., Danvers, Mass.
Morrissey-Kantenberger, Allen Bldg., Dallas, Texas.
M. F. Taylor, Silver Spring, Md.
F. C. Somers, 2004 Grand Ave., Kansas City, Mo.
W. V. Gearhart Co., Volunteer Bldg., Atlanta, Ga.
Burlec, Ltd., Toronto 13, Station H, Toronto, Ont.
Wesley Block & Co., 15 E. 26th St., New York City.

EXPORT

Westex Co., 15 E. 26th St., New York, N. Y.

FERRIS INSTRUMENT CORPORATION

Boonton, New Jersey

PRODUCTS

Standard Signal Generators; Microvolters.

EXECUTIVES

President.....Malcolm Ferris

GENERAL ELECTRIC CO.

Schenectady, New York. Meters.

Testing Instruments (Continued)

GENERAL RADIO CO. (See pages 38, 40 and 46)
30 State Street, Cambridge, Mass.

THE HICKOK ELECTRICAL INSTRUMENT CO.
10514 Dupont Ave., Cleveland, Ohio

PRODUCTS

Meters; Radio Set Testers; Tube Testers; Cathode-Ray Oscillographs.

EXECUTIVES

President.....R. D. Hickok Sales Manager.....R. Williams
Chief Engineer.....W. A. Weiss

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

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 pages 38 and 46)
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 PRODUCTS CO.
145 Sunrise Place, Dayton, Ohio. Tube Testers.

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

RAWSON ELEC. INST. CO.
90 Windsor Street, Cambridge, Mass.

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

SHALLCROSS MFG. CO. (See pages 38 and 44)
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 INSTRUMENT CO.
Bluffton, Ohio.

PRODUCTS

Electrical Measuring Instruments; Radio and Laboratory Test Equipment.

EXECUTIVES

President.....R. L. Triplett Advertising Mgr.....A. R. Baker
Vice-President....A. A. Frederick Radio Engineer.....F. E. Wenger
Sales Manager.. ..N. A. Triplett Production Mgr.....G. Klay
Purchasing Agt.....A. R. Baker

BRANCH OFFICES OR REPRESENTATIVES

At principal points in the United States and throughout the world.

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

WESTERN ELECTRIC CO. (See pages 39 and 46)
195 Broadway, New York City.

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

WESTON ELECTRICAL INSTRUMENT CORP. (See page 58)
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 Chief Electrical Engineer
Vice-President.....Caxton Brown W. N. Goodwin, Jr.
Sales Manager Production Manager...R. R. Lambe
H. Leigh Gerstenberger Purchasing Agent.....A. R. Briggs
Advertising Manager....Sidney Cassey

BRANCH OFFICES OR REPRESENTATIVES

Albany, Atlanta, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, El Paso, Jacksonville, Knoxville, Los Angeles, Meriden, Conn., Minneapolis, Newark, New Orleans, New York, Philadelphia, Phoenix, Pittsburgh, Rochester, San Francisco, Seattle, St. Louis, Syracuse.

Tubes—Receiving and Transmitting Photo Cells—Cathode Ray Tubes

AMPEREX ELECTRONIC PRODUCTS, INC.
79 Washington St., Brooklyn, N. Y.

ARCTURUS RADIO TUBE COMPANY
Newark, New Jersey

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

CONTINENTAL ELECTRIC CO.
St. Charles, Illinois

PRODUCTS

Cetron Photoelectric Cells; Continental Vacuum Power Switches; Tru-Vac Vacuum Gauges.

EXECUTIVES

President.....H. A. McIlvaine Chief Engineer....O. T. McIlvaine
Vice-President....O. T. McIlvaine Purchasing Agent.O. T. McIlvaine
Sales Manager.....R. E. Smiley Advertising Mgr....R. E. Smiley

ALLEN B. DU MONT LABORATORIES (See page 48)
9 Bradford Way, Upper Montclair, N. J.

EITEL-McCULLOUGH CO.
San Bruno, Cal.

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.

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

HYGRADE SYLVANIA CORPORATION
500 Fifth Avenue, New York City.

PRODUCTS

Receiving Tubes of all Types, Incandescent Lamps.

HYTRON CORP.
Salem, Mass.

THE KEN-RAD TUBE & LAMP CORP., INC.
Owensboro, Kentucky.

PRODUCTS

Radio Receiving Tubes; Incandescent Electric Lamps.

