MARCH, 1935

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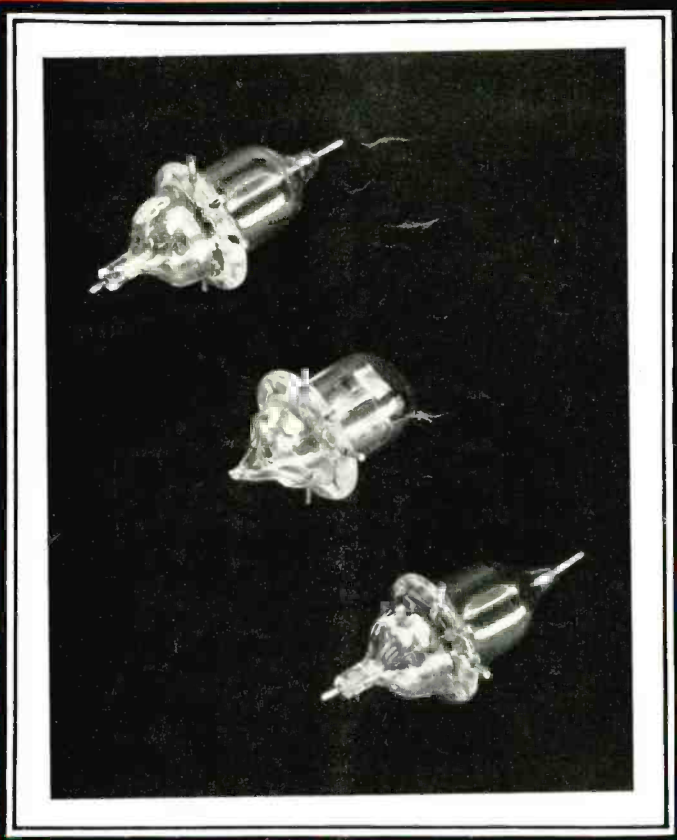

VOL. XV NO. 3

The Journal of the Radio and Allied Industries

# RADIO ENGINEERING

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VOL XV

NO. 3

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Published Monthly by the
Bryan Davis Publishing Co., Inc.
19 East 47th Street
New York City

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Advertising Manager

A. B. CARLSEN
Circulation Manager

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Telephone: Drexel 0718.
Wellington, New Zealand—Te Aro Book Depot.
Melbourne, Australia—McGill's Agency.

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

# EDITORIAL

## ALL-WAVE TUNING

THE SALE OF all-wave receivers continues on the increase. There is every reason to suspect that the radio manufacturer will profit most from this type of set for some time to come.

All-wave reception is popular by the same reason that broadcast reception was popular when first instituted. Many more people would purchase all-wave receivers were they convinced of their practicability, and many present owners of all-wave receivers would purchase new sets if some real advances were made in design. As matters stand, too many listeners have been discouraged by the results they have obtained.

We are convinced of the fact that the "sales worthiness" of any product is based almost entirely upon its element of practicability, and this is the one place where many all-wave receivers fall down. If these receivers are to be generally accepted by the public, more thought should be given to mechanical design.

The most pronounced deficiency of the average all-wave receiver is in the tuning system. It is no exaggeration that with some receivers it is almost impossible to tune in a station operating in a high-frequency band. And if a station can finally be captured, it is impossible to log it accurately for future reference. Since distant station carriers may be almost imperceptible for one or a number of reasons, the difficulty of locating a station is so much the worse, with the result that even a good receiver with an inadequate tuning mechanism may have its reception capabilities reduced as much as 50 percent. What does the listener think of such a receiver?

It is so much twaddle to suggest that the listener should be educated up to the technique of high-frequency tuning. The engineer who promotes such an alternative is passing the buck on to the public.

It is up to the engineer to make high-frequency tuning as simple as broadcast tuning. The public should not be blamed for an engineering inadequacy, yet the burden is placed on the listener.

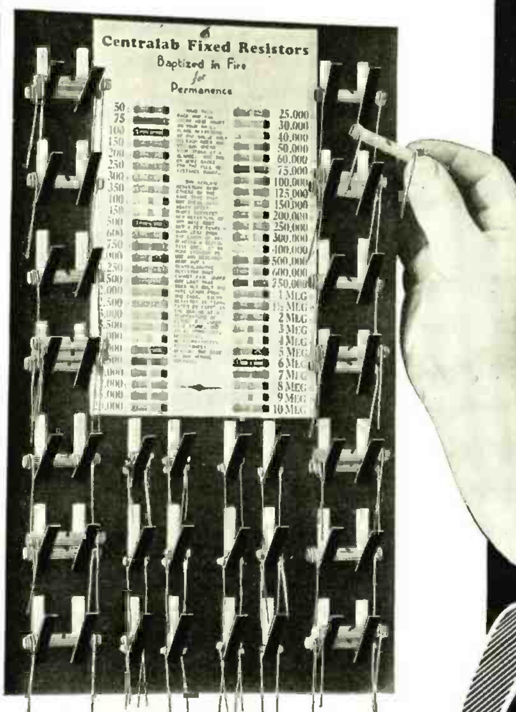
Mechanical or electrical band spreading is an absolute necessity in an all-wave receiver. Electrical spreading, while ideal, is admittedly expensive. But good mechanical spreading systems are not so high in cost that the manufacturer should feel impelled to dispense with their use.

Dial ratios of 20 or 30 to 1 are not sufficient. Ratios should be increased to 100 to 1, or more, if real ease of tuning is to be provided. Moreover, every dial should incorporate some form of vernier pointer and numbered scale, free from backlash, that will permit accurate logging. Anything short of these two features will not suffice.

One other point we believe to be of importance: Tuning dials should be easy to read. Many are not. Yet 90 percent of the population suffer from some form of eye deficiency. Why not make dials about twice their present size? If some thought is given to their functional importance, there is no reason why such dials couldn't be made to harmonize with the receiver cabinet. A good industrial designer could turn the trick.

In any event, why put out an excellent all-wave receiver, capable of reliable distance reception, and tie it down by incorporating a tuning mechanism that will not provide ease of operation in the high-frequency bands? It's too much like hooking up a crystal detector to a loudspeaker.

Our idea of a perfect all-wave tuning system is one having a large dial, with large readings; indirect or diffused dial illumination; a sharp-edged pointer, with the ends painted a dull black; a supplementary numbered dial and pointer of the band-spread type, for accurate station logging; a means of indicating the frequency band in use, and a dual-ratio drive mechanism free of backlash, having "fast" and "slow" tuning knobs, so that ease of tuning may be had in all frequency bands.

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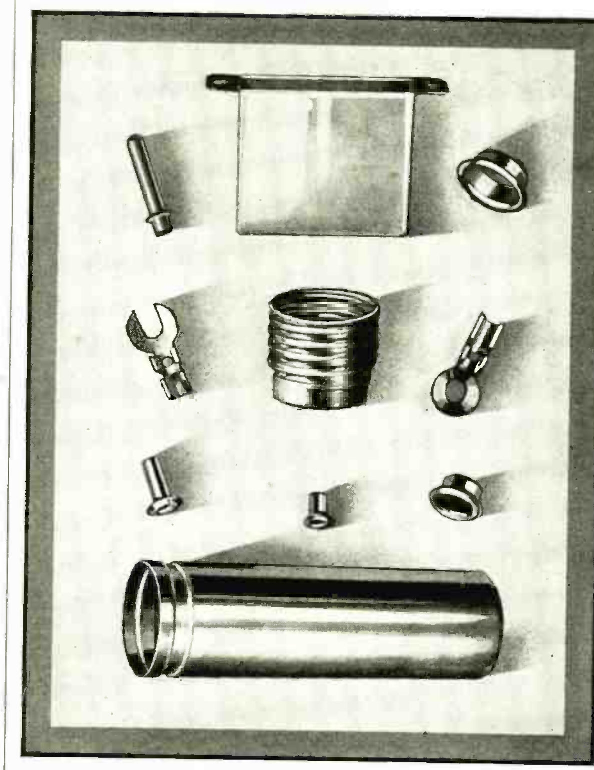

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RADIO ENGINEERING

FOR MARCH, 1935

# OSCILLATOR PADDING

By HANS RODER

General Electric Co., Bridgeport, Conn.

## I—INTRODUCTION

IN A SUPERHETERODYNE receiver with single dial control, a constant frequency difference between the radio frequency and the frequency of the local oscillator must be maintained. This problem of tracking two tuned circuits has been solved in three different ways:

1—Both circuits have the same inductance and identical straight-line-frequency condensers. The rotor of the variable condenser in the oscillator circuit is advanced by just as many degrees as to give the desired frequency difference.

2—The rotor plates of the oscillator variable condenser are shaped to give perfect tracking.

3—In r-f and oscillator circuit, variable condensers of the same type are used. Tracking is obtained by properly choosing the circuit inductance and by adding fixed capacitors.

The third, or padding method, is most widely used in practice because it is cheap, relatively easy for adjustment on the assembly line and yet gives sufficiently good results.

It is a rather tedious procedure to determine experimentally the circuit elements for padding the oscillator circuit. Computing these magnitudes in advance will result in saving of time and labor. This problem has received the attention of various authors and both mathematical[1] and graphical[2] solutions have been published in the past.

In what follows, a new method is given which is quite simple and yet more generally applicable than the ones just mentioned.

## II—DISCUSSION OF THE OSCILLATOR CIRCUIT

The oscillator circuit usually consists of a fixed inductance and a variable capacitor in combination with two or more fixed capacitors. If L denotes the inductance in the r-f circuit, mL shall be the inductance in the oscillator circuit, with m being in most cases smaller than 1. The variable capacitors $C_v$, in both r-f and oscillator circuit shall be equal, the term "equal" meaning that equal increments in rotor position shall correspond to equal increments in capacity. The characteristic "dial versus capacity" is of no interest in connection with our problem.

Two widely used arrangements for superheterodyne oscillator circuits are those shown in Figs. 1 and 2, each having two fixed capacitors in addition to mL and $C_v$. A more general type of circuit is that shown in Fig. 3, wherein we have three fixed capacitors in combination with mL and $C_v$. It is readily seen that the circuits of

**● A COMPLETE DISCUSSION OF THE PROBLEM OF "PADDING" IS GIVEN, INCLUDING ANY TYPE OF PADDING CIRCUIT WHICH POSSIBLY MAY BE USED. FOR THE SOLUTION OF THE PROBLEM A NEW, SIMPLE METHOD IS DERIVED, SUITABLE FOR GRAPHICAL OR MATHEMATICAL EVALUATION. THE APPLICATION OF THE METHOD IS SHOWN ON WORKED-OUT EXAMPLES.**

[1]A. L. M. Sowerby: "Ganging the Controls of a Superheterodyne Receiver," The Wireless Eng. and Exp. Wireless, 9, 70, 1932 (Feb.).

V. D. Landon and E. A. Sveen: "A Solution of the Superheterodyne Tracking Problem," Electronics, August 1932, pg. 250.

Technical Discussion: No. UL8 of Oct. 9, 1934; RCA-Radiotron Co.

[2]B. F. McNamee: "The Padding Condenser"—Electronics. May 1932, pg. 160.

Fig. 1 and Fig. 2 are only special cases of the circuit in Fig. 3.

In an attempt to find another arrangement with one more "degree of freedom," let us take, for instance, the circuit of Fig. 1 and add a new series capacity, $C_4$ (Fig. 4a). This circuit seemingly differs from any of the preceding ones. In reality, however, we have not ob-

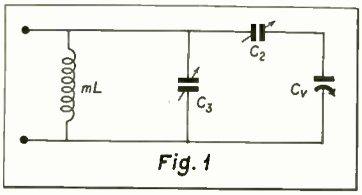


Fig. 1

TYPICAL OSCILLATOR CIRCUIT; SPECIAL CASE OF FIG. 3 WITH $C_1 = 0$.

tained any new features because it is well known that the "star" formed by the capacities $C_2$, $C_3$ and $C_4$ in Fig. 4a, is equivalent to the "delta" connection $C_1'$, $C_2'$ and $C_3'$ in Fig. 4b, which in turn is the same as Fig. 3. For the proof of this identity and for star-delta conversion formulas the reader is referred to the standard text books on transmission systems[3].

Next, let us insert a second series capacity $C_4$ into the circuit of Fig. 3. We obtain Fig. 5a. The same star-delta conversion as before yields Fig. 5b, which is identical with Fig. 3.

Any other attempt will yield the same result. No matter how many fixed capacitors we insert into the network or at what places we put them, we find that the resulting circuit is still identical with that of Fig. 3. (This holds, of course, only as long as we do not add a

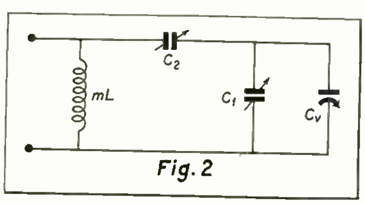


Fig. 2

TYPICAL OSCILLATOR CIRCUIT; SPECIAL CASE OF FIG. 3 WITH $C_3 = 0$.

second inductance or a second variable capacitor. Also the capacitor lead inductances must be negligibly small.)

Hence, we have to consider only one fundamental circuit in our problem: the circuit shown in Fig. 3. This circuit covers any possible arrangement whereby only one fixed inductance and only one variable capacitor is used, the variable capacitor being ganged to and equal to the variable capacitor in the r-f circuit.

## III—THE PROBLEM

Between the radio frequency $f_r$, the oscillator frequency $f_{osc}$ and the intermediate frequency $f_o$, the relation exists:

$$f_{osc} = f_r + f_o \quad \text{.......} (1)$$

i.e., the oscillator frequency is, in practical cases, always chosen to be larger than the radio frequency. If we measure

f in kc
L in microhenries
C in micromicrofarads,

then we have with regard to the r-f circuit,

$$f_r^2 = \frac{253.3 \,.\, 10^8}{L\ C_r} \quad \text{.......} (2)$$

In order to facilitate the line-up of the circuits, it is common practice to build up the r-f circuit capacity by a rotary condenser, $C_v$, and a trimmer capacitor, $C_o$, in parallel (Fig. 6). Thus,

$$C_r = C_o + C_v.$$

The corresponding relation for the oscillator circuit yields:

$$f_{osc}^2 = \frac{253.3 \,.\, 10^8}{mL\ C_{osc}} \quad \text{.......} (3)$$

By $C_{osc}$ we denote the total resulting capacity on the right-hand side of the terminals u-w in Fig. 3. m is a pure numeric; it indicates the ratio between the inductances in r-f and oscillator circuit.

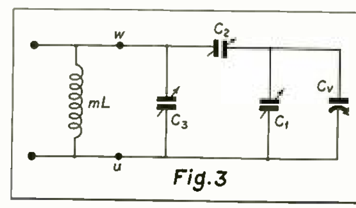


Fig. 3

OSCILLATOR CIRCUIT; GENERAL CASE, EQUIVALENT TO FIGS. 1 AND 2.

For reasons of simplification we introduce two new variables by putting,

$$x = C_r = \frac{253.3 \,.\, 10^8}{L f_r^2} \quad \text{.......} (4)$$

$$y = \frac{1}{m\ C_{osc}} = \frac{f_{osc}^2\ L}{253.3 \,.\, 10^8} \quad \text{.......} (5)$$

Substituting these magnitudes into equation (3) we obtain,

$$y = \frac{1}{m\ C_{osc}} = \frac{L f_{osc}^2}{253.3 \,.\, 10^8} = \frac{L}{253.3 \,.\, 10^8} \left[ f_o + \sqrt{\frac{253.3 \,.\, 10^8}{L\ x}} \right]^2 \quad \text{.......} (6)$$

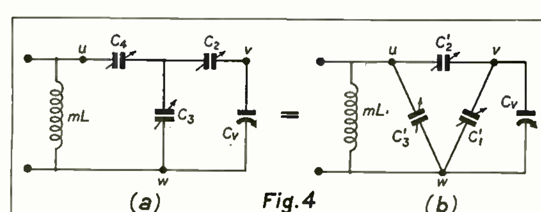
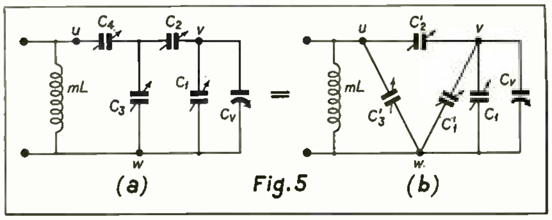


Fig. 4

THE CIRCUITS (a) AND (b) ARE EQUIVALENT.

[3] T. E. Shea: "Transmission Networks & Wave Filters," D. Van Nostrand Co., New York, 1929. Chapter III, section 23.

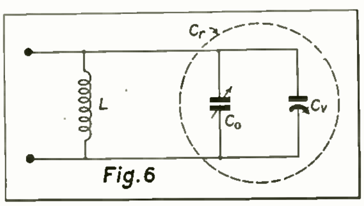



THE CIRCUITS (a) AND (b) ARE EQUIVALENT.

If we plot x versus y, the curve of Fig. 7 will result. The curve has two branches, P and N, the branch P referring to positive values of $f_r$, and the branch N referring to negative values of $f_r$. Of course, only branch P has physical significance. The shape of branch P resembles that of a rectangular hyperbola, the asymptotes being $x = 0$ and $y = Y' = L\ f_o^2/253.3 \cdot 10^8$.

