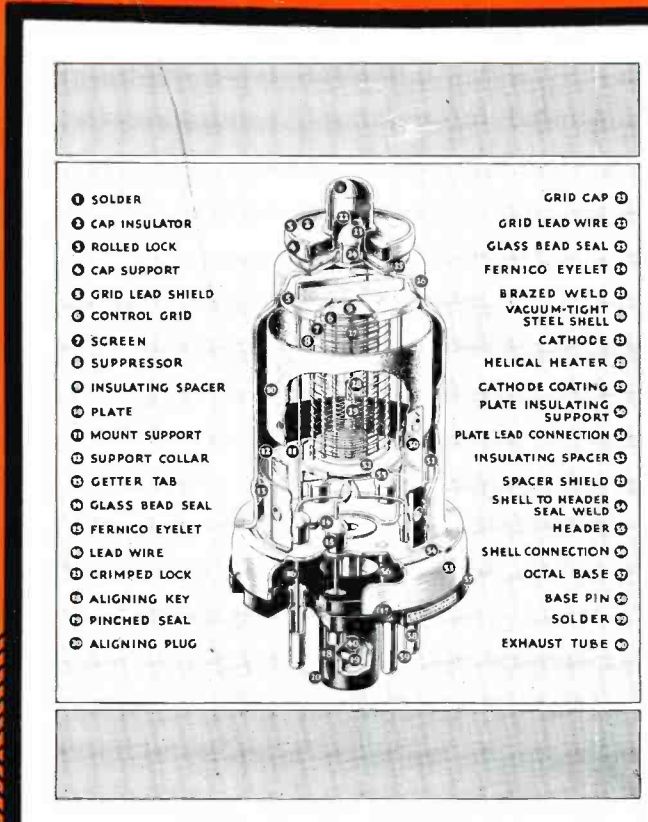
AUGUST, 1935

Radio Engineering

DESIGN • PRODUCTION • ENGINEERING

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



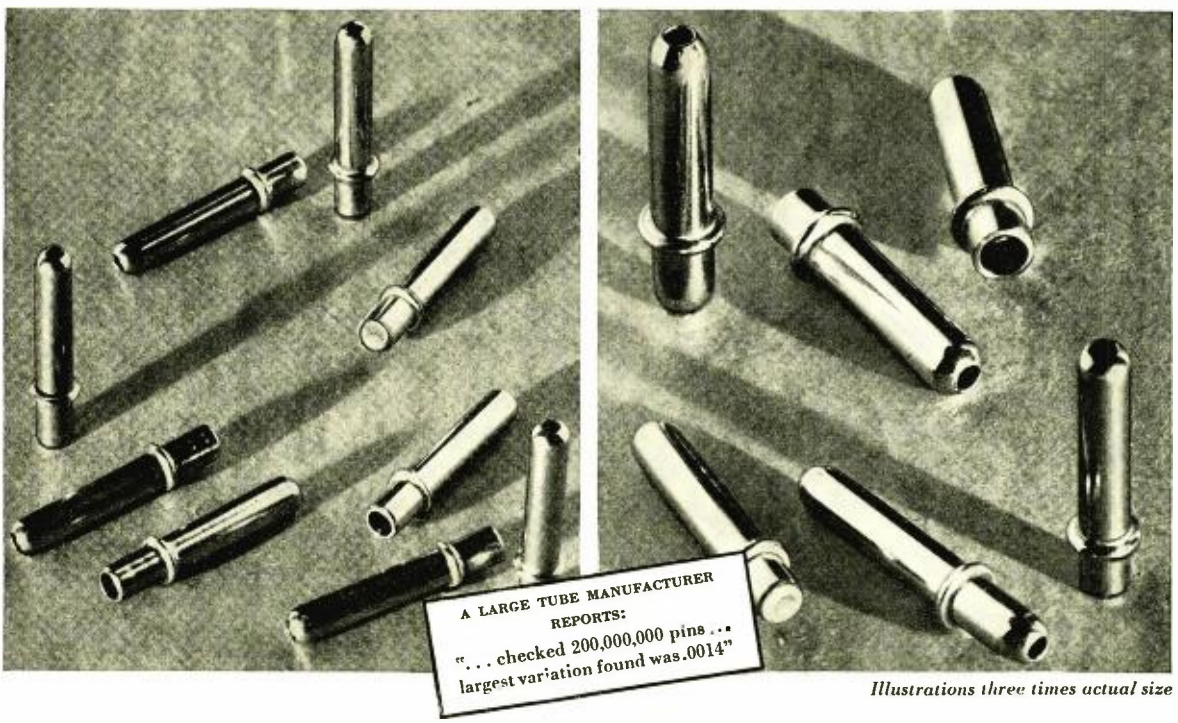
The Journal of the Radio and Allied Industries

VOL. XV NO. 8

RADIO PINS

Moulding-In · Plug · Staked

...for the new tubes ...for the old tubes



Illustrations three times actual size

The Waterbury Brass Goods Branch of The American Brass Company is prepared to furnish practically any quantity of vacuum tube pins—for the new type metal tubes; the glass tube with the new type base; or the old type glass tube.

These pins are *seamless,* concentric, and extremely accurate in size. They are plated, finished and cleaned by special methods and equipment that assure absolute cleanliness both inside and out. *Billions* of these uniformly accurate pins have been made in three types: Moulding-in Pins, Plug Pins and Staked Pins.

The Waterbury Brass Goods Corporation, as this division of The American Brass Company was formerly known, has long been a recognized source of supply for high quality copper and copper alloy radio parts, which include:

Plug and Socket Parts	Electrodes
Eyelets	Fuse Clips
Rivets	Sockets
Grommets	Screw Shells
Terminals	Condenser Shells
Contacts	Miscellaneous Stampings
Aerial Hardware	Shells, etc.

ANACONDA
from mine to consumer
REG. U.S. PAT. OFF.

Our Engineering Department will be glad to cooperate with manufacturers of electrical and radio equipment in designing new parts from the standpoint of economical production. Your inquiry or order will receive prompt and efficient attention.

WATERBURY BRASS GOODS BRANCH

The American Brass Company

General Offices: Waterbury, Connecticut

RADIO ENGINEERING

Reg. U. S. Patent Office

Member
Audit Bureau of Circulations

M. L. MUHLEMAN
Editor

RAY D. RETTENMEYER
Associate Editor

CONTENTS FOR AUGUST

COVER ILLUSTRATION

CONSTRUCTION OF TYPICAL METAL TUBE
(Illustration, Courtesy RCA-Radiotron)

FEATURES

DEPARTMENTS

VOL. XV NO. 8

BRYAN S. DAVIS
President

JAS. A. WALKER
Secretary

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

SANFORD R. COWAN
Advertising Manager

A. B. CARLSEN
Circulation Manager

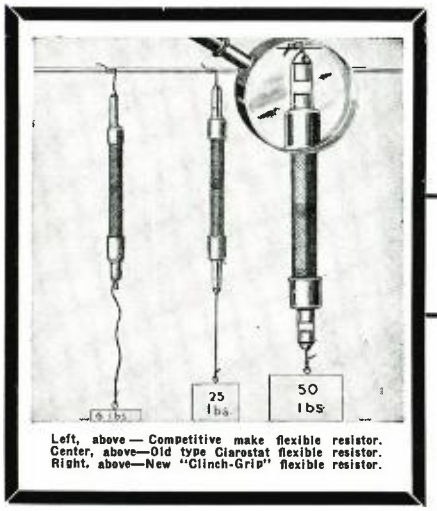
New York Telephone: Plaza 3-0483
Chicago Office—608 S. Dearborn St.—C. O. Stimpson, Mgr.
Telephone: Wabash 1903.
Cleveland Office—10515 Wilbur Ave.—J. C. Munn, Mgr.
Telephone: Garfield 0905-J.

St. Louis Office—505 Star Bldg.—F. J. Wright, Mgr.

Wellington, New Zealand—Te Aro Book Depot.

Melbourne, Australia—McGill's Agency.

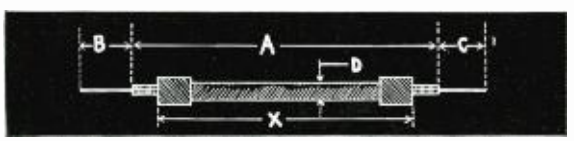
Entered as second class matter August 26, 1931, at the Post Office at New York, N. Y., under Act of March 3, 1879. Yearly subscription rate $2.00 in United States. $3.00 in Canada and foreign countries.



Left, above — Competitive make flexible resistor.
Center, above—Old type Clarostat flexible resistor.
Right, above—New "Clinch-Grip" flexible resistor.

MILLIONS ARE IN USE!

Clarostat FLEXIBLE RESISTORS *are essential components . . . in all radio receivers*



"X" Directly proportional to watt dissipation.
Type "FX"—Watts per inch = one-half. "D" = ⅛ inch.
Type "FY"—Watts per inch = one. "D" = ¼ inch.
"A" = "X" + ½ inch.
"B" = "C" = 2 inches. (Std.)
All linear dimensions ± ⅛ inch.
RESISTANCE TOLERANCE: ± 10% and not more than 1% change of original value when entire resistor is wound upon a ⅜ inch diameter arbor.
TENSILE STRENGTH:
Type "FX"—not less than 10 lbs.
Type "FY"—not less than 25 lbs.
WATT RATING: Continuous.
TERMINALS: No. 24 B & S tin-coated copper wire.
CODE USED:
1" "FX"-500—Type "FX," 1 watt, 500 ohms.
4" "FY"-250—Type "FY," 4 watts, 250 ohms.
STANDARD STOCK:
All popular resistance values and sizes "FX."

Clarostat "Clinch-Grip" flexible resistors are a new series of units made and sold exclusively by us . . . superior in quality . . . yet priced competitively with carbon resistors. The R.M.A. color code for resistance values is used throughout, the color code being woven right into the braid to insure permanency.

In design "Clinch-Grip" flexible resistors are trim. In accuracy, the commercial tolerance is maintained at ±10%. In ruggedness and tensile strength, their new design permits them to exceed manufacturers requirements from 250% to 500%. Production facilities permit unlimited quantities on short notice.

Try them—samples will be sent free to responsible parties. State resistance values desired in ordering your samples.

ALL CLAROSTAT PRODUCTS ARE FULLY COVERED BY PATENTS

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

NEW DISPLAY CARD SENT FREE TO ENGINEERS AND PURCHASING AGENTS

CLAROSTAT MFG. CO., Inc.

285 North 6th Street Brooklyn, N. Y.

EDITORIAL

"ENGINEERING"

THE CAMPAIGN set in motion for the purpose of inducing each of the forty-eight States of the Union to forbid the practice of radio engineering without benefit of license, is supposedly for the protection of the legitimate radio engineer, and the public. It's a good move, but cannot in itself meet and rectify all the factors working against the designer and the ultimate consumer.

What constitutes protection to the legitimate radio engineer—and to the public? The engineer is justified in his demand that the specialized field in which he works, and which is his only means of livelihood, shall not be invaded by self-styled engineers who have a cute way of carrying on their design work by proxy; and he is justified in his plea that the pay he receives shall bear some relation to the work accomplished. The public, were they to have any say in the matter, would be justified in demanding that they be protected through the establishment of a standard of merit for the entire radio industry, based on engineering integrity.

Probably it is none of the public's business that the radio industry has gone in heavily for syndicating engineering talent, though it may be the business of the engineer. If this idea of syndicating design features goes much farther, receivers will be so many peas in a pod.

From the viewpoint of inter-company business—and possibly what might be referred to as "production efficiency"—this idea of selling the same ideas to all receiver manufacturers is absolutely entrancing. What you get is one big, happy family—at the expense of the design engineer. You can sit down and figure out that about five cracker-jack engineers could do the heavy design work for the entire radio industry, with a resultant cost per manufacturer of much less than is paid for the factory drinking water.

But from the viewpoint of personal initiative, individual design merits, legitimate competition and the continued maintenance of radio engineering as a worthwhile and respected profession, the idea is not so hot. As a matter of fact, it's cold and clammy, suggestive of the grave.

The few real research laboratories we have are exceptions. Though their business is to syndicate engineering service, this is their sole business. Their engineers are paid well and given every opportunity to expand the knowledge of the field. The services of these laboratories are carried to a conclusion, with the result that there are few, if any, design errors. The services of the laboratories, moreover, do not infringe upon the individual work of the engineers employed by the receiver manufacturers. And the services are *paid for*.

The real rub is the radio manufacturer who, in his attempt to undersell his big brothers, dispenses altogether with legitimate engineering talent and places the design of his receivers into the hands of parts suppliers. In this event, there can be no collaboration in design efforts. (How in the name of Heaven can the "coil engineer" know what the "tube engineer" and "volume-control engineer" are going to cook up?)

Unfortunately this practice has crept into the upper strata. No one appears to have any control over the situation, and no one, with the exception of the price cutter, likes the condition any more than the many legitimate engineers who are being deprived of positions or who are working for mere chicken feed.

Some of our best receiver design engineers are with parts companies when they should be working for receiver manufacturers or research laboratories. The parts manufacturers are burdened with the additional expense of maintaining a separate engineering advisory service for many of their clients, when the clients should be paying for this themselves, rather than spreading the cost over the entire industry in the form of higher parts prices.

No one is gaining a thing out of this unequalized situation except the receiver manufacturer who gets his engineering information gratis. Everyone else is taking it on the chin—the engineer most of all.

RADIO ENGINEERING

FOR AUGUST, 1935

SOME METHODS FOR MAKING RESONANT CIRCUIT RESPONSE AND IMPEDANCE CALCULATIONS

By H. T. BUDENBOM

BELL TELEPHONE LABORATORIES

THIS ARTICLE PRESENTS a series of short-cut methods for the computation of the amplitude and phase-response characteristics of one- and two-mesh circuits; the extension of the method to three- and four-mesh networks is carried out formally. It also treats the impedance-frequency characteristics of singly resonant circuits. The plan of attack in the single-circuit impedance and multi-mesh response cases is to express the desired circuit or transfer impedance as a polar numeric multiplied by a sizing constant which turns out to be a simple reactance element of the circuit.

AVOIDANCE OF A + JB CALCULATIONS

The methods devised avoid completely the use of any "a + jb" calculations. For persons not continually engaged at such work, "a + jb" calculations are somewhat involved, difficult and tedious, and slips occur easily. Also, in many cases of calculations very close to resonance, the work suffers in accuracy unless calculating machines are employed. On the other hand, the communication art is developing in such a way as to make rapid and accurate selective-circuit-response calculations increasingly requisite.

PARAMETERS

All calculations herein are made in terms of the ratio of inductive reactance to resistance, $\frac{\omega L}{R}$, of the circuit, which factor is designated herein by the symbol Q. The other fundamental parameter is the quantity $\left(1-\frac{f_0^2}{f^2}\right)$ which is designated by the symbol W. In this quantity f is the running frequency at which the computation is being made while f_0 is $\frac{1}{2\pi\sqrt{L_1 C_1}}$ where L_1 and C_1 are the branch inductance and capacity respectively. In the case of mesh circuits the coupling impedance will be designated by Z_2. Some applicational hints are given.

SINGLY RESONANT CIRCUITS

Impedance

Consider the simple series circuit

$$Z = |z| \ \underline{|\theta} = R + jX \qquad (1)$$

This may be written

$$Z = X_L\,(q + jW) = |X_L| \ \ |z'| \ \ \underline{|\tan^{-1} QW} \qquad (2)$$

in which $q = \frac{1}{Q}$ and X_L is of course $2\pi f L_1$. Fig. 1 gives a plot of W as a function of the percentage departure from the resonant frequency f_0 of the circuit. Now by entering Figs. 2 and 3, which are plotted with W as abscissae, we find immediately the desired values: $|z'|$ the modulus needed, also the impedance angle θ.

Now consider the parallel resonant circuit. We have

$$Z = \frac{(R + j\omega L)\left(\frac{1}{j\omega C}\right)}{R + j\omega L + \frac{1}{j\omega C}} \qquad (3)$$

This may be transformed into

$$Z = \left(\frac{1}{j\omega C}\right)\left[\frac{q + j1}{q + jW}\right] \qquad (4)$$

the notation being as before. Now in the above, subject only to the ordinarily justifiable approximation that $q << 1$, we have

$$Z = \left(\frac{1}{\omega C}\right)\left[\frac{1}{q + jW}\right] = \frac{1}{\omega C} \ \ \frac{1}{|z'|} \ \ \underline{|\theta} \qquad (5)$$

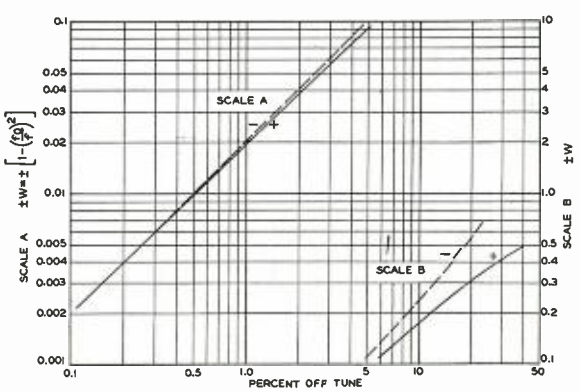


FIG. 1.

in which the modulus and argument of $q + jW$ may be found from Figs. 2 and 3 as before. The modulus of the reciprocal is of course the reciprocal of $|z|$ and the angle is negative θ.

