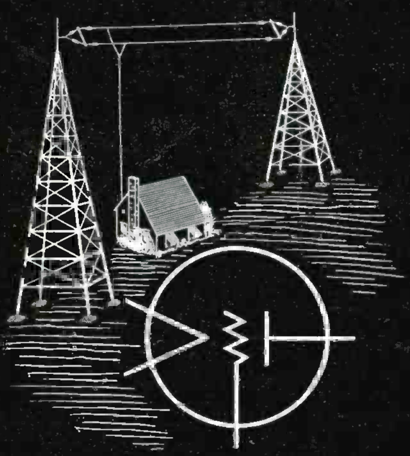
JULY, 1932

Radio Engineering



IN THIS ISSUE

TWELFTH YEAR OF SERVICE

The Journal of the Radio and Allied Industries

Now ARCTURUS Offers Five Improved Tubes

Recent developments in radio demand new types of tubes. To provide the latest in tubes, Arcturus has added Types 46, 56, 57, 58 and 82 to its line. The new 6.3 volt tubes—Types 41, 42 and 44—have also been developed.

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TYPE 82—*Full-wave mercury vapor rectifier.*

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TYPE 46—*Class "B" Power Amplifier.*

TYPE 57—*Screen-grid detector amplifier. Has uni-potential cathode with a. c. heater.*

TYPE 56—*Detector, amplifier and oscillator. Has uni-potential cathode with a. c. heater.*

Technical data sheets on these new tubes will be sent on request.

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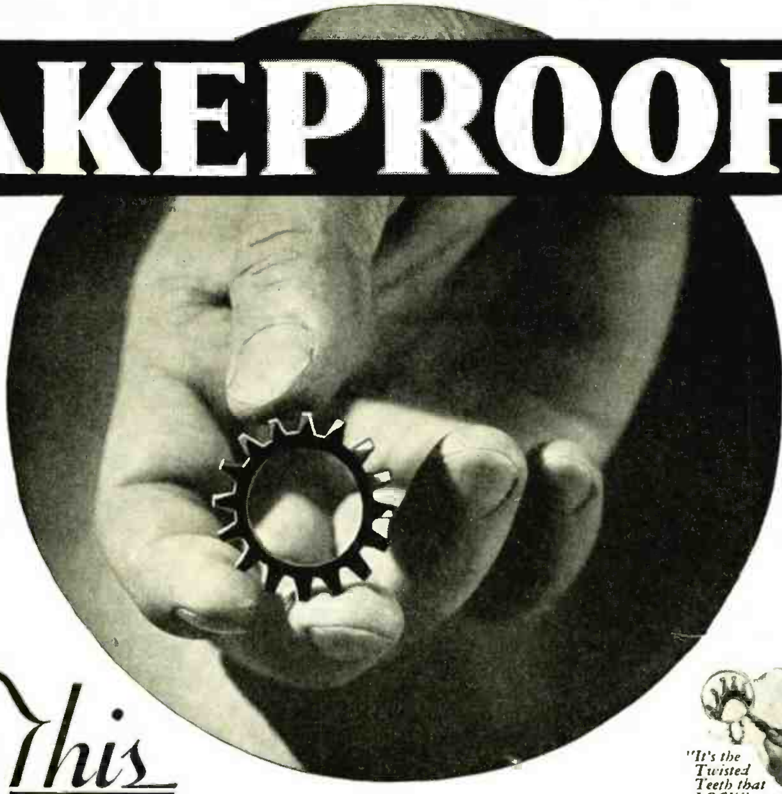

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Contents

Departments

SELLING VS. BUYING CAMPAIGNS

MUCH has been written and advertised about "buying campaigns" in some of the larger cities. In my opinion, this is attacking the problem from the wrong angle. What every company should do is to launch a real selling campaign which will appeal to the buyer, and the money in the country will go flowing into buying channels. This is not a theory, but a fact that has been demonstrated over and over again during the past few months.

A few days ago my business called me to two large department stores in a great city. One of these stores had launched an exceedingly well planned and timely selling campaign for that day. The other store was carrying on the usual type of department store advertising, even though its prices and products were comparable in most instances.

In the department store doing the commonplace and usual thing, I was impressed by the small number of people purchasing in the store, even though a large sum of money had been spent the previous day in advertising certain items which were attractive.

I then went to the other department store where the selling campaign had been well worked out and, to my astonishment, found it hard even to get through the aisles. In talking to one of the buyers, I was advised that their trouble that day was in getting sales people to take care of the customers. Manufacturers' salesmen who happened into that store that day were pressed into service as sales people for the department store.—*Frank F. Whittam, in "Executives Sales Bulletin."*

BRYAN S. DAVIS, *President*

JAS. A. WALKER, *Secretary*

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Editorial

JULY, 1932

THE PRICE OF RADIO PARTS

HE would be a fortunate radio parts manufacturer who could anticipate closely the time when there is to be a demand for high grade workmanship. A large demand for the betterment of quality will coincide closely with an improved sales situation wherein the public will be willing to pay a few dollars additional for "something better."

At the I. R. E. parts show at Pittsburgh in March the parts manufacturers' exhibits disclosed that, on the part of those who had exhibits, real progress has been made in the past two years in improving quality. But, inquiry among receiver manufacturers brings to light the sorry state of affairs that they are still under the necessity of buying to price.

This, no doubt, is not, at the present time, different from what obtains in most other lines of business, but, as has happened on previous occasions, a time will come when quality will be a consideration because of improved purchasing power.

The problem for the parts manufacturer, and for set manufacturers, is to keep close abreast of the times so that at the first turn of the tide all may capitalize the shift from a price market to a quality market.

▲

FIELD INTENSITY MEASUREMENTS

FIELD intensity measurements at frequencies from 285 to 5400 kc., reported by S. S. Kirby and K. A. Norton of the Bureau of Standards, Washington, were made for the purpose of checking the accuracy of the usual methods of measurement of field intensity at broadcasting frequencies at a distance of about 3 km. from a transmitting station.

Obtaining exact data under given conditions is a logical step along the line of inquiry necessary to carry on if there are to be available to engineers dependable formulas for determining station coverage on a received energy basis.

Abstracted, the findings of Kirby and Norton report that:

Radio field intensities were measured at distances of only a few wavelengths from a transmitting station on a wide range of frequencies, including the broadcast band, in order to determine the distance at which ground absorption became appreciable. At a distance of 2.4 km. there was no appreciable absorption for frequencies below about 1,000 kc.; above this frequency, the absorption became appreciable and increased as the frequency was increased. Daylight measurements made at greater distances on broadcast transmissions, airways phones and airways beacons show that field intensities fall off to 1 per cent of what the inverse distance law with no absorption would give at distances from 100 to 400 km., depending on the frequency and the nature of the ground. The experimental data were compared with Rolf's attenuation graphs in order to determine the electrical constants of the land east and west of the Alleghany Mountains. East of and including the mountains (Maryland, Pennsylvania, and New Jersey) the conductivity and dielectric constant were found to be 3.35×10^{-14} e.m.u. and 13, respectively; west of the mountains (near Chicago) they were found to be 1.07×10^{-13} e.m.u. and 13, respectively. Using these constants theoretical values of field intensity were graphed for these two types of ground and for broadcasting frequencies.

The experimental data were also compared with results given by the Austin-Cohen transmission formula. It was found that for overland transmission in the range of frequencies observed this formula did not satisfactorily give the variations in field intensity as the distance was changed or as the frequency was changed.

Donald McNicol
Editor

RADIO ENGINEERING

Production, Administration, Engineering, Servicing

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Notes on the design of radio receivers†

By LINCOLN WALSH

THE design of radio receivers is today a problem of obtaining satisfactory performance within limits set by considerations of cost and size. Satisfactory performance is largely a question of the resistance of the tuned circuits, both radio and intermediate frequency. Sensitivity and selectivity are improved as circuit resistances are decreased. Fidelity is seriously impaired as the resistance is decreased, beyond certain limits, unless band-pass circuits are employed.

The resistance of tuned circuits is commonly expressed in several ways:

The series resistance in ohms, R.

The power factor, pf; or its reciprocal, Q.

The band width at half amplitude, B, expressed in kilocycles at a given carrier frequency.

These expressions are related as follows:

$$\frac{R}{2\pi f L} = pf = \frac{1}{Q} \qquad (1)$$

$$\frac{1}{pf} = Q = \frac{2\pi f L}{R} \qquad (2)$$

$$B = \frac{\sqrt{3}\,R}{2\pi L} = \sqrt{3} \times f \times pf = \frac{\sqrt{3} \times f}{Q} \qquad (3)$$

The expression for B is derived as follows:

The series impedance

$$z = R + j\,2\pi f L + \frac{1}{j\,2\pi f C} \qquad (4)$$

at resonance

$$j\,2\pi f L + \frac{1}{j\,2\pi f C} = O \qquad (5)$$

and

$$z = R \qquad (6)$$

when the amplitude has been reduced to half by shifting the frequency of the applied voltage Δf

$$z = 2R = R + j\,2\pi\,(f \pm \Delta f)\,L + \frac{1}{j\,2\,(f \pm \Delta f)\,C} \qquad (7)$$

An approximation that has negligible error in all practical cases gives

$$z = 2R = R \pm 2\,j\,2\pi \Delta f L \qquad (8)$$

$$4\,R^2 = R^2 + 16\,\pi^2\,(\Delta f)^2\,L^2 \qquad (9)$$

$$\frac{3\,R^2}{16} = \pi^2\,(\Delta f)^2\,L^2 \qquad (10)$$

$$\Delta f = \frac{\sqrt{3}\,R}{4\pi L} \qquad (11)$$

As Δf is the frequency change in one direction to reduce to half amplitude, the band width B is twice Δf.

$$B = 2\Delta f = \frac{\sqrt{3}\,R}{2\pi L} \qquad (12)$$

or

$$B = \sqrt{3}\,f\,\frac{R}{2\pi f L} = \sqrt{3} \times f \times pf = \frac{\sqrt{3} \times f}{Q} \qquad (13)$$

The parallel tuned impedance of a tuned circuit, expressed in ohms, is

$$Rt = \frac{(2\pi f)^2\,L^2}{R} = \frac{2\pi f L}{pf} \qquad (14)$$

$$= \frac{1}{(2\pi f)^2\,C^2\,R} = \frac{1}{2\pi f C\,pf} \qquad (15)$$

expressed as a conductance in mhos

$$g = \frac{1}{Rt} = \frac{R}{(2\pi f)^2\,L^2} = \frac{pf}{2\pi f L} \qquad (16)$$

$$= (2\pi f)^2\,C^2\,R = 2\pi f\,c\,pf$$

Factors in Circuit Resistance

The resistance of a tuned circuit consists of the copper resistance of the coil, and the dielectric loss, made up of the losses in the condenser, in the coil form, in the tube and in the leads. In general, losses are also reflected into the tuned circuit from the primary circuit from which it receives its energy.

The resistance of a coil at radio frequency is many times its resistance to direct current. In a coil designed to cover the broadcast range, the power factor due to copper resistance only, at 1,500 kc. will be close to 0.8 per cent over a wide range of coil dimensions and size of wire. At 600 kc. the power factor due to copper resistance will vary from 2 per cent for some of the smaller coils now in use, to about 0.4 per cent for the larger coils employed in the earlier receivers.

In coils using solid copper wire, the diameter of the wire may be varied from about one-third the distance between turns, up to the point where the wires are almost touching without greatly affecting the power factor. Using larger wire reduces the power factor slightly at low frequencies, and increases it slightly at high frequencies.

The effect of shields is to decrease the inductance of the coil and to decrease the resistance to a slightly less degree, so that the power factor is only slightly increased. The reduction of resistance seems to be due to a reduction of skin effect. When the coil is not shielded the current crowds to the inner surface of the wire. In the shield

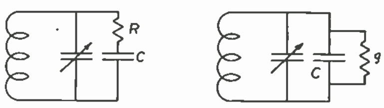

Fig. 1.

$R = \frac{pf}{2\pi fc}$ $g = 2\pi Cpf$

†*Delivered before the Radio Club of America, May 11, 1932.*

the current crowds to both inner and outer surfaces, and the consequent reduction in resistance more than compensates for the energy loss due to currents flowing in the shield, the net result being a drop in the coil resistance almost as great as the drop in inductance.

Coil Diameter

To obtain the coil of lowest power factor in an aluminum shield of given diameter, the coil diameter should be about 0.6 times the shield diameter; in a copper shield about 0.65. Cost considerations will dictate a coil slightly smaller than these sizes, as the power factor does not increase rapidly with decrease of diameter, but the material and labor costs drop in proportion to diameter.

If the coil diameter is 0.707 times the shield diameter the loss is slightly increased, but the coil has the unique property of having its inductance substantially independent of small variations in the diameter of the coil form. This is due to the reluctance of the magnetic path being equal inside and outside the winding, so that any change in diameter increases the reluctance of the inner path by the same amount that it decreases the reluctance of the outer path, or vice versa. The inductance then depends on the diameter of the shield, the length of winding and the number of turns.

The dielectric loss, when expressed as a conductance across the circuit varies in proportion to frequency. It may be represented by a condenser of fixed capacity and constant power-factor comprising part of the tuning capacity of the circuit, as shown in Fig. 1.

In a circuit having fixed inductance, and tuned by a variable capacity, the dielectric loss when expressed as a series resistance or as band width varies as the third power of frequency. Expressed as power factor it varies as the second power of frequency.

Among the main contributors to dielectric loss are the insulators and compensators of variable condensers, and the insulation of the leads connecting the grid, coil high terminal and variable condenser stator. Care should be taken in the placing and insulation of these leads, or their loss may exceed all the other losses of the circuit.

The power factor due to dielectric loss may vary from values too small to measure to about 1.5 per cent, at 1,400 kc.

The r-f. system of the average broadcast receiver has a power factor due to all causes of about 1.4 per cent at 600 kc. and 1.7 per cent at 1,400 kc., corresponding to band widths for individual stages of 15 kc. and 42 kc. The intermediate frequency stages of superheterodynes have band widths of 6-10 kc., corresponding in a 175 kc. amplifier, to a power factor of 2-3 per cent.

The loss reflected from the primary consists of the reflected plate impedance of the tube, and the loss due to current circulating in the primary coil itself. The loss due to circulating current is determined by measuring the power factor of the secondary with the primary removed, and then measuring the power factor with the primary in position and connected to its normal circuit, with the preceding tube plate connected to the primary, but the cathode cold or the tube biased beyond cutoff. The difference of these two power factors gives the loss in the primary.