We note that equation (6) represents the relation which ought to exist between $C_r$ and $C_{osc}$ (or x and y, respectively) in order to maintain *perfect* tracking. Hence, let us call branch P as represented by equation (6) the *"ideal tracking curve."*

In practice, however, $C_{osc}$ is the resulting capacity of




R-F CIRCUIT, WITH FIXED AND VARIABLE CAPACITOR.

the capacity network shown in Fig. 3. This capacity can readily be computed. It is found

$$C_{osc} = C_3 + \cfrac{1}{\cfrac{1}{C_2} + \cfrac{1}{C_1 + C_v}} = \frac{(C_1 + C_v)\ (C_2 + C_3) + C_2\ C_3}{C_1 + C_2 + C_v}$$

Because $C_o + C_v = C_r = x$, this resolves into,

$$y = \frac{1}{m\ C_{osc}} = \frac{c + x}{a + xb} \qquad \ldots\ldots (7)$$

where

$x = C_r$

$a = m\ (C_{10}\ (C_2 + C_3) + C_2 C_3)$ ..............(8)

$b = m\ (C_2 + C_3)$ ..............(9)

$c = C_{10} + C_2$ ..............(10)

$C_{10} = C_1 - C_0$ ..............(11)

Equation (7) yields what values of $C_{osc}$ may be attained in case a tracking circuit of the type drawn in Fig. 3 is used. Hence, equation (7) can be termed the *"obtainable tracking curve."*

We can readily find out what type of curve equation (7) represents. Equation (7) can be written,

$$y = \frac{c + x}{a + xb} = \frac{1}{b} + \left(c - \frac{a}{b}\right) \frac{1}{a + bx}$$

and this, if re-arranged, becomes

$$\left(x + \frac{a}{b}\right) \left(y - \frac{1}{b}\right) = \frac{c\ b - a}{b^2}.$$

This equation represents a rectangular hyperbola of the type

$(x - X)\ (y - Y) = K$ ..............(12)

whose center has the ordinates X and Y (Fig. 8). The auxiliary magnitudes X, Y and K are related to the magnitudes in equations (8), (9) and (10) as follows:

$$X = -\frac{a}{b} = -\frac{C_{10}\ (C_2 + C_3) + C_2\ C_3}{C_2 + C_3} \qquad \ldots\ldots (13)$$

$$Y = \frac{1}{b} = \frac{1}{m\ (C_2 + C_3)} \qquad \ldots\ldots (14)$$

$$K = \frac{cb - a}{b^2} = \frac{C_2^2}{m\ (C_2 + C_3)^2} \qquad \ldots\ldots (15)$$

Now, the problem can be clearly specified: In order to make $f_{osc}$ as nearly as possible equal to the required value (as defined in equation (1) ), we have to determine the magnitudes X, Y and K such that, for the desired frequency range, the hyperbola equation (12), will coincide as nearly as possible with branch P of the "ideal tracking curve," Fig. 7.

Let us first consider what type of solution we may expect for this problem. One fact is immediately evident: The ideal tracking curve (equation (6) ) and the obtainable tracking curve (equation (12) ), can never completely coincide, simply because branch P is not a rectangular hyperbola. However, it is possible to locate the hyperbola so that it has one or more points in common with branch P. A little consideration of Figs. 7 and 8 shows the following possibilities:

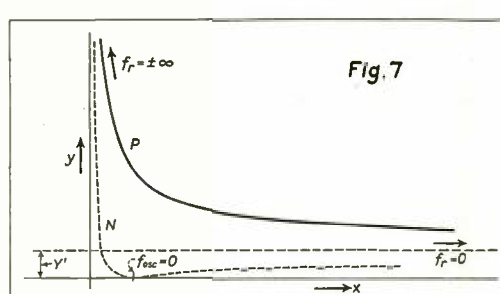
(1) $X > 0;\ Y < Y'$
Only 1 common point is possible

(2) $X > 0;\ Y > Y'$
Either 0 or 2 common points

(3) $X < 0;\ Y < Y'$
Either 0 or 2 common points

(4) $X < 0;\ Y > Y'$
Either 1 or 3 common points

Thereby it is proved that with the "padding" method *perfect tracking is possible at not more than three frequencies,* even under optimum conditions. As has been shown in section 2, this holds for any type of "padding"




CURVE P REFERS TO POSITIVE VALUES OF $f_r$ AND CURVE N TO NEGATIVE VALUES OF $f_r$.

circuits, provided the variable capacitors in oscillator and r-f circuit are equal.

## IV—SOLUTION

### (a) Graphical Method

We select three frequencies suitably distributed over the desired frequency band, and determine the corresponding values of x and y (equations (4) and (5) ). Plotting x versus y yields the points $F_1$, $F_2$ and $F_3$ (Fig. 9) of the "ideal tracking curve." We have now to construct a hyperbola which passes through these points.

This is most readily done by drawing the lines R and S as shown in Fig. 9. Their intersection point, 0', is the center of the hyperbola. Hence, the auxiliary magnitudes X and Y are known, if 0' is determined.

The proof for this method is simple. From geometry, the following law is known: "Those sections on the secant of a hyperbola, which are located between the curve and both its asymptotes, are equal." Hence, with reference to Fig. 9

Distance $a_1 F_1 =$ distance $a_2 F_2$

and, if a is bisecting $F_1 F_2$, then

$$a_1 a = a_2 a$$

Because the asymptotes are at right angles, the line R which connects a and $a_{12}$ represents a geometric locus for the center point 0'. Line S is obtained as a second geometric locus if the same procedure is followed through with respect to points $F_2$ and $F_3$. 0' results as intersection point between R and S.

### (b) Arithmetical Method

If it is desirable to have greater accuracy than obtainable by the graphical method, the magnitudes X and Y can be readily computed. One has to write down the equations for the lines R and S and then to solve for the coordinates of their intersection point. This is a simple problem of analytic geometry, the result of which is

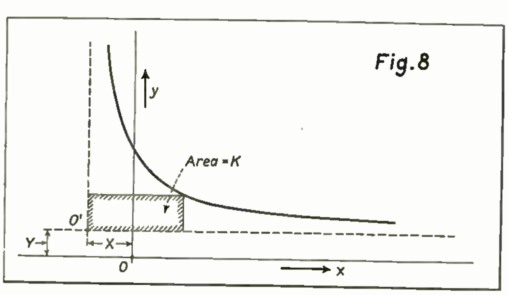
$$X = \frac{y_2 - y_3 + x_2 \tan S - x_1 \tan R}{\tan S - \tan R} \quad \ldots\ldots\ldots (16)$$

$$Y = \frac{y_1 \tan S - y_3 \tan R}{\tan S - \tan R} \quad \ldots\ldots\ldots (17)$$

with

$$\tan R = \frac{y_1 - y_2}{x_2 - x_1}$$

$$\tan S = \frac{y_2 - y_3}{x_3 - x_2}$$




TRACKING CURVE.

### (c) Determining the Unknown Capacities

With X and Y being known, K follows from any one of the equations (equation (12) ):

$$\left.\begin{array}{l}(x_1 - X)\ (y_1 - Y) = K \\ (x_2 - X)\ (y_2 - Y) = K \\ (x_3 - X)\ (y_3 - Y) = K\end{array}\right\} \ldots\ldots\ldots (18)$$

Each equation should yield the same value for K, a fact which may serve to check the accuracy of the drawing or calculation, respectively.

After knowing the values of X, Y and K, equations (13), (14) and (15) can be solved for the unknowns $C_{10}$, $C_2$, $C_3$ and m. We obtain

$$C_2 = \frac{1}{Y}\sqrt{\frac{K}{m}} \quad \ldots\ldots\ldots (19)$$

$$C_{10} = C_1 - C_0 = -X + \frac{1}{Y}\left\{K - \sqrt{\frac{K}{m}}\right\} \ldots\ldots (20)$$

$$C_3 = \frac{1}{Y}\left\{\frac{1}{m} - \sqrt{\frac{K}{m}}\right\} \ldots\ldots\ldots (21)$$

#### Case 1

Circuit of Fig. 1, $C_1 = 0$.

From the preceding equations (for $C_0$ see Fig. 6):

$$C_{10} = -C_0$$

$$C_2 = \frac{K + Y(-X + C_0)}{Y}$$

$$C_3 = \frac{-X + C_0}{K}(K + Y(-X + C_0)) \quad \ldots\ldots (22)$$

$$m = \frac{K}{(K + Y(-X + C_0))^2}$$

#### Case 2

Circuit of Fig. 2, $C_3 = 0$

$$C_2 = \frac{K}{Y}$$

$$C_{10} = -X \quad \ldots\ldots\ldots (23)$$

$$C_1 = -X + C_0$$

$$m = \frac{1}{K}$$

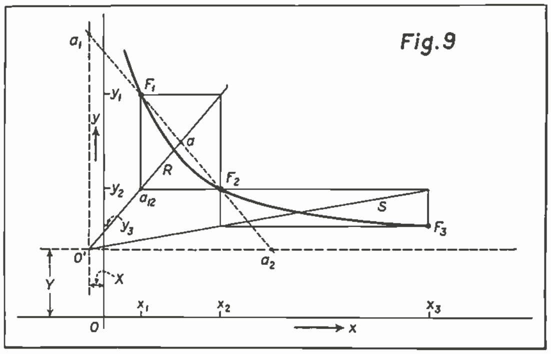
#### Case 3

Circuit of Fig. 3.

In this case we have four unknowns—$C_1$, $C_2$, $C_3$ and m—but only three equations (13, 14 and 15). Hence, one of the unknowns can be chosen arbitrarily.

a.—If the magnitude of the oscillator circuit inductance is *given*—i.e., *the factor m*—then $C_1$, $C_2$ and $C_3$ can be determined from equations (19) to (21).

b.—In practice, however, the capacity $C_3$ is usually a given magnitude, being determined by the distributed capacity of the oscillator inductance. This capacity can be measured or estimated. Hence, *with $C_3$ being known,* we have to solve equation (21) for m. This yields a quadratic equation for m, of which only the negative sign of the root is of interest. For reasons of greater accuracy the result is best written in form of a power series:




TRACKING CURVE.

$$m = \frac{1}{K}(1 - v) \quad \ldots\ldots(24)$$

where

$$v = \frac{3}{6}u - \frac{3.5}{6.8}u^2 + \frac{3.5.7}{6.8.10}u^3$$

and

$$u = \frac{4\,C_3Y}{K}.$$

From equation (20)

$$C_{10} = -X - \frac{K}{Y}\,\frac{v}{2}\left\{1 + \frac{3}{4}v + \frac{3.5}{4.6}v^2 + \frac{3.5.7}{4.6.8}v^4 + \right\} \ldots\ldots(25)$$

From equation (19)

$$C_2 = \frac{1}{Y}\sqrt{\frac{K}{m}}$$

From equation (11)

$$C_1 = C_0 + C_{10}$$

## V—EXAMPLE

The application of the method is best shown by working out an example:

| | | |
|---|---|---|
| Given: | Frequency range | = 500-1500 kc |
| | Tracking frequencies chosen | = 600, 1000 and 1400 kc |
| | R-F circuit inductance | = 200 microhenries |
| | R-F circuit trimmer capacity $C_0$ | = 30 micromicrofarads |
| | Intermediate frequency | = 175 kc. |

| | $f_r$ | $f_{osc}$ | x | y |
|---|---|---|---|---|
| (1) | 1400 | 1575 | 64.5 | $1.950.10^{-2}$ |
| (2) | 1000 | 1175 | 126.6 | $1.085.10^{-2}$ |
| (3) | 600 | 775 | 351.5 | $0.472.10^{-2}$ |

x and y from equations (4) and (5), respectively. The graphical method (Fig. 9) yields:

$X = -6$ micromicrofarads
$Y = 0.112.10^{-2}$ 1/ micromicrofarads

Formulae (16) and (17) yield:

$X = -5.07$
$Y = 0.1127.10^{-2}$

From (18): $K = 1.28$.

*For the circuit of Fig.* 1 (*equation* (22) )

$C_2 = 1172$ micromicrofarads
$C_3 = 36.2$ "
$C_1 = 0$ "
$m = 0.733$

*For the circuit of Fig.* 2 (*equation* (23) )

$C_2 = 1136$ micromicrofarads
$C_{10} = 5.07$ "
$C_1 = 35.07$ "
$C_3 = 0$ "
$m = 0.781$

*For the circuit of Fig.* 3 (*equations* (24), (19), (20) )

Assume $C_3 = 15$ micromicrofarads

$$u = \frac{4\,C_3Y}{K} = 0.0528$$

$m = 0.761$
$C_2 = 1150$ micromicrofarads
$C_{10} = -9.73$ "
$C_1 = 20.27$ "

## I.R.E. SPONSORS RADIO PROJECT

THE REQUEST of the American Institute of Electrical Engineers to withdraw as one of the sponsors of the project on Radio has been granted by the Electrical Standards Committee, the sole sponsorship being given to the Institute of Radio Engineers.

In explanation of its request the A.I.E.E. pointed out that for quite some time the I.R.E. had handled in a satisfactory manner practically all the work of the committee. The Chairman of the E.S.C. expressed the appreciation of that group for the excellent spirit of cooperation shown by the A.I.E.E. in this matter, as well as in improving electrical standardizations generally.

The committee on Radio has developed the American Standard Vacuum-Tube Base and Socket Dimensions, and the American Standard Manufacturing Standards Applying to Broadcast Receivers. This committee is now concerning itself with the Standard Tests of Broadcast Radio Receivers, and Standard Definitions of Terms used in Radio.

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## ESTONIAN RADIO MARKET

THE LATEST TENDENCY in the Estonian market, according to the *Electrical Foreign Trade Notes,* No. 352, December 24, 1934, has been toward small, low-priced sets. As a result, the principal points of interest at the Sixth Estonian Radio Show held last fell in Tallinn were these small sets, both of domestic and foreign manufacture. This so-called popular class of radios was represented by locally made 2-and-3-tube sets, with either dynamic or magnetic speakers, within the price range of 80 to 120 krooni ($22 to $33). The next class of sets, apparently considerably less in demand, was of 4 and 5 tubes, priced from about 160 to 360 krooni ($43 to $99). These latter units were mostly of domestic manufacture, though in this class, too, several foreign manufacturers competed. Luxurious radio sets were almost completely absent from the show, there having been only 3 console models with phonograph attachments exhibited and one of these was American with locally built cabinet.

The United States was represented at the Tallinn show through several local dealers. In all seven makes of American radios were on display, mostly 5-tube superheterodyne sets, within the price range of 160 to 300 krooni. Dealers state that a very good demand exists for these American sets, the domestic and competing foreign sets of approximately equal quality being somewhat higher priced.

One dealer also exhibited American radio tubes, for which he stated there was an increasing demand. The only other exhibit of radio tubes at the show was displayed by Philips.

# Tube Metal Processing

**By L. L. McMASTER, JR.**
ENGINEER

● **THE SUCCESSFUL USE OF NEW TUBE METAL DEPENDS ON THE DEPARTURE FROM ORTHODOX MANUFACTURING PROCEDURE. ONCE ACCOMPLISHED, RESULTS MORE THAN REPAY DEVELOPMENT COSTS.**

IN A COMPARATIVELY short period, Svea metal has been widely adopted as an ideal material for use in electronic devices where a gas-free metal is essential. In this country, eight of the more important tube manufacturers have adopted this material, as well as makers of electronic devices in Canada, Europe, South America, Asia and Australia.

While largely used in radio receiving tubes it is readily adapted to use in power rectifiers, transmitting tubes, cathode-ray tubes, photocells, X-ray tubes and lamps.

Due to pressure of routine and production demands, proper development is often difficult for factory engineers. The usual procedure on factory process testing is to run tests in pairs, the material under test with a control test of regular work, and all processing done as for the regular material. If results do not measure up to the regular product the testing is discontinued. In the case of Svea metal, this procedure may be compared to thinning Duco with linseed oil or paint with a lacquer solvent merely because both paint and lacquer are primarily intended for the same purpose.

The points in processing in which Svea metal procedure varies from previous experience are cleaning, firing, parts handling, bombarding and lighting. In any of these stages, following customary procedure may or may not be detrimental to test results depending on the methods regularly employed and which offer an extreme degree of variation in the industry.

### GAS IN METALS

Before attempting to run tests, let us consider those properties held to be ideal in a metal for vacuum tube use. Of these properties probably the most important is freedom from gas. This should not be thought of merely in terms of gas held in the pores of the metal, but also as bubbles of gas trapped in the ingot. When the material is rolled into strip form these bubbles act in a manner similar to glass tubing. No matter how far the glass is drawn the tube is always hollow. This is true with metal, and bubbles thus trapped may show up only through gassy tubes and not through any preliminary test. Frequently lots of tube metal are rejected because gassy tubes result from its use, though to all appearances the metal is perfect but contains extremely fine gas pockets or "pipes" as they are termed. Due to the refining process used, pipes are definitely eliminated in Svea metal and since the perfection of the process there has never been a lot of material found to contain gas.

Winding tube grids in factory of Hygrade Sylvania Corporation.

The other source of gas in metal is that held in the pores of the metal either through absorption or adsorption. The amount of gas held in this manner depends on the physical structure of the metal. Svea metal has an extremely fine crystalline structure and is so gas-free that firing as a degassing process is unnecessary. Correct processing will not disturb the structure of the metal so as to lose the properties it possesses.