Response-Frequency Characteristic

Amplitude

The well-known expression for the ratio (here called ρ) of the current in a tuned circuit at any frequency f to the current at resonance frequency f_0 may easily be cast into the form

$$\rho^2 = \frac{I_0^2}{I^2} = 1 + Q^2\left[1 - \left(\frac{f_0}{f}\right)^2\right]^2 = 1 + Q^2W^2 = 1 + \tan^2\theta \quad (6)$$

The discrimination of the circuit in db is then

$$10 \log_{10} \rho^2 \quad (7)$$

On Fig. 4 are plotted the values of discrimination for various values of Q in terms of percent off tune. The dotted curves on Fig. 4 applying to frequencies below f_0 were relatively easily derived from the values for frequencies above f_0 by noticing that the two values of running frequency f_1 and f_2 which experience the same amount of discrimination are related by the expression

$$\left(\frac{I_0}{I_2}\right)^2 + \left(\frac{f_0}{f_1}\right)^2 = 2 \quad (8)$$

For most conditions the amplitude-response curves for parallel circuits are effectively the inverse of the series ones.

For small departures from resonance, $\pm \Delta$, the parameter W reduces to

$$W = \frac{2\Delta}{f_0} = 2 \text{ (fractional departure off tune)}$$

$$= \left(\frac{\Delta}{f_0}\right)\frac{2Q}{Q} = \frac{2}{Q} \text{ [Q times fractional departure]}$$

$$= \frac{2}{Q}[X] \quad (9)$$

and so

$$\rho^2 = 1 + 4X^2 \quad (10)$$

which is a "universal resonance curve" analogous to that given in Terman's book.* The exact cure for $Q = 100$ in Fig. 4 becomes such a "universal resonance curve" in its lower portion, if values of X are used as abscissa instead of percentages off tune.

Phase

Of course

$$i = \frac{e}{Z\ \underline{|\theta}} = \frac{1}{\omega L}\left|\frac{e}{z}\right| \underline{|\theta} = \frac{1}{\omega L}\left|\frac{e}{z}\right| \underline{|\Omega} \quad (11)$$

so

$$-\Omega = \tan^{-1} QW \quad (12)$$

which, paralleling (10) is approximately

$$= \tan^{-1} 2X \quad (13)$$

so that the curves for $Q = 100$ in Figs. 2 and 3 are "universal" if desired, provided we use 0.02X as abscissae.

In some applications the phase linearity is of interest. If the phase shift were linear, we would have

$$(-\Omega) = Cf \quad (14)$$

where C is the slope of the phase curve when $W = 0$, which is Q. Therefore, the departure from linearity, which we may call the linear deficiency, is

$$\left.\begin{aligned} \nabla_r &= QW - \tan^{-1} QW \text{ radians or} \\ \nabla^\circ &= \frac{180}{\pi}\nabla_r \text{ in degrees,} \end{aligned}\right\} \quad (15)$$

Radio Engineering by F. E. Terman.

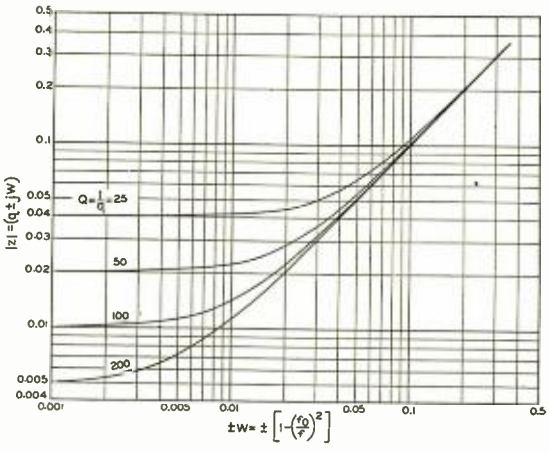


FIG. 2.

in which, from the series expansion for the anti-tangent, it is a close approximation to put

$$\nabla_r = \frac{[QW]^3}{3} = \frac{8X^3}{3} \quad (16)$$

In terms of amplitude, ∇_r is, from (6),

$$\nabla_r = \sqrt{\rho^2 - 1} - \tan^{-1}\sqrt{\rho^2 - 1} \quad (17)$$

Application Note

The above considerations apply of course to a simple resonant circuit with no complications of connection. Actually the circuit may be interposed between two (tetrode or pentode) vacuum tubes. In that case the circuit Q will be reduced by the additional damping X_L^2/R_p reflected in from the plate circuit, where R_p is the plate resistance.

TWO COUPLED ISOCHRONOUS CIRCUITS

Frequency Response

Amplitude

The transfer impedance between the two meshes of a circuit, such as that shown in Fig. 5, is $\bar{Z}$ where

$$\bar{Z} = \frac{e}{i_2} = 2Z_1 + \frac{Z_1^2}{Z_2} = Z_2\left[\frac{2Z_1}{Z_2} + \frac{Z_1^2}{Z_2^2}\right]$$

$$= Z_2 r\,(2 + r) \text{ where } r = \left[\frac{Z_1}{Z_2}\right] \underline{|\theta} \quad (18)$$

Clearly $\bar{Z}$ will be a minimum (amplitude response maximum) when $r = 0$ or $r = -2 = 2\ \underline{|180.}$ This expression is rigorous with no restriction on the nature of Z_1 or Z_2, but for the most usual cases, $Z_1 = X_L(q + jW)$ as explained above. Also Z_2 is ordinarily a reactance whose dissipation will usually be negligible and never sufficient to alter the modulus of Z_2. Therefore we may write

$$r\ \underline{|\theta}\left(\frac{Z_1}{Z_2}\right) = \left(\frac{X_L}{X_2}\right)(q + jW) = \left(\frac{X_L}{X_2}\right)(z')\ \underline{|\theta} \quad (19)$$

where

$\theta = \theta' \mp 90^\circ \pm \phi$, and ϕ denotes the loss angle of Z_2, if any. We have now shown that

$$\left[\frac{\bar{Z}}{Z_2}\right] \cdot \left[\frac{\bar{Z}}{Z_2}\right] = r\,(2 + r) \quad (20)$$

The chart shown in Fig. 6 gives the quantity $r(2 + r)$ as a function of r for all angles θ and ranges of r of ordinary interest. The calculation of two-mesh circuits using these drawings is then as follows: We will, in

general, know the approximate mean frequency which our coupled-circuit system is to accept, also some general idea of the value of Q which is to be considered. Take the mean frequency as f_0; this is only approximately true, but the curve obtained will be exactly identical in shape although shifted by a very few kilocycles; if desired for very accurate work the amount of the shift may be computed from equations given in Appendix A, and f_0 chosen to make the mean or saddle frequency come exactly where desired. Then taking any value f of our frequency variable, we express this value in percentage off tune from f_0 and look up the corresponding value of W on Fig. 1. Then entering Figs. 2 and 3 with this value of W as abscissa, we obtain $(z \,|\, \underline{\theta'})$. Multiplying $z' \,|\, \underline{\theta}$ by the magnitude $\frac{X_L}{X_2}$ we obtain $r \,|\, \underline{\theta}$. Then entering Fig. 6, we obtain the desired value $\frac{\overline{Z}}{Z_2} = \frac{\overline{Z}}{X_2}$. An ordinarily useful approximation of this method is to assume Z_2 to be constant over the small frequency range of usual interest in narrow-band radio-frequency systems.

This method may be used to calculate the response of screen-grid amplifier circuits by the following procedure: Referring to the sketches shown on Fig. 7, we note that, to a close approximation

$$e_2 = i_2 X_L \tag{21}$$

and

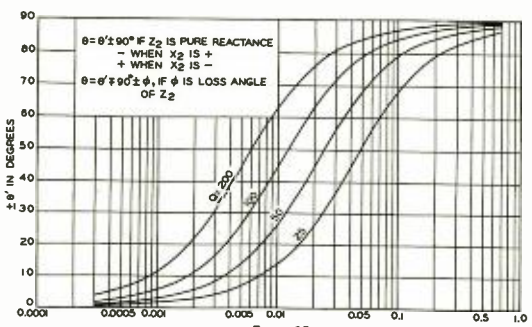
$$e = e_0 \frac{X_L}{R_p} . \tag{22}$$

so that

$$e_2 = e_0 \frac{X_L^2}{R_p} \left[\frac{1}{\overline{Z}} \right] \tag{23}$$

Furthermore,

$$e_0 = \mu \, e_1 \tag{24}$$



$$\pm W = \pm \left[1 - \left(\frac{f_0}{f} \right)^2 \right]$$

FIG. 3.

so that

$$e_2 = \left[\mu \, e_1 \frac{X_L^2}{R_p} \right] \left[\frac{1}{\overline{Z}} \right] \tag{25}$$

and the voltage gain of the amplifier stage grid-to-grid is

$$\frac{e_2}{e_1} = \left[\mu \frac{X_L^2}{R_p} \right] \left[\frac{1}{\overline{Z}} \right] \tag{26}$$

which is the tuned-circuit transfer admittance multiplied by the factor $\mu \frac{X_L^2}{R_p}$. Usually X_L in this expression may to a fair approximation be considered constant over the small frequency band of most interest. This extension to amplifier circuits involves the further approxi-

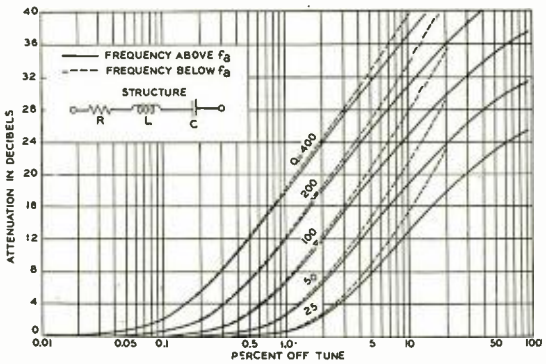


FIG. 4.

mation that the two meshes of the coupling circuit have equal dissipations whereas in practice the one connected to the plate will be affected by R_p and therefore will usually have the larger dissipation. However, it has been found that if we use an average value of Q obtained by adding up the actual values of tuned-circuit resistance and the value of resistance reflected into the circuit from the tuned impedance and consider this total value of resistance equally divided between the two circuits, the resulting value of Q will yield a fairly accurate result.

In Appendix A are tabulated the upper and lower critical frequencies for a few simple types of coupling commonly used, expressed in terms of the resonant frequency of the branch reactance of the circuit, as distinguished from the shunt coupling reactance.

It is also shown in Appendix A, as a matter of interest, that the critical-coupling condition between two isochronous circuits is

$$kQ = k/q = 1 \tag{27}$$

where k is the coupling coefficient of the system, taken as the ratio of shunt to series reactance.

There is some further discussion of the special and important case of transformer coupling in Appendix B.

Phase

We have

$$i \,|\, \underline{\Omega} = \frac{e}{\overline{Z}} \tag{28}$$

$$\overline{Z} = Z_2 \, r \, (2 + r) \tag{29}$$

$$r \,|\, \underline{\theta} = \frac{Z_1}{Z_2} \tag{30}$$

So, for reactance coupling,

$$-\Omega = \pm 90 + \theta + \tan^{-1} \left[\frac{r \sin \theta}{2 + r \cos \theta} \right] \tag{31}$$

A chart for $-\Omega$ is given in Fig. 8. However, in case extensive computations are required for any single type of coupling, it will be easier to express (31) in terms of k, q and W and compute from the resulting expression.

Phase Linearity

It is of course straightforward to plot computations from (31), apply a right line, and obtain the linear deficiencies. But the range covered by (31) is almost 360°. The analytical study of linearity may for some couplings be facilitated if after putting k, q, and W in (31), the half-angle formulae of trigonometry are applied and an expression for $\Omega/2$ is derived. The sweep of angle is then less than 180°, the region of maximum

response only embraces some 90°, and the useful small angle approximations of angle = tangent (or sine) will become more applicable.

It may help to transfer the origin to the approximate mid-point of the characteristics. There will result an expression of the form

$$\tan\left(\Omega+\phi\right)=\frac{B}{A} \tag{32}$$

where B and A are functions of the circuit parameters. Then

$$\tan\left[\frac{\Omega+\phi}{2}\right]=\frac{1}{\sin\left[\Omega+\phi\right]}-\frac{1}{\tan\left[\Omega+\phi\right]}$$
$$=\sqrt{1+\frac{A^2}{B^2}}-\frac{A}{B} \tag{33}$$

Another artifice may be mentioned. Since one is interested in small departures from linearity we may work with the tangent (or sine) of the "linear excess," instead of the angle itself. Then the trigonometric addition formulae may be used.

One may divide through the equation of difference between linear phase and actual angle by the function of

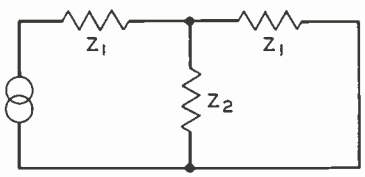


FIG. 5.

frequency (X or W) being used, or by this function multiplied by the slope of the right line. Linear phase then is represented by a horizontal right line, provided the origin of coordinates has been properly shifted, and curvatures are readily seen.

Finally one can always express the total angles relatively simply as the sum of the angle for a single tuned circuit and a residual angle. Then treat the residual

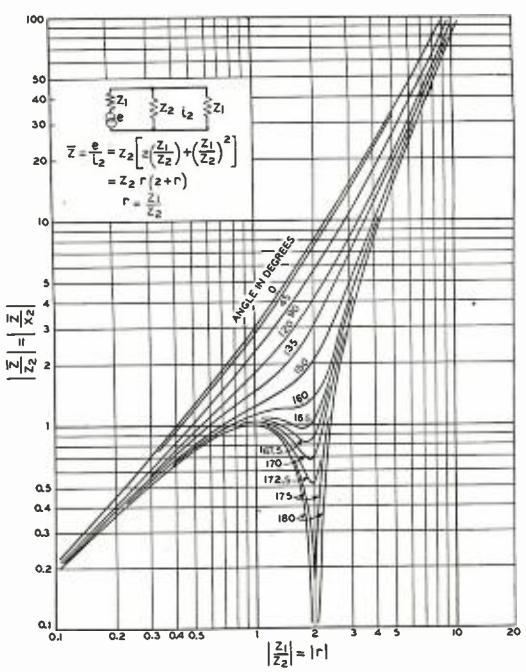


FIG. 6.

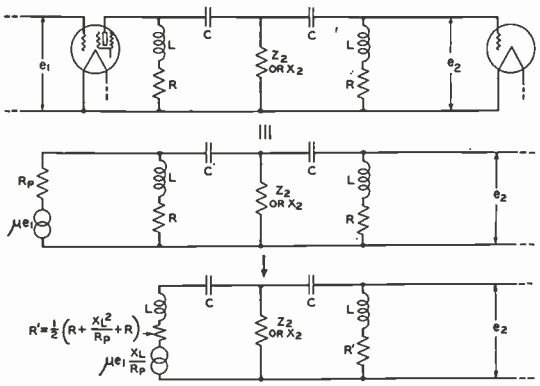


FIG. 7.

angle as a correction term for the linear deficiency of the single circuit.

THREE MESH CIRCUITS

For the circuit of Fig. 9

$$\overline{Z}=\frac{H}{Z_3^2} \tag{34}$$

where

$$H=Z_1\left(Z_2+Z_3\right)\left(Z_1+Z_2\right)+Z_1Z_2\left(Z_1+Z_3\right)+Z_2Z_3\left(Z_1+Z_2\right) \tag{35}$$

We may distinguish two cases for the value of Z_3: If

$$Z_3=Z_1$$
$$H=Z_1\left(Z_1+Z_2\right)^2+2Z_1Z_2\left(Z_1+Z_2\right) \tag{36}$$

and

$$\overline{Z}=Z_2\,r\left(r+1\right)\left(r+3\right) \tag{37}$$

$\overline{Z}$ will have minima for $r=0,-1,-3$.

If

$$Z_3=2Z$$
$$H=Z_1\left(2Z_1+Z_2\right)\left(Z_1+Z_2\right)+3Z_1Z_2\left(Z_1+Z_2\right) \tag{38}$$

and

$$\overline{Z}=Z_2\,2r\left(2+r\right)\left(1+r\right) \tag{39}$$

$\overline{Z}$ will have minima for $r=0,-2,-1$.

FOUR MESH CIRCUITS

In this case, Fig. 10,

$$\overline{Z}=\frac{H}{Z_3^3} \tag{40}$$

where

$$H=\left[Z_2+Z_1\right]\left[Z_1\left(Z_2+Z_3\right)\left(Z_2+Z_3\right)+Z_2Z_3\left(Z_2+Z_3\right)+Z_2Z_3\left(Z_1+Z_2\right)\right]+Z_1Z_2\left[\left(Z_1+Z_2\right)\left(Z_2+Z_3\right)+Z_1Z_3\right] \tag{41}$$

Now for $Z_1=Z_3=Z_5$

$$H=\left[Z_2+Z_1\right]\left[Z_1\left(Z_1+Z_3\right)^2+2Z_1Z_2\left(Z_1+Z_3\right)\right]+Z_1Z_2\left[\left(Z_1+Z_2\right)^2+Z_1Z_3\right] \tag{42}$$

and

$$\overline{Z}=Z_2r\left(r+2\right)\left(r^2+4r+2\right) \tag{43}$$

with minima for $r=0,-2$ and $-2\pm\sqrt{2}$.

