

# Radio Engineering

JANUARY, 1937

VOL. XVII

NO. 1

DESIGN • PRODUCTION • ENGINEERING

Broadcast Receivers  
Auto-Radio Receivers  
Electric Phonographs  
Sound Recorders  
Sound Projectors  
Audio Amplifiers  
P-A Equipment  
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Control Devices  
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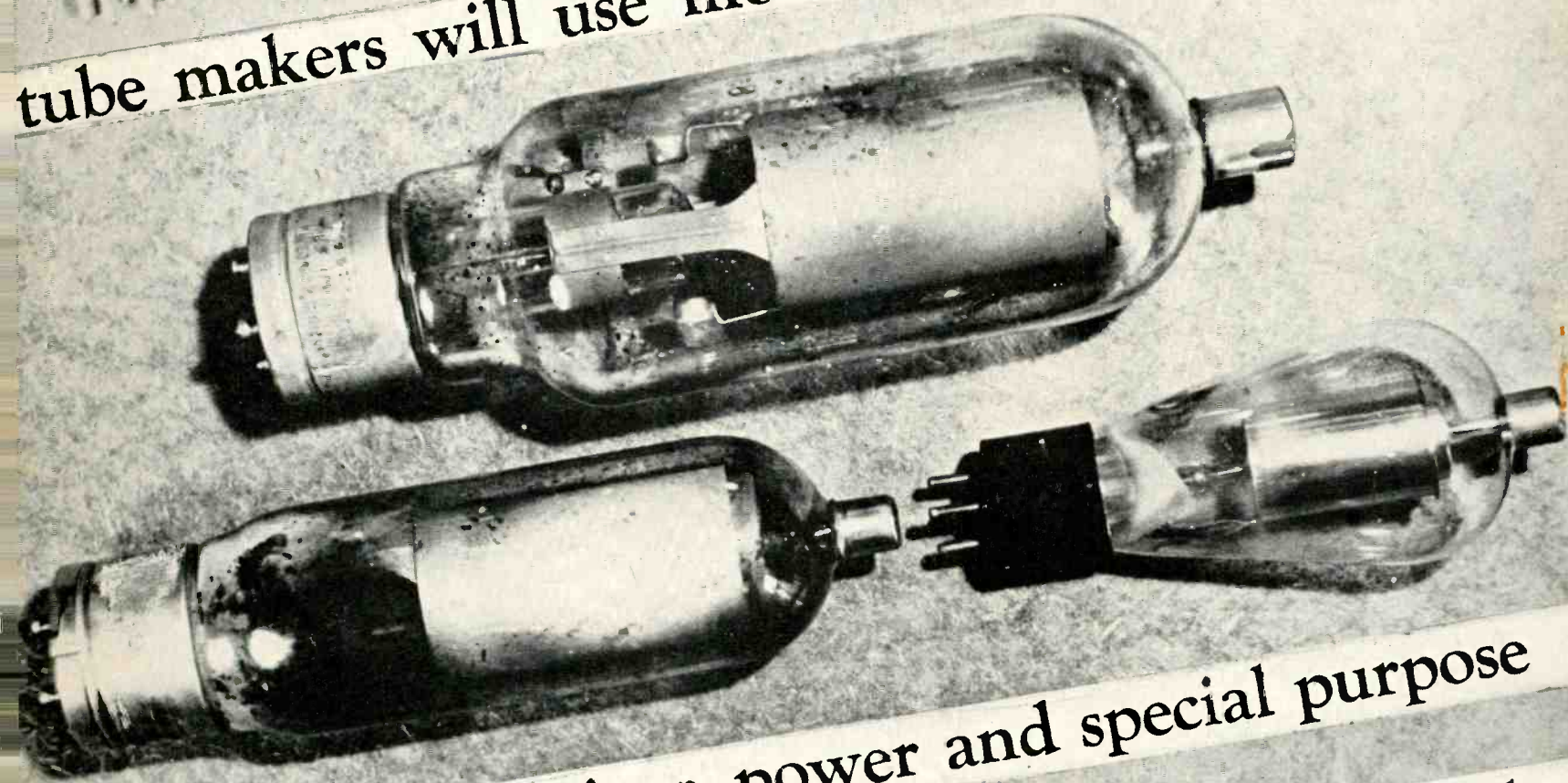
The Journal of the  
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ever before in receiver, power and special purpose  
tubes where it has become permanently established.



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# RADIO ENGINEERING

REG. U. S. PATENT OFFICE

W. W. WALTZ • Editor

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### COVER ILLUSTRATION

THE COMPLETE CHASSIS OF  
THE SAFAR MODEL 1936 TELE-  
VISION RECEIVER.

(SAFAR, Milan, Italy.)

PUBLISHED  
MONTHLY

by  
the

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JANUARY, 1937

Page 1

# Editorial

## THIS MONTH

RADIO ENGINEERING, without any fanfare or other celebration, enters its seventeenth year of publication. Seventeen years, in a field that moves as rapidly as radio, is a long time; space limitations alone—disregarding editorial inertia—would prohibit even a brief review of all that has transpired in radio since 1920. But let the reader recall for himself—it was not until November of 1920 that broadcasting received any attention from the public. The broadcasting, by KDKA, of the election returns that year seemed to be the crystallizing agent, and from that time until now, the air has been full of entertainment (so-called, at least), propaganda and advertising.

Being what we fondly hope is ultra-conservative, we will venture the prediction that the end of another sixteen years will probably see television more or less accepted as the coming medium of entertainment.

For the immediate present, however, this issue will be found to have papers on automatic fidelity control circuits; the calculation of the maximum permissible power output of tubes; antenna distribution systems (which ought to be of interest to the receiver designers as they are the boys who "take it off the antenna," and who might like to have an idea of just what they are getting).

There will also be found some suggestions on what the public does with a radio—"tries" to do might be more appropriate—when it gets into the home, and what the manufacturer might do about it to simplify matters for the service man or for the home tinkerer.

## IT CAN'T BE DONE

DESPITE ALL EVIDENCE to the contrary, that phrase seems to be the inevitable reply of a great many persons to every new idea.

According to that tribe, the Wright brothers were a couple of damfools. Marconi was little, if any, better, Hyatt was "nuts," and so on *ad infinitum*.

Just at present there are several vitally important and exceptionally difficult problems to be cracked. And the calamity brigade is in full cry. Some of these problems rightfully belong to the radio industry; others might possibly be solved by the application of the principles common to every bit of research done in radio communication laboratories.

Among other things, we can suggest that radio ought to keep its nose clean with regard to the apparently unwarranted large number of commercial airline accidents. Every newspaper in the land comes up with scare-heads in which the supposed "failure" of the radio beam is featured. It is to quiet these and other "it-can't-be-done" howlers that the industry should undertake to find out just what has been wrong, *if anything*, with the radio beams. And, if the present beam system is found to be too inaccurate, or too unreliable, for safe flying, something else will have to be found which will meet the requirements.

Along an entirely different line, we'd like to see some smart engineers take a few reefs in the sails of the medical profession—and don't think for a minute that it can't be done, and profitably, too, for the great mass of humanity that has to depend upon a profession whose very axiom seems to be "it's never been done before, therefore, it can't be done."

But it was Whitney of General Electric, and Kettering of General Motors, and the staff of the Naval Research Laboratory (just to mention a few) who showed the doctors how to elevate a person's temperature without subjecting the patient to the dangers of malarial infection.

It was a mere chemist who found what may be the first definitely-known drug to combat arthritis. Another chemist trod on medical toes to isolate vitamin-B.

However, despite all of these brilliant endeavors by the engineers, there remain several medical problems in which some applied engineering plus some highly imaginative guesswork ought to show results.

Artificial fever, induced by ultra-short waves, is difficult to control. The satisfactory use of this fever therapy sometimes involves the elevation of the temperature almost to the danger point—and under present conditions, the temperature may go above this critical level before the condition is apparent to the clinical thermometer. Some kind of a thermo-regulator is needed, one that will act literally in a split second.

And, do you know of anything that might be a better prerequisite to a study of nerve impulses than a knowledge of electrical networks? Whether these impulses are a-c or d-c, the best neurologists can't say. Naturally, they haven't reached first base in their studies, but we'd like to bet that, given laboratory facilities of his own choosing, many an engineer could with reasonable promptness find the answer for the "it-can't-be-done" doctors.



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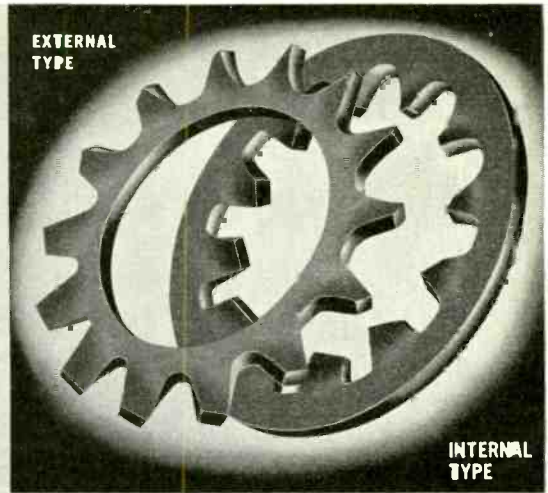
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To insure the performance of any metal product all connections must be locked permanently tight. That's why I specify Shakeproof—I've tested its new tapered-twisted tooth principle and I'm convinced it's the one lock washer that never let's go!



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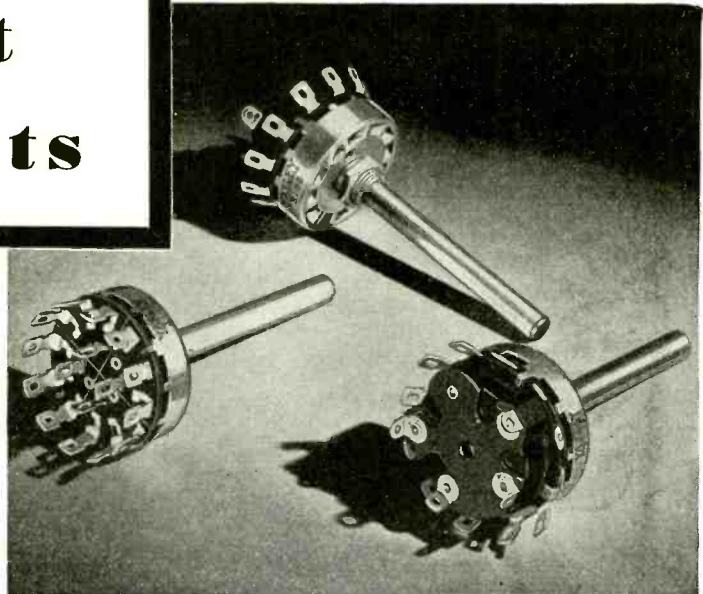
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I'm looking for uniform high quality, dependable performance and a reliable source of supply. Shakeproof meets these requirements fully and also knows how to cooperate with their customers so that orders are handled efficiently.



# Engineering Progress Results in Important Improvements

Marked improvement in Yaxley switches has permitted the domestic and amateur receiver manufacturers to advance into new fields of all-wave set design. Provision is made in Yaxley switch design for shorting the unused taps of the various antenna, oscillator and other similar coils. The capacity effect between the various parts of the switch has been reduced by proper arrangement of the parts and the use of special materials. This offers the added advantage of the very low losses when used as high as twenty-five megacycles.



The fundamental Yaxley design of exclusive silver to silver contact has been further improved until the contact resistance has been reduced to fractional parts of a milliohm.

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A new Yaxley "3100" line of band change switches has the complete mechanism in a self-enclosed cup, grounded and shielded for R. F. purposes from the other component parts of the receiver. One of the

features of the Yaxley 3100 switch line is a novel but highly satisfactory method of eliminating the well-known mounting bushing. This is accomplished by extruding part of the cup and rolling an accurate thread on the extruded surface. This eliminates the necessity of providing an expensive brass bushing.

Most suppliers seek to induce manufacturers to adapt their products to the supplier's wares. Mallory-Yaxley, on the contrary, engineers its products to meet manufacturers' requirements — to solve manufacturers' problems. Which is the basic reason why Yaxley switches are synonymous with leading quality in performance.

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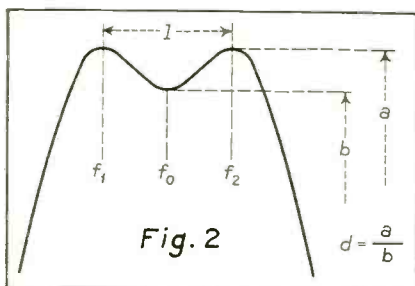
# RADIO ENGINEERING

FOR JANUARY, 1937

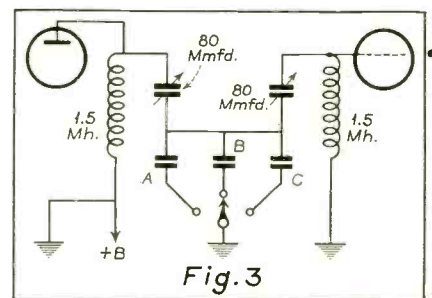
## VARIABLE FIDELITY CONTROL

by A. W. Barber\*

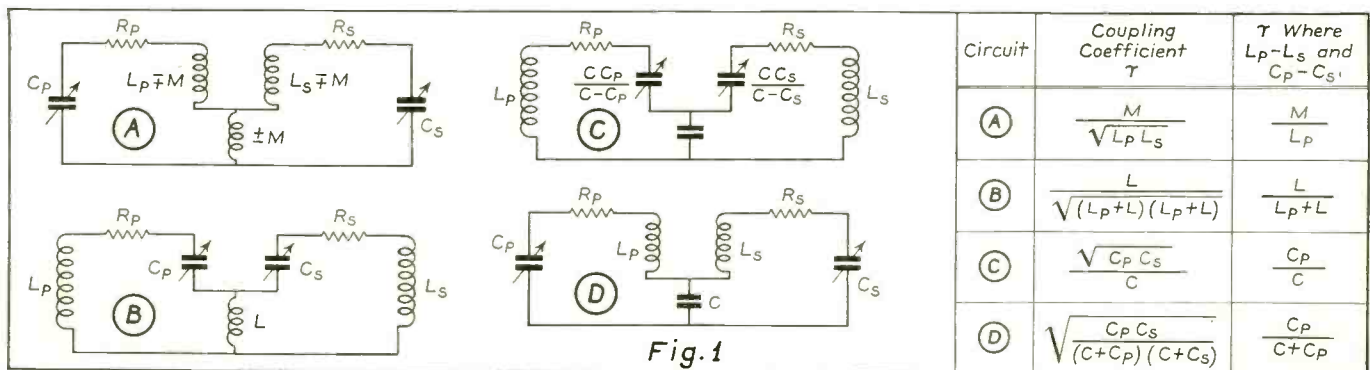
*It is a foregone conclusion that if radio receivers are ever to be high-quality musical instruments, all controls having any effect whatever upon the tone quality must be kept out of reach of the user. Automatic fidelity control, or selectivity control is something in which all engineers will eventually become interested. Here is an authoritative resume of available methods.*

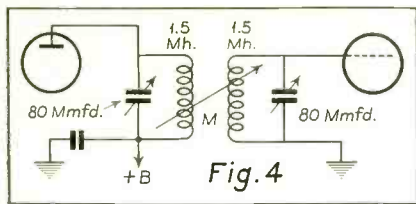


THE SUBJECT OF fidelity control in radio receivers is one of rapidly-growing importance. It has been realized for some time that the ultimate in performance can only be attained by varying the fidelity of a receiver in accordance with the signal strength of the received station. This permits high-fidelity reception of strong signals and interference-free reception of weak signals. Mechanical control of selectivity is rapidly



\*Consulting Engineer.





being adopted and electrical control is being developed in the laboratory. There can be no doubt that both types of control will soon be considered as basic principles in radio-receiver design.

#### COUPLED-CIRCUIT THEORY

The circuits to be considered in this report are tuned pairs of coupled circuits used between pairs of thermionic vacuum tubes. Fig. 1 shows four fundamental coupling systems employing mutual reactances of a single kind. The Standards Committee of the Institute of Radio Engineers has defined the coupling coefficient in such systems as follows: "The coupling coefficient is the ratio of the mutual or common impedance component of two circuits to the square root of the product of the total impedance components of the same kind in the two circuits. (Impedance components may be inductance, capacitance or resistance.)"

Coupling coefficient is usually designated by the Greek letter  $\tau$ . The coupling coefficients of the four circuits shown are also given in Fig. 1.

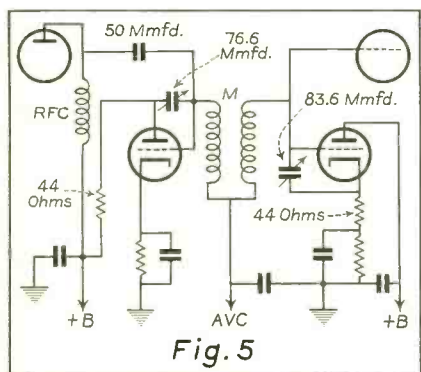
One other property of these circuits is important to the present considerations, and that is  $\tau$  or the circuit resistance divided by the inductive reactance at

$$\text{resonance, } \tau_p = \frac{R_p}{L_p \omega} \text{ and } \tau_s = \frac{R_s}{L_s \omega}.$$

We are assuming equal primary and secondary circuits and hence  $R_s = R_p$

$$\text{and therefore } \tau_p = \tau_s = \frac{R_p}{L_p}.$$

If the two coupled circuits are carefully tuned to the same frequency and



then coupled by varying amounts, the system will exhibit a single response peak for degrees of coupling less than a certain amount, called "critical," and a double response peak for coupling greater than this amount. Critical coupling is defined as  $\tau = \sqrt{\tau_p \tau_s}$ , or since we are assuming equal primary and secondary circuits as  $\tau = \tau_p$ .