In planning a test schedule, the more positive results will be obtained if a use is chosen which does not call for a major change in equipment or schedules. In general it may be said that uses where the metal is not a direct receiver of electrons are less critical to processing factors, such as bombarding and lighting. That is to say, Svea metal parts do not require special attention as to bombing temperature and that usual heats will do little harm even though exceeding recommended temperatures by as much as 250 degrees Centigrade on all parts except primary plates. For the purpose of discussion types 58 and 30 will be considered. These types are representative of the cathode type r-f pentode and filament type triode and have been easily run with Svea parts. While the 30 plate is a direct receiver of electrons it has been chosen because of the fact that, while usually one of the more difficult to process, a substantial increase in emission and longer life has been observed in this type through proper processing of Svea plates.

## PREPARATION

The cleaning process recommended is widely used for any tube material. Either trichlorethylene, or a mixture of the dichlor and trichlorethylene, is quite satisfactory. Carbon tetrachloride in very small quantities will have a very harmful effect on emission and regardless of the solvent used, the parts should be very thoroughly dried before entering a firing or oxidizing chamber. A satisfactory solvent is a petroleum distillate available on the market, which has a high flash point, is very inexpensive and is an excellent grease solvent, though completely volatile and inactive chemically on the metal.

When thoroughly dry, the parts may be hydrogen fired, though this has been found unnecessary, but is required for other materials due to the fact that the metal is porous and must be flushed to eliminate gas harmful to emission. When fired in hydrogen the temperature should never exceed 800 degrees Centigrade or a grain growth will result which causes the metal to be porous, thus losing its chief advantages over other materials. For surface cleaning, 500 degrees is ample.

Oxidation serves a two-fold purpose —it acts as an excellent radiator of heat in finished tubes and makes a surface very resistant to corrosive atmospheres and gas adsorption. Since Svea metal absorbs its oxides when red hot, there is no reduction of the oxide during life. The most suitable oxide may be obtained by heating the parts at 475 degrees Centigrade with air circulating through the heated chamber. A satisfactory oxidation will not chip with bending and will be a uniform blue-gray in color. Degreasing parts before oxidizing is unnecessary as oil will burn off readily if the air supply is sufficient. In the case of small parts, such as mica straps, oxidation is best accomplished by heating the parts in a hydrogen furnace at 500 degrees Centigrade for one minute at that temperature and removing the parts, allowing a slow cooling in air. This also tends to soften the metal, permitting easy forming.

If circumstances require storing of parts, the following simple rules cover this phase of the handling: Bright parts should be lightly oiled and boxed with a reasonably tight cover. Waxed or glazed paper should line the box to prevent contact with any sulphite cardboard. Oxidized parts do not require oil, though a liner should be used in the box. Properly fired or oxidized parts may stand for a considerable period without fear of absorbing gas. Oxidized parts have been exposed to the atmosphere, unprotected, for ninety days and when made into tubes, showed no harmful effect on emission or life. Refiring of parts is eliminated. Some concerns prefer bright metal, oxidizing only those parts which show signs of corrosion from exposure to a humid atmosphere.

Testing tubes in factory of RCA Radiotron Division, RCA Manufacturing Company, Inc.

## BOMBARDING

The vital point in processing is bombarding. While the usual procedure at this point is to bomb from 900 degrees Centigrade to 1,150 or all the material will stand, it is vitally important that bombing temperatures do not exceed 825 degrees Centigrade on primary plates, or 875 on other Svea parts. For top shields, 750 to 800 is all that is required, while on screen types the cage may go as high as 875 to 900 provided the plate does not exceed 825 degrees. One of the outstanding advantages of Svea metal is that in bombarding the equilibrium heat is reached almost instantly. This, in combination with the higher conductivity of the metal, tends to simplify bombing of the more difficult parts, such as 25Z5 plates. The use of a basket type bomber coil will greatly facilitate this phase of processing.

In changing bombarder settings it should be considered that, when oxidized Svea metal is replacing a bright material, the increased radiation will usually lower the plate temperature sufficiently. Results of tests in several plants indicate that the radiation properties of the oxidized material compare very favorably with carbonized surfaces at practically three times the cost.

A point too important to pass without consideration is that of bombing positions on the exhaust schedule. Present schedules have been found satisfactory through experience, yet frequently a change in bombing positions tends to help conditions of low emission or gas. While bombing is a degassing process it does not necessarily mean ridding the material of gas absorbed by the parts from exposure to the atmosphere between firing and exhaust. It must also keep the parts at a temperature sufficient to prevent absorption of gas from breakdown of the carbonates throughout the exhaust schedule when a porous material is used. This is especially true with carbonized parts as the carbon is frequently activated during processing making the degassing difficult.

In the case of Svea metal, experience has shown that a change from routine bombing schedules will be to advantage. The necessity for bombing throughout the schedule is greatly reduced, due to the fact that the material is initially more free of gas and less likely to absorb gas at any stage during processing provided the recommended temperatures are not exceeded. Generally speaking the bombing should be either before, or during, early stages of the breaking down of the cathode coating. This is particularly true in the case of triodes. A study of the schedules which follow will aid in adjusting present bombing conditions.

## LIGHTING

With regard to lighting schedules, it is difficult to suggest changes without knowledge of those in use previous to tests. There are two general methods, each held in favor by engineers and producing very satisfactory results. Some prefer to cause early breakdown through high lighting in the first positions, while others prefer a gradual stepping-up of the filament current with more lighted positions. In the final analysis it is the results which count and in either case may be attributed to the particular type of coating applied. One factor on which all will agree is, that heat radiated from the plate during bombing has a definite part in the breakdown process. If the plate is cooler by approximately 200 degrees Centigrade during this process, the heat required for the reaction must come from the cathode itself. In view of this fact, it is recommended that attention be paid to increasing the filament lighting to compensate for the loss of heat by radiation from the plate. This does not necessarily mean an excessively high current at any particular position, and as a matter of fact the addition of one or two extra positions at approximately 75 percent of rated filament current will not only achieve the desired results but will make the entire schedule more flexible. Engineers familiar with Svea metal have obtained the best results through avoiding high lighting positions and in many cases have obtained excellent results with a maximum filament input only 75 percent of that required in previous schedules.

Frequently the aging schedules may be altered to advantage. Very efficient schedules have been devised through the use of a test kit on which standard aging voltages are obtainable and tried with variable loads under different filament voltage and time conditions. It has been found that aging time may often be shortened and that tubes practically gas-free before aging will be produced through proper processing of Svea metal. *In all events, preliminary tests on Svea metal should be read for gas and emission before and after aging if the highest emission is to be obtained.* Emission the equal of, and as much as 25 percent higher than, regular production should be easily obtainable in many cases.

The emission behavior is apt to vary from that found in past production. Life tests show a tendency to drop approximately 25 percent in emission from the initial reading fairly early, though this value will hold throughout a longer period than usual production. This long steady life will be observed on production tubes showing average but satisfactory emission due to improper bombing. By some this is regarded as an excellent control on the factory, as carelessness in setting bombing temperatures will immediately show up at testing though the life will not be appreciably affected.

#### SCHEDULES

While schedules satisfactory to one exhaust system may not prove so on another, the following should give very favorable indications on preliminary tests. Once the knowledge of correct Svea metal processing has been acquired, it may readily be used in conducting tests on a broader scale.

In the case of a triode, let us consider the type 30. This tube is regarded as one of the more difficult to process but has been produced on a production basis with very high emission and very satisfactory 1,000-hour life with both oxidized and bright Svea metal plates. In setting up this schedule, only two bombing positions are required and it is recommended that bombing be completed before lighting the filament. It is advisable to skip a position between bombings, which should not exceed a temperature of 825 degrees Centigrade. Three lighting positions at approximately .100 ampere should give sufficient breakdown. Lighting during the flashing position is unnecessary. In aging, a brief flash at approximately 75 percent increase in the filament voltage is helpful but the last step should be with the filament running close to rating. Emission at 30 volts should average 50 mils.

The 58 is usually slightly more difficult. However, with Svea metal parts, bombing is made a fairly simple problem. The plate should not exceed 825 degrees Centigrade and the top shield may be satisfactorily degassed from 725 to 850 degrees, depending on the temperature reached while the plate is reaching the correct temperature. Three bombing positions are sufficient and may be the initial lighting positions, provided the current to the filament does not exceed the rating by more than 40 percent. Lighting after bombing may be at 1.60 amps for four positions. Normal aging will probably be satisfactory if a flash position starts the schedule. Emission at 50 volts should average 175 mils.

Svea metal may be used for plates, top shields, top and bottom collars, cages, diode plates, getter cups, eyelets, mica strapping and grids. In addition to major uses, Svea metal offers many advantages for minor parts and when so used has no effect on tube processing. The oxidized material makes an excellent material for grid radiators on power tubes. Its use for connectors and getter cup supports should be considered from the fact that the material does not crystallize when welded.

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## RADIO CONDITIONS IN FRANCE

FRANCE APPEARS to have lagged somewhat behind the other large manufacturing countries in the use of radio and in making "listening" a popular pastime. The same is also true in the manufacture of receiving sets and component parts. During the last five months of the year, however, there has been a noticeable increase in listening interest in French homes, and the number of receiving sets in use has advanced from 1 in 70 to approximately 1 in 28 of the population.

There is little doubt that development was checked by the lack of legislation for the regulation of broadcasting prior to June, 1933. Since then, however, matters have improved. Previously, the local stations were not able to obtain a regular source of income from fees, etc., although paid publicity provided a source of revenue. Thus the various French broadcast stations have not been in a position to produce programs of the highest quality, and a large number of French listeners have had to tune in on foreign stations, notably British.

The net taxes which have been imposed on both receiving sets and tubes will be applied to financing broadcasting, and the State will add a small percentage to the total. The comfort of the listener has also been studied by the various French municipal authorities, who have made regulations compelling tramway companies, factory owners, and other users of industrial or domestic appliances to fit suitable devices for preventing interference with broadcast reception.

Imports of tubes and sets in France is estimated to be about 400-500 million francs per year.

Imports of tubes and sets into France exceed exports in quantity and value, and have gradually increased since 1928. In 1933 the value of imports in million francs was: Tubes, 45; sets, 69. The Netherlands was at one time sending more tubes into France than any other country. Now, however, United States and Germany are making large imports. As regards the United Kingdom, there is no doubt that progress was handicapped for some time by the quota system. Before the quota system was enforced, 75 percent of the French market was held by foreign manufacturers. Germany and the Netherlands together supply about 73 to 88 percent of the total imports of receiving sets.

Further, exports of both sets and tubes from France have declined considerably since 1929, but are now showing improvement. (*World-Radio*, London, Nov. 23, 1934.)

# Simplified Oscillators

## THE USE OF THE 57 OR 6C6 TO OBTAIN NEGATIVE TRANSCONDUCTANCE AND NEGATIVE RESISTANCE*

AMONG THE CIRCUIT combinations possible with three-grid tubes in which the connections to all three grids are brought out, one combination of particular interest produces a simple and reliable negative-resistance device. It is the purpose of this article to explain the operation of such a device utilizing the 57 or 6C6 and to give suitable operating conditions for these types. These types are particularly well suited for this application.

### OSCILLATION BY FEEDBACK

In vacuum tubes connected in the usual manner, a rise (change in positive direction) in control-electrode voltage causes a rise in anode current. With a resistive anode load, the anode voltage drops with a rise in anode current; thus, the grid-voltage change and the anode-voltage change are in exact opposition. In order to make oscillations possible, it is necessary to feed back energy from the anode circuit to the control-electrode circuit in such a way as to increase the controlling voltage. Since, with a resistive grid and a resistive plate circuit, the voltage changes in the two circuits are in opposition, it is not possible to provide feedback in a simple way. Ordinarily, either reactive circuits or magnetic coupling is used in the oscillator arrangement to adjust properly the phase of the voltage feedback from anode to control electrode. Both methods require a more complicated oscillator circuit than that required with simple two-terminal negative-resistance devices such as, for example, the Dynatron.

### NEGATIVE TRANSCONDUCTANCE

If the anode current of a tube could be made to decrease when the control-grid voltage is raised, the grid-voltage change and the plate-voltage change with resistive circuits would no longer be in opposition but would be in the proper relation to produce feedback effects. Such an arrangement would avoid the feedback complications of the ordinary oscillator, since only a large fixed condenser between the control electrode and anode is necessary to transmit anode-voltage fluctuations to the control electrode in proper phase. A tube in which the anode current drops when the control-electrode voltage rises has a grid-plate transconductance opposite in sign to that of the usual tube, and may therefore properly be described as a tube having negative grid-plate transconductance.

If the No. 3 grid (suppressor) of the type 57 or 6C6 is used as a control electrode and is made more negative, some of the electrons will be turned back toward the cathode; the plate current, therefore, decreases. See Fig. 1-A. The electrons which are turned back, however, are attracted by the positive voltage impressed on the No. 2 grid (screen), and pass to it so as to increase its current. If, then, the No. 2 grid be considered as the anode in place of the usual plate and the No. 3 grid be considered as the control electrode, the arrangement will have negative grid-plate transconductance. When a pentode is used in this fashion, the current which passes to the usual plate is not employed. This is similar to conventional applications where the screen current is not utilized. Although no mention has been made of the No. 1 grid, this grid does have a valuable function in the tube, because it can be used to control the total amount of cathode current and, therefore, the magnitude of the effect. In this respect, it is analogous to the function of the No. 1 grid in the Pliodynatron. In addition, it exerts a limiting action on the total current so that the No. 2 grid resistance is increased.

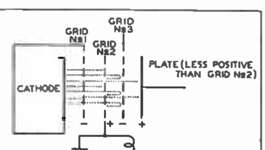


FIG. 1-A PATHS OF ELECTRONS IN A PENTODE WHEN OPERATED AS A NEGATIVE TRANSCONDUCTANCE TUBE

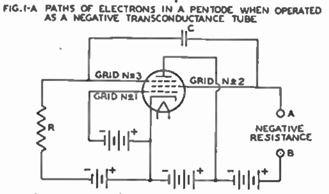


FIG. 1-B VOLTAGE-CONTROLLED OSCILLATOR CIRCUIT

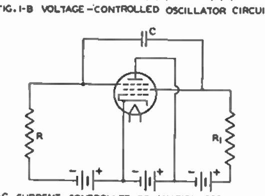


FIG. 1-C CURRENT-CONTROLLED RELAXATION OSCILLATOR CIRCUIT

**Illustration of negative transconductance operation, and two types of oscillator circuits.**

### CIRCUIT AND OPERATION

A circuit using the 57 in this manner to obtain a negative resistance is shown in Fig. 1-B. The No. 1 grid can, for simplicity in explaining the operation, be connected directly to the cathode. The usual plate is connected to a positive potential. The No. 3 grid is connected to the No. 2 grid through a large condenser, C. A suitable negative bias is applied to the No. 3 grid through the high-resistance grid leak, R. The negative resistance is exhibited between terminals A and B. The operation of the circuit is as follows:

An instantaneous rise in voltage across the terminals AB is transmitted by the condenser C to the No. 3 grid, which has its potential increase, thereby decreasing the No. 2 grid current. Since the No. 3 grid is biased negatively and draws no current, the total current in whatever circuit is connected to AB is determined only by the No. 2 grid current. It is, therefore, evident that the instantaneous rise in voltage across AB is accompanied by a drop in current. This is the characteristic of a negative resistance. From the explanation, it is seen that the negative resistance occurs only for variations in voltage which are rapid since, otherwise, the condenser C does not transmit the variations. A static characteristic taken on the arrangement shows no negative resistance, although the negative resistance is present for alternating voltages. As either the condenser C or the grid leak R is made

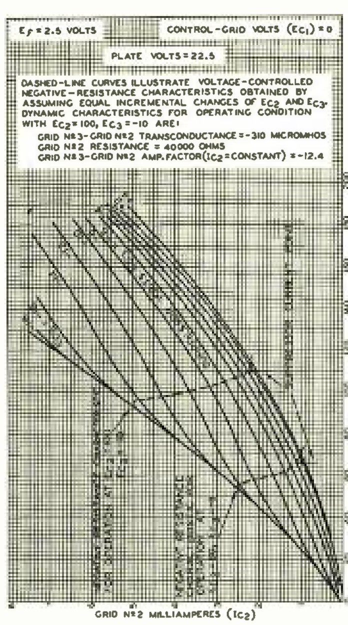
*A report from the Engineering Department, RCA Radiotron Division, RCA Manufacturing Co., Inc.

larger in value, the lowest frequency to which the circuit behaves as a negative resistance is made less. The condenser C and the grid leak R must be chosen in the same way as the coupling condenser and leak in a resistance-coupled amplifier, i.e., the condenser reactance must be small compared to the grid-leak resistance, to transmit satisfactorily the lowest frequency to be used.

The value of the negative resistance produced may be calculated as follows: When the instantaneous voltage on the No. 2 grid rises a small amount $\triangle E$, a rise in current $\triangle E/r_{g2}$ would be expected where $r_{g2}$ is the No. 2 grid resistance. At the same time, however, the condenser to the No. 3 grid permits its voltage to rise an amount $\triangle E$. This tends to lower the No. 2 grid current by an amount $s_{m3-2}\triangle E$. The effective resistance of the combination is represented by the change in voltage divided by the total change in current and is therefore given by:

Resistance $= \triangle E/\triangle I = \triangle E/(\triangle E/r_{g2} - s_{m3-2}\triangle E) = 1/(1/r_{g2} - s_{m3-2})$.