But if $Z_3=Z_5=2Z_1$

$$H=\left[Z_2+Z_1\right]\left[Z_1\left(Z_2+2Z_1\right)^2+2Z_1Z_2\left(Z_2+2Z_1\right)+2Z_1Z_2\left(Z_1+Z_3\right)\right]+Z_1Z_2\left[\left(Z_1+Z_3\right)\left(Z_2+2Z_1\right)+Z_1Z_3\right] \tag{44}$$

and

$$Z=Z_2r\left(r+2\right)\left(2r+1\right)\left(2r+3\right) \tag{45}$$

$\overline{Z}$ will have minima for $r=0,-2,-\frac{1}{2},-3/2$.

APPENDIX A

Consider two circuit meshes of self-impedance

$Z_1 = R_1 + jX_1$ coupled by a common reactance $Z_2 = jX_2$. The transfer impedance between meshes is

$$\overline{Z} = 2Z_1 + \frac{Z_1^2}{Z_2} \qquad (1a)$$

With the above components of Z_1 and Z_2 we have

$$\overline{Z} = 2(R_1 + jX_1) + (R_1 + jX_1)\left(\frac{R_1 + jX_1}{jX_2}\right) \qquad (2a)$$

For maximum energy transfer, this impedance must be a minimum. If we make the temporary substitutions

$$\frac{X_1}{R_1} = s; \qquad \frac{X_2}{R_1} = t \qquad (3a)$$

we may transform (2a) into

$$\overline{Z} = R_1/t\ ([2(t+s)] + j[s^2 + 2st - 1]) \qquad (4a)$$

$$|\overline{Z}| = \left|\frac{R_1}{t}\right| \sqrt{4(t+s)^2 + (s^2 + 2st - 1)^2} \qquad (4b)$$

We then find that the conditions for the first derivative to equal zero are

$$t + s = 0 \quad \text{or} \quad t = -s \qquad (5a)$$

and

$$s^2 + 2st + 1 = 0 \quad \text{or} \quad t = -\left[\frac{1+s^2}{2s}\right] \qquad (5b)$$

Therefore

$$X_1 = -X_2 \qquad (6a)$$

$$X_1 = -X_2 \pm \sqrt{X_2^2 - R_1^2} \qquad (6b)$$

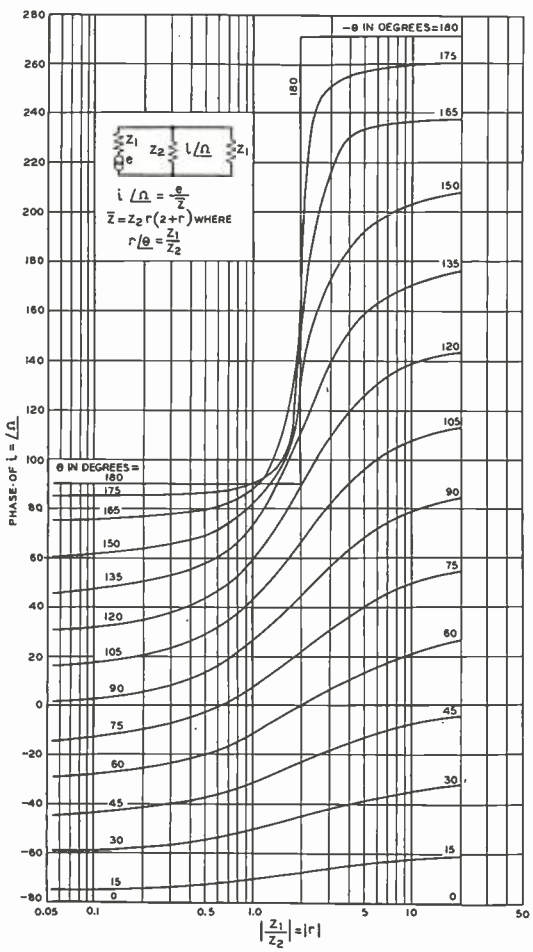


FIG. 8.

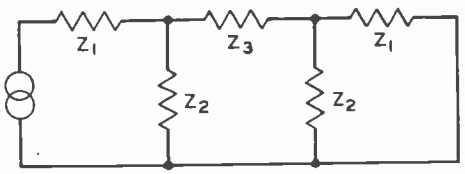


FIG. 9.

It appears obvious from inspection that (6a) must represent the saddle of the curve and (6b) the two outer maxima or horns if such are present, as is the case for $X_2 > R_1$. Furthermore, the critical coupling condition, in which the saddle and maxima "coincide" must be $X_2 = R_1$. But then

$$X_2 = \omega L_2 \quad \text{or} \quad \omega M \quad \text{or} \quad 1/\omega C_2 \qquad (7a)$$

and

$$R_1 = \frac{\omega L_1}{Q} \quad \text{or} \quad \frac{1}{\omega C_1 Q} \qquad (8a)$$

So if k is the coupling coefficient, defined as the ratio of shunt to series reactance, critical coupling means

$$kQ = 1 \qquad (9a)$$

This result gives a rather simple method of finding the critical coupling condition for any type of coupled circuit. For by means of relatively simple transformations* any particular type of coupling involved may without much difficulty be thrown into a form in which the coupling is exhibited as a common or mutual impedance type such as is considered here.

It is considered of interest to list the values of critical frequency for shunt capacity, shunt inductance and mutual inductance coupling with and without the assumption of dissipation in the series arm. The conditions are

$$X_1 = -X_2 \quad \text{and} \quad X_1 + X_2 = \pm\sqrt{X_2^2 - R_1^2}$$

a. When $R = 0$ the frequencies are derived from $X_1 = 0$ and $X_1 = -2X_2$ giving the following

Type of Coupling	$\omega_1 = 2\pi f_1$ (lower)	$\omega_2 = 2\pi f_2$ (upper)
Shunt Capacity	$\dfrac{1}{\sqrt{L_1 C_1}}$	$\dfrac{1}{\sqrt{L_1\left[\dfrac{C_1 C_2/2}{C_1 + C_2/2}\right]}} = \dfrac{1}{\sqrt{L_1 C_1\left[\dfrac{C_2}{2C_1 + C_2}\right]}}$
Shunt Inductance	$\dfrac{1}{\sqrt{C_1(L_1 + 2L_2)}} = \dfrac{1}{\sqrt{L_1 C_1\left[1 + \dfrac{2L_2}{L_1}\right]}}$	$\dfrac{1}{\sqrt{L_1 C_1}}$
Mutual Inductance	$\dfrac{1}{\sqrt{C_1(L_1 + M)}} = \dfrac{1}{\sqrt{L_1 C_1\left[1 + \dfrac{M}{L_1}\right]}}$	$\dfrac{1}{\sqrt{C_1(L_1 - M)}} = \dfrac{1}{\sqrt{L_1 C_1\left[1 - \dfrac{M}{L_1}\right]}}$

*See K. S. Johnson, "Transmission Circuits" for Tel. Comm.

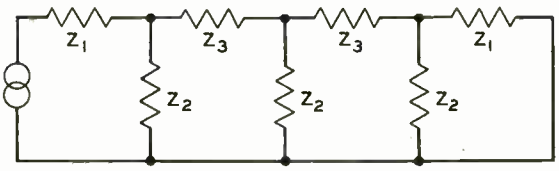


FIG. 10.

Note that for the first two types one frequency is the circuit $L_1 C_1$ by itself while the other is the circuit in series with twice the coupling impedance, as though the

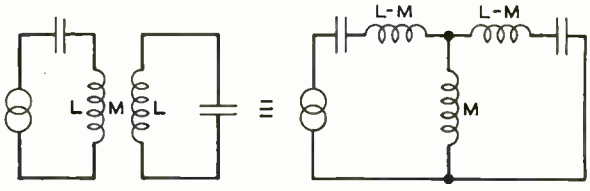


FIG. 11.

coupling impedance actually consisted of two parallel parts of double value, giving two symmetrical meshes. The mutual inductance case values correspond to the two permissible signs for M provided we replace L_1 by $(L_1 - M)$, or it may be thought of as following the same law as the first two if we consider that the series mesh alone is actually $L_1 - M_1$ as shown by the T network.

b. When $R > 0$, the solutions are less accessible. Starting with

$$X_1^2 + 2X_1X_2 + R_1^2 = 0,$$

note that $X_1 = \omega L_1 - 1/\omega C_1 = \omega L_1\left(1 - \frac{\omega_0^2}{\omega^2}\right)$ where $\omega_0^2 = 1/L_1 C_1$; also that $\frac{\omega L_1}{R_1} = Q$. Let $W = \left(1 - \frac{\omega_0^2}{\omega^2}\right)$ and $\omega L_1 = X_L$. Then the initial equation may be recast into

$$W^2 Q^2 + 2Q^2 \left(\frac{X_2}{X_L}\right) W + 1 = 0$$

Solving, we can get

$$-\left(\frac{X_2}{X_L}\right) = \frac{1 + W^2 Q^2}{2Q^2 W} = \frac{1/Q^2 + W^2}{2W} = \frac{q^2 + W^2}{2W}$$

if we let $1/Q^2 = q^2$, or

$$W = \frac{-2Q^2\left(\frac{X_2}{X_L}\right) \pm \sqrt{4Q^4\left(\frac{X_2}{X_L}\right)^2 - 4Q^2}}{2Q^2}$$

$$W = -\left(\frac{X_2}{X_L}\right) \pm \sqrt{\left(\frac{X_2}{X_L}\right)^2 - q^2}$$

Whence

$$\omega = \frac{1}{\sqrt{(L_1 C_1)\left(1 + \left[\frac{X_2}{X_L}\right] + \sqrt{\left[\frac{X_2}{X_L}\right] - q^2}\right)}}$$

Our table of peak frequencies, including dissipative effects, then will be as follows:

Type of Coupling	$\omega_1 = 2\pi f_1$ (lower)	$\omega_2 = 2\pi f_2$ (lower)
Shunt Capacity	$\frac{1}{\sqrt{L_1 C_1\left[\frac{C_2 + C_1 + \sqrt{C_1^2 - C_2(2C_1 + C_2)q^2}}{2C_1 + C_2}\right]}}$	$\frac{1}{\sqrt{L_1 C_1\left[\frac{C_2 + C_1 - \sqrt{C_1^2 - C_2(2C_1 + C_2)q^2}}{2C_1 + C_2}\right]}}$
Shunt (Direct) Inductance	$\frac{1}{\sqrt{C_1(L_1 + L_2 + \sqrt{L_2^2 - L_1^2 q^2})}} = \frac{1}{\sqrt{L_1 C_1\left[1 + \frac{L_2}{L_1} + \sqrt{\left(\frac{L_2}{L_1}\right)^2 - q^2}\right]}}$	$\frac{1}{\sqrt{C_1(L_1 + L_2 - \sqrt{L_2^2 - L_1^2 q^2})}} = \frac{1}{\sqrt{L_1 C_1\left[1 + \frac{L_2}{L_1} - \sqrt{\left(\frac{L_2}{L_1}\right)^2 - q^2}\right]}}$
Mutual Inductance	$\frac{1}{\sqrt{C_1(L_1 + \sqrt{M^2 - q^2(L_1 - M)^2})}} = \frac{1}{\sqrt{L_1 C_1\left[1 + \frac{\sqrt{M^2 - q^2(L_1 - M)^2}}{L_1}\right]}}$	$\frac{1}{\sqrt{C_1(L_1 - \sqrt{M^2 - q^2(L_1 - M)^2})}} = \frac{1}{\sqrt{L_1 C_1\left[1 - \frac{\sqrt{M^2 - q^2(L_1 - M)^2}}{L_1}\right]}}$

For $q = 0$, all these of course reduce to the forms given in the earlier table.

APPENDIX B—TRANSFORMER COUPLING

We may apply the preceding treatment to the case of transformer coupling by resolving the transformer into its equivalent T network, as in Fig. 11,

and we shall have

$$Z_1 = \omega\ (L - M)\ (q + jW') \qquad (1b)$$

$$Z_2 = j\omega M \qquad (2b)$$

$$r = \frac{Z_1}{Z_2} = \frac{L - M}{M} z' \Big| \tan^{-1} \frac{W'}{q} - \pi/2 \qquad (3b)$$

In this we must remember that our W refers to the series branch resonance at $\omega^2 (L - M) C = 1$, and is given a prime mark to emphasize this fact. This resonance is the upper critical or maximum response frequency, the other being $\omega^2 (L + M) C = 1$. These are, for the usual weak couplings, about symmetrical with respect to the mesh resonance $\omega^2 LC = 1$. Observe that also for the usual weak couplings,

$$\frac{L - M}{M} \cdot \frac{L}{M} = \frac{1}{k} \qquad (4b)$$

if k represents the usual coupling coefficient M/L.

It is possible to apply the general method in another way. Call the total impedance around the primary (or secondary) mesh Z_p and the mutual impedance Z_m. Then it is easily shown that the transfer impedance

$$\overline{Z} = \frac{Z_p^2 - Z_m^2}{Z_m} = Z_m \left[\frac{Z_p^2 - Z_m^2}{Z_m^2} \right] = Z_m\ [r_0^2 - 1] \qquad (5b)$$

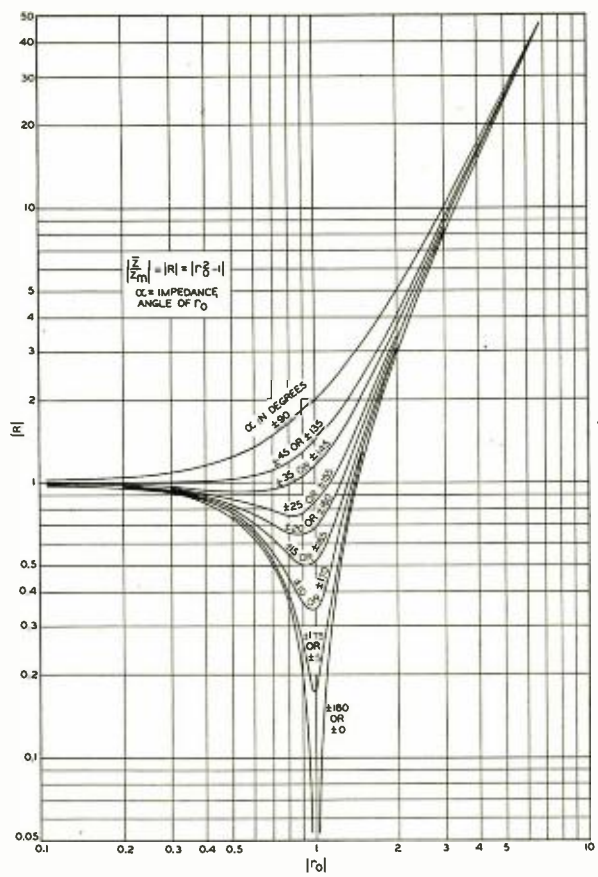


FIG. 12A.

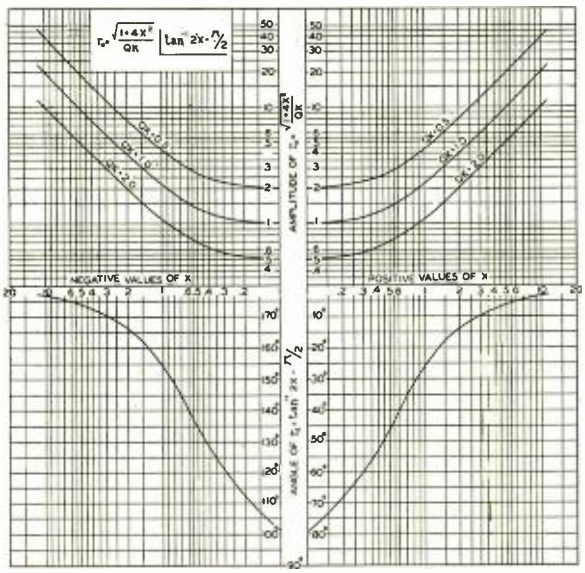


FIG. 12B.

in which

$$r_0 = \frac{Z_p}{Z_m} = \frac{\omega L\ (q + jW)}{j\omega M} = \frac{L}{M} z \Big| \tan^{-1} \frac{W}{q} - \pi/2 \qquad (6b)$$

By constructing a chart of $r_0^2 - 1$ the general method is nicely usable in this manner. Since we now operate symmetrically about the resonance of either circuit alone, many workers will prefer this alternative. The resulting chart is given in Fig. 12-A.

Of course we may apply the "universal curve" approximation of equation (9),

$$W = \frac{2}{Q} [X] \qquad (7b)$$

and find

$$r_0 = \frac{\sqrt{1 + 4X^2}}{Qk} \Big| \tan^{-1} 2X - \pi/2 \qquad (8b)$$

but this is not particularly useful in (5b) until charted in Fig. 12-B as will be noted.

An alternative chart construction for (5b) is of interest.