Fig. 2 shows a double-peaked resonance curve in which the distance between the two peaks, or points of maximum response, is designated as  $l$  and the dip or difference between the amplitude of maximum response and the amplitude of the mean response is designated as  $d = \frac{a}{b}$ . This distance  $l$  may

$$\text{be expressed as } l = \frac{f_2 - f_1}{f_0}, \text{ and in}$$

terms of coupling and damping is  $l = \sqrt{\tau^2 - \tau_p^2}$ . Likewise the dip, which may be expressed in terms of coupling

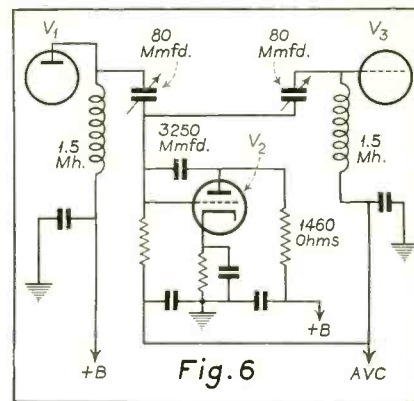
$\tau$	$\tau$ for $l=0$	$\tau$ for $l=0.022$ (10 Kc. at 456 Kc.)	$d$ for $l=0.022$	$\tau$ for $l=0.044$ (20 Kc. at 456 Kc.)	$d$ for $l=0.044$
0.030	0.030	0.037	1.07	0.053	1.15
0.020	0.020	0.030	1.08	0.048	1.41
0.010	0.010	0.024	1.41	0.045	2.33
0.005	0.005	0.023	2.44	0.044	4.32
0.003	0.003	0.022	3.64	0.044	7.20

and damping, is  $d = \frac{\tau^2 + \tau_p^2}{2\tau_p \tau}$ . These

simple equations express the important characteristics of over-coupled or double-peaked circuits in terms which make their design easy for various uses.

The response of the circuits of Fig. 1 may thus be varied by varying either the coupling or the damping of the individual circuits. If we start out with a pair of circuits coupled to give critical coupling and increase or decrease it, the response will become double peaked. If the two peaks are equally spaced with respect to the initial single peak, we may speak of the system as symmetrically expanding while if one peak moves further from the initial peak than the other we may speak of the system as unsymmetrically expanding. In general, if  $\tau$  or  $\eta$  is varied to cause expansion without changing the total circuit reactance, the expansion will be symmetrical. In Fig. 1 systems A and C are shown as circuits where expansion by varying  $\tau$  may be carried out to give symmetrical expansion.

In general, symmetrical expansion is the more desirable type although under some conditions unsymmetrical expansion



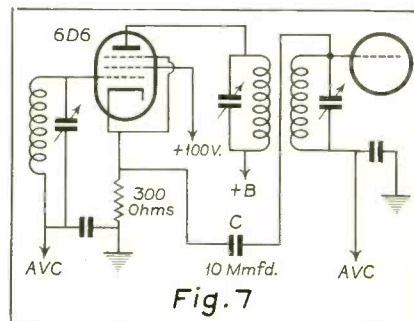
may be preferable. Where it is desired to obtain improved fidelity and at the same time to avoid interference on one side of a carrier, expansion may be made unsymmetrically on the opposite side of the carrier. Unsymmetrical expansion is also permissible in manually-controlled systems where essentially all the selective circuits are equally expanded.

In order to show the range of constants usually encountered in expanding circuits Table I has been prepared. We may assume that the receivers involved are superheterodynes with either expanding or non-expanding preselectors. We may further standardize by assuming an intermediate frequency of 456 kilocycles since this is the most commonly used frequency and circuits for other frequencies may be easily computed.

From Table I it may be seen that moderately good circuits—that is, circuits with  $\tau$  of 0.01 or more—are best suited to expansion circuits. The dip, as shown by values of  $d$ , is kept within satisfactory limits and the variation of  $\tau$  required to produce a given amount of expansion is smaller for larger values of  $\tau$ .

#### MANUAL-EXPANSION SYSTEMS

There are many ways in which fidelity expansion may be carried out manually. Fig. 3 shows a simple expansion system in which the coupling and hence the expansion is controlled by switching coupling condensers. The constants shown are for an intermediate-





frequency amplifier operating at 456 kilocycles. Assuming that the coils have an  $\eta$  of 0.01 a condenser A having a capacity of 8000 micromicrofarads is necessary to give critical coupling. Condenser B of 3250 micromicrofarads capacity will give a  $\tau$  of 0.024 or a bandpass of 10 kilocycles while condenser C of 1,700 micromicrofarads will make  $\tau$  equal 0.045 and give a bandpass of 20 kilocycles.

While the expansion produced by this system is unsymmetrical, that is, the expansion is all to one side of the initial response peak, it is simple and particularly adapted to inexpensive receivers where several fidelity conditions are desired. Two or more stages may be expanded at the same time by using a gang switch for changing coupling condensers in each stage. An additional switch section may be used to vary the audio-amplifier tone control to further compensate the overall receiver response. The tone control should raise the audio-amplifier high-frequency response as the coupled circuits are expanded. The addition of the tone control has the advantage that the cut-off beyond the response band is made sharper as the response is made broader helping to exclude possible interference.

Fig. 4 shows an interstage-coupling system which produces symmetrical expansion. The coupling between the coils of the two tuned circuits is inductive and variable by mechanical means. Recommended circuit constants are for an intermediate frequency of 456 kilocycles; coil inductances 1.5 mh, tuning condensers 80-mmfd less tube and circuit capacities, and  $\eta$  of both primary and secondary coils 0.01. With these constants a coupling factor  $\tau$  of 0.01 gives critical coupling. In order to expand from critical coupling to a total bandpass of 10 kilocycles,  $\tau$  must be increased from 0.01 to 0.024 or from 1 to 2.4 percent coupling. In order to expand to a bandwidth of 20 kilocycles the upper limit of coupling must be raised to 0.045 or 4.5 percent.

While this variable mutual-inductance expansion system is more complicated mechanically than the capacity system it has the advantages of symmetrical expansion and continuous control of expansion. In general either one of two methods may be used for varying the inductive coupling. One method consists in mounting one of the coils so that its plane may be rotated toward the plane of the other or fixed coil. The two limits of rotation should be determined by the maximum and minimum desired coupling coefficients. The other method of varying the coupling is to mount the two coils coaxially and to slide one of the coils toward and away from the other coil. The rotating-coil system, in

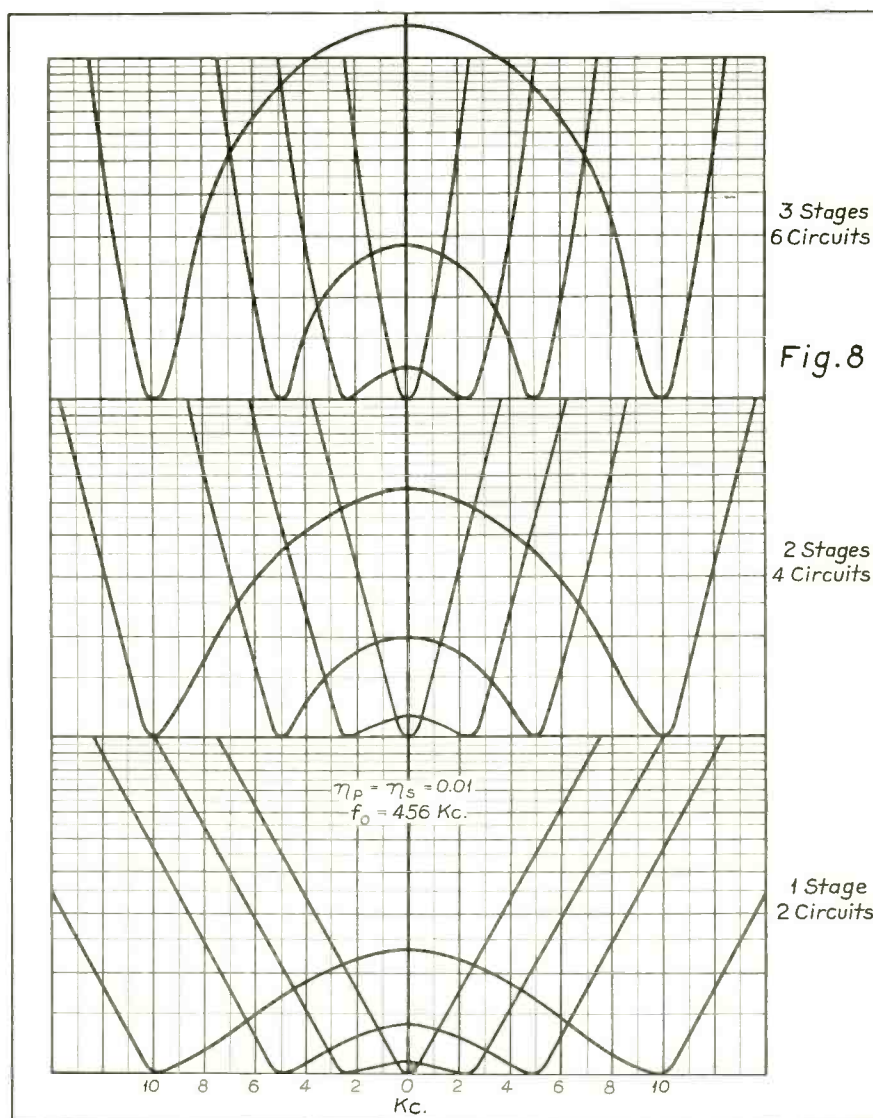
general, seems to be the simpler and to lead to a more compact coil arrangement. The mutual-inductance variable-coupling system is best adapted to more expensive receivers where the greatest degree of refinement in manually-operated systems is desired.

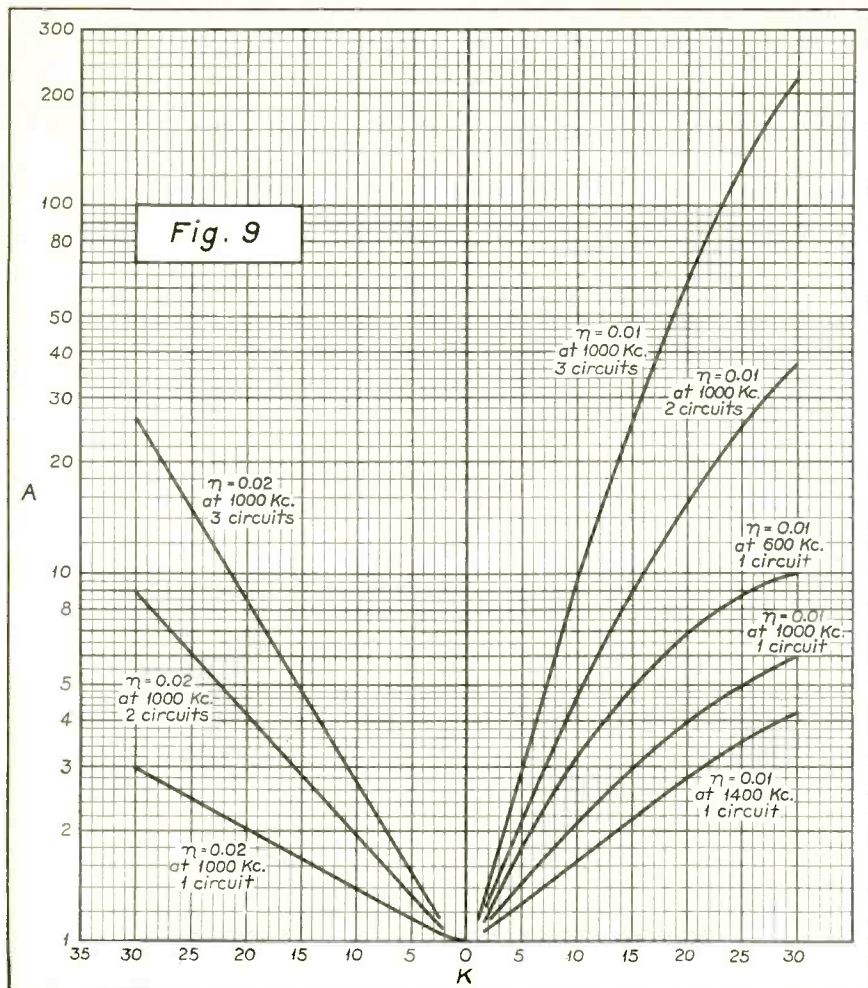
#### AUTOMATIC-EXPANSION SYSTEMS

Electrical-expansion systems fall into three general classifications. First, there are the systems which expand the circuit response by detuning one or both circuits of a coupled pair. Second, there are the systems which vary the coupling  $\tau$  between the two circuits of a coupled pair. Third, there are the systems for varying the  $\eta$  of the component circuits of a pair of coupled circuits.

The detuning systems in their best form function by lowering the resonant frequency of one circuit and by raising the resonant frequency of the other circuit forming a pair. Fig. 5 shows a suitable interstage-coupling system for producing a symmetrical 10-kilocycle de-

tuning when receiving a large signal. The primary coil is tuned by the effective input capacity of a triode which has a condenser connected between plate and grid and a gain-producing load resistor in series with its plate. The secondary coil is tuned by the effective input capacity of a triode which has a condenser connected between cathode and grid and a gain-producing load resistor in series with its cathode. The constants given are for a 456-kilocycle intermediate-frequency stage and the detuning tubes are assumed to have a mutual conductance of 1,000 micromhos at normal bias. For small received signals there will be no automatic-volume-control voltage fed back and the two control tubes have a net bias determined by the cathode-resistor drop. The tube connected across the primary coil will have a gain of 0.001 times 44, or 0.044, and the capacity between plate and grid will yield an effective input capacity 1.044 times this capacity. If then the plate-to-grid capacity is adjusted to 76.6 mmfd, the effective input





capacity will be 80 mmfd and will resonate the primary coil to 456 kilocycles. When a large signal is received, however, the automatic volume control will function, reducing the gain of the detuning tube. The maximum detuning will take place when the automatic-volume-control voltage is large enough to cause plate-current cut-off in this tube. The effective input capacity under these conditions will be the actual plate-to-grid capacity of 76.6 mmfd and the primary coil will be resonated 10 kilocycles above the initial 456-kilocycle intermediate frequency.

The detuning tube connected across the secondary coil has an effective input capacity less than the grid-to-cathode capacity at normal gain, since the phase of the current in the gain-producing resistor is opposite to that of the primary-connected tube. Thus with a grid-to-cathode capacity of 83.6 mmfd the effective grid-to-cathode capacity at maximum tube gain will be 80 mmfd. In the presence of a large signal the tube gain is reduced to zero and the input capacity becomes 83.6 mmfd, detuning the secondary 10 kilocycles below the initial 456-kilocycle intermedi-

ate frequency.

The coupling between the primary and secondary coils may conveniently be magnetic by an amount yielding critical coupling. Many modifications of this expansion system are possible. For instance, a double-triode tube may be used in place of the two detuning tubes.

The second type of electrical automatic-expansion control is shown in Fig. 6. This is a modification of circuit C of Fig. 1 with fixed tuning condensers and automatically-variable coupling condenser. The coupling condenser is the effective input capacity of  $V_2$  having a large added plate-to-grid capacity and a gain-producing plate load resistor. With small received signals there is no automatic-volume-control voltage and  $V_2$  operates at normal bias. If this tube has a mutual conductance of 1,000 micromhos at normal bias, a load resistor of 1,460 ohms and a plate-to-grid capacity of 3,250 mmfd, its effective input capacity will be 8,000 mmfd. With primary and secondary circuits of 1.5-mh inductance, having  $\tau = 0.01$  tuned by condensers of 80 mmfd, this coupling capacity will yield critical coupling. When large signals are received the gain of  $V_2$  is finally reduced to zero and the effective coupling capacity becomes 3,250

mmfd, yielding a bandpass of 10 kilocycles. The expansion produced by this circuit is unsymmetrical since the total capacity reactance of the circuits is varied.

An example of the third type of automatic expansion control<sup>1</sup> is shown in Fig. 7. While many circuits have been proposed for automatic expansion by control of circuit  $\tau$ , this one seems to be satisfactory and is far simpler than most of the circuits tried. A positive feedback is used to increase  $\tau$  for small signals, corresponding to maximum tube gain, by means of condenser C connected between the coupled-circuit secondary and the cathode of the amplifying tube. Since the feedback voltage appears across the cathode bias resistor it is left unbypassed. The phasing of this circuit is accomplished by the 90-degree shift between primary and secondary of the coupled circuit and the 90-degree shift in the feedback RC circuit. Initially the primary and secondary coils are coupled to give the maximum desired bandpass in the presence of large signals, that is, with the tube gain low and hence the feedback ineffective. Then C is chosen to give feedback to produce a single peak at maximum tube gain. This circuit has the desirable features of increasing the circuit selectivity and gain for small signals and decreasing the circuit selectivity and gain for large signals, thus aiding the automatic-volume-control action.

Since over-coupled circuits do not give flat-topped bandpass characteristics but exhibit a dip at the mean frequency, the application of these circuits to radio receivers requires compensation for this dip. One method of accomplishing this is to expand one or more intermediate-frequency amplifier stages and to so design the radio-frequency preselector circuits as to compensate for the dip in the expanded circuit response. Figs. 8 and 9 show various selectivity curves which are useful as a guide in designing a complete radio receiver. Fig. 8 shows the selectivity of one, two and three pairs of coupled 456-kilocycle intermediate-frequency circuits in cascade. Each circuit is assumed to have an  $\tau$  of 0.01. Each set of curves shows the curve for critical coupling and 5, 10 and 20 kilocycle bandpass. These curves show the amount and type of complimentary compensation needed to produce a flat-top total response. Fig. 9 shows various curves of preselector circuits at 1,000 kilocycles for 1, 2 and 3 circuits having  $\tau$  of 0.1 and 0.02. This frequency was chosen since it is the mean frequency of the broadcast band and is suitable as a design compromise. The addition of various combinations of the curves shown in Figs. 8 and 9 will show what results may be expected from a given design.

<sup>1</sup>See U. S. Patent No. 2,033,330 issued March 10, 1936, to L. F. Curtis.



# CALCULATIONS FOR CLASS A AMPLIFIERS

by E. K. Brown

WESTERN ELECTRIC CO., LTD., NEW ZEALAND

WHILE AN ANALYSIS of the operation of Class A amplifier tubes will show that the maximum power output, for the usual given conditions, is obtained when the load impedance is equal to the tube impedance, this does not represent the maximum power output of which the tubes are capable. The limiting factor in tube operation is the power than can be dissipated at the plate of the tube, and by increasing the efficiency of conversion to a value greater than 50 percent (that obtained when the load impedance equals the tube impedance), it is obvious that the power output may be increased to a value greater than that usually associated with any particular tube.

It is evident, from an inspection of the characteristic curves, that symmetrical swing over the load impedance is a function of the input voltage and that this is limited by the value of grid voltage which gives a static plate voltage and plate current which causes the maximum plate dissipation of which the tube is capable. The problem then resolves itself into one of determining a relationship between the input voltage and the load impedance, with the plate dissipation held at a constant maximum.