In the 57 and 6C6 tubes, $1/r_{g2}$ is much smaller than $s_{m3-2}$ under best operating conditions to produce negative resistance. The negative resistance produced is, therefore, approximately the reciprocal of the negative transconductance between the No. 3 and the No. 2 grids. The lowest negative resistance is thus found at the point having highest negative transconductance.




Typical "Grid No. 2" characteristics, to show performance as a negative transconductance tube.

## OPERATING CONDITIONS

Suitable operating conditions for a tube may be found by choosing a value for No. 1 grid voltage ($E_{c1}$), No. 2 grid voltage ($E_{c2}$) and plate voltage ($E_b$) to give a reasonable cathode current, and then by varying No. 3 grid voltage ($E_{c3}$) to find the point of maximum transconductance to the No. 2 grid. This value of $E_{c3}$ may then be used as the bias value.

Typical operating conditions for the two types of tubes are:

| | *Type* 57 | *Type* 6C6 |
|---|---|---|
| Heater Volts ($E_f$) | 2.5 | 6.3 |
| No. 1 Grid Volts ($E_{c1}$) | 0 | 0 |
| No. 2 Grid Volts ($E_{c2}$) | 100 | 100 |
| No. 3 Grid Volts ($E_{c3}$) | –10 | –10 |
| Plate Volts ($E_b$) | 22.5 | 22.5 |
| No. 2 Grid Milliamperes ($I_{c2}$)* | 4 | 4.1 |
| Plate Milliamperes ($I_b$)* | 2.9 | 2.4 |
| No. 3 Grid to No. 2 Grid Transconductance—micromhos ($s_{m3-2}$) | –320 | –280 |
| Negative Resistance Produced—ohms* | 3400 | 4000 |

*Approximate.

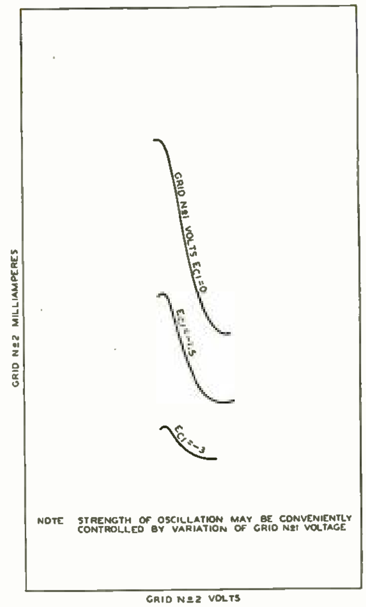
In addition to the operating conditions for the values given, the 57 and 6C6 may be operated over a wide range of voltages. For example, increasing $E_{c1}$ in the negative direction reduces the cathode current and increases the negative resistance. If $E_b$ is increased, $E_{c3}$ must be increased in the negative direction by approximately the same ratio in order to continue to operate at the center point of the negative-resistance characteristic. No improvement in operating characteristics is obtained by raising $E_b$. An increase in $E_{c2}$, though not advised from the point of view of tube life, will cause an increase in $s_{m3-2}$ and hence a decrease in the negative resistance.

The complete negative-resistance performance of a three-grid tube may be predicted from the No. 2 grid characteristic curves, i.e., the $I_{c2}$ vs. $E_{c2}$ curves for various values of $E_{c3}$ (holding $E_{c1}$ and $E_b$ constant) may be used to plot the dynamic characteristics. Such a set of characteristics is shown in Fig. 2 for a type 57 tube.

The dashed-lined curves indicate the dynamic negative-resistance characteristics to be expected at the terminals AB in Fig. 1-B when the frequency is sufficiently high to make the condenser reactance negligible as compared with the grid-leak resistance.

## PRODUCING OSCILLATION

In order to utilize the negative-resistance circuit for the production of oscillations, it is simply necessary to connect a parallel tuned circuit to the




**Representation of negative resistance characteristics for type 57 tube.**

terminals AB of Fig. 1-B. Variation of the No. 1 grid voltage provides a simple and convenient method of controlling the strength of oscillation. This is illustrated by the curve of Fig. 3. It should be pointed out that the advantages of simplicity, stability, and good wave-form obtainable with the Dynatron are all present in the negative-transconductance method. In addition, *the negative resistance produced does not depend on secondary emission* so that a degree of uniformity and reliability not ordinarily found in Dynatrons is present. The negative resistance produced is lower than that of most tubes used as Dynatrons when the same cathode current is permitted. This is an advantage, since the lower negative resistance permits oscillation with a higher-loss tuned circuit. At the same time, the total shunt capacitance of the tube, feedback condenser and leak may be made almost as small as that of most commercial tubes used as Dynatrons.

To give practical data on the advantages of the 57 and 6C6 tubes over the Dynatron method of obtaining negative resistance and to compare results with similar data taken on the 57 and 6C6 in the negative-transconductance circuit, measurements were taken on some type 24-A tubes used as Dynatrons. The results are presented briefly in Table I. The data were taken on 24-A tubes of present production having carbonized plates. The voltage conditions were adjusted to obtain approximately the same cathode current as that of the 57 and 6C6 tubes.

TABLE 1

| | Type 57 | Type 6C6 | Type 24-A (Dynatron-operated) |
|---|---|---|---|
| Mean Negative Resistance........ | 3400 ohms | 3900 ohms | 59000 ohms |
| Average Deviation from Mean.... | 8% | 3% | 44% |
| Maximum Deviation from Mean.. | 23% | 15% | 87% |

Although the 24-A tubes tested were extremely poor as Dynatrons because of the use of carbonized plates, it is believed that the variations between tubes as measured by the percentage deviations from the mean are typical. Thus, the use of a more suitable plate material might lower the negative resistance to an average of 20,000 ohms or so, but the variations between tubes expressed in percent would probably remain nearly the same for tubes chosen at random.

In most applications, a figure of merit for a negative-resistance device of the class in which the Dynatron and the negative-transconductance method fall is given by 1/CR where C is the total effective shunt capacitance, and R the negative resistance. On this basis, the 24-A's which have an effective capacitance of approximately 10 micromicrofarads would have a figure of merit of 1.7. If it is assumed that more suitable plate material could be used, this figure might be increased to 5. In the 57 or 6C6 circuit, the tube contributes about 12 micromicrofarads to the shunt capacitance and the external coupling condenser and leak may be caused to contribute as little as 6 micromicrofarads. The figure of merit is then approximately 15 or three times as great as the best figure given for the Dynatron.

LIMITATIONS

Electron transit-time effects limit the upper frequency at which the 57 or 6C6 will oscillate to approximately 20 megacycles. This limitation makes it impracticable to use these tubes as oscillators in all-wave receivers or at frequencies much above 15 megacycles. The negative-transconductance tube can, however, be used to advantage as a two-terminal oscillator in receivers, measuring devices, or other equipment in which the frequencies involved are lower than 15 megacycles. No tickler coils or taps are required for this type of oscillator. This is a feature which greatly simplifies the switching problem for apparatus employing more than a single frequency band, since but one switching terminal need be considered for each band; the other terminal can be connected permanently in the circuit.

Fig. 1-B shows how the 57 or 6C6 can be connected for use in a voltage-controlled negative-resistance oscillator in conjunction with a tuned circuit. This arrangement will produce sinusoidal oscillations. Fig. 1-C illustrates a relaxation-oscillation circuit using the 57 or 6C6 in a current-controlled circuit. For operation at small amplitudes, the oscillations are approximately sinusoidal.

# A-F CIRCUITS FOR AUTO RADIOS


By A. W. KEEN

Engineering Department, Hygrade Sylvania Corp.


THE WIDESPREAD use of the 41 in the output stage of automobile radios has given rise to detailed studies of efficient audio combinations utilizing this type of tube. In the more expensive receivers, designed to furnish more power output with a minimum of distortion, it is quite probable that the output stage may be operated as a push-pull arrangement. It is the purpose of this article to present detailed data on desirable audio combinations employing type 41 tubes in this manner.

| | CIRCUIT 1 Type 79 Phase Inverter | | CIRCUIT 2 Two Type 75's Phase Inverter | | CIRCUIT 3 Type 85 & Type 76 | |
|---|---|---|---|---|---|---|
| Output Milliwatts | Input | Distortion | Input | Distortion | Input | Distortion |
| 500 | .12 | 0.7 | .06 | 0.5 | .21 | 0.4 |
| 1000 | .18 | 1.0 | .09 | 1.2 | .30 | 0.6 |
| 1500 | .23 | 1.6 | .12 | 2.0 | .39 | 0.7 |
| 2000 | .27 | 2.5 | .14 | 2.6 | .45 | 0.8 |
| 3000 | .34 | 4.2 | .17 | 4.0 | .57 | 1.3 |
| 4000 | .42 | 6.6 | .21 | 5.6 | .68 | 2.0 |
| 5000 | .50 | 8.9 | .25 | 7.7 | .80 | 2.9 |
| 6000 | .60 | 10.0 | .29 | 10.5 | .94 | 4.3 |

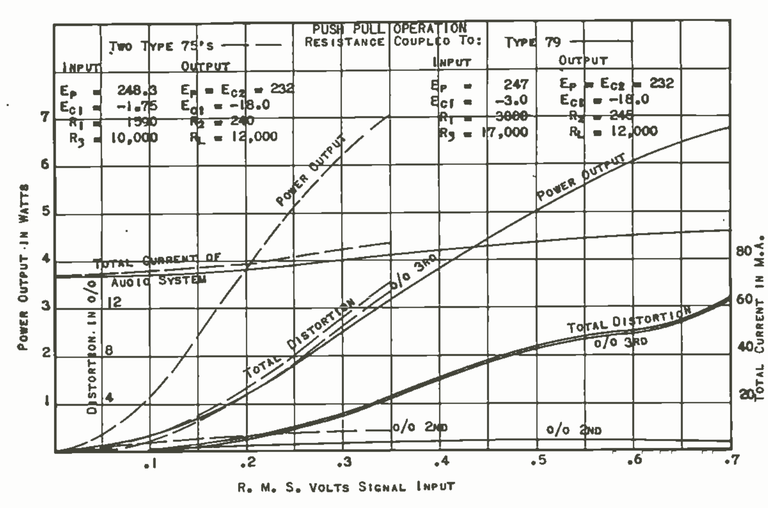



Fig. 1. Data on type 41 tubes in resistance-coupled push-pull circuits, in conjunction with two type 75's or a single type 79.

The audio systems are described and curves showing power output and distortion as a function of input signal volts to the initial audio tube are given for each combination. The coupling employed is either entirely resistance-coupling or a combination of this method with transformer-coupling to the output stage.

CIRCUITS AND RESULTS

The circuit diagrams in Fig. 2 indicate a type 79, with one section of the tube used as a phase inverter, resistance-

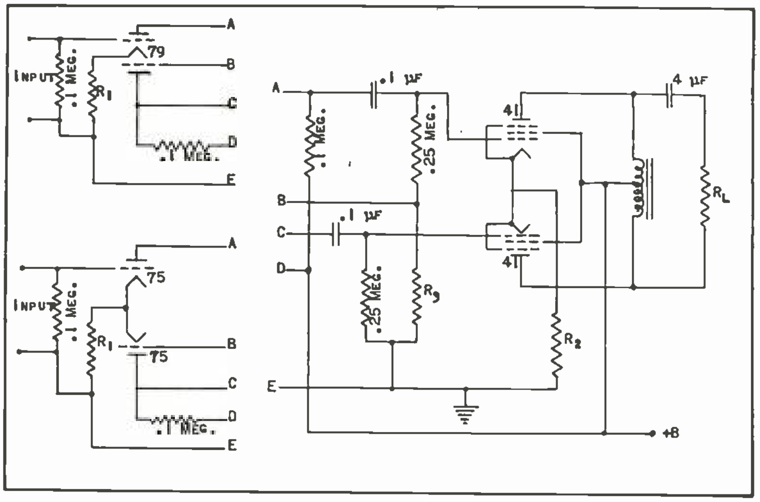



Fig. 2. Resistance-coupled push-pull circuit with type 41 tubes with which may be used a type 79 with one section used as a phase inverter, as shown, or a pair of 75's, the triodes of which are employed in a similar manner.

coupled to a pair of 41's, and an alternative arrangement of two type 75 tubes, the triodes of which are employed in a similar manner.

Points marked "A," "B," "C," "D," and "E" indicate connections to the output stage from either the 79 or the two 75's. The data secured with these systems are given in Fig. 1. It will be noted that the principal difference between the performance of the two arrangements appears in the sensitivity, being about two-to-one in favor of the 75's.

Fig. 4 shows a type 85 resistance-coupled to a type 76, which in turn is transformer-coupled to the output stage. Although there is a considerable decrease in sensitivity as compared to either of the other two systems, the data (Fig. 3) shows a decided reduction in total harmonic distortion, which is a very desirable feature.

Some additional comparisons may be noted. The combinations shown in Fig. 2 may prove advantageous where space requirements are at a premium since no interstage transformers are necessary. The initial circuit requires but three tubes while the other two necessitate four. The second arrangement offers four diodes, and the one shown in Fig. 4 has two diodes, which are available for use in the receiver. Decision as to the most suitable combination will probably be governed by the specific requirements of the complete circuit.

The accompanying summary table gives a comparison of input volts and percentage distortion for various values of power output for the three different combinations described.

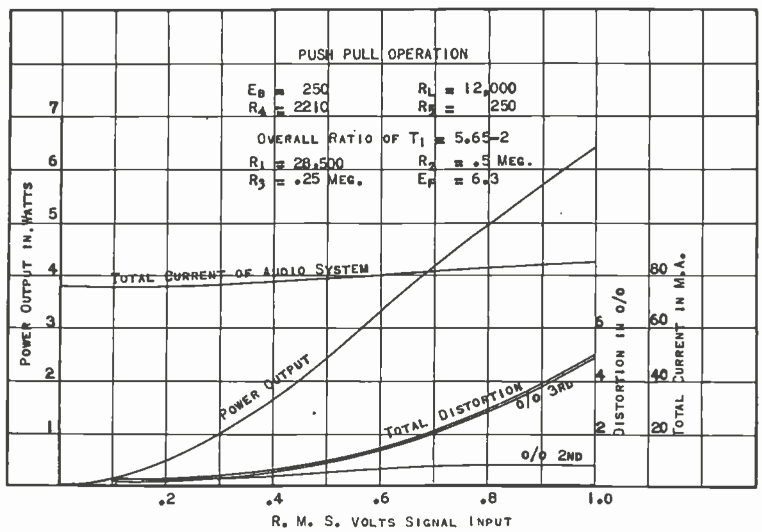



Fig. 3. Data on 41's in transformer-coupled push-pull circuit, which shows reduction in total harmonic distortion. For circuit, see Fig. 4.

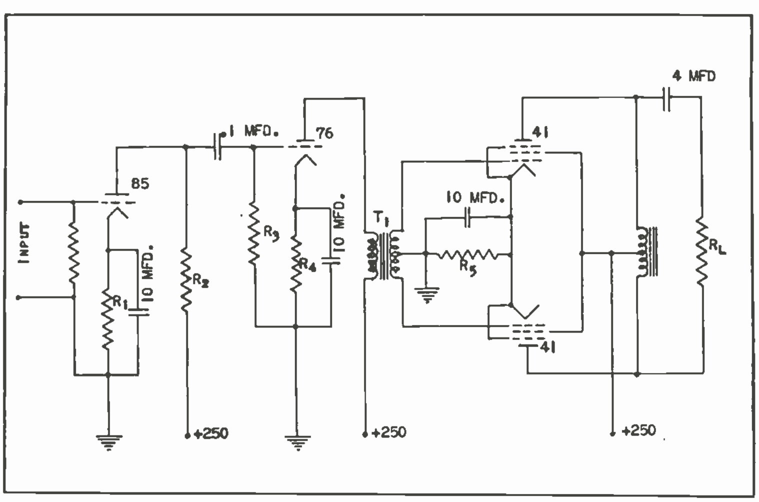



Fig. 4. A type 85 resistance-coupled to a type 76, which in turn is transformer-coupled to the output stage.

# WORK OF THE RMA ENGINEERING DIVISION

By VIRGIL M. GRAHAM

Chairman, Standards Section

THE ENGINEERING DIVISION of the Radio Manufacturers Association has in the past few years carried on a portion of such standardization work as was necessary to the industry. In addition, important work along service and safety lines has been accomplished. Now under the active and progressive leadership of Mr. W. R. G. Baker of Camden, N. J., as Director of Engineering, more work of vital importance to the industry is being undertaken, and activity on present projects is being pushed.

### SAFETY SECTION

The Safety Section, under the able chairmanship of Mr. L. F. Curtis of Springfield, Mass., has performed great service for the radio industry through the Industry Conferences with the Underwriters Laboratories. These Industry Conferences are the only official contacts between the Laboratories and the manufacturers for discussing requirements on power-operated receiving equipment. Mr. Curtis also has done a great deal of work on the radio phases involved in the latest revision of the N.E. Safety Code.

The Service Section, of which Mr. E. M. Hartley of Camden, N. J., is chairman, has done most useful work in its field, and has cooperated with the Institute of Radio Service Men in their valuable activities.