Let

$$r_0 = \rho \Big| \alpha \quad \text{and} \quad |r_0^2 - 1| = R \qquad (9b)$$

Then

$$r_0^2 - 1 = [\rho^2 \cos 2\alpha - 1] + j\rho^2 \sin 2\alpha \qquad (10b)$$

and

$$R^2 = (\rho^2 + 1)^2 - 4\rho^2 \cos^2 \alpha \qquad (11b)$$

This is transposable into

$$R^2 + (2\rho \cos \alpha)^2 = (\rho^2 + 1)^2 \qquad (12b)$$

which is the equation of a family of circles with center at the origin. Now we are only interested in positive values of R and in values of α between 0 and $-\pi$. So plot two families of half circles with centers in a common vertical line. The lower family is plotted in polar coordinates with radius vectors 2ρ long, so the X projection is $2\rho \cos \alpha$. This abscissa is then projected up into the upper circle family until the circle of same ρ is intersected (its real length is $[\rho^2 + 1]$). The corresponding ordinate is R. A plot of (8b) is indicated on Fig. 12-B.

Tantalum Capacitors

By BERNARD H. PORTER, Sc.M.

ELECTROLYTIC CONDENSERS as developed from Wheatstone's discovery of the polarizing effect of aluminum have become one of the important devices utilizing the characteristics of a filmed metal in the presence of a suitable electrolyte. The dielectric properties of films in this condition provide the electrostatic capacity that is used to advantage in such applications as high-capacitance filter condensers for both radio and d-c telephone power circuits. While an electrolyte-like ammonium borate solution has proven quite satisfactory for use with aluminum, the chemical action of certain electrolytes on the electrodes and the corrosion of the anode are oftentimes troublesome conditions affecting the life of the cell. These factors along with the tendency for the energy losses of the aluminum capacitors to increase with time as the voltage is increased are the major reasons that have prompted extensive laboratory studies on the use of tantalum as an anode for the electrolytic condenser. As this type of cell continues to enjoy applications in radio and related fields, a brief review of its characteristics, methods of testing, and applications should be of general interest.

TANTALUM

Tantalum sheet, commercially available only within the last few years, is relatively expensive and for this reason must be made very thin before comparing favorably in price with aluminum used in condenser manufacture. Such a foil presents, however, many advantages in superior performance. Not only can a tantalum cell be used for the same purposes as aluminum electrolytic condensers but it is generally adaptable to any application where a permanent capacitor is required to carry considerable currents. Such adaptability to broader fields of application is partly because the internal resistance of a tantalum cell can be made very low and partly because the condenser will operate at the high temperatures that would ordinarily destroy the film on an aluminum anode. The fact that the oxide coating on tantalum is not soluble in the electrolyte also contributes to a condenser of more permanent character when this metal is employed.

Furthermore, tantalum resists the corrosive action of all chemicals except strong caustic alkalis and mixtures containing hydrofluoric acid, thus making possible many electrolyte solutions as, for example, sulphuric acid, the chloride, borate, and sulphate of ammonium in addition to various mixtures of sulphuric acids with other salts. Recent investigations on the use of other prepared electrolytes, particularly those of the reputed "cell-healing" type, have permitted increasing the critical voltages of the uni-directional tantalum cell beyond those values, as follows:

Sulphuric acid (1.01 sp. gr.)..150 volts
Sulphuric acid (1.20 sp. gr.)..100 volts
Ammonium borate .....250 volts

Inasmuch as acid electrolytes have relatively low electrical resistance, the more compact design of electrodes is unnecessary as in the aluminum cell when small resistance is desired. The negative electrode of the tantalum cell may be of any material not soluble in the electrolyte, pure molybdenum and molybdenum-tungsten being satisfactory for use in sulphuric-acid solutions.

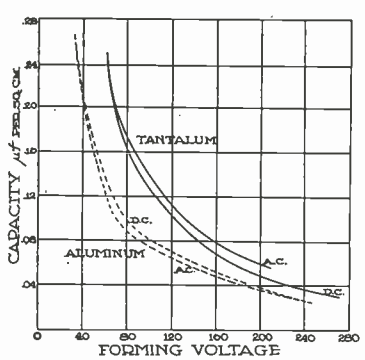


Fig. 1. Capacity and effective forming voltage for the a-c and d-c formation of tantalum films. For the purpose of comparison this relation is shown by the dotted line for aluminum foil.

FILM PROPERTIES

Theoretically, the valve action of a tantalum condenser is explainable by one of three concepts: The gas-oxide theory suggesting a solid oxide film in which a layer of gas forms, the solid oxide proposal that the film alone acts as a dielectric, and the adsorbed-liquid

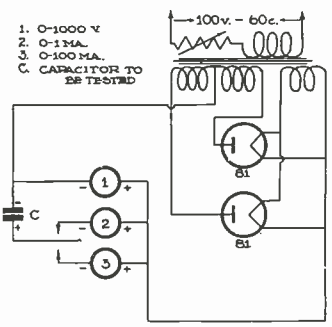


Fig. 2. Circuit for a d-c leakage test.

postalate wherein there is a diffusion of ions from the electrolyte into the film layers. In any case (the first theory being preferred), the film is extremely thin and is formed when some voltage greater than the critical one is impressed across the cell terminals. The thickness of the film and its rate of formation depends on the potential applied. If the voltage is now reduced after having reached a maximum, the film gradually reduces its thickness to a point where it will permit an increase in capacity. Because of this slow reduction in the thickness of tantalum films, it is imperative that the same be subjected to voltages not higher than the normal operating value, as an increase in film thickness and a corresponding decrease of capacity will result. Under normal conditions, however, the fact that a current of a density less than one microampere per sq. cm. of film will flow when a small fraction of the maximum voltage is impressed explains the high order of resistances attainable from such a condenser. The relation of decreased capacitance as the impressed voltage is increased is shown in Fig. 1.

LEAKAGE

The electrical leakage of a tantalum capacitor operating below its critical voltage is extremely small. Condensers having a capacitance of several hundred microfarads frequently have leakage currents of only a fraction of a milliampere. Whenever the leakage greatly exceeds this value the cause is usually due to metals that have become attached to the anode, as for instance,

the deposits burned into tantalum from welding electrodes during the fabrication by spot welding. It is also true that cell leakages in excess of the above value result in the electrolytic decomposition of the cathode, a defect much to be avoided. The conventional procedure of measuring direct-current leakage by applying the rated voltage to the capacitor through a milliammeter is shown in Fig. 2. Two milliammeters are provided in this circuit for the measurement of the initial high values as well as the lower stable ones that are present after the capacitor has assumed normal characteristics.

A-C TYPE CAPACITORS

The alternating-current type of electrolytic capacitor differs from the direct-current design by being non-polarized. When forming the cell by the former current, it is necessary to use two anodes of equal areas since the positive electrode of a cell serves as a good rectifier and will permit the flow of conduction currents if its potential is lower than that of the electrolyte. Because of this rectifying action at the anode, the electrolyte will acquire a negative charge of sufficient magnitude to stop the flow of current from the solution to the electrodes. Each anode, of course, functions alternately and at the moment when negative merely serves as electrical contact for the cell solution. The general characteristics of these condensers are similar to the uni-directional designs. Practical experience, however, has shown that the wet type electrolytic capacitors are not readily adaptable for alternating-current service. Not only is the power factor relatively high for this type of cell, but the questions of economy and size must also be considered. (A discussion of the dry-type of a-c electrolytic capacitor appeared in the May issue of RADIO ENGINEERING.)

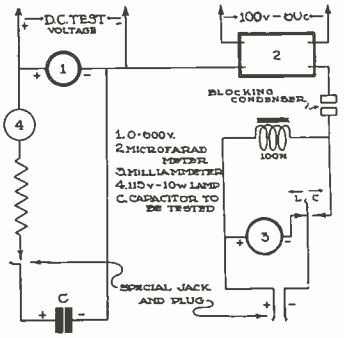


Fig. 3. Circuit for the rapid measurement of electrolytic capacitance and leakage.

TESTING

In the capacitance measurements of an electrolytic cell, either the impedance method using a voltmeter and an ammeter, or the usual bridge method may be employed. In any case, a direct-current polarizing voltage should be maintained and in excess of the peak value of the alternating-current measuring voltage. Such a procedure prevents the anode from becoming negative in relation to the electrolyte.

Fig. 3 shows a circuit successfully used for the rapid measurement of capacitance and leakage. This impedance method employs a Weston microfarad meter that has been recalibrated to take into account the blocking capacitor. The 10-watt lamp indicates conditions of high leakage and the presence of a short. Leakage is read when the switch-key is in position L and capacitance is noted when the same is in position C.

APPLICATIONS

Although only recently developed, tantalum capacitors enjoy a wide range of application. Of these the suppression of radio interference in special instances is noteworthy. Whenever the interference can be traced to the make and break of electrical contacts in rotating machines, synchronous converters, etc., a substantial reduction and in some instances a complete elimination of the same can be effected by connecting capacitor-type filters on both the alternating- and direct-current terminals of the machine in question. The capacitor's role as a filter of large capacitance for use in many radio power circuits has already been mentioned. As low-pass electric wave filters, the same are placed in the supply circuits of central office storage batteries to eliminate noise-producing pulsations from subscriber's circuits when the battery is charged while operating the switchboard. Similar units furnishing power for telegraph hook-ups also use such filters.

The electrolytic cell, as a device for power-factor correction, has already been used on neon signs and condenser-type induction motors and may offer other possibilities in this connection, as for instance, alternating-current networks, when further research makes this type of cell more applicable to a-c service. Development work on their use for the starting of certain synchronous motors and for the surge protection of direct-current generating equipment has reached an advanced stage. Prospects for the future developments utilizing the tantalum cell will undoubtedly be related to its ability to carry large currents at greater temperatures than the aluminum capacitor.

HIGH-FIDELITY RADIO IN GERMANY

LITTLE HAS BEEN done in Germany to cover the entire country with high-fidelity radio. The main transmitter in Berlin handles broadcasts ranging from 30 to 10,000 cycles per second. The cables for this transmitter, as well as those connecting it with other transmitters, handle from 50 to 6,400 cycles per second.

The broadcasters feel that this covers the complete range as to fidelity of sound, but unfortunately no receiving apparatus is built in Germany that will give such true fidelity. The buying public does not appear to be interested in improving the quality, and the manufacturers believe that to enter the field of high-fidelity reception would increase the cost of receiving sets which are already extremely high.

Patent exchange agreements and foreign exchange regulations make it impossible to sell American receiving sets in Germany. (Assistant Trade Commissioner Rolland Welch, Berlin, *Electrical Foreign Trade Notes.*)

•

CANADIAN RADIO BROADCASTING ACT EXTENDED

UNDER TERMS of Bill No. 99 Parliament passed an amendment to the Canadian Radio Broadcasting Act, 1932, which extends the life of the Commission a further period of nine months, to March 31, 1936.

In introducing the government bill the Minister of Marine observed that reports of recent governmental investigations into radio had made no deviation from the unanimous decision of Parliament in 1932 that radio broadcasting should become a public utility. However, it was not considered at this time advisable to implement the recommendations of the last parliamentary committee of inquiry which suggested provision for better broadcasting facilities throughout the Dominion and the substitution of a general manager for the present Commission of three members in charge of the national system.

It was brought to the attention of Parliament by one of the members that among smaller stations a number of instances of a single company owning several outlets existed in Canada. It was suggested that a monopolistic trend was developing. The Prime Minister made reply to the statement that all new licenses had been issued subject to the condition that the state may take over facilities and that no good-will value attaches a license. It was again stated by the Minister of Marine that the Commission intended to construct a powerful station in the Vancover area in the near future. (*Electrical Division, Department of Commerce.*)

The Spanish Radio Market

BY ANDREW W. CRUSE*
Chief, Electrical Division,
U. S. DEPARTMENT OF COMMERCE

BROADCASTING

SIXTY-FIVE STATIONS are listed as operating in Spain at present by the Direccion General de Telecomunicacion, with one being under construction. All these stations, with the exception of one, operate on wavelengths from 200 to 500 meters.

Tenders for a group of 10 stations forming a national network were called and opened on June 10, 1935, with four international groups bidding. It will require some months to determine the most advantageous of the bids, because of the technicalities of the various bids, and after adjudication action by the "Cortes" (national legislature) it will be necessary to authorize the credits involved.

A short-wave station, of probably 20,000 watts power, is considered for possible future action.

The legislation authorizing the national network provides for a gradual elimination of existing stations as their concessions expire, with a proviso that stations will be continued where the replacing national stations are not operating by the date of such expiration.

The national chain is to include a 150,000-watt long-wave station at Madrid and nine stations on the broadcast band; a 60,000-watt station in Seville province; 50,000-watt stations in Madrid and Barcelona provinces; 30,000-watt station in Couina and Vizcaya; a 20,000-watt station in Valencia; and 5,000-watt relay stations in Murcia and Oviedo. The tenth station will be of 10,000 watts, in the Canary Islands.

With the construction of the 10 stations above described, receiving license fees will be materially increased, it is stated at Government offices. Although provision was made for license fee increases in a Law of June 26, 1934, these have not been put into effect, pending the completion of the national "network." Under that law crystal sets would be assessed 1,50 pesetas a year, one to five-tube sets 12 pesetas a year, more than five tubes 24 pesetas a year.

MARKET

Crystal Receiving Sets: The demand for crystal sets is limited, especially since the advent of medium priced tube sets. Only between 6,000 and 7,000 crystal sets are estimated in use at present. A great part of these are home assembled and are found mostly in homes not provided with electric service.

Battery Receiving Sets: These are not sold in any appreciable quantity, inasmuch as it is difficult to obtain recharging in sections of Spain where current is not available. The number of these in Spain is roughly estimated at from 2,000 to 3,000.

Socket Power Receiving Sets: Approximately 80 percent of all sets in Spain is estimated to be of this type.

Short-Wave Receiving Sets: The number of short-wave receiving sets is estimated at only about 200, mainly in commercial telegraphic services.

All-Wave Sets: This class surpasses all others in popularity, according to present sales information, and may for the present be considered the standard marketable type.

Table Sets: Use of this type of receiver has increased extensively, especially during the past year. The five- and six-tube, all-wave table sets are proving most popular, and those with the "airplane dial" are most in demand.

Automobile Sets: Sales of automobile sets have not been active, owing largely to difficulties of proper installation on older cars. Also, their cost militates against their sale. Therefore, the bulk of them are on cars in which they are imported already installed. The total number is estimated at 2,000.

GENERAL MARKET

It is estimated that since January 1, 1935, 40,000 radio receiving sets have been sold in Spain of which fully 30,000. it is stated, would be all-wave sets. Of these, it is estimated, fully 85 percent are portable or table type receivers. The percentage of all-wave sets in operation is believed to be 25 percent of the estimated total of 500,000 receiving sets owned in Spain. It is expected that this percentage of all-wave sets to total sets will markedly increase, owing to the present active demand for all-wave receivers.

Non-Assembled or Partially Manufactured Sets: Independent manufacture of radio sets from non-assembled parts, apart from the Philips of Holland branch factory in Spain (Philips Iberica S. A. E.) using almost exclusively Dutch imported parts, is very restricted. It is believed that independent assemblage does not amount to more than 5,000 units a year. There are, it is stated, from 20 to 30 small "factories" in Barcelona, changes among which are said to be frequent. These "factories," it is reported in the trade, sell their products direct to the consumer. Their output is said not to be more than 2,000 sets a year.

Category C-654 bis of the Spanish tariff covering radio tubes provides for a conventional import duty of 59.80 gold pesetas per kilogram, whether imported as component parts of sets or not. (The latest declared value of the gold peseta for customs purposes is 2.3879 paper pesetas equal to 1 gold peseta).

The Establecimientos Castilla, S. A. E. of Madrid, was originally formed to manufacture radio tubes. It now also manufactures radio sets on a small scale. Industrias Rodioelectricas Gortari, of Madrid, turns out the "Askar" receiver in different models. This firm is reported to have no distributors and to sell directly to the consumer. A large part of the production of both these firms is said to be from imported non-assembled or partially assembled apparatus.

Receiving Sets in Use: Details as to license charges current in Spain and those provided for under the Law of June 26, 1934, to go into effect at the completion of the 10 new stations have been previously mentioned. The number of licenses outstanding as of June 1, 1935, is estimated at about 250,000. At the beginning of the year the number of licenses issued during 1934 was placed at 210,000. Licenses issued during 1933 total 154,662. It is estimated, however, that these figures must be multiplied by at least two to obtain an approximate estimate of the number of sets operating in Spain. Following the eventual inauguration of the 10 new radio stations provided for in the recent tender, it is planned to conduct a widespread campaign against unlicensed sets.

Competitive Position of Foreign Sets:

*Revised by Assistant Trade Commissioner Miles Hammond, Madrid.

Generally in the trade it is estimated that American sets account for 60 percent of all sales. About 20 percent is allotted Philips of the Netherlands; about 8 percent to Germany and the remaining 12 percent among Great Britain, Belgium, and other countries. The outstanding foreign sets are "Philips," "His Master's Voice," "Telefunken," "Nora," "Seibt," "Blau-Punkt" (sold under the trade name, "Punto Azul"), and "Ericsson, S. A." This latter make, it is stated, has not obtained an appreciable amount of business as yet, inasmuch as it sells for 1,150 pesetas for the five-tube set, which is higher than similar foreign products.

American Makes: Five popular American sets are offered in an average of 13 models each. These models are priced from a minimum of 250 to a maximum of 3,200 pesetas. One-half of the models are priced between 580 and 1,300 pesetas, but the most closely grouped prices fall between 500 and 800 pesetas.

TELEVISION IN SPAIN

No steps whatsoever, it is stated, have been taken by the Government to conduct any experiments in television. Private activities in this matter have been likewise negative in recent years. About 4 years ago some experiments were carried out by Union Radio, S. A., Madrid, but the results were reported negative.