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

RCA MFG. CO., INC. (See page 38)
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 Vice President & General Mgr.,
David Sarnoff J. C. Warner
President.....E. T. Cunningham Asst. to President on Sales
Executive Vice President Judson S. Sayre
G. K. Throckmorton

RCA MFG. CO., INC. (See pages 38 and 46)
Camden, New Jersey.

RAYTHEON PRODUCTION CORP.
420 Lexington Avenue, N. Y. C.

TAYLOR TUBES, INC.
2341 Wabansia Ave., Chicago, Ill.

TRIAD MANUFACTURING CO., INC.
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 pages 39 and 46)
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

ELECTRONICS MACHINE CO.
742 13th Street, Newark, N. J.

PRODUCTS

Incandescent Lamp Machinery; Incandescent Lamp Parts; Radio Tube Machinery; Radio Tube Parts; Neon Tube Machinery; Neon Tube Electrodes; Neon Tube Supplies; Electronics Tube Machinery; Laboratory Equipment; Glass Working Machinery; Power Tube Machinery; Transformers, all types.

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

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

KAHLE ENGINEERING CORP.
941 De Mott Street, North Bergen, N. J.

PRODUCTS

Vacuum Pumps; High Frequency Bombarders and Furnaces; Burners for Glass Work; Machinery and Equipment for Manufacturing Radio Tubes; Incandescent Lamps; Gaseous Discharge Devices; Luminous Tubing; etc. Spot Welders; Butt Welders.

EXECUTIVES

President and Chief Engineer.....L. C. Kahle
Sales Manager.....Jac. Hohenstein

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 — General Mgr.....E. R. Capita

Tube Parts and Materials

THE AMERICAN BRASS COMPANY (See page 58)
(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 (See page 56)
Chattanooga, Tenn.

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

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

PRODUCTS

Tungsten and Molybdenum in shape of rod, sheet and wire filament; Contact Points of Tungsten, Molybdenum and their special alloys; Precious Metal Laminated Contacts; Silver and Platinum Contacts; Radio Products; Refractory Carbide Tools and Dies; Lead-in Wire; Kulgrid Wire; Copper and Silver Callinite; Calliflex; Thermostatic Bimetal.

EXECUTIVES

President.....C. A. Laise — Chief Engineer.....G. Wheeler
Vice-President.....C. H. Kraft — 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. (See page 56)
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.

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

NEWARK WIRE CLOTH CO.
358-372 Verona Ave., Newark, N. J.

PRODUCTS

Wire Cloth; Mesh; Ribbon of Molybdenum and Pure Nickel.

EXECUTIVES

President, Vice-President and General Manager.....J. C. Campbell
Sales Manager.....L. C. Campbell
Chief Engineer.....L. Beyer

BRANCH OFFICES OR REPRESENTATIVES

Chicago, Ill. — Houston, Texas
Detroit, Mich. — San Francisco, Calif.
Tulsa, Okla. — Havana, Cuba

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

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

STUPAKOFF LABORATORIES, INC. (See page 56)
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 54)

NEWS OF THE INDUSTRY

(Continued from page 47)

WIRE CATALOG

A new edition of the well-known Driver-Harris catalog of resistance wires has just come from the presses. Copies may be obtained from Driver-Harris, Harrison, N. J.

— RE —

TURNER REPRESENTATIVE

The Turner Co., Cedar Rapids, Ia., announces the appointment of the L. G. Cushing Company, 540 North Michigan Avenue, Chicago, Illinois, as their new Illinois representative.

— RE —

LATEST SOLAR CATALOG

A new and comprehensive catalog, describing and illustrating their products, has just been issued by the Solar Manufacturing Corp., 599 Broadway, New York, N. Y.

Complete specifications, along with suggestions regarding the use of the units described, are included in this booklet, copies of which may be obtained by addressing the company.

— RE —

COIN RADIO SUCCEEDS OLD MECHANICAL PIANO

The old nickel-a-tune mechanical piano has passed on, and left no mourners, and, rising phoenix-like from its ashes, a new and gleaming, coin-operated radio phonograph has appeared in restaurants and tea rooms all over the country. Today, instead of tunes ranging from "After The Ball" to "Home On The Range," the chronic nickel-inserter may choose from the radio programs of the world, or a variety of recordings of popular and classical music.

An average of seven-a-day of the big machines, which weigh 360 pounds each, is expressed from the manufacturer in North Tonawanda, N. Y., to dining places all over the country, according to Superintendent F. F. LaRowe of the Railway Express Agency, which handles the musical monsters.