The peak plate current is given by,

$$I_{pp} = \frac{\mu E_g}{R_o + R_p} \dots\dots\dots (1)$$

where,

- $I_{pp}$  = peak plate current
- $E_g$  = peak grid voltage
- $\mu$  = amplification factor of tube
- $R_o$  = load impedance
- $R_p$  = tube impedance

Since

$$P_o = \frac{E_{ps} \times I_{ps}}{8} \dots\dots\dots (1a)$$

$$= \frac{2\mu E_g}{2} \times \frac{R_o}{(R_o + R_p)} \times \frac{I_{ps}}{2} \times \frac{1}{2} \dots\dots\dots (1b)$$

$$\frac{I_{ps}}{2} = P_o \times \frac{2(R_o + R_p)}{\mu E_g R_o} \dots\dots\dots (1c)$$

$$= \frac{\mu^2 E_g^2 R_o}{2(R_o + R_p)^2} \times \frac{2(R_o + R_p)}{\mu E_g R_o} \dots\dots\dots (1d)$$

from which

$$I_{pp} = \frac{\mu E_g}{(R_o + R_p)} \dots\dots\dots (1)$$

Then

$$E_g = \frac{I_{pp} (R_o + R_p)}{\mu} \dots\dots\dots (2)$$

$$= \frac{(I_p - I_{pm})}{\mu} R_p (n + 1) \dots\dots\dots (3)$$

where

- $I_p$  = static plate current
- $I_{pm}$  = minimum plate current allowable during operation
- $n = R_o/R_p$

thus

$$E_g = \frac{(E_p I_p - E_p I_{pm})}{E_p \mu} \cdot R_p (n + 1) \dots\dots\dots (4)$$

where

$E_p$  = static plate voltage.

$E_p I_p$  is, however, the plate dissipation,  $D$ , and we have,

$$E_g = \frac{(D - E_p I_{pm})}{E_p \mu} R_p (n + 1) \dots\dots\dots (5)$$

or

$$n = \frac{\mu E_g E_p}{R_p (D - E_p I_{pm})} - 1 \dots\dots\dots (6)$$

The minimum allowable plate current,  $I_{pm}$ , will be fixed by the distortion factor but can in general be taken as 10 percent of  $I_p$ , which will give a satisfactory value, and in this case (6) will become,

$$n = \frac{\mu E_g E_p}{R_p (0.9D)} - 1 \dots\dots\dots (7)$$

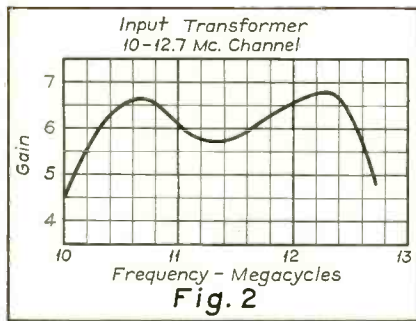
This equation will then give the ratio of load impedance to plate impedance which should be used to accommodate any given input grid swing,  $E_g$ , when the plate dissipation is fixed at a value of  $D$  watts.

The derivation of the equation, it will be seen, assumes that the plate-voltage and plate-current swings are symmetrical about the operating point, i.e., that there is no distortion. While this is not actually true the error introduced by this assumption is small and, if necessary, can be corrected by an adjustment of the load line on the  $E_p I_p$  curves.

(Continued on page 14)

# THE RCA MULTIPLEX

by V. D. Landon \*



THE PROBLEM of obtaining all wave reception in the average apartment building is a difficult one. The least desirable solution is the common one of allowing each tenant to put up an antenna to suit his own taste. The resulting maze of poles, antennas, and guy wires is seldom a thing of beauty. An alternate solution of limiting the tenant to indoor antennas is no solution at all, because satisfactory signals cannot be obtained in most buildings, especially those employing modern steel-frame construction.

The Antennaplex idea is to combine a noise reducing antenna with an amplifier and a distribution system to supply a number of radio receivers with signals from a common antenna. This sort of system has been commercialized since about 1928, but operation has always been confined to the standard broadcast band.

Extension of the operating range into the short-wave spectrum presents considerable difficulty. One of the major difficulties is that of obtaining sufficient amplification over such a wide frequency band.

The voltage which may be transferred from a capacitive antenna to a transmission line is inversely proportional to the square root of the frequency band to be covered. The available gain of each stage of an amplifier is inversely proportional to the band width. These factors make wide frequency coverage difficult in a single channel amplifier.

In the Antennaplex system, the gain difficulty is eliminated by using a multi-channel amplifier. The frequency spectrum is divided into a number of comparatively narrow bands and a separate amplifier used for each band.

\*Engineering Dep't., RCA Mfg. Co.

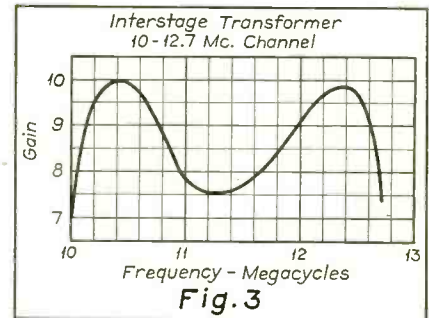
## THE MULTI-CHANNEL AMPLIFIER

There are other considerations which make it desirable to increase the number of channels even above the number required to obtain the required amplification efficiently.

First, a high gain from antenna to first grid is important to reduce the amplification required after the first tube, thus reducing the hiss.

Second, cross modulation may occur if strong s-w transmitters exist nearby. This interference will be confined to the channel containing the interfering station; hence, less interference will be produced if channels are narrow.

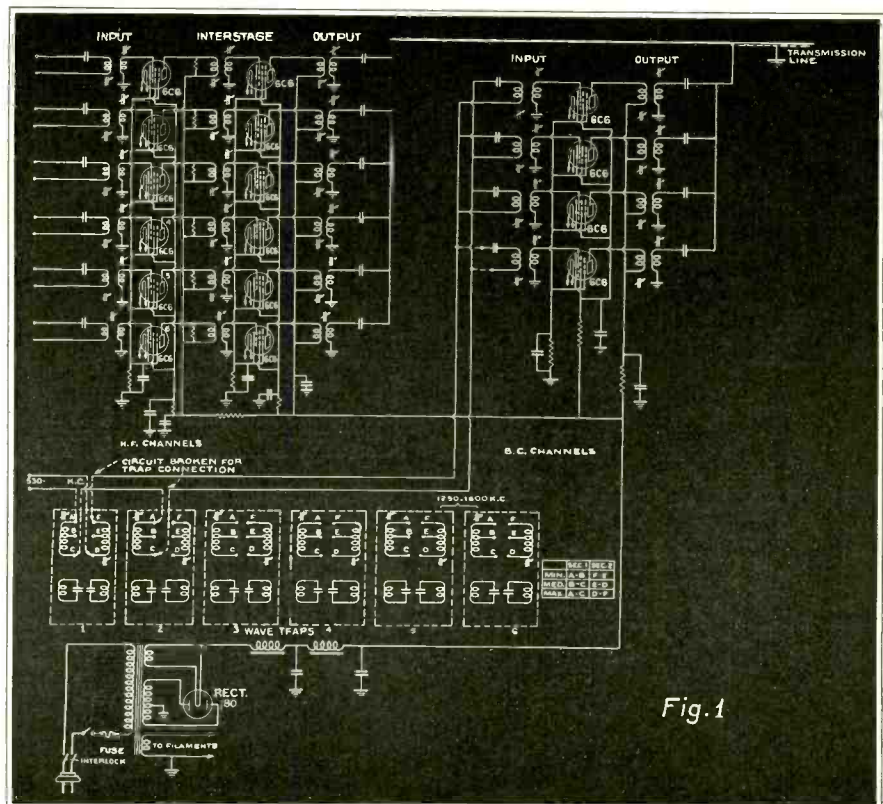
Third, the available gain of an output transformer feeding the main transmission line, is limited by the output capacity of the tube to a value which is inversely proportional to the square root of the band width covered. For a given level of output the last tube is working at a lower signal level with a narrow frequency band. Thus, the



chance of obtaining cross modulation is less in a narrow channel.

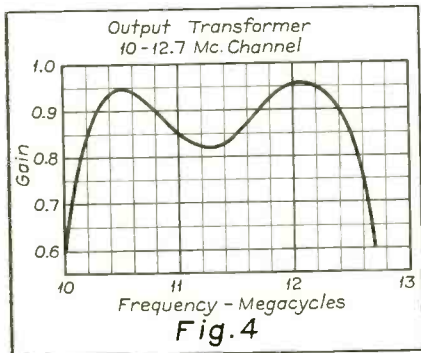
Fourth, through rectification in the amplifier tubes, second harmonics and sum and difference frequencies are produced. These undesired signals are attenuated more in the output transformer if the transformer is designed for a narrow band.

On the other hand, if channels are made too narrow, the number becomes unduly large and accidental capacity and





# ANTENNAPLEX SYSTEM



inductance variations detune the circuits to a serious extent.

In the Antennaplex, the short wave spectrum from 2 to 18 megacycles is divided into six bands, each band having its own amplifier channel as shown in the circuit diagram of Fig. 1. Two tubes and three transformers are used in each short wave channel.

In each channel the transformers are resonated to the corresponding frequency band. The desired bandwidth is obtained in each case by a proper choice of transformer coupling and damping. The transformers are all designed for a maximum product of gain times bandwidth.

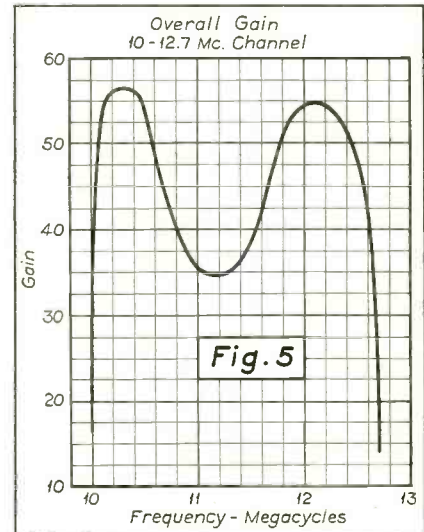
All of the resonant circuits of each channel are tuned to the proper frequency by an adjustable magnetite core. An exception is the 2 mc channel where

the tight coupling required makes it impossible to separately tune the two resonant circuits of each transformer. Fixed tuning is used in this band.

The input transformers have a gain of about five from the line to the first grid. The interstage has a gain of about 8 from grid to grid. The output transformer has a gain of about unity from grid to line. The overall gain from line to line is about 40. Fig. 2 gives a performance curve on a typical input transformer, Fig. 3 gives a curve on an interstage transformer, Fig. 4 is for the corresponding output transformer, and Fig. 5 is the overall curve for the channel.

Although the output transformers are all connected to the same load, they may be designed separately with only a small error. The interaction between transformers of different channels is reasonably small if the amplification of each output transformer is down about 60% at the channel frequency limits. If broader transformers are used, however, the performance curves are radically changed when adjacent transformers are connected across the line.

For the broadcast band the previously mentioned considerations indicating the desirability of narrow channels seem to apply with increased force, because of the greater utilization of these frequencies. For this reason the band from 530 to 2000 kc is divided into four channels.

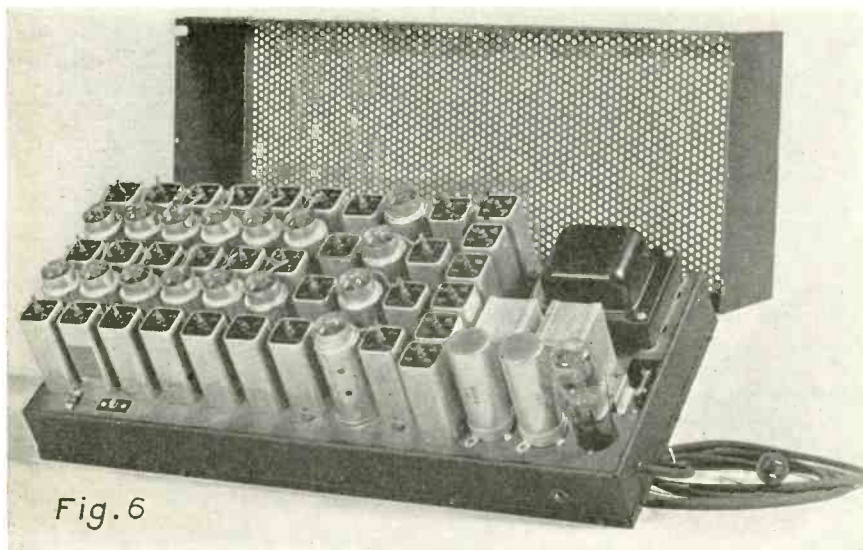


For the narrow bandwidth required, the available gain per stage is sufficient to require only a single tube per channel. The input transformers have a gain of about 20 and the output transformers a gain of about 2. The principles involved in the design of these transformers are the same as for those of the short-wave channels.

In metropolitan areas, there are usually several stations which deliver signals to the antenna which are too powerful for the amplifier to handle. These are attenuated to a reasonable signal strength by wave traps which are supplied on the amplifier and which may be wired into the input line when needed. The degree of attenuation may be adjusted in three steps by varying the number of coupling turns used.

Fig. 6 is a photograph of the amplifier chassis with the cover removed. The short-wave input transformers are in the row at the far side. In the row on the near side are s-w output transformers. The three cans and two tubes on the left constitute the highest frequency channel. The other short-wave channels are placed along side in the order of their frequencies.

The row of cans at the right, next to the power transformer, are the wave traps. The adjacent row of four cans comprise the broadcast band input transformers. The individual broadcast channels feed from right to left through the adjacent tubes and output trans-



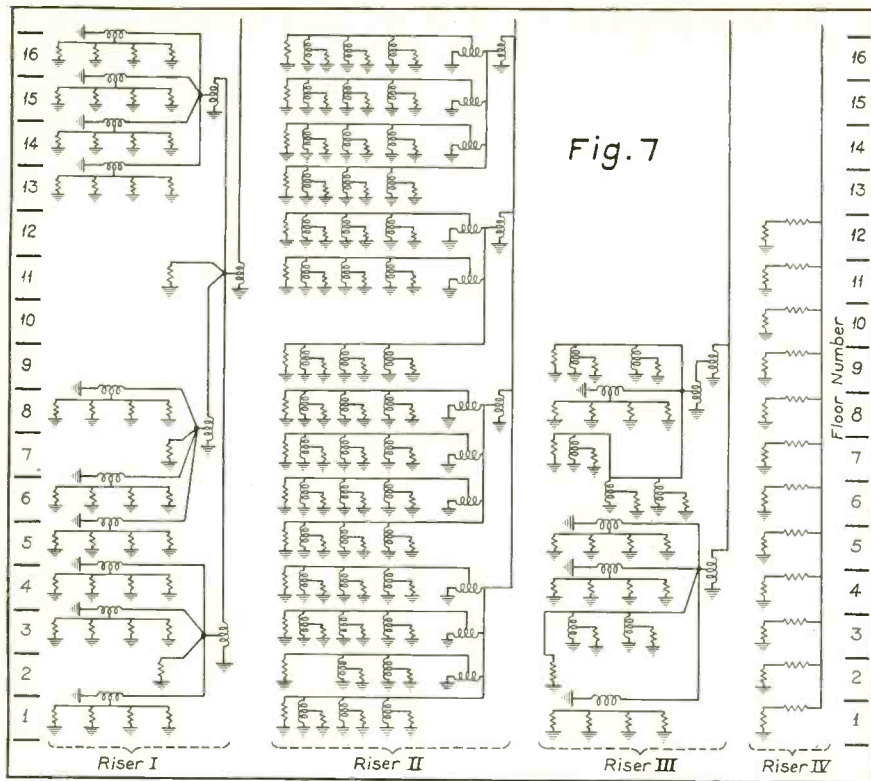


Fig. 7

formers. When the amplifier is for airport use, the 1600-2000 kc channel is omitted and a 200-400 kc channel is substituted.

#### THE ANTENNA SYSTEM

Each of the six short-wave channels has a separate antenna and a separate line from antenna to amplifier. For the five highest frequency bands the antenna consists of a dipole resonant to the center of the band. For the 2 mc band a "T" antenna is used feeding a transmission line through a suitable transformer.

A single antenna, antenna transformer and line are used for the four broadcast channels so that the wave traps are effective on all four bands.

The antenna wires are strung horizontal and parallel to each other with a 2-foot separation. Each of the eight wires is 50 ft long. Insulators are placed at the proper points to resonate the short wave dipoles at the proper frequencies. Two parallel 50 ft wires are used for the broadcast band.

The wires may be strung in a single vertical plane one above the other, or in a horizontal plane side by side, or the wires may be spaced at 2 ft intervals around a rectangular or circular spreader.

#### THE DISTRIBUTION SYSTEM

The problem of distributing the available signal energy, of the main line, equally to all the desired outlets is not an easy one. In an ideal case, the main line should feed all the outlets in parallel through a transformer having a turn

ratio equal to the square root of the number of outlets. However, only one type of transformer has been found which has a high efficiency over the whole desired frequency spectrum. This transformer has a two-to-one ratio and is wound in such a manner as to minimize the leakage reactance. Its frequency characteristic is given in Fig. 8.

For an impedance match and for highest efficiency, this transformer should always feed from one line into four lines as shown in riser I of Fig. 7. The single resistors on floors 2, 7 and 11 illustrate how various lines should be terminated when the corresponding outlets are not yet installed. Each of these resistors may be omitted if the line from the transformer is omitted. In other words, a transformer from one line to three is not a serious mismatch. A line must never be left without a terminal resistor as this would reduce the signal strength in other branches at certain frequencies due to resonance of the open line.

A second method of distribution is illustrated in riser II.

The same 2-to-1 transformer is used, but in a different way. The first transformer bleeds off some of the signal into a single branch line and allows the remainder to continue along the main line. The second and third bleeder transformers shown on the 8th and 12th floors feed additional branch lines. After having passed three bleeder transformers the signal remaining on the main line has been attenuated an average of 2-to-1, so this line is treated as

the fourth branch line feeding floors 1 to 4.

In a similar manner, each branch line feeds 4 sub-branch lines which in turn feed 4 outlets apiece. Any bleeder transformer may be omitted when not needed, as shown on the 2nd, 8th and 10th floors.

In fact, the attenuation on the line after passing three bleeder transformers varies with frequency and with the spacing of the transformers along the line. Also, the signal on the third branch is somewhat less than on the first branch. The method of riser I gives a more equal distribution of signals and should be used unless economic considerations strongly favor the second method.

The first method has the advantages of more equal distribution of energy and the smaller number of transformers required.

The second method has the advantage of requiring less transmission line. A further advantage is the greater flexibility in supplying numbers of outlets differing widely from the powers of 4 (i.e., differing from 16, 64, or 256).

A mixture of the two methods will often be best. This is illustrated in riser III. Here it is assumed that only 9 floors need be supplied and some floors with less than four outlets, so that only one bleeder transformer is needed on the riser. On floors 2, 3, 6, 7 and 9, less than 4 outlets are required and appropriate methods of handling are shown.