The power factor due to reflected plate impedance is a measure of efficiency of coupling between the plate of the amplifier and the tuned circuit. For maximum transfer of energy into the secondary circuit, the impedance of the primary should equal the plate impedance of the tube. The primary impedance is

$$z_1 = R_p \times \frac{pf}{pf_o} - 1 \qquad (17)$$

where R_p is the plate impedance of the tube.

pf is the power factor of the circuit in normal operation with the tube operating at R_p normal.

pf_o is the power factor of the circuit normal except that R_p is substantially infinite (cathode cold, or tube biased almost to cutoff).

The expression for primary impedance is derived as follows:

Neglecting $L_{1L}\ \tau^2$, the total resistance across the tuned circuit is Z_2

$$\frac{1}{Z_2} = \frac{1}{Z_{2-o}} + \frac{1}{R_p\tau^2} \qquad (18)$$

$$\frac{pf}{2\pi f L} = \frac{pf_o}{2\pi f L} + \frac{1}{R_p\tau^2} \qquad (19)$$

$$\frac{pf - pf_o}{2\pi f L} = \frac{1}{R_p\tau^2} \qquad (20)$$

$$\frac{pf - pf_o}{pf_o} = \frac{2\pi f L}{R_p\,\tau^2\,pf_o} \qquad (21)$$

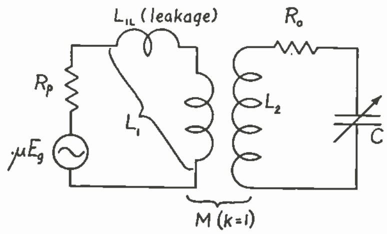

Fig. 2. Actual circuit.
Effective turns ratio or voltage turns ratio $\tau = \frac{L_2}{M}$

$\frac{2\pi f L}{pf_o}$ is the secondary tuned impedance and $\frac{2\pi f L}{pf_o\ \tau^2}$ is the primary tuned impedance. Then the preceding equation reduces to

$$\frac{pf}{pf_o} - 1 = \frac{z_1}{R_p} \qquad (22)$$

This method must be modified when the primary leakage inductance is not negligible relative to R_p.

The method as described in general is correct for all circuits except those employing a primary circuit tuned to a frequency below the low end of the frequency range.

The relation between primary impedance, voltage ratio, gain, and power factor is shown in Fig. 4.

It will be seen that if the primary impedance is made somewhat below optimum, the power factor, and therefore the selectivity are considerably improved, with a very slight reduction of gain.

Computation of Gain

Knowing the inductance L, power factor pf_o, and voltage ratio or effective turns ratio τ of a tuned amplifier stage, the gain can be computed as follows:

Tuned secondary impedance

$$z_2 = \frac{2\pi f L}{pf_o} \qquad (23)$$

Tuned primary impedance

$$z_1 = \frac{2\pi f L}{pf_o \times \tau^2} \qquad (24)$$

The voltage developed across the primary is

$$\mu E_g \times \frac{z_1}{z_1 + R_p} \qquad (25)$$

The voltage developed across the secondary

$$E_s = \tau\,\mu\,E_g\,\frac{z_1}{z_1 + R_p} \qquad (26)$$

Amplification

$$\frac{E_s}{E_g} = \tau\,\mu\,\frac{\frac{2\pi f L}{pf_o\,\tau^2}}{\frac{2\pi f L}{pf_o\,\tau^2} + R_p} \qquad (27)$$

The optimum effective turn ratio or voltage ratio is

$$= 1 \quad \sqrt{\frac{z_2}{R_p}} = \sqrt{\frac{2\pi f L}{pf_o \times R_p}} \qquad (28)$$

The optimum gain is

$$\frac{\tau_{opt} \times \mu}{2} = \frac{\mu}{2}\sqrt{\frac{2\pi f L}{pf_o \times R_p}} \qquad (29)$$

The above expressions are primarily for use with 3-element tubes in which the plate impedance is low. When the plate impedance is greater than the tuned secondary impedance, it is in general not possible to secure optimum coupling and gain.

When the plate impedance is very much greater than the primary impedance (27) reduces to

$$\frac{E_s}{E_g} = \frac{\mu}{R_p} \frac{2\pi f L}{pf_o \tau} = g_m \frac{2\pi f L}{pf_o \tau} \quad (30)$$

When the plate is directly coupled to the tuned circuit this further reduces to

$$\frac{E_s}{E_g} = g_m \frac{2\pi f L}{pf_o} \quad (31)$$

Most superheterodynes employ in their intermediate-frequency stages a pair of coupled circuits, the first of which is directly coupled to the plate of the amplifier tube, with the coupling between them critical or over. The tuned primary impedance is half the impedance of one circuit alone. The tuned impedance of such a circuit is generally a considerable fraction of the impedance of the screen grid amplifier tube.

The primary impedance is then

$$\frac{2\pi f L}{2\ pf} \quad (32)$$

The voltage amplification is (33)

$$\frac{E_s}{E_g} = \mu \frac{\dfrac{2\pi f L}{2\ pf_o}}{\dfrac{2\pi f L}{2\ pf} + R_p}$$

the voltage being substantially the same across both primary and secondary.

Methods of Measuring Resistance

The more common methods of measuring resistance at high frequencies may be grouped under the following headings:

High frequency bridge.
Resistance variation.
Capacity variation.
Frequency variation.

The ordinary a-c. bridge has been used to measure the series resistance of tuned circuits. It has been used also to measure the primary impedance of tuned transformers at resonance, when this value was of the order of 1,000 to 10,000 ohms. This method has been found fairly accurate, but it is so difficult to operate a bridge of this character that is very rarely used.

The resistance variation method is perhaps the most widely used method of measuring resistance. A voltage is induced in the tuned circuit, and a vacuum tube voltmeter connected across

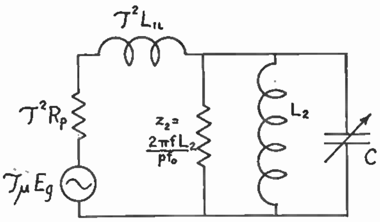

Fig. 3. Equivalent circuit.

the circuit or an ammeter connected in series with the coil and condenser, and the circuit tuned to the applied voltage. The reading of the meter is noted. Resistance is introduced in series with the inductance and capacity, and its value adjusted until the meter reading indicates half current or voltage. When the meter reading is proportional to voltage squared, the reading should be adjusted to quarter the original deflection. The value of resistance introduced is then equal to the resistance of the circuit.

Precaution must be taken that the induced voltage does not change when the resistance is introduced.

This method is open to the serious objection that the results are accurate only when the resistance is in series with all the tuning capacity. In the average broadcast circuit at 1,400 kc. more than half of the capacity of the circuit is distributed, or reflected from the primary, and less than half is in the condenser, and the results obtained are correspondingly in error.

In the capacity variation method, a small calibrated variable condenser is connected in parallel with the tuning condenser; the circuit is tuned to resonance with an applied voltage as indicated on a vacuum tube voltmeter. The meter reading is noted and the auxiliary condenser setting increased until the voltmeter reading has dropped to quarter scale, indicating one-half voltage. This is repeated, decreasing the condenser setting.

Call the difference of the two settings $2\Delta C$. Then

$$\frac{2\pi f}{\sqrt{3}} \Delta C = \frac{pf}{2\pi f L} = \frac{R}{(2\pi f L)^2} \quad (34)$$

or

$$\frac{\Delta C}{\sqrt{3}\, C} = pf = \frac{R}{2\pi f L} = \frac{1}{Q}$$

This method is quite satisfactory and accurate. It does call for the inductance or capacity being known. The auxiliary condenser may add sufficient dielectric loss to the circuit to seriously affect the results at high frequencies.

When the voltmeter reading is dropped to half instead of quarter on a square law meter, the same expression results, but the $\sqrt{3}$ (1.732) drops out of the expression.

Then

$$2\pi f \,\Delta C = \frac{pf}{2\pi f L} = \frac{R}{(2\pi f L)^2} = \quad (35)$$

$$\frac{1}{Q\, 2\pi f L} = pf\ 2\pi f C = \frac{2\pi f C}{Q}$$

$$\frac{\Delta C}{C} = pf = \frac{1}{Q} \quad (36)$$

Frequency Variation Method

In the frequency variation method the circuit is tuned to resonance with a voltage from the signal generator, as indicated by a vacuum tube voltmeter. The frequency of the generator is increased until the voltmeter falls to half it original value, and the frequency noted. The frequency is then decreased until the voltmeter falls to the same half value. The difference of frequency for the high and low settings represents the band width at half amplitude. From this figure the power factor may be directly determined

$$pf = \frac{B}{f \times \sqrt{3}} = \frac{B}{f \times 1.732} \quad (37)$$

The main requirement of the frequency variation method is that the signal generator shall be accurately calibrated for small changes in frequency. It is desirable to have the scale divisions in fifths of a kilocycle in the broadcast range to permit band width measurements to tenths of a kilocycle. This does not mean that the frequency calibration of the generator must be within one-fifth kilocycle, but that for small variations of frequency, the vernier shall read to fifths.

In practice, measurements have been found to be reproducible to plus or minus 1 per cent. The accuracy of calibration of the vernier is well within 2 per cent.

The vacuum tube voltmeter used in this work is of the conventional plate rectification type, uses any type of tube, and imposes zero load on the tuned circuit. The type of tube used is the type with which the circuit is intended to operate, so that the measurements are taken with the circuit normal in every respect. When a screen grid tube having four or more elements is used, the control-grid is the input element of the voltmeter, the plate and screen are connected together and act as the plate. The suppressor grid is connected to plate or to cathode.

In measuring the antenna circuit of a complete receiver the signal generator is connected through the dummy antenna to the antenna lead of the receiver, and the grid lead of the first tube is connected to the grid of the voltmeter tube. The band width measurement is then made without making any changes in the receiver. For measurement of interstage circuits, the generator is connected to the grid of the amplifier tube, the grid lead to the succeeding tube connected to the voltmeter tube, and the band width measured.

It is not necessary to feed the energy into the circuit through the amplifier tube or the primary circuit. The energy may be fed through a coupling coil connected to the generator and very loosely coupled to the coil under test. The generator frequency may be changed slightly by connecting the coupling coil across its terminals, but this does not introduce any appreciable error into the band width measurement.

The frequency variation method has the advantage that no change is necessary in the circuit to be measured; it is not necessary to open the circuit to insert a resistance, or to add a calibrated vernier condenser in parallel with the circuit. The inductance does not have to be known to determine power factor or band width. Over the resistance variation method it has the advantage that the results do not depend on a resistance standard, which may not be accurate at the frequency of the test. These points become increasingly important at the higher frequencies. The method does call for a special form of signal generator having a calibrated frequency vernier.

Band Pass Circuits

The frequency variation method cannot be applied directly to measure the resistance of tuned circuits in band-pass coupled circuit systems. In this case it is necessary to uncouple the coils before measuring them. Energy may be fed to the first coil of the coupled system through its primary, and to the other coil or coils by loosely coupling them to a coupling coil connected to the generator.

A useful method of measuring band-pass circuits is to measure the band width of the pair of coils at quarter amplitude. If the coils are very loosely coupled this band width will be the same as the average of the band widths of each of the two coils at half amplitude. As the coupling is increased, the band width at quarter amplitude increases in proportion to the increase in coefficient of coupling. The gain of the circuit also increases, reaching within 5 per cent of the maximum attainable when the band width has increased about 50 per cent over the minimum band width.

Measurement of Resistance Units at High Frequency

The frequency or capacity variation method can be used to measure the

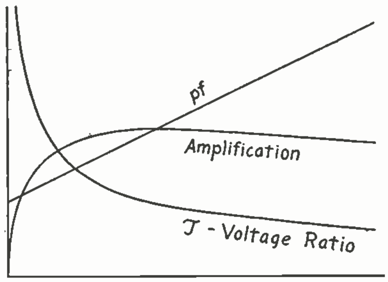

Fig. 4.

value of any resistance unit at any frequency by noting the change in power factor when the resistor is connected in series or parallel with a tuned circuit. The choice of series or parallel connection and the value of inductance and capacity should, if possible, be such that the power factor of the circuit with the resistance connected is not over 5 per cent. The error due to the approximation in expression (8) used to determine the simple expression for power factor, multiplies the result by 1.004 at 5 per cent power factor, and increases as the second power of power factor.

When the resistance R is in series

$$R = 2\pi f L \times (\text{change in power factor}) \quad (38)$$

When in parallel

$$R = \frac{2\pi f L}{(\text{change in power factor})} \quad (39)$$

The Decibel as a Method of Rating Receivers for Sensitivity

We have found the use of the decibel as a measure of the sensitivity of receivers, of the gain of amplifier stages, and of the sensitivity of detectors, to be a distinct advantage. The system which has been under consideration by the I. R. E. Technical Committee on Radio Receivers expresses voltages in decibels below 1 volt. Sensitivity is then the signal input expressed as decibels below 1 volt, modulated 30 per cent, required to give normal output of 50 milliwatts. The decibel rating has the advantage that the rating of a receiver increases with its sensitivity, and that the number representing the rating does not vary over a great range for variations in sensitivity which perhaps are barely noticeable to the user. The difference in usefulness between a 5 microvolt set and a 1 microvolt set is not such as to justify a difference of 5:1 in their rating. On the decibel rating these sets are rated respectively 106 and 120, which ratings represent better the usefulness of the receivers to the user who is looking for sensitivity.

The fact that the rating increases with sensitivity eliminates the confusion which the microvolt rating caused all except engineers.

Much work is being done on field strength measurement in decibels so that these measurements can be more easily correlated with receiver sensitivity in decibels than with sensitivity in microvolts.

In laboratory work the decibel system is a great convenience. By having the output of the generator and the scale of the vacuum tube voltmeter calibrated in decibels, all need for computations to determine the gain of a stage or the sensitivity of a receiver is eliminated. When the tube of the vacuum tube voltmeter is changed the only change in calibration is to use a calibration figure which is added to the scale reading in decibels. All tubes can be made to follow the decibel scale, which is made square law, by adjusting the grid voltage. Most tubes should be adjusted to a plate current with no a-c. voltage applied, of approximately .5 ma. The exact value should be determined by trial, applying voltages differing by 5 or 6 db. and noting whether the meter reading changes by exactly that amount. This simple calibration eliminates the need of making a new scale or a new calibration curve when the voltmeter tube is changed.

The sensitivity of a projected receiver can be computed very quickly as follows:

Detector sensitivity (defined same as receiver sensitivity)	2 db.
I-F. amplifier gain	44
Translator gain	30
R-F. amplifier gain	30
Antenna stage gain	14
Receiver sensitivity	120 db.