The Standards Section handles, through its technical committees, the standardization work of the Division as well as many items of engineering importance to the industry. Under the recently adopted new standardization procedure, the action of the General Standards Committee *in meeting* is final after the proposed standards have been circulated to the membership for comment and criticism. This arrangement prevents adoption of minority standards, due to non-return of letter ballots as in the old procedure.

The chairmen of the technical committees are all active and carry the responsibility of the engineering work. In some cases, subcommittees are an essential part of the committee activities, particularly where there are divergent interests headed by one main committee such as in the case of the Committee on Component Parts. In the Committee on Vacuum Tubes, under the direction of Mr. Roger M. Wise of Emporium, Pa., the vital work of assigning tube designations is naturally of a confidential nature, and is handled by a sub-committee of one engineer from the RCA License Laboratory, pending the time when this function may be assumed by an engineering office of the RMA. Without this activity, the chaos in which the industry would be is unthinkable.

### INTERFERENCE COMMITTEE

The Committee on Interference, with Dr. A. N. Goldsmith of New York as chairman, is charged with the responsibility of setting up a long-time program of reduction of electrical interference with radio reception. This Committee is composed of representatives of a score of interested organizations, and will arrange for joint committees between organizations where detailed technical work is necessary. One such joint group has been functioning in a most satisfactory and useful manner for several years. This is the Joint Coordination Committee on Radio Reception of EEI, NEMA, and RMA.

The work of the Engineering Division on component parts standardization until a few months ago lagged other activities. However, under the chairmanship of Mr. A. F. Van Dyck, this committee has started intensive work, and results will be evident in the near future. This committee has the potentialities of saving the industry an enormous amount of money through parts standardization, and it is the responsibility of those engaged in this work to see that the results are proportionate to the outstanding accomplishments of the parts standardization work of the Society of Automotive Engineers. One of the items now being studied is the possibility of adoption of preferred number systems in sizes of such things as fixed resistors and capacitors.

### AUTOMOTIVE RADIO COMMITTEE

The Committee on Automotive Radio has in the past met jointly with the corresponding Committee of the Society of Automotive Engineers, and the data resulting from the discussions has been very useful to both groups. Under the direction of Mr. J. H. Pressley, it is expected that this work will go forward with renewed activity.

The Committees on Television and Facsimile are engaged in formulating definitions and terms, so that every one can speak the same language when these fields are open to commercial exploitation. The new Committee on Special Receivers is surveying the whole field outside of broadcast receivers to find out what the needs of technical activity are on the part of the radio industry.

### BROADCAST RECEIVER COMMITTEE

The Committee on Broadcast Receivers, under the chairmanship of Mr. E. T. Dickey of Camden, N. J., is continually working on technical problems confronting the radio manufacturers. One of the latest projects is that of obtaining data preliminary to formulation of a standard on intermediate frequencies for superheterodyne receivers.

Among other projects that are up for consideration by the RMA is revision of the handbook of RMA Standards and Engineering Information, which must be brought up-to-date soon. At present, new standards and other matters of technical importance are brought to the attention of the membership by means of Engineering Bulletins sent out by the Chairman of the Standards Section.

With the whole-hearted cooperation of the radio industry, the Engineering Division of the RMA will be worth to each individual manufacturer many times the time and money that may be spent in taking part in its activities.

## SUPPRESSOR-GRID OSCILLATORS

THE USE OF the dynatron to obtain negative resistance has been common for many years. Prior to the advent of electron coupling, converter tubes, etc., the dynatron oscillator probably represented the most stable circuit it was possible to construct without the use of piezo-electric crystals.

The arrival of suppressor-grid tubes such as the 57, in which the suppressor grid is brought out, has made certain circuit combinations possible which produce simple and reliable negative-resistance devices. When a three-electrode or multi-grid tube is connected in the usual manner, a decrease in the negative bias of the control grid causes a rise in plate current. If the tube is terminated in a resistance load the plate voltage drops with a rise in plate current. Consequently, the grid-voltage change and the plate-voltage change are in phase opposition.

The conditions necessary for oscillation of a vacuum-tube circuit requires that the energy fed back from the plate circuit to the control-grid circuit be vectorially additive. If both the control-grid and plate circuits are terminated in resistances, the voltage changes in the two circuits are in phase opposition and it is not possible for the tube to produce sustained oscillations without a phase reversal in the feedback circuit. That is to say, feedback cannot be provided in a simple manner. Ordinarily, reactive circuits are used to couple the plate and grid to produce oscillation. Either a phase-reversing feedback circuit or a more complicated two-tube circuit is required to produce sustained oscillations. (The multi-vibrator is a familiar circuit of the latter type.) Such methods require a more complicated circuit arrangement than that of the simple dynatron with which it is possible to produce a simple two-terminal negative resistance.

### DYNATRON OSCILLATOR

The dynatron, which in recent years has lost something of its initial prestige, is a vacuum tube in which secondary electron emission is employed to give a negative resistance characteristic. The usual dynatron consists of a screen-grid tube operated with a plate voltage that is appreciably less than the screen-grid potential. Under these conditions there is an appreciable range of plate voltage in which the plate current decreases with increasing plate voltage. The plate current—plate voltage characteristic of such an arrangement is

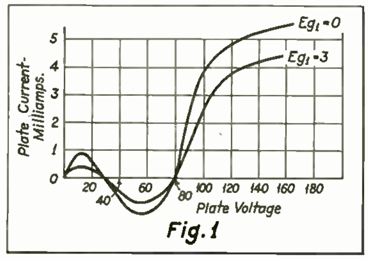



Plate current — plate voltage characteristics of dynatron.

illustrated in Fig. 1. A characteristic of this type represents a negative dynamic resistance, since a positive increment in plate voltage causes a negative increment of plate current.

The negative resistance characteristic of the dynatron results from the secondary emission of electrons at the plate. The number of electrons due to primary emission from the cathode which arrive at the plate of a screen-grid tube is determined primarily by the screen and control-grid potentials and the projected area of the screen grid. In general, it may be said that the number of electrons due to primary emission from the cathode that reach the plate of a screen-grid tube are substantially independent of the plate potential. The number of secondary electrons that are produced at the plate increases as the plate potential increases, because a higher plate potential increases the velocity with which the stream of electrons impinges upon the plate. Since all of the electrons produced by secondary emissions at the plate are drawn to the more positive screen the net plate current, which is represented by the difference between the primary electrons received from the cathode and the secondary electrons lost to the screen, decreases as the plate becomes more positive with the result that the plate circuit possesses a negative dynamic resistance.

### CONTROL ARRANGEMENT

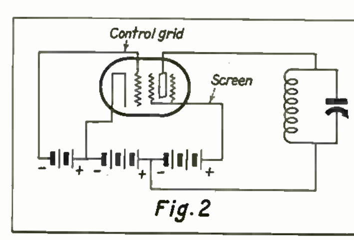
The magnitude of the negative resistance of the dynatron plate circuit varies inversely with the number of primary electrons which impinge upon the plate, and this in turn is determined by the control-grid and screen potentials. It is common practice in dynatron circuits to use the control grid as a means of controlling the magnitude of the negative resistance. It has been found expedient to use this form of control since by maintaining the control grid at a negative potential with respect to the cathode, such control can be obtained without the consumption of energy. If a family of plate-current curves are drawn in which control-grid potential is the parameter it will be observed that all the curves will pass through zero plate current at about the same plate voltage. The plate voltage at which this occurs is the potential which causes the primary electrons to impinge upon the plate with sufficient velocity that each dislodges one secondary electron from the plate. Under these conditions it is obvious that the net plate current will be zero irrespective of the control-grid potential which merely serves to vary the number of primary electrons that impinge upon the plate without in any way affecting the impact velocity.

### USES OF DYNATRON

The negative resistance of the dynatron has been utilized in numerous ways. It may be used to neutralize a positive resistance, thus effectively increasing the voltage step-up in circuits. It may also be used as an arm of a variable-losser pad in which the loss is to be controlled by a potential applied to the control grid of the tube. Another use of the dynatron characteristic of the screen-grid tube is to neutralize a resistance in the plate-cathode circuit of the dynatron tube. When properly arranged the net resistance which the whole circuit offers to an applied voltage may be made very low so that the current in the circuit will be very large. Consequently, the voltage developed across the positive resistance will be extremely high and as a result varied amplifications can be attained.

### DYNATRON CIRCUIT

Of course the most common arrangement is the dynatron oscillator which is illustrated in Fig. 2. In this case the negative resistance of the tube is shunted across the tuned circuit and has a magnitude that is numerically less than the parallel resonant impedance of the circuit. The net resistance of the com-



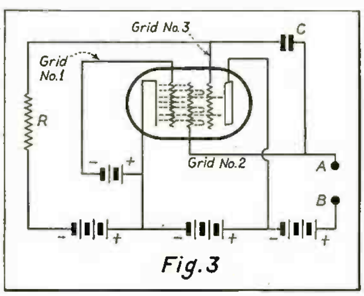

Fundamental circuit of dynatron oscillator.

bination is therefore negative and oscillations will result. One of the reasons that the dynatron oscillator has not met with more favor lies in the fact that many tubes do not exhibit uniform dynatron characteristics. Moreover, the variation between tubes in a given circuit may be relatively large. This explains why the dynatron oscillator has not been more popular in broadcast and all-wave receivers, since it is obviously impracticable to make a circuit adjustment whenever the oscillator tube is changed.

An oscillator circuit of the dynatron type would obviously be of great advantage in all-wave circuits for, by eliminating the feedback connections there are fewer circuits to be switched. As a matter of fact, in a dynatron or negative feedback circuit only one connection need be switched.

#### IMPROVED CIRCUIT

Fig. 3 illustrates a circuit utilizing the 57 to obtain a negative resistance.* This circuit differs materially from the




Circuit using a 57 to obtain a negative resistance characteristic.

dynatron circuit and operates on the following principle: When the No. 3 grid (suppressor) is used as a control electrode and is made more negative some of the electrons will be turned back towards the cathode, causing the plate current to decrease; but the electrons which are turned back are attracted by the positive voltage impressed on the No. 2 grid (screen) and impinge upon it, thus increasing its current. If then the No. 2 grid be considered as the usual plate and the No. 3 grid as the control electrode, a negative grid-plate transconductance will result.

#### FREQUENCY LIMITATION

Electron transit time limits the upper frequency to which the 57 or 6C6 will oscillate to approximately 20 mc. This limitation makes it impracticable to use tubes as oscillators in all-wave receivers at frequencies much above 15 mc. The negative transconductance tube may, however, be used to advantage as a two-terminal oscillator at all lower frequencies. No tickler coils or taps are required for this type of oscillator. This is a feature which greatly simplifies the switching problem for apparatus employing more than a single frequency band, since but one switching terminal need be considered for each band . . . the other terminal can be connected permanently in the circuit.

*See RCA article in this issue on the use of the 57 and 6C6 tubes to obtain negative transconductance and negative resistance.

#### PROPOSED CIRCUIT

The upper frequency limitation is, however, not a matter of great importance since the second harmonic of the oscillator could conceivably be used at frequencies above 15 mc. It would appear that the use of converter tubes as modulators in which the inner grid is saturated with the oscillator voltage, might be used to produce even higher harmonics than the second harmonic of the oscillator frequency for beating with the incoming signal. Converter tubes have already found rather extensive use as modulators and there seems no reason to believe that they might not be applied in this manner to permit the use of the stable oscillator circuit just described in all-wave receivers.

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## THE 1-V AS DIODE DETECTOR

CERTAIN RECEIVERS have exhibited overloading tendencies at levels below that at which the output tubes would normally overload. In a number of cases this can be traced directly to insufficient amplification of the audio signals produced by the diode detector. While it is essential to load a diode rather heavily if linear detection is to result, it can and does show signs of overloading in many receivers.

An interesting innovation in the G.E. Model M-106, is the use of the 1-V as the second detector and avc tube. While the 1-V has far more capacity than is necessary in a detector circuit, it is certainly capable of providing sufficient audio signal to overload the audio amplifiers following it. This circuit refinement is indicative of the present tendency among receiver designers to clear up many of the circuit details which have been overlooked in previous years.

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## WEATHER BANDS IN ALL-WAVE RECEIVERS

IT HAS BEEN our opinion that much of value has been lost in all-wave receivers because of the omission of the weather and beacon bands between 200 and 400 kc. While it is realized that the inclusion of this band would add appreciably to the cost, size and complication of a receiver, it is believed that most users of all-wave sets would find the weather information broadcast by the Aircraft Beacon Stations of the Department of Commerce highly desirable. Certainly the finest weather information now available is being broadcast (at 15 minute intervals) from some 200 of these stations. It goes without saying that many listeners would be very glad to have this service placed at their disposal.

It is gratifying to note that both Crosley and RCA now include this band in some of their all-wave receivers. It is to be hoped that this band will also be included in some of the future automobile sets to provide motorists with the much-needed weather information now made available.

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## AUDIO-FREQUENCY AVC

THE AVC CIRCUITS which operate on the incoming carrier and serve to adjust the receiver gain in accordance with the strength of the incoming signal, have been in common usage for some two or three years. This, of course, provides the same audio output on every station, provided all stations are modulated to the same degree. However, it is well known that due to the differences in percentage modulations of the various broadcast stations it is necessary to readjust the volume each time a separate station is tuned in, irrespective of whether or not the receiver employs avc.

The modulation capability of all broadcast stations is, of course, not identical. While most stations have provision for deep modulation, this does not mean that all of them can modulate 100 percent. Moreover, some stations prefer to reduce the modulation in order to insure better fidelity of their programs. Since this is the case, it appears likely that there will be a wide variation in the depth of modulation from station to station for some time to come.

#### AUDIO LIMITING CIRCUIT

This state of affairs has indicated the desirability of some audio limiting device which would preclude the necessity of constant adjustment of the volume or level control. It is gratifying to note that this matter has received the attention of the designers of some of the new Crosley receivers which provide avc on the first audio tube for the express

(*Continued on page 22*)

## "RADIO CLUB" SILVER ANNIVERSARY YEAR BOOK

IT GIVES US a great deal of pleasure to be able to review the Twenty-Fifth Anniversary Year Book of the Radio Club of America, Inc. Dedicated to "The Spirit of Good Fellowship and the Free Interchange of Ideas Among All Radio Enthusiasts," this book contains a wealth of information and inspiration in its many pages. In fact, a comprehensive review would, we feel, require nearly as many pages as this year book contains; and so this review shall consist of only a very brief summary of a few of the many highlights incorporated in its 85 pages.

The preface, which outlines the spirit that has contributed so much to the growth and prestige of the Radio Club of America from the eight charter members of the Junior Wireless Club Limited to its present 320, was written by George Eltz, Jr., who it happens was one of those charter members.

"A History of the Radio Club of America, Inc.," by George E. Burghard, traces in a very interesting and vivid manner the story of the Radio Club from its beginning in 1909. Mr. Burghard has condensed his material into some 38 well-illustrated pages.

Immediately following is a foreword by Lawrence C. F. Horle. This foreword precedes the complete listing of the Proceedings of the Radio Club. To appreciate the value of this listing of the Proceedings, even if only for reference purposes, one needs but glance at names of the engineers who have presented papers.

An enrollment of past officers, condensed history of each member, and the Constitution of the organization completes this year book.

The members of the Twenty-Fifth Anniversary Year Book Committee, namely, George E. Burghard, Ernest V. Amy, Edwin H. Armstrong, George J. Eltz, Jr., John F. Grinan, Lawrence C. F. Horle, Frank King, Robert H. Marriott, Fred Muller, Joseph J. Stantley, and W. E. D. Stokes, Jr., deserve a vote of thanks from the Radio Club.

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## SYLVANIA CATHODE-RAY TUBE RATINGS

CONCERNING THE article "New Sylvania Cathode-Ray Tube," page 19, January, 1935, RADIO ENGINEERING, we have been advised that operation tests have proven the desirability of making certain changes in operating values.

The first sentence under the heading "Cathode Circuit" reads: "The filament may be operated at any voltage (ac or dc) within a maximum rating of 2.5 volts, according to the intensity of beam required. Conservative operation of the cathode will increase the life of the tube." Low-voltage operation has been found to be detrimental to the life of these tubes, and it is recommended that they be operated with a filament voltage as near the rated 2.5 as possible.

The heater-current rating, listed as 2.1 amperes, should be 2.5 amperes; while the focusing electrode voltage, recorded as 250 maximum volts, should be 300 volts.

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## DUTIES IN TURKEY MODIFIED BY RECLASSIFICATION

EMPTY RADIO CABINETS imported separated have been reclassified as furniture. according to kind, and hence became dutiable at reduced rates. Radio loudspeakers, formerly classified under item 634 and dutiable at 200 Turkish pounds per 100 kilos, have been reclassified under item 619 and are now dutiable at 500 Turkish pounds per 100 kilos, according to a report of Oct. 18, 1934, from Commercial Attache Julian E. Gillespie, Istanbul, in *Electrical Foreign Trade Notes,* No. 351, December 15, 1934.

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## NOTES AND COMMENT

(*Continued from page* 21)

purpose of preventing audio overload when tuning from a weakly modulated station to one with deeper modulation. The tendency of such a circuit is, naturally, to keep the audio output substantially constant. When this control is applied to a variable-mu audio tube it would appear that this should result in little if any distortion and should prove a boon to the radio listener.