It should be noted that when a bleeder is wanted to feed into four lines, as shown on the 8th floor, two transformers together are required to prevent too great a proportion of the signal from being drawn out of the main line at this point.

In riser IV, a method of distribution is shown which is satisfactory for 12 or less total outlets. If less than 12 are required, the lines from the large resistors are omitted first.

In locations where the small size of the available conduit makes other methods impossible, the method of riser IV may be used in each of four risers fed from a main line by an impedance matching transformer. This gives a

(Continued on page 14)

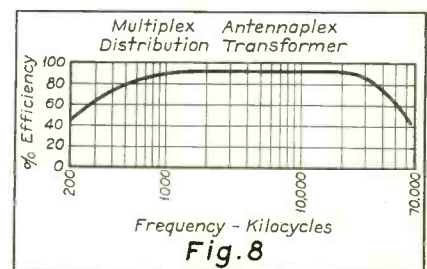


Fig. 8



# NOTES ON CATHODE-RAY TUBES

by Bernard H. Porter\*

IN THE DESIGNS of kinescopes or cathode-ray tubes heretofore proposed for television reception, it has been necessary to maintain the normal ray intensity at an undesirably high value in order to secure satisfactory contrast of the resulting image. This effect is explained by realizing that when a sufficiently brilliant image is formed on the fluorescent screen, part of the light emitted therefrom is radiated inwardly and reflected back to the screen from the envelope walls and metal parts of the electron gun. Obviously, reflected radiation penetrating the translucent screen also decreases the picture intensity.

Earlier experimenters, following the initial work of Rosing, Campbell-Swinton, and Dieckman in 1906-1907, observed that interior tube walls metallized by reducing salts of silver or similar metal also reflect a considerable amount of this inwardly radiated light both to and from the screen. A background of appreciable brilliancy is thereby created that decreases the contrast of the image unless, as we have said, the intensity of the cathode ray is maintained at a high value.

In addition to the effects just named, the advent of the high-vacuum designs have made it imperative to provide a conductive path for the electrons that accumulate on those areas of the screen where the cathode ray might be directed. This path must then extend from the fluorescent screen to the cathode forming part of the electron gun in order to provide a ground for those stray charges striking the side walls and to eliminate any external effects that might influence the path of the electron stream. In the former gas-filled tubes this conducting feature was provided automatically by the ionization of the argon or other gas employed.

With the continued development of cathode-ray techniques, the use of metallic coatings on the side walls of the glass envelopes has been discarded in favor of graphite films. The commercial impracticability of using silver, its cost, and inability to adhere tenaciously to certain types of glass are factors responsible for the change. In general, it has been demonstrated that graphite deposits reduce optical defects, provide a suitable focusing or second anode in the region extending from the tube neck to the edges of the fluorescent screen, and improve with age the usual vacuums ( $10^{-5}$  millimeters of mercury or better).

## METHOD OF APPLICATION<sup>1</sup>

A simple combination of funnel, or aspirator bottle and airvent, is employed for applying graphite to the

interior of the tube following its careful cleansing with an oxidizing agent like chromic acid. Rotary motion in the case of the funnel method, or change of height of the aspirator bottle for the second case enables one to control the area covered by solution. For regulating the thickness of the deposited films, one dilutes with distilled water the concentrated graphite preparation as commercially available. The treated envelopes are then dried with warm air and later baked at 450 degrees Centigrade in order to eliminate occluded moisture and decompose any protective agents present.

## GROUNDING THE SCREEN

To provide a conducting layer on the face or screen of the tube for the purpose of dissipating accumulative electron charges has offered difficulties for some time. For those tube designs used in oscillographs it is feasible to form a conductive path by drawing a single line of dilute graphite solution over the face of the tube and permitting it to dry before the fluorescent powders are applied. Later when the side walls are coated by the procedure described above, care is taken that the end portions of the single line are also covered to make electrical contact. This method, however, is obviously not adaptable for the shielding of screens in cathode-ray tubes employed for television purposes.

One process<sup>2</sup> for producing electrically-conductive, fluorescent, and translucent screens consists of mixing relatively small particles of fluorescent materials with even finer divided particles of a conducting substance, dispersing the mixture in liquid vehicles, and permitting the solids to settle out on the tube parts according to the formula

$$v = \frac{2r^2 (S-S') g}{9n}$$

where  $v$  is the rate of fall,  $r$  the radius of the particles,  $S$  their specific gravity,  $S'$  the specific gravity of the carrier,  $n$  the viscosity of the liquid, and  $g$  the force of gravity. Since the smallest particles, as for example silver or other conducting substance, settle first, a conductive film is deposited upon which the fluorescent powders later precipitate to form the screen. After the clear liquid is drawn off and the screen dried, the focusing anode of graphite is applied, care being taken that the

<sup>1</sup>For a discussion of cathode-ray techniques abroad see page 7, December 1935 issue of RADIO ENGINEERING.

<sup>2</sup>J. C. Batchelor. U. S. Patent 2062858, (1936).

\*Acheson Colloids Corp.

outer edges of the metal screen-deposit come in contact with the graphite wall-layer.

### TUBE LIFE

One important consideration is that of tube life. Former gas-filled types of cathode-ray tubes are known to possess a limited life because the bombardment by gas ions ultimately destroys the coating. The later high-vacuum designs are supposed to have overcome this difficulty, though according to some observers the early experiences unfortunately did not fulfill this promise. After a life of a few hundred hours, the brilliance of the picture begins to fade. It can be restored, however, by increasing the cathode temperature (i.e., increasing the filament current), though this is said to hasten the end.

The evacuation of a large bulb such as a cathode-ray tube having within it relatively large masses of metal is not simple, with the result that there is inevitably a small trace of gas left. Consequently, when the tube is in operation there will be a small drift of positive ions towards the cathode, resulting in a bombardment of the screen. The severity of such bombardment depends upon the potential gradient near the cathode. If, then, there is a powerful electrostatic field in this area, the positive ions will move with a high velocity and may be rather destructive in their effect. If the electric field, however, is re-

duced in intensity the undesired effects are diminished somewhat. The actual energy contained in the particles is proportional to the square of the velocity, so that if the potential gradient is halved, the destructiveness of the screen is reduced to one-quarter and the tube will normally last four times as long.

### RESUME OF CHARACTERISTICS

In reviewing the characteristics of present cathode-ray tubes designed for television purposes, one might indicate their advantage as follows:

- (1) Noiseless operation of non-mechanical parts.
- (2) High limits of image detail.
- (3) Possibility of colored images.
- (4) Ease of changing picture shape.
- (5) Flexibility of scanning system.
- (6) Ease of eliminating stratified effects.
- (7) Less flicker.

In contradistinction to these factors the disadvantages of the tube might be summarized thus:

- (1) Necessity of complicated circuits.
- (2) High upkeep cost.
- (3) Limitation of picture size.
- (4) Limitation of light available.
- (5) Danger from high voltages.

## CALCULATIONS FOR CLASS A AMPLIFIERS

(Continued from page 9)

The equation can be most conveniently applied as follows,

- (1) Determine the operating point at the intersection of the peak grid-input-voltage curve with the maximum plate-dissipation curve, which will give  $E_p$  and  $I_p$ .
- (2) Calculate  $n$  from equation (6).
- (3) Calculate  $R_o$ , which equals  $nR_p$ .
- (4) Calculate  $E_s$ , the supply voltage, which is given

by

$$E_s = E_p + R_o I_p.$$

- (5) Draw the load line through  $E_s$  and the operating point, and this should pass through the curve  $2E_g$  at a plate current not less than the fixed minimum plate current  $I_{pm}$ .

It is apparent that this method of working Class A amplifier tubes is superior to the usual method, where the plate impedance is made double the tube impedance, since the harmonic distortion is reduced by the operation into a higher load, and the lowered plate current

and plate-current swing imposes a decreased demand upon the regulation of the power supply.

As an example of the application the case of a type 45 tube is taken where it is intended to drive the grid with a signal voltage of 100 volts. In this case,

$$n = \frac{3.5 \times 100 \times 410}{1600 \times 0.9 \times 10} - 1 \\ = 9 \text{ approx.}$$

Hence  $R_o = 14,400$  ohms, and the power output under these conditions will be, as calculated from the usual power equation, 3.4 watts. Two of these tubes in a push-pull circuit would give a power output of 6.8 watts. In this example it will be seen from an examination of the characteristic curves for the tube that the — 100 grid-volts curve intersects the 0.025-ampere plate-current line at a plate voltage of approximately 410 volts which gives a plate dissipation of 10.25 watts which is the maximum rating for the tube. The supply voltage will be 410 plus  $14,400 \times 0.025$  or 770 volts, and a load line drawn through the points  $E_p$ , 770 volts,  $I_p$ , 0 ma and  $E_p$ , 410 volts,  $I_p$ , 25 ma, will be the required load line.

## THE RCA MULTIPLEX ANTENNA- PLEX SYSTEM

(Continued from page 12)

maximum of 48 outlets for this method.

For as many as 64 outlets, the method of riser II may be used throughout, though it will usually be better to use the method of riser I wherever economic considerations permit. When more than 64 outlets are desired, the main reliance must be placed on the first method, though the second may be used at a few of the split-up points.

By using the first method throughout, as many as 256 outlets may be used and the signal strength in each outlet will average greater than that available on

the roof ahead of the amplifier. By adding one more stage of distribution, a maximum of 1024 outlets may be used but signals may average slightly below roof signal strength. In both cases, the method of riser I must be used almost entirely to conserve the signal energy as much as possible.

The transmission line adopted for short runs consists of 7 strands of No. 30 copper wire built out to  $\frac{1}{4}$ " diameter with high grade rubber and covered with a braided copper shield which acts as the outer conductor. This line has an attenuation of 2.25 db per hundred ft at 10 mc.

For longer runs, a lower loss cable, such as the concentric type made by

Western Electric Co., should be used, especially if the number of outlets is large.

It would be possible to develop another multi-channel amplifier for ultra-high frequencies covering possibly 20 to 60 mc in 5 or 10 mc steps with perhaps 3 or 4 tubes per channel. Such an amplifier might become as necessary as the one here described when television is commercialized and if this band becomes active with local broadcasting. The distribution system of the present design has purposely been made to pass these frequencies so that a new amplifier with an appropriate antenna would be the only additional requirement for ultra-high frequency operation.



# HOW ARE RADIOS USED?

*Our Unofficial Observer discovers that in addition to providing entertainment, many radios have other and important functions. We discuss a few of them, and offer some suggestions to manufacturers on how to make a receiver still more attractive to those who insist upon multi-function sets.*

THE RADIO RECEIVER which as its primary function tunes in entertainment and advertising, is capable of and is used for a number of secondary purposes, which are of interest to manufacturers, since they assist in sales.

The nature of that assistance is twofold, and only in part due directly to the additional uses the receiver can be made to serve. The people who retail receivers to the general public often earn an unusually large profit in modifying some set to serve an auxiliary function, and the good-will of those individuals (dealers and servicemen) is valuable to any set manufacturer. If the receiver is so built as to facilitate its adaption to supplementary purposes, the manufacturer has added to his product a feature that assists the retailer in reaping much more than the usual return. It is only natural for the dealer and service man to favor and recommend sets that offer this opportunity.

The conversion of a receiver to purposes for which it was not primarily intended can be very troublesome in the field, while inclusion at the factory of proper provisions for such conversion may be simple and extremely inexpensive.

One of the secondary services often performed by sets is that of an inexpensive hearing aid. The experience of the movies after installation of sound, and the prosperity of hearing-aid manufacturers right through the depression, indicate that the number of persons needing such aid is much larger than commonly realized—perhaps at least as

large as the number of persons that require eye glasses.

There are three reasons why the extent of the need for hearing aids has been obscured. Such aids are new. They are more expensive than eye glasses, and less often seen for that reason alone. Lastly, the hard-of-hearing seem to have an almost morbid fear of making their affliction known. Devices now available for their assistance have to be as small and inconspicuous as possible—that is, for use in public; and this requirement is one reason for their cost.

Naturally, many of those who need help in hearing cannot afford commercial aids that are priced in the vicinity of a hundred dollars, yet can and do afford midget radios. The use of a radio for help in hearing is of course conspicuous, but within the limits of the patient's home and family, to which its use for that purpose is confined, concealment is obviously less important.

Retailers and service men are occasionally asked to convert a small receiver for this function. Radio mail-order houses receive similar requests. Yet the shyness of the hard-of-hearing, their unwillingness to confess their handicap, indicates that the demand is incomparably less than it might be if the same facility were tactfully and inconspicuously offered.

A receiver used to help the deafened is equipped with a headphone jack, and with a microphone jack. The patient wears the phone, and the microphone is used to pick up family conversation. Very often the loudspeaker is muted

entirely, in order that a 360-degree microphone may be used without acoustic feedback, and the patient enabled to pick up everything said in the room without moving the microphone around.

A seeming objection to using a small radio in this way proves, on experience, to be no objection at all. One would naturally think that the hum level, and background noise level, would make use of a headphone unpleasant in the case of many receivers, especially the smaller ones. But actual test shows that the deaf never hear these disturbances and do not know they are present. Neither do such persons hear distortion objectionable to others.

The problem of retailing a receiver that possesses the supplementary facilities of a microphone jack and a phone jack is psychologically complicated by the unwillingness of persons who need such help to admit their need. Therefore it is advantageous, as a sales method, for the manufacturer to tell the retailer, and the retailer to tell the customer, that the primary purpose of the added convenience is to enable one member of the family to listen in without disturbing others, whenever a loudspeaker would be objectionable. Having established that point, it becomes possible to suggest that, of course, if by any chance someone in the family happens not to hear very well, the same provision will serve as an inexpensive aid to hearing if a microphone is added.

Even this circumlocution may not complete the sale unless a satisfactory excuse for buying the microphone can

be thrown in, and it may be as well to add that the microphone will help Sister practice for a radio audition, and serve for general amusement.

The use of headphones for quiet listening in, which will not disturb other members of the family is of course a separate and useful function that appears in the industry from time to time, either as an additional facility added to a radio, or in the form of small bedroom or hospital radios meant for phones alone, and having no loudspeaker. As such, that facility has sales advantages of its own, as every retailer knows who has been called upon to revamp a midget in that way for the service of someone confined to hospital, or for ending a family quarrel.

When used with headphones in the ordinary way, however, by persons with normal ears, the receiver needs more than a phone jack. The power pack must be quieted, and various small background noises carefully taken out by means that will insure their staying out.

Those who have had occasion to follow radio advertising in the metropolitan newspapers of such centers as New York and Chicago know that there is a steady and healthy market for "pillow" and other headphone receivers to be used in small apartments. It is also noteworthy that bone-conduction units are now coming to replace headphones for normal hearing as well as for the help of the deaf.

Another facility that may profitably be added to any radio, small or large, is based upon one of the supplementary services the radio normally performs in any home. Housewives turn it on during the day and let it run while they go about their chores. They are less concerned with what they hear than with the idea of hearing something. Primarily, what they ask of the radio at such times is not entertainment, but only company. Any music, any subject of discourse, is satisfactory provided

they are kept from feeling they are alone.

But entertainment would naturally be welcome if it were possible. At present it usually is not, since the listener moves from room to room about her business, and is too far from the loudspeaker, much of the time, to hear distinctly what is going on. She would find extension speakers welcome, if they were inexpensive. And of course they can be. Present-day permanent magnet speakers, wired through a flat cable something like the "talking tape" indoor antenna, need retail for not more than three or four dollars apiece. Whether such speakers are sold by the set manufacturer or not, the fact that a jack or other simple provision for connecting them has been made available, is one more selling point.

Extension speakers were common enough in the early days of the industry. But when console models became general, and binding posts marked "Spkr" disappeared, the average listener seems to have felt that connecting them in was too difficult and cumbersome, and their use declined. If connection is again made easy, there is no reason why they should now be less popular than they ever were.

All of these aids are of interest principally to the home user of the radio and are especially desirable in connection with the smaller set, but there is another that will prove more directly profitable to the retailer and service man, although useful only in connection with the more powerful equipments and particularly with radio-phonograph combinations. The average retailer draws only part of his sustenance from the actual sale of radios. The balance, including his profit, comes from repairs, rentals and other supplementary work. One of the most profitable of such activities is public address. The retailer finds a good market for p-a systems in which, very often, a radio tuner speci-

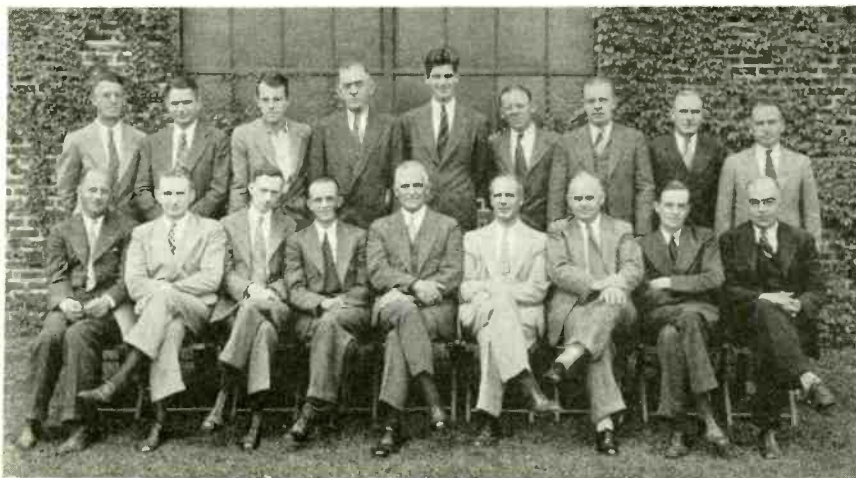
fically built for p-a work is added to a p-a amplifier.

But p-a equipment is not made in mass production on the same scale as radios, and is correspondingly more expensive. A radio set with from 10 to 25 watts power output, which many home units have nowadays, will serve perfectly as the core of a p-a system, provided two small changes are made in it. One of these changes is a tapped output transformer, by means of which the number of loudspeakers (permanent-magnet type) necessary for any given p-a installation can be connected to a suitable output impedance. The other is a microphone jack with enough gain behind it to permit the use of modern low-level, p-a microphones.

A third facility, almost equally necessary, would be inclusion of an input mixer. In place of the arrangement of the ordinary radio-phonograph combination, in which a switch substitutes one type of input for the other, a pair of potentiometers may be used to fade the one input against the other. The microphone jack should then operate through an additional stage, or two stages, depending upon the a-f gain already present. In many receivers, a single 6C6 behind the microphone jack will be wholly adequate. A switch permits the microphone to be substituted for one of the mixer inputs already provided, and thus faded against the other input.