In a well designed receiver, the sensitivity will be found to agree very closely with the computed sensitivity.

The decibel as originally defined is a measure of power gain or loss.

$$\text{Gain or loss in db.} = 20 \log_{10} \frac{E_2}{E_1} \quad (40)$$

when E_1 and E_2 are measured across equal impedances. As used in radio receiver work, the decibel is a measure of voltage gain or loss, and the impedances are neglected. This is because vacuum tubes in general are voltage rather than power operated devices, and their input resistance very high. This neglect of impedance should be borne in mind when comparisons are made with decibel measurements where impedance is taken into account.

REFERENCE

L. A. Hazeltine, "Discussion on The Shielded Neutrodyne Receiver," Proc. I.R.E., Vol. 14. No. 3, June 1926.

A new zero bias output tube

By J. R. Nelson*

THE use of two tubes operated under class B conditions in the output stage is becoming increasingly popular. New tubes designed to work under class B conditions have been made for a-c. receivers. The use of such tubes is, however, more justified in the case of battery operated receivers, where the efficiency of conversion of d-c. to a-c. power is of paramount importance, than in the case of a-c. receivers where the power efficiency is of not much importance.

The 230 type of tubes have been used for some time in a push-push connection in the output of two-volt receivers. With these tubes, it is necessary to use a bias voltage in order to operate under class B conditions. The plate current is very low with no signal. The power output of the 230 stage is slightly over one watt with a 230 driver tube worked up to grid current and coupled to the output stage by means of a suitable step-down transformer.

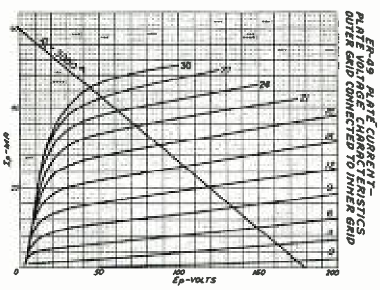

Fig. 1.

The ER-49 is a new type of zero bias output tube designed for class B operation in two-volt receivers and offers the following advantages over the 230 tube when used in the same position. First, the tube operates at zero d-c. bias, thus simplifying circuit arrangements. Second, the theoretical power output is about three times that of the 230 tube when both tubes are pushed to extreme conditions. Third, the maximum value of power output is reached with considerably less input voltage in the case of the ER-49 than in the case of the 230 type. Fourth, the maximum power output with the same driver tube is about twice that of the 230 type of tube. The no-signal battery drain is about the same in each case and the efficiency of the output stage is about the same for the same power output. Thus the 49 output stage gives better driver voltage sensitivity than the 230 output stage and in addition offers a means of obtaining approximately twice the maximum power output for the same circuit conditions.

*Engineer, Raytheon Production Corpn.

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The ER-49 tube was designed for Class B operation in 2-volt radio receivers.

Rating and Characteristics

Filament voltage	2.0 volts
Filament current	0.12 amp.
Bulb	S-14
Base	Medium 5 prong
Overall length	4-11/16" (max.)
Diameter	1-13/16" (max.)
As Class B Amplifier:	
Plate voltage	180 volts (max.)
Grid bias (both grids)	0
Plate current at zero signal (two tubes)	4 ma.
Optimum load resistance (per tube)	3000 ohms
Optimum load resistance (plate to plate)	12,000 ohms
Power output (two tubes)	3.5 watts
Peak plate current (per tube)	50 ma.
As Class A Amplifier:	
Plate and outer grid voltage	135 volts (max.)
Grid bias (inner grid)	–20 volts
Plate current	5.7 ma.
Amplification factor	4.5
Plate resistance	4000 ohms
Mutual conductance	1125 micromhos
Power output	170 milliwatts

The Ip-Ep curves of the ER-49 type of tube taken under class B conditions are shown in Fig. 1. The outer grid

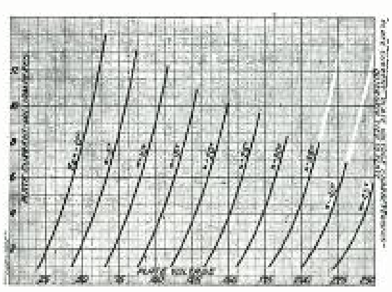
Fig. 2.

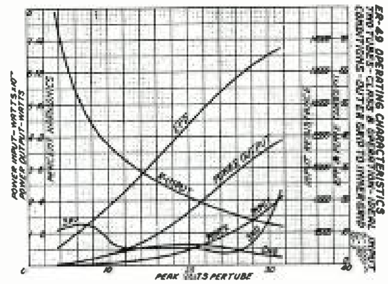

Fig. 3.

is tied to the control grid in this case. A load line of 3,000 ohms is shown drawn in this figure. The value of 3,000 ohms represents about optimum value as regards both power and distortion. It should be borne in mind that this is the load resistance per tube and the actual resistance from plate to plate should be four times this value or 12,000 ohms.

The Ip-Ep curves as a class A amplifier with the outer grid tied to the plate are shown in Fig. 2. The tube under these conditions has characteristics intermediate between a 230 and a 231 type.

The values of power output, power

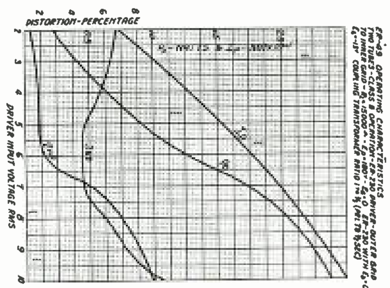

Fig. 4.

input, efficiency, input resistance and distortion are shown plotted in Fig. 3. The above quantities were measured under ideal conditions; that is, with a low resistance input transformer fed from a generator. The input power required to work this tube up to 32 volts input is considerably more than the 230 driver will deliver. The above conditions represent what could be obtained from the tubes if we had a driver tube which would deliver the required power.

A consideration of possible drivers showed that the 230 tube would be the only practical tube if B-drain economy were considered of prime importance. The results given later are for the case of a 230 driver. Results approaching those given for ideal conditions may be obtained by using a better power

(Concluded on page 34)

Modern production sensitivity measurement

By Richard F. Shea*

THIS article is intended as a discussion of the problems of production set testing, the common methods at present in use in plants of various sizes, and, lastly, a really up-to-date system which is both practical and accurate for manufacturing plants both large and small.

Generally speaking, there are two common methods of checking the sensitivity of production receivers. One, the comparison method, employs a standard set against which the production sets are checked. There may be a standard set permanently set up, and a switching arrangement employed so that either the standard or the set under test may be cut in at will, or some sort of attenuator may be used, and adjusted several times daily by means of a standard set, and passing limits set for output under these conditions. The chief advantages of this system are simplicity, low cost, and speed.

Comparatively little apparatus is required in these attenuators, and the problem of accuracy is not present, leakage does not bother the operator unless very bad, and to test a set it is merely necessary to put it on, and if the output reaches the passing level the set is acceptable.

There are several disadvantages in this system. One is the frequent necessity of checking the attenuator settings; another the possibility of error in these settings; still another the effect of variations in line voltage while adjusting the attenuators, and another is the effect of humidity on passing or rejecting the sets. Probably the most serious drawback to this system is the difficulty of checking trouble when it develops as there is no obvious indication of whether the oscillator output, the attenuator input, or the sensitivity of the set is off when there is an epidemic of rejects.

The other common system used at present is the signal generator system. This is most commonly used by the smaller manufacturers, those of them who use any apparatus for testing set performance. Obviously it is expensive for larger manufacturers, as it costs at least several hundred dollars to build signal generators, and this figure multiplied by ten or twenty becomes pretty considerable. The signal generator has one very distinct advantage, however, in that it gives the operator at all times a visual picture of what is going on. Fluctuations of oscillator voltage do not worry him, and, furthermore, the passing limits can be definitely tied up with laboratory sensitivity measurements without interpretation. Obviously the signal generator system would be of real value if it could be applied to large production. It is the purpose of this article to show how this can be done.

Practically all the larger companies at present use some variety of master oscillator system. There are several very distinct advantages in this. For one thing, there is considerable saving by being able to combine oscillators. By this means it is possible, using only three or four master crystal controlled oscillators to provide control for any production up to several thousand sets per day. This obviously means a great saving in time also, as these few oscillators can be checked very quickly. A big advantage is that we have absolutely the same frequencies at all test positions, thus insuring uniformity of scale adjustments, which is absolutely necessary where a calibrated scale is supplied, as is the case in most modern receivers.

Fig. 1 illustrates a representative production testing setup. For purposes of illustration only three oscillators, three test lines, and five attenuators per line have been shown. However, the principle is the same regardless of the number of units, up to the limit of the tubes, when it merely becomes necessary to increase the number of tubes.

Fig. 2 shows roughly the method of obtaining this hookup. A crystal oscillator is used for each desired frequency, and its output is fed to a buffer amplifier, thus preventing any change in line load from reacting on the oscillators. The output transformer of the buffer amplifier is so arranged that it will supply excitation to the line amplifiers through the step-down transformers, the step-up transformers at the other end, and the transmission lines between the master amplifiers and the line amplifiers.

The audio modulation is inserted in the plate circuit of the buffer tube as shown in Fig. 2, thus avoiding frequency modulation. This audio source may be any conventional audio oscillator customarily operating at 400 cycles and with sufficient power to modulate the signal to the desired amount, usually thirty per cent.

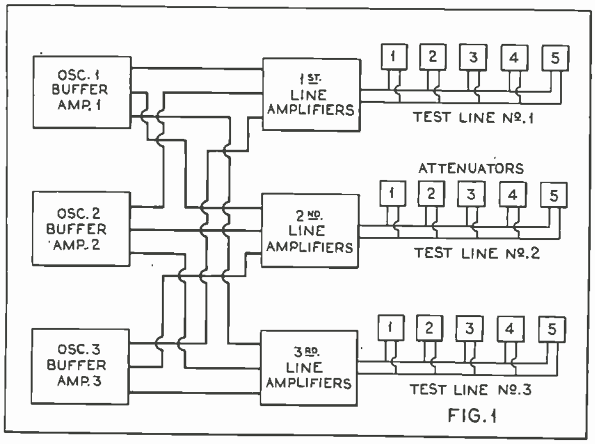

Fig. 1. Typical production test setup.

Each master oscillator buffer amplifier unit has a transmission line running to each line amplifier on each test line, and each line amplifier unit has a line coming into it from each master oscillator position. Thus in our illustration each oscillator unit will have three transmission lines leaving it, and each line amplifier will contain three amplifiers, each excited by one of the master oscillator units.

On the output side of the line amplifiers there are coupling transformers, stepping down into the impedance of

*President, The United Radio Laboratories.

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Detail description of receiver testing equipment suitable for large or medium size radio manufacturing plants.

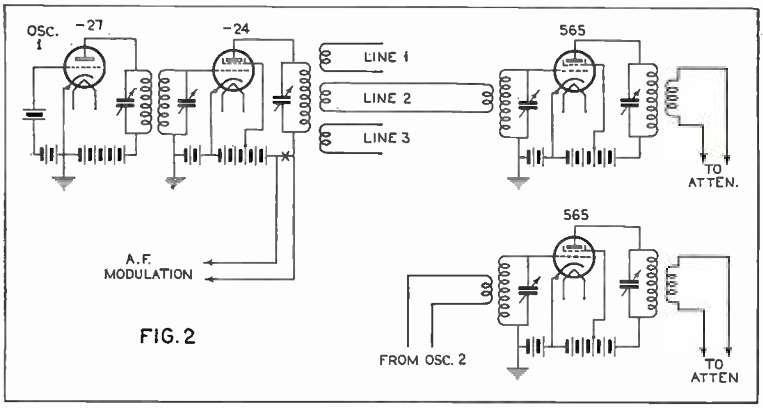


Fig. 2. Details of test system.

the lines to the attenuator boxes. The output windings of each tube are connected as shown, and thus the transmission lines running to the attenuator boxes contain three sets of lines, each carrying one of the test frequencies.

Functioning of Test System

Referring to Fig. 3 the manner in which these three different frequencies are fed into the attenuator boxes may be noted, and the method of selection and attenuation. The switch, S, is cam actuated, which at one and the same time removes the desired input lead from its 100 ohm load and connects it to the compensated potentiometer, leaving the other input lines still grounded through 100 ohms. Thus if our three frequencies are respectively 600, 1000 and 1400 kc., we connect the 600 kc. line to the potentiometer first, leaving the other two grounded through their resistances, then the next position on the selector switch connects the 1000 kc. line in, and the third position shifts to the 1400 kc. line. This potentiometer is a duel affair so arranged that the input resistance is always very nearly 100 ohms, regardless of its setting.

The attenuator has an input of 40 ohms, and the meter about 125 ohms, so that the effect of moving these resistances up and down the potentiometer must be compensated for. By means of the cam switch and the compensated potentiometer the impedance across the line is always 100 ohms, thus preventing variations in the voltage at other positions when any other one is being used.

Required Voltage

In modern production set testing it is necessary to have available a maximum voltage of at least 2 volts to check overload, and also when automatic volume control is used. This attenuator system is designed to provide about four volts maximum, but is limited to a maximum meter reading of 3.2 volts. This, however, is ample to test any modern set. However, in order to obtain this voltage we must supply about 6 volts to the attenuator box terminals, and as the input resistance is 100 ohms this requires about one-third of a watt input power. The number of positions is the determining factor dictating the choice of tubes for the line amplifiers.

As shown in the drawing of Fig. 2 the type 565 tube is recommended for this purpose, and it should be possible to handle ten to fifteen or even more test positions from this tube. If more test positions are needed than can be handled by one 565 it becomes necessary to increase the number of 565 tubes at each test position.

Regarding transmission lines, various concerns have different preferences for this feature. Some use double flat strip, some use sheathed cable. The writer has found sheathed cable, using double conductor, the sheath being grounded at the oscillator end, the ground conductor being grounded at the amplifier end, to be quite satisfactory. However, in addition to this it is usually necessary to use shielded booths, particularly if the extraneous disturbances are bad, and for best results double shielding is best, with absolutely no connection between the two shields. It may also be necessary to employ line filters using shielded transformers, and low resistance filters, to reduce interference coming along this carrier.

The proper impedance at which to work the various transmission lines depends upon the terminations and the length of the lines. Also, if too high impedance lines are used the trouble of extraneous noise pickup becomes aggravated. In some locations transmission lines may very satisfactorily be worked into terminations of several hundred ohms, but it will usually be found in practise that the highest practical impedance is about one hundred ohms. If the impedance becomes too low the difficulties due to standing waves become important. The best solution to this problem is found by individual experimentation.

