SEPTEMBER, 1934

Radio Engineering

DESIGN • PRODUCTION • ENGINEERING

Broadcast Receivers

Auto-Radio Receivers

Electric Phonographs

Sound Recorders

Sound Projectors

Audio Amplifiers

P-A Equipment

Electronic
Control Devices

Testing and
Measuring Equipment

Television Apparatus

Loudspeakers

Components

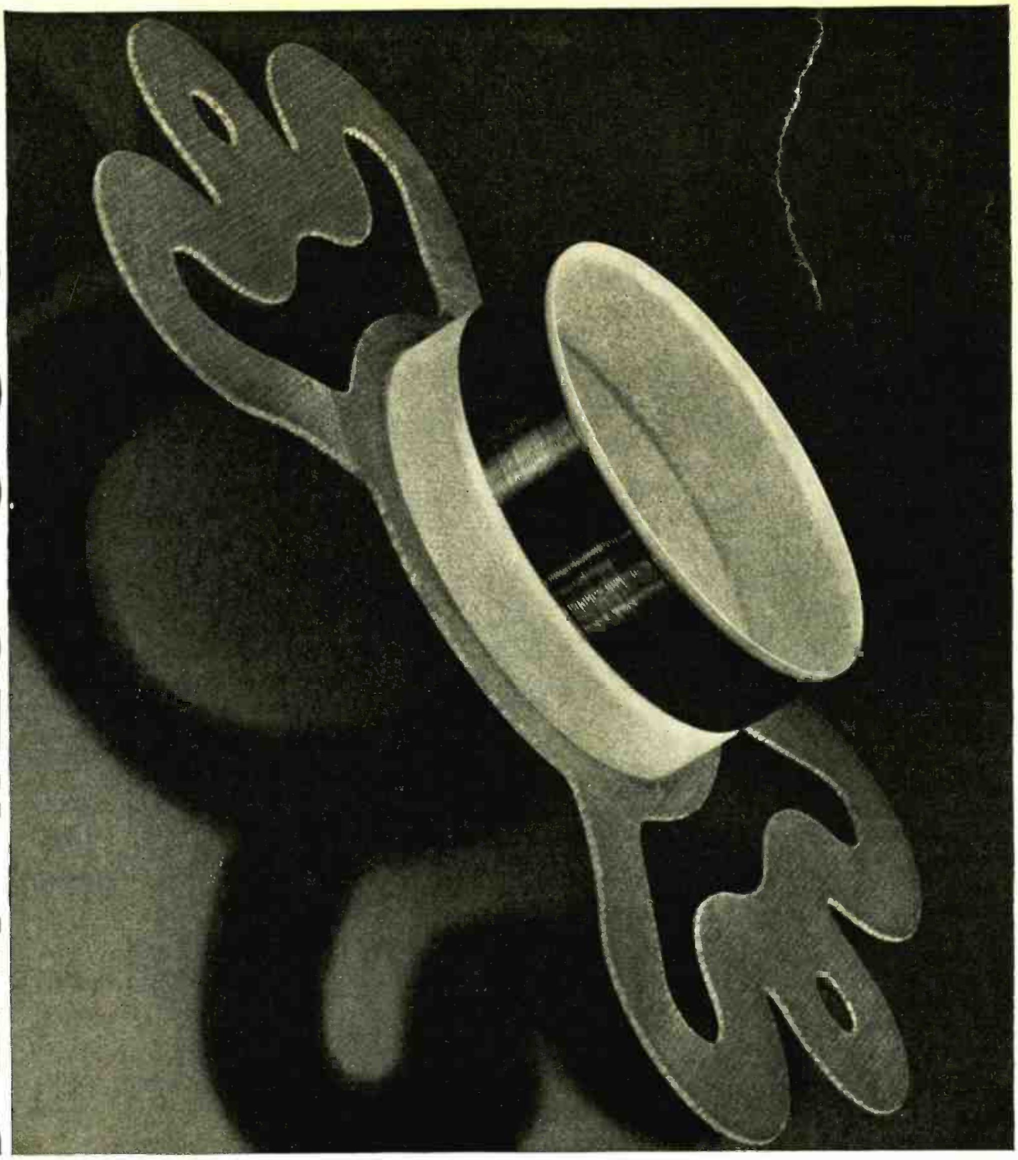
Tubes

Photocells

VOL. XIV NO. 9

The Journal of the
Radio and Allied Industries

DETAILS COUNT



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Vol. XIV — SEPTEMBER, 1934 — Number 9

CONTENTS

DEPARTMENTS

RADIO INDUSTRY CODE

SPECIAL CONSIDERATION by the National Industrial Advisory Board of the RMA application for exemption from the electrical manufacturing code and a separate code for the radio industry has resulted in negotiations with NRA and between RMA and NEMA which are proceeding satisfactorily. Final action by the NRA is expected in September.

Independent code operation for the radio industry is the objective in the Washington negotiations. The National Industrial Advisory Board intervened in the NRA code proceedings instituted by the RMA, viewing the problem as an important matter affecting the two large industries, radio and electrical. The RMA code committee, headed by Captain William Sparks of Jackson, Michigan, and also a committee of NEMA, with NRA officials present, have been holding conferences with the National Industrial Advisory Board. These have delayed action both on the RMA proceeding and also on further revision of the electrical code.

●

BRYAN S. DAVIS
President

JAS. A. WALKER
Secretary

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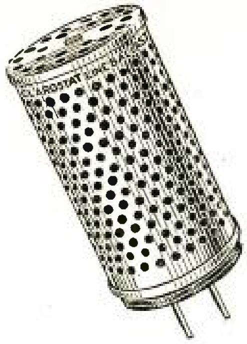

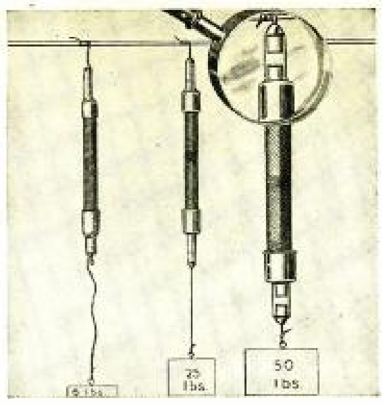

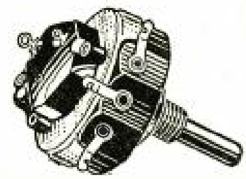

Savings are effected when Clarostats are used in line production...that's why leading manufacturers specify 'em.

LINE RESISTORS

EXTERNAL TYPE: These line reducing resistors are equipped with both male and female plugs in five varying combinations, are especially suitable for the export market and designed to reduce line voltage.

INTERNAL TYPE: This line of fixed resistors has been designed especially for use in reducing the voltages of 110 volts and 220 volts DC line, to the values required by the filament circuit of receivers. These new units eliminate the necessity of using protective housings over such resistors. They readily mount into standard tube sockets and operate at lower temperatures due to their efficient design.

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FLEXIBLE RESISTORS: We have just perfected a new series of flexible resistors of superior quality at prices competitive with carbon resistors. In design they are trim. In accuracy, the commercial tolerance is maintained at ±10%. In ruggedness and tensile strength, their new design permits them to exceed manufacturers requirements from 250% to 500%. The R.M.A. color code for resistance values is used throughout. Production facilities permit unlimited quantities on short notice.

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We solicit inquiries on mass production or special resistor problems, for radio, sound, communication or industrial application.

NEW CONTROL REPLACEMENT GUIDE UPON REQUEST

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285 North 6th Street Brooklyn, N. Y.

"AD-A-SWITCH" was originated by Clarostat

EDITORIAL

MANUFACTURING

RECEIVERS

PHILCO HAS STARTED high fidelity on its way. By this time the public is fairly well acquainted with the salient features of a high-fidelity receiver and will pattern their demands in accordance with their conceptions of what a modern receiver should be.

Unfortunately, the public may expect everything from soup to nuts in a single receiver, and grumble a bit if they do not get what they want. At the moment it is next to impossible to combine the true features of high-fidelity and all-wave reception into a single unit. There is no doubt, however, that it can be done in time. In the meantime, the manufacturer who wishes to offer both high-fidelity reception and all-wave reception, will do well to provide these features in separate units, or through the use of a built-in short-wave converter.

With the present popularity of all-wave receivers, and the probable popularity of high-fidelity receivers to a less marked degree, the usual necessity of perfection in design and manufacture arises. In both types of receivers closer tolerances appear necessary. The preciseness of design required in both instances also demands more rigid methods of factory testing and adjustment.

All-wave and high-fidelity receivers call for components which will maintain their prescribed electrical and mechanical characteristics throughout the useful life of the receiver.

COMPONENTS

THE MANUFACTURERS OF radio-receiver components have made considerable progress in improving both the mechanical and electrical features of their products. Their research activities have increased over the past five years with the result that most component suppliers have not only contributed considerably to the improvement in receiver design, but likewise to a reduction in the cost of finished sets—often at their own expense.

The problem of simplifying production operations is shared alike by the manufacturer and the parts supplier. For some years production men have directed their attention to the simplification of actual fabrication in radio factories. Components have been grouped for the purpose of saving space, wire, supporting and anchoring devices, and for the purpose of reducing the number of receiver-assembling operations.

There is considerable opportunity in the parts field for the development of entirely new components. The application of new materials and new tolerances are called for in the design of all-wave and high-fidelity receiver components. It may become desirable to revert to more expensive components, such as air dielectric condensers, to give accuracy and permanency of adjustment.

TUBES

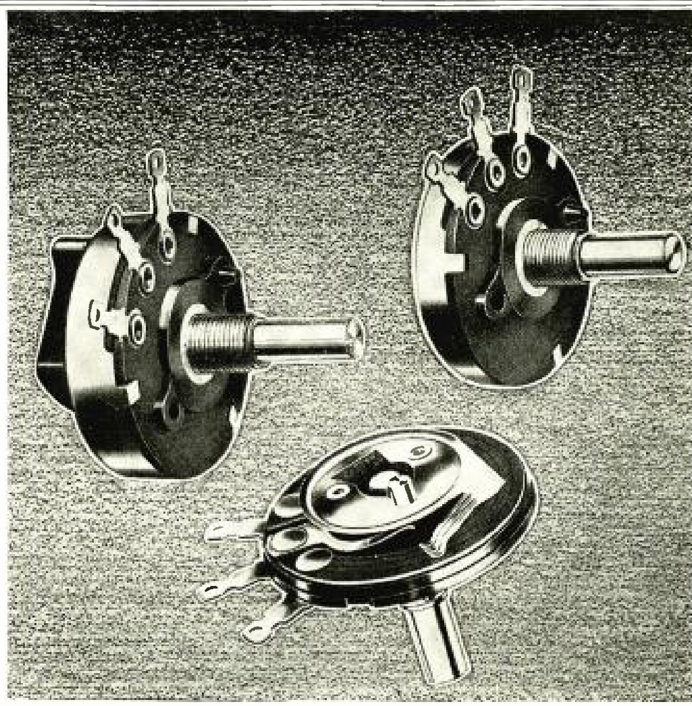
THE 6-SERIES TUBES are now employed in the auto receiver, the universal, the all-wave receiver and the standard broadcast receiver. The field has practically standardized on this series and it appears that in the future the sale of the early 6-series, and the 2.5-series, will be entirely for replacement purposes.

In the case of ac-operated receivers, it is now general practice to employ one transformer winding for the filament of the rectifier tube, and a second winding for supplying the heaters of all other tubes. In a few cases, where an 84 rectifier tube is used, the job is done by a single heater winding. Since there are no high-current rectifier tubes of the indirectly-heated type, this simplification is restricted to small receivers and short-wave converters.

The new 6-series tubes are great space savers. The possibility of compactness is but one of their advantages. The small tube also permits a more sensible spacing of components and apportioning of vacant areas for the purpose of good ventilation and the isolation of high-frequency units from others operating at high temperature, without increasing manufacturing costs or adding materially to the size of the finished receiver.

FIELD TESTED FOR TWO YEARS...

ANNOUNCED TODAY!



IRC
REG. U.S. PAT. OFF.

VOLUME CONTROLS

IRC Volume Controls are a logical development of the IRC method of applying resistance coatings to insulating bases, used so successfully for years in the well-known Metallized resistors.

Nor is this their only recommendation. For two years prior to this general announcement, they have seen extensive service under all conditions of use in radio receivers produced by several manufacturers. Constantly increasing orders from these same firms tell their own story of quality coupled with sound economy.

The IRC Volume Control is especially designed to resist humidity. The resistance coating is permanently bonded at a high temperature, to a hard, moisture-proof base. Contact is made by three slider fingers that always follow the same course and which positively eliminate any jumps in resistance due to shifting of the points of contact. Wear is reduced to a minimum.

Write for Catalog M-26 describing this new IRC development in detail.

INTERNATIONAL RESISTANCE CO.

2100 ARCH ST. PHILADELPHIA, PA.

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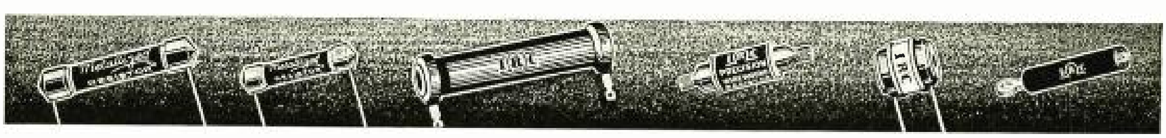
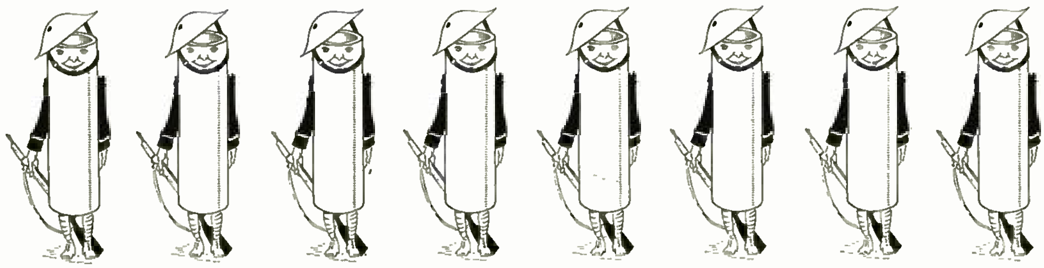


BY THE MAKERS OF METALLIZED, PRECISION AND POWER WIRE WOUND RESISTORS

SUMMERILL SEAMLESS CATHODES are

UNIFORM



PICK OUT 1 OR 10,000 . . .
. . . THEY'RE IDENTICAL!

- They have no burrs, all are clean cut.
- Pure Nickel of absolutely uniform density is used.
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¶ *If your company happens to be among the very few who are not using* SUMMERILL SEAMLESS NICKEL CATHODE SLEEVING, *we sincerely request a trial order, large or small, to introduce our tubing.*

OTHER SUMMERILL PRODUCTS INCLUDE:

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Golf Shafts and Fishing Rods
Industrial Control Equipment
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Tubing of Stainless Steels and Other Alloys

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WE carry a full range of stock in all sizes. Rounds, squares, hexagons, streamline, ovals . . . . in Chrome-Molybdenum, carbon steel and other steel alloys, including stainless. Aircraft material is furnished either normalized or heat-treated to government specifications.

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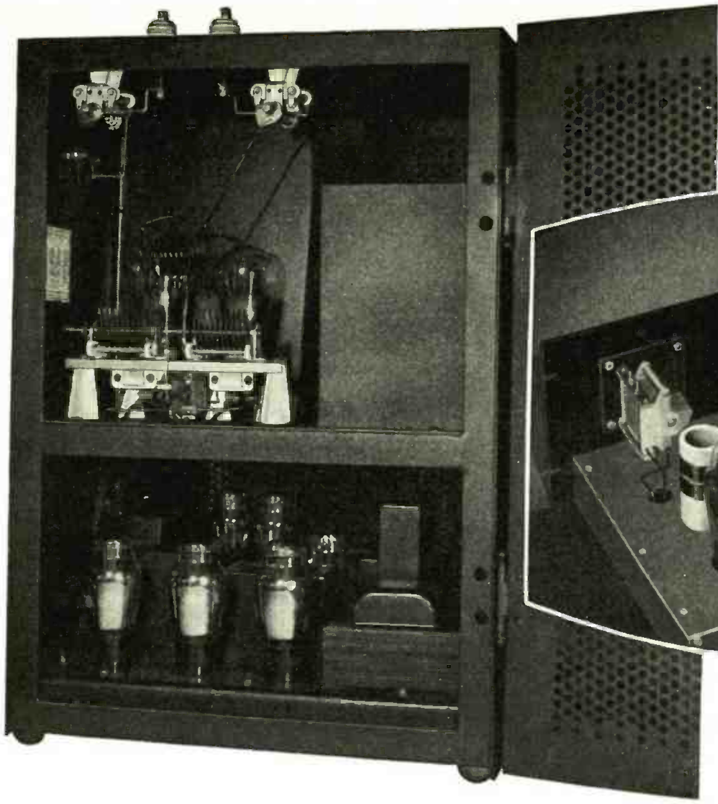


RCA Victor "Terra - Wave" — Ultra-short-wave Police telephone and telegraph transmitter, type ET-5004, using ISOLANTITE insulation.

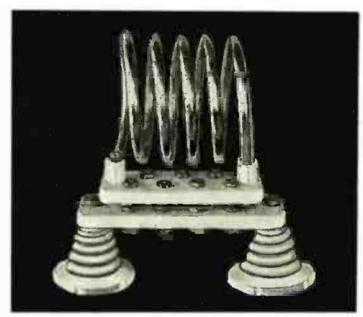
The Collins Radio Company employ ISOLANTITE extensively in the 10-J unit of their type 30 FXB short-wave transmitter.

DEPENDABILITY MUST BE THERE!

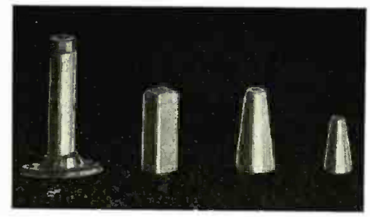
The new and rapidly developing field of Police Radio Communication—indispensable for curbing criminal activity—requires extreme dependability in transmitter construction. That is why manufacturers of police and other short-wave radio communication equipment employ ISOLANTITE insulation.

ISOLANTITE coil supports, stand-off insulators, tube sockets and bases, and many other elements too numerous to mention, are contributing daily to these exacting requirements.

For dependability and precision, specify ISOLANTITE insulation. Write for a copy of our Bulletin 100-F giving full details.



Short - wave power coils by Premier Crystal Laboratories are insulated with ISOLANTITE.



Standard ISOLANTITE stand-off insulators used in transmitter construction.

Isolantite Inc.

FACTORY AT BELLEVILLE, N. J.

New York Sales Office: 233 Broadway

RADIO ENGINEERING

FOR SEPTEMBER, 1934

ENGINEERING INSPECTION

NOTES ON THE APPLICATION OF STATISTICAL METHODS TO PRODUCTION

By C. F. NORDICA

A UNIFORM PRODUCT is desirable if not essential to every manufacturer. In order to insure the required uniformity of a product it is customary to set up definite limits which the product must meet or which a specified portion of the product must meet. Regardless of the care taken with manufacturing processes or of rigorous inspection methods, it is known that no two units of any product will be identical. Such factors as wear of machines, lack of homogeneity of materials, humidity, temperature, and the psychological conditions of the manufacturing and inspection personnel, all contribute to lack of uniformity. Certain random variations are usually accepted as inevitable and it is customary to attempt to eliminate or reduce to a minimum only phenomena which produce irregular, cyclic, or secular trends in the product. In addition to maintaining a uniform product it is the duty of the inspection personnel to observe and trace to its source anything producing a definite trend in the product, as well as to segregate random or natural variations from those due to assignable faults in processes, materials, etc.

STATISTICAL INSPECTION METHODS

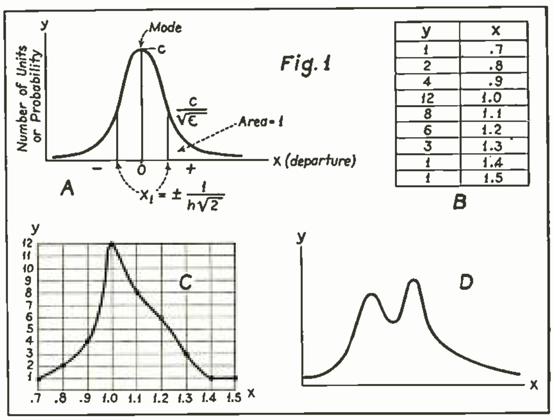
Inspection can be divided into two parts: first, gathering the data, and second, interpreting it. It is to the interpretation of the data that statistical methods can be usefully applied. In general there are two methods of rating a given characteristic of a product. The first is called the method of variables and consists of rating a product in terms of its variation from the desired value. The second is usually referred to as the method of attributes, and consists in rating a product as satisfactory or unsatisfactory. In numerous instances both may be employed on the same characteristic of a given product. As an example, suppose we are interested in the inductance of a coil. We can either measure the variation of the inductance of the coils from the assigned value or we can rate them as acceptable or non-acceptable as the inductance falls within certain specified limits. Again, every unit of a product may be measured, or only a selected number may be tested. The choice between inspecting each unit and sampling the product depends upon the effect of the inspection operations on the later characteristics of the product, upon the rigidity of the requirements and upon economic considerations.

A good example of a product requiring sampling inspection is the current rating of fuses. In this case the product is destroyed by inspection and inspection is called upon not only to determine whether the product meets the requirement, but also to find the most probable value for the normal rating of the product.