PATENT LICENSING

The Philips Iberica, S. A. D. (branch of Philips, Holland) is reported to be the only organization holding Spanish radio patents. Small manufacturers do not generally observe patent procedure. The Establecimientos Castilla have a license to manufacture radio tubes under Philips' patents.

TERMS OFFERED ON SETS

Installment sales are usual. Philips grants terms up to one year. It is stated, however, that several dealers of other makes allow still larger terms going up even to 2 years, but in the case of these longer extensions, prices are increased by 10 percent and sometimes 15 percent.

Cutting of prices is common and this is said to be particularly true regarding American makes. This is laid to the fact that numbers of dealers found themselves overstocked with American makes, having imported sizable quantities from the United States on the prospect of selling them on a good margin of profit* Too many dealers, it is stated, had the same idea. Now those overstocked are endeavoring to rid themselves of some of their stocks—at least, by cutting prices, with the result that price competition is very active.

*It is believed that overstocks are principally standard broadcast receivers.—EDITOR.

● **SPANISH STATIONS OPERATE IN STANDARD (AMERICAN) BROADCAST BAND, THE GREATER MAJORITY USING WAVELENGTHS FROM 200 TO 239 METERS. PRESENT DEMAND IS FOR TABLE MODEL ALL-WAVE RECEIVERS WITH AIRPLANE DIALS AND USING BETWEEN 5 AND 7 TUBES. AMERICAN RECEIVERS AND TUBES LEAD THE MARKET. FUTURE PROSPECTS APPEAR GOOD, DUE TO ESTABLISHMENT OF BROADCAST-STATION NETWORK.**

As a rule, wholesalers representing American makes give 60- and 90-day credit terms to their dealers, although as stated above longer terms are allowed in the retail trade, the general period for installment payments is one year. Several firms finance sales to dealers through an associated organization which handles the credit papers. Firms representing American manufacturers generally sell at least two makes: One for high quality and the other to be sold on a price competition basis.

EXCHANGE SITUATION

The exchange situation created by measures restricting the granting of foreign exchange by the Exchange Control Board has created an increasingly serious problem in the radio market, it is stated, not only from the point of view of the exporter and his bank, but also as concerns the importer who is faced with the uncertainty of possible future exchange fluctuation through the necessity of waiting for authorization for the remittance of dollars to cover orders. One firm is of the opinion that as a result of the exchange control problem that prices in consequence will advance, but this fails to bear out other reports that a number of dealers are at present overstocked with American makes.

SPANISH IMPORT STATISTICS

The outstanding comparison noted in 1934 kilogram figures as contrasted to 1933 in tube importations is the very marked increase of 187.1 percent. This increase is laid to increased importation of sets, which for 1934 amounted to 70.0 percent more than for 1933, thereby increasing the demand, to the reported inability of the Spanish tube industry to compete with foreign, especially American, tubes, and particularly to the ministerial order of March 13, 1934, published in the Gaceta de Madrid of March 15, 1934, page 1998.

Under this order tubes imported with sets are placed in the C-645 bis category of the customs tariff covering radio tubes, while formerly they were classified under category C-643 as component parts of radio sets. This latter category also includes telephone and telegraph material though it is considered radio sets and equipment predominate. Tube importations since March, 1934, therefore, would be shown at a greatly increased figure inasmuch as those in sets would be included in the category covering radio tubes. Category C-643 (radio equipment) carries a conventional duty of 2.88 gold pesetas per kilogram net weight and category C-645 bis, radio tubes, is assessed a conventional duty of 59.80 gold pesetas net weight.

An increase has not taken place to an extent to be expected in radio equipment imported from the Netherlands as the result of the new commercial treaty between Spain and that country (Decree of December 7, 1934, Gaceta de Madrid of December 9, 1934), whereby radio parts imported from the Netherlands under category C-643 of the Spanish tariff would pay 2.30 gold pesetas per net kilogram instead of the conventional rate of 2.88 gold pesetas per net kilogram. Netherlands' participation in total kilogram Spanish radio equipment (radio equipment is grouped in the general category with all telephone and telegraph material, though radio equipment is considered to predominate) imported under category C-643 during January-April, inclusive, 1935 (provisional figures), was 29.1 percent as compared with the 1934 like period (provisional figures) participation of 19.6 percent and the 1934 year participation of 20.0 percent. In fact, quantity imports from the Netherlands in this category declined from 149,666 kilograms for January-April, 1934, to 97,157 kilograms during the like 1935 period. The lower percentage participation of the Netherlands in radio equipment importation during January-April, 1934, was due to especially heavy imports from the United States. Quantity (in kilograms) imports of radio equipment from the United States increased 72.6 percent in 1934 over 1933 as compared with increased quantity total imports under this category of 70 percent.

Tube imports by weight from the United States increased by 333.3 percent in 1934 contrasted to 1933, whereas total tube imports by weight during the same comparative period increased 187.1 percent.

BOOK REVIEW

FUNDAMENTALS OF RADIO, by R. R. Ramsey (Professor of Physics, Indiana University), published by Ramsey Publishing Co., Bloomington, Indiana, second edition, 426 pages, price $3.50.

Probably the most satisfactory way of describing the nature of this book is to quote from the preface to the first edition written by R. R. Ramsey in 1929:

"In the *Fundamentals of Radio* I have endeavored to give the basic theory of radio as it is exemplified in modern practice. Perhaps if the fundamentals were limited in number to two, they might be given as the resonant, or wave meter circuit and the three-electrode vacuum tube. This book will be found to be largely based on these two conceptions. An elementary knowledge of electricity, such as that usually given in a first course in Physics, is assumed. Although I have endeavored to give a non-mathematical treatment of the subject, some Calculus has been introduced in a few sections. These mathematical sections have been developed and explained in a way which I hope will be helpful to the non-mathematical reader. The text has been illustrated by a large number of diagrams and pictures of radio apparatus. It has not been my purpose to illustrate all the modern circuits and 'hookups.' A few typical circuits are given to show how the fundamentals are applied in modern practice."

For those who are already familiar with the first edition of this book, the second edition contains a new chapter on "Multi-Electrode Tubes." The new tubes and the classification of amplifiers and oscillators into Class A, B, and C have necessitated many changes in the old chapters. The chapter on "Coupling" has been rewritten so as to have a more direct application to the usual radio circuits. And, lists of problems and questions have been added.

Fundamentals of Radio contains thirty-one chapters the titles of which follow: "Electricity, Direct Current," "Batteries," "Measurement of Resistance," "Alternating Current," "Introduction to Radio," "Capacity," "Inductance," "Radio Waves; Radio Current; Transmission," "Detectors," "Vacuum Tubes," "The Two-Electrode Tube and Rectified Alternating Current," "Vacuum-Tube Constants," "The Vacuum Tube Used as a Detector," "The Tube as an Amplifier," "The Tube as an Oscillator," "Multi-Electrode Tubes," "Coupled Circuits," "How Radio Messages Are Transmitted by the Ether," "Radiation From An Aerial," "Aerials," "Radio-Frequency Instruments and Apparatus," "Radio Resistance," "Spark Transmission," "Long-Wave C. W. Transmitters," "Vacuum-Tube Transmitters," "Radio Telephone," "Receivers," "Audio Amplification," "Balanced Circuits," "Loudspeakers," and "Applications of the Vacuum Tube," respectively. Numerous references are given throughout the book and these add considerably to its completeness. *Fundamentals of Radio* is to be recommended.

•

RADIO DESIGN PRACTICE, edited by James Millen, with drawings by M. B. Sleeper, published by James Millen, Inc., Malden, Mass., 260 printed pages, looseleaf binding with board cover. Price $1.00.

Radio Design Practice, First Edition, 1935, is an unusual compilation of mechanical and electrical specifications of radio components and complete units. Your reviewer does not recall ever having seen anything quite like it in print. Mr. Millen refers to it as "An idea book for engineers, experimenters, and designers of radio and associated equipment." Certainly it should be of unending value to the design engineer, the amateur and the experimenter, who require precise component specifications.

As far as possible, all drawings have been made one-half size. These drawings were made from the actual parts themselves, and care has been taken to assure their accuracy in order that dimensions not given may be scaled off.

The First Section deals with the assembly practice of relay racks. Specifications are given for National and Western Electric units. The Second Section deals with transmitting- and receiving-type variable condensers. Specifications are provided in the latter part of the Second Section for high- and low-voltage fixed condensers; paper, mica and electrolytic.

Subsequent sections deal with dials, inductance forms, r-f chokes, coil and tube shields, sockets, insulators, resistors, switches, plugs and jacks, and meters. Companies represented are: National, General Radio, Electrad, Aerovox, Weston, and General Electric.

Specifications for National and Delta transformers and chokes are also included.

The Third Section covers National, Western Electric, and Federal receivers. The Fourth and Fifth Sections deal with Western Electric and Federal transmitters and speech-input equipment. The Sixth Section with special apparatus, such as signal generators, made by General Radio.

These sections are followed by 78 pages providing the characteristics and operating conditions for the complete line of Sylvania receiving-type tubes. No data are provided on transmitting type tubes.

Twenty pages are given over to design details, servicing data, etc., on the National HRO Communication Receiver. The last 24 pages in the book are National and Acme-Delta catalogue sheets.

•

PRACTICAL RADIO COMMUNICATION, by Arthur R. Nilson and J. L. Hornung, published by McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y., first edition, 754 pages, price $5.00.

As the name implies, this is a practical book covering the field of radio communication. This book was planned to meet the expanded scope of technical radio developments, and was written to provide within one volume most of the technical information required by the practical radio operator-technician.

The authors state that "The book is divided roughly into two parts: Principles and Practice. The first six chapters are given over to principles and the remaining nine chapters to practice. High-grade technical skill is always founded on a sound basis of fundamental principles. It has been our purpose, therefore, to go into these principles extensively, delving deeply into alternating current, which plays an important part in modern radio. It is on the assumption that these principles have already been mastered that the practical sections of the book have been written. In fact, it is necessary that these principles be understood before the practical sections can be read intelligently."

Chapter I, entitled "Direct-Current

Electricity and Magnetism," has been divided into three parts. The first part covering "Elementary Electricity" begins with the customary electric charges and forces, protons, electrons, potential, and the like, and ends with dry cells, the telephone receiver and transmitter. Part two discusses "Magnetism and Electromagnetism," covering natural and artificial magnets, poles of a magnet, magnetic fields, theory of magnetism, production of an electromotive force by a field cutting a conductor, etc. The third part deals with the magnetic circuit covering Ohm's law for the magnetic circuit, computations, and hysteresis.

Chapter II has been given over to the subject of alternating currents, the subjects of alternating-current generation and transformation, inductance, capacity, and the elements of alternating-current engineering each receiving their allotted space.

The third chapter discusses vacuum tubes, their characteristics, radio-frequency amplifiers, and vacuum-tube oscillators. Chapters III and IV are entitled "Transmitting-Circuit Principles" and "Receiving-Circuit Principles," respectively. The next chapter is devoted to "Antennas and Wave Propagation," including antenna measurements and calculations.

"Studio Acoustics and Apparatus" and "Control-Room Equipment and Operation" are the title of Chapters VII and VIII. Additional chapters on Broadcast Transmitters, Communication Transmitters, Radio Receivers (including all-wave, aircraft, marine and police), Radio Aids to Navigation and Rectifier Units follow; while the last two chapters in the book cover Electric Machines and Meters and Storage Batteries.

Two appendices are also included. Appendix A gives technical information, charts and tables, and Appendix B is devoted to operating information of various sorts.

While the authors have succeeded in making *Practical Radio Communication* a book to be recommended to the practical radio operator-technician, they have also written a book that will make a worthwhile addition to any radio engineer's library.

•

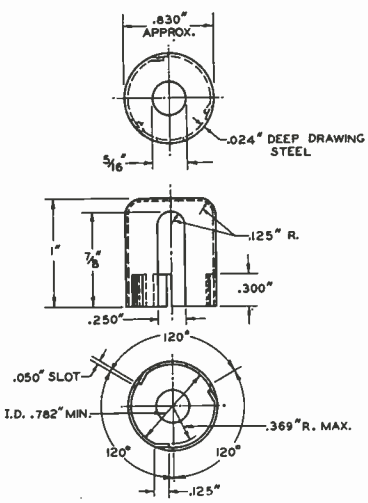
TELEVISION IN THE UNITED KINGDOM

IN THE HOUSE of Commons it was stated that, although no date could be announced when the broadcast of television might begin the "Baird Television Company and the Marconi M. E. I. Television Company have been invited to tender for the supply of the necessary apparatus for the operation of their respective systems" at the station which had been chosen at the Alexandra Palace. It was also stated that the Television Advisory Committee have satisfied themselves that receivers can be constructed capable of receiving both sets of transmissions without unduly complicated or expensive adjustment. (Counselor of Embassy Ray Atherton, London, *Electrical Foreign Trade Notes.*)

•

CONSTRUCTION OF A TOP-CAP SHIELD FOR METAL TUBES

ONE OF THE MANY significant features of the new metal tubes is that the tube elements are shielded by the metal envelope from external disturbances; the effectiveness of the metal envelope as a shield has been found to be more than sufficient for most receiver designs. However, attention is called to the fact that possibly a small, but sometimes necessary, increase in receiver stability may be obtained by shielding the top cap of one or, perhaps, two of these tubes in a receiver. In all probability,



Details of top-cap shield for metal-tube types.

this top-cap shield will not be needed except in very sensitive receivers requiring careful alignment of the tuning circuits.

It is not necessary to enclose the entire tube in order to provide shielding for the small top cap. A thimble-shaped metal shield with the proper diameter to grip the dome of the tube and with sufficient length to house the top cap and its terminal meets requirements. A further requisite is that the shield be arranged to cut through the paint on the dome in order to insure good electrical contact with the metal envelope of the tube. The accompanying drawing shows the essential constructional details of a suggested type of shield; other constructions will occur to those interested in this problem.

A slot, approximately 7/8" long and 1/4" wide, along the length of the shield permits the use of a shielded connection to the top cap; the hole through the top of the shield may be utilized for the same purpose. Three equidistant slits are provided; one face of each of these slits is bent inwardly, as shown, in order that the flanges may cut through the paint and grip the dome of the tube.

RCA Manufacturing Co., Inc.

•

BROADCASTING DEVELOPMENTS IN SOUTH AFRICA

BROADCASTING DEVELOPMENTS in South Africa over the past year have been extensive. The decision to remove broadcasting from private control and set up an organization similar to that under which the service is conducted in Great Britain is the outstanding development.

Under the African Broadcasting Company the number of licensed listeners have increased from 17,000, four years ago, to over 100,000, at the present time.

Broadcasting studios with modern equipment have recently been put into service at Capetown and Durban, and Johannesburg has under construction in its new "Broadcast House," the most ambitious radio building in Africa. It is 8 stories high with 13 studios, all with the most modern layout. Telephone lines connect the building with all the important entertainment places in the city.

The buoyant economic situation in South Africa, particularly at Johannesburg and vicinity, owing to the high price of gold, resulted in a greatly increased demand for radio equipment and receivers, of which American manufacturers enjoyed a large share. (Commercial Attache Samuel H. Day, Johannesburg, in *Electrical Foreign Trade Notes.*)

•

FRENCH RADIO FAIRS IN LYON AND LILLE

THE SYNDICAT des Radioelectricians du Nord de la France have announced the organization of a radio fair at Lille from September 20 to September 29.

Another radio fair is to be held in Lyon from September 21 to September 29, at the Palais de la Foire de Lyon. Approximately 250 manufacturers will be represented and a special part of the exposition will be devoted to phonographs, records, photography and cinema. (Assistant Trade Commissioner Lestrade Brown, Paris. *Electrical Foreign Trade Notes.*)

Design .. NOTES AND

THE 6E5, ELECTRON-RAY, INDICATOR TUBE

THE 6E5 IS A high-vacuum, heater-cathode type of tube designed to indicate visually the effect of change in the controlling voltage. The tube, therefore, is essentially a voltage indicator and as such is particularly useful to facilitate exact tuning of a radio receiver.

The visible effect is observed on a fluorescent target located in the dome of the bulb. For different controlling voltages, the pattern on the target varies through a shaded angle from 90° to approximately 0°. Exact tuning is indicated by the narrowest shaded angle obtainable.

The RCA-6E5 provides a convenient and non-mechanical means to indicate accurate tuning of a receiver to the desired station.

ELECTRON-RAY TUBE CONSIDERATIONS

In the basic design of an electron-ray tube, a hot cathode provides a source of electrons. These are attracted to a positively-charged target coated with a fluorescent material. Electrons impinging on the coated target cause it to glow. The extent of the fluorescent area can be controlled by means of a third electrode placed between cathode and target. The pattern developed on the fluorescent target depends on the contour of the target as well as on the position and shape of the third electrode.

Details of the physical arrangement of electrodes are illustrated in Fig. 1 which shows a cut-away view of the 6E5. The third electrode is identified as "ray-control electrode," and is an extension of the triode plate. The visible effect produced by different voltages on this electrode is shown for two adjustments by the shaded areas of Fig. 2.