Attenuator Construction

Regarding the construction of the attenuator proper, Figs. 3 and 4 give the details. Fig. 4 shows the panel layout, and Fig. 3 gives the resistance values and wiring details. The meter is a 0-8 milliampere thermocouple, calibrated as 0-16 microvolts, similar to those used in General Radio signal generators. This meter must be filtered, the filter not shown in Fig. 3, for simplicity. The filter must be made up for that individual meter, and the meter calibrated with the filter.

The attenuator box is divided up into several shielded compartments. The lowest contains the frequency selector switch, and the 100-ohm resistances. Above that comes the dual potentiometer, likewise in a shield. Then the meter, and lastly the attenuator proper. The attenuator is divided into two sections, as illustrated in Fig. 3, thus providing double shielding. The section marked B in the drawing is in the inside shield, next to the panel, and this also encloses the antenna and ground posts; the other half of the attenuator, section A, is outside. The switch taps

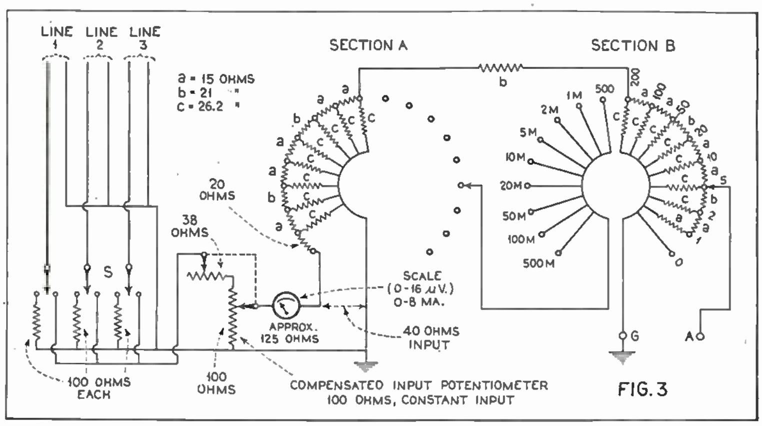
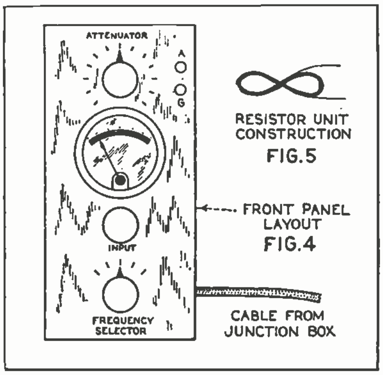


Fig. 3. Circuit details.

are mounted on bakelite panels, with the resistance units mounted directly between the taps, and the ground bus is also carried on these panels. Fig. 5 illustrates the method of constructing these resistances. Two pegs are driven in a board, and the resistance wire is doubled up and wound around these pegs, making a very compact bifilar winding. The whole unit can be made about one half inch long, and mounts nicely on its own leads. After winding, it is bound at the center with thread, and shellacked.

In order to reduce ground drops the common grounds in each compartment are insulated from each other, and are brought individually to chassis at the ground output terminal.

To avoid panel current the apparatus is mounted on a subpanel, which is insulated from the front panel, except at the ground post. In the installation in the test booths, the attenuator box is set into the wall of the booth, so that the front panel is flush with the wall of the booth. The cables from the test amplifiers to the attenuator box are grounded to the ground post also, thus providing a strictly one point ground. The cables fit into the attenuator box by a pipe fitting, and make contact with the internal wiring by means of spring contacts. Thus the attenuator boxes are easily removable by loosening the cable attachment, and removing the whole panel from the wall. This construction thus is very convenient and compact, and replacement units may be made up quite inexpensively, and kept for emergencies. This is a very distinct improvement over the individual signal generator system. The front panels are of heavy aluminum, painted black, with crystalline finish, and present an attractive appearance.



Figs. 4 and 5. Panel layout.

Number of Test Positions

For small manufacturers who do not need more than ten or fifteen test positions the line amplifiers at the test positions may be eliminated and the attenuators fed directly from the buffer amplifiers, by substituting 565 tubes for the 224s, and increasing the excitation from the oscillators. This is a considerable saving, even over individual signal generators, yet has all the advantages of the latter.

At the master oscillator positions there should be indicating lights to show that everything is working properly, and each standard oscillator should be properly metered to indicate the correct output. In this respect it is proper to emphasize here the importance of an accurate indicator of percentage of modulation. It must be borne in mind that the readings on the attenuator meters are proportional to carrier, also the output of the receiver to carrier and per cent of modulation, consequently unless a frequent check is made on the per cent of modulation there may be an epidemic of rejects, without an obvious reason. Probably the simplest method of measuring this is by means of a Weston modulation meter, but it is also easy to obtain satisfactory results by maintaining the plate voltage and imposed audio voltage at a constant figure. Tube voltmeter methods may also be used.

Also, it will be found of prime importance to use regulators, either electronic or magnetic, to maintain constant voltage on the oscillators and amplifiers, in order that the operators in the test booths will not find it necessary to be constantly manipulating their controls. However, the fact that the operator has a visual indication before him of his input alleviates these effects.

The system described in this article has been satisfactorily applied to production testing in one of the largest radio manufacturing establishments. The principles are equally adaptable whether the production reaches three thousand a day or three hundred, and it is felt that the system herein described will be found valuable to large and small manufacturers alike, and will give them consistent and accurate results at comparatively low outlay.

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DUKE M. PATRICK NAMED GENERAL COUNSEL OF FEDERAL RADIO COMMISSION

DUKE M. PATRICK, who has been serving as assistant general Counsel in charge of court cases since January 27, 1930, has been appointed general counsel of the Federal Radio Commission as successor to Colonel Thad H. Brown, who has taken office as a member of the Commission representing the second zone.

For about a year Mr. Patrick practiced law in Lafayette, Ind., and until his appointment to the Commission practiced law in Indianapolis. His legal associate in Indianapolis was a member of the Public Service Commission of that State. Mr. Patrick's experience as a practicing attorney before coming to the Commission was largely that of handling rate cases before the Public Service Commission and the trial of such of these cases as have been taken to the State and District courts.

Mr. Patrick, under the supervision of Col. Thad H. Brown, general counsel, participated in nineteen appeal cases and in the vast majority the Court upheld the decisions of the Commission. In those cases the Court has passed upon vital radio issues, clarifying the Radio Act, as amended, and indicating the broad powers of the Commission.

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AUTHORS WANT MORE FROM BROADCASTERS

AN increase of more than 300 per cent in the license fees assessed against broadcasting stations for the use of copyrighted music is proposed by the American Society of Authors, Composers and Publishers, it was disclosed on April 16 by E. C. Mills, general manager of the society. The terms of the proposal, submitted to the National Association of Broadcasters, would provide a 5 per cent fee on the gross income from commercial non-network programs in addition to a sustaining license fee approximately equivalent to the toll exacted under the present system of assessment.

The terms of this new "yardstick," which Mr. Mills described as an "economic emergency measure," would become effective on June 1. The present system of flat assessments is based upon station power, radio population and service area coverage, Mr. Mills explained.

In the case of network programs, the 5 per cent on gross receipts would be payable by the key stations, two or more stations simultaneously broadcasting the same program being considered as a network.

The society derived approximately $933,000 from its present system of flat assessments on broadcasting stations during 1931, Mr. Mills said, and plans to exact that revenue as a "sustaining" charge in addition to increasing it with the 5 per cent tax. The total time sold to clients on the air last year brought the broadcasting stations between $50,000,000 and $60,000,000, Mr. Mills pointed out. Based on the $50,000,000 figure, with the new system of license fees in effect, the society would derive annually approximately $2,500,000, in addition to the $933,000 required as the "sustaining" license fee.

Electrolytic condensers for the transmitter

By WILLIAM MASON BAILEY*

High capacity values obtainable at low cost and with splendid results if simple precautions are observed by user

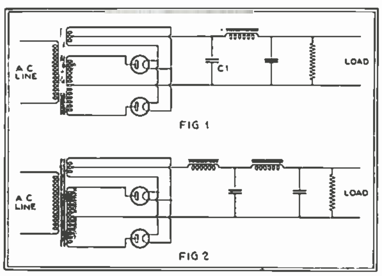
THE economical capacity inherent in the electrolytic condenser may be applied to the rectifying end of the amateur and to the professional transmitter provided due precautions are observed. In fact, for the past two years electrolytic condensers have found a place in transmitting radio work, and splendid results have been obtained by users fully acquainted not only with electrolytic condenser technique but also with the operating voltages dealt with. Hence a few notes at this time may prove well worthwhile.

There are in general use only five voltages employed in experimental practice, namely, 600, 1,000, 1,500, 2,000 and 2,500 volts, as delivered *to the load.* A condenser in order to be suitable for such applications should be capable of withstanding these operating voltages without any sputtering or similar troublesome phenomena. Since for the present the available radio electrolytic condensers are limited to a working voltage of 500, it is obvious that two or more units must be wired in series to obtain the necessary working voltage. Also, in series operation the effective capacity is represented by the capacity of a single unit divided by the number of units in series. Thus with three 500-volt units wired in series to operate in a 1,500 volt rectifier circuit, the capacity required is a third of 15 ufd. or 5 ufd.

The difficulty usually experienced with condensers of any type when employed by experimenters may be traced to lack of knowledge regarding actual working conditions as well as the limitations of the condensers. For this reason the user should make sure that he knows definitely the peak or surge voltages that obtain in the circuit, and that these extreme voltages are fully matched by the working voltages specified by the makers of the condensers employed. Unfortunately, the voltmeter inserted in the rectifier circuit does not always indicate the correct operating voltage, due to circuit peculiarities. The actual peak voltage may be considerably higher, placing a severe strain on the condensers.

There are two classes of rectifying circuits in common use, shown in the accompanying diagrams. Fig. 1 illustrates the circuit most commonly used by experimenters, since this type of circuit will deliver a somewhat higher voltage for the same load and transformer voltage. The use of such a circuit especially with the now universally used mercury-vapor rectifiers places an enormous overload on the rectifiers and condensers. The untrained constructor usually blames both tubes and condenser manufacturers, not realizing that the condensers may be operating at a voltage much higher than the meter usually associated with such equipment would indicate.

The circuit shown in Fig. 2 will increase the life of the apparatus considerably and, at the same time, provide much better regulation. Drawbacks to this circuit are the slightly higher transformer voltage required as well as the additional choke.



Figs. 1 and 2.

For the present, the standard 500-volt electrolytic condenser units are available. If the recently improved and refined units are employed within their rated working voltage, there should be no sputtering or other troublesome effect. The main point is to use a sufficient number of units in series, properly wired with regard to polarity, employing one additional unit in series so as to come somewhat below the maximum working voltage of each unit. Such a safety factor pays in reliability as well as long service life.

TABLE I
RECOMMENDED USE OF ELECTROLYTIC CONDENSERS

Maximum D-C. volts	Number of series units 500-volt type	Capacity using 8 ufd. units
600- 800	2	4.0
850-1,200	3	2.6
1,250-1,600	4	2.0
1,700-2,000	5	1.6
2,100-2,500	6	1.3

The low cost of electrolytic condenser capacity, even when the capacity is but a fraction of the unit capacity due to wiring in series, makes it possible to employ a liberal amount of capacity in the filter circuit of the rectifier end of the transmitter, thereby securing an exceptionally smooth output so desirable for radio telephone work. In time this application may lead to special electrolytic units designed for higher operating voltages, but for the present the standard units already available are highly economical.

*Chief Engineer, Dubilier Condenser Corporation.

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FADA RADIO INCREASES PRODUCTION

Announcement has been made by Mr. Frank A. D. Andrea, president of the Fada Radio and Electric Corporation, Long Island City, that approximately 200 employees have been added to the payroll and that with continued evidence of increased buying power as recently experienced by the corporation, between 1200 and 1500 workmen may be added to the Fada payroll by Fall.

This indication of increased business has been received by business executives as indicating a decided trend for improvement and has increased considerably enthusiasm and industrial undertaking in all sections.

Mr. Andrea states that "the increase in orders pouring into the Fada factory from all parts of the United States as well as from export trade seems to indicate that we are entering upon a successful radio year.

"Production is being built up correspondingly and the company is operating on a profitable basis."

A tube for class B amplifier service†

New '46 tube is so constructed that its two grids may be connected in the circuit to make the tube applicable either to the output or the driver stage of a class B amplifier

IN the application of the type 46 tube to a-c. operated receivers, there are certain points in the design of the circuits which require careful consideration. The characteristics of plate load, input transformer, and B-supply are all inter-related. The particular values of certain constants in these circuits will depend upon the objects of the designer. The cost of parts permissible for a given design and the amount of output required will in general influence the choice of certain circuit constants. These constants will in turn determine suitable values of the related constants.

An understanding of the circuit relations are important for the proper use of the tube. These relations can be most readily explained by considering the fundamental characteristics of the tube.

The general method of calculating circuit constants is first briefly outlined. Certain simplified curves and relations are then given. An example illustrates the use of these.

A simple method for designing the audio-frequency class B amplifier is to design the input transformer with sufficient stepdown ratio to make the impedance of the source of driving power plus the transformer impedances appear as an impedance in the grid cuicuit which is negligible in comparison with the internal grid resistance (roughly 1,000 ohms) of the tube. With this arrangement and a source of driving power which is limited, the voltage on the grids of the class B tubes is limited. For a limited grid voltage on the class B tubes, the power output will be greatest for a plate load which causes the greatest value for the product of plate voltage and plate current swing.

Fig. 1 represents the I_p-E_p curves of of the tube. A signal of amplitude E_c will swing the plate current from E_B to the E_c curve. Load line 1 represents a value of load resistance too low for maximum power output, since the plate voltage swing is too small. Load line 5 represents a value of load resistance too high for maximum power, since the plate current swing is reduced. Load line 4 represents the load resistance for which the product of plate current and plate voltage swing is a maximum and hence the maximum power output. Load line 3 represents a load resistance less than load line 4. The distortion for load line 3 is appreciably less than for load line 4. The distortion with load line 4 occurs because plate current for successive values of E_c does not increase in proportion to E_c. For signal amplitudes appreciably less than E_c load line 4 would be satisfactory. In fact at reduced signal levels the plate circuit distortion is less and the power output greater for load line 4 than for load line 3. The difference is, however, not great so that the load chosen for maximum power output with say 5 per cent overall distortion, will give equally good performance throughout the lower range of signal levels.

For the maximum signal voltage of amplitude E_c the load line 3 gives less distortion than any other load either higher or lower.