Inspection must be able to differentiate between natural or non-assignable variations and controllable or assignable variations. It is only by such methods of analysis that significant trends may be observed early and corrected. In order to do this it is customary to arrange inspection data in such form that significant trends may be readily observed.

PROBABILITY CURVES

When such data is plotted with the number of units having a given value as a function of the departure from some assigned value, a curve similar to the probability curve is usually obtained. Such a curve is shown in Fig. 1-A. This may be arrived at as follows: Suppose measurements were made at intervals of 0.1 henry on a series of 1.0-henry coils. Let the values of the table of Fig. 1-B represent the measured variations and Fig. 1-C the resulting curve. This gives a measure of the variation of the product. If the curve had the form shown in Fig. 1-D, however, it would be immediately



THE FREQUENCY POLYGON OR DEPARTURE CURVE.

obvious that something was tending to make for a non-uniform product. This might be too large a diameter, too many turns, difference in winding tension, or difference in the incremental permeability of the core. Again, if the curves of several consecutive days' production were as shown in Fig. 1-E, it would be obvious that some definite factor or factors were tending to increase the value of the inductance. If the day-to-day curves had varied more or less uniformly about some one day's production, then random variations might account for it. If a persistent trend appears, however, it is usually due to some assignable phenomena.

In arriving at the most probable value of some quantity such as the inductance of a coil or the capacity of a condenser, the same sort of measurements will be made on all or on a sample lot of the units. There are then three possible average values that may be assigned. First, the arithmetic mean; second, the mode or value which occurs most frequently; and third, the median, or central value, when the observations are arranged in order of magnitude. Thus, let a series of observations of a given characteristic of some product be as follows:

5, 6, 7, 8, 9, 9, 9, 9, 10, 10, 10, 11, 11, 12, 13, 14, 15.

The arithmetic mean is: $\dfrac{168}{17} = 9.9.$

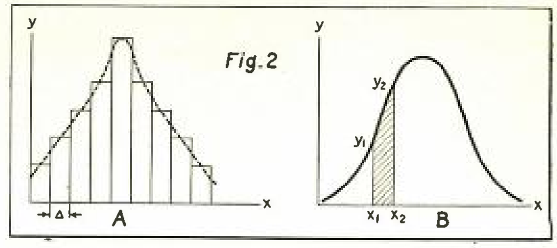
The mode is: 9.

The median value is: 10.

All three values are used to some extent in determining the most probable value although the arithmetic is probably the most generally useful. Had these observations been plotted as shown in Fig. 1 the modal value would have been that corresponding to the peak of the curve, while the median value would have been the value whose ordinate would divide the curve into two equal areas.

THE ERROR EQUATION

Now the curve of Fig. 1-A is represented by $y = c\varepsilon^{-h^2x^2}$ which is called the error equation from its association and use in determining the errors of observation, etc. This was first derived by Gauss and is a fundamental formula around which much statistical theory has been built. The quantity *h* is called the precision index and has to do with the precision of observations or the difference between successive departures from the modal value of the curve. Thus, large values of *h* indicate high precision or small incremental departures. If these incremental departures are plotted as shown in Fig. 2-A, it may be shown that:



THE FREQUENCY HISTOGRAM AND FREQUENCY POLYGON.

$$c = \frac{h\,\Delta}{\sqrt{\pi}}$$

from which we have the error equation reducing to:

$$y = \frac{h\,\Delta}{\sqrt{\pi}}\,\varepsilon^{-h^2x^2}.$$

One of the most important problems in statistical theory is to find the probability that a given observation will be between two given limits x_1 and x_2. This may be obtained in terms of the precision index *h*, for the result sought is merely the sum of the probabilities of all observations between x_1 and x_2 which is:

$$Y = \frac{h}{\sqrt{\pi}}\int_{x_1}^{x_2}\varepsilon^{-h^2x^2}\,\Delta = \frac{h}{\sqrt{\pi}}\int_{x_1}^{x_2}\varepsilon^{-h^2x^2}\,\delta x$$

$$= \frac{h}{\sqrt{\pi}}\int_{0}^{x_2}\varepsilon^{-h^2x^2}\,\delta x - \frac{h}{\sqrt{\pi}}\int_{0}^{x_1}\varepsilon^{-h^2x^2}\,\delta x.$$

This expression has been termed the probability integral. Tables of the values of this integral are given in numerous reference works on the subject of statistics.

DERIVATION OF EQUATION

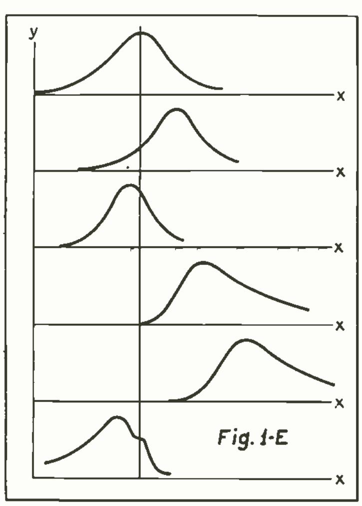
Gauss's derivation of the error equation is of interest in that it indicates the assumptions and boundary conditions necessary in arriving at this fundamental relation. Let q represent the unknown value of a quantity and let a series of *n* measurements be made upon it, *n* being assumed to be very large. Let the departures from the true value be $x_1, x_2 \ldots x_n$. It is obvious that the probability of the occurrence of a departure *x* is some sort of inverse function of its magnitude. Designating the probabilities of these respective departures as y_1, $y_2 \ldots y_n$, this fact may be expressed by:

$y_1 = f(x_1)$
$y_2 = f(x_2)$
. . .
$y_n = f(x_n)$.

It remains to determine the form of $f(x)$. We do not know the true value q of the observed quantity, nor do we know the true departures *x*. We may, however, assume various tentative values of q and study the resulting tentative systems of departures, particularly with a view to selecting that one which seems most naturally distributed in accordance with experience. We are, therefore, seeking to find that system of values for *x* which as a whole has the greatest probability. Whence:

$Y = y_1, y_2 \ldots y_n = f(x_1)\ f(x_2) \ldots f(x_n)$.

In order that the system of *x* shall have the greatest probability, the assumed value for q should be such that *Y* is a maximum. This condition is attained when:



PLOTTED CURVES OF SEVERAL DAYS' PRODUCTION, INDICATING DEFINITE VARIANCES.

$$\frac{\delta Y}{\delta q} = 0.$$

We therefore have:

$$\frac{\delta Y}{\delta q} = \frac{Y}{f(x_1)} \cdot \frac{\delta f(x_1)}{\delta q} + \frac{Y}{f(x_2)} \cdot \frac{\delta f(x_2)}{\delta q} + \ldots = 0$$

or:

$$\frac{Y}{\delta q}\left[\frac{\delta f(x_1)}{f(x_1)} + \frac{\delta f(x_2)}{\delta f(x_2)} \ldots + \frac{\delta f(x_n)}{\delta f(x_n)}\right] =$$

$$\frac{Y}{\delta q}\left[\delta \log f(x_1) + \delta \log f(x_2) + \ldots \delta \log f(x_n)\right] = 0.$$

Replacing $\delta \log f(x)$ by $\varphi(x)\, \delta x$ we have:

$$\varphi(x_1)\frac{\delta x_1}{\delta q} + \varphi(x_2)\frac{\delta x_2}{\delta q} + \ldots \varphi(x_n)\frac{\delta x_n}{\delta q} = 0.$$

If the results of the respective n measurements on q be designated by S_1, $S_2 \ldots S_n$ having definite fixed values, then the departures x are:

$$x_1 = S_1 - q$$
$$x_2 = S_2 - q$$
$$\ldots$$
$$x_n = S_n - q.$$

From which:

$$\frac{\delta x_1}{\delta q} = \frac{\delta x_2}{\delta q} = \frac{\delta x_n}{\delta q} = -1.$$

Which reduces to:

$$\varphi(x_1) + \varphi(x_2) + \ldots \varphi(x_n) = 0.$$

Assume that the resultant departure curve is symmetrical about the value q; that is, that the number of positive departures is equal to the number of negative departures for an infinite number of observations and that the algebraic sum of all departures is zero. We then have: $x_1 + x_2 + \ldots x_n = 0.$

Now the last two equations are satisfied if:

$$\varphi(x_1) = Kx_1$$
$$\varphi(x_2) = Kx_2$$
$$\ldots$$
$$\varphi(x_n) = Kx_n$$

where K is a constant. To prove this let us add a finite quantity a to any one of the x's, say x', and subtract it from any other, say x'', This will not alter the conditions that: $x_1 + x_2 + \ldots x_n = 0.$ nor the condition that: $\varphi(x_1) + \varphi(x_2) \ldots + \varphi(x_n) = 0$ since by hypothesis these conditions are to be simultaneous. This necessitates the condition that:

$$\varphi(x') + \varphi(x'') = \varphi(x' + a) + \varphi(x'' - a)$$

or that:

$$[\varphi(x' + a) - \varphi(x')] + [\varphi(x'' - a) - \varphi(x'')] = 0.$$

Dividing through by a we have:

$$\frac{\varphi(x' + a) - \varphi(x')}{a} - \frac{\varphi(x'' - a) - \varphi(x'')}{-a} = 0.$$

If a approaches zero this becomes as a limit:

$$\frac{\delta}{\delta x'}\varphi(x') - \frac{\delta}{\delta x''}\varphi(x'') = 0$$

or in general:

$$\frac{\delta}{\delta x_n}\varphi(x_n) = 0.$$

It follows at once that since the x's may be varied in any manner among themselves only so $x_1 + x_2 \ldots x_n = 0$ holds, that:

$$\frac{\delta}{\delta x}\delta(x) = K = \text{constant}.$$

Therefore, upon integrating, we have:

$$\varphi(x) = Kx + c.$$

But from $x_1 + x_2 + \ldots x_n = 0$ and $\varphi(x_1) + \varphi(x_2) + \ldots \varphi(x_n) = 0$ jointly, it follows, since substitution in the latter gives:

$$K(x_1 + x_2 + \ldots x_n) + nc = 0$$

that: $\varphi(x) = Kx.$

Now since

$$\varphi(x)\,\delta x = \delta \log f(x) = \delta \log y$$

then:

$$\delta \log y = Kx\, \delta x.$$

Integrating:

$$\log y = \tfrac{1}{2} Kx^2 + c'.$$

Or: $y = \varepsilon^{\frac{1}{2}Kx^2 + c'}$

which is one form of the error equation. Now we have assumed that the larger the error the less likely it is to occur, whence the larger x the smaller y. From which it is obvious that K is a negative quantity. Replacing $\tfrac{1}{2}K^2$ by $-h^2$ and $\varepsilon^{c'}$ by the constant c, the error equation in its usual form results; thus:

$$y = c\, \varepsilon^{-h^2 x^2}.$$

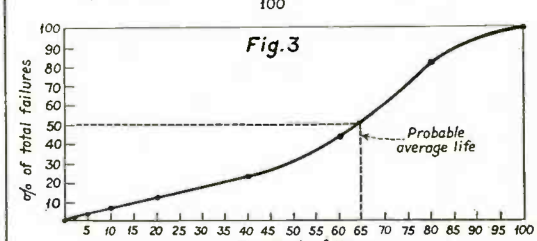
The bilateral symmetry of the function y is evident from the appearance of x in the second degree only. This indicates the equal possibility of positive and negative departures of the same magnitude. The function approaches zero as x increases in magnitude, which indicates that very large departures are extremely improbable. The derivatives of y are:

$$\frac{\delta y}{\delta x} = -2\, ch^2 x\, \varepsilon^{-h^2 x^2}$$

$$\frac{\delta^2 y}{\delta x^2} = -2\, ch^2\, \varepsilon^{-h^2 x^2}\,[1 - 2h^2 x^2].$$

From this since $\frac{\delta y}{\delta x} = 0$ and $\frac{\delta^2 y}{\delta x^2} < 0$ when $x = 0$, y is a maximum when $x = 0$. Which states that zero

Number of Operations or Hours	Number of Failures	Total Failures or Failures as % of Total
1000	0	0
2000	2	2
5000	2	4
10,000	3	7
20,000	5	12
40,000	10	22
60,000	20	42
80,000	40	82
100,000	18	100
	100	



CUMULATIVE FREQUENCY DISTRIBUTION CURVE.

departure has the greatest probability. We may now draw the curve of Fig. 2-B since the y intercept is the maximum value of y and equal to c at $x = 0$. And from

$$1 - 2h^2x^2 = 0$$

$$x = \pm \frac{1}{h\sqrt{2}}$$

we have the two points of inflection of the curve. The ordinate at the points of inflection is:

$$y = + \frac{c}{\sqrt{\varepsilon}}.$$

The quantity c represents the probability of zero departure.

So far we have treated the departure x as a continuous variable which might have any value from zero to infinity. But to assume this would be to assume an infinitely minute graduation of the measuring scale. Thus the probability of any particular departure out of the infinity of possible ones would be infinitesimally small. It is thus apparent that the variable departure x instead of varying by infinitesimal increments δx does have finite discontinuities Δ, which represents the smallest fraction of a unit in which the measured results are expressed. The curve should therefore be represented as shown in Fig. 2-A, the width of the departure compartments being Δ and their height y. And:

$$\Sigma y = 1.$$

The curve of Fig. 2-A is usually called the frequency histogram, while that of Fig. 2-B is usually referred to as the frequency polygon.

DEPARTURE VALUES

If a series of direct measurements be made upon a single quantity under constant conditions the result is a series of values each approximating the true value. However, no one of them is the true value and it therefore becomes a matter of judgment to select a value which will make the departures have a most natural distribution. The symmetry of departures from the true value has been shown to be symmetrical when the departures are due to natural causes. This leads at once to the axiom that the best value is probably the arithmetic mean. If the measured results be $S_1, S_2 \ldots S_n$ and their arithmetic mean be m, then the departures from the mean are:

$$x_1 = S_1 - m$$
$$x_2 = S_2 - m$$
$$\ldots$$
$$x_n = S_n - m.$$

By summation we obtain:

$$\Sigma x = \Sigma m - n m = 0$$

which expresses the fact that the arithmetic mean of the results is the value with respect to which they are symmetrically placed; that is, the sum of the departures are equal to zero. From which it follows that in this case the arithmetic mean is the most probable value that can be assumed.

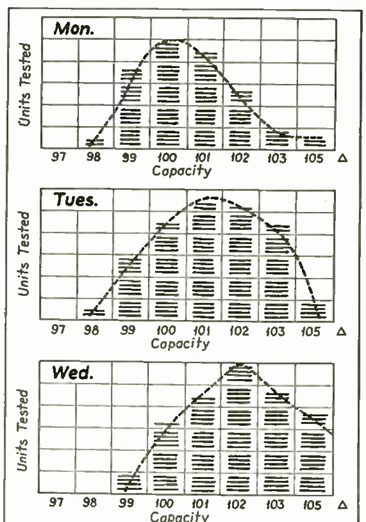


Fig. 4

A GROUP OF THREE CAPACITY DEPARTURE CURVES; FOUR CHECKS PER SQUARE.

METHOD OF LEAST SQUARES

If this is true, then we should obtain a similar result by using the method of least squares. This principle may be stated as follows: The most probable value of a measured quantity that can be deduced from a series of direct observations, made under identical conditions, is that for which the sums of the squares of the departures is a minimum. Again, let the results of observations be $S_1, S_2 \ldots S_n$. If we designate the most probable value by m, then:

$$y_1 = c\,\varepsilon^{-h^2 x_1^2}$$
$$y_2 = c\,\varepsilon^{-h^2 x_2^2}$$
$$\ldots$$
$$y_n = c\,\varepsilon^{-h^2 x_n^2}.$$

The probability of the occurrence of the assumed system of events is:

$$y_1, y_2 \ldots y_n = c^n\,\varepsilon^{-h^2 (x_1^2 + x_2^2 + \ldots x_n^2)}.$$

Now, if $y_1, y_2 \ldots y_n$ is to be a maximum, then $x_1^2 + x_2^2 + \ldots x_n^2$ must be a minimum. That is, m must be chosen so that Σx^2 is a minimum in accordance with the principle just stated. Whence:

$$\Sigma x^2 = (S_1 - m)^2 + (S_2 - m)^2 + \ldots (S_n - m)^2 = \text{minimum}$$

and:

$$\frac{\delta}{\delta m} \Sigma x^2 = -2\,[S_1 - m)^2 + (S_2 - m)^2 + \ldots (S_n - m)^2] = 0$$

$$\text{or: } m = \frac{S_1 + S_2 + \ldots S_n}{n}$$

which is simply the arithmetic mean of the observations.

CUMULATIVE FREQUENCY DISTRIBUTION

So far we have confined the discussion to random observations due to natural or non-assignable causes. Consequently when the controllable variations are reduced to a minimum as they should be, then the above results apply. Now suppose we are to determine the probable life of a series of switches, or circuit breakers, or relays. Let the results be those given in the table of Fig. 3.

Probably the curve which reveals the most information is that shown in Fig. 3, in which the percentage of failures is plotted as a function of time or number of operations. This type of chart is usually referred to as a cumulative frequency distribution curve. The average life expectancy is then the ordinate corresponding to 50 per cent failure. This is an example of the use of sampling inspection of a given characteristic of the product.

Suppose we are interested in variable condensers. Certainly one of the quantities which will be carefully scrutinized is maximum capacity. Suppose we decide that the value Δ or the steps in which we are interested, or which can be accurately measured, is 1.0 micro-microfarad. Then a chart such as that shown in Fig. 4 might be used and the inspector might simply draw a line in the proper column for each condenser. This results in a chart which can be observed even while the chart is still in the making, if desired. Moreover, it eliminates any re-arrangement of data for later analysis.

Distribution curves for different lots or different days can be readily examined without transcribing any of the data. A tendency for capacity to run toward the lower limit in condensers having plates accurately centered might at once point to plate material which is too thin, etc. This permits early correction of controllable errors, or early changes in design without a large waste of material or undue delay which might result if extensive analysis of inspection data were undertaken. Because of the immediacy of the data, departures from engineering specifications provided the supplier are instantly noted, with the result that the actual degree and nature of the departure can be transmitted to the supplier for correction without delaying the production line.

CHOOSING VALUE

Now assume that it was required to establish a capacity rating for a lot of fixed condensers. It is then required to establish a most probable value of capacity. Suppose the results are those given in the table of Fig. 5. While the curve is not symmetrical, it is still sensibly so. Had it been exactly symmetrical the three average values would be identical and we would know that the differences were due to random or non-assignable causes. Since it appears that manufacturing irregularities are actually playing a part, the mode would ordinarily be chosen as the most probable value, since it occurs most frequently. The more unsymmetrical the curve the further the departure of the three average values and the more excuse there would be for using the modal value as the most probable value for the rating.

Value of Capacity	Number of Units
1.5	0
1.6	1
1.7	2
1.8	4
1.9	6
2.0	10
2.1	8
2.2	6
2.3	3
2.4	1
	41

$\frac{82.9}{41} = 2.03$ = Arithmetic mean

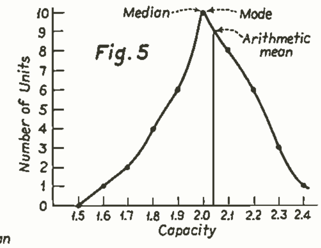


ILLUSTRATION OF USE OF FREQUENCY POLYGON IN DETERMINATION OF MOST PROBABLE VALUE.

CONCLUSIONS

From the foregoing discussion it is evident that no two items of a given product can be identical and that attempts to reduce random variations due to non-assignable causes is more or less a waste of effort. It is therefore essential to determine which of the variations are due to controllable causes and which are not. In general we can expect random variations to obey the law of error distribution as derived by Gauss, knowing that this will produce a symmetrical series of results. It is therefore necessary to scrutinize carefully the unsymmetrical curves and by analysis eliminate the causes of irregularity in the product. One method of recording data in a readily usable form is illustrated. By the exercise of reasonable judgment and proper recording of inspection data it is therefore a reasonably simple matter to insure a stable and uniform product.

Weather-Report Receivers

INTERMEDIATE-WAVE radio receivers at filling stations and other points along highways to obtain weather information for motorists have been suggested by the Bureau of Air Commerce. Every hour from the 68 airways broadcast stations scattered throughout the United States along the Federal Airways System weather reports are sent out on the air to assist flyers, and small receiving sets with a range of from 200 to 400 kc could make this information available to motorists.

WEATHER BULLETINS

This service, if organized, could be made available to the transient motorist in the form of small bulletin boards to be placed in conspicuous places in service stations, bus stations, and local automobile clubs and associations on heavily traveled highways where an attendant could post the weather broadcasts as soon as they were sent out on the air. This would be of particular importance in the more rugged and mountainous sections of the country, where a fog may mean delay, heavy rain, a washout, and a snow an impassable section of roadway. Using these proposed bulletins the motorist may take another route and avoid the possibility of these delays.

DATA BEING USED

Automobile test tracks and automobile clubs have already found this means of determining the weather very valuable, but this service has not yet been placed at the convenience of the casual motorist, the bus operator and the cross-country driver. Just as the airplane pilot depends on the weather reports to guide him through the skies, so will the automobilist depend on them in his selection of routes and the length of his day's travel.

It has been previously suggested by the Bureau of Air Commerce that the automobiles themselves carry these receivers for the reception of this weather information. The service that would be offered by filling stations and other points where the motorist is likely to stop would include cars not equipped with radios.