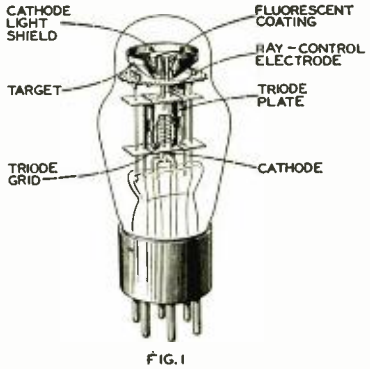
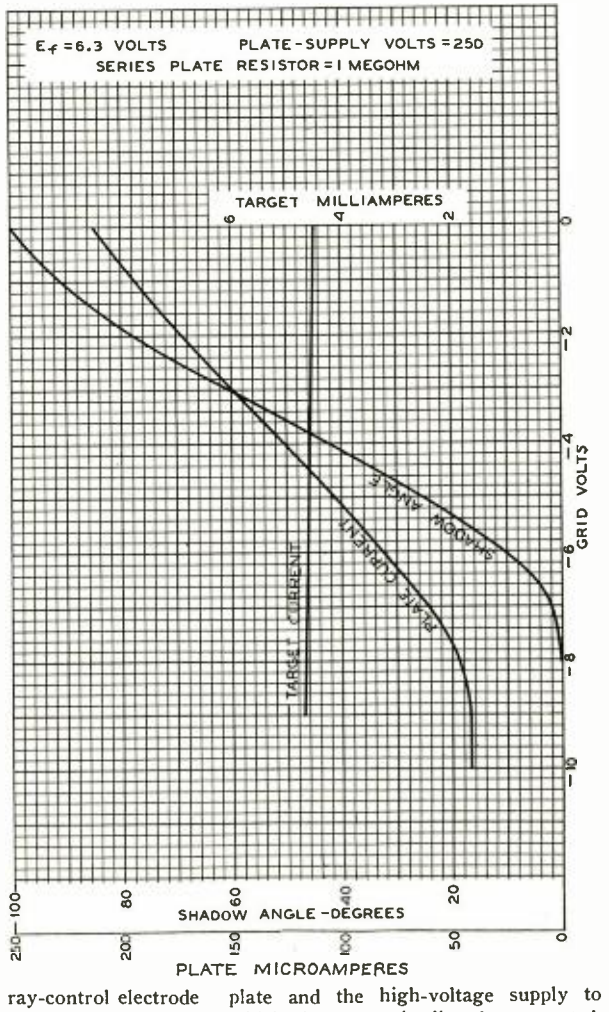


FIG. 1

Details of the 6E5 Electron-Ray Tube.



Average control characteristics of the 6E5 Electron-Ray tube.

The voltage on the ray-control electrode is determined by the voltage applied to the grid of the triode connected as a d-c amplifier. A series resistor of one megohm is placed between the triode plate and the high-voltage supply to which the target is directly connected, as shown in Fig. 3.

The effect of the series resistor is to reduce the voltage applied to the triode

TENTATIVE DATA ON 6E5

Heater Voltage (A-C or D-C)		6.3	Volts
Heater Current		0.3	Ampere
Plate-Supply Voltage		250 max.	Volts
Target Voltage		250 max.	Volts
TYPICAL OPERATION:			
Plate- and Target-Supply Voltage	200	250	Volts
Series Triode-Plate Resistor	1	1	Megohm
Target Current (Approx.)	4.0	4.5	Milliamperes
Triode-Plate Current for Zero Triode-Grid Voltage	0.2	0.25	Milliampere
Triode-Grid Voltage for Shadow Angle of 0° (Approx.)	—6.5	—8.0	Volts
Triode-Grid Voltage for Shadow Angle of 90° (Approx.)	0	0	Volts
Maximum Overall Length			3 5/8"
Maximum Diameter			1-9/16"
Bulb			ST-12
Base			Small 6-Pin

COMMENT . . *Production*

The 6E5 Electron-Ray Tube.

plate, and consequently to the ray-control electrode, under conditions of decreased triode-grid bias (increased triode-plate current). For conditions of increasing triode-grid bias (decreasing triode-plate current), the triode-plate voltage increases and approaches the value of the supply voltage. In the practical use of the 6E5 as a tuning indicator, controlling voltage applied to the triode grid is obtained from a suitable point in the avc circuit.

INSTALLATION

The *base* pins of the 6E5 fit the standard six-contact socket which may be installed to hold the tube in any position.

The *bulb* of this tube becomes hot under certain conditions of operation. Sufficient ventilation should be provided to circulate air freely around the tube to prevent overheating.

FIG. 2

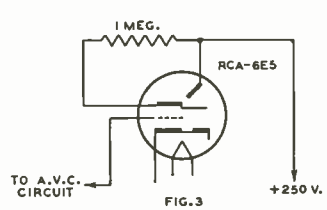


FIG. 3

Above: Maximum and minimum shadow. Below: The basic tuning-indicator circuit.

RECENT DEVELOPMENTS ON LIGHT-VALVES FOR TELEVISION

KERR'S DISCOVERY in 1875 that a pure and isolated liquid, when submitted to the action of an electric field, becomes birefringent has long since been adapted for television purposes in the form of an aperiodic light-control valve. The popularity of the nitrobenzene cell, most applicable for this purpose because of its high Kerr constant, however, may be somewhat weakened by the recent publicity given to the zinc-sulphide cell as designed for the same application. Following the revival of Procopiu's[1] work on an isotropic crystal-like zinc blend and his discovery that the same is doubly refractive in the presence of an electrostatic field, considerable doubt has centered about the linear response of light-cells utilizing the properties of this mineral. Whether the response curve is related to the light intensity factor, or to retardation as plotted against the voltage applied to the crystal, may still be debatable.

ZINC-SULPHIDE DESIGN

Further investigation and more recent comparative tests on the zinc-sulphide design and the nitrobenzene cell has not clarified the situation but has indicated that the light absorption of the former is far too excessive and much greater than that of the latter hermetically glass-sealed type employing rough nickel electrodes. Moreover, it is reported that the response frequency of the former type is of such low value that a 240-line receiver employing the same will not give greater definition that that of a 90-line picture.

THE COLLOID CELL

Seeking to improve upon both the above designs for light-control valves, recent research, perhaps again inspired by Procopiu's work on the birefringence of liquids having fine metallic particles in suspension, has developed the so-called colloid cell. While the potentialities of this new device as a light valve may not displace the specially designed prisms[2] that have been demonstrated can dispense with Nicol polarizers and analyzers to give even brighter pictures than the Kerr cell, the invention is described as being of greater originality than the zinc-sulphide design. As yet it is too early to definitely announce the characteristic performance of this light-control device in actual practice.

The colloid cell functions on the principle of the molecular motion of suspended particles giving rise to the Brownian movement. The particles in this case, however, are asymmetrical so that when disposed heterogeneously within a carrier they form an opaque mass. If now the suspended particles are of truly colloidal dimensions and can be oriented uniformly so that their axes are mutually parallel, the colloid will become transparent, provided the light passes along the plane of the particles. Such an orientation can be effected by either electromagnetic or electrostatic means, the latter being preferred. A molecular layer of platinum sputtered on a transparent base constitutes the electrodes of such a cell when employing the electrostatic field.

Possible colloidal dispersions to be employed in the colloid light-control cell include graphite in oil, aluminum in ethyl acetate, dichroic sulphide of

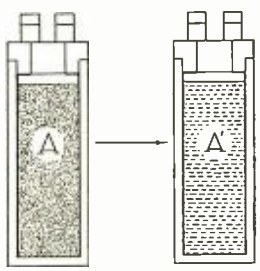


Fig. 1. An electric field applied in the direction of the arrow permits the passage of light in A' (in the same direction) through a heterogeneous colloid like A.

iodoquinine in cellulose ester, and a suspension of mica in aluminum. Each of these colloids is heterogeneous in the absence of the electrostatic field and is perfectly opaque, yet a field readily renders the same homogeneous and transparent. Particularly is this effect true of a colloidal graphite dispersion in oil[3]. This preparation is composed of a mineral oil and 10% by weight of pure electric-furnace graphite that has been reduced to colloidal dimensions —a condition permitting it to remain suspended in oil for long periods of time. The particles, of 75 millimicrons average size are hexagonal-shaped plates having a basal cleavage that permits them to divide into laminae like mica. It is evident that such minute planes, which, incidentally, bear positive charges are particularly advantageous for the device herein described.

[1]Ann. de Phy. 10,213. 1924.
[2]Meyers, Electrician. 109.665. 1932.
[3]"Oildag."

· RMA NEWS ·

RMA AND BROADCASTERS PLAN INDUSTRY AWARDS

THE RMA AND THE National Association of Broadcasters have arranged to cooperate in an annual industry event providing awards in broadcasting similar to the annual Pulitzer press competition. A tentative plan for such an annual radio industry event was submitted by RMA to the broadcasters at the recent annual convention of the NAB at Colorado Springs. The RMA proposal was presented to the NAB Board of Directors by Bond Geddes, executive vice-president—general manager of the manufacturing organization, and the NAB authorized a special committee to meet with an RMA committee and develop the plans. Details will be worked out by the two Association committees. Powel Crosley, Jr., of Cincinnati, is chairman of the RMA committee which includes President Leslie F. Muter of the manufacturing association. Other members of the RMA committee are: Commander E. F. McDonald, Jr., of Chicago; Geo. A. Scoville, of Rochester, N. Y., and N. P. Bloom, of Louisville, Ky.

RADIO EMPLOYMENT INDICES

The latest report for May 1935, on radio factory employment of the U. S. Department of Labor, Bureau of Labor Statistics, showed a substantial increase in average per capita weekly earnings of radio employees, only a slight increase in working hours following termination of NRA, together with a slight seasonal decrease in employment and payrolls.

For the month ending May 15, 1935, forty-nine radio and phonograph establishments reported employment of 28,523 employees, compared with 30,499 employees reported by forty-eight companies during the previous month. No wage increases or decreases were reported during May.

Radio factory employment in May 1935 was 16.5 percent below May 1934, and 7.9 percent less than April 1935, but 168 percent compared with the official three-year average of 1923-25.

Radio payrolls during May 1935 decreased 5.1 percent from April 1935 and were 9.7 below May 1934.

Per capita weekly earnings in radio factories reported in May 1935, however, were $19.13, compared with $18.63 during April 1935, an increase of 3 percent over the past month and 8.3 percent above per capita weekly earnings of May 1934.

Average hours worked per week during May 1935 were 33.7 hours, an increase of 2.4 percent over the previous month, and 2.2 percent over May 1934.

Average hourly earnings of radio factory employees during May 1935 were 57 cents, compared with 56.7 cents during April 1935, an increase of .9 percent, but an increase of 5 percent over average hourly earnings during May 1934.

RMA REQUESTS FEDERAL FINANCING FOR RADIO

Further financing of radio sales under the Federal Housing Administration law has been applied for by RMA with the active support of several large companies. The new proposal to the Federal Housing Administration is that the FHA financing privileges be extended to receiving sets selling at $75 or more. In the past the federal agency has declined to extend its financing privileges to such radio sets and many other "movables." The FHA rules have specifically excluded radios, unless built-in, from its financing benefits. Built-in radio is eligible for FHA financing and it is now hoped to extend the federal financing system to the more expensive type of radio sets, similar to the financing privileges available in sales of refrigerators and recently extended by the FHA to washing machines.

RMA STANDARDS PROPOSED FOR NEW METAL TUBES

Introduction of the new metal tubes for radio sets, presenting many new engineering problems, has been promptly met by the RMA in providing industry standards for the new tubes. The proposed metal tube standards were adopted at a meeting July 25 in New York by the RMA Tube Committee of which Roger M. Wise is chairman, and the proposed standards have been submitted to RMA members by Chairman Virgil M. Graham of the Association's Standards Section. Many other tube engineering problems also were considered at another meeting of the tube committee, August 2, in New York.

RADIO EXPORTS

The latest statistics on radio exports, for May, 1935, of the U. S. Bureau of Foreign and Domestic Commerce, show a slight decrease compared with exports in May, 1934. They were 41,302 receiving sets, valued at $1,078,377, exported in May, 1935, compared with 48,439 sets, valued at $1,160,205 during May, 1934. Tube exports last May were 673,606, valued at $281,941, compared with 597,947 tubes, valued at $286,916 in May, 1934. Exports of parts and accessories amounted to $349,964 in May, 1935, against $350,658 in May, 1934. An increase, however, in exports of loudspeakers was reported, from 7,468 speakers, valued at $23,781 in May, 1934, to 27,615 speakers, valued at $55,279, last May. Other radio exports reported last May were $38,306 of other receiving set accessories and $88,684 of transmitting sets, tubes and parts.

The revised figures of total 1934 exports also have been issued by the U. S. Bureau of Foreign and Domestic Commerce. The 1934 exports broke all previous records and included 612,084 receiving sets, valued at $15,338,143; 6,682,083 tubes, valued at $3,209,946; parts and accessories valued at $4,358,827; 144,768 loudspeakers, valued at $360,954; other miscellaneous accessories valued at $498,453, and transmitting sets, tubes and parts, valued at $1,090,269.

NEW RMA EXPORT COMMITTEE ACTIVE IN TRADE PROMOTION

Following organization of the new RMA Export Committee last June at the Association's annual convention, many problems in the export field, in many countries, are being handled to stimulate sales of American manufacturers. In the reciprocal trade agreements now in negotiation by the State Department, especially the proposed French treaty, important data to develop American radio sales abroad has been collected and submitted.

Export managers of all RMA members are requested to advise Vice-Chairman E. G. Hefter of the Association's Export Committee or RMA headquarters of any export problems coming to their attention. Export managers are also requested to attend the next meeting of the committee which probably will be held in New York late in September.

Modification of existing tariffs and quotas in several foreign countries is an immediate effort of the Export Committee. Other questions before the committee include uniform markings to show country of origin, trade marks, freight rates, handling of defective parts, export packing practices, advertising allowances, and other matters.

The RMA Export Committee operates immediately under the Set Division of which Arthur T. Murray of Springfield, Mass., is chairman. E. G. Hefter is vice-chairman and in active charge of the Export Committee's work, and other members appointed include J. F. Weldon of Philadelphia; C. H. Green of Chicago; R. Bohn of Springfield, Mass.; A. G. Lindsay of Cincinnati; S. T. Thompson of Long Island City; C. A. Richards and D. M. McIntosh of New York, and F. R. Deakins of Camden, N. J.

CANADIAN SALES

Reports on Canadian sales, received by the RMA through cooperation of the Canadian RMA, show sales for the month ending June 30, 1935, of 3,399 a-c sets, valued at $314,773; 1,517 battery sets, valued at $124,069; and 2,065 automobile sets, valued at $127,307.

Canadian inventories June 30, 1935, including stocks of jobbers and branches, totaled 26,028 a-c, 7,888 battery, and 1,926 automobile sets. Projected production of Canadian manufacturers from July 1 to September 30, 1935, was reported at 70,203 sets, including 49,120 a-c, 20,543 battery, and 540 automobile sets.

EXCISE TAX COLLECTIONS FOR JUNE AND FISCAL YEAR

U. S. Internal Revenue Bureau collections of the 5% excise tax on radio and phonograph apparatus during the month of June, 1935, were $199,885.37, according to official government figures just released,

(*Continued on page 28*)

NEWS OF THE INDUSTRY

TEXIDO VISITS NEW YORK

Homer Texido, Chief Engineer of FERM Works, and Technical Director of Station EAJ-15, sailed from Cherbourg August 7th and is expected to arrive in New York August 15th.

Mr. Texido is to study the radio situation in this country and is interested in receiving quotations on radio chassis, transmitter parts, sound equipment, television equipment, etc.

Mr. Texido may be reached through his New York representative, Mr. F. Del Carpio, 505 Fifth Ave., New York, N. Y.

•

GAALAAS RECEIVES APPOINTMENT

George L. Gaalaas has been appointed by the Empire Sheet & Tin Plate Company of Mansfield, Ohio, in the capacity of Sales Engineer of the Electrical Sheet Department.

Mr. Gaalaas is a graduate of the University of Minnesota in the class of 1926. After completing his Electrical Engineering course, he became affiliated with the Ideal Electric Mfg. Company. For the past nine years he has served as Design Engineer, Sales Engineer and Manager of Synchronous Motor Division.

•

HOLYOKE CHANGES CHICAGO OFFICES

The Chicago Office of The Holyoke Company, Inc., in charge of F. William Bauer, was changed August 1, from 65 E. South Water Street, to larger quarters at 325 W. Huron Street, Room 608.

A stock of radio hook-up wires and cords will be maintained by Mr. Bauer for the accommodation of Holyoke customers.

Mr. Bauer will be glad to welcome old, as well as new friends, in his new quarters. The new telephone number is Superior 9770.

Holyoke have added a number of new products during the past year, and are working on many new developments which they expect to place on the market very shortly.

•

WARD LEONARD BULLETIN

Ward Leonard Electric Co., Mount Vernon, N. Y., announces a new 507-A Bulletin on Replacement Resistors for Service Men.

The bulletin lists a number of new items, higher resistance values, larger resistor units and new prices on both fixed and adjustable types.

•

UTC MOVES OFFICES AND PLANT

United Transformer Corporation announces the removal of its offices and plant to a new location at 72 Spring Street, New York City. The new plant represents a consolidation of the three floors formerly occupied at 264 Canal Street into one large plant having more than twice the previous area and production facilities.