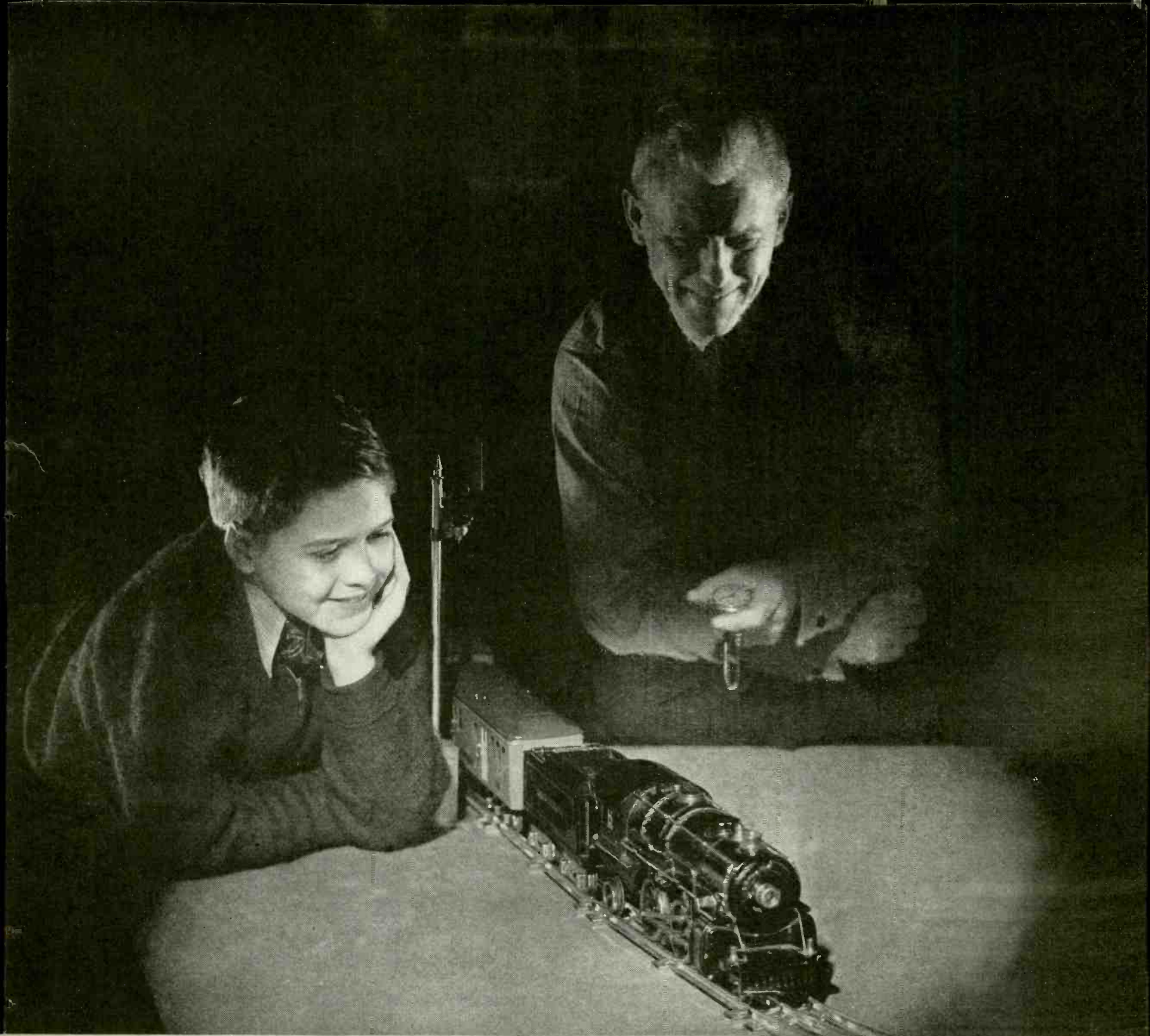
These facilities are of little use to the average home, but should greatly assist sales to restaurants, bars and grills, and other places of public gathering. These are sales the retailer finds exceptionally profitable, and if the receiver is so wired that he can also sell a few supplementary speakers, a microphone, and an installation job, he is obviously going to favor that receiver as against others.

It will be noted that none of these auxiliary uses for radios requires any great change in manufacturing.



The Sales and Engineering Staffs of the Synthane Corporation.





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SHEETS • RODS • TUBES • FABRICATED PARTS

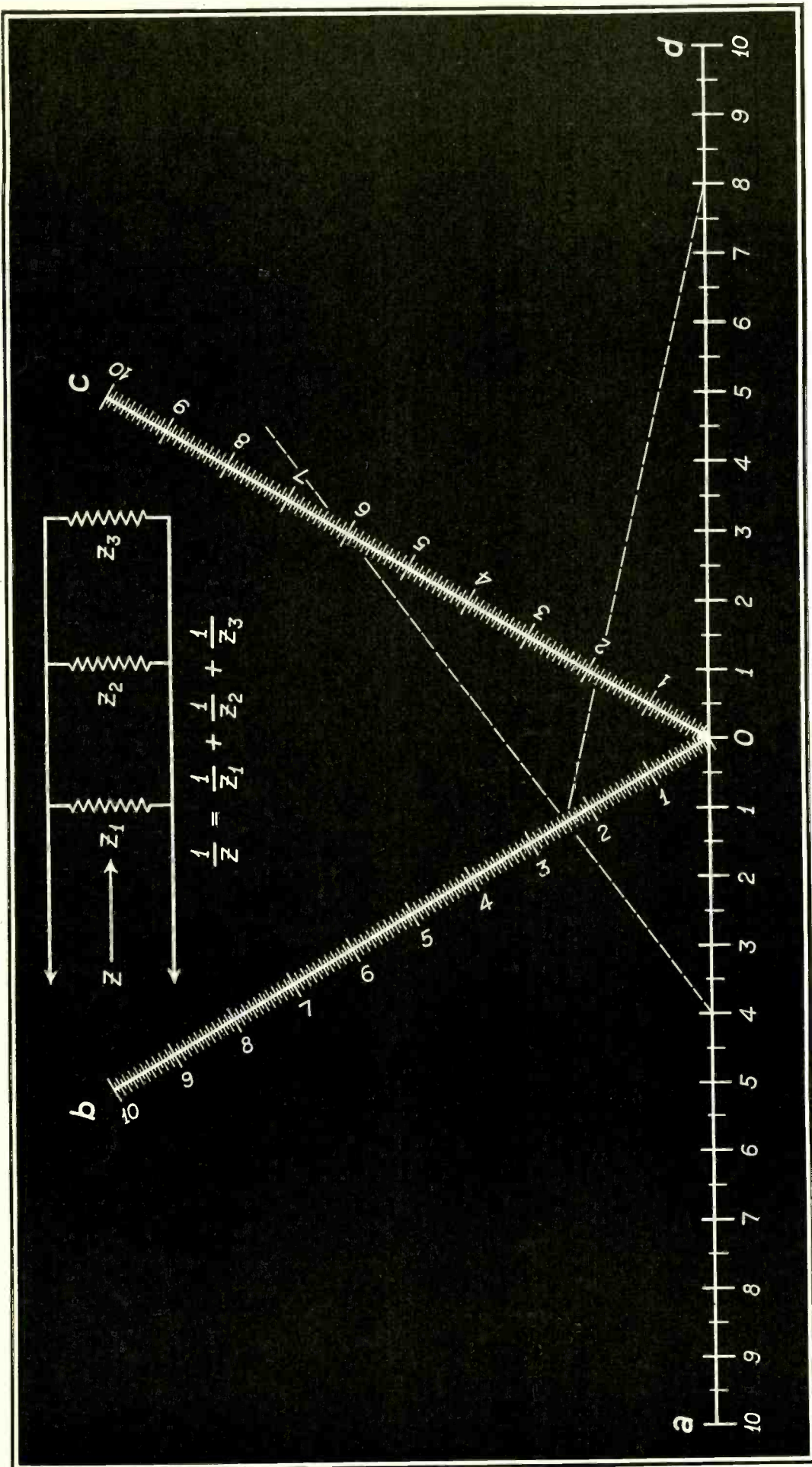


# SYNTHANE

CORPORATION



OAKS • PENNA



### PARALLEL RESISTANCE CHART

Shown above is a handy chart for finding resultant values of resistances in parallel. To use this chart lay a straight edge on two resistance values, say on scale (a) and scale (c), and read on scale (b) . . . or on (d) and (b) and read on (c). The dotted lines drawn in represent a calculated problem of three resistances of 4, 6 and 8 ohms in parallel. Thus 4 ohms on (a) is joined with 6 ohms on (c), indicating 2.4 ohms on (b). This value is in turn joined with 8 ohms on (d), giving the answer of 1.85 ohms on scale (c). This process may be repeated for any number of resistances.

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# BRITISH TELEVISION

*The television receiver which is discussed below, was first described in our contemporary, "Wireless World." There are few points of similarity in British and U. S. design practices, and, as our author points out, the differences seem to favor the American system.*

DESPITE THE INTEREST and activity in television in the United States, almost nothing has been written on the subject of television receivers. In fact, the description of the Farnsworth receiver, in RADIO ENGINEERING for September 1936, is to the writer's knowledge, the first published description of a modern television receiver.

In England, however, the situation differs greatly from that in the U. S. due to the control of television transmission by the B B C, and much information has been released through the press during the last few months—particularly since the institution of daily test broadcasts. These broadcasts, which began at about the same time as RCA's Empire State emanations, are conducted for those who care to purchase or construct receivers as well as for the benefit of transmitter and receiver engineers.

In the belief that information on practical receivers will be of interest to the fraternity, at this time, we shall attempt to analyze the design of a recent television receiver described by *Wireless World* of December 18, 1936. Also, a comparison between this English receiver and the Farnsworth unit may be of interest.

Of primary interest is the statement that this receiver was designed to operate on a "single sideband," an idea recently advocated by Epstein of RCA at the Rochester IRE convention. This is a misnomer, of course, as both sidebands are transmitted; the low-frequency end of one sideband is utilized in addition to the other complete sideband. The term sesqui-sideband, originated by Harold Wheeler, of Hazeltine Corporation, would seem more accurate. This method of reception is of interest

because it reduces the receiver pass-band required for high definition, making its design simpler. The ultimate goal, of course, will be the suppression of the second sideband at the transmitter, thus doubling (approximately) the number of available channels.

To return to the English receiver, this was designed to operate from either a doublet or Marconi antenna, the latter to be capacitively coupled to the grid of the converter tube. Experience seems to indicate that a vertical doublet, well in the clear and with a well-designed transmission line to the receiver, is necessary in any location to obtain favorable signal-noise ratios.

Next, is the frequency changer, which employs a triode-pentode (similar to the 6F7, but with twice its conversion transconductance). This type of frequency

*(Continued on page 24)*

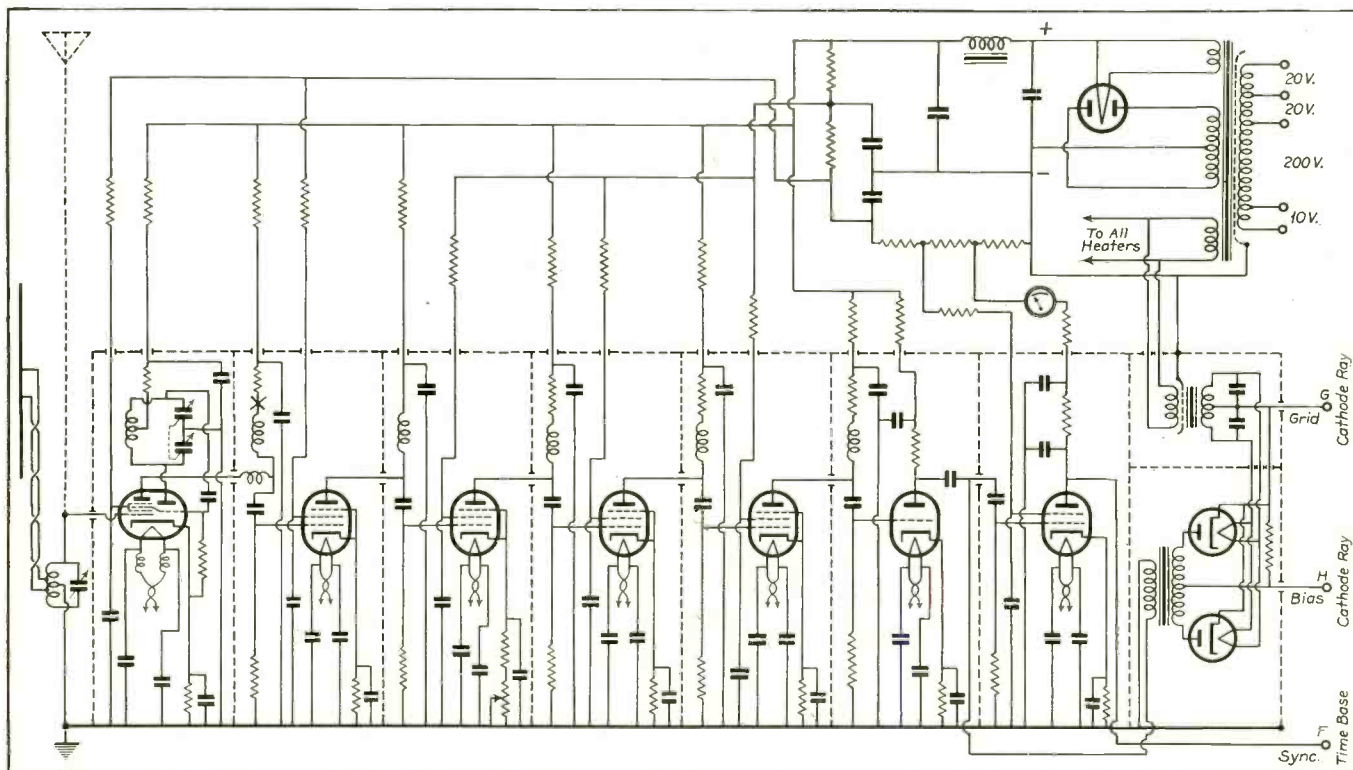


Fig. 1.

# Design . . NOTES AND

## "TOUCH" TUNING

IT IS SOMETIMES necessary to employ as a criterion of correct tuning a maximum volume of the low notes or a minimum of distortion. This method of tuning requires, however, considerable skill with the result a set of this type is frequently flat tuned, thus affecting the purity of reproduction owing to the absence of the low notes and the occurrence of distortion.

It is not surprising, therefore, that means have been sought to eliminate these difficulties and which would indicate in a simple manner when sharp tuning was realized. One method evolved for this purpose was that of "visual" tuning in which a maximum or minimum deflection of a pointer was obtained when tuning was sharp. Circuits were also evolved with which, as in early receiving sets, a fairly definite maximum volume was obtained when sharp tuning was attained so that tuning was again an audible process. An entirely new method of tuning has however been developed, viz., a method of "touch" tuning, which considerably facilitates accurate adjustment. Sharp tuning is here indicated by a sudden braking of the tuning knob, being achieved by means of a circuit in which as sharp tuning is approached there is a sudden increase in current which is utilized to hold the tuning shaft by means of a magnet. An arrangement can also be quite easily incorporated with this circuit which by mechanical means keeps the receiver completely silent until it has been sharply tuned to the station (so-called "silent" tuning); as soon as the braking magnet is energized a contact is closed at the same time which connects up the loudspeaker system. In this way "touch" tuning is combined with "silent" tuning.

When the set is sharply tuned the high-frequency portion is adjusted to the frequency of the incoming signal

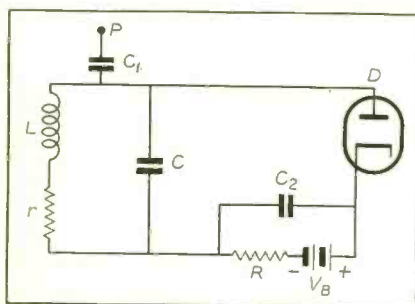


Fig. 1.

and at the same time the oscillator tuned to a frequency such that the differential frequency generated in the mixer valve is exactly equal to the intermediate frequency  $f_0$  to which the intermediate-frequency portion is tuned. On a slight departure from the sharp-tuning position by giving the tuning knob a little turn, the oscillator becomes detuned. The differential frequency has thus been altered and no longer coincides with the intermediate frequency. The circuits in the high-frequency portion are also detuned, so that in consequence there is a slight change in the amplitude of the signal passed to the mixer tube. If detuning is not excessive, then owing to the operation of the automatic volume control it may be expected that to a first approximation a signal whose frequency varies while the amplitude remains substantially the same will be obtained at the output of the intermediate-frequency amplifier; on sharp tuning the frequency is exactly equal to the intermediate frequency  $f_0$ .

The circuit shown in Fig. 1 is now connected to the i-f amplifier through a small condenser  $C_1$ . This arrangement consists of a circuit (LCr) which is tuned to the intermediate frequency  $f_0$ . The oscillating alternating voltage in this circuit is rectified by the diode, so that a direct voltage is obtained at the resistance R, which is by-passed by the condenser  $C_2$ . R is also connected in series with a direct-current source  $V_B$  whose negative pole is connected to the plate, so that in the absence of alternating voltage in the circuit the plate of the diode is negative with respect to the cathode. It should be noted that a rectified current only commences to flow when the amplitude of the alternating voltage is greater than the threshold voltage  $V_B$ .

When the receiver is sharply tuned the input to this circuit will have a voltage with the frequency  $f_0$ . The voltage resulting therefrom in the oscillating circuit will have an amplitude  $V_0$ . On slight detuning the amplitude of the voltage will remain practically unchanged. If the frequency is altered to  $f_0 + \Delta f$  (or  $f_0 - \Delta f$ ) the circuit voltage will then drop to:

$$V_0 \frac{1}{\sqrt{1 + \left(\frac{4\pi\Delta f}{r/L}\right)^2}}$$

If  $V_0 > V_B$  the diode will pass current at tuning and a direct voltage will be

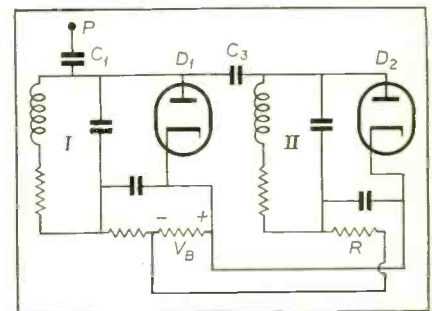


Fig. 2.

produced at R. On detuning this current ceases to flow as soon as  $\Delta f$  reaches a limiting value  $\Delta f_{lim}$  as expressed by the equation:

$$V_0 \frac{1}{\sqrt{1 + \left(\frac{4\pi\Delta f_{lim}}{r/L}\right)^2}} = V_B$$

Thus by a suitable choice of the threshold voltage  $V_B$  it is possible to determine in what frequency range on both sides of the resonance frequency  $f_0$  rectification will occur and a direct voltage be obtained at resistance R. This direct voltage can, for instance, be utilized for modulating an amplifier such that a magnet inserted in the plate circuit will brake the tuning-knob shaft.