NEW MARKET

There are literally thousands of service stations, filling stations and auto-camps dotted along the principal highways of this country. The market appears to be sufficiently large to warrant the manufacture of inexpensive intermediate-wave receivers expressly for the purpose of picking up the weather information.

The radio service man is in a position to develop the market. It has been suggested that he do so in the September issue of SERVICE.

Factory Processing of

By L. L. McMASTER, Jr.
COMMERCIAL ENGINEER

THE PROBLEMS INVOLVED in the activation of oxide-coated emitters are an endless source of trouble to factory engineers. At times the factory is suddenly plunged into an epidemic of low emission or slumping emission, only to run out of the trouble as quickly as it was encountered, the solution remaining a mystery. There is a cause for every effect. To find that cause as quickly as possible means a quicker solution of the effect. This theory is presented for the factory engineer. It is not offered as the latest theory on a question thus far unsatisfactorily answered; rather it is the result of considerable study of the literature plus practical experience.

Many theories have been advanced on emission from oxide-coated filaments. There have been many presentations in the literature both in this country and abroad and a study of these theories has led to a consolidation of many of the ideas suggested into a theory which has been found to be practical for the man responsible for the processing of tubes.

CHEMICAL REACTIONS

The chemical reactions involved may be represented by simple equations, the primary reaction being the breakdown of the carbonates into the oxides:

$$BaCO_3 \xrightarrow[1000^\circ c]{900\ to} BaO + CO_2$$

This reaction takes place during the breakdown of the carbonates on exhaust, though to various degrees. Frequently the secondary reaction is partially carried out during this period and is completed during aging. This secondary reaction is the vital part of the process. On it everything depends, such as stability of characteristics and emission life.

SECONDARY REACTION

The secondary reaction is the formation of metallic barium which produces the emission and is believed to be an equilibrium reaction:

$$2BaO \xrightarrow[heating]{Further} Ba \rightleftarrows O \rightleftarrows Ba + (?)O$$

The emission actually takes place from the metallic barium produced by the unsatisfied equation. If there is sufficient oxygen to satisfy the barium there will be little emission, while if the reduction has been carried too far there will not be sufficient oxygen to carry on the continuous reaction with the excess barium. It is believed that the reaction itself is what keeps the barium on the surface of the cathode and is taking place continually, the barium never having enough oxygen to complete the reaction. This may be confirmed by the effect of further heat applied to the cathode. If there is incomplete breakdown, additional gas is introduced, while if there is insufficient oxygen, the barium will be vaporized giving short life and possibly secondary emission from the grid.

There is evidence that emission is from a monatomic film of barium, also that electrolysis within the coating is responsible for the phenomena. Evidence also shows that barium takes part repeatedly, moving toward the core in the form of barium ions which lose their charge and diffuse back as atoms. It has been shown that metallic barium evaporates from the surface and that the barium surface can be supplied through an external source.

PRODUCTION OF BARIUM

Most theories express the belief that emission is from the metallic barium though few offer an explanation as to how this barium is produced. It has been suggested that there are three possibilities:

1.—Thermal decomposition of the oxide.

2.—Chemical reduction.

3.—Electrolytic reduction.

In the opinion of the writer all three possibilities have a definite part in the activation. Heat alone will reduce the barium oxide while there is possible chemical reduction due to the reaction between the core material and the coating. The electrolytic reduction which takes place during aging is due to the application of the anode voltage. The ion bombardment dissociates or reduces the oxide carrying the secondary reaction to the necessary equilibrium.

ACTUAL PROCESSING

Let us now follow through actual processing, observing possibilities which might affect our goal of high emission plus long life. In the preparation of the coating solution we use a mixture of barium carbonate plus strontium carbonate. The reason for this is the activity of the barium, which if used alone would tend to form little pools of barium emission centers when activated, drawing the emission current from spots on the cathode which would tend to cause "hot spots," disturbing the equilibrium, vaporizing the emitter and in the case of a light filament causing burnout. The strontium, being less active, tends to smooth out the barium while itself a fairly good emitter.

BINDER MATERIALS

Some form of nitrocellulose binder is generally added. While to some the presence of carbon formed by the decomposition of the binder on exhaust is a source of worry it is rather quite beneficial as shown:

$$BaCO_3 + C \longrightarrow BaO + 2CO$$

Actually, the presence of free carbon lowers the breakdown temperature of the carbonate as well as yielding carbon monoxide, a good reducing agent. Carbon is frequently added and while many engineers realize they get better results they do not like to admit they add carbon either directly or indirectly. Cases are known where 5% pure carbon is added to the coating solution; other engineers use turpentine inside the anode; another bombs carbonized plates before the cathode is heated, as it deposits a film of carbon on the cathode surface; and sugar has been added to the binder.

In the breakdown of the coating, if too much heat is applied it will be hard to start activation due to the fact that at the high temperatures its mechanically occluded or chemically combined gas is driven off. This is particularly true when an especially gas-free metal is used for the other elements in the tube.

AGING SCHEDULE

In establishing a "lighting up" or an aging schedule, the most common factors seem to be past experience, cut and try voltages, plus a leaning to some favored theory that the cathode should be flashed as high as the filament will permit, or that bombing should be just under the melting point of the anode or cage in the tube. An application of the "cause and effect theory" should enable us to line up a possible set of schedules which should be reasonably close, being corrected later for variations in conditions, equipment and machine speed.

Thermionic Emitters

● Detailing the problems involved in the activation of oxide-coated emitters with data on the reduction of "low-emission" productions.

It should be kept in mind that the formation of metallic barium by the reversible equilibrium reaction is what controls the electron emission. *Every action which helps to set up this reaction should be considered, while any action which will upset the proper balance of barium and oxygen should be avoided.* Let us first consider the effect of bombarding before breaking down the coating. With freshly fired parts, or with parts of a metal having a low occluded gas content, this is not vital. If, due to circumstances, mounts have been exposed to air, permitting absorption or oxidation, the bombing is an advantage as any oxygen will be released into the bulb without affecting the carbonates in the coating. If Svea Metal parts are used, the oxides are absorbed into the surface of the metal, eliminating any danger of poisoning the emitter at a later stage. Pre-bombing should be regarded as a precautionary measure.

The following position is the proper place to start the primary breakdown reaction. As to an initial flashing, it is a matter of opinion, some preferring it, others not. In the opinion of the writer it should be avoided as it tends to liberate carbon dioxide so rapidly as to disturb the bond and loosen the coating. If a porous coating is desired, it should be sprayed on in such a manner during the cathode preparation.

LIGHTING SCHEDULE

The actual lighting schedule depends entirely on conditions and is practically never the same for any two machines or with any two engineers. From the standpoint of production it is an advantage to process the emitter as far as possible on the pumps while to obtain the highest degree of activation requires an ion bombardment internally. In consideration of this fact, aging is recommended. It is generally conceded that carbon dioxide plays a very important part in the activation of the emitter. If this be the case, care should be taken not to carry the primary breakdown too far on the pumps as there will be no residual gas to be ionized by the application of anode voltage on aging. This gas may be from two sources, either breakdown of the carbonates, or from absorbed gas in the parts not completely removed during bombing. If the parts contain little occluded gas, or are completely degassed on bombing, the supply has to be from the further breakdown of the carbonates. This is the better practice as oxygen as well as carbon dioxide may be released from the parts, poisoning the emitter. In view of that fact, too high a lighting schedule should be avoided and a flashing position be used initially on aging.

GAS EFFECT ON AGING

The effect of gas on the aging of the tube offers an interesting phenomenon . . . one not too well understood. It is believed that the application of an anode voltage ionizes the gas present and that the ion bombardment dissociates or reduces the barium oxide, carrying the secondary reaction to the desired equilibrium if properly controlled. If the quantity of gas is excessive, sputtering will be observed. This sputtering is evidently due to positive ions formed by collision with electrons in inert gases and is to be avoided as it tends to actually knock pieces of the coating loose. The control of the amount of carbon dioxide present during aging is both critical and important.

SALVAGING LOW EMITTERS

Another problem faced by the tube engineer is recovery of low emission tubes containing cathodes which have a coating of a light gray or brown color. This color is thought by many to be impurities, possibly carbon from decomposed binder. This material is probably barium peroxide (BaO_2). It is formed by the action of oxygen on barium oxide, is gray to brown in color, and breaks down at a relatively low temperature. It is frequently observed up and down the cathode opposite the grid support wires and sometimes even the grid turns may show by faint lines on the coating.

The control grid, because of the shielding action of the other elements, receives little heat during bombardment on the pumps. Any gas absorbed by the grid will, therefore, be likely to be driven off during aging when the grid is heated by internal electron bombardment. If this gas is oxygen, and because of the closeness to the cathode, a reaction takes place which forms barium peroxide on the cathode at points nearest the control grid. In addition to this there is oxygen provided to satisfy the free barium on the emitter surface, upsetting the equilibrium, and driving the reaction one way to form the inactive barium oxide thus poisoning the emission.

FLASHING

It is well known that flashing these tubes will bring back the cathode to the white color. This is not sufficient alone. If the cathode is heated to a temperature sufficient to break down the peroxide, oxygen is given off which may be taken up by reflashing the getter while the cathode is thus heated, after which the cathode should be flashed or put through the regular aging. Tubes treated in this manner will often give fairly good life.

●

INCREASE IN AMATEURS

EVIDENCING THE ever-widening interest in amateur radio throughout the United States, its territories and possessions, records just compiled by the Federal Communications Commission disclose that there were 46,390 valid amateur station licenses in existence at the close of the last fiscal year, June 30, 1934.

During the year 8,782 new station licenses were issued and there were 12,279 modifications, reissues and renewals.

Authorizations as amateur operators totaled 16,686; operator license endorsements for higher privileges 209; duplicates of lost or destroyed licenses 161, and special authorizations 15, making a grand total of 38,132 authorizations issued during the year, or well over 100 per day, relating to amateurs alone.

Applications for amateur operator station licenses pending July 1, 1933, were 497, while 33,184 were received during the fiscal year. Of the total, 21,672 were approved; 8,211 were returned, or referred; 3,631 applicants failed to pass required examinations, and 11 were denied formally, leaving 156 cases pending at the close of June 30, 1934.

Return of applications occurred for many reasons such as lack of citizenship, alien control of premises and misconception of the proper use of an amateur station. Many others had only formal defects, curable by amendment of applications.

1933 CENSUS
of Radio Manufacturers

RADIO APPARATUS AND PHONOGRAPHS to the value of $112,279,565 (at f.o.b. factory prices) were made in the United States in 1933 by establishments engaged wholly or principally in these lines of manufacture, according to a preliminary tabulation of data collected in the Biennial Census of Manufactures taken in 1934, released by Director William L. Austin, Bureau of the Census, Department of Commerce. This is a decrease of 40.2 per cent as compared with $187,717,880 reported for 1931, the last preceding census year. The decrease in wage-earner employment was much less pronounced, however—only 11.4 per cent, from 36,490 in 1931 to 32,339 in 1933.

(Continued on page 22)

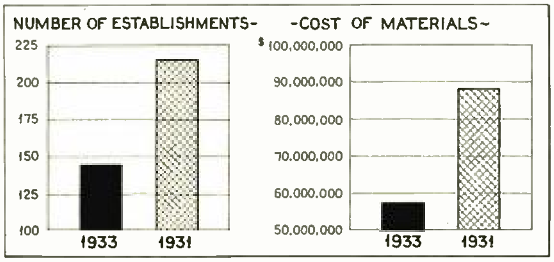


Table 1.—Summary for the Industry: 1933 and 1931

	1933	1931	*Per cent of increase (+) or decrease (—)*
Number of establishments	145	217	—33.2
Wage earners (average for the year)[1]	32,339	36,490	—11.4
Wages[2]	$29,124,981	$35,145,577	—17.1
Cost of materials, containers, fuel, and purchased electric energy[2]	$57,483,028	$88,402,858	—35.0
Products, total value[2]	$118,273,470	$193,142,845	—38.8
Radio apparatus and phonographs	$112,279,565	$187,717,880	—40.2
Other products	$4,690,515	$4,479,966	+ 4.7
Custom, repair and contract work	$1,303,390	$944,999	+37.9
Value added by manufacture[3]	$60,790,442	$104,739,987	—42.0

[1]Not including salaried officers and employees. Data for such officers and employees will be included in a later report. The item for wage earners is an average of the numbers reported for the several months of the year. In calculating it, equal weight must be given to full-time and part-time wage earners (not reported separately by the manufacturers), and therefore it exceeds the number that would have been required to perform the work done in the industry if all wage earners had been continuously employed throughout the year. The quotient obtained by dividing the amount of wages by the average number of wage earners cannot, therefore, be accepted as representing the average wage received by full-time wage earners. In making comparisons between the figures for 1933 and those for 1931, the possibility that the proportion of part-time employment was larger in one year than in the other should be taken into account.

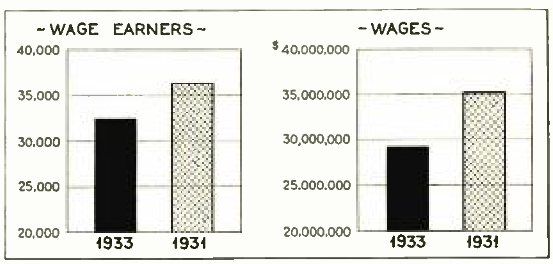
[2]Manufacturers' profits or losses cannot be calculated from the census figures because no data are collected for certain expense items, such as interest, rent, depreciation, taxes, insurance and advertising.

[3]Value of products less cost of materials, containers, fuel, and purchased electric energy.

Table 2.—Radio Apparatus and Phonographs—Production, by Kind, Quantity and Value: 1933

	Number	*Value*
Radio apparatus and phonographs made in the radio and phonograph industry, value....	......	$112,279,565
Receiving sets, complete (cabinet, chassis, speaker, and tubes):		
Number reported	3,451,112	66,839,828
Number not reported, value....	......	2,161,587
For the home, total....	2,788,467	53,837,362
Covering standard broadcast band—Socket-power operated—Factory price—		
Not over $11....	404,839	3,400,240
Over $11, but not over $30....	1,877,166	31,550,623
Over $30	305,726	12,217,077
Battery operated (excluding batteries)	92,284	1,922,647
Extending beyond standard broadcast band—all-wave receiving sets, both socket-power and battery operated (excluding batteries)	108,452	4,746,775
Automobile sets (excluding those for police use)		
Power-operated, including all accessory equipment—Factory price—		
Not over $22....	443,301	7,519,948
Over $22	219,344	5,459,246
All other sets (including those for police use)[2]	......	2,184,859
Tubes:		
Receiving tubes, total....	57,042,409	24,197,086
For Replacement, total....	34,965,113	15,308,022
Rectifiers (intended primarily for use with receiving sets)....	4,864,120	1,967,594
Other (including television-neon and other converters)	30,100,993	13,340,428
For initial equipment, total....	22,077,296	8,889,064
Rectifiers (intended primarily for use with receiving sets)	5,736,584	2,157,984
Other tubes	16,340,712	6,731,080
Transmitting tubes, value	(1)	937,213
Light-sensitive (all sizes, all purposes); other, primarily for industrial control apparatus; and rectifier tubes other than for use with receiving sets[2], value....	(1)	141,470
Transmitters (including all associated equipment):		
Broadcast type, aircraft and ship transmitters[2]	108	970,035
Other transmitters for use at fixed locations	74	296,473
Phonographs and accessories:		
Phonographs for mechanical or electrical reproductions of records, not including dictating machines[2], value	(1)	301,436
Records and blanks[2], value....	(1)	2,562,082
Needles, value	(1)	272,284
Combination radio and phonograph units....	30.092	1,407,650
Miscellaneous:		
Receiving set chassis for sale separately as such	25,725	378,371
Loudspeakers for sale separately as such. value	(1)	2,797,048
Microphones (all types), value....	(1)	198,858
Other apparatus and products (including dictating machines)[2] associated with radio and phonograph equipment, and products not reported by kind, value....	(1)	8,818,144

[1]Data incomplete.
[2]Figures combined to avoid disclosing approximations of data for individual establishments.



Insulated Wire and Set Production

By **RAYMOND G. ZENDER**
LENZ ELECTRIC MANUFACTURING CO.

RAYMOND G. ZENDER.

THE ELECTRICAL characteristics of textile-insulated wire will depend largely on; the kind of fibre, the chemical nature of the insulating materials, the atmospheric conditions under which it is used and the effects of aging.

CHEMICAL ANALYSIS

There are several ways in which electrical leakage can take place in insulated wire but the most important is surface leakage and electrolytic action, present in impure textiles and inferior impregnating compounds when hygroscopical. The electrolytic action will depend largely on the chemistry of the insulating materials and the humidity to which it is subjected.

In laboratory tests the author has found that impurities in the form of salts of potassium and sodium found in unwashed textiles have the most damaging effect on insulation resistance. When insulated wire is placed in a humid atmosphere, small beads of water form on the surface. If exposed for some time, the beads of water spread out and unite to form a continuous film, and during this time water is absorbed by the insulation. This water in turn dissolves the soluble chemicals and electrolytic action takes place. The film of water, together with the soluble salts, form a network of conducting paths on the surface of the insulation.

Insulated wire used in high-frequency circuits, exhibits losses which change with the temperature of the insulation, frequency and applied voltage. In all cases, the radio-frequency phase difference was found to increase after a sample had been subjected to high humidity, and it was found to decrease upon expelling the moisture by heating. Note power factor difference in the accompanying Tables. Impregnating the textile insulation with a high-dielectric wax compound reduced this effect.

TABLE NO. 1

Insulation: 2 Cotton Braids Waxed

	At 74° F. 90% R.H. for 100 Hours.	At 120° F. 38% R. H. for 100 Hours.
Insulation Res.	0.29 Meg. per ft.	8.8 Megs. per ft.
Moisture Absorption	0.94%	Infinity
Power Factor	6.63%	0.08%

Average voltage breakdown at room temperature: 1925 volts.

Note: In each of the three Tables, insulation and voltage breakdown measured on one-foot samples immersed in mercury. Moisture absorption by weight. Power factor measured at 1000 kc. (Tests conducted by A. R. McLellan, Consulting Engineer.)

TABLE NO. 2

Insulation: 2 Silk Wraps Plus 1 Cotton Braid Waxed

	At 74° F. 90% R.H. for 100 Hours.	At 120° F. 38% R. H. for 100 Hours.
Insulation Res.	513 Megs. per ft.	557 Megs. per ft.
Moisture Absorption	0.94%.	Infinity
Power Factor	6.93%	0.17%.

Average voltage breakdown at room temperature: 2100 volts.

TABLE NO. 3

Insulation: 2 Wraps Cellulose-Acetate-Treated Textile Plus 1 Cotton Braid Waxed

	At 74° F. 90% R. H. for 100 Hours.	At 120° F. 38% R. H. for 100 Hours.
Insulation Res.	1792 Megs. per ft.	2083 Megs. per ft.
Moisture Absorption	0.94%	Infinity.
Power Factor	6.68%.	0.15%.

Average voltage breakdown at room temperature: 2800 volts.

Insulated wire, used in auto-radio sets and home sets, is subject to contamination in the form of dust and dirt containing electrolytic impurities. Auto sets are subject to the oxides of sulphur and carbon which react with the surface film of water on the insulation to form solutions of sulphuric and carbonic acids. This condition has also been found in home radio sets that have been operated adjacent to large industrial factories.

Therefore, those impregnating compounds should be accepted which do not soften at operating temperatures and which do not break down at these temperatures to form any of the series of weak organic acids which create electrolytic action.

The reader will note that the tests shown in the tables were run under two different atmospheric conditions; first, the extreme, and secondly, what is to be conceived as set-operating temperature. In comparing the results it will be noted that the best results, shown in Table No. 3, were obtained on the combination of two wraps of cellulose-acetate-treated textile plus one cotton braid, waxed.

In the selection of proper insulation for hook-up wire, four essential dielectric characteristics should be considered, namely: *insulation resistance, power factor, voltage breakdown,* and *moisture absorption.*

ELECTRICAL ANALYSIS

The growing demand for better hook-up wire in radios, necessitated by high-gain r-f systems and short-wave receivers, calls for a new type of

(*Continued on page 22*)

● The importance of adequate insulation for wire used in radio receivers cannot be overemphasized. This article covers recent research into this subject

Design .. NOTES AND

SHORT-CUT FOR DETERMINING OPERATING CONDITIONS OF POWER OUTPUT TRIODES

THE APPROXIMATE operating conditions for output triodes can be readily obtained by graphical methods. In the following notes prepared by the Engineering Department of RCA Radiotron Co., Inc., the Power Output Rule is described and simple formulas are given for obtaining the operating current, bias, and load for both single and push-pull triodes. Other formulas are included for converting power output, load, and plate current from one set of plate voltage conditions to another. These formulas are based upon the assumption that the $E_c = 0$ curve of the plate family follows the three-halves power law.

POWER OUTPUT RULE

The Power Output Rule (frequently referred to as the Distortion Rule) is used to obtain the plate load and the corresponding power output. This rule was first described by K. S. Weaver in *QST* of November, 1929. It is the doublescaled rule illustrated in Fig. 1. L_1 and L_2 have a ratio of 11 to 9, since this is the ratio corresponding to 5% distortion. The zero of the rule is placed at the point on a plate family corresponding to the values of plate voltage and plate current or grid bias under consideration. The slope of the rule is then adjusted so that the reading of the rule at one extreme of the assumed grid swing is the same as that at the other extreme of the grid swing. The slope of the rule when so adjusted corresponds to the load line for 5% distortion.