The additional manufacturing facilities have been necessitated by the great demand for the company's diversified lines of audio transformers, power transformers, filters, etc., it is stated. The scope of operations of the new plant includes audio transformers up to 50,000 watts and power transformers up to 100 kva, 100,000 volts.

The new plant will enable UTC to render broader, more cooperative service to its manufacturing and distributing outlets.

•

SOLAR ANNOUNCES NEW LINE

A complete line of radio noise-eliminators known as Elim-O-Stats has been announced by the Solar Mfg. Corp., 599 Broadway, New York City, makers of condensers, and the trade is invited to write at once for the catalog illustrated.

This line is designed to suppress noise in the operation of sensitive all-wave re-

ceiving sets, and the maker points out that every set owner is a prospect for one or more Elim-O-Stats, depending upon the number and types of electrical conveniences in each home.

•

"MICROPHONE HEADQUARTERS" ORGANIZES EXPORT DEPARTMENT

The organization of an export department and the appointment of Mr. John C. Hill as Export Manager, is announced by S. N. Shure, president of Shure Brothers Company, "Microphone Headquarters," manufacturers of a complete line of crystal, condenser and carbon microphones and accessories for high-fidelity, wide-range, general-purpose and special sound reproduction applications.

The Shure line will be merchandised abroad through wholesale importers and direct to broadcast stations in localities where no importer has been appointed. All correspondence should be addressed to the company at 215 West Huron Street, Chicago, U. S. A.

•

FORREST NOW IN U. S. A.

Charles E. Forrest, Managing Director, International Radio Co., Ltd., 254 Castlereagh Street, Sydney, N. S. W., is making his yearly visit to the United States. Mr. Forrest, who has been paying this country a yearly visit since 1927, will be in the United States through September, returning to Australia via the Pacific Coast.

The International Radio Company, Ltd., has been in the radio business since 1920, and has branches in Queensland, Australia, Adelaide, South Australia, Melbourne, Victoria, and Auckland, New Zealand. This organization acts as exclusive factory representatives and distributors for the whole of Australia and New Zealand for such firms as the National Union Radio Corp., Sprague Specialties Co., Ohio Carbon Co., Jensen Radio Manufacturing Co., Sparks-Withington Co., Lenz Electric Manufacturing Co., Diamond Braiding Mills, Amperite Corp., Shure Brothers Co., Goat Radio Tube Parts, Inc., and American Phenolic Corp.

If there are any American manufacturers who have any associated radio or refrigerator lines and who are not represented in Australia, they can contact Mr. Forrest by addressing the International Forwarding Co., 431 South Dearborn Street, Chicago.

•

1935 NATIONAL ELECTRICAL AND RADIO EXPOSITION

The 1935 Electrical and Radio Exposition, which will be held in Grand Central Palace, September 18 to 28 inclusive, under the sponsorship of the Electrical Association of New York, is expected to be one of the most comprehensive and complete displays of the latest advances in the fields of domestic and industrial appliances and services, and radio, yet held.

A feature that will be of great interest is the "Hall of Science," in which will be shown and demonstrated the many electrical and scientific achievements of which the average layman knows little but which are in themselves of consuming interest. The advances and discoveries made in the electrical and scientific fields during late years are so numerous that the opportunity to see them and hear about them at first hand should attract thousands of people. This feature of the Exposition is being offered as an entertainment, and will include nothing of a commercial character, it is stated.

In the "Hall of Science" there will be a group of scientific men to show, demonstrate and explain such discoveries as the electric eye, the radio knife, the electric brain, the talking book for the blind, the ship's eye, the electric tongue, the "electric frisker," the "lie detector," the electric guide for the blind, the electric valet for the helpless, the music of the electrons, the home radio printing press, transmitting pictures over the telephone wires, how the ultra-violet ray works, and the dance of the molecules, a special exhibit by the New York Museum of Science and Industry which will demonstrate how to hear your voice in telephone conversations, the fathometer, the Barkhaussen effect, etc.

The plan under which the country's leading manufacturers and distributors of electrical products and electrical services are exhibiting in this year's Electrical and Radio Exposition is said to be an assurance that the public will have a better opportunity than ever before to get a real "close up" of what the industry has accomplished within the short space of one year.

NEW PRODUCTS

"SATINSTRIPE"

Strip steel in a new and attractive finish is now being marketed by Acme Steel Company, Chicago.

"Satinstripe" is the name of this new type of finish, which is composed of stripes or patterns rolled into the steel by specially ground rolls. Acme states that "Satinstripe" is available in many different kinds of stripes, varying in width and depth.

Even with the application of chrome, nickel or color finishes, the beauty of the design is said to show through clearly.

It is expected that "Satinstripe" will have wide application in providing both practical and smartly attractive finishes for a large number of different products.

•

SOLAR CAPACITOR ANALYZER

As an aid in detecting leaky, shorted, open, off-capacity and intermittent defects in capacitors, Solar has introduced an analyzer, which, it is stated, will fill a long-felt need. This instrument will quickly determine the quality of all paper, electrolytic, and mica capacitors, thereby providing a method of selecting the better types.

The housing is attractive, contents compactly arranged, so that here the user has a regular carry-about unit which actually makes portable the precision Wien Bridge

Laboratory method of capacity measurement with accuracy independent of line voltage, it is stated.

The capacity range, which extends from .00002 to 70 microfarads, is read directly, after visible balance of the bridge circuit is obtained by the indication of thermionically controlled neon-glow tube. This is said to be more convenient and more accurate than the use of headphones for balancing.

The use of this precision analyzer for testing the dielectric resistance of cables, insulators, between transformer windings and for power-factor indication is also stressed by the manufacturer.

All interested are invited to write to Solar Mfg. Corp., 599 Broadway, New York City, for descriptive literature.

•

"VELVALAC"

The Allied Phonograph and Recording Co., Hollywood, late in July placed on the market its new "Velvalac" wax substance for electrical transcriptions.

The new preparation is said to have a minimum surface noise, non-warping, non-breakable and of lighter weight than the usual laminated and solid transcriptions stock.

The Velvalac disc have been taken by the Freeman Lang Sound Studios for its usual recording service, but with option of laminated or solid stock on order.

The Velvalac process has been in the Allied research laboratory for the past ten months under the direction of Archie Josephson, vice-president.

They will come in a variety of colors, including desert brown, royal blue, black, sunkist orange and emerald green..

Though distributed at a slightly higher cost than the previous material, Velvalac will be cheaper to ship because of the light weight.

•

RADIOTONE DUPLEX RECORDER

The Radiotone Recording Co., 6103 Melrose Ave., Hollywood, Calif., announce their new professional Duplex Recorder.

This new model was brought out to fill a demand by recording studios and broadcast stations for an instantaneous recording unit, capable of recording continuous radio broadcasts or transcriptions. This is said to be effected by a switching device throwing from one cutting head to the other.

This Duplex Recorder comprises dual sixteen-inch turntables, dual screw-feed mechanisms and dual cutting heads, and also includes a high-fidelity pickup for use in duplicating or dubbing copies from the original.

The Radiotone Duplex Recorder is manufactured in two separate units, the recording chassis proper, assembled in one solid frame, which mounts on a suitable table or bench in the studio, and the motor drive assembly comprising a synchronous motor, self-starting type, gear reduction and filter couplings, which mounts directly under the recording chassis on the studio floor.

Interchangeable pulleys are provided for 33 1/3 and 78 rpm recording. The cutting heads are designed for flexibility in recording on cellulose, acetate and nitrate instantaneous recording discs.

•

NEW JEFFERSON PRODUCTS

The Jefferson Electric Company, Bellwood, Illinois, has recently started production on a complete line of transformers, chokes, and other products designed particularly for the radio amateur. The long experience of Jefferson in designing and manufacturing parts for radio set manufacturers is said to be very evident in this

new line. It incorporates convenience and adaptable ranges and includes over 130 numbers, one of which is illustrated.

A complete catalog has been prepared for free distribution.

DRY ELECTROLYTIC CONDENSERS

A late development is the Aerovox midget electrolytic condenser, based on the treatment of the aluminum foil so as to obtain greater capacity and adequate working voltage rating in less bulk than heretofore considered necessary. The 8-mfd, 450-volt unit, for example, measures but 2-7/16 x 1⅛ x 11/16 inches, in the cardboard case container. The new midget condensers are available in the 200-volt and 450-volt ratings, and in capacities of 2 to 16 mfd.

The compactness of these new midget electrolytics is said to make them popular in assemblies where space is at a premium, and in replacing wornout condensers with units of greater capacity and higher working voltage.

•

WIND-POWERED 6-VOLT GENERATOR

To provide a simple means of charging the storage batteries used by a half million or more farmers throughout the country, the Pioneer Gen-E-Motor Corporation of Chicago has brought out, for the first time, a wind-powered 6-volt generator unit providing 5 amperes of direct current which may be used in keeping the battery charged for radio set operation or for lighting operation.

The generator unit is said to be completely weather-proof and is provided with overload relay and cut-off as well as a

tipping arrangement which is thrown into operation by too great a wind velocity and which throws the unit out of operation.

A circular describing this new charging device will be sent without charge by the Pioneer Gen-E-Motor Corporation, 460 W. Superior Street, Chicago, Illinois, on request.

•

PRECISION RESISTORS

A series of wire-wound resistors, known as Microhm, constructed in various forms to satisfy both production and laboratory requirements, is offered by the Precision Resistor Co., 334 Badger Avenue, Newark, N. J. These resistors may be obtained in ratings from ¼ to 5 watts in non-inductive type units, and other types up to 40 watts.

THORDARSON CONDENSER CAPACITY-LEAKAGE TESTER FOUNDATION UNIT

Two service instruments combined in one "build-it-yourself" design is the feature of the Thordarson Condenser Capacity-Leakage Tester Foundation Unit.

The Thordarson Electric Manufacturing Company, 500 W. Huron St., Chicago, Illinois, have produced a foundation unit consisting of a portable walnut instrument

case, an etched and drilled metal panel with a scale calibrated in microfarads, matched panel mounting screws, and complete instructions and assembly plans for a condenser capacity-leakage tester.

Most of the additional parts required to complete this unit are stock items carried by radio Service Men. The completed unit will measure capacity between 0.001 to 50 mfd and indicate leakage on a neon glow lamp. The capacity-measuring portion operates from 105 to 120 volts, 60 cycles a-c employing the Wheatstone Bridge principle. The leakage-tester derives its power from the receiver in which the condenser is used and thus tests the condenser under actual operating conditions.

The foundation unit is available through distributors at regular dealer discounts.

•

NEW TOMLAB MIKE

The TomLab MC-30 microphone is a moving-coil unit designed to meet the requirements of broadcast, recording and sound engineers.

The MC-30 is said to have a substantially flat-frequency characteristic over the useful audio range. It is encased in a one-eighth inch aluminum casting, protecting the unit from shocks. Wide variations of temperature or humidity do not change the characteristics of the mica diaphragm, it is stated.

This unit has an impedance of 30 ohms which permits running microphone lines 500 feet. The field is provided by a cobalt-steel permanent magnet. Any pre-amplifier necessary may be located at the main amplifier or incorporated in it. The output level of the MC-30 is approximately minus 75 db.

Thomaston Laboratories, Inc., 220 West 42nd Street, New York, N. Y., are the manufacturers.

•

NEW IRC INSULATED METALLIZED RESISTORS

Unique modern resistors specifically designed for exacting radio requirements of the present day and known as IRC Type "B" Metallized Resistors, have just been announced by the International Resistance Company.

Retaining all advantages of the familiar Type "F" Metallized Resistors, these new units have complete high-voltage insulation protection and are constructed without metal ends. They can contact other parts without danger of shorting. Utilizing an improved metallized resistance element, they have an extremely low noise level and represent a distinct improvement in essential resistor characteristics such as accuracy, permanency of resistance value and durability under all operating conditions, it is said.

In the new Type "B" Insulated Resistors a sturdy casing of insulating compound is moulded completely around the Metallized resistance element, sealing it against moisture and protecting it from shorting on other parts. Like bakelite, this insulating material will not crack or deteriorate. Permanent contact between element and wire leads is obtained by a special bonding process which, after the insulation is moulded solidly around the assembly, cannot break or develop poor contact. Noise level is said to be unusually low, making these new resistors ideally suited for amplifier circuits and for critical television requirements.

IRC Insulated Resistors are both color coded and individually marked with resistance value and wattage rating. Identification is quick and easy. They are available in ½-watt and 1-watt ratings which will suffice for practically every installation however crowded it may be. Not only is the ½-watt (Type B-½) resistor as small as the usual ¼-watt resistor, but it may be used universally for any rating up to and including ½-watt with greater efficiency and a higher factor of safety.

Flexible wire leads extend straight out from the ends giving a more effective lead length and avoiding danger of breakage when installing. They are tinned for easy soldering.

The 1-watt (Type B-1) IRC Insulated Resistor is made in all ranges from 300 ohms to 10 megohms. The ½-watt unit (Type B-½) is made in all ranges from 100 ohms to 5 megohms.

A new catalog containing full details will be sent on request to International Resistance Co., 2100 Arch St., Philadelphia, Pa.

•

CUTTING AND PLAYBACK NEEDLES

Several years ago the Sound Apparatus Co., 150 West 46th St., New York City, introduced special steel cutting and playback needles for use with all types of coated records, Duralotone, etc. In line with other improvements in the disc recording field, they wish to announce that their needle manufacturer, as a result of experience and continued research, has perfected the product to a remarkable extent. In addition, the product is said to be maintained at a uniform high quality by the use of best materials and production accuracy.

•

NEW UNIVERSAL RECORDING MACHINE

A new professional recording machine was put on the market in May by the Universal Microphone Co., Inglewood, Cal. The assembly is completely mounted on cast iron castings and weighs 125 pounds with a turntable disc of 16 inches.

A rim drive feature, which "steadies" recording, distinguishes the model from earlier non-professional types of machines. The motor is a constant-speed type, not self-starting, 110-volt a-c, is 100% synchronous and is reversible.

One outstanding feature is the countershaft which makes it possible to use 78 or 33⅓ rpm, and on 50 or 60 cycles a-c. Although the machine is set for 108 lines per inch, standard, it can be changed to any number of lines desired.

The cutter is a special Universal power cutter with four pole pieces and screw adjustments for damping. The magnet is of cobalt steel. The cutter arm is of heavy bronze casting. For grooving aluminum an adjustment screw in soft rubber cushion is provided to maintain a constant pressure on the point of stylus, thus controlling groove depth. For cutting cellulose, acetate or nitrate discs a different situation exists and the professional recorder comes equipped with minute adjustments for different types.

•

MUTER CERTIFIED RESISTANCE BRIDGE

To meet the demand, from both shop and laboratory, for an accurate Wheatstone type Resistance Bridge at a price that makes it practical to have a sufficient number of them for general use, The Muter Company has designed the Muter Certified Resistance Bridge.

The Muter Resistance Bridge is recommended for use by Service Engineers to replace the comparatively inaccurate "ohmmeter." Commercial laboratories, it is said, find that its low cost allows the simultaneous use of individual bridges in various experiments. Radio and electrical apparatus manufacturers are finding that its rugged construction makes it especially adaptable for use on production lines.

The internal construction of the new Muter Certified Resistance Bridge is unusual. The resistor elements are wound in strip form, the taps being set to an extreme degree of accuracy. Thorough

vacuum impregnation insures freedom from variation due to changes in humidity. A special alloy resistance wire is employed to maintain constant resistance regardless of reasonable changes in temperature.

It is stated that each Muter Resistance Bridge is checked and certified by a graduate electrical engineer before shipment.

•

AUTO INTERFERENCE-SUPPRESSOR CONDENSERS

A line of auto interference-suppressor condensers designed to reduce background noises to a minimum and thereby permit modern auto-radio sets to operate at maximum sensitivity and volume, is announced by Aerovox Corporation, Brooklyn, N. Y. These units have been specifically designed for auto-radio use. Because of extreme temperatures and severe vibration encountered in such service, the units are extra ruggedly built, housed in heavy casings and thoroughly sealed and impregnated.

Among the units available are generator condensers with side bracket and special curved bracket for Ford generators, ammeter condensers, dome light filters, oil-filled vibrator condensers, oil impregnated paper tubular vibrator condensers, and a wide assortment of exact duplicate replacements for the auto-radio set itself. Special bulletin describing the line may be obtained by writing the manufacturer direct.

CATHODE-RAY VISUAL RECEIVER SERVICER

A number of entirely new features are said to be introduced in this new cathode-ray equipment for servicing radio receivers, which has just been announced by the Clough-Brengle Co., of 1134 W. Austin Ave., Chicago, Ill.

Among these is an entirely new sweep system that produces on the cathode-ray tubes a receiver selectivity curve that is accurately calibrated and can be read directly in kilocycles width. This is secured by maintaining a uniform width of sweep

(plus and minus 15 kc) at all test frequencies from 100 kc to 30 mc.

Another new feature in receiver servicing made possible with this equipment is the feeding of an r-f wave modulated by a 400-cycle sine wave into the receiver at antenna and ground and then observing the shape of the wave at the speaker voice coil, as pictured by the cathode-ray tube. This test will show overall receiver audio distortion, including such distortion as may occur in first detector, second detector, avc, and audio stages.

A complete Cathode-Ray Visual Radio Servicer is composed of the Model OM Signal Generator with built-in frequency modulator and the Model CRA or Model CRB Oscilloscope.