Since the tube is operated with zero bias voltage, the different positive values of grid voltage correspond to the signal voltage effective on the grid of one tube at various instants throughout the half cycle for which this grid is positive. The plate current cutoff occurs at a very small value of negative voltage. The negative voltage variations on the grid of one tube are positive voltage variations on the grid of the companion tube. A small region of overlapping of the characteristics of the two tubes permits the transfer of load from one tube to the other without appreciable distortion.

The lower the power of the driving source and the smaller the maximum signal voltage delivered to the grids of the class B tubes, the larger the value of load resistance required for maximum power output with minimum distortion, and vice-versa.

The discussion so far has been entirely regarding the plate circuit, when a certain maximum signal voltage can be delivered to the grids. It was assumed that the impedance in the grid circuit was so small that the voltage drop caused by the grid current flow

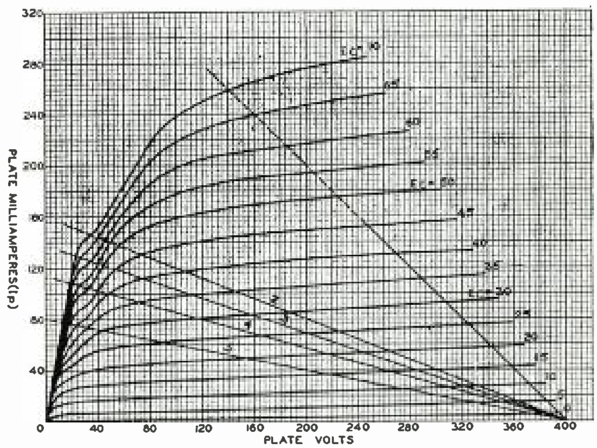

Fig. 1. Average plate characteristics, class B operation.

RCA Radiotron RCA-46; Cunningham C-46.

Load Line	Resistance Load	Load Line	Resistance Load
1	1600 ohms.	4	3500 ohms.
2	2500 ohms.	5	5000 ohms.
3	2900 ohms.		

E_f = 2.5 volts a-c.

†*Technical material prepared by R. C. A. Radiotron Co., Inc. and E. T. Cunningham, Inc. engineers.*

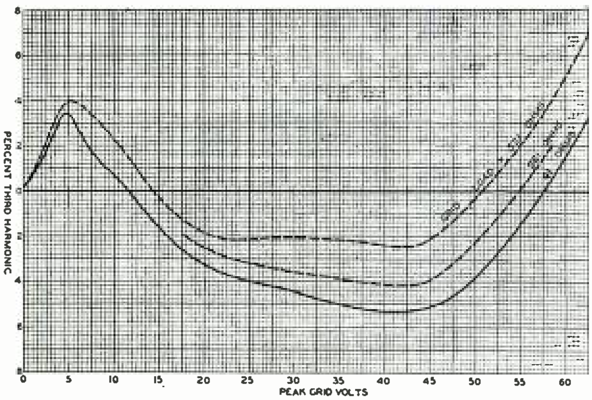

Fig. 2. Average Operation Characteristics, class B operation.
RCA Radiotron RCA-46; Cunningham C-46.
E_f = 2.5 volts a-c. Plate volts = 300.
Resistance load (per tube) = 1200 ohms.

through this impedance was negligible in comparison with the applied grid voltage. Practically with a limited source of driver power it is necessary to allow some impedance in the grid circuit.

There is a factor which has an appreciable effect in determining the load which will produce greatest power output for a given amount of distortion. With a resistance in the grid circuit the third harmonic distortion due to the upward curvature of the grid current curve appears in the plate circuit in opposite phase to the distortion caused by the upward curvature of the plate current curve. Fig. 2 shows the distortion measured with resistances of 41 ohms, 221 ohms, and 521 ohms in series with each grid lead. An appreciable reduction in distortion results from the resistance in the grid circuit. It should be noted that leakage reactance will shift the phase and prevent cancellation of the distortion voltage developed in it. Also the impedance of the leakage reactance is higher to higher frequencies. A low value of leakage reactance is required in the grid circuit to avoid excessive amplification of small amounts of higher frequency distortion components.

The use of an input transformer with less step-down ratio to the grids, and with close coupling between primary and secondary will reflect the plate resistance of the driver as a greater resistance in the grid circuit. The resulting grid distortion will cancel part of the output plate distortion. For example, if the third harmonic in the grid circuit is 3.5 per cent, load 3 will give +3.5 per cent third harmonic in the output, while load 2 will give +1.2 per cent. A value of load near load 2 would then give greatest output with minimum overall distortion. At the points of zero third harmonic there is a small percentage of fifth harmonic plus the driver tube second harmonic so that the total output harmonics is not zero. Less step-down ratio will also cause the grid resistance of the class B tubes to be reflected in the plate circuit of the driver tube as a lower load resistance. More power is obtained with a lower load resistance in the driver plate circuit but the second harmonic distortion from the driver is increased.

For an overall distortion of 5 per cent total harmonics, usually not more than 2 per cent of second harmonic can be tolerated from the driver tube. This usually requires a load resistance on a triode driver tube of three to four times the plate resistance of the tube. A load somewhat lower can be used with a push-pull driver.

Fig. 3 shows the load line for the grids of the type 46 class B tubes (and transformer losses) reflected on the plate characteristics of a type 46 tube operated class A as the driver tube. The load line is curved due to the curvature of the grid current characteristic.

In this case the plate voltage on the class B tube was 300 volts and the output load resistance from plate to plate was 5200 ohms. The input transformer ratio from primary to one-half the secondary was 2.44 to 1.0. The dotted line in Fig. 8 represents the load resistance determining the peak output power delivered to the primary of the transformer. In this case the dotted line represents a load of 7250 ohms or 3.0 times the plate resistance of the tube. The dotted line might have been assumed for the purpose of calculation. The peak power for the extremes of this line multiplied by the permissible peak power efficiency for the transformer gives the amount of the peak power available at the grids of the class B tubes. From the amount of peak power and the I_c-E_c characteristics, in conjunction with the I_p-E_c or I_p-E_p characteristics, a suitable load resistance for the class B tubes can be chosen.

The choice of output load as outlined above is for maximum power output with a limited amount of distortion. It is conceivable that other factors might influence this choice such as too much leakage reactance in the input transformer. This could, for example, be overcome by a higher step-down ratio if the driver tube could supply a sufficiently great voltage swing. The output load might then be chosen for the maximum power with a given amount of distortion remembering that very little grid distortion would be produced with which to cancel plate distortion.

Another factor which might influence the choice of output load would be the

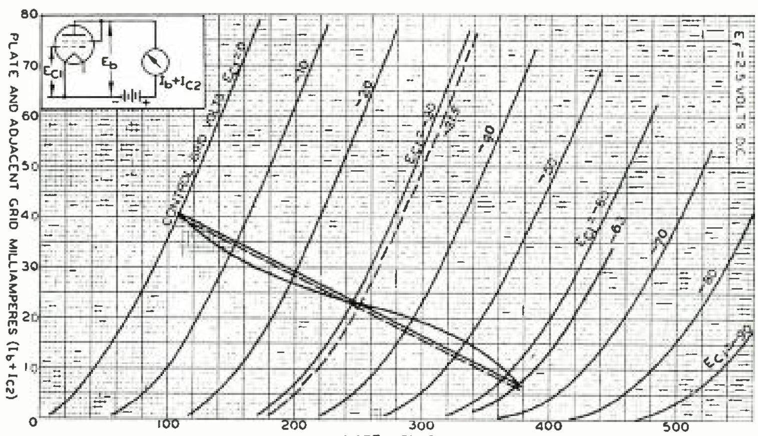

Fig. 3. Average Plate Characteristics, class A operation.
RCA Radiotron RCA-46; Cunningham C-46.

amount of peak current which the B-supply could deliver. High peak currents pulsating at an audio-frequency rate are required from the B-supply. A specially designed B-supply is necessary. The use of a higher output load resistance reduces the peak currents required from the B-supply. With a poorly designed B-supply the voltage fluctuations caused by high peak currents might be great enough to cause instability in other circuits of the receiver. These are all problems which are of more or less importance depending upon the magnitude of these effects in the particular design.

In order to facilitate the choice of plate load which will give maximum power with approximately 5 per cent total distortion, curves have been made showing the approximate value of the plate load, power output, and peak grid resistance versus peak grid power. The curves are shown in Fig. 4.

The peak grid power is equal to the product of maximum instantaneous grid voltage and maximum instantaneous grid current.

The plate load per tube is one-fourth of the load resistance effective from plate to plate of the output tubes.

The power output is the average watts output for the two tubes.

The peak a-c. grid resistance is defined here as the ratio of the maximum instantaneous grid voltage to the maximum instantaneous grid current. This

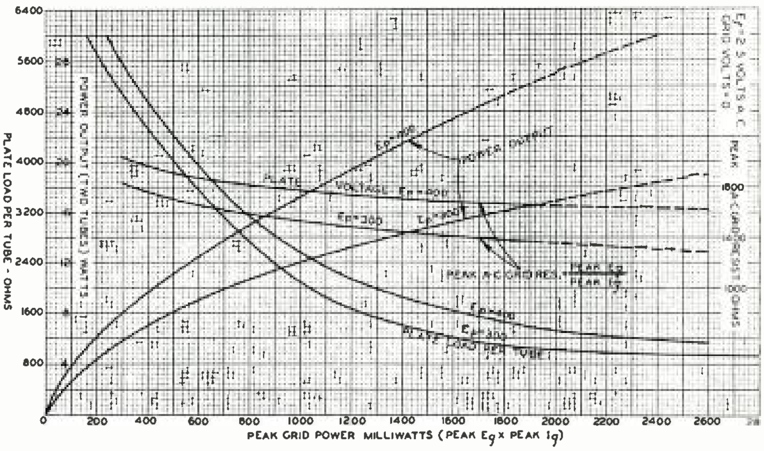

Fig. 4. Optimum Operation Characteristics, class B operation. RCA Radiotron RCA-46; Cunningham C-46.

quantity is convenient for use in calculating the input transformer characteristics.

An example will illustrate the use of these curves. Consider one type 46 tube operated class A as the driver. The plate voltage is 250 volts, and bias —33 volts. The peak power output of the driver is found by drawing a load line through this point on the I_p-E_p characteristics of the tube. For a single triode the load line should represent a resistance of three to four times the plate resistance of the driver tube to assure sufficiently low distortion.

It is only necessary to divide the total plate voltage swing and the total plate current swing each by 2 then multiply these together and the product is the peak power output of the driver. For convenience a table of values of plate load and peak power output are shown. The values shown are those found to give approximately optimum performance for the different types of tubes driving the type 46 tubes. From the table we find for one type 46 tube at 250 volts, the driver peak plate load is 8000 ohms and the peak power output is 2.15 watts.

OPTIMUM DRIVER OPERATING CONDITIONS

Type	Plate Voltage	Bias Voltage	Peak Plate Load** Ohms	Peak Power Output*** Watts
1-27	200	—15	23000	0.50
1-27	250	—21	21000	0.92
1-45	250	—50	8000	2.50
1-46	200	—24	9000	1.15
1-46	250	—33	8000	2.15
2-27*	250	—21	16000	2.00
2-45*	250	—50	16000	5.0
2-46*	250	—33	15000	4.5

* Push-pull.
** Maximum peak a-c. plate voltage divided by maximum peak a-c. plate current.
*** Maximum peak a-c. plate voltage times maximum peak a-c. plate current.

Suppose the transformer efficiency q is 80 per cent (peak power efficiency). The available peak grid power is (.80 x 2.15) = 1.72 watts. On the curves of Fig. 9 we find for E_B 300 volts and peak grid power of 1.72 watts the plate load of the class B tubes should be 1110 ohms per tube. This means the load from plate to plate should be (4 x 1110) = 4440 ohms. The power output curve shows the power output from the two tubes is 15.7 watts.

On the curve for peak a-c. grid resistance we read 1390 ohms. This is an instantaneous resistance value corresponding to the ratio of the maximum peak grid voltage to the maximum peak grid current. The equivalent resistances of the transformer losses should be added to the peak grid resistance to get the total load effective on the driver.

The resistance equivalent of the transformer losses is represented by a T-network having primary and secondary resistances as the series arms and the equivalent core loss resistance as the shunt arm.

Fig. 5 shows the peak grid resistance R_g and the resistance equivalent of the transformer losses reflected in one half of the secondary winding. Since the secondary load consists of the grid of one tube and alternates from one half of the secondary winding to the other half on alternate half cycles, it is only necessary to consider the relations between primary and one half of the secondary.

The secondary copper resistance (one half) is represented by r_2. The core loss equivalent resistance in one half of the secondary circuit is R'_o. The primary copper resistance equivalent in one half of the secondary circuit is r'.

(The leakage reactance should be small enough to be negligible. The primary inductance should be as high as that for a transformer working into no load, as the grid resistance is high for small signals). The combined resistance of the transformer and the peak grid resistance of the tube should be re-

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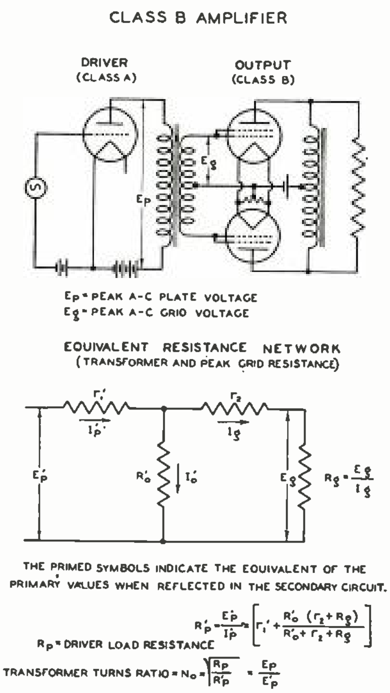


Fig. 5.

Elastic stop nut applications in the radio industry

By HAROLD B. THOMAS*

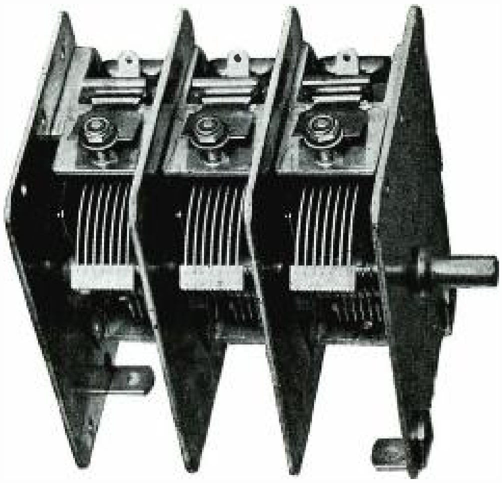


Fig. 3. Variable condenser. All trimmers using No. 6/32 elastic stop nut.