By this method "touch" tuning of stations of a specific strength becomes possible. But if a station is chosen with a much greater strength, the voltage, in spite of automatic volume control, can be as much as several times greater than in the case just considered. As a result the frequency sweep over which "touch" tuning is effective will also increase. Consider the example of a circuit in which  $r/L = 6280 \text{ sec}^{-1}$  and  $V_B/V_0 = 0.86$ . From the equation we get  $\Delta f_{lim} = 300$  cycles/sec. If for a more powerful station  $V_0$  is, say, twice as powerful,  $V_B/V_0$  will be 0.43 and hence  $\Delta f_{lim}$  will be 1050 cycles/sec. The range over which touch tuning operates thus varies fairly considerably for transmitters of different strengths, so much that the tuning knob in the case of the powerful stations becomes already braked at an excessive distance from the sharp-tuning position.

This difficulty may be overcome in the following way. It follows from the equation that for a given value of  $r/L$  the term  $\Delta f_{lim}$  will also have a definite value, provided the ratio of  $V_B$  to  $V_0$  is unchanged. This would be the case



# COMMENT . . . Production

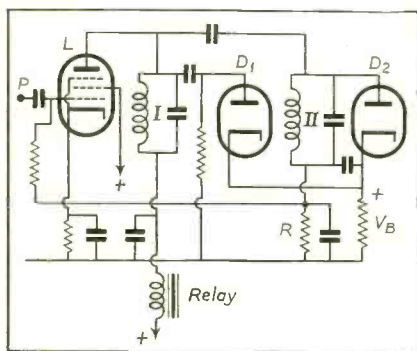


Fig. 3.

if in the circuit shown in Fig. 1 the threshold voltage  $V_B$  were not constant but increased in proportion to  $V_o$ . Fig. 2 shows how this is achieved and represents two circuits, I and II, which are both tuned to the intermediate frequency, as well as two rectifying diodes.  $C_s$  is a small condenser.

The diode  $D_1$  rectifies the voltage in circuit I, part of the rectified voltage constituting the threshold voltage  $V_B$  for the rectifying circuit of  $D_2$ . This circuit ensures that the rectifying action of the diode  $D_2$  always commences at the same degree of detuning  $\Delta f_{11m}$  irrespective of the signal strength, whereby a direct voltage is obtained at the resistance  $R$  which through an amplifying tube energizes the braking magnet.

In the practical design of this arrangement as shown in Fig. 3 circuit I is not connected directly to the intermediate-frequency section, but is linked up through an amplifying tube  $L$ . Tube  $L$  is modulated by the rectified voltage at  $R$ ; in the sharp tuning range the voltage at  $R$  makes the grid of  $L$  more negative so that the relay inserted in the plate circuit of  $L$  trips and thus closes a contact in a circuit which energizes the braking magnet. If the relay simultaneously closes a second contact, for instance for switching on the loudspeaker, a "silent" tuning system is arrived at in a very simple way.

*The above material is from "Improvements in Radio Receivers" by C. J. Van Loon. The original paper was published in the Philips Technical Review (Eindhoven, Holland) for September 1936.*

*Additional data from Mr. Van Loon's article, covering European practice in the use of inverse feedback, will appear in an early issue.—EDITOR.*

## ACOUSTIC STANDARDS

A STANDARD Acoustical Terminology for "sound" engineers which will eliminate confusion in movie, radio, and building fields has just been completed. This standard, four years in development, is the work of engineers, musicians, manufacturers, and scientists working together under the auspices of the American Standards Association.

Leopold Stokowski, a member of the committee in charge, says, "In the America of the future radio and motion pictures will be important in developing our civilization. For this we need a complete understanding between engineers and musicians." This "understanding" is definitely achieved in the new standard.

The committee gives a broader meaning to the word "noise," now defined in terms of the listener as an "unwanted" sound, rather than in terms of the sound itself. Thus the notes of a soprano in the next studio may under certain circumstances be rightly described as "noise." Another section of the standard deals with architectural acoustics. Another which provides standard terms for the measurement of hearing, will be used widely by the medical profession and by manufacturers of aids for the partially deaf. Other parts dealing with the conversion of sound to electrical energy, and with acoustic transmission systems, will be of particular value to the movie and radio professions.

A separate section for music brings engineers and acoustical experts into agreement with musicians on a basic standard pitch, the importance of which can be judged by the fact that an increase of only 4.14 per cent in pitch carried out through the entire keyboard of a piano would throw an additional strain of something like half a ton on the framework of the instrument. Singers, also, are interested in knowing that the pitch of the orchestra they sing by tonight will be identical with the piano in their practice studio.

Accredited representatives of many groups including radio, motion picture, building, manufacturing, electrical, medical, municipal, and Departments of the Federal Government, contributed to the development of this standard. The Association has already approved two other standards in the "sound" field. One of these, completed eight months ago, establishes "reference" and "intensity" levels for sound measurement.

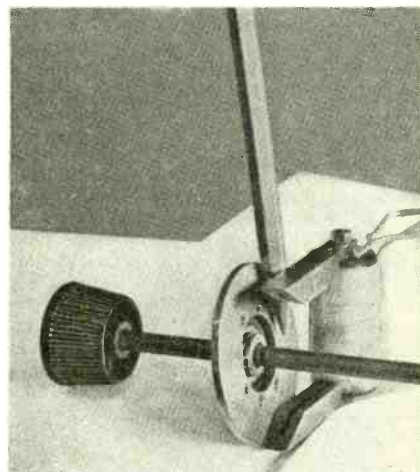
The other specifies the characteristics of "noise meters" used by builders, radio engineers, and music teachers. Before this second standard became available no two meters on the market could be depended upon to register similar or even comparable results for the same sound.

## NBC TELEVISION DEMONSTRATION

TELEVISION PROGRAM TRANSMISSION was demonstrated on Friday, November 6, by the National Broadcasting Company in a 40-minute program illustrating RCA experimental developments. The pictures were broadcast from the transmitter on top of the Empire State Building, and were received on the 62nd floor of the RCA Building.

The demonstration possessed four features not included in previous demonstrations of television. It was the first made by RCA and the National Broadcasting Company for the press under practical working conditions, although previous demonstrations of laboratory television have been given. It represented the first showing of a complete program built for entertainment value as well as a demonstration of transmission. It also included the first showing of a new 12-inch receiving tube, which reproduces a picture on a  $7\frac{1}{2}$  by 10-inch screen.

A fourth feature of the demonstration was a television tour behind the scenes. By means of an especially prepared moving-picture film, the guests were conducted through the NBC television studios in the RCA Building and the transmitter station at the top of the Empire State Building.



The mechanical "brake" used with the "touch" tuning system described on the opposite page.



### NOVEMBER EXCISE TAXES MAKE NEW RECORDS

Collections during November of the 5 percent tax on radio and phonograph apparatus by the U. S. Internal Revenue Bureau made several records. The November excise tax collections (not including automobile radio) were \$639,630.11, an increase of 12 percent over the tax collections of \$571,479.61 in November 1935. Excise taxes on mechanical refrigerators during November were \$162,696.60 compared with \$309,108.68 in November 1935.

For the eleven months' period ending November 1936 the total collections of the 5 percent radio and phonograph tax were \$5,608,540.04. This was an increase of 51.3 percent over such taxes collected of \$3,706,420.65 during the same eleven months of 1935.

The collections for the eleven months ending November 30 last were 26.4 percent more than the total radio taxes collected during the entire calendar year of 1935 which were \$4,436,423.34.

### SEPTEMBER LABOR INDICES

September employment in radio manufacturing did not increase as much as usual, the seasonal increase being much smaller than last year. The September report of the U. S. Bureau of Labor Statistics recorded an increase of only 2.6 percent in radio factory employment over the previous month of August, but this was an increase of 2.7 percent over radio employment in September 1935. The September index figure was 261.7 compared with the three-year official average of 1923-25.

Radio factory payrolls last September decreased 2.3 percent from the previous month of August but were 1.2 percent above September 1935. The September payroll index figure was 168.3 compared with the three-year official average of 1923-25 and with the 172.2 percent index of the previous month of August.

Average weekly earnings during September of radio factory employees also showed a decline. The September average earnings were \$19.68, a decrease of 4.7 percent compared with the \$20.71 average of August. The September weekly earnings also were 1.4 percent under those of September 1935. The September national average of all manufacturing industries was \$22.20, and the national average of all durable goods manufacturing establishments was \$19.73.

Average hours worked per week in radio factories last September were 37.6 hours, a decrease of 4.7 percent, compared with the average work hours of the previous month of August of 39.4 hours; they also were 4 percent less than average hours worked in September 1935. The national average work hours, of all manufacturing industries, during September was 38.7 hours, and the national average of non-durable goods manufacturers was 37.4 hours.

Average hourly earnings last September of radio factory employees were 52.4 cents, a decrease of .3 percent less than August hourly earnings of 52.8 cents, but they were

2.5 percent above the September 1935 average. The national average hourly earnings of all manufacturing industries was 56.9 cents and that of non-durable goods manufacturers was 52.8 cents.

### RMA PATENT SERVICE

Wide approval from RMA members of the new quarterly index of the Association's weekly patent bulletins has been received. Large and small companies have advised RMA headquarters that they regard the quarterly index of great value and desire its continuance. Recent patent bulletins have been interrupted by absence of the RMA patent attorney but the weekly bulletins and also the quarterly index will be continued.

### DEPARTMENT OF COMMERCE AND RMA PUBLISH SHORT-WAVE MANUAL

An instruction pamphlet on operation and installation of modern short-wave radio receiving sets, prepared by the RMA for the U. S. Department of Commerce, was published on December 15 by the U. S. Bureau of Foreign and Domestic Commerce. The manual is designed to instruct listeners in use of modern short-wave receiving sets and enable them to get the best results, of international short-wave broadcasting from their receivers.

The short-wave instruction pamphlet is distributed solely by the U. S. Bureau of Foreign and Domestic Commerce, not by RMA. Its price is 25c per copy but it may be reprinted without limitation. A copy of the new government pamphlet has been sent to all RMA members.

Arrangements for the government pamphlet, which is a most important promotion of short-wave radio, were made by Bond Geddes, executive vice president-general manager of RMA, with the U. S. Bureau of Foreign and Domestic Commerce. The pamphlet was prepared by Lawrence C. F. Horle, radio consultant engineer of New York, who was specially engaged by the RMA, and edited by various groups of the RMA engineering division, including its receivers and special publications committees, comprising outstanding industry engineers.

Proper antenna for short-wave sets is emphasized in the Department of Commerce pamphlet, including instructions for installation of the noise suppression type of special short-wave antennae. Other instructions cover current connections, lightning arresters, etc.

Detailed advice on tuning short-wave stations including use of station selectors, volume and tone controls, etc., is provided and the principal short wave stations of the United States, Europe and Latin America are given. No attempt is made to give service or construction detail, but the pamphlet is designed to advise listeners, in simple understandable terms, to secure the maximum results from the wealth of the world's short-wave broadcasting.

### "THE VERY RICH" LIKE RADIO

"The Very Rich," a new publication of the Columbia Broadcasting System's Sales

Promotion Bureau, details the radio ownership and listening habits in homes of the wealthy. A personal survey by the Boston University Bureau of Business Research showed that some rich families have fourteen radios each, that more families own four or more radios than own one, and that the average of the survey among the "very rich" was three sets per household. Eighteen percent of the families questioned own five or more radios.

"The very rich," sometimes suspected of an indifference to radio, the CBS survey states, "nevertheless insist on having a set in almost every room of their many-roomed houses. Like the house in Delaware, you may have heard about, with forty bedrooms and forty radios."

### FCC CALLS TECHNICAL CONFERENCE ON JAN. 18

Definition of blanket field intensity will be studied at an informal engineering conference called by the Federal Communications Commission on January 18 at Washington. The Commission desires additional data, from broadcasters, the RMA, the IRE, and other interests on the question, particularly on recommendations at the Commission's October conference that a field intensity of 1 v/m be selected as a limit of blanket area, in view of improvements in broadcast receivers during recent years. The RMA Engineering Committee is arranging for representation of the receiver industry at the January conference.

### RADIO INDUSTRY BREAKS RECORDS

Widely published in the press, at the peak of the holiday buying period, was an industry summary for 1936 by Bond Geddes, executive vice president-general manager of RMA. The 1936 record-breaking manufacture of modern sets, tubes and parts was detailed in the statement by Geddes. In addition to the newspaper publicity, some manufacturers made further effective use of the material by sending it to their distributors and dealers.

Mr. Geddes' 1936 estimates, carefully and conservatively compiled from industry, government and many other sources, were as follows:

"All previous records in radio production will be eclipsed in 1936 when the records are complete," said Mr. Geddes in his statement estimating this year's production of receiving sets would be 7,600,000 and 96,300,000 radio tubes. The previous peak was in 1935 when 6,300,000 sets were produced and 65,500,000 tubes.

"On January 1, 1937, it is estimated that there will be 24,269,000 families radio equipped, a new high record, but 17,500,000 families, or 70 percent, have obsolete sets, without the modern receivers for short-wave foreign broadcasting. In addition there are about 4,000,000 automobile radio sets in use and many thousands of families have two or more radio sets in their homes.

"Improved business conditions, increased buying power, the 'radio election' campaign, wide increase in interest in short-wave international programs, larger purchases of battery and other sets in rural districts



and increased foreign buying of American radio all have contributed to the industry peak being established this year. Improvements in radio broadcasting programs both in the United States and also foreign short-wave broadcasting have been a tremendous stimulus to the trade and the usual holiday sales of large volume are again occurring.

"Other outstanding factors in the 1936 records are the increasing use of two, three or more radios in the home and the tremendous popularity of automobile radio. About 1,500,000 automobile radio sets were sold this year through an investment by the American motoring public of \$65,000,000.

"In foreign countries American radio also is proving more popular. Exports of U. S. radio sets this year will be more than \$28,000,000, including about 650,000 sets shipped abroad, an increase of 10 percent over last year's previous high record.

"In excise taxes the government will be paid over \$6,000,000 this year by radio manufacturers, compared with \$4,436,000 in 1935.

"Radio prospects for 1937 also are encouraging, including such outstanding features as the inauguration of President Roosevelt next month and the coronation of a British King.

"The 1936 industry records demonstrate that the so-called 'saturation' point of radio is a myth. New sales largely are for replacement, but it is estimated that 1,400,000 new homes were equipped this year with radio, an increase of about 6 per cent. Of the 24,269,000 estimated radio families, only about 6,700,000 have modern short-wave receivers to hear international broadcasting, leaving an enormous replacement market.

"Statistics show that 1936 sales increased about 30 percent over last year to an estimated retail value, including exports, of about \$430,800,000, compared with \$332,300,000 last year. It is estimated these sales will be divided as follows: receiving sets, \$315,800,000; tubes, \$70,000,000, and radio parts and accessories, \$45,000,000. While the 1936 set production of 7,600,000 is a new record in number, the dollar volume is comparatively smaller because of the greatly reduced prices, despite vast improvements in radio products in recent years, but the 1936 dollar volume is the largest since 1930."

#### RMA SOUND DIVISION MEETS ON TRADE PRACTICES AND STANDARDS

Trade practices, engineering standards and excise taxes of amplifier and loud speaker manufacturers were considered at a meeting of the RMA Amplifier and Sound Equipment Division at the Stevens Hotel on December 4 with Chairman Peter L. Jensen presiding.

The round-table discussion of trade practices of the group resulted in action regarding frequent requests for response curves of loud speakers. These are meaningless in most cases and result in undesirable trade practices because of the variance of the tests. To improve trade practices of speaker manufacturers, a draft of a letter was approved by the Division to be sent in reply to such requests for uniform response curves of speakers.

Progress on RMA standards for loud speakers was reported to the Division by Hugh S. Knowles, chairman of the amplifier and loud speaker section on standards. The RMA General Standards Committee has approved a new wire color code for speakers. In the development of amplifier standards the Division, at the Chicago meeting, voted to request cooperation of

amplifier manufacturers in the development of tentative standards for submission to the RMA general engineering body.

Action to clarify administration of the excise tax on amplifiers and loud speakers also was taken by the Division. Data on such excise taxes has been assembled with a view to discussion with Internal Revenue Bureau headquarters. It is hoped that better administration, with more uniformity of the amplifier and speaker tax, will result.

#### IMPORTANT RADIO LEGISLATION AHEAD, INCLUDING EXCISE TAXES

One of the most important functions of RMA—action on legislation affecting the industry—will be unusually prominent when Congress reconvenes. In addition, legislatures of forty-three States also will hold sessions this year, many beginning in January.

The national and state legislatures promise an unusually busy season for the RMA officers and directors and the Association's Legislative Committee headed by Chairman A. H. Gardner of Buffalo and Bond Geddes, executive vice president-general manager of RMA.

Of special interest to the industry is the five percent radio excise tax which with other "nuisance" taxes is scheduled to expire June 30. Although present prospects, are for continuation of all, or nearly all, of the special excise taxes because of government revenue requirements, nevertheless the RMA is preparing for any action possible for repeal or reduction of the discriminatory tax on radio. Chairman Gardner and the Legislative Committee are securing data for any possible use which may develop for relief from the radio tax. If congressional committees hold hearings, the RMA will be prepared to take action.

In Congress also there will be an unusual number of legislative affairs affecting the industry and requiring proper action by the RMA. These include the 30-hour week bill, proposed federal incorporation of all corporations engaged in interstate commerce, prospective revision of the social security act and the Walsh-Healey law, Representative Patman's bills to prohibit interstate corporations from engaging in direct selling, the Federal Trade Commission's proposed legislation to penalize "deceptive acts or practices" and many others.

From the forty-three state legislatures which will start in January, much special legislation on radio also is expected. During the biennial sessions of the state legislatures two years ago, the RMA opposed and was successful in defeating a number of anti-radio bills. In the prospective program of state legislation there is a bill pending in Nevada to require state registration of trade marks, and the legislative work of the RMA promises to be unusually active in Congress when the many state legislatures reassemble in January.

#### ANDREW CRUSE TRANSFERS FROM DEPT. OF COMMERCE TO FCC

Andrew W. Cruse, chief of the Electrical Division, U. S. Bureau of Foreign and Domestic Commerce, resigned on December 16 following his appointment by the Federal Communications Commission as assistant chief engineer. Mr. Cruse will be remembered as the principal speaker at the annual convention of the RMA in Chicago last June and during his service as chief of the Electrical Division he has inaugurated many projects of great value to radio. He will be in charge of engineering work for the telephone section of the FCC.