— RE —

COBURN NEW N U SALES CHIEF

R. M. Coburn has been appointed General Sales Manager of National Union Radio Corporation of N. Y., according to an official announcement released this week by S. W. Muldowny, National Union's Chairman of the Board. During the several years of his association with the National Union organization, Mr. Coburn has served in the capacity of Sales Statistician, Office Manager, and more recently Assistant Sales Manager.

— RE —

NEW SHALLCROSS PLANT

The Shallcross Mfg. Co., manufacturers of precision wire wound resistors, decade resistance boxes, bridges, test equipment and switches, have moved into their new daylight, fireproof factory. The new factory at 10 Jackson Ave., Collingdale, Pa., has three times the former floor space, which will greatly enhance the facilities of production.

Tube Parts and Materials (Continued)

(Continued from page 52)

EXECUTIVES

President.....E. L. Parker
Vice-President.....J. P. Boore
General Manager.....N. H. Wolf
Sales Manager.....J. P. Dods
General Supt.....R. R. Lawson
Production Mgr.....Theodore Heske

BRANCH OFFICE OR REPRESENTATIVES

Edgar T. Ward's Sons Company of: Boston, Mass.; Buffalo, N. Y.; Chicago, Ill.; Cleveland, Ohio; Detroit, Mich.; Milwaukee, Wis.; Philadelphia, Pa.; Pittsburgh, Pa.; Newark, N. J.; Hartford, Conn.; Indianapolis, Ind.; Rochester, N. Y.; Rockford, Ill.; St. Louis, Mo.; and St. Paul, Minn.
Foucar, Ray and Simon, Inc., San Francisco, Calif.
California Panel and Veneer Co., Los Angeles, Calif.

SUPERIOR TUBE CO.

P. O. Box 227, Norristown, Penna.

PRODUCTS

Seamless Tubing in Nickel, Monel, Aluminum, SVEA Metal, Brass Copper, Carbon Steels, Stainless Steels; Exhaust Tubes.

EXECUTIVES

General Manager, Sales Manager, Adv. Manager ...S. L. Gabel
Chief Engineer.....R. H. Gabel
Superintendent.....Wm. Boughter
Purchasing Agent...Jack Buckley

EXPORT

Stupakoff Laboratories, Inc., 6627 Hamilton Ave., Pittsburgh, Penna.

SWEDISH IRON & STEEL CORPORATION (See page 58)

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

301 N. Wells 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.)
Gilby Wire, S. A. 11 bis, Rue d'Aguesseau, Paris, France.

Wire—Antenna, Hook Up, Magnet, etc.

ACME WIRE COMPANY (See page 40)

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

AMERICAN ENAMELED MAGNET WIRE CO.

Port Huron, Michigan.

ANACONDA WIRE & CABLE CO.

20 N. Wacker Drive, Chicago, Ill.

BELDEN MANUFACTURING COMPANY

4647 W. Van Buren Street, Chicago, Ill.

CORNISH WIRE COMPANY, INC.

30 Church Street, N. Y. C.

CRESCENT INSULATED WIRE AND CABLE CO.

Trenton, N. J.

PRODUCTS

Complete Radio Cord Sets; Receiver Cords; Assembly Cords; Antenna Cords; Shielded Cords; Weatherproof Wire; Armored Cable Building Wire; Flexible Cords; Radio Wires; Lead-Encased Cables; Parkway Cable; Service Entrance Cable; Varnished Cambric Cable; Signal Cable; Rubber Power Cables; Crescent Endurite Super-Aging Insulation; Bare Wire; Cresflex Non-Metallic Sheathed Cable; Magnet Wire.

EXECUTIVES

President.....C. E. Murray
Vice-President..C. E. Murray, Jr.
General Manager....J. C. Murray
Sales Manager.....E. L. Robinson
Chief Engineer.....M. J. Rich
Production Mgr.....A. W. Staller
Purchasing Agent...A. H. Battye
Adv. Mgr.....C. E. Murray, Jr.