THE increasing use of elastic stop nuts in radio manufacturing makes a description of this lock nut, with an explanation of its principles and a summary of its uses, of particular interest at this time.

Inventors have doubtless burned much midnight oil in seeking means for keeping nuts tight. An indication of the study that has gone into this problem is grasped from the knowledge that the patent office has registered over seven thousand patents on lock nuts.

The elastic stop nut is the invention of Gustaf Rennerfelt, of Stockholm, Sweden. It was originally designed for use on heavy vibrating equipment such as rock drills, etc., but once in production the principle was found to work equally well regardless of size.

The elastic stop nut resembles an ordinary standard nut increased in height to permit the insertion of a fibre collar. Aside from the increased height, and the presence of the fibre, elastic stop nuts are identical with common nuts in thread value, form, pitch and fit.

The unthreaded fibre washer incorporated into the top of the nut is securely held in its recess and kept from turning, by rolling in the end of the nut under considerable pressure. The inside diameter of this washer is smaller than the outside diameter of the bolt.

*Engineer, A. G. A. Company.

Why It Locks

Before the bolt enters the fibre washer, the stop nut has all the shortcomings of the common nut. There is the usual play between the nut and bolt threads corresponding to that found in ordinary commercial fits. (See Fig. 1.)

As the bolt meets the unthreaded fibre collar, there is a point of momentary resistance to its further upward movement. After this pressure has reached its maximum, the bolt impresses its way through the fibre ring without cutting any chips, but creating a 100 per cent full thread and an airtight fit. There is considerable outward compression of the fibre after the bolt has passed through.

Once the bolt is through the fibre collar (Fig. 2), the upper side of the nut threads are passed into contact with the lower sides of the bolt threads. These are the same sides which carry the load if the nut is drawn home against a support. This total elimination of play between load carrying thread sides creates a gauge tight fit kept in that position regardless of vibration so long as the bolt is through the fibre collar.

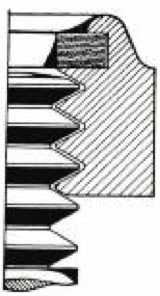
When the nut is drawn home against a support, it is the metal threads that carry all the load, no load whatever being taken by the fibre.

Special Quality Fibre

It might appear that the weak part of the nut is the fibre. However, such is not the case, for the fibre used is of special quality, the general properties of which are not well known. It is true that ordinary fibre when free will absorb 25 per cent moisture and swell, but the fibre collar in the nut herein described is so compressed and so little exposed that neither moisture nor total immersion in water have any effect whatever on it.

In addition, it is treated to retain its normal moisture content. It will not crystallize under severe vibration, is insoluble in ordinary solvents, will resist atmospheric conditions better than other materials, such as steel (painted or galvanized), and will not disintegrate or be injured by contact with alcohol, petroleum, gasoline, etc. Extremes in weather conditions have absolutely no effect on this fibre and it may be used where the temperature does not exceed 275° F.

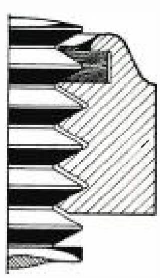
The fibre collar has a very desirable elastic nature which makes it possible to use the nut repeatedly with no loss in locking efficiency. The bolt does not take out a chip when passing through the fibre but depresses its way through



BEFORE

Before the bolt reaches the unthreaded fibre collar, the threads of an Elastic Stop Nut correspond to the threads of a standard nut and act in the same way. Note the play on both the upper and lower sides of the bolt threads. Such play is inevitable where auxiliary locking devices such as lock washers, cotter pins, etc. are used. Nuts back off because of this play between the two units

Fig. 1.



AFTER

As the bolt reaches and passes through the fibre collar, it forces the nut upward until all play is eliminated and the thread flanks are pressed in permanent contact. This contact causes considerable metallic friction which is increased as the nut is drawn home.

No relaxation of this upward pressure can take place as long as the bolt remains in the fibre collar.

Thus, commercially threaded nuts and bolts are forced into gauge tight fits.

Fig. 2.

instead. This elastic property further causes the fibre collar to grip harder on its bolt as vibration increases. This is due to the vibrations facilitating the inward movement of the fibre, thus causing it to wedge its way into the unevenesses of the bolt thread flanks, creating a suction tight fit.

These stop nuts were first manufactured in this country in the early part of 1927. Standard designs were made for U. S. S., S. A. E. and A. S. M. E. thread systems. Nuts made to these designs were first made experimently and placed in service on many kinds of vibrating mechanical equipment.

Radio Uses

Radio manufacturers are using elastic stop nuts for miscellaneous applications on sets, including use for adjustment purposes, holding terminal connections and for holding the structure, etc.

R. C. A.-Victor Company was the first radio manufacturer to adopt these nuts. They were first applied on special apparatus such as aircraft receivers, being used with screws instead of the soldered connection.

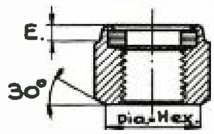


Fig. 4. Cross section of elastic stop nut.

Later that company standardized use for maintaining the adjustment of the trimmer plate on variable condensers (see Fig. 3). As the nut was to be used wholly for adjustment purposes without carrying any load, a special thin nut was designed for that purpose.

It was found that these nuts were ideal for this application. Inasmuch as this lock nut stays fixed at any adjusted position along the threaded length of the screw, its use for trimmers and balancing condensers has become standardized throughout the industry.

Manufacturers in the special apparatus radio field have learned there are advantages in using elastic stop nuts in the construction of equipment, aside from the dependability of the device as a lock nut. The single unit feature is a distinct aid to faster assembly. The stop nut held terminal connection is more readily taken down in field servicing than the soldered joint. The elimination of staking screws shows time saving and permits faster disassembly when necessary. The fibre collar effectively seals both the nut and screw threads from corrosive influences.

Microphonic Noise Eliminated

The use of rubber cushion mountings in general industry is spreading and this is true in the radio field as well. The use of nuts for fastening frames to cushion mountings is proving successful because of the nut locking to the bolt independently of whether drawn home or not. On such applications particularly the total absence of play between bolt and nut eliminates the possibility of microphonic noises that might result were a standard nut used.

Elastic stop nuts may be used in the construction of radio apparatus for both army and navy under the specifications put out by those services.

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PROPERTIES AND APPLICATIONS OF NICKEL ALLOY THERMOCOUPLES

A PAPER contributed to the Jubilee volume of the *Siebert Platinschmelze* contains a considerable amount of data on base and precious metal thermocouples. The information relative to nickel alloys is summarized as under:

"Curves are given showing the e.m.f. of iron/copper-nickel alloy couples for nickel contents between 0 per cent and 40 per cent; addition of small quantities of iron and manganese reduces only slightly the e. m.f. of the couple, but iron alone has a more marked effect. The conditions under which the alloys have been prepared also affect the thermoelectric properties, higher e.m.f. values being obtained for alloys melted in a carbon monoxide atmosphere than for those melted in a vacuum. The presence of iron in nickel-7 per cent chromium alloy wires alters the e.m.f. against pure nickel by an amount which is at a maximum at 600° C.; for the 5 per cent iron alloy the difference is 2 mv. against the iron-free alloy. A base metal couple comprising a positive wire of 12-3 per cent nickel and 87-7 per cent copper and a negative wire of 20 per cent nickel and 80 per cent copper gives, up to 900° C., an e.m.f. closely following that of the platinum/platinum-rhodium 10 per cent couple."

Emphasis is laid on the importance of adequate working and annealing, to secure homogeneity in base metal thermocouples.

W. GOEDECKE.—"On Thermocouples and the Reproducibility of Their Data. Criteria for Their Usefulness in Measuring Temperatures." *Festschrift zum 50-jahrigen Bestehen der Platinschmelze G. Siebert, G.m.b. H., Hanau*, 1931, pp. 72-99. (Abs. in *Jnl. Inst. Metals*, Feb., 1932, p. 94.)

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A TUBE FOR CLASS B AMPLIFIER SERVICE

(*Concluded from page* 18)

flected into the driver plate circuit as the peak plate load of the driver tube. The transformer turns ratio is the square root of the ratio of driver peak plate load resistance to the resistance equivalent of transformer losses and peak grid resistance.

For the example here the assumed transformer efficiency q equals 80 per cent. Considering the transformer losses distributed, so that (1) copper losses equal core losses, and (2) primary copper loss equals secondary copper loss, the power losses will be 10 per cent in the core, 5 per cent in the primary winding, and 5 per cent in the secondary winding.

The secondary winding resistance should be,

$$r_2 = R_g \left(\frac{1-q}{4\,q}\right) = 1390 \times .0625 = 87.0$$

ohms (one side).

The equivalent core loss resistance reflected in the secondary circuit should be,

$$R'_o = R_g \left[\frac{(3q+1)^2}{8q\,(1-q)}\right] = 1390 \times 9.05$$

$= 12{,}550$ ohms.

The primary resistance reflected in the secondary circuit should be,

$$r_1' = R_g \left[\left(\frac{1-q}{4q}\right)\left(\frac{3q+1}{3+q}\right)^2\right]$$

$= 1390 \times .05 = 69.5$ ohms.

The combined resistance of grid plus transformer losses would be,

$$\left[\left(\frac{(R_g + r_2)\,R_o'}{R_g + r_2 + R_o'}\right) + r_1'\right] =$$

$$\left[\frac{(1390 + 87)\ 12{,}550}{1390 + 87 + 12{,}550} + 69.5\right]$$

$= 1389.5$ ohms — equivalent in one-half of the secondary circuit.

The transformer turns ratio from primary to one half of the secondary should be,

$$N_o = \sqrt{\frac{8000}{1389.5}} = 2.40$$

The resistance of the primary should be,

$$(69.5 \times 2.4^2) = 400 \text{ ohms.}$$

The core loss equivalent resistance in the primary circuit should be,

$$(12{,}550 \times 2.4^2) = 72{,}300 \text{ ohms.}$$

Production testing of small power transformers

By R. M. Hukle, E.E.*

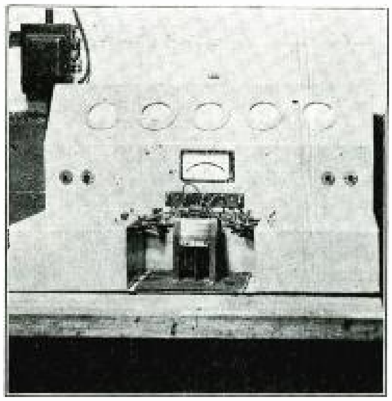

Fig. 2.

IN the manufacture of a product such as radio receiving sets and their associated equipment, it is essential that the various component parts meet certain requirements in order to assure satisfactory operation. These requirements make necessary accurate inspection processes.

One of the most important components of a radio receiving set is the power transformer. It is apparent that the satisfaction of the consumer depends to a large degree on the proper performance of this component. With this in mind, a power transformer test was designed to properly test all types of power transformers for radio receiving sets. In designing apparatus of this type, two controlling factors must be considered. First, the test must be complete and thoroughly applied, and second, cost of testing must be as low as possible. The tests applied are as follows:

1. Secondary no-load voltages measured with constant voltage on primary.
2. Leakage resistance and breakdown checked between successive windings, and also each individual winding and core with 1,500 volts a-c.
3. Shorted turns and breakdown between layers using 360 volts a-c., 175 cycles.

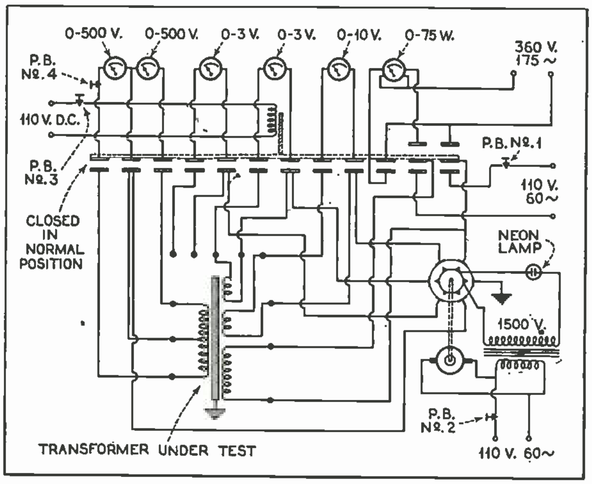

Fig. 1. Transformer test.

The majority of radio manufacturers purchase transformer coils and the lamination assembly operations are performed in their own plants. In view of this, it is necessary to design a suitable fixture to substitute for the actual laminations with which the transformer will operate. Fig. 3 shows a sketch of the fixture used. It consists of a stack of laminated steel cut in the shape of the usual E and I laminations. The core dimension is on the maximum tolerance and the window size is the minimum dimension for the particular transformer to be tested. Using this combination of dimensions, it is evident that any coil that can be placed on the test fixture is bound to meet the customer's requirements for size. The I's are bolted together forming one piece and tapered sufficiently so that a very snug fit results when they are forced into place with the heavy spring, as shown in the sketch. The spring is released or compressed by the foot lever so that when the operator's foot is removed from the lever, the stack of I's fits snugly into the same position each time.

Specially designed terminal connectors make the operation of connecting the leads a simple one. These connectors are fastened to the end of a fibre arm which is adjustable for any lead length. Hence when the various terminals are connected, they are at the same time measured for length.

Fig. 1 is a schematic circuit diagram of the complete test set, while Fig. 2 is a photograph of the tester showing the meter locations, push-buttons, etc.

After the transformer coil to be tested is inserted in the fixture and the leads are connected to the proper terminal connectors, the test is carried through by successively pressing the four push-button switches shown on the front of the tester, see Fig. 2. Switch number one connects the primary of the transformers to the line and secondary voltages are read on meters as indicated in Fig. 1.

The next procedure is to apply a breakdown voltage of 1,500 volts between successive windings and between winding and ground. This is accomplished by using a commutator arrangement rotated with a small motor. Breakdown and excessive leakage is indicated by a neon lamp connected in series with the breakdown voltage and windings under test. The neon lamp is used because of its extreme sensitivity to low currents. A good indication can be obtained through a resistance of 3 megohms. Push-button switch No. 2 connects the motor to the line, the motor rotates a commutator—thus applying the breakdown voltage. See Fig. 3.

After measuring secondary voltages and testing for breakdown between windings, the transformer is then given

*Coil Engineering Department, Anaconda Wire and Cable Co.