RMA, NEMA, the National Association of Broadcasters and the Edison Electric Institute were invited by Secretary Roper of the Department of Commerce to assist in selection of a successor to Mr. Cruse. Executives of the industries served by the Bureau of Foreign and Domestic Commerce have been asked for their advice in filling the vacancy, an innovation in official appointments.

#### NEW FACILITIES ARRANGED FOR RMA TRAFFIC COMMITTEE

To facilitate work and meetings of the RMA Traffic Committee, membership is being taken in the Philadelphia Traffic Club, located in the Warwick Hotel. Included is a complete traffic library citing decisions on rate and classification cases which will be available to Vice Chairman O. J. Davies of the RMA committee and members.

#### CANADIAN SALES

Sales of 37,768 receiving sets with a list value of \$3,591,096 were made by Canadian manufacturers during October 1936, according to statistics received by RMA from the Canadian RMA. The October sales in Canada compare with 34,447 sets valued at \$3,390,572 in October 1935. Of the sales last October by Canadian manufacturers, 25,988 were A.C. sets, valued at \$2,762,152; 11,567 battery sets valued at \$816,361, and 213 automobile sets valued at \$12,583. Canadian inventories on October 31 were 44,458 sets and the Canadian manufacturers production projected from November 1 to January 31, 1937, was 52,003 sets.

#### EXPORT TRADE NOTES

*Costa Rica*—The Costa Rican Government, in another of the reciprocal trade agreements negotiated by the State Department and recently concluded, will not increase the existing tariff rate on radio. Under the new reciprocal treaty the radio rates are "bound." During the life of the treaty a guarantee against any increase in the radio tariff of Costa Rica follows similar favorable action for radio in the many reciprocal treaties with other countries.

*Chile*—Chile will permit importation of a radio quota of 1,539 units for the twelve months beginning October 1, according to a recent cablegram from the U. S. Commercial Attache at Santiago. On radio sets Chile will provide no definite quotas but will restrict import licenses severely, according to unofficial reports.

*Germany*—A new schedule of maximum trade discounts has been decreed by the German Government. Manufacturers can only grant certain specified rates of maximum discounts on retail values to wholesalers and retailers, whose discounts also are limited by the official decree.

*Philippine Islands*—Owners of radio sets in the Philippines must pay annual registration fees to the new Filipino government under new regulations for the registration of receiving sets. The fees range from two pesos on crystal sets to 10 pesos annually on vacuum tube sets.

*Australia*—A new radio tube factory will be established in Australia by the Philips organization of Holland. This will give Australia two tube factories and follows sharp restrictions, under license, of American tubes since last May. Advices to the U. S. Bureau of Foreign and Domestic Commerce also state that operation of the new Philips factory "may render further imports from the United States unnecessary or at least severely reduce the quantity of tubes permitted entry from the United States."

## BRITISH TELEVISION

(Continued from page 19)

changer was chosen because of its freedom from interaction, although it would seem that for complete isolation between the two functions of the converter, the 6L7 mixer and triode oscillator should be more satisfactory. Farnsworth makes use of this design principle by utilizing the Acorn pentode as first detector, and a triode as oscillator. This should give not only greater freedom from "pull-in," but the receiver noise level should be materially lower due to the fact that the r-f grid resistance of the Acorn may be as high as 75,000 ohms at 50 mc, while it is probable that this quantity may be as low as five to ten thousand ohms in the conventional tube. This difference in input conductance should result in an improvement in conversion transconductance of 5/10 to one. Also, if the diagram (Fig. 1) is compared with that of the Farnsworth receiver, it will be noted that the signal frequency circuits of the former are not loaded with resistors as are those in the American receiver. This is doubtless due to the load imposed by the low grid resistance of the converter tube which should be sufficient to allow fairly uniform transmission of the modulation frequencies although it would seem advisable to use resistors for this purpose—when practicable.

The next point of note is that no attempt is made to gang the two controls in the English receiver. This is unimportant, however, because but one transmitter is in operation in England at this time. Also, this receiver was designed to permit of duplication by the advanced experimenter, who usually lacks the precision laboratory equipment to undertake such a job with confidence. However, a similar tuner was recently described in the same journal (W.W.-7/24/1936) in which these controls were ganged for single control.

Before considering the i-f amplifier, it might be of interest to mention that the designers of the English receiver chose the Colpitts oscillator because of

its freedom from parasitics at the very high frequencies, while, Farnsworth makes use of the Hartley circuit, although his use of the 955 Acorn in this circuit may be partially responsible for its success.

It will be noticed that no provision for sound reception is shown in the diagram. This is due to the fact that the designers were probably of the opinion that many of its builders were already equipped with sound receivers or adaptors for use on those frequencies. They suggest, however, the sound i-f may be "picked off" the mixer plate circuit and fed to its own amplifier. Little need be said about this amplifier, as its design is entirely conventional. A point of difference, however, between English practice and American is that the English recommend the sound i-f be taken from the converter plate while Farnsworth makes use of two mixers, both 954 Acorn, fed from the input tuned circuit feeding their respective sound and picture amplifiers. In both systems, a common oscillator is employed.

It would seem that the American receiver embodies much better design in its input and frequency-conversion circuits. The i-f amplifiers, however, should be equally effective. The advantages possessed by the English system are, largely, ease of construction and freedom from many adjustments; also, greater stability (freedom from incipient regeneration) should result from this system.

In discussing the two i-f amplifiers, it will be seen that the Farnsworth amplifier is quite conventional—3 stages coupled by double-tuned over-coupled circuits using 954 pentodes. The only departure from the usual lies in the shunting of each tuned circuit with resistance in order to give a 6-mc flat-topped resonance curve. The foreign receiver, however, employs 5 i-f stages. Conventional variable- $\mu$  pentodes are employed in connection with impedance coupling. The plate loads for these tubes consist of inductance (200-400  $\mu$ h) and resistance (3-5000 ohms)

which gives a slightly rising gain/frequency characteristic. This type of coupling was described by Cocking in W.W. (4-26-1935 & 5-3-1935) and also by von Ardenne in his recent book "Television Reception." By suitable design, any reasonable gain/frequency characteristic may be obtained, which with freedom from the complications of multiple-tuned circuits with their usual inherent regeneration, should prove very attractive to the designer of commercial television receivers.

Because this impedance-coupled i-f amplifier transmits uniformly a bandwidth of 5 mc, the advantages of sesqui-sideband reception are not evident, in as much as a total bandwidth of only 5.5 mc is required for normal reception of a 450-line picture (Engstrom-IRE). However this point is stressed, so that single sideband reception (so-called) is apparently advantageous from other viewpoints.

To improve the stability in this five-stage amplifier, i-f gain control is effected by bias control of but one tube, instead of the more normal method of passing cathode current from several stages through a common resistor. This latter method might cause feedback, due to the resistance common to several cathodes.

It will be of interest to note that the fifth i-f amplifier employs a triode of the low plate resistance, semi-power output variety. This tube feeds both the synchronizing tube and the second detector—a linear demodulator—via an untuned "iron dust" core transformer.

The second detector differs greatly from that in the Farnsworth receiver, as the latter is a plate detector (954 pentode) while the former is a full-wave diode looking into a load resistance of approximately 12,000 ohms. As very little i-f should be present across the output of a full-wave diode, no carrier frequency filtering is resorted to, other than stray capacities. This rectified signal is then fed directly to the cathode-ray tube control-grid (no coupling condenser used).

## A SUGGESTION

*Quite often, the most interesting and valuable part of the technical sessions at the engineering conventions comes when the papers are discussed.*

*With this in mind, we should like to invite our readers to submit discussions of the papers presented in RADIO ENGINEERING. When interest in a paper is sufficient, and space permits, we will publish these discussions.*

*Anonymity will, of course, be maintained where requested, although we feel that an author is entitled to know his critics.*



# NEWS OF THE INDUSTRY

## NEWARK WIRE CLOTH APPOINTS NEW REPRESENTATIVES

The Newark Wire Cloth Company, Newark, New Jersey, manufacturers of woven wire screens, and wire cloth products, announce the following changes in their sales organization:

Harry G. Mouat has been appointed to represent them in the Birmingham territory. Address: Martin Bldg., Birmingham, Alabama.

W. C. Myers & Company have been appointed to represent them in the Tulsa territory. Address: 8 No. Cheyenne St., Tulsa, Oklahoma.

The Pittsburgh office has been discontinued.

— RE —

## NEW RESEARCH LABORATORY

Announcement has been made of the establishment of the Rowe Radio Research Laboratory Co. at Suite 207-8, 1103 Bryn Mawr Avenue, Chicago, Ill. A complete radio engineering consultation and laboratory service is offered by this new organization.

— RE —

## CANADIAN SALES

The Canadian RMA reports total sales during August, 1936 of 24,715 receiving sets with a list value of \$2,396,091, compared with 15,024 sets valued at \$1,438,283 in August, 1935. The Canadian sales last August included 17,776 a-c sets valued at \$1,887,481; 5,992 battery sets valued at \$451,293, and 947 automobile receivers valued at \$57,317.

Canadian manufacturers' inventories on August 31 included 28,575 a-c sets; 16,400 battery sets, and 613 automobile sets, a total of 45,588 receivers of all types.

Projected production of Canadian manufacturers from September 1 to November 30, 1936, was 75,457 a-c sets; 16,023 battery sets, and 636 automobile sets, a total of 92,116 sets of all types.

— RE —

## N. U. SEEKS NEW PRODUCTS

National Union Radio Corporation of N. Y., announced the appointment of J. H. Robinson as Director of New Products Research. Mr. Robinson assumes the new title and duties, in addition to his regular work as Export Manager.

It is said that Mr. Robinson has been assigned the task of seeking out and analyzing the marketability of new products, patents and ideas having to do with radio, electronics, television and electrical industries.

Inventors are invited to correspond in strict confidence with Mr. Robinson, c/o National Union Radio Corporation, 570 Lexington Avenue, New York, N. Y. It is the belief of the National Union organization that an era of great development and advancement is at hand and they are prepared to encourage the promotion of new practicable ideas.

## SALES MANAGERS AND RMA PLAN SHOWS

Two shows, to be sponsored jointly by the Radio Manufacturers Association and the Sales Managers Club, are scheduled to be held in 1937.

The spring show will be held at the Hotel Stevens, Chicago, over a four-day period, June 10 to 13, inclusive. The New York City show is scheduled for October 1 to 3, inclusive, at a hotel yet to be selected.

— RE —

## AIR EXPRESS BREAKS RECORDS

The gross revenue from air express shipments for November exceeded the gross revenue of the old and new contract airlines for the same month in 1935 by 99 per cent, the Air Express Division of the Railway Express Agency announced tonight.

All one-day records for air express shipments in and out of New York City were broken on December 22, when 1,973 packages were handled.

— RE —

## WARD OCCUPIES NEW PLANT

The Ward Products Corporation, manufacturers of automobile aerials and sound systems, have recently moved into their own new building on East 45th Street, Cleveland, Ohio. They have doubled their manufacturing space and enlarged their sales offices. In addition to their Cleveland plant, the Ward Products Corp., have a branch in Canada and an export office in New York City.

— RE —

## GREGORY JOINS FARQUHAR

D. J. Gregory, who has had experience in both Europe and the United States as a designer of high speed hydraulic presses, joins A. B. Farquhar Co., Limited, of York, Penna., as chief engineer of the hydraulic press division.

The Farquhar Company is expanding its hydraulic press division, which includes high speed production presses, hot and cold process presses, and automatic and semi-automatic types.

— RE —

## ERIE RESISTOR COMPLETES PLANT ADDITION

Erie Resistor Corporation has recently completed a large addition to its main factory at Erie, Pa., containing over 16,000 square feet and three stories in height. This building houses the plastic molding division and general offices of the company.

Because it brings together under one roof the molding, finishing and engineering activities that were formerly located in separate buildings, the new arrangement greatly increases operating efficiency, according to Harold C. Sherk, vice-president and general manager. This is the second expansion program undertaken by this company in three years.

## NEW WEBSTER-CHICAGO BUILDING

To provide increased facilities for the manufacture of Webster-Chicago products, construction has been started on a new Webster-Chicago factory.

This new factory is located on Bloomington St. at Central Ave., Chicago, and has the advantage of a railroad siding. It will be a single story structure with approximately 50,000 square feet of floor area, to be completed by April 1, 1937.

— RE —

## INSULINE CATALOG

The 1937 catalog of the Insuline Corp. of America, 25 Park Place, New York City, is now available to amateurs, service men and experimenters.

Copies of this new catalog (No. 190) are obtainable, free of charge, directly from the Insuline home office.

— RE —

## TOBE REPRESENTATIVE

Mr. James H. Vawter, 259 North Drive, Buffalo, N. Y., has been appointed Northern New York factory representative for the Tobe Deutschman Corp. Canton, Mass. Mr. Vawter will operate out of Buffalo.

— RE —

## THORDARSON CATALOG

"Tru-Fidelity" is the title of a new 8-page catalog recently released by the Thordarson Electric Manufacturing Company, 500 West Huron Street, Chicago. Besides describing the Thordarson "Tru-Fidelity" line of transformers, this catalog contains considerable information on the construction of these units and their operating characteristics. Write for Catalog No. 500.

— RE —

## SHURE CHART

In response to requests Shure Brothers, 215 West Huron Street, Chicago, have issued a microphone application and specification chart. This chart gives convenient technical data on 50 Shure microphones. The chart folds to 8½ by 11 inch size and is punched for standard three-ring binders.

— RE —

## HUMIDITY FACTOR IN RADIO WORK

Interesting graphs dealing with the effect of moisture on wire insulation and again on trimmer condensers, as expressed in terms of circuit Q, the Q of condensers and the capacitance of condensers, are available in a bulletin offered by Boonton Radio Corporation, Boonton, N. J. This humidity data, together with a description of the method followed in obtaining same, is the work of L. O. Cook and R. W. Knebel of the Boonton engineering staff, and is reported by its chief engineer, H. A. Snow. A copy of the bulletin, "The Humidity Factor in Radio Work," will be sent on request.

# NEW PRODUCTS



## NEW AMERICAN PRODUCT

A voltage regulator for alternating-current circuits which offers the same smooth control as obtained from a rheostat plus the high efficiency, good regulation and great flexibility of a transformer has just been announced by American Transformer Company, of Newark, N. J. This new device is known as the Type TH Transtat and is available in various standard sizes for controlling voltage to loads up to 2.5 kva on either 115- or 230-volt lines.

— RE —

## METAL-TUBE BALLAST RESISTORS

Another line of handy replacement parts appears in the form of metal-tube ballast resistors offered by Clarostat Mfg. Co., Inc., 285 N. Sixth St., Brooklyn, N. Y. Having produced thousands for set manufacturers, this organization is now making available a line of replacement units. The requirements have been critically studied and reduced to the smallest number of different types to take care of the greatest variety of sets so equipped.

— RE —

## PORTABLE RECORDERS

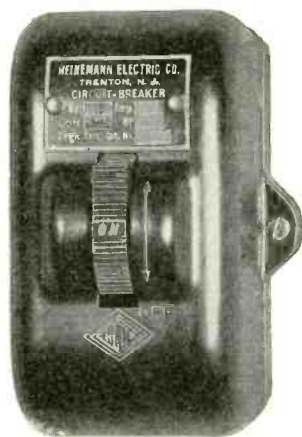
Introducing their new line of instantaneous recording machines under the "Remco" trade name, Recording Equipment Manufacturing Co., 6611 Sunset Boulevard, Hollywood, Calif., announces four new types of machines ranging from the "Babytone" model for home recording to the "Mastertone De-Luxe" for professional and studio use.

Both the "Babytone" and the "Babytone De-Luxe" Models consist of an amplifier, loud speaker, crystal microphone, combination cutting and reproducing head with a tracking device, turntable and motor. The "De-Luxe" model differs from the standard model in that it is equipped with a self-contained radio receiver, permitting it to be used for recording radio programs and a small public address system. Both models are readily portable, the "Babytone" weighing only 25 pounds and the "Babytone De-Luxe" 35 pounds.

Page 26

## SENSITIVE CIRCUIT-BREAKER

Costly tubes, transformers and condensers need no longer be junked through accidental overloads or short-circuits. The ingenious fully-magnetic, non-thermal Re-Cirk-It breaker available in capacities ranging from 50 milliamperes up to 35 amperes, is said to fully safeguard the radio experimenter's major investment at insignificant cost. It is a product of the Heinemann Electric Co., Trenton, N. J.



— RE —

The Re-Cirk-It breaker has a tumbler handle switching current on and off under normal circuit conditions. There are two types: instantaneous trip and time-delay action. The latter is provided with a hermetically-sealed magnetic trip which ruptures the circuit in from 5 seconds up to 8 minutes on a 125% load, or correspondingly faster on greater overloads, depending on which of four time-overload curves is selected. On short-circuits, it trips within 1/2 cycle on A.C., or 1/100 second on D.C. The instantaneous trip type may be adjusted for plus or minus 20% of rating.

## ALLOY FOR SEALING TO GLASS

"Kovar" is the trade name of an alloy, having a low coefficient of expansion developed for making vacuum tight seals with glass, and is now being distributed by The Stupakoff Laboratories, Inc., 6627 Hamilton Avenue, Pittsburgh, Pa.

A bulletin recently issued by the Stupakoff Laboratories, Inc., contains technical data including properties, sealing technique, typical uses and list of available standard shapes.

— RE —

## MAGNAVOX HEAVY-DUTY SPEAKERS

The Magnavox Company, Fort Wayne, Ind., has just announced heavy-duty speakers, models 505 DC and 525 AC. The power handling capacity of these models is said to be 25 watts with sufficient reserve to carry peak levels ordinarily encountered.

These speakers were especially designed for use in high quality radio, phonograph and public address systems.

## CENTRALAB SWITCHKIT

An assortment of parts, which is said to permit the assembly of 161,700 different types of switches, has been announced by Centralab, 900 East Keefe Avenue, Milwaukee, Wis. The parts are supplied in a twenty-five drawer steel cabinet. The total number of switches provided for by the kit is thirty-five. This kit is designed to provide a great selection in the matter of switches of the so-called selector or wave-band type both for replacement and experimental purposes.

— RE —

## "END-SHAK" TESTING SIEVE SHAKER

The Newark Wire Cloth Co., Newark, N. J., well known manufacturers of high quality wire cloth and wire cloth products, now announces a new "End-Shak" Testing Sieve Shaker for testing fine materials. The new shaker is provided with a simplified hold-down device which permits the sieves to be easily and quickly put in place and removed, regardless of the number of sieves used.