SELECTION OF THE LOAD FOR A SINGLE-TRIODE OUTPUT TUBE

The plate circuit load for a triode is determined from its plate characteristics curves. If the operating point I_o of Fig. 2 is known, the distortion rule can be used directly to obtain the load. If I_o is not known, it can be determined from the simple relation, $I_o = \frac{1}{4} I_m$. I_m is obtained by drawing a vertical at the desired operating plate voltage and extending the $E_c = 0$ curve until it intersects the vertical line. One quarter of this value, I_m, locates I_o, the operating point. The Distortion Rule is then applied with its zero placed at I_o and adjusted until L_1 reads for the intersection with the zero bias the same as L_2 reads for the intersection with the curve for twice the operating bias. The slope of this line represents the load resistance. The power output can be obtained from the formula:

$$P = \frac{(I_{max.} - I_{min.})\ (E_{max.} - E_{min.})}{8}.$$

LIMITATIONS OF METHOD

The only limitation to the general use of this method is that conditions should not be chosen which exceed recommended maximum plate dissipation of the tube. The best guide to this value is the product of the maximum recommended plate voltage and the maximum recommended plate current. When a value of I_o giving too high a tube plate dissipation is obtained, I_o should be arbitrarily lowered to bring the plate dissipation within limits. Tubes such as the 112-A, 71-A, 45 and 2A3 are generally operated with control-grid voltages somewhat greater than the theoretical bias value for their maximum plate voltage rating in order that plate dissipation may be kept down. The operating points (I_o values) obtained by this method will be found to check the established operating points for types 10, 31, 50 and 89 with triode connection, and to be fairly close for the 112-A and the 71-A. Some readjustment of the grid bias is required for the 45 and 2A3 when used above 180 plate volts.

CONVERSION FORMULAS FOR SINGLE AND PUSH-PULL TRIODES

When a set of conditions for single or push-pull operation of power triodes is known and when operation under some other plate voltage condition is desired, the power output, load resistance, and plate current can be quickly computed by means of the following conversion formulas:

For power output $P = A\ (E)^{5/2}$ where

P = the power output for the new operating conditions,

A = the power output for the old operating conditions,

E = the ratio of the old and the new plate voltage.

For load resistance $R = B\ (E)^{-1/2}$ where

R = the load resistance for the new operating conditions,

B = the load resistance for the old operating conditions,

E = the ratio of the old and the new plate voltage.

For plate current $I_b = C\ (E)^{3/2}$ where

I_b = the plate current for the new operating conditions,

C = the plate current for the old operating conditions,

E = the ratio of the old and the new plate voltage.

The practicability of these formulas is shown by the example of a triode-connected 89 given in the accompanying table:

	Known Values	Conversion Factors	Calculated Values	Actual Values
Plate Volts	180	1.39*	250	250
Grid Volts	22.5	1.39	31.4	31
Plate Milliamperes	20	$(1.39)^{3/2}$	32.7	32
Plate Load (ohms)	6500	$(1.39)^{-1/2}$	5500	5500
Power Output (watts)	0.4	$(1.39)^{5/2}$	0.91	0.9

*250/180 = 1.39.

For filament types of tubes, such as the 10, 45, 50, 71-A, and 2A3, the plate characteristics curves are given for dc filament excitation, although operating characteristics are generally shown for ac filament excitation. For these types, conversion calculations are made on a dc excitation basis. To adjust ac excitation bias values to corresponding dc values, reduce the dc values by ½ the peak value of the rms filament voltage. To adjust dc values to ac values, add ½ the peak value of the rms filament voltage to the dc value of grid bias.

LIMITATIONS OF FORMULAS

The conversion formulas are accurate except for over-biased operation. Thus, for the 45 and 2A3 at voltages greater than 180 volts, these conversion formulas can not be used unless adjustment is made to keep plate dissipation within limits.

SELECTION OF LOAD FOR TRIODES IN PUSH-PULL

To obtain the proper load for triodes in push-pull, the relation $E = 0.6\ E_o$ is used (see Fig. 3). Plate characteristics curves for the triode are required. An operating plate voltage E_b is then selected. A vertical is erected at $E = 0.6\ E_o$ and the intersection of this vertical with the $E_c = 0$ curve determines one end of the load line. The other end is at E_b, the operating plate voltage. The slope of this line multiplied by four is the correct value of plate-to-plate load for two triodes operating in a Class A push-pull amplifier. Thus, for the 45 (see Fig. 3), the plate-to-plate load is equal to

$$\left(\frac{250-150}{0.096}\right) \times 4, \text{ or } 4160 \text{ ohms.}$$

This simple method for determining the plate-to-plate load is applicable to all power-output triodes. The operating point can be anywhere between the bias voltage specified for single-tube operation and the bias voltage obtained by taking one-half of the control-grid bias at plate current cut-off for a plate voltage value of 1.4 E_o. Fig. 3 shows the plate family of a 45 tube. The recommended operating point as a single triode is — 50 volts. The maximum bias that can be used without departing from Class A operation is — 55 volts. Plate current cut-off at 1.4 × 250 volts, or 350 volts, occurs with a control-grid bias of —110 volts. One-half of this value is —55 volts, the maximum bias. Operation beyond this value of grid bias will be accompanied by rectification and will no longer be representative of a Class A amplifier.

POWER OUTPUT FORMULA FOR PUSH-PULL TRIODES

The method just described of determining the plate-to-plate load also makes it possible to determine the power output for push-pull triodes by means of the following simple formula:

$$P = \frac{I_m E_o}{5}$$

Thus, for the 45's of Fig. 3, power output is equal to

$$\frac{0.096 \times 250}{5}\text{, or 4.8 watts.}$$

•

RCA-955 (ACORN TYPE) TUBE

RCA RADIOTRON will soon announce the acorn-type tubes, which were designed some time ago for use in connection with equipment operating at ultra-high frequencies.

The acorn-type tubes have been developed for the use of experimenters and amateurs and are not considered in any way as an addition to the standard line of receiving tubes. No doubt these tubes will eventually find general use. In the meantime there is much to be learned about their capabilities and the fact that they are to be made available for experimental purposes will expedite individual research.

CHARACTERISTICS OF TUBE

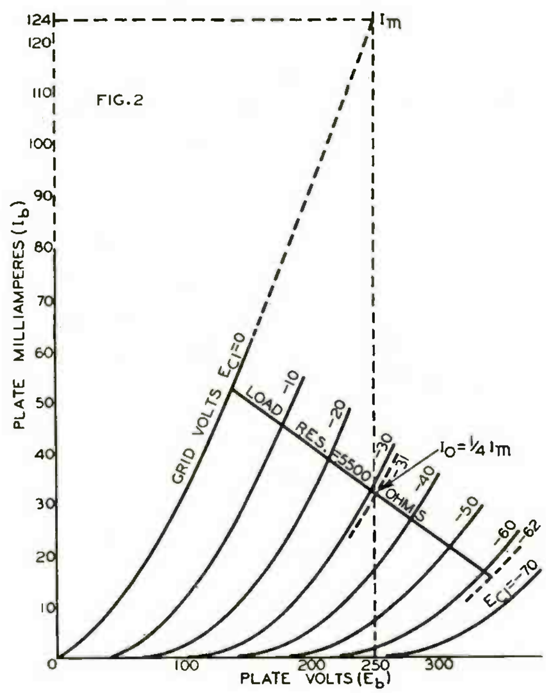
The 955 tube may be used as an amplifier, a detector or an oscillator. The tubes will oscillate at frequencies up to 600 megacycles, or approximately 0.5 meter.

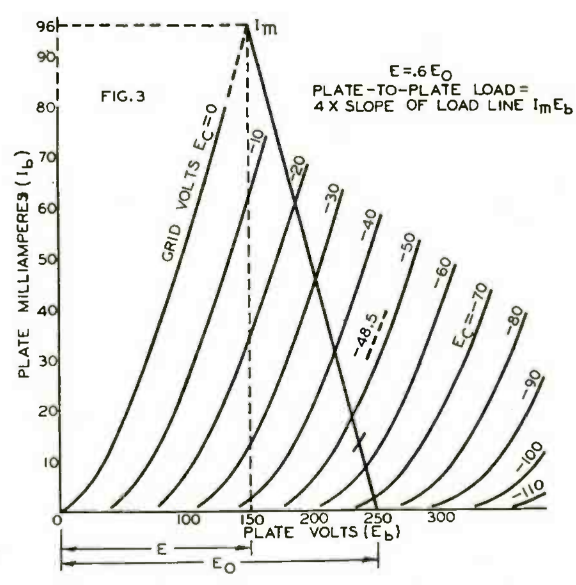
The essential characteristics are as follows:

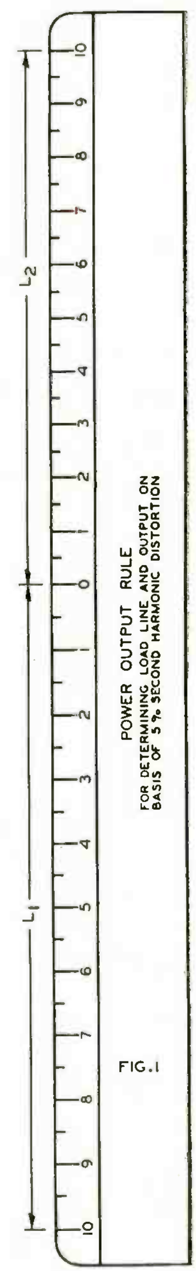
Heater Voltage	6.3 volts
Heater Current	0.16 amp
Plate Voltage (max.)	180 volts
Grid Voltage	—5 volts
Plate Current (max.)	4.5 ma
Mutual Conductance	2000 m-mhos
Amplification Factor	25
Plate Resistance	12,500 ohms

Mechanical and electrical features which permit unusual applications rather than the features which would make the tube suitable for use in commercial production receivers, have been stressed. These features provide considerable latitude to the experimenter.

No attempt should be made to solder connections to the electrode leads of the tube, since soldering usually results in breaking the glass envelope of the tube. The r-f ground must be extremely good at ultra-high frequencies.







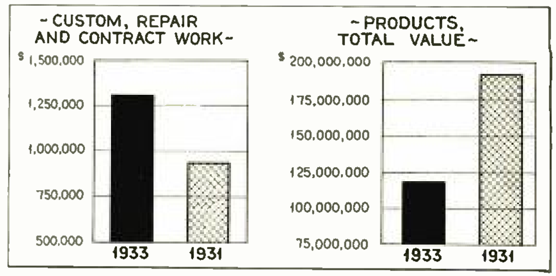
1933 CENSUS of Radio Manufacturers

(*Continued from page* 18)

1933 PRODUCTION TOTALS

The more important items which contributed to the production total for 1933 are as follows: Radio receiving sets for the home (except combination radio and phonograph units), 2,788,467, valued at $53,837,362; combination radio and phonograph units, 30,092, valued at $1,407,650; all other receiving sets (including automobile and aircraft sets), $15,164,053; receiving tubes for initial equipment, 22,077,296, valued at $8,889,064; receiving tubes for replacement, 34,965,113, valued at $15,308,022; phonographs (not including dictating machines), $301,436; records and blanks, $2,562,082.

The industry, as defined for census purposes, embraces establishments engaged wholly or principally in the manufacture of radio apparatus, phonographs and parts and accessories for either or both.



Summary statistics for 1933 in comparison with 1931 are presented in Table 1, and detailed production statistics for 1933 are given in Table 2. All figures for 1933 are preliminary and subject to revision.

AUDIO-FREQUENCY TESTING

(*Continued from page* 16)

added to that produced by the attenuation network in all cases to obtain the total network loss. The loss increases with the ratio of impedances, and may be calculated from the following expressions:

$$\text{Insertion Loss} = 20 \operatorname{Log}_{10} \left[\sqrt{\frac{R_A}{R_N}} + \sqrt{\frac{R_A}{R_N} - 1} \right]$$

HUM MEASUREMENT

With an ac-operated amplifier set up in the gain test, other pertinent data may be obtained. The hum level may not only be noted but, in addition, the relative components of hum frequency may be approximately evaluated. It often-times happens, especially in push-pull amplifiers, that the observed hum with no signal is quite permissible due to cancellation in the output circuit with well balanced tubes, but when the amplifier is excited the tone is garbled by the unbalanced condition that obtains during a portion of the audio cycle. A transmission test for hum is especially desirable for the detection of the latter condition.

With the amplifier set-up in the circuit of Fig. 2, a normal input voltage is applied at a frequency differing from 60 cycles by a small amount, say, one-half to one cycle. The output meter will indicate this beat and swing slowly between certain limits on the scale and the amplitude is a qualitative indication of the 60 cycle component of hum. In the same way the 120 cycle and higher harmonics can be evaluated. By learning the relative amplitudes of the various hum frequencies in a qualitative way much of the probable cause of the hum in the design is indicated. The method can be arranged, of course, to provide quantitative results, (See Suits, *Proceedings* I.R.E.) but the application suggested is probably sufficiently indicative of the true operation of the amplifier for most purposes.

OTHER AUDIO MEASUREMENTS

The basic principles of gain measurements as outlined above may be applied to all sorts of audio-frequency equipment. Telephone lines are measured with the line substituted for the amplifier shown in Fig. 2. Usually individual volume indicators are employed at the sending and receiving ends of the line. The attenuation network at the line input is not always necessary.

The beat-frequency oscillator and auxiliary equipment is indispensable in overall tests of sound reproducing equipment of all types.

INSULATED WIRE CHARACTERISTICS

(*Continued from page* 19)

insulation to meet the requirements. In the accompanying Tables are characteristics of various combinations and types of textile-insulated hook-up wire, including results of tests on a most recently developed and, incidentally, highly efficient insulation, as shown in Table No. 3.

UNDERWRITERS' VIEWPOINT

Through the courtesy of the Underwriters' Laboratories, the writer is privileged to set forth other interesting information. As is generally known, the Underwriters are chiefly concerned with those destructive hazards that may create property damage or personal injury. Consequently, their interest centers on component parts and their proper assembly into complete units functioning efficiently with wide safety margins.

They specify that insulation must withstand a breakdown test involving a potential of three times the maximum open-circuit voltage to which wires are subjected. Therefore, since the average peak voltage in most radio circuits is 500 volts, it follows that any combination of insulations shown in the breakdown tables will suffice. However, insulation resistance, power factor and moisture absorption must also be considered for efficient performance.

The following information taken from the published pamphlet entitled "Underwriters' Laboratories Requirements for Power-Operated Radio Receiving Appliance," dated April, 1933, shows the attitude and refinement of these laboratories on temperatures to which several types of insulation may be subjected:

"Materials will be considered adversely affected if temperatures higher than the following are attained:

90° C.—On conductors having fiberous textile materials such as cotton, silk, etc.

90° C.—On conductors having slow-burning insulation.

49° C.—On conductors having rubber insulation."

I. R. E. FALL MEETING

THE ANNUAL FALL meeting of the Institute of Radio Engineers will be held in Rochester, N. Y., November 12, 13, 14, 1934. This is one of the highlights of the year and every engineer should plan to attend.

An outstanding program has been arranged. There will be the usual Technical Sessions and Enginering Exhibits.

NEWS OF THE INDUSTRY

SVEA METAL ENGINEER

The Swedish Iron & Steel Corporation, 17 Battery Place, New York City, suppliers of Svea Metal for internal vacuum tube parts, announced the engagement some time ago of Mr. Lauren L. McMaster, Jr., as Chief Engineer.

L. L. McMASTER, JR.

Mr. McMaster is a chemical engineer with five years experience in two of the major radio tube plants where he has been in constant contact with all phases of factory management. He has likewise done considerable research work on oxide coated cathodes and made a careful study of the processing of tubes in production.

Since his association with the Swedish Iron & Steel Corporation, Mr. McMaster has been successful in solving many of the problems which have arisen in connection with the application and use of Svea Metal in the electronic tube field.

AIR EXPRESS RATE REDUCTIONS

Substantial rate reductions in air express handled over a nationwide network of commercial airlines by Railway Express Agency, became effective August 15, according to J. H. Butler, General Manager. Outstanding reductions permit air express shipments of packages weighing ¾ lb., or less, at the flat rate of 85c, regardless of distance carried. The corresponding charge for one pound shipment is $1. Minimum charges previously ranged up to $1.80. General lowering of tariffs affects particularly the lighter-weight shipments, which now constitute the greatest percentage of packages handled over the airlines. Yet new low rates also provide for air shipment of packages weighing up to 25 lbs. between cities 149 air miles apart, at a cost of $1, including special pick-up and delivery.

SPANGLER APPOINTED SALES MANAGER OF NATIONAL CARBON

John M. Spangler, who as "Jack" Spangler is personally known to hundreds of officials and salesmen throughout the country in the railroad, electrical, hardware, radio and automotive fields, has been made general sales manager of National Carbon Company, Inc.,

The promotion is the latest of a series of advances which began almost with Mr. Spangler's initial connection with the National Carbon Company in 1915. Previous to that, he had devoted two years, following his graduation from Penn State College, to railroading with the New York Central, where he was connected with the signal department, chiefly in Albany and Rochester, N. Y.

MAJOR ARMSTRONG WITH COLUMBIA UNIVERSITY

Major Edwin Howard Armstrong has been appointed professor of electrical engineering in Columbia University, it is announced by President Nicholas Murray Butler.

Major Armstrong, carrying on a notable Columbia tradition. will direct instruction in radio communication and high frequency research in the Hartley laboratories, the scene of Prof. Michael I. Pupin's triumphs in electrical transmission and of his own early efforts in the development of the vacuum-tube oscillator. which revolutionized radio.

INCREASE IN SHOW ACTIVITY

A listing of the more important industrial and trade shows, issued recently in a Bulletin of the Exhibitors Advisory Council, revealed the fact that more shows and expositions have been held during the first six months of 1934 than were scheduled over a similar period in 1933.

In addition the Council. through its trade association and show management contacts, has learned that show promoters and trade groups sponsoring shows are anticipating a larger number of exhibitors and more responsive attendance at their shows scheduled this Fall and next Spring.

EARPHONE-MIKE FOR TRANSCEIVERS

Universal Microphone Co., Inglewood, Cal., will soon manufacture a combination earphone-microphone to be used on the new five-meter transceivers. It will weigh approximately nine ounces.

BOOK ON APPLICATION OF NICKEL

A new booklet on the applications of Monel Metal, Nickel, and Nickel-clad steel has been issued by the Technical Service Department of the International Nickel Company. It has been prepared especially for users of industrial processing equipment.

Besides giving data on the physical and mechanical properties of these materials, the booklet contains considerable miscellaneous information, including instructions on the selection of suitable welding rod and other details on fabrication. Copies will be supplied without charge on request to the Editorial Department. The International Nickel Company, Inc.

NATIONAL UNION DIRECTORS ELECT OFFICERS

S. W. Muldowny, Chairman of the Board of National Union Radio Corporation, announced this week that, at a meeting of the Board, held at New York City on July 31st, Mr. H. A. Hutchins, National Union General Sales Manager, was made Vice President, as was Mr. George Ernst, who has held the position of General Superintendent of factory operations.

Another election at the same meeting elevated Dr. Ralph E. Myers to the First Vice Presidency. Dr. Myers has heretofore held the title of Vice President in charge of manufacturing and engineering. Mr. H. R. Peters remains as President.

ZENDER MADE RMA CHAIRMAN OF WIRE GROUP

Raymond G. Zender, Sales Manager of Lenz Electric Manufacturing Company, has been appointed RMA Chairman of the Wire and Transformer Coil Group. It is Mr. Zender's intention to work towards standardizing on color coding and various constructions of lead wires during the time of his chairmanship.

ALLEN-BRADLEY APPOINTS NEW CLEVELAND MANAGER

R. J. Roy, formerly Cleveland branch manager for the pump and electrical department of Fairbanks, Morse & Company, was recently appointed district manager of the Allen-Bradley equipment in the Cleveland, Pittsburgh, and Cincinnati territories.

SIPP JOINS BURGESS

Mr. E. A. Sipp, until recently Manager of the Lighting Division of Pyle-National Company, has become associated with the management of the Burgess Battery Company and C. F. Burgess Laboratories, Inc.

E. A. SIPP.

Mr. Sipp will maintain his headquarters in the offices of the Burgess organizations at 111 West Monroe Street, Chicago, Illinois.

LINCOLN TO BE N. E. E. HEADQUARTERS

Hotel Lincoln is to be official headquarters for the delegates to the National Electrical Exposition at Madison Square Garden September 19-29, 1934. The Lincoln

(*Continued on page* 24)

will take a progressive and important step by being probably the first hotel to exhibit at a trade show.

The hotel will exhibit the equipment of one of its typical two-room suites in the section adjacent to the broadcasting studios on the Exposition Floor of Madison Square Garden.

Many rooms at the Lincoln will be set aside for private showing of various electrical companies, who will repeat last year's special sales campaign at that hotel during the trade show.

NEW KENYON CLASS A-B AMPLIFIER KIT

The Kenyon Transformer Co., Inc., 840 Barry St., New York City, has introduced a unit designed to act as a public-address amplifier capable of delivering either 18 or 36 watts power output. This output is achieved by using either push-pull Class A-B 45s or push-pull parallel Class A-B 45s in the output stage. By unique type of chassis construction, using one chassis for the audio channel and one chassis for the power channel, it is possible to change this amplifier from an 18-watt amplifier to a 36-watt amplifier by merely installing two tubes, two transformers, and a filter reactor. The mechanical construction of the chassis also permits the operation of the amplifier as a rack and panel unit, or as a table mount unit. In the past on rack mount amplifiers built on a chassis, it was necessary to remove the amplifier chassis from the panel before the amplifier wiring became accessible. With the new units it is only necessary to remove four 10-24 screws to remove the panel. When the panel is removed, the chassis is held in place to the rack by an additional four screws which have no connection whatsoever with the panel. Thus, when the panel is removed, all wiring is exposed.