BRANCH OFFICES OR REPRESENTATIVES

E. E. Dawes, A-4 Rhodes Building Annex, Atlanta, Ga.
Electrical Sales Co., 111 Cheapside St., Baltimore, Md.
C. C. Pierce, 241 Purchase St., Boston, Mass.
G. Eberhardt, 294 Elm St., Buffalo, N. Y.
Crescent Electric Sales Corp., 622 W. Adams St., Chicago, Ill.
Henger-Fairfield Co., 1808 Columbus Rd., Cleveland, Ohio.
R. Smith, 912 Commerce St., Dallas, Texas.
Hemphill & Co., 517 E. Woodbridge St., Detroit, Mich.
D. R. Smith, 307 Arcade Building, Harrisburg, Pa.
A. L. Clifford, 330 W. New York St., Indianapolis, Ind.
Henger-Seltzer Co., 945 E. Pico Street, Los Angeles, Cal.
R. H. Cupples, 324 First St. No., Minneapolis, Minn.
Electron Engineering Co., 1812 Masonic Temple, New Orleans, La.
Kearton & Nagle, 555 W. 25th St., New York, N. Y.
E. R. Blyler, Bourse Bldg., Philadelphia, Pa.
Crescent Sales Co., 298 Duquesne Way, Pittsburgh, Pa.
Hodges & Glomb, 1264 Folsom St., San Francisco, Calif.
L. A. Doxsee, 815 S. 11th St., St. Louis, Mo.

ESSEX WIRE CORPORATION

37 Manchester Avenue, Detroit, Mich.

GENERAL CABLE CORPORATION

420 Lexington Avenue, New York City.

THE HOLYOKE CO., INC.

720 Main Street, Holyoke, Mass.

PRODUCTS

Insulated Wires for Electrical and Specialty Purposes.

EXECUTIVES

President.....H. T. Smethurst
Chief Engineer.....M. Andrews
Purchasing Agent...D. S. Sullivan

BRANCH OFFICES OR REPRESENTATIVES

The Holyoke Co., Inc., 29 W. 36th St., New York, N. Y.
F. W. Bauer, 325 W. Huron St., Chicago, Ill.
Jefferies & Hartweg, 800 N. Delaware Ave., Philadelphia, Pa.
Signal Elec. Supply Co., 314 E. 3rd St., Los Angeles, Calif.
Russ Hines, San Francisco, Calif.
A. J. Loeb, Cleveland, Ohio

EXPORT

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

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.

WHEELER INSULATED WIRE CO.

Bridgeport, Conn.

Wire—Resistance

DRIVER-HARRIS CO.

Harrison, New Jersey.

WILBUR B. DRIVER CO.

Newark, N. J.

THE HOLYOKE CO., INC. (See listing above)

Holyoke, Mass.

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.

METAL COVERED FUSE MOUNTING

Designed for the new metal covered tube sets

Littelfuse No. 1126 Mounting

meets requirements of Underwriters' Laboratories for 1, 1½, 2 or 3 amp. standard 3AG fuses. No mounting screw needed — time and material saved. Only 2½" x ⅞" x ¾" overall. Supplied with approved fuses or without fuses.

Manufacturers, write for test samples.

Littelfuse Laboratories
4244 Lincoln Ave. Chicago, Ill.

STOP

Transformer Trouble Caused by High Humidity

FRANKLIN TRANSFORMERS

Are NOW **Thermo-Vacuum Impregnated**

Another important step forward in the transformer field made — as usual — by Franklin.

Let us quote on your specifications.

FRANKLIN MANUFACTURING COMPANY
607 22nd Ave. N.E. Minneapolis, Minn.

Laminations

for Audio and Power Transformers.
Standard stocks in a wide range of sizes.
Write for dimensions and price sheets.

Dies . . . Tools . . . Metal Stampings

- 35 years experience manufacturing all types of magnets
- Suppliers of ALNICO MAGNETS

Specialized methods . . . Prompt service

THOMAS & SKINNER STEEL PRODUCTS CO.
1113 East 23rd Street Indianapolis, Ind.

TYPE CR-4 BEAT FREQUENCY

AUDIO OSCILLATOR

PRICE **$77.00**

- Portable, A. C. Operated.
- 10 cps to 20,000 cps.
- Reed for Calibration Check.
- High and Low Impedance Outputs.
- Direct Reading Dial. Accuracy 2%.
- Low Hum and Distortion.
- High Output, 30 Volts Max.
- Drift after Warmup Negligible.

Write for Catalog

UNITED SOUND ENGINEERING CO.
Manufacturers of Electronic Equipment
2229 UNIVERSITY AVE. ST. PAUL, MINN.

Preferred by Radio Engineers

● HOTEL ●

FOUNTAIN SQUARE

You too will like the comfortable rooms, fine food and the low rates.

200 Rooms with Bath $2 and up

VIRGIL MURPHY, MGR.