The Model OM Signal Generator has a built-in frequency modulator oscillator and motor-driven condenser unit. It is essentially similar to the usual r-f oscillator

except that it has a second modulated oscillator that wobbles the output of the first oscillator plus and minus 15 kc when it is desired to use with a cathode-ray oscilloscope. With the wobble circuit switched off, the Model OM may be used as a standard 400-cycle modulated oscillator for output meter indications.

Two new cathode-ray instruments are offered in the Clough-Brengle line. The Model CRA is a complete Oscillograph with built-in linear sweep circuit, input amplifiers, and complete power supply for operating the standard 3-inch cathode-ray tube.

The Model CRB Cathode-Ray Oscilloscope is identical with the above instrument, with the exception that the linear sweep circuit is not included. This circuit is not required for securing receiver selectivity curves when the Model OM Modulated Oscillator is used, as well as in many other applications.

Kendall Clough, chief engineer of the Clough-Brengle Company, has just written a 24-page booklet on Cathode-Ray Test and Analysis, which is of unusual interest to every Service Man. Copies may be secured from your jobber or by sending 25 cents in stamps to the manufacturer.

•

NEW WESTON TUBE CHECKER

A modern-tube checker which represents a striking departure from former types, in external appearance, electrical and mechanical design, and in convenience to the user, has just been placed on the market by the Weston Electrical Instrument Corporation, Newark, N. J. The tester has socket mountings covering all pin combinations for glass and metal tubes now commercially available, with provision for combinations which may be introduced in the future.

The circuit assembly of the new unit

incorporates a fundamental advance in testing tubes on the basis of total emission, in that three separate loads, one for general purpose tubes, one for battery types and one for diodes, are available as required at the throw of a switch. Thus, total emission tests for each type of tube may be obtained on a specific load basis, and without possibility of damage to the tube structure itself.

A group of seven individual electrode switches, grouped on the center operating panel, provides a highly flexible means of setting up the various electrode combinations for any type of tube. Individual portions of all tubes may be checked, no matter how complicated they may be, including individual diode readings and separate portions of double tubes, without removing the tube from the socket.

A complete inter-element neon short test, carried out while the tube is hot in the socket, used for emission readings, is made simply by throwing the "short-test" switch previous to the regular test operation.

A self-contained transformer supplies all necessary potential from a 105 to 130-volt a-c line. The line voltage adjustment on the center panel, operating in conjunction with a direct meter reading, is connected through a toggle-switch to permit a check on line-voltage at any time while a tube is under test.

The unit is completely enclosed in a durable cast aluminum case, divided in the center by an engraved bakelite panel section carrying the indicating instrument and all controls. The meter itself is of modern rectangular shape with an easily read scale. Switch handles and trim of red bakelite add to the appearance of the tester. Four sockets are located on each side of the center panel, providing all standard pin layouts from 4 prongs to 8 prongs inclusive. A spare 8-prong socket and the neon lamp socket complete the symmetry of the arrangement.

A guard plate mounted on the bottom of the tester completes the dust-proof housing. Fuses within the bakelite plug on the line cord provide added convenience by making it unnecessary to open the instrument for fuse replacement. Overall dimensions of the instrument are 12 x 9¼ x 6 inches. A compact carrying case for the unit may be obtained if required.

•

IMPROVED DYNAMIC MIKE

The Radio Receptor Co., Inc., 106 Seventh Avenue, New York, N. Y., have announced that their Model 6-C moving-coil microphone has been improved to such a degree that it possesses practically the same sensitivity as the better-type carbon mikes. The improvement has been accomplished through the use of a specially designed input transformer. This development is said to make it possible to replace carbon microphones with the dynamic type whenever desired.

•

NEW BELL MOBILE P-A SYSTEM

A new 6-volt mobile public-address system, known as Model M-6, has recently been introduced by Bell Sound System, Inc., of Columbus, Ohio, manufacturers of an extensive line of sound systems. The Model M-6 is entirely operated by a 6-volt storage battery, making it suited for sound trucks, cars or any other place where 110 volts a-c is not available.

The turntable and amplifier are built into one compact unit, but with each having its separate volume control. A special

leveling arrangement maintains the unit in a level position when placed on the seat by the operator. The amplifier is the Class A, 4-stage type, which develops a power output of 18 watts. It has an overall gain of 97 db, it is said.

Three separate power switches are provided, which effect a saving in total current consumption.

The complete system comes with two 8-ohm speakers. It is said that one feature of this system of special interest is the high-fidelity crystal microphone. It eliminates the rattle, aggravating noises and need for special handling, customary to the older types of microphones.

The overall size of the turntable-amplifier unit is 16" wide, 19" long and 8½" high. When desired, trumpets can be supplied for the speakers. For further information write for Model M-6 Bulletin.

Communication and Broadcast Engineering

The monthly journal for engineers and executives in the fields of telephony, telegraphy, radio broadcasting and communication, aeronautical, police and marine radio, signalling, etc.

Recent Numbers of Communication and Broadcast Engineering have carried the following articles:

N. B. C.'s Studio System ..... by T. H. Phelan
High Fidelity Remote Pickup Equipment ..... by John P. Taylor
Maintaining and Measuring the Frequency of Transmitters .... by V. J. Andrew, Ph.D.
Coupling the Broadcast Antenna to the Transmission Line ..... by Paul Rosekrans
An Efficient Remote Amplifier ..... by J. C. Bailey
Accounting System for Broadcast Engineers ..... by R. C. Powell
WOR's Directive Antenna ..... by J. F. Morrison
Design of Pads ..... by L. W. Barnett
Ultra High Frequency Police Radio ..... by Paul F. Godley
Concentric Transmission Line at KDYL ..... by John M. Baldwin
High Fidelity Broadcasting ..... by John J. Long, Jr.
Commercial Radio Trends ..... by Haraden Pratt
Continuous Aural Frequency Monitoring ..... by Robert C. Moody
Temporary Vertical Radiator Construction ..... by George Brown

Departments in each number cover New Products and Equipment, Federal C. C. Activities and Reports, "Telecommunication," Maps of Communication and Broadcast Systems, etc.

Subscription Rate
$3.00 Yearly
(Foreign and Canada $4.00)

BRYAN DAVIS PUBLISHING CO., 19 East 47th Street, New York, N. Y.

☐ Enclosed find 25c. to cover mailing costs of one sample copy of "Communication and Broadcast Engineering."

☐ Enclosed find { $3.00 for 1 yr. / $5.00 for 2 yrs. } subscription.

Name (Please Print) .....
Address .....
Town and State .....
Name of Company .....
Title or Occupation .....

NON-DIRECTIONAL DYNAMIC MIKE

A non-directional dynamic microphone has just been announced by Western Electric. This new microphone has a frequency response independent of the angle of sound incidence and uniform over an extended frequency range. High-grade pickup throughout the range of from 40 to more than 10,000 cycles without regard to the direction of sound approach, is entirely practicable with this unit.

The difficulty of achieving this result is apparent when it is realized that the mere presence of a microphone or other object in a sound field tends to distort that field. This distortion appears in the output as non-uniformity of response, both with re-

spect to the angle of incidence of the sound wave upon the microphone and with respect to frequency.

Studies made by the Bell Telephone Laboratories have made possible a new method of solving this problem by the application of modern acoustic streamline principles and the careful working out of proper mechanical proportions for a balance of acoustic forces. Moreover, this unit has been designed to operate into existing amplifier equipment.

Other features of this instrument are freedom from electrical interference, high signal-to-noise ratio, ruggedness, dependability and freedom from temperature, barometric and humidity effects. Another characteristic is the low electrical impedance which allows its use several hundred feet from the amplifying equipment.

Floor, table and suspension type mountings are available. Each is terminated in a plug fitting a recessed jack in the bottom of the microphone, permitting the microphone to be instantly released when it becomes desirable to change mountings.

•

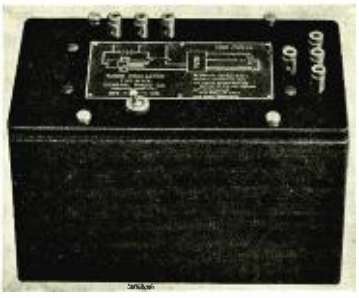
IMPROVED AUDIO OSCILLATOR

For a number of years the General Radio Type 213 audio oscillator has served in laboratories as a tone source for bridge measurements and other purposes. This oscillator, which consists of a single-button microphone-driven tuning-fork, has been widely used because of its simplicity, compactness, low cost, and ease of operation.

A redesign of this instrument, resulting in the Type 813 audio oscillator, has produced improvements along the following lines: More accurate calibration to any specified frequency value; lower damping and greater frequency stability; complete independence of output and fork driving circuits; more reliable operation and self-starting characteristics; lower harmonic content in output, fork enclosed and free from damage and dirt; provision made for a small self-contained 4½-volt dry battery for intermittent operation, or, alternately, outside batteries for continuous service or greater power output; and a reduction of the sound in air produced by the oscillator.

These improvements have been accomplished by the use of a more massive fork, by employing two microphones of an improved type symmetrically loading each time, and by the use of an output filter which reduces the harmonics in the output.

The fork is cut from a rectangular bar of cold-rolled steel which is then cadmium plated to resist corrosion. Two rigid-back microphones are mounted from the heel of the fork and are located symmetrically on the tines at, or back of, the point where maximum flexure occurs. In this manner, the free vibration of the fork is influenced only to a very slight degree by the load of the microphones.



Output impedances of 50, 500, and 5000 ohms are provided. Four output terminals are so arranged that the Type 274-M double plug may be quickly attached to give any one of these three internal impedance values. The output circuit is completely isolated from the driving circuit, and there is no direct-current component in the output.

The Type 813 audio oscillator is available in two models, 400 cycles and 1000 cycles. Other frequencies between 300 cycles and 1500 cycles can be obtained on special order.

RMA NEWS

(Continued from page 22)

and brought the total tax collections since the law became operative on June 20, 1932, to $8.988,445.08, not including large additional automotive excise taxes on automobile sets. Excise taxes collected in June, 1935, on mechanical refrigerators were $1.202,976.91, as compared with $1,346,-528.38 in June, 1934.

As a barometer of radio industry sales, the radio excise taxes for the fiscal year ending June, 1935, showed an increase of 14.8 percent over the previous fiscal year. the total for the fiscal year of 1935 being $3.624,904.31. as compared with $3,156,-777.38 during the previous fiscal year. An increase of 6.6 percent was recorded in the radio taxes for the six months ending June, 1935. compared with the six months ending June, 1934.

Detailed figures on the radio and phonograph taxes, which do not include additional and substantial taxes collected on automobile sets and accessories subject to automotive taxes, are given in the accompanying table.

RMA REQUESTS SPECIAL SALES STATISTICS FROM U. S. CENSUS

Following allotment by the administration to the U. S. Census Bureau of a special appropriation for a new 1935 census of commodity sales, the RMA has requested the Census Bureau to make the federal statistics more valuable by securing details of radio sales from jobbers and dealers. Separate statistics to show sales of new radios, used or second-hand radios and also built-in radio equipment have been requested by the RMA and are under favorable consideration by the Census Bureau. The commodity sales census to be secured from radio jobbers and dealers is distinct from the annual federal radio manufacturing census.

Fiscal Year 1934-35		Fiscal Year 1933-34		Fiscal Year 1932-33	
				June 20 to	
July	$ 92,007.81	July	$ 191,074.94	July	$ 32.848.57
August	229,681.76	August	125,865.08	August	76,445.47
September	305,291.91	September	147,930.49	September	165,710.65
October	280,699.11	October	292,332.20	October	218,722.70
November	462,638.47	November	246,526.75	November	298.577.86
December	568,117.99	December	570,629.50	December	392,204.81
Total 6 mos.	$1,938,437.05	Total 6 mos.	$1.574,358.96	Total 6 mos.	$1,184,510.06
January	$ 398,177.40	January	$ 415,358.83	January	$ 283,425.27
February	193,467.30	February	272,335.09	February	173.987.28
March	350,334.03	March	268,136.45	March	149,859.66
April	253,066.45	April	202,301.98	April	138,587.02
May	291,536.71	May	234,010.60	May	110,747.70
June	199,885.37	June	190,275.47	June	165,646.40
Total 6 mos.	$1,686,467.26	Total 6 mos.	$1,582.418.42	Total 6 mos.	$1,022,253.33
Total Year	$3,624,904.31	Total Year	$3,156,777.38	Total Year	$2,206,763.39

INDEX TO ADVERTISERS

THE Group Subscription Plan for RADIO ENGINEERING enables a group of engineers or department heads to subscribe at one-half the usual yearly rate.

The regular individual rate is $2.00 a year. In groups of 4 or more, the subscription rate is $1.00 a year. (In Canada and foreign countries, $2.00.)

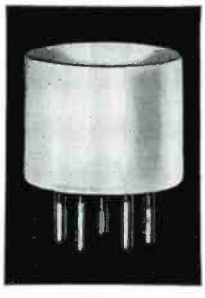
The engineering departments of hundreds of manufacturers in the radio and allied industries have used this Group Plan for years, in renewing their subscriptions to RADIO ENGINEERING.

Each subscriber should print his name and address clearly and state his occupation—whether an executive, engineer, department head, plant superintendent, or foreman, etc.

Remember this Group Plan when *Your* Subscription Expires

(Radio Engineering)
BRYAN DAVIS PUBLISHING CO., Inc.
19 East 47th Street, New York, N. Y.

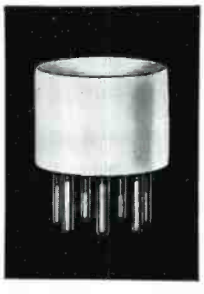
Leaders in their field!



THE development from the original Fleming valve to these modern vacuum tube devices is a long story. It is a story of unceasing effort to improve manufacturing methods and to find new and better materials.

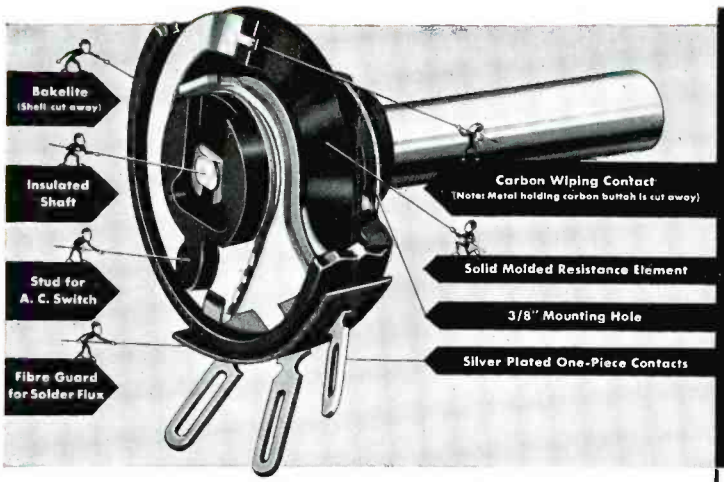
For years the leading tube manufacturers have been using ISOLANTITE insulation—a tribute to the quality and dependability of a product which has contributed much to the production of better vacuum tubes.

Your tubes also can be improved by the use of ISOLANTITE insulation. ***Isolantite, Inc., factory at Belleville, N. J.; Sales Office at 233 Broadway, New York City.***



Isolantite

CERAMIC INSULATORS



ALLEN-BRADLEY RADIO RESISTORS

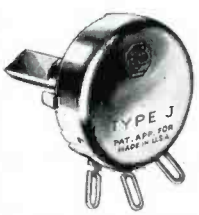
the Choice of the World's Largest Radio Manufacturers

Severe Service

Cannot Change Type J Bradleyometers

The solid molded resistor is homogeneous in cross section—it is not a film-type unit. In longitudinal section, the material is varied to suit specified resistance-rotation curves; after molding, the unit cannot change. Severe service cannot alter its performance. Long wear has no deteriorating effect on this molded resistor.

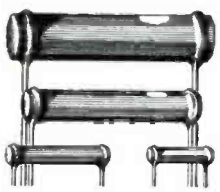
The small size of the Type J Bradleyometer—it is only 1 1/16" in diameter—makes it ideal for all radio receivers including midgets and auto-radio tuning heads. A fiber guard fitted over the silver-plated one-piece contacts effectively excludes solder flux. High humidity has no effect on Bradleyometer J, and the control remains permanently noiseless.



Type J Bradleyometer

Type JS Bradleyometer

The Type J Bradleyometer is made in two types: Type J is a volume control without line switch; Type JS has a built-in line switch actuated by the control knob. Both units are interchangeable with other types of volume controls built to R.M.A. standards. Therefore, every radio receiver can easily be improved by standardizing on these dependable and compact controls.



BRADLEYUNITS FIXED RESISTORS

These solid molded fixed resistors have an exceptionally low voltage coefficient. Moisture and age do not affect them. All manufacturing processes are under continuous laboratory control. Such uniformity of manufacture assures resistors that are quiet and dependable in radio receivers.

SUPPRESSORS

Allen-Bradley Suppressors do not "open circuit" in service; they do not "drop" in resistance and, therefore, fail as suppressors; they do not have a high voltage characteristic; they do not fail from exposure to oil and water; they do not break due to car or engine vibration. These resistors are enclosed in rugged, non-arcing bakelite casings.

Write for Allen-Bradley data.

ALLEN-BRADLEY 126 W Greenfield Ave., MILWAUKEE, WIS.