A common voltage amplifier is used for either the 18- or 36-watt condition. This amplifier consists of a pair of 77 pentodes operating push-pull impedance coupled to a pair of push-pull 76 tubes. The overall gain is said to be 80 db. Despite the high gain of the voltage amplifier, it is said the hum level has been kept down to 50 db with respect to full power output. Microphonic noises which might otherwise be transmitted through the amplifier by the 77 or 76 tubes have been eliminated by mounting these voltage amplifier tubes in a phosphor bronze spring suspension.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

GEORGE H. CLARK
"Radio's Toastmaster"

Graduated an Electrical Engineer by the Massachusetts Institute of Technology in '03—with John Stone Stone in Boston for five years as Radio Engineer—entered active duty in Navy Department at Washington in 1908 and advanced to the office of Expert Radio Aide—joined the Marconi Wireless Telegraph Company of America in 1919—became the Showman of Radio for RCA in 1921—awarded medal at Sesquicentenial in Philadelphia for "excellent historical display"—and throughout that period to the present functioning as Radio's Toastmaster at dinners and banquets giving thumbnail sketches of radio developments and its associated aspects, George H. Clark has been conspicuously active. Organizing and bringing together remotely associated interests in the radio art and industry, he is known from coast to coast. He has helped promote many successful social functions through which the personnel of the radio industry has become better acquainted to the advantage of their respective business enterprises.

Despite the prominence of his activities he remains the easily approachable acquaintance and friend of all. He is the unspoiled "Man With the Hoe," ever thinking of the other fellow and his interests. The V. W. O. A. is proud of his record as Vice-President, Director and Chairman of many committees, but as Toastmaster at our Annual Banquets he has excelled.

His name is a by-word in radio circles, known everywhere—for hasn't he toured every neck and corner of the country as the "RCA Showman"? Yes, and he is known in other countries, too. His first big engineering job following the termination of his Navy service at the conclusion of the war, was the construction of the two big radio stations in Venezuela.

Marconi in Italy knows him as "George". Radio men in other countries have become familiar with the far-reaching cry for obsolete radio equipment to complete the only Radio Museum of note, of which he is Curator.

G. H. CLARK
Vice-President

To the veteran wireless men the name of this distinguished pioneer engineer symholizes much more than a personage of world-wide fame. He is one of the mainstays of the Veteran Wireless Operators Association. He loves what the organization stands for. He has done much for it in the past and today he is doing still more.

There is an exhibit at the Century of Progress Exposition in Chicago which graphically portrays the quarter-Century of Progress in the development of radio. George Clark designed it and during the Exposition, as visitors come and go, George will be found near it ready to greet veteran and novice in the art of radio with equal pleasure.

"CHINA SKYWAYS"

The return address on the envelope is Foreign Y. M. C. A., 150 Bubbling Well Road, Shanghai, China. The letter is signed by Wm. W. ("Flying Bill") Ehmer, the original "WE" for that was his sign on the air lanes twenty years back. "WE" is a true veteran radio operator but during recent years has confined his activities to piloting. He holds a Commercial Transport Pilot's license and is at present engaged in blazing new trails for China Airways Federal, Inc., throughout China. He writes, in part, as follows:

"By the way, chop suey is a food that very few folks eat out here when they visit a Chinese restaurant. There are so many other nice foods that chop suey takes a back seat. It takes considerable experience to order correctly, and after a year I get my soup last or in the middle of the meal and am beginning to think it is some sort of 'Chinese' custom.

"Our flying on the Canton line has been temporarily suspended until we receive the new planes which have been ordered. We get some very bad weather on the Shanghai-Canton route. In one season we encounter bad fogs on the northern end and heavy squalls on the southern and central sections with heavy monsoon winds which bucks us going and helps us coming back. However, in the other season we have only a dozen or more typhoons and frequent thunderstorms to worry about.

"To overcome these conditions we are getting faster ships and putting in more radio stations. We always had radio at every stop but there was no way of obtaining information on conditions in between; thus, if conditions at the point of departure and the destination were favorable, the plane would leave. We are at present installing stations in between stops, especially in the worst weather sectors, so that a plane's pilot will know what to expect at all times. At present I am preparing to put in a 100 watter in a little lighthouse in the middle of Hangchow Bay. I am temporarily handling radio installations. We use all English speaking Chinese operators and they are quite capable.

"We are also getting radio direction finders out here. The type used will be stationed at the ground stations and take bearings on planes on wavelengths of 187 to 197 meters. Good results have been obtained thus far.

"Have met many operators and ex-operators in these parts. The ex-operators are generally sound-motion-picture or broadcast men. George F. Shecklen, one of our members, represents RCA here. Best regards to all." "WE"

MEETING

The next regular meeting of the membership of the Veteran Wireless Operators Association will be held at 6 PM Wednesday evening, October 10th, 1934, at Daniel's Grill, 94 Chambers Street in the City of New York. Plans for a Fall Smoker as well as other plans for our winter activities will be discussed. At this meeting. We urge the attendance of our membership to this, the first meeting after the summer vacation.

Purchasing Guide

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

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

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

INDEX

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

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

AMERICAN MICROPHONE COMPANY

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

AMERICAN TRANSFORMER COMPANY

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

PRODUCTS

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

EXECUTIVES

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

BRANCH OFFICES OR REPRESENTATIVES

James H. Southard, 420 Market Street, San Francisco, Cal.
Kelburn Engineering Co., 600 W. Jackson Blvd., Chicago, Illl.
Electrical Apparatus Sales Co., 10 High St., Boston, Mass.
J. W. Jones, 660 So. 18th Street, St. Louis, Mo.
Arthur C. Stallman, 218 Waile Avenue, Ithaca, N. Y.
K. J. Banfer, 1311 Terminal Tower, Cleveland, Ohio.
L. D. Joralemon, 112 So. 16th Street, Philadelphia, Pa.
Arthur L. Pollard, 307 New Sprankle Bldg., Knoxville, Tenn.
Electrical and Mechanical Engineering Co., 612 Title and Trust Building, Phoenix, Ariz.

EXPORT

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

AMPERITE CORPORATION

561 Broadway, New York, N. Y.

PRODUCTS

Microphones.

ASTATIC MICROPHONE LABORATORY, INC.

40 Hubbard Road, Youngstown, Ohio.

PRODUCTS

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

EXECUTIVE

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

BRANCH OFFICES OR REPRESENTATIVES

C. C. Baines Sales Co., 4107 River Park Drive, Louisville, Ky.
R. L. Cooper, 3917 Morrell Ave., Kansas City, Mo.
Merton A. Dobbin, 407 Postal Bldg., Portland, Oregon.
B. J. Fitzner Company, 153 E. Elizabeth St., Detroit, Mich.
M. E. Foster Company, 601 Cedar Lake Road, Minneapolis, Minn.
General Engineers, 2201 Laws Street, Dallas, Texas.
Walter V. Gearhart, Volunteer Bldg., Atlanta, Ga.
L. H. Jackman, 2043 E. 77th St., Cleveland, Ohio.
D. R. King, King Sales Co., 2203 W. Clybom 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.

BEACON MICROPHONE CO.

590 Sumner Street, Akron, Ohio. Microphones.

BLILEY ELECTRIC COMPANY

237 Union Station Bldg., Erie, Pa.

PRODUCTS

Piezo-Electric quartz crystals and holders for use between 20 kcs and 15,000 kcs, used in transmitters, receivers, monitors, and laboratory standards.

EXECUTIVES

General Manager...F. Dawson Bliley Chief Engineer....C. C. Collman
Sales Manager....Joseph Haller Production Mgr..Thomas Hellmann
Advertising Mgr....R. W. Hall

BRANCH OFFICES OR REPRESENTATIVES

Pacific Coast Office: Mr. Don C. Wallace, 4212 Country Club Drive, Long Beach, Calif. . . . Sold through the best radio transmitting parts distributors throughout the United States and many foreign countries.

BRUNO LABORATORIES

20-26 West 22nd Street, New York, N. Y.

PRODUCTS

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

EXECUTIVES

General Manager...John J. Kopple Chief Engineer....W. A. Bruno

BRANCH OFFICES OR REPRESENTATIVES

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

BRUSH LABORATORIES

3715 Euclid Avenue, Cleveland, Ohio. Crystal Speakers, Crystals.

BUD SPEAKER CO.

1112 Jackson Street, Toledo. Ohio—Microphones.

THE ALLEN D. CARDWELL MANUFACTURING CORP.

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

PRODUCTS

Variable and Fixed (air and oil dielectric) Condensers for receivers, transmitters, high frequency furnaces.
Maintains a Contract-Manufacturing Service specializing in designing, or manufacturing to specifications, of Inductances, Transformers, Relays, Automatic Telegraph equipment, electro-mechanical devices and instruments and stamped and welded aluminum and duralumin products.

EXECUTIVES

President and Chief Engineer....Allen D. Cardwell

EXPORT

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

CARRIER MICROPHONE CO.

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

S. H. COUCH CO., INC.

89 Broad Street, Boston, Mass. Amplifiers.

DELTA MFG. CO.

37 Osborne Street, Cambridge, Mass. Low Voltage Rectifiers—Rectifier Parts.

DOOLITTLE & FALKNOR

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

EASTERN COIL CO.

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

EGERT ENGINEERING CO.

179 Varick Street, New York, N. Y. Monitors.

FEDERAL TELEGRAPH CO.

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

GATES RADIO & SUPPLY COMPANY

Main Office and Factory—Quincy, Illinois.

PRODUCTS

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

EXECUTIVES

General Manager....H. C. Gates Chief Engineer....P. S. Gates
Assistant Chief Engineer....P. L. Tourney

GENERAL RADIO COMPANY

30 State Street, Cambridge, Mass. Instruments.

HAMMARLUND MANUFACTURING COMPANY, INC.

424 West 33rd Street. New York City.
Established for over a quarter of a century.

PRODUCTS

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

EXECUTIVES

President....Oscar Hammarlund Production Mgr..H. B. Macartney
Treasurer....Joseph Lush Chief Engineer....D. K. Oram
Sales Mgr..Lloyd A. Hammarlund 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.

HEINTZ AND KAUFMAN, LTD.

311 California Street, San Francisco. California. Transmitting tubes.

HYGRADE SYLVANIA CORPORATION (See page 36)

Electronics Department, Clifton, New Jersey

PRODUCTS

Radio Transmitting Tubes, Phototubes, Industrial Power Tubes, Radio Transmitters. Special Radio Receivers, Sound Amplifiers, Broadcast Speech Equipment, Custom-Built Electronic Devices.

INT'L BROADCASTING EQUIPMENT CO.

3112 W. 51st Street, Chicago, Ill. Frequency Monitors—Amplifiers.

(Continued on page 28)

Broadcasting and Public Address Equipment (Continued)

(Continued from page 27)

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

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

OPERADIO MFG. CO.
13th & Indiana Streets, 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

Universal Recorders, Overhead Feed Mechanisms, Amplifiers, Tuners, Playback Machines.

EXECUTIVES

President................Sol Sholes Vice President......M. M. Gruber
Electrical Engineer....George Soliba

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

PRODUCTS

Broadcast Receivers for the Home. Broadcast Transmitters. Electric Phonographs and Records. Sound Reinforcing 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.

EXECUTIVES

Chairman.........David Sarnoff
President.....E. T. Cunningham
Executive Vice President G. K. Throckmorton
Vice President in Charge of Sales......G. K. Throckmorton
Vice President in Charge of Manufacturing and Engineering........W. R. G. Baker

THE RADIART CORP.
13229 Shaw Avenue, Cleveland, Ohio. Amplifiers.

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

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

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

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

PRODUCTS

Single-Button and Two-Button Microphones of all types, Studio and Bullet-type Condenser Microphones, Condenser Microphone Power Supplies, "Automatic Friction Lock" Floor Stands, Banquet Stands, Desk Stands, Microphone Rings and Suspension Adapters, Collapsible Floor Stands, Duplex Fixtures, Hand Mountings, Stand Type Switches and Volume Controls, Microphone Tilt Swivels. Microphone, Matching and Speech-Input Transformers, Microphone Adapters, Shielded and Unshielded Microphone Cable, Complete Microphone Repair Service on all makes and models, Microphone Preamplifiers, and Acoustic Measurements.

BRANCH OFFICES OR REPRESENTATIVES

C. C. Baines, 4107 River Park Drive, Louisville, Ky.
R. R. Bauman, 2168 Ann Arbor St., St. Paul, Minn.
W. T. Croysdill, 966 Lafayette Ave., Buffalo, N. Y.
Joseph Gardberg, 915 Atlantan Hotel, Atlanta, Ga.
Howard P. Hardnsty, 356 East Grand Blvd., Detroit, Mich.
R. C. James, 2310 Second Avenue, Seattle, Wash.
Leonard C. Kohn Co., 504-505 Baum Bldg., Omaha, Nebraska.
S. K. MacDonald, 217 Riggs Bank Bldg., Washington, D. C.
H. B. Parke, 508 Third Ave., Pittsburgh, Pa.
J. O. Russell, Box 1255, Little Rock, Ark.
F. Edwin Schmitt, 25 Warren St., New York, N. Y.
The M. Simons & Sons Co., 25 Warren St., New York, N. Y.
O. H. Smith, The Rauland Corp., 3341 Belmont Ave., Chicago, Ill.
J. A. Wherry, 424 Camp Street, New Orleans, La.
L. M. Wood, Wood & Anderson Co., 915 Olive St., St. Louis, Mo.
J. P. Kay, Box 266, Tulsa, Oklahoma.
Clawson, care Harry W. Gebhard, 55 Kilby St., Boston, Mass.

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

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

PRODUCTS

Crystal Microphones. P. M. Dynamic Speakers. Amplifiers and Control Equipment for Rack and Panel Mounting. Precision Equipment for Special Uses. Special Systems for Dance Bands, Funeral Parlors. School and Hospital, Sound and Centralized Radio. Hotel Systems. Hearing Aids. Turntables. Transformers. Crystal Pickups, High-Fidelity Units.

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

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

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
850 Blackhawk Street, Chicago, Ill. Amplifiers.

WEBSTER ELECTRIC COMPANY
Racine, Wisconsin. Amplifiers, Pickups.

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

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

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. Vacuum thermo-couples, cathode ray oscillographs. Audiometers, hearing aids, electrical stethoscope. Talking picture equipment.

BRANCH OFFICES OR REPRESENTATIVES
IN THE UNITED STATES

For Aviation Communication Equipment, Marine Radio-telephone Equipment, Point-to-point Radio-telephone Equipment: H. E. Young, General Commercial Engineer, Western Electric Company, Inc., 195 Broadway, New York City.
For talking picture equipment: C. W. Bunn, General Sales Manager, Electrical Research Products, Inc., 250 West 57th Street, New York City.
For all other Western Electric equipment, the distributor is the Graybar Electric Company through their branches.

CANADA

Northern Electric Company, Ltd., 1620 Notre Dame Street, West, Montreal, Quebec.

OTHER COUNTRIES

For Talking Picture Equipment, Audiometers, Hearing Aids, Electrical Stethoscopes: Electrical Research Products, Inc., 250 West 57th Street, New York, N. Y.
For all other equipment: International Standard Electric Corporation, 67 Broad Street, New York City, U.S.A.

Coils and Coil Forms Radio Frequency

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

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

HAMMARLUND MFG. CO. (See page 27)
424 W. 33rd Street, New York City.

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

SICKLES COMPANY
300 Main Street, Springfield, Mass.

PRODUCTS

Radio Coils.

EXECUTIVES

President.............R. F. Sickles Chief Engineer..........H. J. Benner
General Manager.....Monte Cohen Production Mgr.........Fred Janotta
Sales Manager........Monte Cohen Purchasing Agent......R. F. Sickles
Advertising Mgr........Monte Cohen

BRANCH OFFICES OR REPRESENTATIVES

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

EXPORT

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

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

ACME WIRE COMPANY (See page 40)
New Haven, Connecticut. Paper Condensers and Condenser Parts.

AEROVOX CORPORATION
70 Washington Street, Brooklyn, N. Y. All types.

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

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

CONTINENTAL CARBON, INC.
13900 Lorain Avenue, Cleveland, Ohio.

CURTIS CONDENSER CORP.
3601 W. 140th Street, Cleveland, Ohio.

MAGNAVOX CO., LTD. (See page 34)
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.

Condensers, Fixed. (Continued)

THE MUTER COMPANY

1255 So. Michigan Avenue, Chicago, Illinois.

PRODUCTS

Candohm Wire Wound Resistors, Aerial Accessories and Humidity Gauges.

EXECUTIVES

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

BRANCH OFFICES OR REPRESENTATIVES

District Representatives in Principal Cities.

SOLAR MFG. CORP.

599 Broadway, New York City. All types.

SPRAGUE SPECIALTIES CO.

No. Adams, Massachusetts. All types.

SANGAMO ELEC. CO.

Springfield, Illinois. Mica Condensers.

TOBE DEUTSCHMANN CORP.

Canton, Massachusetts. Paper Condensers, Filters, etc.

Condensers, Variable

ALLEN D. CARDWELL MFG. CO. (See page 27)

81 Prospect Street, Brooklyn. N. Y.

DEJUR-AMSCO CORP.

95 Morton Street, New York City.

THE H. H. EBY MFG. CO., INC.

21st & Hunting Park Avenue, Philadelphia, Pa.

GENERAL INSTRUMENT CO.

225 Varick Street, New York City.

GENERAL RADIO CO.

30 State Street, Cambridge A, Mass.

HAMMARLUND MFG. CO. (See page 27)

424 W. 33rd Street, New York City.

OAK MFG. CO.

308 W. Washington 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.

SCOVILLE MFG. CO.

Waterbury, Conn.

UNITED SCIENTIFIC LABS.

510 Sixth Avenue, New York City.

Insulation, Molded and Laminated (Molding Powders)

BAKELITE CORPORATION

247 Park Avenue, New York, N. Y.

This business was established twenty-four years ago and was founded by Dr. L. H. Baekeland. From a small beginning, it has grown to a point where it now has large modern manufacturing plants and representatives in all the major industrial centers of the country, as well as affiliations in the leading industrial countries in the world.

PRODUCTS

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

BRANCH OFFICES OR REPRESENTATIVES

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

CONTINENTAL DIAMOND CO.

Newark, Delaware.

FORMICA INSULATION CO.

4614 Spring Grove Avenue, Cincinnati, Ohio.

GENERAL ELECTRIC CO.

Schenectady, New York (Textolite)

GENERAL PLASTICS, INC.

North Tonawanda, N. Y. Durez.

MICA INSULATOR CO.

200 Varick Street, New York, N. Y.

PRODUCTS

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

EXECUTIVES

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

BRANCH OFFICES OR REPRESENTATIVES

Mica Insulator Co., Sales and Executive offices, 200 Varick Street, New York, N. Y.
Mica Insulator Co., Branch Offices in Chicago and Cleveland.

Electric Specialty Co., San Francisco, Los Angeles, and Seattle.
Ebbert & Kirkman, Birmingham, Alabama.
New York Insulated Wire Co., Boston, Mass.
D. M. Fraser Co., Ltd., Toronto, and Montreal.

NAT'L VULCANIZED FIBRE CO.

Wilmington, Delaware.

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, Stabilized Gear Material.

Synthane Corporation has devoted itself exclusively to the production of laminated bakelite. The plant itself was laid out and built in 1929 to the requirements of laminated bakelite manufacture. This also guided the selection of equipment and, in several instances, machines were specially designed and constructed that would definitely contribute to a better and more uniform product. Enlarged in 1934. Facilities for machining and assembling laminated bakelite parts on a production basis are now available to manufacturers.

EXECUTIVES

President..R. R. Titus
Vice President and Secretary..........................Jacob B. Rittenhouse

BRANCH OFFICES OR REPRESENTATIVES

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

EXPORT

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

TAYLOR & CO., INC.

Norristown, Pa.

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.

70 Washington Street, Brooklyn, N. Y.

ALLEN-BRADLEY COMPANY

126 West Greenfield Avenue, Milwaukee, Wisconsin.

PRODUCTS

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

EXECUTIVES

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

BRANCH OFFICES

Boston, Mass.
Buffalo, N. Y.
Chicago, Ill.
Cincinnati, O.
Indianapolis, Ind.
Cleveland, Ohio.
Detroit, Mich.
Milwaukee, Wis.
New York, N. Y.
Philadelphia, Pa.
Pittsburgh, Pa.
St. Louis, Mo.

EXPORT

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

AMPERITE CORP. (See page 27)

561 Broadway, New York City.

CARTER RADIO CO.

812 Orleans Street, Chicago, Ill.

CENTRAL RADIO LABORATORIES

900 East Keefe Avenue, Milwaukee, Wisconsin.

PRODUCTS

Variable Resistors and Fixed Resistors manufactured primarily for radio service.