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## LESS SELECTIVITY FOR THE AVC

THE NEW CROSLEY Centurion Models employ a 76 tube fed from the plate of the first i-f tube, for avc. This is done to permit inter-channel noise to operate the avc and thus lower the receiver gain when tuning between stations.

With the usual circuit the avc is actuated only over the i-f band, since the full receiver selectivity precedes it. This means that the receiver gain is limited only by the manual gain-control setting (if a manual gain control is used) when the set is detuned. As a result higher receiver gain is had between stations where the avc does not act.

When the avc tube is operated at reduced selectivity the noise itself serves to reduce the gain between channels, thus reducing the need for squelch circuits or channel-control circuits.

In this same circuit arrangement, the voltage developed in the load circuit of the avc tube is fed back to the r-f and modulator tubes and fed forward to the second i-f tube. The control is consequently more effective and tends to eliminate the possibility of distortion due to overload.

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## THE 41 TUBE AS OSCILLATOR

THERE HAS BEEN a tendency for the past two years toward the reduction of load on the beating oscillator. This has been brought about by the desire to prevent oscillator drift.

It has long been realized that the weaker the coupling between the oscillator and the modulator, the more stable the oscillator. Electron coupling was developed to reduce the load on the oscillator to practically zero, in order that there be little or no reaction between the oscillator circuits and the rest of the receiver.

Another way of attacking this problem lies in the use of a larger tube for the oscillator, permitting a reduction in coupling between the oscillator and modulator. One of the noteworthy advances in some of the newer Colonial receivers is the use of the 41 pentode as an oscillator. In addition, these receivers use suppressor-grid modulation. Since the suppressor grid is a relatively high-impedance circuit, the coupling to the oscillator is necessarily very weak. Both of these departures are probably destined for wide use, particularly in all-wave receivers.

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## FILTERED OSCILLATOR

EVER SINCE THE introduction of all-wave receivers some few years ago, there has been a certain amount of trouble with noisy oscillator tubes. Part of this has been due to microphonic tendencies, and these in the main have been largely overcome by the shock mounting of either the tuning condenser or the oscillator tube, or both. While these troubles have usually been laid solely to microphonics this has not always been the case.

Part of the trouble has been due to hum modulation of the beating oscillator, and to interaction between the oscillator circuits and other components of the radio receiver. In certain types of circuits, insufficient isolation of audio and oscillator power-supply circuits have resulted in audio modulation of the oscillator.

There has recently been a tendency to segregate the oscillator supply circuits from the rest of the receiver circuits to prevent audio modulation. In certain of the new Crosley models, this matter has been carried one step further and the oscillator circuits have been carefully filtered to prevent both hum and audio modulation. This is certainly a step in the right direction and it seems safe to predict that it will be followed by other designers.

# PROGRAM of JOINT MEETING I. R. E. and AMERICAN SECTION, I. S. R. U.

ON APRIL 26, 1935, there will be two sessions at the National Academy of Sciences Building, 2101 Constitution Avenue, Washington, D. C., beginning at 10 a. m. and 2 p. m. Papers will be limited to fifteen minutes each to allow time for discussion.

### PAPERS TO BE PRESENTED

*The London General Assembly of the International Scientific Radio Union,* by J. H. Dellinger, National Bureau of Standards.

*Further Results of a Study of Ultra-Short-Wave Transmission Phenomena,* by C. R. Englund, A. B. Crawford and W. W. Mumford, Bell Telephone Laboratories.

*Experiments With Ultra-High-Frequency Transmitting Antenna in Close Proximity to the Ground,* by H. Diamond and F. W. Dunmore, National Bureau of Standards.

*Ionosphere Measurements During the Partial Eclipse of the Sun of February 3, 1935,* by J. P. Schafer and W. M. Goodall, Bell Telephone Laboratories.

*The Graphical Analysis of a 10,000-Hour Kennelly-Heaviside Layer Record,* by Harry Rowe Mimno, Harvard University.

*Recent Ionosphere Measurements in the Southern Hemisphere,* by L. V. Berkner, H. W. Wells and S. L. Seaton, Carnegie Institution of Washington.

*Some Continued Observations of Ultra-High-Frequency Signals Over Long Indirect Paths,* by Ross A. Hull, American Radio Relay League.

*Terrestrial Magnetism and Its Relation to World-Wide Short-Wave Communications,* by Henry E. Hallborg, RCA Communications, Inc.

*Radio Propagation Over Spherical Earth,* by C. R. Burrows, Bell Telephone Laboratories.

*Direction Finding of Atmospherics,* by John T. Henderson, National Research Council of Canada.

*Theoretical Explanation of Published Measurements of Vertical-Plane Radiation Characteristics of High Vertical Radiators,* by K. A. MacKinnon, Canadian Radio Broadcasting Commission.

*Some Developments in Low-Loss Inductances,* by F. E. Terman, Stanford University.

*Measurement of High-Frequency Impedance With Networks Simulating Lines,* by W. L. Barrow, Massachusetts Institute of Technology.

*The Accuracy of the Low-Voltage Cathode-Ray Tube for Oscillographic Radio Measurements,* by L. E. Swedlund, Westinghouse Electric and Manufacturing Company.

*The Detection of Frequency Modulated Waves,* by J. G. Chaffee, Bell Telephone Laboratories.

*A Novel Modulation Meter,* by H. N. Kozanowski, Westinghouse Electric and Manufacturing Company.

*On the Nature of Transmitter Key Clicks and Their Suppression,* by A. Hoyt Taylor and L. C. Young, U. S. Naval Research Laboratory.

*Grid Dissipation as a Limiting Factor in Vacuum-Tube Operation,* by I. E. Mouromtseff and H. N. Kozanowski, Westinghouse Electric and Manufacturing Company.

*Application of Secondary Emission,* by K. V. Zworykin, RCA Victor Company, Inc.

### SUPPLEMENTARY PROGRAM

(Papers to be presented if time permits)

*A Graphical Aid in the Design of Networks for Distortion Correction,* by E. A. Guillemin, Massachusetts Institute of Technology.

*The Directive Antenna of KYW Station,* by R. N. Harmon, Westinghouse Electric and Manufacturing Company.

*Industrial High-Frequency Generators Using Vacuum Tubes,* by H. V. Noble, Westinghouse Electric and Manufacturing Company.

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## MISBRANDING OF RADIO SETS

METRO MANUFACTURING COMPANY, Brooklyn, engaged in the manufacturing and/or assembling of radio sets, was directed to discontinue the use of the words "Edison" or "Brunswick" in advertising matter, on escutcheon plates, or in marking the instruments in any way, and to discontinue representing that the instruments were manufactured or endorsed by Thomas A. Edison or any organization formerly endorsed or empowered thereby, or by Brunswick-Balke-Callander Company, Warner Brothers Pictures, Inc., Brunswick Radio Corporation, or any one affiliated therewith. (Federal Trade Commission report.)

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## 1934 RADIO EXPORTS ESTABLISH ALL-TIME RECORD

A NEW ALL-TIME record for exports of radio equipment from the United States was recorded in the calendar year 1934, when sales abroad were valued at $24,856,898 compared with $16,125,719 in 1933, an increase of $8,731,179, or 54 percent, according to Andrew W. Cruse, Chief, Electrical Equipment Division, Department of Commerce.

Overseas sales of radio equipment during the year exceeded by $1,723,083 the former record sales of 1930, it was stated.

Exports of all classes of radio equipment during 1934 increased compared with 1933, statistics show. Foreign sales of radio transmitting sets, parts and tubes were valued at $1,090,269 compared with $743,423 in the preceding year, an increase of 47 percent; receiving sets were valued at $15,338,143 against $9,323,535, or 65 percent; components, $4,358,350 against $2,783,730, or 56 percent; receiving tubes, $3,210,729 against $2,623,261, or 22 percent; loudspeakers, $361,076 against $338,055, or 7 percent; and other accessories, $498,331 against $313,725, 59 percent.

During the past few years the average unit value of radio receiving sets sold abroad from the United States has steadily decreased until 1933 when the value was recorded at $18. This decrease, Mr. Cruse stated, has been occasioned by the increasing popularity of small receiving sets in foreign markets. All-wave sets are credited with the increase in 1934 to $25.

The value of the export sales for the year evidences a recovery in foreign markets from the conditions which adversely affected sales abroad of American radio equipment in 1932 and 1933.

While complete statistics showing the destination of exports during the year are not yet available, Mr. Cruse stated that it is quite evident that our current markets for radio equipment are in countries other than those to which such exports were consigned in the years prior to 1933.

Spain, the United Kingdom, Mexico and Brazil will undoubtedly be shown in the complete statistical compilation as first-ranking foreign markets for American radio equipment.

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## CZECHOSLOVAK PHILIPS CONCERN SHOWS LOSS

THE CZECHOSLOVAK BRANCH of the Dutch Philips concern closed its fiscal year ended June 30, 1934, with a loss of 937,593 crowns ($37,500). The loss is to be covered to the extent of 841,734 crowns ($33,670) from profits accumulated in the previous years, and the balance of the deficit carried forward.

The business of this company has been unfavorably influenced during the year by the new tax on electric light bulbs and radio tubes. At present the local Philips concern employs 768 persons. (*Sam E. Woods, Com'l Attache, Prague.*)

# · RMA NEWS ·

### RMA INTERFERENCE COMMITTEE MEETING

ORGANIZATION BY RMA of an inter-industry committee on radio interference has been effected. Dr. Alfred N. Goldsmith of New York, prominent radio engineer, is chairman of the committee which includes representatives of the U. S. and Canadian government commissions, associated radio and also electrical organizations. Reduction of man-made noises which interfere with radio reception is the objective of the committee.

The first meeting of the committee was held March 8 at the Hotel New Yorker in New York. Last November at a general "interference conference" at Rochester the RMA, through its Engineering Division of which Dr. W. R. G. Baker of Camden, N. J., is chairman, arranged for the inter-industry committee. Invitations were sent to the leading organizations in the radio, electrical and allied fields, and acceptance of membership on the committee of a distinguished group of leading organizations augurs well for the future activities and success of the committee. Their participation promises broad cooperation of the radio and electrical industries for the benefit of radio listeners. The following constitutes the present list of organizations on the committee:

*Federal Communications Commision*
*U. S. Bureau of Standards*
*Canadian Department of Marine*
*RMA of Canada*
*National Association of Broadcasters*
*Society of Automotive Engineers*
*National Electrical Manufacturers Assn.*
*American Institute of Electrical Engineers*
*Institute of Radio Engineers*
*Radio Wholesalers Association*
*American Radio Relay League*
*Institute of Radio Service Men*
*Radio Club of America*
*Dr. O. H. Caldwell (Member at Large)*
*Mr. R. D. Duncan, Jr. (Guest Member)*

In addition the American Standards Association will cooperate fully with the new committee.

### DECEMBER EXCISE TAXES

The U. S. Internal Revenue Bureau collections on the five percent excise tax on radio and phonograph apparatus during the month of December 1934 were $568,117.99, according to official government reports and brought the total of 1934 tax collections to $3,520,855.47. This was an increase of 35.6 percent over the total excise tax collections of 1933 which were $2,596,612.29.

As a barometer of radio industry sales, the excise tax collections showed a greater increase during the first six months of 1934. This increase was 54.8 while the increase in the last six months' period of 1934 was 23.1 percent over the similar period of 1933.

Since institution of the excise tax law June 20, 1932, the radio industry has paid $7,301,977.82, and the five percent tax promises to be continued by the new Congress. Detailed figures on the 1934 radio excise tax collections follow:

CALENDAR YEAR 1934

| | |
|---|---|
| January | $415,358.83 |
| February | 272,335.09 |
| March | 268,136.45 |
| April | 202,301.98 |
| May | 234,010.60 |
| June | 190,275.47 |
| Total Six Months | $1,582,418.42 |
| July | $ 92,007.81 |
| August | 229,681.76 |
| September | 305,291.91 |
| October | 280,699.11 |
| November | 462,638.47 |
| December | 568,117.99 |
| Total Six Months | $1,938,437.05 |
| Total Calendar Year | $3,520,855.47 |

### CODE AFFAIRS

Announcement of the Administration's plans for temporary extension of NIRA for two years insures continuation of industry codes and brings the NRA before Congress for revision. Elimination of price-fixing provisions from all codes seems a certainty but no changes in the 7-A labor provisions are in prospect. NRA held a hearing January 30 on labor policies with the American Federation of Labor continuing its agitation for a general 30-hour week which is not favored by the Administration. Several months of controversy in Congress on revision of NRA codes and labor questions are in prospect.

Committees of RMA and NEMA are engaged on procedure to make effective the agreement of January 15 with NRA on operations of radio manufacturers under the electrical code. Definitions of radio apparatus, for whose manufacturers code jurisdiction will be carried on by the radio group supervisory agency, are being exchanged between RMA and NEMA. A new questionnaire to transformer manufacturers soon will be circulated by NRA preliminary to a hearing on a supplemental code for industrial transformer manufacturers.

#### Automobile Sets

Automobile receiving sets sold by jobbers and dealers are subject to the supplemental code for radio wholesalers, according to an interpretation of NRA Divisional Administrator Brady. The ruling does not apply to manufacturers selling automotive sets as such manufacturers are subject to the electrical code. Although the Internal Revenue Bureau in administering the radio excise tax law has ruled, for taxation purposes, that automobile sets are automotive accessories, for NRA code purposes they are ruled to be radio rather than automotive products, at least when sold by distributors and dealers.

#### Radio Cabinets

The Furniture Manufacturers' Code Authority is taking a letter ballot on a proposed amendment to the furniture code providing four months' exemption for radio cabinet manufacturers, during peak production periods, from overtime penalties of the furniture code. It is believed that the vote will be favorable, permitting outside and specialty manufacturers of radio cabinets to operate under the furniture code. Not affected are radio manufacturers who make their own cabinets, who will continue under the electrical code. Following is the proposal under consideration by the furniture code authority:

> "That the manufacture of radio cabinets, other than those manufactured by radio manufacturers who make the complete radio and all parts thereof, be included under the Furniture Code and that such manufacture shall be exempted from the provisions of Article IV, Section 5 of the Code for not more than four months a year, continuously, in not more than two separate periods during the year; that any manufacturer availing himself of this exemption shall report to the Furniture Code Authority prior to the beginning of such exemption, explaining the necessity for the utilization of the exemption, and when he has completed the period of exemption. It is understood that this motion shall be submitted to the members of the Code Authority through the mail, accompanied by the pros and cons, and that it may be adopted only by a substantial (not a bare) majority of the votes cast."

### RURAL RADIO SURVEY

A test of radio reception in rural and remote sections of the country is being made by the Federal Communications Commission in cooperation with the National Association of Broadcasters. It has sent 100,000 postcard questionnaires to farmers and others in sections selected to test the efficiency of broadcasting on the forty clear channels from coast-to-coast and the necessity for maintenance of clear channel broadcasting. The postcards bear three questions:

1. *Do you own a radio set? If so, what is its make, model number, number of tubes, when purchased, and is it now in good operating condition?*

2. *Name your favorite radio stations by call letters in the order of your preference.*

3. *What is your post office address?*

An engineering survey to secure data also will begin in about two weeks by the Commission and the NAB involving an expenditure of about $60,000., largely borne by the broadcasters.

### CANADIAN SALES IN DECEMBER

The Canadian RMA reports sales during December 1934 of 20,770 receiving sets valued at $2,312,000. Of these 17,783 were ac sets, 2,771 battery sets, and 216 automobile sets. Of the ac sets 5,823 were of console dual-wave type, 4,723 of the mantel dual-wave type, and 3,090 of the console all-wave type, with 2,324 of the mantel

*(Continued on page 26)*

# News Of The Industry

### NEW CORNELL-DUBILIER CATALOGS

Three new 1935 catalogs are announced by the Cornell-Dubilier Corporation, condenser manufacturers, 4377 Bronx Boulevard, Bronx, N. Y.

Catalog No. 128 (16 pages) is for use by radio parts distributors, dealers, service men and amateurs. It lists a wide variety of mica, paper and electrolytic condensers in many capacities, voltage ratings and sizes for general radio applications. Suplementing this, is Catalog No. 129, which contains a comprehensive listing of standard types of replacement condensers of both paper dielectric and electrolytic construction.

For manufacturers and engineers, a special industrial catalog bearing the number 127 has been compiled. This contains much useful information on the use of condensers in power-factor correction, motor startng, high-voltage circuits, etc.

Copies of these catalogs are available free of cost to users of condensers. Requests should be mailed directly to the main office of the Cornell-Dubilier Corporation at the above address.

### NEW TRANSFORMER MANUAL

Balsley and Phillips Industries, 1455 North Gordon Street, Hollywood, Calif., have available their 25-page Transformer Manual . . . a manual of BPI products for the amplification, recording, reproduction and transmission of sound. Descriptions, technical data, wiring diagrams, dimension charts, curves, and the like are given for input audio transformers, mixing or impedance-matching transformers, interstage (coupling) transformers, output transformers (including modulation type), audio chokes and modulation reactors, saturated (swinging) chokes, smoothing chokes, power amplifier-power transformers, plate transformers, filament transformers, etc.

The information included in this manual should be of considerable value.

### BUCHER ELECTED VICE-PRESIDENT OF WESTINGHOUSE

At a meeting of the Board of Directors of the Westinghouse Electric and Manufacturing Company held in New York, George H. Bucher was elected a Vice-President of the company. Mr. Bucher will make his headquarters in this city.