Performance of power transformers in radio receivers dependent upon inspection by proper test methods

an induced voltage test to test the insulation between turns and between layers of the windings. This test consists of applying 360 volts, 175 cycles to the primary of the transformer under test and measuring the no load watts under these severe conditions. A wattmeter, specially designed for this voltage and frequency, is used. One shorted turn in the high voltage secondary will give an indication of 1.5 to 2 watts above normal. A single shorted turn in any other winding of the transformer will give a greater indication, depending on the particular size wire.

When this test is applied, it is necessary, due to the high secondary voltage developed, to disconnect all meters from the secondaries. This is accomplished by the use of a specially designed 12 pole single-throw switch operated by an electromagnet. See Fig. 1. The switch is so arranged that when it is in the normal position, the voltmeters are connected to the corresponding secondaries and the primary is connected through the switch to the line; the primary circuit is open, however, due to push-button switch No. 1 being in series with the line. When push-button switch No. 3 is pressed, the electromagnet is energized and pulls the connecting switch to an open position, also the two blades connected to the primary make contact with two blades mounted above which are connected to the 360 volt, 175 cycle supply. When the test is completed, the push-button is released and the connecting switch falls back to its normal position.

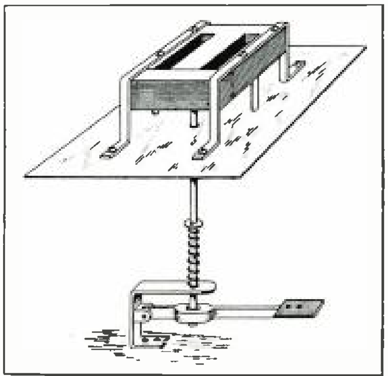

Fig. 3. Jig for transformer laminations.

The fourth push-button switch is used in conjunction with the voltage test to check the continuity of the secondary tap.

The flexibility of the testing device is brought about by the use of plug-in connections and removable fixtures. The plug-in connections make possible the connecting of any meter to any set of connecting terminals, and in so doing, takes care of the variation in lead locations due to differences in transformer design. The lamination jig is removable so that a jig can be inserted for any size transformer to be tested. Also, the location of the connecting terminals can be changed as previously referred to.

The actual time consumed in applying the complete test is approximately forty seconds, which is very short considering that it is complete and thoroughly applied.

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New use for old circuit

IN the September, 1931, issue of RADIO ENGINEERING appeared an article submitted by H. G. Boyle, describing a modern adaptation of the Autoplex receiver circuit of several years ago.

The present interest in midget receiver design and in greater amplification per tube renews inquiry into the possibilities of circuits such as that known as the Autoplex.

Amplifying his description of the system (RADIO ENGINEERING, September, 1931), Mr. Boyle says further:

Applying the Autoplex

In the design or development of any radio receiver which contains any new element, or different method of doing something there are generally as many results obtained as there are experimenters. Even though every detail is carried to the last exactitude an unfamiliar atmosphere produces variations which may be good or bad and it is hoped that any attempt to emulate the results obtained with the circuits and constants which are here presented will be made with this thought in mind and allowances made accordingly.

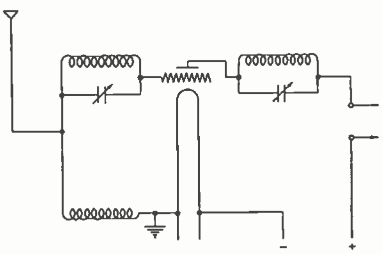


Fig. 1. The fundamental Autoplex circuit upon which the second detector circuit is based.

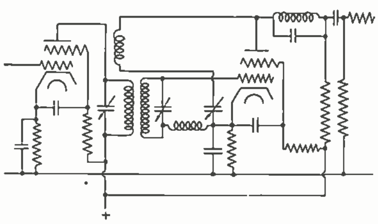


Fig. 2. A typical arrangement for a superheterodyne second detector of high sensitivity.

So far as is known there are three commercial receivers which use systems similar to that which is used in the accompanying circuit diagram for the first detector, Autodyne oscillator, detector-oscillator, beat-detector; or name it as you will. However, to our knowledge the second detector circuit is new and is not used in any known receiver.

The tables herein give the coil constants of a simple, workable preselector which will give an image ratio of approximately 250 to 1 and should be sufficient for most districts to prevent cross talk or cross modulation. All coils are contained in aluminum cans, oval in shape, 1½ inches by 2¼ inches in cross section and 2⅝ inches in depth. All coils are wound on threaded bakelite forms 1¼ inch outside diameter. They are tuned with a variable condenser having a maximum capacity of 480 $\mu\mu f$ in the preselector sections. The oscillator tuning section should be of the compensated type and may be easily adjusted to track properly with the preselector.

As 175 kc. is more or less a standard frequency for this type of receiver it was chosen as the intermediate or "snake frequency." Any standard 175 kc. transformer may be used providing a tickler coil is added between the primary and secondary windings. In the original model a midget transformer was used, it being wound on a wood bobbin ¼ inch in diameter, both primary and secondary consisting of 1,250 turns of No. 38 single silk insulated wire, spaced five-eighths of an inch

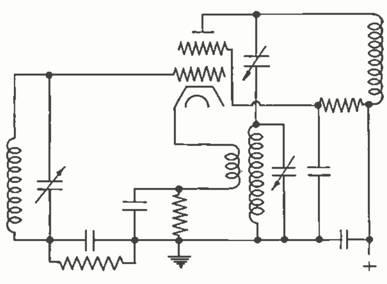


Fig. 3. An example of oscillating, or zero-beat, first detector. Probably the most sensitive detection device known.

with a tickler of 500 turns wound half way between them. The shield is 1 inch diameter and 1½ inches deep.

The suppressing inductance which is inserted in the grid return circuit of the second detector consists of 7,500 turns of No. 30 enameled wire wound on a ½ inch form. It may be mentioned that this inductance must be out of the field of the power transformer and at right angles to it in order to prevent a strong inductive hum which would otherwise be produced.

Other constants of the circuit are of standard practice and may be disposed in the design as convenient. No particular mechanical difficulties will present themselves if a normal, logical arrangement of the various parts is produced.

In operation the selecting transformer should be accurately aligned to 175 kc. It will be found that the tuning is exceptionally sharp and approaches the critical.

Preselector and Oscillator Coil Data

Antenna transformer secondary:
- 338.25 μh inductance
- No. 31 enameled wire
- 134.5 turns 1¼ inch form
- ½ turn capacity coupling

Primary:
- 950 μh inductance
- 400 turns ¼ inch bobbin
- No. 38 single silk ins.
- 11.3 uuf. dist. cap.

Primary placed directly under low side of secondary, center under last turn of secondary:
- R-F. coupling coil
- 337 μh inductance
- No. 31 enameled wire
- 134.5 turns 1¼ inch form

Oscillator coil (plate):
- 208.25 μh inductance
- No. 28 enameled wire
- 109.5 turns 1¼ inch form

Oscillator coil (cathode):
- 19.5 turns No. 36 d.c.c. wire wound directly over B— end of plate coil

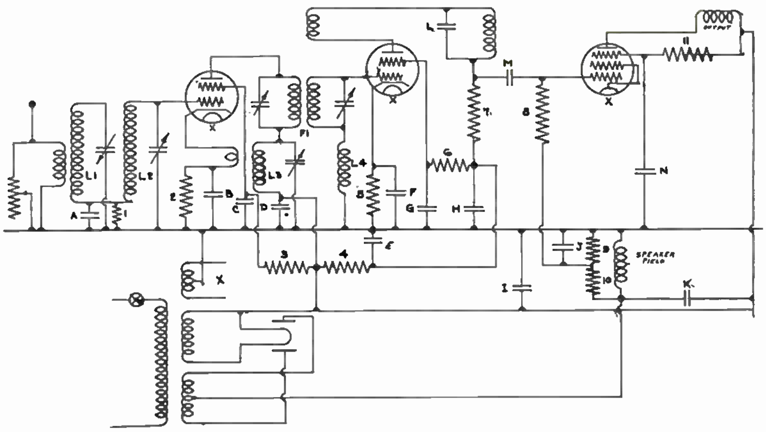


Fig. 4. Complete wiring, with constants designations.

Circuit Diagram Legend

Resistors:
1. 10,000 ohms
2. 6,500 ohms
3. 1 megohm
4. 10,000 ohms
5. 10,000 ohms
6. 1 megohm
7. 300,000 ohms
8. 1. megohm
9. 300,000 ohms
10. 1 megohm
11. 200 ohms

Condensers:
- A. .02 ufd.
- 8. .001 ufd.
- C. .1 ufd.
- D. .5 ufd.
- E. .5 ufd.
- F. .5 ufd.
- G. .1 ufd.
- H. (Optional filter)
- I. 12. ufd.
- J. .5 ufd.
- K. 8. ufd.
- M. .02 ufd.
- N. .1 ufd.

Miscellany:
- L 175 kc. filter
- L_1 Antenna coil
- L_2 R-F. coupling coil
- L_3 Oscillator coil
- L_4 Suppressing inductance.
- Speaker field 1,250-1,350 ohms

If operating properly signals should come in with a strong hiss as resonance is approached, the hiss snapping out at resonance. In the original receiver the measured sensitivity over the broadcast band was between 2,000 and 2,500 microvolts with a band width of 28 to 32 at a thousand times resonance input.

In considering this design it must be remembered that the main gain with the number of tubes represented is in selectivity without a loss of sensitivity. It is realized that all of the effects may be obtained by other methods and that many refinements are possible in individual setups that will give improved results. The data given is exactly that of a model which operated well and can be easily copied.

Further experimentation might well be carried out with an additional tube, operating either as an i-f. or r-f. amplifier depending upon the effects desired. In all probability an r-f. amplifier would assist in reducing cross talk in congested areas. Where such conditions do not exist an i-f. amplifier of standard design might easily be added to give greatly increased sensitivity with slightly better selectivity.

The latter combination should produce a 5-tube receiver of not over 10 microvolt sensitivity.

▲ ▲ ▲

Batavia (Java) radio amateur invents radio-telephone device

The Batavia radio amateur, W. P. G. van der Horst, an electro-technical engineer, has obtained a patent in England on an invention which makes the transmission of several radiotelephonic conversations with one transmitter and permanent wavelength possible, according to a cable from The Hague received by Aneta News Service. (Assistant Trade Commissioner, Carl H. Boehringer, Batavia, Java.)

A chronological history of electrical communication —telegraph, telephone and radio

▲

This history was begun in the January, 1932, issue of RADIO ENGINEERING, and will be continued in successive monthly issues throughout the year. The history is authoritative and will record all important dates, discoveries, inventions, necrology and statistics, with numerous contemporary chronological tie-in references to events in associated scientific developments. The entries will be carried along to our times.

▼

Part VII

1858 (257) Telegraph communication is established between London and Constantinople, and between England and Germany (Emden).

(258) A telegraph line is constructed between San Francisco, Calif., and Sacramento, Calif., the intention being to use the House printer. Within a few months printer operation was abandoned in favor of the Morse system.

(259) Charles S. Bulkley devises and installs the first hotel annunciator, in New Orleans, La.

(260) The reflecting, or mirror, galvanometer invented (April) by William Thompson (later Lord Kelvin).

(261) Rudolph Herman Kohlrausch dies. (Born Germany, 1809.)

(262) Cooper Institute is erected in New York by Peter Cooper at a cost of $600,000 for the purpose of furnishing popular instruction.

1859 (263) A submarine cable is laid between Aden and Suez,

(264) Raymond L. G. Plante uses lead plates in constructing storage batteries.

(265) Magneto electric light is successfully tried at South Foreland lighthouse, Dover, England.

(266) The Phelps' printer, known as the "combination" instrument, is introduced on American lines.

(267) Latimer Clark becomes chief engineer of the Atlantic Telegraph Company.

(268) Julius Plucker, in Germany, discovers cathode rays.

(269) Great aurora borealis electrical disturbances occur (August 28) throughout the Northern States and Canada, interfering with the operation of telegraph lines.

(270) Alfred Vail dies. (Born U. S. A., 1807.)

(271) A submarine cable to connect England with British India is laid through the Red Sea and Arabian Sea to Kurrachee, India, having a total length of 3,043 nautical miles, with several intermediate stations. The line worked unsatisfactorily and, as a through circuit, was for the time abandoned.

(272) Frederick H. Von Humboldt dies. (Born Germany, 1769.)

1860 (273) Edme H. Marie-Davy introduces the sulphate of mercury battery.

(274) J. J. Clark, in the United States, invents an automatic telegraph repeater.

(275) Augustus Stroh, a skilled German watchmaker, establishes in London a factory for the manufacture of Charles Wheatstone's automatic telegraph apparatus.

(276) *The New York World* makes its first appearance (June).

(277) Professor Hittorf finds that the luminous discharge in a Geissler tube may be deflected by a magnet.

1861 (278) Telegraph communication is established between the Atlantic coast and California (October 26).

(279) Reis, in Germany, transmits sound by electrical means.

(280) At the Manchester meeting of the British Association, Latimer Clark and Charles Bright propose the formation of standards of electrical quantity and resistance.

(281) Antonio Paccinotti, in Italy, makes important improvements in direct-current dynamos.

(282) A submarine telegraph cable is laid across the Mediterranean from Malta to Alexandria, Egypt, with intermediate landings at Tripoli and Benghazi. The conductor is seven-strand copper, covered with several coatings of gutta percha alternated with other insulating and waterproof material, and armored with eighteen iron wires wound spirally. The speed of operation on the separate sections is ten words per minute. With the entire line connected through the 1,331 miles, the speed is but three words per minute, the same as on the transatlantic cable, while the latter remained operative.

1862 (283) Matthiesen's copper wire conductivity determinations made.

(284) The Northwestern Telegraph Company erects a No. 8 iron wire between Milwaukee, Wis., and St. Paul, Minn. At the various points where the wire crosses the Mississippi river, watchmen are stationed to lower the wire into the river as steamboats pass up or down stream.

(285) Peter Barlow dies. (Born in England 1776.)

(286) George F. Milliken, of Boston, invents an improved automatic telegraph repeater.

(287) The Royal Society, in Great Britain, reorganized, July 15.

(288) James Bowman Lindsay dies. (Born in England 1799.)

(289) A submarine cable laid across the Mediterranean between France and Algeria in 1861 fails after a few months' operation.

(290) Heyworth patents a method of conveying electric signals without the use of continuous artificial conductors.

(291) Jean Baptiste Biot dies. (Born in France 1774.)

1863 (292) S. F. B. Morse's original telegraph patent expires.