EXECUTIVES

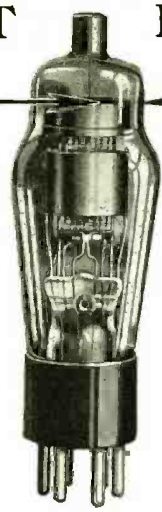
President............E. R. Stoekle
Vice President......H. E. Osmun
Secretary.............T. B. Inglis

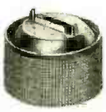
BRANCH OFFICES OR REPRESENTATIVES

T. B. Hunter, 160 E. Illinois Street, Chicago, Ill.
Mr. W. J. Kelley, c/o Electrical Apparatus Sales Co., 10 High Street, Boston, Mass.
Samuel K. MacDonald, 220 Riggs Bank Bldg., Washington, D. C.
W. Sharp, 67 W. 44th St., Suite 2005, New York City, N. Y.
Leslie M. De Voe, 5779 North Delaware St., Indianapolis, Ind.
Henry W. Burwell, 413 Le Bron Ave., Montgomery, Alabama.
L. H. Jackman, 2043 E. 77th St., Cleveland, Ohio.
Jas. J. Backer Co., 109-11 Bell Street, Seattle, Wash.
W. T. McGary, 3800 North Grand Ave., St. Louis, Mo.
Roland Moeller, 2105 North Third Street, Milwaukee, Wis.
Merrill K. Franklin, 490 Sexton Bldg., Minneapolis, Minn.
J. P. Kay, Kay Sales Co., 219 South Boulder, Tulsa, Okla.
R. C. Merchant, 572 Macabees Bldg., Detroit, Mich.
J. O. Russell, P. O. Box 1255, Little Rock, Ark.
Carl A. Stone, Ltd., 209 West 17th Street, Los Angeles, California.
W. F. Seeman, 763 Racoma Ave., Buffalo, N. Y.

GOAT PRODUCTS

TUBE PARTS — TUBE SHIELDS




SHIELD


PLATE


COLLAR


DIODE SHIELD


DIODE PLATE

GOAT QUALITY PARTS IMPROVE TUBE PERFORMANCE.

WE MANUFACTURE AT MODERATE PRICES AND IN UNLIMITED QUANTITIES PARTS FOR ALL STANDARD RECEIVING TUBES, AND ALSO HAVE FACILITIES FOR PRODUCING SPECIAL PARTS FOR CATHODE RAY RECTIFIERS, POWER TUBES, X-RAY TUBES, ETC.

GOAT FORM FITTING TUBE SHIELDS HAVE REVOLUTIONIZED SET DESIGN.

THEY IMPROVE THE PERFORMANCE AND APPEARANCE OF THE SET, ARE MORE COMPACT, MORE EASILY MOUNTED AND COST ABOUT TWENTY-FIVE PERCENT LESS THAN THE OLD STYLE "CAN" SHIELDS.

Write for Further Information, Samples and Engineering Data, pertaining to Goat Parts and Tube Shields.

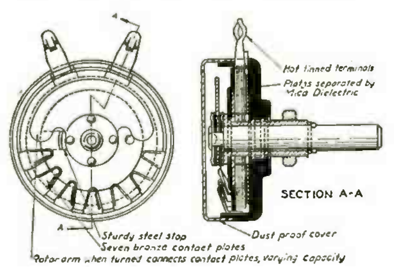
GOAT RADIO TUBE PARTS, INC.

314 DEAN STREET, BROOKLYN, N. Y.

NOW!... *for receiver and transmitter manufacturers*

F. M. C. *"all weather"* Porcelain Case MICA CONDENSERS

Over 100 Manufacturers Use



OCTAVE TONE CONTROLS

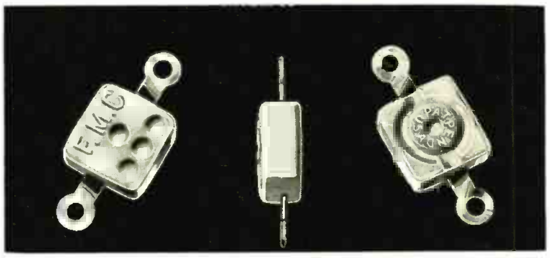
They afford an unequalled smooth tone taper from treble to bass between 7 variable capacity steps. Compact, accurate and very reasonable in price, they cut space requirements and assembly costs, and no condenser need be added. That is why more than 100 leading receiver and sound equipment manufacturers specify Octave Tone Controls.

SPECIFICATIONS:

Standard shaft ¾" long, bushing ⅜" long, ⅜" diameter. Standard capacity range from 50 M. MFD. to .006 MFD. (Other capacities available from almost zero to .02 MFD.) Dimensions: 1⅝" diameter by 11/16" deep. Controls furnished with or without power switch. (Special shafts available to specifications.)

Write today for literature and prices.

Competitive in Price—Unequalled in Quality



● F.M.C. porcelain case fixed condensers were designed to meet the demand for rugged commercial units of exceptional quality. Yet they are priced low enough to warrant their use in even the cheapest receivers.

Study these F.M.C. features . . . compare these new units on a quality and price basis.

1. The molded porcelain cases prevent carbonized tracks, leaks and shorts are impossible under severe high voltage stress.
2. Climatic conditions, heat and cold, cannot effect them. They are moisture proof, very rugged, and compact.
3. Commercial tolerances of 10% are maintained. For special purposes, units to within 2½% of their rating are available.
4. Condenser plates and lugs are one piece die punched bronze insuring perfect contact.
5. Pressed uniformly in their making, F.M.C. condensers maintain their original capacity ratings and will not change in use.
6. Prices are very low. Despite their fine quality, these units cost no more than competitive brands made with molded plastic cases.

Send for Your Samples Today

FILTERMATIC MFG. CO.

6913 DITMAN ST., TACONY, PA.

Resistors, Controls, Rheostats, Etc. (Continued)

CLAROSTAT MANUFACTURING COMPANY

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

PRODUCTS

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

EXECUTIVES

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

BRANCH OFFICES OR REPRESENTATIVES

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

EXPORT

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

CONTINENTAL CARBON, INC.

13900 Lorain Avenue, Cleveland, Ohio. Resistors and Suppressors.

CHICAGO TELEPHONE SUPPLY COMPANY

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

ELECTRAD, INC.

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

ERIE RESISTOR CORPORATION

Erie, Pa.

PRODUCTS

Fixed and Variable Carbon Resistors, Moulded Carbon Resistors and Moulded Carbon Suppressor Resistors.

EXECUTIVES

President...............G. P. Fryling   Chief Engineer.....B. B. Minnium
Vice President........W. H. Fryling   Purchasing Agent..R. P. Houlihan
General Manager........H. C. Sherk

EXPORT

Erie Resistor of Canada, Ltd., 49 Bathurst Street, Toronto, Canada.
Erie Resistor, Ltd., Waterloo Road, Cricklewood, London, England.

FILTERMATIC MFG. CO.

6913 Ditman Street, Philadelphia, Pa.

PRODUCTS

Condensers.

EXECUTIVES

President.............C. H. Draving   Vice President...John W. Draving
General Manager..Arthur M. Draving

BRANCH OFFICES OR REPRESENTATIVES

Adolph Friedman, 220 East 23rd Street, New York City.
Edward Peel, Chicago, Ill.
Harry Fox, 1157 South Hill St., Los Angeles, Calif.
L. W. Nutt Sales Co., 618 Dayton Industries Building, Dayton, Ohio.
Hilliard, Philadelphia, Pa.

EXPORT

Associated Radio Industries, 115 Broad St., New York, N. Y.

GLOBAR CORP.

Niagara Falls, New York.

HARDWICK, HINDLE, INC.

40 Harmon Street, Newark, N. J. Wire-wound.

INTERNATIONAL RESISTANCE CO.

2100 Arch Street, Philadelphia, Pa.

PRODUCTS

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

EXECUTIVES

President............Ernest Searing   Chief Engineer......Jesse Marsten
Vice President...Dr. Harold Pender   Production Mgr...M. W. Weiscopf
Sales Manager..Daniel J. Fairbanks   Purchasing Agt...M. W. Weiscopf
Advertising Mgr.....Dan. J. Fairbanks

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

EXPORT

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

LYNCH MANUFACTURING CO., INC.

51 Vesey Street, New York City.

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

3029 E. Washington Street, Indianapolis, Ind.

MICAMOLD RADIO CORP.

1087 Flushing Avenue, Brooklyn, N. Y.

THE MUTER CO. (See page 30)

1255 S. Michigan Avenue, Chicago, Ill.

OHIO CARBON COMPANY

12508 Berea Road, Cleveland, Ohio.

PRODUCTS

Ohiohm Resistors, Suppressors, Condensers for Radio and Television, Ohio Carbon, Graphite and Metal-Graphite Brushes for Motor and Generator applications. Ohio Brush assortments, Carbon Contacts and Carbon Specialties.

EXECUTIVES

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Vice-Pres. and Ch. Engr.....................L. L. Stoffel
Sec. and Treas. ....John E. Schunck
Sales Manager....................Dr. I. W. Brandel
Advertising Manager....................E. J. Gee

BRANCH OFFICES OR REPRESENTATIVES

International Radio, Ltd., 254 Castlereagh St., Sydney, Australia.
James Backer, 109 Bell Street, Seattle, Wash.
E. L. Burke, 1503 Hennepin, Minneapolis, Minn.
Leroy Eschner, 9 So. Clinton Street, Chicago, Ill.
E. J. Fenton, 1775 Broadway, New York City.
J. L. Finnicum, 4500 Euclid Avenue, Cleveland.
Jeffries & Hartweg, 916 Packard Bldg., Philadelphia, Pa.
W. B. Knight, 115 W. Venice Blvd., Los Angeles.
John O. Olsen, 5314 Beelermont Place, Pittsburgh, Pa.

OHMITE MFG. CO.

636 N. Albany Street, Chicago, Ill.

PRECISION RESISTOR CO.

334 Badger Avenue, Newark, N. J. (Wire-wound)

SHALLCROSS MFG. CO.

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

SPEER RESISTOR CORP.

St. Marys, Pennsylvania

STACKPOLE CARBON CO.

Tannery Street, St. Marys, Pennsylvania.

PRODUCTS

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

EXECUTIVES

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Vice President & Gen. Mgr., H. S. Conrad   Production Manager A. A. Haberberger
Sales Manager......H. S. Conrad   Purchasing Agent.....L. F. Joyce

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

SOLAR MFG. CORP.

599 Broadway, New York City.

WARD LEONARD ELECTRIC CO.

Mt. Vernon, New York.

S. S. WHITE DENTAL MFG. CO.

152 West 42nd Street, New York City.

PRODUCTS

Resistors; Flexible Shafting for Remote Controls, Production Tools, and Power Drives; and Grinding Tools.

WIRT COMPANY

5221 Greene Street, Philadelphia, Pa.

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

THE D. L. AULD COMPANY

5th Avenue and 5th Street, Columbus, Ohio

ALDEN MANUFACTURING CO.

Campello Station, Brockton, Mass.

BASTIAN BROS. CO.

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

Sockets, Dials, etc. (Continued)

BEST MANUFACTURING CO.
1200 Grove Street, Irvington, N. J.

CENTRAL RADIO CORPORATION
Beloit, Wisconsin

CARTER RADIO CO.
812 Orleans Street, Chicago, Ill.

CINCH MANUFACTURING CORPORATION
2335 W. Van Buren Street, Chicago, Ill.

CROWE NAME PLATE & MFG. CO.
1749 Grace Street, Chicago, Illinois.

PRODUCTS

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

EXECUTIVES

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Radio Sales Manager....Winslow C. Goodwin

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I. Robinson Smith, 142 Liberty Street, New York City.

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Rocke International Electric Corp., 15 Laight Street, New York City.
W. Burt Knight, Inc., 1646 West Adams Street, Los Angeles, California.
C. C. Meredith, Streetsville, Ontario, Canada.

THE H. H. EBY MFG. CO.
21st & Hunting Park Avenue, Philadelphia, Pa.

EDDIE MFG. CO.
9 W. Illinois Street, Chicago, Ill.

FAHNESTOCK ELECTRIC CO.
46-50 Eleventh Street, Long Island City, N. Y.

GENERAL RADIO CO.
30 State Street, Cambridge, A, Mass.

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

P. R. MALLORY CO. (Yaxley Div.)
Indianapolis, Ind.

THE MUTER CO. (See page 30)
1255 S. Michigan Avenue, Chicago, Ill.

OAK MANUFACTURING CO.
308 W. Washington Street, Chicago, Ill.

SORENG-MANEGOLD CO.
1901 Claybourne Avenue, Chicago, Ill.

Speakers and Headphones (Dynamics, Magnetic, Crystal Types)

BEST MANUFACTURING CO.
1200 Grove Street, Irvington, N. J.

BRUSH LABORATORIES
3715 Euclid Avenue, Cleveland, Ohio.

C. F. CANNON CO.
Springwater, New York.

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

ELECTROPHONE CORP.
Philadelphia, Pennsylvania.

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

MAGNAVOX CO., LTD.
Fort Wayne, Indiana

PRODUCTS

Dynamic Speakers, High-Fidelity Speakers and Permanent Speakers as Standard Reproducing Equipment in All Makes and Types of Radio Broadcast Receivers, Public-Address Installation, Sound Distribution Systems, and Kindred Apparatus. Also Wet and Dry Electrolytic Capacitators of All Kinds for Use in Radio Broadcast Receivers, Radio and Line Wire Transmitting Stations, Motor Starting and Control Apparatus, and Industrial Applications.

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General Mgr..Richard A. O'Connor — Chief Engr........Fred W. Kranz
Advertising Mgr..............Stanley S. Sondles

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Magnavox (Great Britain), Ltd., London, England.
R. J. Patell, Room 629, Osaka Bldg., 1 Soze Cho. Kitaku, Osaka, Japan.

EXPORT

H. C. Chilibroste and Cia, Buenos Aires, Argentina.
Benjamin Electric, Ltd., London, England.
Melodium, S. A. R. L., Paris, France.
Societa Anonima Fimi, Saronno, Italy.
Microfarad, Milan, Italy.

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

PHILCO RADIO & TEL. CORP.
Philadelphia, Pennsylvania.

RCA VICTOR CO. (See page 28)
Camden, New Jersey.

RACON ELEC. CO., INC.
52 East 19th Street, New York City.

PRODUCTS

Air Column Horns, Electro-dynamic Speakers, High-frequency Speakers, Public Address Equipment.

EXECUTIVES

President...A. I. Abrahams
Sales Engineer..C. J. Brown
Chief Engineer...A. I. Abrahams

THE ROLA CO.
2570 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.

PRODUCTS

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

EXECUTIVES

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

EXPORT

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

UTAH RADIO PRODUCTS CO.
820 Orleans Street, Chicago, Ill.

VICTORY SPEAKERS, INC.
7131 East 14th Street, Oakland, Calif.

VOICE OF THE AIR CO.
730 Phillips Avenue, Toledo, Ohio.

PRODUCTS

Speaker Units and Trumpets.

WESTERN ELECTRIC CO.
195 Broadway, New York City.

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

Transformers and Chokes (Speaker Coils)

THE ACME ELEC. & MFG. CO.
1440 Hamilton Avenue, Cleveland, Ohio.

PRODUCTS

Radio Transformers, Neon Transformers, Stepdown Transformers, Voltage Adjustors, Spark Plug Testers, Ozone Devices.

EXECUTIVES

President..........G. R. Hillstrom — Sales Manager.......C. H. Bunch
Vice President.....J. A. Comstock — Chief Engineer....J. A. Comstock
Purchasing Agent........J. A. Comstock

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A. D. Strathy, 308 Atlantic Avenue, Brooklyn, N. Y.
C. H. Fryburg, 402 Cherry Street, Philadelphia, Pa.
W. E. Judge, 606 Atlantic Avenue, Boston.
A. M. Baehr, 1400 West 25th Street, Cleveland, Ohio.
F. C. Somers, 2004 Grand Avenue, Kansas City, Mo.
R. M. Campion, Box 4101, Station A, Dallas, Texas.
Jas. J. Backer Co., 109 Bell Street, Seattle, Wash.
Lombard Smith Co., 425 East Pico St., Los Angeles, Calif.
L. G. Cushing, 9 South Clinton Street, Chicago, Ill.
Harry C. Harrison, 409 South 7th St., St. Louis, Mo.
O. M. Conrad, Box 1971, Atlanta, Ga.

AMERICAN TRANSFORMER CO. (See page 27)
178 Emmet Street, Newark, N. J.

CENTRAL RADIO CORP.
Beloit, Wisconsin

CHICAGO TRANSFORMER CORP.
2626 W. Washington Boulevard, Chicago, Ill.

DONGAN ELECTRIC MFG. COMPANY
2987-3001 Franklin Street, Detroit, Michigan.

GENERAL TRANSFORMER CORP.
1900 N. Kilbourn Avenue, Chicago, Ill.

THE HALLDORSON COMPANY
4500 Ravenswood Avenue, Chicago, Ill.

JEFFERSON ELECTRIC CO.
Bellwood, Illinois.

KENYON TRANSFORMER CO., INC.
840 Barry Street, New York, N. Y.

PRODUCTS

Amplifiers, Transformers and Reactors.

EXECUTIVES

President...........F. P. L. Kenyon — Sales Mgr.........Paul R. Fernald
Chief Engineer....Edward J. Friebele

(Continued on page 36)

NEW POLICY
FOR
Dealers and Distributors
LIMITED TERRITORY AVAILABLE

WRITE FOR DISCOUNTS

Portable address systems for inside and outside use - $87.50 and up

Crystal Microphones. P. M. Dynamic Speakers, Amplifiers and Control Equipment for Rack and Panel Mounting. Precision Equipment for special uses. Special Systems for Dance Bands, Funeral Parlors. School and Hospital, Sound and Centralized Radio. Hotel Systems. Hearing Aids. Turntables. Transformers. Crystal Pickups. High Fidelity Units.

Sound Systems, Inc.

1311 TERMINAL TOWER — CLEVELAND, OHIO

ENAMELITZ
(LITZ WIRE WITHOUT A FABRIC COVERING)

REDUCES MANUFACTURING COSTS in the production of I. F. and R. F. coils

1—Lower wire cost
2—More coils per pound
3—Less space . . . Greater safety

Write for Sample and Technical Bulletin

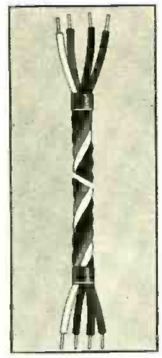
Other ACME WIRE CO. Products

MAGNET WIRE (All Insulations)
COILS (Magnet Wire Wound)
VARNISHED INSULATIONS (Cambric, Paper, Silk, Tape)
PARVOLT CONDENSERS (Filter, By-pass, Power Factor Correction
AERIAL WIRE (Stranded or Solid, Bare or Enameled)

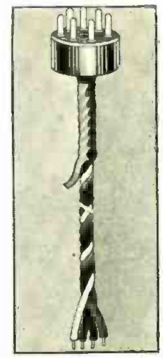
THE ACME WIRE CO.
NEW HAVEN, CONN.

For over 30 years, suppliers to the largest radio and electrical manufacturers

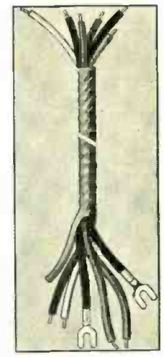
SPECIAL WIRES-CABLES
FOR HOME SETS and AUTO RADIOS



DYNAMIC SPEAKER CABLE



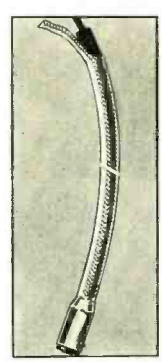
BATTERY ADAPTER CABLE



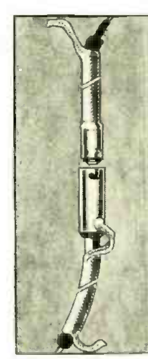
BATTERY SET CABLE

RADIO ENGINEERS
send your specifications and blue prints to us

Benefit by the experience of our engineering staff. The special wires and cables shown here were designed for specific needs and have proven to be time and money savers. Satisfied set builders can recommend to you our service and quality workmanship. Let us suggest to you the proper types of cable and wires for your particular purpose. We are so equipped to manufacture all types of special cords and cables for radio installation. Send your blueprints and specifications. Quotation will be sent and actual samples if requested.



SHIELDED LOW CAPACITY AUTO ANTENNAE LOOM WITH CONNECTOR



SHIELDED AUTO RADIO AMMETER CABLE WITH FUSE HOUSING

LENZ ELECTRIC MFG. CO.
1751 NORTH WESTERN AVE. — CHICAGO, ILL.

Established 1904

Telephone: Armitage 4454 — Cable Address: "Lenzco" Chicago

Transformers and Chokes (Continued)

(Continued from page 34)

BRANCH OFFICES OR REPRESENTATIVES

A. H. Baier, 5005 Euclid Avenue, Cleveland, Ohio.
Jas. J. Backer & Co., 109-11 Bell Street, Seattle, Washington.
Joseph Gardberg, 915 Atlantan Hotel, Atlanta, Georgia.
Harry Gerber, 94 Portland Street, Boston, Massachusetts.
Howard P. Hardesty, 356 East Grand Boulevard, Detroit, Michigan.
Kay Sales Co., P. O. Box 266, Tulsa, Oklahoma.
Byron L. Moore, 191 Starin Avenue, Buffalo, New York.
James P. Herman, 235 Ninth Street, San Francisco, California.
Marshank Sales Co., 1224 Wall Street, Los Angeles, California.
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Samul Bialek, 205 East 42nd Street, New York City.
Gilroy M. Barker, 1440 Tolma Avenue, Dormont, Pittsburgh, Pa.
C. C. Baines Sales Co., 4107 River Park Drive, Louisville, Kentucky.
B. G. Paylor, Hotel Waco, Waco, Texas.
G. C. Wacker, 1913 Washington Avenue, St. Louis, Missouri.
R. E. Stemm, 28 East Jackson Boulevard, Chicago, Illinois.
The Foster Co., 17 South 6th Street, Minneapolis, Minnesota.
E. Lewis Sales Co., 300 Youngerman Block, Des Moines, Iowa.
E. H. Pratt, 4110, East 51st Terrace, Kansas City, Missouri.