PICK HOTELS

CINCINNATI

CONDENSERS and RESISTORS

Metal and cardboard case electrolytics.

All types of paper condensers.

Large line of molded bakelite mica units.

Oil-filled condensers for X-mitting use.

Wire-wound and carbon resistors.

Two things stand out in dealing with AEROVOX: First, thorough engineering to ensure a good product fitted to the application; second, a large, efficient, economical plant insuring real quality at mass-production price. ● So write for general catalog, engineering aid, and quotations.

AEROVOX

CORPORATION
70 Washington St. - Brooklyn, N. Y.

LOW WHOLESALE PRICES GET THIS FREE CATALOG!

Over 10,000 items in this big catalog including radio receivers, nationally known radio parts and broadcasting equipment. A catalog of great value to dealers and servicemen offering the best in radio at low wholesale prices. Write today for your FREE copy of this big catalog. Get your name on the list to receive monthly "Hot Shot" Bulletins sent to every Burstein-Applebee customer.

BURSTEIN-APPLEBEE CO.
1012-14 McGee Street Kansas City, Mo.

SOLDERS BETTER—COSTS LESS

1, 5 and 20-lb. spools.

In production you'll welcome the quick, neat work you can do with Gardiner Rosin-Core Solder — You can always depend on Gardiner—it goes farther and costs less. Does not sputter.

Gardiner also produces top quality solid wire solders as fine as 1/32" diameter.

Gardiner METAL CO.

4819 S. CAMPBELL AVE., CHICAGO, ILL.
EASTERN SALES OFFICE AND WAREHOUSE
David M. Kasson & Co., 264 Canal St., New York

Ceramics

AMERICAN LAVA CORPORATION (See page 52)
1411 Williams Street, Chattanooga, Tennessee.

PRODUCTS

Insulating parts for receiving and broadcasting tubes, radio parts, etc. 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."

EXECUTIVES

President.....Paul J. Kruesi
Vice-President.Warren A. Jeffords
Sales Manager..G. E. Richter, Jr.
General Mgr....Ralph deP. Clarke
Production Mgr..Harold R. Smart
Chief Engineer..Frank J. Stevens
Research Engineer.....Hans Thurnauer

BRANCH OFFICES OR REPRESENTATIVES

Boston, Mass.
Chicago, Ill.
Newark, N. J.
Cleveland, Ohio.
St. Louis, Mo.
San Francisco, Calif.
Philadelphia, Pa.
Toronto, Ont.

HENRY L. CROWLEY & CO. (See page 52)
1 Central Ave., West Orange, N. J.

PRODUCTS

Electrolytic Condensers; Magicore; Ceramics; Ceramic Condenser Plates; Resistors.

EXECUTIVES

President.....Henry L. Crowley

BRANCH OFFICES OR REPRESENTATIVES

Hamilton Associated Industries, 646 N. Michigan Ave., Chicago, Ill.
J. T. Hill, 821 W. Olympic Blvd., Los Angeles, Calif.
I. R. Smith, 259 W. 14th St., New York, N. Y.
Wesley Block & Co., 15 East 26th Street, New York, N. Y.

ISOLANTITE, INC.
233 Broadway, New York, N. Y.

PRODUCTS

Specialty Ceramics of all kinds, Strain Insulators, Standoffs, Spacers, Bushings, Washers, Coil Bodies, Radio Tube Bases and Parts, Trimmer 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

C. E. White, Bulkley Building, Cleveland, Ohio.
601 Edison Bldg., Los Angeles, Cal.

MYCALEX CORP. OF AMERICA
101 W. 31st St., N. Y. C.

STUPAKOFF LABORATORIES, INC. (See page 52)
6617 Hamilton Ave., Pittsburgh, Pa.

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.

Export Organizations

AD. AURIEMA, INC.
116 Broad St., New York, N. Y.

ROCKE INTERNATIONAL ELECTRIC CORP.
100 Varick St., New York, N. Y.

M. SIMON & SONS CO.
25 Warren St., New York, N. Y.

Felt

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

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

FELTERS COMPANY
210 South Street, Boston, Mass.

WESTERN FELT WORKS
4115 Ogden Avenue, Chicago, Ill.

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.

E. V. SUNDT CO.
4507 Ravenswood Ave., Chicago, Ill.

PRODUCTS

Gaseous Surge Protectors and Arc Suppressers; Neon Voltage Indicators and Pocket Testers; Special Rare Gas Tubes; Electrodeless Neon Tubes and Specialties.

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