Mr. Bucher, who is also President and General Manager of the Westinghouse Electric International Company, has been connected with the Westinghouse organization since September 1, 1909. After graduating from Pratt Institute, Brooklyn, in both steam and machine design, and also electrical engineering, Mr. Bucher joined the Westinghouse Electric and Manufacturing Company at East Pittsburgh as a graduate student. In 1911, he was transferred to the Export Department in New York and in 1920 he was appointed assistant to the General Manager of the Westinghouse Electric International Company. In 1921 he was promoted to the position of Assistant General Manager. In 1932 he advanced to the position of Vice-President and General Manager, and in 1934 he was elected President of the same company.

Mr. Bucher is a member of the American Institute of Electrical Engineers, and Engineers' Club of New York.

### NATIONAL UNION ADDS NEW PRODUCTS

National Union Radio Corporation of New York has announced the further expansion of their organization in the field of electronic products through the addition of a line of radio-panel lamps, photoelectric cells and cathode-ray tubes.

Five types of radio-panel lamps have been made available, three types of photoelectric cells are included in the line and four types of cathode-ray tubes have been produced.

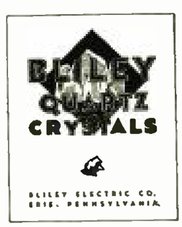
These new National Union products are in addition to the regular line of radio-receiving tubes, 6-ampere rectifiers for multiple battery-charging units and exciter lamps.

All products are being offered through the regular National Union distributor channels.

### BLILEY ELECTRIC BULLETIN

The Bliley Electric Company has recently issued an eight-page bulletin describing its complete line of quartz crystals for transmitters, single-signal filters and standard-frequency bars.

A separate section devoted to special crystals between 7 kc's and 15 mc's is of special interest to the radio engineer and




experimenter. Copies of this bulletin may be secured by writing to the Bliley Electric Company, 201 Union Station Building, Erie, Penna.

### POLYMET CATALOG

The Polymet Manufacturing Corporation, 829 East 134 Street, New York City, have available a complete 23-page catalog covering their products. Included in this catalog is data on their complete line of paper, mica, electrolytic, and oil-filled condensers, together with information relative to resistors and volume controls. Also included is interference filters. Further, technical data on condensers, resistor and volume controls is given.

Polymet have also recently announced a new type of electrolytic condenser which is said to feature the following: Compactness, lower cost, simplicity of mounting, maximum safety in operation, high standard electrical characteristics, and imperviousness to humidity.

Information regarding these new condensers may be obtained on request.

### KEN-RAD TUBE EXPORTS

According to Leonard Minthorne, export manager, 116 Broad Street, New York City, Ken-Rad Radio Tubes are enjoying a very satisfactory percentage of total export sales to the foreign field. The figures that he presents are obtained by comparing the total value of Ken-Rad export sales with the total value of U. S. Government radio-tube exports. The evidence thus obtained is extremely satisfactory to the Ken-Rad officials at Owensboro, Kentucky, and is a tribute to the selling efforts of Mr. Minthorne.

Of the radio tubes exported from this country to France, 27% of the total value of sales is credited to Ken-Rad. In like manner, 36% of the value of Belgium's import of radio tubes from the United States goes to Ken-Rad; Spain, 38%; Portugal, 15%; and Bulgaria, 100%.

In Brazil 26% of the total value of American-made radio tubes imported are Ken-Rad Radio Tubes; Argentina, 21%; Uruguay, 40%. In Siam, 22% of the total value of radio tubes imported by U. S. is claimed by Ken-Rad; in Morocco it is 61%. The Virgin Islands pledge allegiance to Ken-Rad by giving them 100% of their import radio-tube business from this country.

### TRANSFORMER COMPONENTS

The United Transformer Corporation, 264-266 Canal Street, New York City, New York, have available a catalog on Transformer Components. This 24-page catalog contains a great amount of technical data, circuit diagrams and the like. Also included is a very useful chart for determining values of L, C and R at different frequencies.

### ISOLANTITE PLANS FOR EXPANDED BUSINESS

Isolantite, Inc., Belleville, N. J., manufacturers of ceramic insulators, have acquired the property and buildings of the former Lyons Storage Battery Co., also of Belleville. The purchase, which was made on an all-cash basis, was to provide facilities immediately for enlarged business and to permit further expansion which is anticipated.

The transaction included a group of buildings, the largest one being approximately 50 x 200 feet, two stories high. The additional facilities will enable the company to improve its service.

Isolantite, Inc., maintains sales offices in the Woolworth Building. 233 Broadway, New York City. The company, which has been in the business since 1922, has pioneered in the manufacture of specialty and custom-made ceramic insulators. The low electrical loss character of the product, mechanical strength and precision of dimension, made it suited to radio work and it is in this field that it has gained its greatest distinction. Some of the radio products of this company are inductance forms, resistor tubes, antenna insulators, vacuum-tube sockets, bases and internal spacers, condenser insulators and concentric transmission lines. Other products are oil burner ignition insulators and complete assemblies, chemical valves, nozzles and tower packing.

### WRIGHT-DECOSTER CATALOG

Wright-DeCoster, Inc., St. Paul, Minn., have recently issued their 1935 catalog covering reproducers. This catalog, besides illustrating, gives design, construction, and reproduction information for some twelve of their reproducers, including high-fidelity, short-wave and vehicle units. This catalog may be had on request.

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### HYGRADE SYLVANIA ANNUAL REPORT

Nineteen hundred and thirty-four marked the 20th consecutive year of profitable operation for Hygrade Sylvania Corporation and its predecessor companies, according to the annual statement as of December 31, 1934, which was issued February 13.

Net income for the year after all charges and taxes amounted to $874,416.54 equal to 6.21 times the $6.50 a share preferred dividend requirement for 1934 and equal to $3.81 a share on the 192,684 shares of common stock after deducting the preferred dividend of $6.50 a share. This compares with 1933 earnings of $655,072.86 or $2.67 a share on the common stock.

The Company's balance sheet showed current assets of $4,221,876.66, or 7.9 times current liabilities. This compared with $3,694,625.04 on December 31, 1933.

Cash, plus U. S. Government obligations, municipal and other marketable securities at December 31 market values, amounted to $2,070,294.69. Similar assets were $1,541,703.84 at the end of 1933. Year end inventories of finished products represent less than three months' sales.

The report notes that Hygrade Sylvania's position as second largest producer of radio receiving tubes was continued with substantial sales increases both in domestic and foreign sales, the company now having accredited representation in 86 foreign countries.

Lamp sales during 1934 maintained the high standard of 1933.

The Company's position as an employer of labor places it high in its own industry with an average number of employees of 3,099 in 1934 as compared to 2,888 in 1933, and with total employee earnings in 1934 of $3,069,000. as compared to $2,870,000. in 1933.

Maintaining its reputation as a "management owned" company, Directors and Employees own 68 percent of the total common stock outstanding, according to the report.

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### ACHESON COLLOIDS BULLETIN

The Acheson Colloids Corporation of Port Huron, Michigan, has available for distribution Technical Bulletin No. R191, dealing with "Colloidal Graphite—An Ideal Ray-Focusing Anode Material for Cathode-Ray Tubes". Copies will be furnished free to those interested.

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### ELECTRONICS AND ELECTRON TUBES

Three publications on theoretical and experimental electronics and electron-tube applications, originally published for educational institutions have now been made available to the public, at a nominal charge, by General Electric Company, Schenectady, N. Y.

"Electronics and Electron Tubes" was written by E. D. McArthur of the G-E vacuum tube engineering department in response to requests from schools and colleges for a publication giving, in easily understood language, the fundamentals underlying the vacuum tube, and including simple experiments to illustrate these fundamentals. References are included which enable the reader to delve more extensively into many subjects treated in the 48-page booklet. Designated by General Electric as publication GET-568-A, it is priced at 25 cents.

The other two publications, GET-566 and GET-620, deal with laboratory experiments on electron-tube theory and on electron-tube applications, respectively. The former is intended as an experimental supplement to McArthur's "Electronics and Electron Tubes," while the latter is a laboratory manual covering a number of fundamental electron-tube applications. The two booklets are obtainable as a combination priced at 25 cents. Address: Educational Section, General Electric Company, Schenectady, N. Y.

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### ELECTRONIC RECTIFIER BULLETIN

The B-L Electric Manufacturing Co., St. Louis, Mo., have announced their latest B-L Electronic Rectifier Bulletin. This bulletin contains a general description of these units together with a partial list of their many uses. Also included is up-to-date information on the commercial sizes and types available.

This bulletin should prove of considerable interest to those readers who are interested in rectifiers. Copies are available upon request.

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## RMA NEWS

*(Continued from page 24)*

standard type, and 1,174 of the console standard type.

### BATTERY SETS

Battery sets enjoyed an increased sale during 1934 according to information secured by RMA. Sales of battery sets last year aggregated about 300,000, according to the best information available and are regarded as another evidence of increased rural purchasing power.

### ENGINEERING COMMITTEES MEET

Further revision of tube standards was considered by the RMA Tube Committee under Chairman Roger M. Wise on January 25 in New York, and on February 6 the RMA Committee on Broadcast Receivers, of which Mr. E. T. Dickey is chairman, also met for further consideration of a proposed definition for the standard and short-wave receiver. Various new terms are under consideration following a questionnaire sent to set manufacturers for their suggestions.

The Receivers Committee also considered possible standard dimensions for loudspeaker mountings, proposed power transformer standards under consideration with NEMA, and a possible standard color code for chassis wiring. Detailed advices will be given later to RMA members.

### RADIO LEGISLATION

Radio legislation which has thus far developed from many State Legislatures in session has brought several new sales tax proposals. The new tax bills introduced, however, have proposed general uniform sales taxes and none thus far have attempted to single out radio products for special taxation. Many bills affecting broadcasters have been introduced, to prohibit libel and also liquor advertising by radio.

Favorable radio legislation has included a bill in California to exempt radio sets up to $50. in value for attachment. In Iowa a bill has been introduced to exempt all "home" receiving sets from taxation.

Also noted in new radio legislation is the extension of state police and university broadcasting. California, Rhode Island, North Dakota and North Carolina have pending bills authorizing or extending state police-radio systems. In some states bills have been introduced to require broadcasting of home football games by state college stations.

### 1934 RADIO SALES

Supplementing the RMA news bulletin of November 16, 1934 (p. 3), statistics of sales of radio products for the first six months' period, January 1 to June 30, 1934, compiled from manufacturers' reports filed under the NRA code for the electrical manufacturing industry, record a large increase in sale of radio sets, parts and accessories over the similar six months' period of 1933.

According to the statistics, radio industry sales for the first six months of 1934 totaled $49,407,000 at manufacturers' invoice prices, compared with $31,311,000. during the six months ending June 30, 1933. The statistics did not include reports from a number of radio manufacturers and some radio products were not segregated from similar electrical products, leaving the statistics incomplete but still of some comparative value.

The detailed statistics are given in the accompanying table.

### SUMMARY OF SALES TO DOMESTIC CUSTOMERS
**Manufacturers' Invoice Prices**

| | 1934 1st Half | | 1933 1st Half | |
|---|---|---|---|---|
| | Number Companies | Value | Number Companies | Value |
| Radio & Television Sets for Entertainment (without tubes).... | 45 | $24,925,000 | 52 | $12,266,000 |
| Radio Receiving Tubes........... | 22 | 7,278,000 | 21 | 7,312,000 |
| Radio & Television Parts & Accessories for Entertainment.... | 79 | 8,643,000 | 81 | 5,685,000 |
| Fixed Capacitors (Condensers of all kinds, radio condensers not separately reported) .......... | 25 | 2,579,000 | 23 | 1,942,000 |
| Radio Transformers ............ | 25 | 1,561,000 | (Not reported) | |
| Radio Transmitting Apparatus... | 25 | 2,191,000 | 24 | 2,206,000 |
| Public Address and Music Distribution Apparatus .......... | 22 | 639,000 | 18 | 466,000 |
| Radio Transmitter Tubes........ | 10 | 1,198,000 | 6 | 968,000 |
| Commercial Radio Receivers and Direction Finders ............. | 12 | 272,000 | 12 | 358,000 |
| Industrial Electronic Tubes...... | 5 | 121,000 | 5 | 108,000 |

# WHAT—
# FOR THE ENTIRE OUTFIT?

That is exactly what one Broadcaster asked when we told him the complete price of the new 1200-B Speech Input rack pictured to the left and to be ready for delivery Feb. 15th. In fact, he regretfully added he had just paid substantially more for an amplifier alone.

The new 1200-B is complete with Amplifier, Volume level indicator, four position mixer and Power Supply, all mounted and wired on the rack at a price so low that you will be thoroughly convinced that "Gates" is trying hard to cope with limited Broadcast Station budgets.

***Are you on our mailing list?***

## GATES RADIO & SUPPLY COMPANY

Manufacturing Engineers since 1922

QUINCY, ILLINOIS, U. S. A.

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# 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***

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# PYRANOL

HEAVY DUTY CONDENSERS

Cornell-Dubilier pioneered again in using PYRANOL—the exclusive non-inflammable condenser impregnator—for the manufacture of Hi-Voltage Transmitting Condensers.

**Complete range of capacities at voltages from 600 to 100,000. Fully fifty per cent smaller in cubic volume, and seventy per cent lighter in weight than previous types obtainable.**

Cornell-Dubilier engineers feel a justifiable pride in knowing that this condenser is used as a standard throughout the industry.

*Write for Your Copy of the New No. 128 Catalog— Just Off the Press*

## CORNELL-DUBILIER

CORPORATION

4388 BRONX BOULEVARD • NEW YORK

# New Products

## INSIDE BULB ETCHING MACHINE

A bulb etching machine for stamping a trademark, monogram or rating on the inside of glass bulbs has been developed by Charles Eisler of the Eisler Engineering Co., 765 So. 13th St., Newark, N. J. Foot-controlled and operated on an air pressure of two and one-half pounds, this machine is capable of etching from six to eight hundred bulbs an hour, it is stated.

When placed on the inside surface of the bulb, the etching is thus protected by the glass from being rubbed or buffed off.

The machine which is also adaptable to outside bulb etching, is designed to take care of various sizes of glass bulbs commonly used in the manufacture of incandescent lamps, radio and transmission tubes, electronic tubes and similar devices.

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## DEJUR-AMSCO TUNING DIALS

The DeJur-Amsco Corporation, 95 Morton Street, New York City, are presenting a new series of airplane-type tuning devices for all purposes. The complete line consists of many sizes, friction and gear drives, and band-spread pointer arrangements. These latter mechanical band-spreading dials are of particular interest.

Many escutcheons and standard scales can also be supplied, while scales with particular calibration will be made to order.

Further information may be obtained from Bulletin No. 35.

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## NEW TUBULAR CONDENSERS

Newly designed paper dielectric tubular condensers have just been made available by the Tobe Deutschmann Corporation, Canton, Mass., through its wholesale parts distributors. Features of this new series of condensers are: Metal end discs are soldered to the condenser terminals to provide a path for quick radiation of solder iron heat; dual impregnation of the entire condenser assembly to prevent moisture absorption; extra-heavy double-tinned wire lead terminals; the outside foil terminal plainly marked; and compact physical sizes.

It is claimed by the manufacturer that the new condensers are priced extremely low consistent with high quality of materials used, true voltage ratings, and the care taken in manufacture.

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## NEW PRE-AMPLIFIER

Sound Systems, Inc., 1311 Terminal Tower, Cleveland, Ohio, have announced a new pre-amplifier, the PA-105, that has been designed to be used with the sound-cell crystal microphone.

The PA-105 has been designed to raise the level of the CY-20 and CY-40 sound-cell crystal microphones, as well as the CY-37 single-cell crystal mike of the diaphragm type, so that the output is sufficient to properly excite any inter-stage or voltage amplifier having an input impedance of 50, 125, 200 or 500 ohms. The circuit employed is double push-pull, and by using the crystal mike in push-pull, it is said to be possible to operate it at any distance up to 150 feet from the pre-amplifier, providing a two-conductor, well shielded line is used. The frequency response is not affected by the longer microphone line. The only effect on the crystal microphone is a loss of output level.

This pre-amplifier has an output transformer of special moisture-proof construction to guard against corrosion. The coil is of four-section construction, and the core laminations are of high permeability alloy. The overall gain is 70 db with a flat frequency response from 30 to 12,000 cycles within plus or minus 1 db.

Further information may be obtained by writing for Bulletin No. 12.

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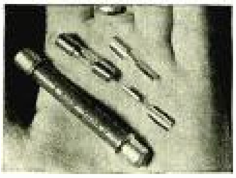
## ANTI-VIBRATION LITTELFUSES

Anti-Vibration Littelfuses are designed to fulfill the need for a high strength fuse, capable of withstanding severe vibration. They are made in low- and high-voltage types and are designed for airships and aircraft radio transmitters, railway signal work, bus transportation, power-supply circuits, alarm systems, etc.