EXPORT

M. Simons & Sons, 25 Warren Street, New York City.

KINGSTON PRODUCTS CORP.
Kokomo, Indiana.

RCA VICTOR CO., INC. (See page 28)
Camden, New Jersey.

THE RADIART CORPORATION
13229 Shaw Avenue, Cleveland, Ohio.

STANDARD TRANSFORMER CORP.
850 Blackhawk Street, Chicago, Ill.

THORDARSON ELEC. MFG. CO.
500 W. Huron Street, Chicago, Ill.

UNITED TRANSFORMER CORP.
264 Canal Street, New York City.

PRODUCTS

Transformers, Reactors, Voltage Regulators, Audio Equalizers, Test Transformers for Broadcast Stations, Sound Studios, Laboratories, Commercial and Industrial Applications.

EXECUTIVES

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

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R. C. James, 2319 Second Avenue, Seattle, Washington.
H. Gerber, 94 Portland Street, Boston, Massachusetts.
Wm. T. McGary, 3800 North Grand Boulevard, St. Louis, Missouri.
James Millar, 316 Ninth Street, N. E., Atlanta, Georgia.
Conrad R. Strassner, 160 South Hobart, Los Angeles, California.
Arnold Sinai, 341 Tenth Street, San Francisco, California.
G. O. Tanner, 345 Fourth Avenue, Pittsburgh, Pennsylvania.
A. H. Baier, 2015 E. 65th Street, Cleveland, Ohio.

EXPORT

Rocke International Elec. Corp., 15 Laight Street, New York City.

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

APPARATUS DESIGN CO.
Little Rock, Arkansas. Tube Testers.

ALLEN B. DU MONT LABORATORIES
542 Valley Road, Upper Montclair, N. J.

PRODUCTS

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

EXECUTIVES

President.........Allen B. Du Mont   Sales Manager.......H. C. Holmes
General Manager......H. C. Holmes   Chief Engineer..Allen B. Du Mont

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Paul W. Koch and Co., 20 N. Wacker Drive, Chicago, Illinois.
John O. Olsen, 5314 Beelermont Place, Pittsburgh, Pennsylvania.
J. T. Hill Sales Co., 1724 S. Flower Street, Los Angeles, California.
W. Stuart Canton, 70 Arnold Avenue, Edgewood, Rhode Island.

EXPORT

Burkholder and Kelley, Ltd., Jarvis and Richmond Sts., Toronto, Canada.
American Radio Corp., 175 Rue Blomet, Paris, France.
G. M. Giannini, 304 E. 45th Street, New York, N. Y.

CLOUGH-BRENGLE CO.
1138 West Austin Avenue, Chicago, Illinois.

PRODUCTS

Oscillators and Test Equipment

EXPORT

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

GENERAL ELECTRIC CO.
Schenectady, New York. Meters.

GENERAL RADIO CO.
30 State Street, Cambridge, A. Mass.

HICKOK ELEC. INST. CO.
10514 DuPont Avenue, Cleveland, Ohio. Tube Testers.

INTERNATIONAL RESISTANCE CO. (See page 32)
Philadelphia, Pennsylvania. Volt-Ohmmeters.

JACKSON ELECTRICAL INST. CO.
432 Kiser Street, Dayton, Ohio. Tube Tester, etc.

G. F. LAMPKIN
146 W. McMillan Street, Cincinnati, Ohio. Monitors.

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

RCA VICTOR CO., INC. (See page 28)
Camden, New Jersey.

RADIO CITY PRODUCTS CO.
48 W. Broadway, New York, N. Y. Radio Testing Equipment.

RADIO PRODUCTS CO.
5th & Norwood, Dayton, Ohio. Tube Testers.

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

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

READRITE METER WORKS
136 E. College Avenue, Bluffton, Ohio. Meters.

SHALLCROSS MFG. CO.
700 Parker Avenue, Collingdale, Pa. Wheatstone Bridge—Decades, etc.

SUPREME INSTRUMENTS CORP.
Greenwood, Mississippi. Tube Testers.

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

WESTERN ELECTRIC CO. (See page 28)
195 Broadway, New York City.

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

WESTON ELECTRICAL INSTRUMENT CORP.
612 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

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In All Principal Cities.

EXPORT

In All Principal Cities in All Foreign Countries.

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179 Varick Street, New York City.
Cathode Ray Equipment—Beat Frequency Oscillators.

Tubes—Receiving and Transmitting Photo Cells—Cathode Ray Tubes

ARCTURUS RADIO TUBE COMPANY
Newark, New Jersey

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

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

ALLEN B. DU MONT LABORATORIES
9 Bradford Way, Upper Montclair, N. J.

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

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

GENERAL ELECTRIC CO.
Schenectady, New York.

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

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

GORDOS PRODUCTS CO.
17 W. 60th Street, New York, N. Y.

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

HYGRADE SYLVANIA CORPORATION
500 Fifth Avenue, New York City.

PRODUCTS

Receiving and Transmitting Tubes of all Types, Photo Cells, Broadcasting Equipment, Police Radio Equipment, Incandescent Lamps.

(Continued on page 38)

Tubes (Continued)

(Continued from page 36)

EXECUTIVES

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

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Offices located at Emporium, Pennsylvania; 500 Fifth Avenue, New York City; 10 Post Office Square, Boston, Massachusetts; 445 Lake Shore Drive, Chicago, Illinois, and 3440 South Hill Street, Los Angeles, California.

HYTRON CORP.
Salem, Mass.

THE KEN-RAD CORPORATION
Owensboro, Kentucky.

NATIONAL UNION RADIO CORP.
400 Madison Avenue, N. Y.

RCA RADIOTRON COMPANY, INC.

201 North Front Street, Camden, N. J.

PRODUCTS

Receiving Tubes, Transmitting Tubes, Cathode-Ray Tubes, and Amateur Radio Tubes.

RCA Radiotron Company, Inc., was incorporated as a subsidiary of Radio Corporation of America, January 1, 1930, to take over the manufacturing activities of General Electric Company and Westinghouse Electric and Manufacturing Company, and the commercial activities of Radio Corporation of America, relating to vacuum tubes and other apparatus in the field of radio.

In November, 1932, a unification of the sales direction of RCA Radiotron Company, Inc., and E. T. Cunningham, Inc., was effected and the same progressive program has since been applied to both brands of radio tubes.

EXECUTIVES

President.......E. T. Cunningham
Executive Vice President G. K. Throckmorton
Vice President & General Mgr., J. C. Warner
Vice President Manufacturing J. M. Smith
Sales Manager.........C. R. King
Advertising Mgr.....T. F. Joyce
Purchasing Agent....J. D. Leeson

DIVISION AND DISTRICT SALES OFFICES

EASTERN DIVISION

W. H. Thompson, Division Mgr., Front & Cooper Sts., Camden, N. J.
L. W. Teegarden, District Manager, 66 Broad St., New York City.
H. C. Brown, District Manager, 2009 Holland Ave., Utica, N. Y.
F. B. Wanselow, Manager, 201 N. Front St., Camden, N. J.
P. M. Jeffreys, District Manager, 498 Spring St., Atlanta, Ga.

WESTERN DIVISION

F. H. Larrabee, Division Mgr., 520 N. Michigan Ave., Chicago.
H. A. Edwards, Manager, 925 Euclid Ave., Cleveland, Ohio.
R. A. Graver, District Manager, 520 N. Michigan Ave., Chicago, Ill.
F. E. Harding, Manager, 4415 Aldrich Ave., S., Minneapolis, Minn.
J. W. Cooke, Manager, 2200 Griffin St., Dallas, Texas.
E. L. Sutton, Manager, 325 Ninth St., San Francisco, Calif.

EXPORT

N. A. Woodford, Export Sales Manager, Camden, N. J.

RCA VICTOR CO., INC. (See page 28)
Camden, New Jersey.

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

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

TRIAD MANUFACTURING CO.
Pawtucket, Rhode Island.

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

WESTON ELEC. INST. CORP. (See page 36)
Newark, New Jersey.

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

WESTERN ELECTRIC CO. (See page 28)
195 Broadway, N. Y. C.

Tube Machinery

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

EISLER ENGINEERING CO.

760 South 13th Street, Newark, N. J.

PRODUCTS

Incandescent Lamp Machinery, Radio Tube Machinery, Neon Tube Machinery, Laboratory Equipment, Glass Working Machinery, High Vacuum Pumps, Electric Spot Welding Machines, Oil Burners, Gas Burners, Oxygen Burners, and Butt Welding Machines.

EXECUTIVE

President............Charles Eisler
Vice President.......J. A. Morick
General Manager....Charles Eisler
Sales Manager.......Charles Eisler
Chief Engineer......Charles Eisler
Production Mgr......J. A. Morick
Purchasing Agent....J. A. Morick
Advertising Mgr.......F. Stanton

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

PRODUCTS

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

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

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

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

Tube Parts and Materials (including Wire)

ALLOY METAL WIRE CO., INC.
Moore, Pa.

ALO LABORATORIES
Glenwood Avenue, Bloomfield, N. J. Parts.

THE AMERICAN BRASS COMPANY

(Waterbury Brass Good Branch)
26 Crane Street, Waterbury, Conn.

PRODUCTS

Screw Shells, Fuse Caps, Ferrules, Clips, Terminals, Push-Buttons and Receptacle Plates, as well as Cups and Shells, Blanks or Stampings, Washers, Rivets, Brazing Solder.

EXECUTIVE

Vice President.........H. W. Coe
Manager................J. L. Smith
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.
70 Sayre Street, Buffalo, N. Y.

AMERICAN ELECTRO METAL CORP.

Lewiston, Maine.

PRODUCTS

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

EXECUTIVES

President....Dr. Paul Schwarzkopf
Vice President........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

Chattanooga, Tennessee.
Established 1903.

PRODUCTS

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

EXECUTIVES

President...........Paul J. Kruesi
Sales Manager..Gus E. Richter, Jr.
Asst. Sales Mgr.....Carl R. Hower
Secretary..............H. R. Smartt
Treasurer........Warren A. Jeffords
Engineer in Charge.Frank J. Stevens

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Boston—No. 80 Federal Street, Room 223.
Chicago—1112 Merchandise Mart.
Cleveland—Newman Stearns Building.
Newark—Globe Indemnity Bldg.
St. Louis—1623 Locust Street.
San Francisco—163 Second Street.
Washington—Room 441, Evening Star Building.

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

CALLITE PRODUCTS CO.

540 39th Street, Union City, N. J.

PRODUCTS

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

EXECUTIVES

President...............C. A. Laise
Vice-President............C. Kraft
General Manager......C. A. Laise
Sales Manager............J. Kurtz
Chief Engineers.. M. Rogers and G. Wheeler
Production Manager........C. Kraft
Purchasing Agent.......Geo. Dewey
Advertising Manager.......J. Storrs

BRANCH OFFICES OR REPRESENTATIVES

Eisler Electric Corp.., Union City, N. J.
International Wire Co., North Bergen, N. J.

EXPORT

R. G. McLeod, London, England.
International Save Co., Paris, France.
Braun & Braun, Vienna, Austria.
Carl Bondy & Co., Vienna, Austria.

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

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

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

ELECTRICAL INSULATION

EMPIRE ...Varnished Cloth, Tapes, Silks and Papers

MICANITE ...Plates, Segments, Rings, Tapes, Tubes, Washers

LAMICOID ...Laminated Bakelite Fabricated Parts, Sheets, Rods and Tubes

MICO ...Untreated Papers, Linen and Silk Tapes, Varnishes, Fibre, Spaghetti Tubing, Cotton Sleeving, etc.

RAW MICA, Uncut blocks, or cut to size.

MICA SHAPES

Write for Bulletin 92 containing data and prices

200 Varick Street, New York; 542 So. Dearborn Street, Chicago; 1330 Schofield Bldg., Cleveland. *Branches at:* Birmingham, Boston, Cincinnati, Los Angeles, San Francisco, Seattle, Montreal, Toronto

MICA INSULATOR CO.

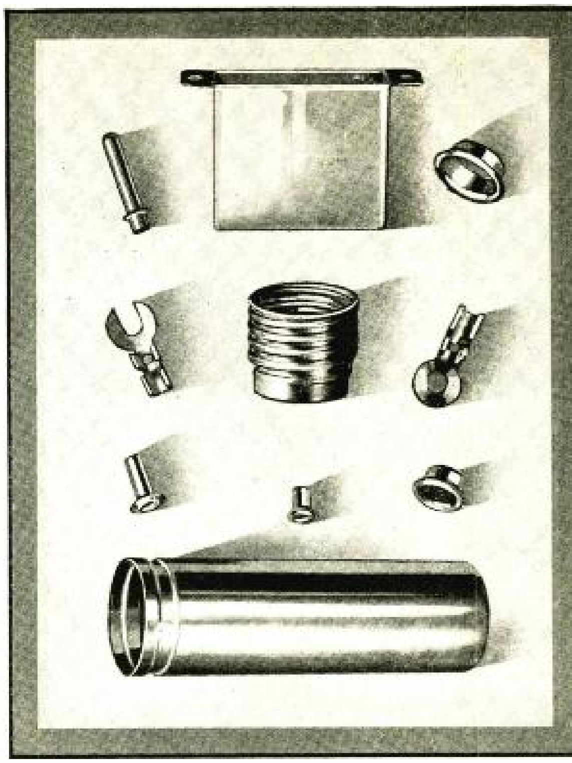
FELT

The largest manufacturers of felt in the world, the American Felt Company, maintains a staff of experts anxious to co-operate with you in the solving of difficult situations. Felt may be cut to exacting standards or supplied in bulk. It is most durable.

American Felt Company

TRADE MARK

NEW YORK BOSTON SAN FRANCISCO CHICAGO DETROIT
PHILADELPHIA CLEVELAND ST. LOUIS MONTREAL



A recognized source of supply for

RADIO PARTS

of Copper and Copper Alloys

VACUUM tube base pins, eyelets, grommets, terminals, contacts, electrodes, fuse clips, sockets, screw shells, condenser shells, push-button and receptacle plates, miscellaneous stampings, shells, etc. The Waterbury Brass Goods Corp. has long been a recognized source of supply for these and similar radio parts of copper and copper alloys.

As the Waterbury Brass Goods Branch of The American Brass Company, the comprehensive scope of our lines and the unvarying high quality of our products ...combined with prompt and efficient handling of orders and inquiries...provide an ideal service for manufacturers of electrical and radio equipment. May we quote on your present requirements or work with you in the design of a new product?

ANACONDA
from mine to consumer

WATERBURY BRASS GOODS BRANCH

The American Brass Company

General Offices: Waterbury, Connecticut

Offices and Agencies in Principal Cities

Tube Parts and Materials (Continued)

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

PRODUCTS

Molybdenum and Tantalum Sheet, Rod and Wire. Tungsten Sheet and wire. Alloys, Electrical Contacts of Tungsten and Molybdenum, Battery Chargers, and Rectifiers.

EXECUTIVE

President..............J. M. Troxel
Vice President....R. J. Aitchison
General Manager..R. J. Aitchison
Sales Manager........J. M. Troxel
Chief Engineer......G. E. Stryker
Production Mgr.......A. J. Dowe
Purchasing Agent.....A. J. Dowe
Advertising Mgr....C. E. Stryker

BRANCH OFFICES OR REPRESENTATIVES

Park B. Hyde Company, 58 Main Street, San Francisco, Calif.

EXPORT

Tungsten Manufacturing Co., 8 Francis St., Victoria St., London. SW1, England.

WALTER GILBY ALLOY COMPANY
850 Mt. Prospect Avenue, Newark, N. J. Svea, Nickel, Alloy Wires.

GILBY WIRE COMPANY
150 Riverside Avenue, Newark, N. J.

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

PRODUCTS

Radio Tube Parts (Stamped and Formed Metal Elements, Plates, Shields, Cups, Collars, Clips, etc.), Tube Shields (Form-Fitting).

EXECUTIVES

President.............Walter Goat
Vice President...J. N. Mortensen
General Manager......Edward F. Stauer

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Fred Garner, 43 East Ohio Street, Chicago, Ill.
R. C. Veale, 125 Church Street, New York, N. Y.
Frank A. Emmet, 1341 South Hope Street, Los Angeles, Calif.
Atlas Radio Corp., 500 King St., W., Toronto, Ont., Canada.

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

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

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

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

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

PRODUCTS

Insulating Parts.

EXECUTIVE

President ....S. H. Stupakoff

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

PRODUCTS

Seamless Tubing for: Mechanical Tubing, Aircraft, Radio Cathode Sleeves and Other Electrical Applications, Industrial Control Equipment, Oil and Diesel Engines, Capillary Tubes, and Composite Tubes.

EXECUTIVES

President.............E. L. Parker
Vice President.........N. H. Wolf
General Manager.......N. H. Wolf
Sales Manager............J. P. Dods
Chief Engineer........R. R. Lawson
Production Mgr.....Theodore Heske
Purchasing Agent....Ross Saylor

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Edgar T. Ward's Sons Company of: Boston, Mass.; Buffalo, N. Y.; Chicago, Ill.; Cleveland, Ohio; Detroit, Mich.; Milwaukee, Wis.; Philadelphia, Pa.; and Pittsburgh, Pa.
Foucar, Ray and Simon, Inc., San Francisco, Calif.
California Panel and Veneer Co., Los Angeles, Calif.

SWEDISH IRON & STEEL CORPORATION
17 Battery Place, New York City. ¼

PRODUCTS

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

EXECUTIVES

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

BRANCH OFFICES OR REPRESENTATIVES

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

EXPORT

R. G. McLeod, Ltd., 17 Southampton Street, London, W. C. 1.

Wire—Antenna, Hook Up, Magnet, etc.

ACME WIRE COMPANY
New Haven, Connecticut.

PRODUCTS

Paper Condensers and Condenser Parts, Magnet Wire, Coils, Varnished Insulations and Aerial Wire.

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

AMERICAN ENAMELED MAGNET WIRE CO.
Port Huron, Michigan.

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

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

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

ESSEX WIRE CORPORATION
37 Manchester Avenue, Detroit, Mich.

GENERAL CABLE CORPORATION
420 Lexington Avenue, New York City.

HOLYOKE COMPANY
720 Main Street, Holyoke, Mass.

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

PRODUCTS

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

EXECUTIVES

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

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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.

EXPORT

Sydney Ginsburg, 86 Rue de Pelican, Antwerp, Belgium.

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

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

SPARGO WIRE COMPANY
Rome, New York.

Wire—Resistance

DRIVER-HARRIS CO.
Harrison, New Jersey.

WALTER GILBY ALLOY CO.
850 Mt. Prospect Avenue, Newark, N. J.

GILBY WIRE COMPANY
150 Riverside Avenue, Newark, N. J.

HOSKINS MANUFACTURING CO.
Detroit, Michigan.

GEORGE W. PRENTISS AND CO.
Holyoke, Mass.

Wire Strippers

THE WIRE STRIPPER COMPANY
1727 Eastham Avenue, E. Cleveland, Ohio.

PRODUCTS

Wire Strippers, Brush Type Strippers, Knife Type Strippers.

MISCELLANEOUS EQUIPMENT (See Index, Page 26)

Cabinet Ornaments

CROWE NAMEPLATE & MFG. CO. (See page 34)
1749 Grace Street, Chicago, Ill.

SYRACUSE ORNAMENTAL COMPANY
Syracuse, N. Y.

Ceramics

AMERICAN LAVA CORP. (See page 38)
1411 William Street, Chattanooga, Tenn.

THE COLONIAL INSULATOR CO.
Akron, Ohio

PRODUCTS

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

EXECUTIVES

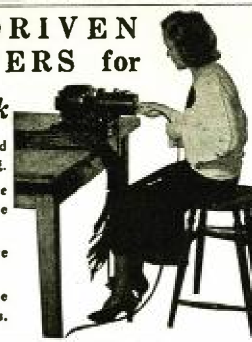
President.........Jas. R. Hemphill
Secretary...........R. W. Hemphill
Treasurer................W. H. Motz

BRANCH OFFICES OR REPRESENTATIVES

1800 Grace Street, Chicago, Illinois.

Use MOTOR DRIVEN WIRE STRIPPERS for

Faster, Better Work



Our machines are especially adapted for Radio Coil and Wire Stripping.

BRUSH TYPE STRIPPERS remove insulation from coil leads as close to coil as desired.

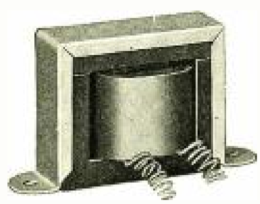
KNIFE TYPE STRIPPERS remove insulation from all wire ends.

Write today for Bulletin on these and other Insulated Wire Strippers.

THE WIRE STRIPPER CO.
1725 Eastham Ave. E. Cleveland, Ohio

ACME TRANSFORMERS

Power—Audio—Step-Down



Write for Bulletin 132 describing Power and Audio Transformers. Bulletin 129 describes Step-Down Transformers.