— RE —

## R-F VOLTMETER

Ferranti Electric, Inc., 30 Rockefeller Plaza, New York City, have announced an r-f voltmeter which may be used on power, audio and radio frequencies up to 1500 kc. This instrument, employing electrostatic construction, is said to be independent of temperature, frequency and waveform. It may be used for making measurements on high-impedance circuits or measuring the voltage in the tank circuit of a radio transmitter.

Up to 3500 volts these meters can be directly connected either to a-c or d-c circuits. They are supplied in three standard dials: 2 1/2 inches, 3 1/4 inches and 4 inches.

— RE —

## ASTATIC MODEL B PICKUP

The new Astatic model B pickup—known as the Tru-Tan—is constructed with a unique, scientifically designed offset head which is said to hold the needle practically tangent to the circle of the record throughout the entire playing surface of a 12-inch disc. The maximum deviation from a true tangent is said never to exceed 1.5 degrees.

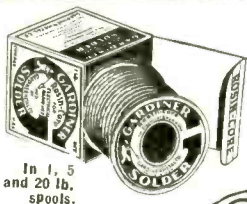
Other features include a tilting head which permits top loading of the needle; elimination of mechanical resonance in the pickup arm; and double row ball bearing swivel base.



RADIO ENGINEERING



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# RADIO ENGINEERING BUYER'S GUIDE

A continuous, indexed recording of the reliable sources of supply of

## Materials—Component Parts

### BASES, VACUUM TUBE

AMERICAN LAVA CORP., Chattanooga, Tenn.  
American Phenolic Corp.  
American Record Corp.  
ISOLANTITE, INC., 233 Broadway, N. Y. C.  
Kurz-Kasch Co.  
RCA MFG. COMPANY, INC., Camden, N. J.  
Richardson Company, The  
Westinghouse Lamp Co.

### BRASS—COPPER

AMERICAN BRASS CO., THE, Waterbury, Conn.  
ANACONDA COPPER CO., 25 Broadway, N. Y. C.  
Hillmore Brass Co.  
Bristol Brass Corp.  
Ryerson & Son, Inc.  
Seville Mfg. Co.  
WATERBURY BRASS GOODS BR., Waterbury, Conn.

### CABINETS—WOOD

Adler Mfg. Co.  
Alden Corp.  
Caswell-Runsan Co.  
Peerless Cabinet Co.  
Superior Cabinet Corp.

### CATHODES (See Tubing, Seamless Cathode)

### CATHODE RAY—TUBES

DUMONT LABORATORIES, ALLEN B., 542 Valley Rd., Upper Montclair, N. J.  
General Electric Co.  
HYGRADE-SYLVANIA CORP., Clifton, N. J.  
RCA MANUFACTURING CO., INC., Camden, N. J.  
WESTERN ELEC. CO., 195 Broadway, N. Y. C.  
Westinghouse Elec. & Mfg. Co.

### CERAMICS

AMERICAN LAVA CORP., Chattanooga, Tenn.  
American Phenolic Corp.  
Colonial Insulator Co.  
CROWLEY & CO., INC., H. L., W. Orange, N. J.  
ISOLANTITE, INC., 233 Broadway, N. Y. C.  
Kirchberger & Co., Inc., M.  
Mycalex Corp. of Amer.  
STUPAKOFF LABORATORIES, INC., 6627 Hamilton Ave., Pittsburgh, Pa.  
Tennessee-Eastman Co.

### CHOKES

ACME ELECTRIC & MFG. CO., 1440 Hamilton Ave., Cleveland, Ohio  
AMERICAN TRANSFORMER CO., 175 Emmet St., Newark, N. J.  
General Transformer Co.  
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.  
Kenyon Transformer Co., Inc.  
UNITED TRANS. CORP., 72-74 Spring St., N. Y. C.

### COIL MACHINERY

UNIVERSAL WINDING CO., Providence, R. I.

### COILS—POWER

ANACONDA WIRE & CABLE CO., Muskegon, Mich.  
ACME WIRE COMPANY, 1255 Dixwell Avenue, New Haven, Conn.  
American Enameled Magnet Wire Co.  
Belden Manufacturing Co.  
Coto-Coil Co., Inc.  
General Electric Company  
Roebling's Sons, John  
Westinghouse Elec. & Mfg. Co.

### COILS—RADIO RECEIVER

ALADDIN RADIO INDUSTRIES, INC., 466 W. Superior St., Chicago, Ill.  
Alden Products Co.  
Automatic Winding Co.  
Colls, Inc.  
Coto-Coil Co., Inc.  
General Mfg. Co.  
GUTHMAN & CO., INC., Edwin I., 1036 W. Van Buren St., Chicago, Ill.  
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.  
MEISSNER MFG. CO., Mt. Carmel, Ill.  
Norwalk Engineering Corp.  
Nickles Company

### COILS—SPEAKER

ACME ELECTRIC & MFG. CO., 1440 Hamilton Ave., Cleveland, Ohio  
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ANACONDA WIRE & CABLE CO., Muskegon, Mich.  
Chicago Transformer Corp.  
Dongan Electric Mfg. Co.  
GENERAL TRANSFORMER CORP., 502 S. Throop St., Chicago, Ill.  
HALLDORSON COMPANY, 4500 Ravenswood Ave., Chicago, Ill.  
JEFFERSON ELECTRIC COMPANY, Bellwood, Ill.  
Kenyon Trans. Co., Inc.  
RCA MANUFACTURING CO., INC., Camden, N. J.  
STANDARD TRANSFORMER CORP., 854 Blackhawk Street, Chicago, Ill.  
THORDARSON ELEC. MFG. CO., 500 W. Huron St., Chicago, Ill.  
UNITED TRANS. CORP., 72-74 Spring St., N. Y. C.

### CONDENSERS, FIXED PAPER

ACME WIRE COMPANY, 1255 Dixwell Ave., New Haven, Conn.  
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CORNELL-DUBILIER CORP., S. Plainfield, N. J.  
CURTIS CONDS. CORP., 3088 W. 106th St., Clevel., O.  
Dumont Electric Co.

### ELECTRONIC LABORATORIES, INC., Indianapolis, Ind.

Flechthelm & Co., A. M.  
Magnavox Co., Ltd.  
MALLORY & CO., P. R., Indianapolis, Indiana  
MICAMOLD RADIO CORP., Brooklyn, N. Y.  
SOLAR MFG. CORP., 599-601 Broadway, N. Y. C.  
SPRAGUE SPECIALTIES CO., North Adams, Mass.  
TOBE DEUTSCHMANN CORP., Canton, Mass.

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Magnavox Co., Ltd.  
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MICAMOLD RADIO CORP., Brooklyn, N. Y.  
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SPRAGUE SPECIALTIES CO., North Adams, Mass.

### CONDENSERS, ADJUSTABLE

HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.  
MEISSNER MFG. CO., 4500 Ravenswood Ave., Chi., Ill.  
SOLAR MFG. CORP., 599-601 Broadway, N. Y. C.  
TOBE DEUTSCHMANN CORP., Canton, Mass.

### CONDENSERS, VARIABLE

CARDWELL MFG. CO., ALLEN B., 81 Prospect St., Brooklyn, N. Y.  
DeJur-Anso Corp.  
General Instrument Co.  
GENERAL RADIO CO., 30 State St., Cambridge, Mass.  
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.  
OAK MFG. CO., 711 W. Lake Street, Chicago, Ill.  
Precision Mfg. Co.  
Radio Condenser Co.

### CONTACTS, METAL

Baker & Co., Inc.  
CALLITE PRODUCTS CO., 542 39th St., Union City, N. J.  
General Tungsten Mfg. Co.  
MALLORY & CO., P. R., Indianapolis, Indiana  
Wilson Co., H. A.

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AMERICAN LAVA CORP., Chattanooga, Tenn.  
Colonial Insulator Co.  
ISOLANTITE, INC., 233 Broadway, N. Y. C.  
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SCIENTIFIC RADIO SERVICE, University Pk., Hyattsville, Md.

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GENERAL RADIO CO., Cambridge, Mass.  
Magnavox Company, The

### ELECTRODES, NEON

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EISLER ENGINEERING CO., INC., Newark, N. J.  
SWEDISH IRON & STEEL CORP., 17 Battery Pl., N. Y. C.

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STUPAKOFF LABS., INC., 6627 Hamilton Ave., Pesh., Pa.  
United Shoe Mach. Co.  
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### FIBRE (See Insulation, Laminated)

### FLEXIBLE SHAFTING

Fischer Spring Company, Chas.  
White Dental Mfg. Co., S. S.

### FUSES

LITTELFUSE LABS., 4244 Lincoln Ave., Chicago, Ill.

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ELECTRONIC LABORATORIES, INC., 122 W. New York St., Indianapolis, Ind.  
MALLORY & CO., P. R., Indianapolis, Indiana  
Onan & Sons, D. W.  
PIONEER GEN.-E-MOTOR CORP., 466 W. Superior St., Chicago, Ill.

### GETTERS (See Nickel Tube Parts)

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### HORNS

Atlas Sound Corp.

### FOX SOUND EQUIP. CORP., 3120 Monroe St., Toledo, Ohio

RACON ELEC. MFG. CO., 52 E. 19th St., N. Y. C.  
WRIGHT-DECOSTER, INC., 2253 University Ave., St. Paul, Minn.

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CLOUGH-BREngle CO., 2817 W. 19th St., Chi., Ill.  
DUMONT LABORATORIES, ALLEN B., 542 Valley Rd., Upper Montclair, N. J.  
FERRANTI ELECTRIC, INC., 30 Rockefeller Plaza, N. Y. C.  
FERRIS INSTR. CORP., Boonton, N. J.  
GENERAL RADIO COMPANY, Cambridge, Mass.  
HICKOK ELEC. INSTRU. CO., Cleveland, O.  
Jackson Elec. Instruc. Co.  
RCA MFG. CO., INC., Camden, N. J.  
Radio City Products Co.  
Radio Products Co.  
Rawson Elec. Instru. Co.  
READRITE METER WORKS, Bluffton, Ohio  
SIMPSON ELEC. CO., 5218 W. Kinzie St., Chicago, Ill.  
SOLAR MFG. CO., 599 B'way, N. Y. C.  
SUPREME INSTRUMENT CORP., Greenwood, Miss.  
TRIPLETT ELEC. INSTRU. CO., Bluffton, Ohio  
TRIMM MFG. CO., 4017 W. Lake St., Chicago, Ill.  
WESTERN ELECTRIC CO., 195 Broadway, N. Y. C.  
WESTERN ELEC. INSTRU. CORP., Newark, N. J.

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Glenn & Co., J. J.  
MAAS & WALDSTEIN, 438 Riverside Ave., Newark, N. J.  
MICA INSULATOR CO., 200 Varick St., N. Y. C.  
STUPAKOFF LABS., INC., 6627 Hamilton Ave., Pesh., Pa.  
ZOPHAR MILLS, INC., 120 26th St., Brooklyn, N. Y.

### INSULATION, FABRIC TUBING

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Bentley Harris Mfg. Co.  
BRAND & CO. WM., 276 Fourth Ave., N. Y. C.  
Glenn & Co., J. J.  
MICA INSULATOR CO., 200 Varick St., N. Y. C.

### INSULATION, LAMINATED BAKELITE—

### VULCANIZED OR PHENOL FIBRE

American Mica Works Corp.  
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Continental-Diamond Fibre Co.  
Formica Insulation Co.  
Franklin Fibre-Lamite Corp.  
General Electric Co.  
MICA INSULATOR CO., 200 Varick St., N. Y. C.  
National Vulcanized Fibre Co.  
Resinox Corporation  
Richardson Company, The  
SYNTHANE CORPORATION, Oaks, Penna.  
TAYLOR & CO., INC., Norristown, Pa.  
Westinghouse Elec. & Mfg. Co.  
Wilmington Fibre Co.

### INSULATION, MOLDED

American Insulator Corp.  
AMERICAN LAVA CORP., Chattanooga, Tenn.  
American Phenolic Corp.  
American Record Corp.  
Bakelite Corp.  
Chicago Molded Prods. Corp.  
CROWLEY & CO., INC., H. L., W. Orange, N. J.  
Formica Insulation Co.  
General Plastics, Inc.  
ISOLANTITE, INC., 233 Broadway, N. Y. C.  
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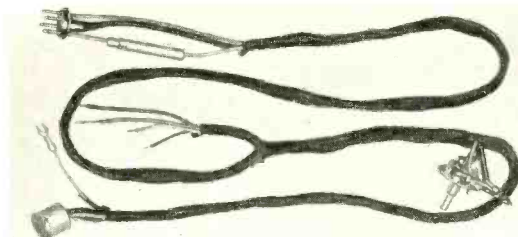
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Macellen Co.  
MICA INSULATOR CO., 200 Varick St., N. Y. C.  
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Westinghouse Elec. & Mfg. Co.  
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AUDAK COMPANY, THE, 500 Fifth Ave., N. Y. C.  
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Fansteel Metallurgical Corp.  
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## RECTIFIERS

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MALLORY & CO., INC., P. R., Indianapolis, Indiana  
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Westinghouse Elec. & Mfg. Co.  
WARD LEONARD ELEC. CO., Mt. Vernon, N. Y.

## RELAYS

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STANDARD TRANS. CORP., 866 Blackhawk St., Chi., Ill.  
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General Cable Corp.  
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CORNISH WIRE COMPANY, 30 Church St., N. Y. C.  
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CRESCENT INSULATED WIRE & CABLE CO., Trenton, N. J.  
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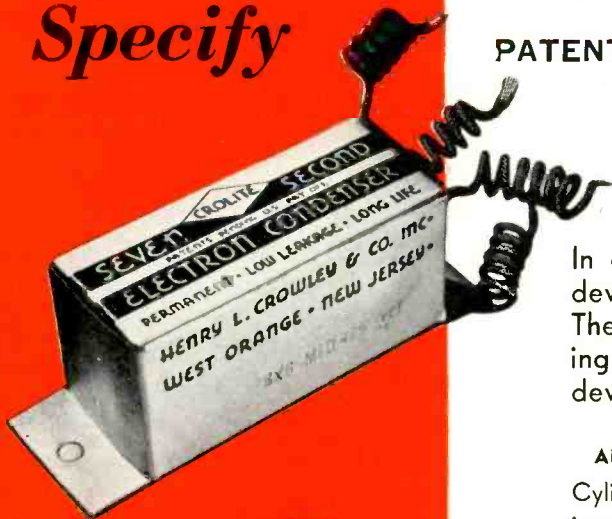
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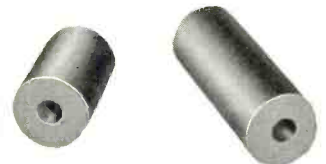
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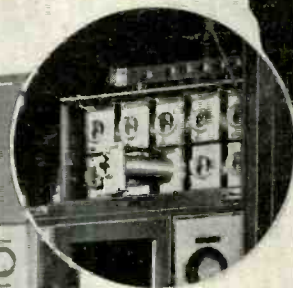
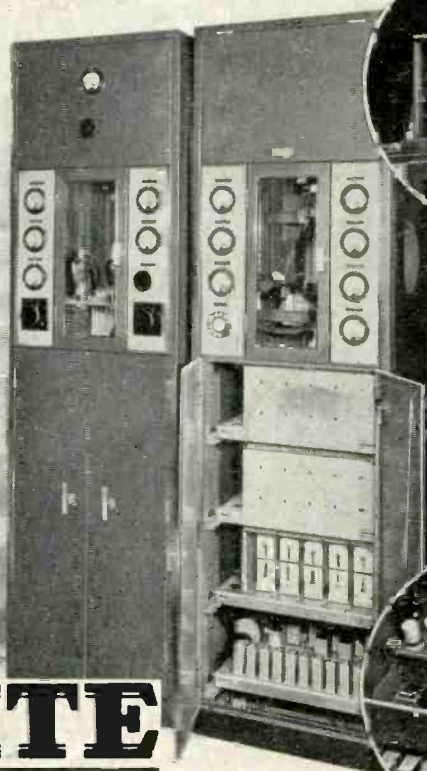
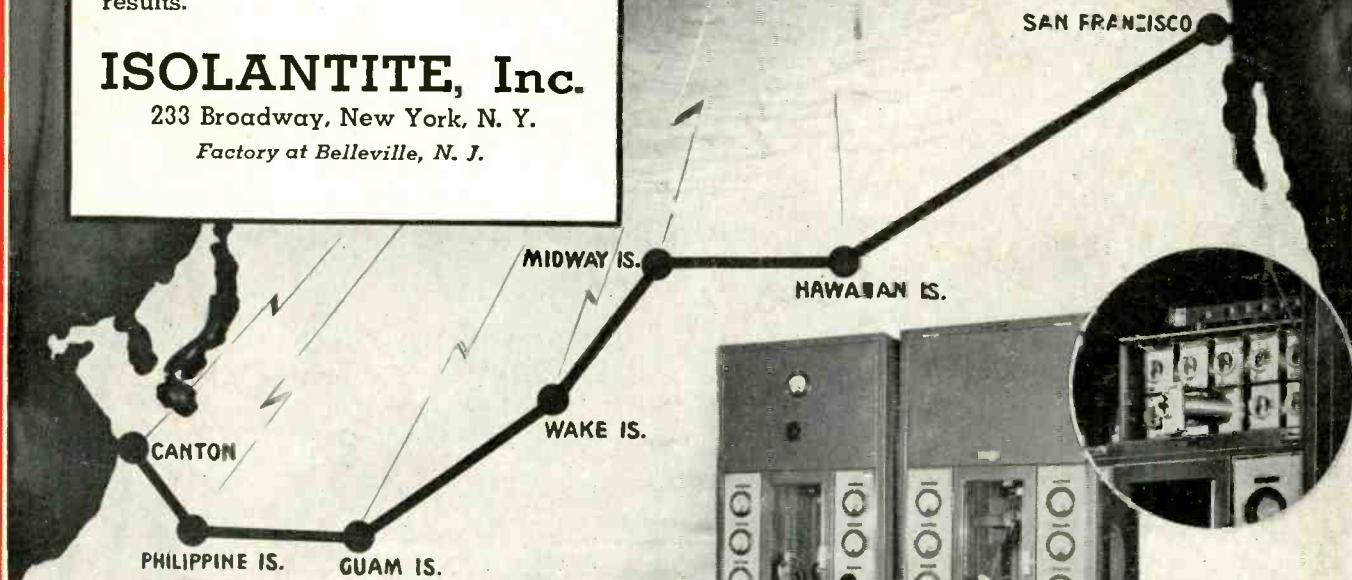
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