The low-voltage types, for storage battery use, have elements that are punched from tempered zinc sheet and notched out to provide a place for fusion. A re-inforcing rib runs the entire length of the element and the sides are provided with supporting fins which fit snugly into the glass tube, thus preventing the element from vibrating as a separate unit. The most important anti-vibration feature, however, is a 90° twist given the element in the center. This simple expedient increases the stiffness of the element almost three times, increases



the natural period of vibration four times, and brings it far above any period of vibration encountered in service and eliminates the possibility of sympathetic vibration, it is stated. By a new method, the end caps, glass tube, and fuse element are locked together with a special solder. These fuses are made in the standard 4 AG size (1-¼" x 9/32" diameter) and are rated to National Electric Code specifications.

The high-voltage Anti-Vibration Littelfuses are fibre enclosed and are rated for 1,000-, 2,500-, and 3,000-volt service. The elements are made of phosphor bronze, supported by aluminum bushings within the tube. Full vibration life test data is not available at this time, but tests run by customers indicate a vibration life five to fifteen times higher than regular telegraph fuses with which they are interchangeable, it is said. Their principal field for protection is radio aircraft transmitters.

Further information may be obtained from the Littelfuse Laboratories, 4507 Ravenswood Ave., Chicago, Ill.

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## NEW DYNAMIC MICROPHONE

Universal Microphone Co., Inglewood, Cal., has started to produce a dynamic microphone as a new number in the spring catalog. The instrument, according to the factory, is primarily recommended for use where complete freedom of trouble from rough handling, damp atmosphere and unusual climatic variations make it necessary to utilize a microphone with extreme ruggedness and wide-angle pickup.

But one stage of pre-amplification is needed for ordinary use. No dc exciting voltage is required. Bass is obtained through side venturi tube with screw cap. High-frequency adjustment is provided in diaphragm dome spacer. The permanent magnets are made of high-grade cobalt steel.

The output, without pre-amplification, is —65 db. The response is from 50 to 10,000 cycles and the impedance 30 ohms. The new dynamic model comes in black enamel finish with a highly polished ring, and the diaphragm is protected by heavy screen grating.

Universal has also started to produce its No. 1078 dynamic matching transformer. It has seven variable impedances for input side which, in effect, really allows a tone adjustment controlled by tap switch and built to feed into a 500-ohm line. Phone tip jacks are provided for input and output connections. The instrument is marketed in a black crackled finished steel case.

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## NEW TYPE MONEL METAL

After twelve years of research and development, engineers of The International Nickel Company have produced a new type of Monel Metal which is said to combine the strength of alloy steel with the corrosion resistance of regular Monel Metal.

This new alloy, known as K Monel, was announced at the recent meeting of the American Institute of Mining and Metallurgical Engineers by Dr. W. A. Mudge, metallurgist of the Huntington, West Virginia, works of the company where it was perfected.

In analysis the new alloy is practically the same as regular Monel Metal with the exception of about 4 percent added aluminum and fractional amounts of other elements. It is readily heat treated and its fully hardened condition shows Brinell values above 350, though it is available also in softer forms. Its tensile strength runs higher than 160,000 pounds per square inch, it is stated.

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## NEW ELECTRO-DYNAMIC REPRODUCERS

Sonochorde Sales Company, Medford, Mass., offer a new line of Electro-Dynamic Reproducers in four sizes: 5", 6", 8" and 11". They are sturdy in construction, carefully engineered and attractively finished in silver; and they are said to sell at very reasonable prices. All speakers possess a good frequency response, even in the case of the small five-inch unit, it is stated.

Diaphragms are of high-acoustic quality material; and voice-coil suspension is by a patented "wave-form" spider. Power handling capacity is rated from 4 watts to 15 watts and speakers are available with re-inforced voice coils for increased performance. Stock specifications cover seven hundred and forty-one combinations of size, field and transformer values.

Available to manufacturers and to the retail trade through dealer and Service Man distribution.

## NEW JUNIOR VELOCITY MIKE

About the size of a match box, with an output that is said to be equal to a large velocity mike (and constant for any position of the speaker's head), the new Junior Velocity Microphone has been designed for after-dinner speakers, sports announcers, and for use as detective equipment. This unit is a product of the Amperite Corporation, 561 Broadway, New York City.

Including the transformer, which is inside the microphone case, the total weight of the 7-Point Junior Mike is about 8 ounces. This makes it adaptable for use as a hand microphone as well as many others. This unit is obtainable with 50- or 200-ohm output impedance and it has a frequency response from 60 to 7500 cycles. The output is —68 db on open line. The microphone cable can be any length up to 2000 feet, it is said.

The Amperite Corporation will gladly furnish further information.

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## "WAVE-EQUALIZED" CONDENSER MIKE

The Shure Brothers Company, 215 West Huron Street, Chicago, Ill., have announced their New High-Fidelity, "Wave-Equalized" Condenser Microphone.

The "Wave-Equalized" principle is said to overcome the deficiencies and retain the advantages of the conventional type condenser mike, thus making possible the achievement of high-fidelity response. The overall frequency response of this type mike has a variation of 4 db between 40 and 10,000 cycles.

These microphones have the following output level: Minus 32 to minus 38 db, depending on the particular model (Zero level 6 milliwatts. Sound pressure 10 bars.) The output impedance is 200 ohms.

The accompanying amplifier is a high-gain. two-stage unit with 6C6 and 76 tubes. It has been designed for ac or storage-battery heater supply. Requires 6 volts ac or dc, and 180 to 200 volts dc at 5 ma.

Complete information regarding these high-fidelity microphones may be obtained from the Shure Technical Bulletin, Vol. 2, Nos. 4 and 5.

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## TRIPLE-SEALED CARTRIDGE CONDENSERS

Unusual moisture-proof qualities are claimed for Aerovox triple-sealed cartridge condensers. Originally introduced some time ago by the Aerovox Corporation of Brooklyn, N. Y., this design was temporarily set aside in favor of the shorter, spun-over-end design because of space limitations in tiny ac-dc miniature sets then in the ascendency. With the return to full-sized sets and more critical electrical requirements, the triple-sealed condenser is re-introduced.

Being made available as rapidly as production schedules will permit, triple-sealed units are distinguished by: Wax-coating of the non-inductive section of selected paper and foil; the use of a wax-impregnated tubing, with imbedded aluminum foil; and wax-sealed ends in place of usual spun-over ends.

Foil lining was found impractical with the spun-over-end design. Although units with wax-sealed ends are more costly to make, the new units are being offered at no price advance.

Comparative humidity tests are said to indicate the marked superiority of triple-sealing: At 98 percent relative humidity, triple-sealed units indicate 4½ times longer life than conventional tubulars; in a 100-hour 98 percent relative humidity test, a batch of .1 mfd triple-sealed units averaging an initial insulation resistance of 14,500, dropped only to 13,000 megohms. The new units are especially desirable for overseas shipments and for use in humid climates.

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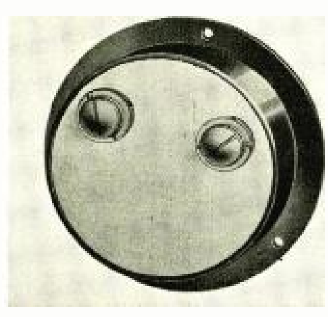
## NEW WESTON UNITS

The trend in voltmeters is towards higher and higher ohms per volt which require a higher total resistance. This can be taken care of readily on low-range instruments but on high-range instruments requiring external resistors it has been found that the leakage resistance across the surface of the external resistor would, under certain atmospheric and temperature conditions, be sufficiently low to affect the accuracy of the instrument unless special precautions were taken to reduce this leakage resistance, which in reality acts as a shunt across the resistance in the external box.

In order to accomplish the above, Weston Electrical Instrument Corp., has turned to the use of Isolantite because it has the properties more suitable for the purpose, the most important of which is high leakage resistance under practically all conditions of temperature and humidity normally encountered.


The illustration above shows an external box with Isolantite insulation.

In the past several years definite demand has arisen for thermal instruments for use on very high frequencies. If a normal thermal instrument employing a high-grade school condensate base were used on such apparatus, especially where the voltage was high, it would be found that the bases would become so hot that they would blister, crack open and possibly even cause



the instrument to become overheated and burn out.

The only solution to this problem, it is said, was to employ materials which had a very low loss factor combined with the other necessary properties, so Isolantite was selected for the base of the Weston Model 425 Thermo-Ammeters.

## PUBLIC-ADDRESS AMPLIFIER

The Gates Radio and Supply Company, Quincy, Illinois, have recently announced their Model MT-70 Amplifier. This amplifier is said to have been designed especially for those who prefer the best in public-address equipment. This particular unit features convenient control, a frequency-response curve flat from 30 to 10,-000 cycles, and good construction.

Further information may be obtained by writing to the above organization for Catalog G-34.

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## RAYTHEON HIGH-VACUUM RECTIFIERS

Raytheon, pioneer of the 83-V rectifier, now contributes to the solution of the problems encountered at high altitudes in aircraft by developing three higher voltage high-vacuum rectifiers, known as RK-19, RK-21 and RK-22. These three new tubes are rated at 1250 volts rms per anode and 3500 volts maximum inverse peak voltage —their peak current rating is 0.600 ampere. The RK-19 is a full-wave rectifier with a 7.5-volt, 2.5-ampere heater. The RK-21 is a half-wave restifier with a 2.5-volt, 4.0-ampere heater, and the RK-22 combines the elements of two RK-21 tubes in a single envelope with the heater operating at 2.5 volts, 8 amperes.

The 866-A rectifiers in airplane equipment are being replaced in many instances with the new RK-21 and RK-22 tubes. In general, where the rms voltage per anode does not exceed 1250 volts, type RK-21 is interchangeable with the 866-A and two 866-A rectifiers can be replaced by a single RK-22. The RK-19 with a 7.5-volt heater is suited for the operation of amateur power-supply and public-address equipment.

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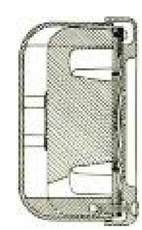
## NEW "RECEPTOR" DYNAMIC MIKES

The Radio Receptor Co., Inc., 106 Seventh Ave., New York City, have announced their new Series "6" Dynamic Microphones, a cross-sectional view of one of these units being shown in the accompanying illustration.



The Model 6A is suitable for both voice and high-fidelity music reproduction; for public address, broadcasting and recording. It covers the widest tonal range, and its sensitivity is said to make unnecessary the amount of amplification required by other types of self-generating mikes.

The Model 6B is especially adapted for public-address work and remote pickup for broadcasting, has a high output, and may be substituted in most cases for a carbon microphone without use of a pre-amplifier.

The Model 6C is designed for public-address and amateur transmitter work where price is the important consideration. It is not as sensitive as the 6A or 6B but is said to give good results for the use specified

# INDEX TO ADVERTISERS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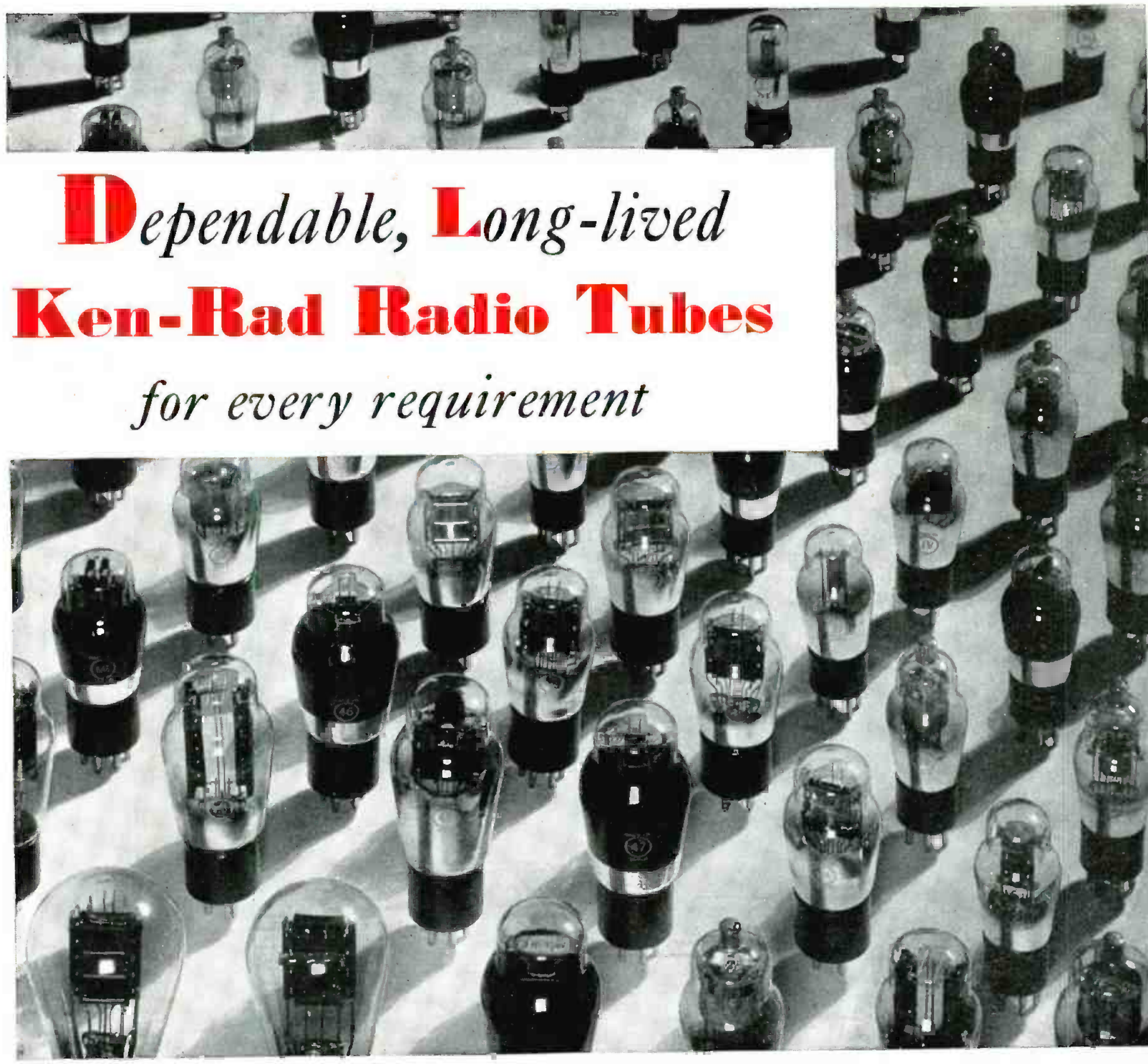

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# CATHODE RAY OSCILLOGRAPH

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## Complete . . .

The RCA Cathode Ray Oscillograph, Stock No. 9545, is complete in every essential requirement for immediate use. It includes two power supplies (one for the cathode ray tube and one for the amplifier), vertical and horizontal amplifiers, saw-tooth frequency generator and six tubes, including the RCA 906 Cathode Ray Tube (3-inch).

## 2 Volts per Inch . . .

Through the use of two wide-frequency-range high-gain amplifiers, the sensitivity is guaranteed at 2 volts A. C. per inch for both vertical and horizontal deflection. The amplifiers have flat frequency characteristics between 20 and 90,000 cycles ± 10 per cent.

## 20-15,000 Cycles . . .

A linear saw-tooth timing frequency oscillator with a special synchronizing circuit is an integral part of the RCA Oscillograph. The frequency range extends from 20 to 15,000 cycles and permits the examination of a single cycle up to 15,000 cycles or the examination of six cycles up to the limit of the amplifier—90,000 cycles. Suitable switching is provided so that either the internal timing oscillator or an external source of frequency may be connected to the plates through the amplifier. The binding posts may be connected directly to the plates for operation above 90,000 cycles.

## Frequency Modulator . . .

The RCA Frequency Modulator, price $27.50, and the RCA Test Oscillator, Type TMV-97-C, are auxiliary instruments for aligning radio circuits with the RCA Oscillograph. The Frequency Modulator is a combined motor-driven capacitor and a-c generator. The Test Oscillator has a range from 90 to 25,000 kc.

### SPECIFICATIONS

TUBES—1 RCA 906, 1 RCA 879, 1 RCA 885, 1 RCA 80, 2 RCA 57. Total tubes, 6.

ACCURATE FOCUSSING—Control on panel. Screwdriver adjustments for beam centering.

ILLUMINATION—Brilliant image — may be photographed with ordinary commercial camera.

SENSITIVITY—From 20 to 100,000,000 C.P.S.: 27.0 Volts R.M.S. for 1 inch deflection, 74.0 Volts R.M.S. for full screen image. From 20 to 90,000 C.P.S.: 0.7 Volts R.M.S. for 1 inch deflection, 1.9 volts R.M.S. for full screen deflection.

SWEEP CIRCUIT—Linear "saw-tooth" oscillator, adjustable from 20 to 15,000 cycles, positively synchronized with voltage under test by special circuit. Binding posts also for external synchronization.

AMPLIFIERS—Horizontal and vertical. Linear from 20 to 90,000 cycles ±10%. Amplifier gain is approximately 40.

### NEW APPLICATIONS

The RCA Cathode Ray Oscillograph, the X-Ray of the engineer, can be used to interpret any phenomenon which can be represented electrically, as well as for the more common use of examining alternating current wave shapes, phase relations, or any intermittent electrical currents.

New applications of the Cathode Ray Oscillograph are being discovered constantly in the RCA Victor research laboratory. Correspondence regarding your possible use of the RCA Oscillograph is invited.

*Write to RCA Parts Division, Camden, N. J., for Instruction Book RE and treatise on Oscillographs*

**RCA PARTS DIVISION**

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