THE ACME ELECTRIC & MANUFACTURING CO.
1445 HAMILTON AVE., CLEVELAND, OHIO

NEW LOW PRICE Gen-E-Motors

Low Current Drain Plate Voltage Supply for 32 and 6 volt farm radios

Used by leading set manufacturers to provide economical, trouble-free plate potentials up to 250 volts from 6 and 12 volt D.C. Eliminate interference on short-wave reception.

Write or Wire for Full Data

PIONEER GEN-E-MOTOR CORP.
460-B W. Superior St. — Chicago, U. S. A.

THOUSANDS OF

Astatic Microphones

now in use are daily proving their merit and dependability.

No fine adjustments to get out of order. Their ruggedness makes them especially adaptable to P. A. work.

List Price - $21 Net to Amateurs - $12.60

Licensed under Brush Development Co. patents.

Astatic Microphone Laboratory, Inc.
YOUNGSTOWN, OHIO

RACON

The COMPLETE Line

4½' Trumpet

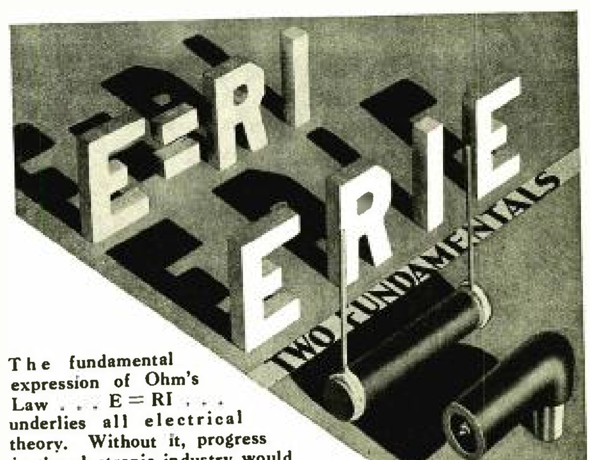
Among the more than 35 types of *Racon* air-column sound projectors are ten models of 4½-foot trumpets, available in regular and *Stormproof* construction, of the exclusive *Racon* acoustic cloth, or heavy-gauge aluminum. For especially severe operating conditions, the newly developed *unbreakable* projector can also be furnished.

Practically every large fair and road show this year is using *Racon P.A. Products*. Experienced rental companies know that the service and reliability of *Racon Horns and Units* is well worth their initial cost—which is usually as low as inferior products.

Racon electrodynamic units and horns are manufactured under 14 exclusive Racon patents.

Write Dept. RE9 for catalog.

RACON ELECTRIC CO. INC.
52 East 19th St., New York, N. Y.
London, Eng. Toronto, Can.



The fundamental expression of Ohm's Law . . . E = RI . . . underlies all electrical theory. Without it, progress in the electronic industry would have been greatly retarded.

Fundamental research resulting in constant improvement of Erie Moulded Carbon Resistors and Erie Suppressors makes possible continued electronic progress.

A well equipped research laboratory, competent engineering staff and automatic manufacturing equipment keep Erie high resistance products more than abreast of the industry's requirements.

Precision-made Erie Resistors and Erie Suppressors have been the solution to many resistance problems. A letter to us will bring you complete technical data and samples to test in your own laboratory.

ERIE RESISTOR CORP.
TORONTO, CAN. ERIE, PA. LONDON, ENG.

Ceramics (Continued)

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

PRODUCTS

Ceramic Products (Crolite), Radio Tube Parts, Spacers for Radio Tubes, Cathode Insulators, Insulating Materials, Tubing, Insulator, Heat-proof Materials, Coil Forms, Crolite, Resistor Tubing, Resistors

Heaters for Radio Tubes
1 Central Avenue, W. Orange, N. J.

EXECUTIVES

Henry L. Crowley........President George Crowley......Sales Manager
Robert Crowley....Production Manager

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

PRODUCTS

Ceramic Insulators, Coil Forms, Concentric Radio-Frequency Transmission Lines, Oil Burner Ignition Assemblies, Chemical Tower Packing, Ceramic Valves and Nozzles for Chemical Uses.

EXECUTIVE

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

BRANCH OFFICES OR REPRESENTATIVES

New York Sales Office, 233 Broadway, New York, N. Y.
C. E. White, Bulkley Building, Cleveland, Ohio.

Diaphragms for Speakers

HAWLEY PRODUCTS COMPANY
St. Charles, Illinois.

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

UNITED PRESSED PRODUCTS CO.
407 S. Aberdeen Street, Chicago, Ill.

PRODUCTS

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

EXECUTIVE

President.............Frank Raffles

Felt

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

PRODUCTS

Felt in Rolls or Sheets, or cut to Specified Size or Part.

EXECUTIVES

President.........John T. Lawless Sales Manager...Jule F. Marshall
Purchasing Agent..........Geo. W. Gay

BRANCH OFFICES OR REPRESENTATIVES

H. J. Hartwick, Chicago, Ill.
F. B. Ellery, Boston, Mass.
P. H. Lang, New York, N. Y.
W. F. Meinhard, Detroit, Mich.
Port Chester, N. Y.
Glenville, Conn.
Franklin, Mass.
City Mills, Mass.
Newburgh, N. Y.
Rahway, N. J.
Detroit, Mich.

EXPORT

H. F. Roche, Export Manager, New York.

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

PRODUCTS

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

FELTERS COMPANY
210 South Street, Boston, Mass.

WESTERN FELT WORKS
4115 Ogden Avenue, Chicago, Ill.

Flexible Shafting

CHARLES FISHER SPRING CO.
240 Kent Avenue, Brooklyn, N. Y.

THE S. S. WHITE DENTAL MFG. CO. (See page 32)
152 W. 42nd Street, N. Y. C.

Foil

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

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

Fuses

LITTLEFUSE LABORATORIES
1772 Wilson Avenue, Chicago, Illinois

PRODUCTS

Instrument Fuses, Aeroplane Fuses, Radio Fuses, High Voltage Fuses, Fuse Clips, Fuse Mountings and Retainers.

EXECUTIVES

President..E. V. Sundt
Production Manager...B. Kollath

BRANCH OFFICES OR REPRESENTATIVES

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

FOREIGN DISTRIBUTORS

South America—Ad. Auriema, Inc., 116 Broad Street, New York City.
Sweden—Aktiebolaget Zander & Ingestrom, Fredsgatan 4, Stockholm.
Germany—D. Bercovitz & Sohn, Belziger Str. 61, Berlin-Schoneberg.
Holland—A. F. Hulsewe, Ingenieursbureau, Keizersgracht 188, Amsterdam C.
Italy—Ing. S. Belotti & C., S. A. Piazza, Trento N. 8, Milan.
New Zealand—Johns Limited, Chancery Street, Auckland
Norway—Maskin Aktieselskapet Zeta, Drammensveien 26, Oslo.
Spain—Sánchez Ramos y Simonetta, Avenida de Pi y Margall, Madrid.
Australia—Warburton Franki, Ltd., 307 Kent Street, Sydney, N. S. W.; Warburton Franki, Ltd., 380 Bourke Street, Melbourne, Cl.
England—R. G. McLeod, Ltd., 17 Southampton St., London, W. C. I.
Chile—Besa y Cia, Ltda., Casilla 1147, Santiago.
Canada—Distributors in all large centers.

Graphite

ACHESON OILDAG COMPANY
Factory—Port Huron, Michigan.
New York Office—654 Madison Avenue.

PRODUCTS

Colloidal-Graphited Oil. Colloidal-Graphited Water. Colloidal-Graphited Castor Oil. Graphited Water. Colloidal-Graphited Glycerin.

Laminations and Stampings

THOMAS & SKINNER STEEL PRODUCTS CO.
1100 E. Twenty-Third Street, Indianapolis, Ind.

PRODUCTS

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

EXECUTIVES

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

F. R. ZIERICK MFG. WORKS
68 E. 131st Street, New York City.

Lacquers and Varnishes

BAKELITE CORPORATION
River Road, Bound Brook, N. J.

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

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

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

THE ZAPON COMPANY
Stamford, Connecticut

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

PRODUCTS

Waxes and compounds for condensers, transformers, coils, resistances, lightning arrestors, battery seals, impregnators for cloth and wire, some types of varnishes, etc. The Company also manufactures compounds meeting specifications of buyers.

EXECUTIVES

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Vice-President and Secretary..............................C. W. Gramm
Credit and Accounting.......................................T. C. Pearlstone
Purchasing Department......................................E. C. Zolkoski

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Technical Laboratory...A. Saunders

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SHAKEPROOF LOCK WASHER COMPANY
2501 North Keeler Avenue, Chicago, Ill.

PRODUCTS

Lock Washers, Screws, Nuts, Locking Terminals.

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Andrew Carrigan Co., Rialto Building, San Francisco, California.
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F. T. Donnelly, Century Building, Pittsburgh, Pennsylvania.
Clyde D. Eno, 1340 Palmetto Avenue, Toledo, Ohio.
C. O. Hard, 322 4th Street, Scotia, Schenectady, New York.
F. C. Mortensen, 1027 West McKinley Street, Milwaukee, Wisconsin.
Canada Ill Tools, 121 St. Patrick Street, Toronto, Ontario, Canada.
H. M. Howison, 401 Swetland Building, Cor. 9th and Euclid, Cleveland, Ohio.
C. E. Nagel, 41 Park Row, New York City, New York.
Chase, Parker & Co., 288 Congress Street, Boston, Massachusetts.
Carroll Company, 1323 Wall Street, Dallas, Texas.
McVoy & Hausman, Birmingham, Alabama.
Duane Ketcham, Box 110, Hamburg, New York.

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I. Meye & Company, Rotenwaldstrasse 94, Stuttgart, Germany.
R. S. Stokvis et fils, 20-22 Rue des petits hotels, Paris, France.

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TUNGSTEN..... MOLYBDENUM.. KULGRID WIRE

TUNGSTEN..... in rod, sheet, wire and special shapes. Welds for all applications.

MOLYBDENUM.. in rod, sheet, wire and special shapes, for grids, supports, heating elements and contacts.

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TUNGSTEN CONTACTS . . . All shapes for all purposes.

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"Winning New Friends"

The RV-3 High Fidelity VELOCITY MICROPHONE

is now in regular use in 42 U. S. broadcasting studios while nineteen universities and numerous industrial institutions rate them as their acoustical standard.

The Bruno Model RV-3 is not "just a microphone." It is a scientific device designed and constructed in accordance with the most modern acoustic principles.

Characteristics

Frequency response of 30 to 14,000 C.P.S.
Output level —69 db (0 level = 6m.w.)
Highly directional.
Not affected by humidity or temperature variations.
Sparkling, faithful tone quality.
High gain.
Reduced feed back.

Write for Bulletin Series "B"

Our laboratory is equipped to calibrate any device within ±1db. and to make sound measurements of laboratory standards. Quotations will be sent upon request.

PAT. PEND.

BRUNO LABORATORIES
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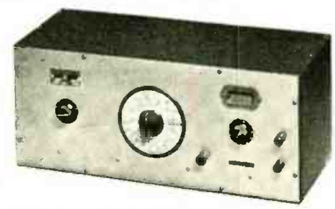
ANNOUNCING NEW ADVANCES

in Precision Laboratory Equipment

• Audio Oscillator—Beat Frequency



Precision Calibrated from 20 to 15,000 cycles. Pure sine-wave form. Accurate, free from frequency shift. . . . Easy to use. Write for full information. Net to manufacturers. . **$93.75**

• R. F. Oscillator—50 k.c. to 30 m.c.

110 A.C. or D.C. line operated. Three tubes. Frequency stable under change of line and output load. Modulated r.f., unmodulated r.f. and 400 cycle audio frequency output. Write for manufacturers discount. List **$49.85**

• Cathode Ray Oscillograph

New oscilloscope and sweep circuit units. Permanent records without photographing. Flexible and easy to operate. Improved focus and time controls. Write for prices and full information.

For information on the complete line, write

The CLOUGH-BRENGLE CO.
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PRICE $175.00

A NEW PORTABLE CATHODE RAY OSCILLOGRAPH

The Du Mont Type 142 portable cathode ray oscillograph is a compact and rugged self-contained instrument for general laboratory or industrial use. A type 54-8 Du Mont cathode ray tube with indirectly heated cathode and separate leads from each deflection plate is mounted in the unit behind a graduated scale. The power supply of the instrument furnishes all the necessary voltages for this tube and the linear sweep circuit provides a variable sweep voltage from 10 to 5000 cycles per seconds. Means for synchronization of recurrent patterns are provided.

Complete data on this instrument upon request. Also data on our complete line of cathode ray tubes and oscillographs.

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2200 Washington Avenue, Philadelphia, Pa.

RIVERSIDE METAL COMPANY
Riverside, New Jersey.

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AMERICAN BRASS CO. (See page 38)
Waterbury, Conn.

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

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

PRODUCTS

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5-261 General Motors Building, Detroit, Mich.
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2020 Lewis Tower, Philadelphia, Pa.
1632 Henry Oliver Building, Pittsburgh, Pa.
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506 Boston Safe-Deposit Building, Boston, Mass.
540 10th Street, San Francisco, Calif.

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Armco, 6 Ave., Gourgaud, Paris 17E, France.
The Armco International Corp., Thames House, Millbank, London, SW 2, England.
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268 Fourth Avenue, New York City.

FORD RADIO MICA CO., INC.
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MICA INSULATOR CO.
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ELECTRIC SPECIALTY CO.
211 South Street, Stamford, Conn.

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Dynamotors. These include 32-volt dc to 225-volt dc units for Plate Power of 32-volt dc Farm Receivers; High-Voltage Supplies for Power Amplifiers; 32-volt dc to 110-volt ac and 110-volt dc to 110-volt ac Converters.

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FRED C. STRYPE
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2595 Third Avenue, N. Y. C.

THE PAPER TUBE COMPANY
1718 Damen Avenue, Chicago, Ill.

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AUTOMATIC ELECTRIC, INC.
1033 W. Van Buren Street, Chicago, Ill.

J. H. BUNNELL & CO.
215 Fulton Street, New York City.

STRUTHERS-DUNN, INC.
139 Juniper Street, Philadelphia, Pa.

PRODUCTS

Relays for Remote Control, Public-Address Systems, Glow Tubes, etc., Tube Testing Circuits.

EXECUTIVE

President..J. Struthers Dunn

WARD, LEONARD ELECTRIC CO.
Mt. Vernon, New York.

WESTON ELEC. INST. CORP.
Frelinghuysen Avenue, Newark, N. J.

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

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RADIO DIVISION

C. S. Trott..........Sales Manager.

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GOAT RADIO TUBE PARTS, INC. (See page 40)
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HAMMARLUND MANUFACTURING CO.
424 W. 33rd Street, New York City.

SCOVILL MANUFACTURING CO.
Waterbury, Connecticut.

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KESTER SOLDER COMPANY
4201 Wrightwood Avenue, Chicago, Ill.

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AMERICAN GAS ACCUMULATOR CO.
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RAILWAY EXPRESS AGENCY, INC.
95 years of service.
NATION-WIDE SERVICE

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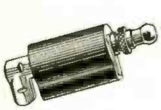
When the frantic parents of a once-healthy radio call on you to revive their loved one . . . see that your stock of life-giving CENTRALAB replacement parts is in order.

The sturdy fixed RESISTOR

For D. R.'s* all over the country are doing heroic work with Centralab Radiohms, Resistors and Suppressors.



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Experimenters too are using Centralab parts for better results.

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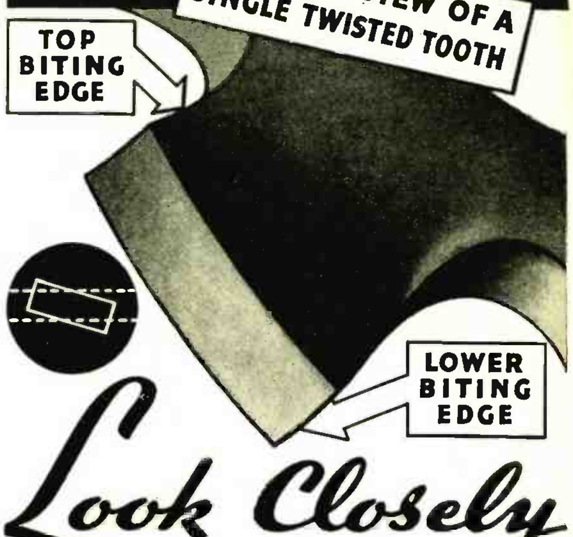

Look Closely AT THIS TWISTED TOOTH

Send today for your free copy of this complete Shakeproof Catalog. Explains thoroughly the many advantages that Shakeproof offers—also shows new patented Shakeproof products.

HERE you see the reason for Shakeproof's great locking power. This exclusive feature makes possible the most positive method for holding nuts and screws absolutely tight. A solid, rigid contact is made between the nut and the work, producing a lever action which makes the two biting edges dig in deeper as vibration tries to loosen the nut. Now, consider that there are several twisted teeth on each Shakeproof Lock Washer—each one exerting its powerful force against any backward movement of the nut. The performance of your product is certain to be definitely improved by this modern locking principle—Write for free testing samples today.

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Distributors of Shakeproof Products
Manufactured by Illinois Tool Works

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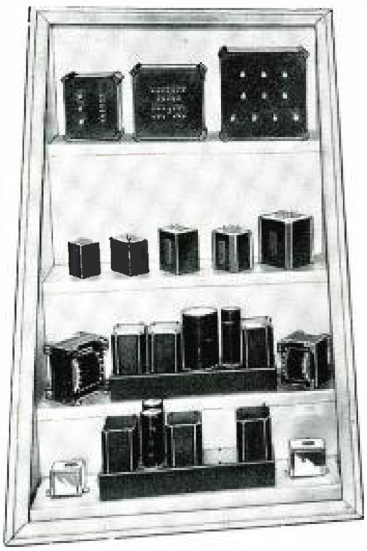
Type 12. Internal	Type 11. External	Type 15. Countersunk	Type 20. Locking Terminals

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

UTC

The UTC Engineering Laboratories

have developed NEW



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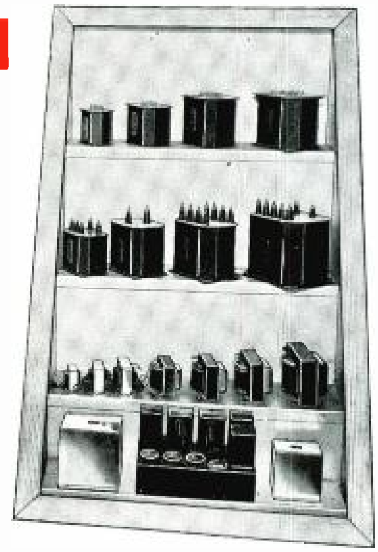

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The output transformer illustrated, designed either for 204A's or 849's in class B, has a linear response from 30 to 12,000 cycles. The unit is oil immersed and shielded in a heavy gauge high permeability casting. All leads are terminated in high tension ceramic bushings. The transformer is insulated for 20,000 volts and will handle 1,000 watts audio power.

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Standard designs are now available on these units having a frequency response of ± 2 Db. from 30 to 12,000 cycles.

UTC linear standard and public address amplifier kits are available with completely drilled chassis carefully engineered for maximum results.

Write for the new U-1000C Manual. 24 pages devoted to basic amplifier circuits, including fundamental charts on attenuation network data, decibel charts, reactance charts, rectifier constants and class B circuit constants.

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Amplifier illustrated incorporates three push-pull audio stages; gain: 80 Db.; linear from 30 to 15,000 cycles. Tubes used: 4 - 56's, 2 - 2A3's, 1 - 5Z3, 1 - 45. Fixed C bias for output stage.

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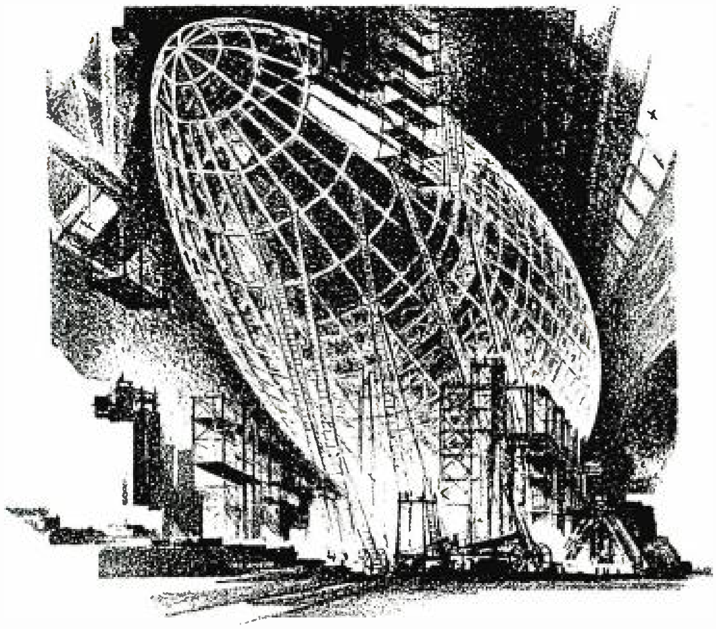

PRECISION

● Beneath the fabric of a modern dirigible lies a masterpiece of intricate construction. Thousands of metal parts... each scientifically processed for strength, accurately balanced, precision fitted.

Yet, to the radio tube engineer, even such exacting construction seems relatively rough. *His* materials must be even finer, his design more exact, his tolerances a thousand times closer!

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There is a definite reason why an organization so extensive as the Hygrade Sylvania Corporation can adhere to such high standards. This company is management owned. It is run by men whose only goal is the mutual success of their company and its customers.

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