(293) The Hicks automatic telegraph repeater introduced.

(294) J. W. Brett dies. (Born in England 1805.)

(295) While the Civil War in the United States continues (1861-1865) the telegraph lines of the country are wherever required operated for the benefit of the Government and the armies. A number of telegraphers from railroad and commercial services enter the service of the United States Military Telegraph Corps and render service of a high order to the Government. Among these are Andrew Carnegie, David Homer Bates, Albert B. Chandler, Richard O'Brien, David Strouse, Samuel M. Brown, James A. Swift, William J. Dealy, William Bender Wilson, R. F. Morley, C. W. Jacques, J. E. O'Brien, C. A. Tinker, Thomas T. Eckert, W. R. Plum, George Sheldon, S. H. Beckwith, J. Hervey Nichols, Robert C. Clowry and many others.

1864 (296) With the expiration of Morse's patents various independent telegraph companies combine under the name of the United States Telegraph Company.

(297) Large shipments of telegraph wire arrive from England for delivery at St. Paul, Minn. In October a line is built from St. Paul to Fort Garry (Winnipeg, Manitoba).

(To be continued)

An advanced television and short-wave superheterodyne receiver

By Ralph William Tanner

Herewith are the engineering details for designing a dependable single control superheterodyne receiver useful in television reception

IT is generally argued among engineers that the superheterodyne circuit offers the greatest possibilities from the viewpoint of sensitivity. The gain is also far more uniform over the range of any band than can be obtained with any type of tuned r-f. tuner. There is, however, a very real disadvantage to the super for short waves; that is, the difficulty of providing true single control.

To be sure, there are supers now being sold (and also super short-wave converters) in which the first detector and oscillator tuning condensers are ganged. A vernier condenser in parallel with the first detector section (some manufacturer's place the vernier across the oscillator section) is then a necessity in order to provide the proper beat frequency. Single control is claimed for these sets, but the fact remains that it is essential to operate both dial and vernier when tuning.

If both oscillator and first detector could be tuned to the same frequency, single control would be simple, but these circuits must be tuned to a difference in frequency, the difference corresponding to the intermediate frequency. By such tuning, neither oscillator nor first detector have the same tuning range.

The new short-wave superhet. herein described eliminates this disadvantage and allows true single control of all tuned circuits without an auxiliary vernier condenser. This feature alone makes the circuit one of paramount importance in television and short-wave operation. There are other important features.

The engineer and set builder alike have difficulties with the problem of feedback and, in the instance of a television receiver, trouble from motor-boating in the audio-frequency amplifier. Nearly all design engineers agree that the cause of these troubles, particularly the latter, lies almost entirely in the detector operated from the same B supply as the r-f. and a-f. tubes (assuming that the shielding is sufficient). When resistance-coupled audio amplifiers are employed, it is necessary to resort to audio filters in the amplifier and detector B positive leads which, even then, do not always effect a cure.

It is well known that a vacuum tube detector, either three-electrode or screen grid, is not a very efficient device. Therefore, why not use these tubes as amplifiers where their efficiency will be higher and replace them as detectors with good, stable crystal systems? Certainly a carborundum crystal is sufficiently stable and sensitive.

A crystal detector is notorious for its flat frequency response which makes it better suited to television sets, where the image (audio) frequency range is from approximately 20 to 43,200 cycles, than any type of tube detector.

In the frequency changer circuit, a crystal rectifier can again be used to great advantage. In original design work on super circuits, engineers have had trouble with an audio howl due to feedback of energy from the i-f. amplifier into the first detector. The cure generally was the resort to better r-f. filtering in the B positive and screen grid leads and, quite frequently, to better shielding of the i-f. circuits. In nearly every instance the use of a crystal detector will eliminate this feedback except when due to insufficient or poor shielding.

The use of carborundum crystal rectifiers as both first and second detectors is another feature of the new superhet. This permits a very material increase in sensitivity and selectivity over that obtained with the same number of tubes, two of which are detectors, as well as a minimum of feedback trouble. Better quality of television and music can also be attributed to a crystal second detector.

A schematic diagram of the short-wave circuits is shown in Fig. 1. A total of only two tubes is employed, a '35 screen-grid radio-frequency amplifier and a '35 oscillator. It will be noted that four tuned circuits, not including the oscillator, precede the crystal first detector with all five tuning condensers ganged together. This results in two band-pass filters which give sufficiently sharp tuning to eliminate image frequency interference and repeat spots. The band filter between the r-f. stage and first detector reduces capacity coupling to a minimum.

Energy is fed from the plate of the '35 oscillator tube to the crystal detector through a small condenser and variable resistor allowing the coupling to be adjusted to the point of minimum "hiss."

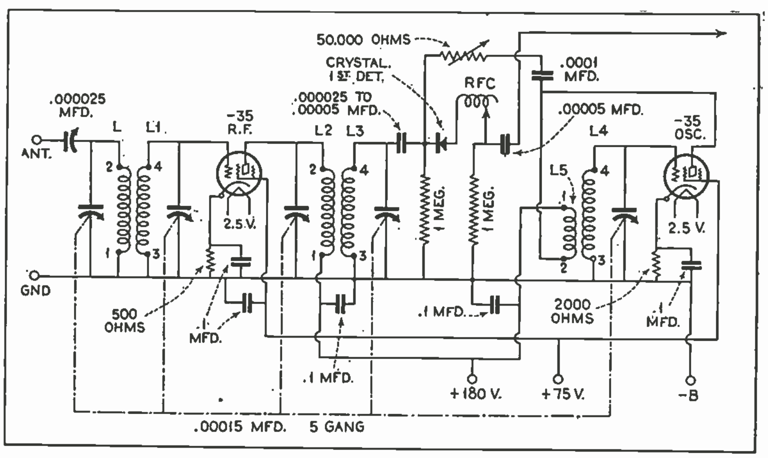


Fig. 1. Short-wave circuits.

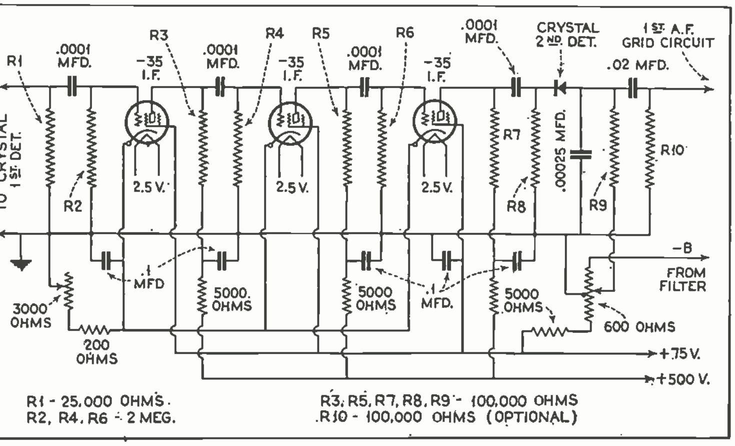


Fig. 2. Resistance coupled, untuned i-f. amplifier.

Plug-in coils were selected for the model of this super since all methods of switching can only result in large losses unless the individual coils are well spaced from the others, producing a set far from reasonable in dimensions.

Three sets of coils are needed, one for antenna and r-f. grid, one for r-f. plate and detector and one for the oscillator. Considering a tuning range from 15 to 200 meters, four band shifts are necessary, making a total of 12 plug-in coils.

A five gang broadcast condenser was used with plates removed from the rotor. The resulting capacity per section was then approximately .00015 mfd. In this case four rotor plates were left in each section. If a five gang unit is not available, a three and a two gang may easily be coupled to one shaft.

In any superheterodyne having sharply tuned i-f. stages, if the pre-selector and oscillator condensers are ganged and the i-f. circuits peaked at, say, the high end of the tuning dial, reducing the capacity of the gang condenser will change the beat frequency allowing reception only at the high end of the scale (unless, of course, each of the band selector circuits is provided with vernier condensers). At the low end of the scale the beat frequency would be far from that of the i-f. amplifier.

On the other hand, if the i-f. amplifier is untuned or very broadly tuned, any change in the beat frequency is compensated for automatically providing the i-f. stages amplify over a sufficiently wide range.

In the first experiments with this circuit, an oscillator having fixed values of inductance and capacity for each band was tried. This, however, required too many band shifts to cover the range of 15 to 200 meters as well as an i-f. amplifier giving uniform response over a range of approximately 40 to 1500 kc. The final decision was a regular type of variable oscillator using a '35 vario-mu tube, and with the tuning condenser ganged to the pre-selector tuning condensers. This allowed a much narrower frequency response in the i-f. amplifier as well as a material increase in sensitivity.

Although broadly tuned coupling impedances having rather high r-f. resistance and relatively large iron cores would probably result in slightly greater gain per stage, it was decided to use straight resistance coupling since suitable resistors are easily obtainable. It was found, however, that all types of resistors were not suitable due to variations in values and noises developed from changes in atmospheric conditions. The climate in which the writer resides is frequently subject to extremes in dryness and moisture.

With resistors of 100,000 ohms and 2 megohms for the plate and grid circuits respectively and coupling condensers of .0001 mfd., the response to all frequencies within the required range of approximately 200 to 500 kc. is practically uniform.

Three i-f. stages have been found to give sufficient gain for almost any purpose, the gain per stage being not far below that of the usual 1500 kc. tuned i-f. amplifier found in most short-wave supers. It should be remembered that the overall gain also includes that derived from the use of a tuned signal frequency r-f. amplifier.

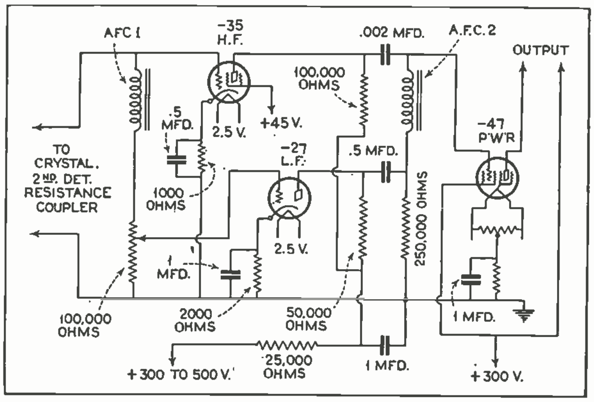
The circuit of the three stage i-f. amplifier and crystal second detector is shown in Fig. 2. Filter resistors of 5000 ohms each are connected in the B positive leads and by-passed by .1 mfd. condensers.

A new method of coupling the last i-f. stage to the crystal and crystal to a-f. had to be developed due to the relatively low internal resistance of the carborundum crystal. It was merely necessary to employ the proper values of resistors and condensers. Carborundum crystals generally function in a more sensitive manner when biased with a low voltage. (Note: this does not apply to the first detector as this has a rather high current flowing into it from the oscillator.) Whether the bias voltage is positive or negative depends upon which way it is connected. The 100,000 ohm resistor connected to the output of the crystal goes to a 400 to 1000 ohm potentiometer connected as shown. In this way it is possible to obtain the correct bias and at the proper polarity regardless of which way the crystal is connected.

In television reception this possibility of phase reversal in the crystal circuit is a very important and desirable feature. If a negative picture is reproduced, merely reverse the crystal detector connections and readjust the bias, regardless of the number of a-f. stages employed.

Volume is controlled by a 3000 ohm variable resistor in the cathode leads, which functions very well although not the best method. If impedance coils were employed in the plate circuits in place of resistors with a normal voltage of 180, it would possibly be better to place the volume control in a voltage

Fig. 3. Circuit of new audio compensation for high frequencies.



divider arrangement as is recommended by tube manufacturers.

Although the i-f. amplifier offers no selectivity the tuning in the short wave or signal frequency circuits is in the vicinity of 10 kc. depending upon the degree of coupling in the band-pass filters. This tends to ruin quality of television pictures but not of music or speech.

It is entirely possible to sharply tune the r-f. circuits and compensate for the loss in high frequencies within the audio amplifier. An audio amplifier has been developed which can produce a rising characteristic above any predetermined frequency, thereby compensating for the loss in the r-f. circuits.

The circuit of such an amplifier is shown in Fig. 3. The latest types of tubes are shown. In the original models of this amplifier three stages were employed with a '250 tube for power, high frequency compensation occurring in the middle stage.

The low frequencies, below 5000 cycles, are amplified by the '27 tube and passed through a resistance-capacity coupler to the grid of the pentode power tube. This part of the circuit can be designed to have a flat curve from 20 to 5000 cycles. The upper tube, a '35, amplifies the higher frequencies. The choke AFC 1 is designed to have the correct impedance at approximately the highest image frequency, 43,200 cycles for standard 60-line transmissions.

The secondary of 30 kc. intermediate frequency transformer was employed in the original experiments. An Acme 30 kc. transformer was installed in this circuit and resulted in a fair degree of gain, although nothing like that obtained from one designed for the purpose. As the audio frequency increased, above 1000 cycles, the gain also increased.

If such a transformer could amplify at 1000 cycles, it was decided that an audio amplifier could be designed for television reception having a rising characteristic towards the higher frequencies which would compensate for the very sharp tuning in the r-f. stages.

It was found necessary to employ a type of tube in the high-frequency section which would give considerably greater gain than the low frequency section otherwise the characteristic curve would take an abrupt dip at about 5000 cycles, rising gradually to the highest image frequency. Therefore, a standard three-electrode tube was selected for the low frequency section and a vario-mu tube, or other screen-grid type, for the high. The 100,000 ohm variable resistor shown in the grid circuit of the '27 tube is used to adjust the low frequency gain to the proper value.

The writer believes that this audio amplifier will be a very great help to the television art as well as broadcasting.

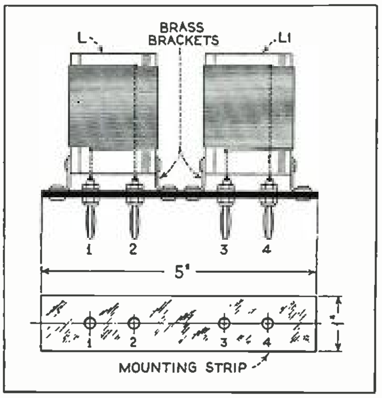


Fig. 4. Band-pass coils (oscillator mounted in center of strip).

A few constructional details will be given for the benefit of the readers who have had experience in the construction of complicated circuits.

A reference to Fig. 4 will show how the plug-in coils were constructed. The band pass filter coils are mounted side by side in an upright position. This method of coupling was necessary to conserve space and for mechanical strength. The winding forms are all 1½ inches in diameter, the length depending upon the wave band. The largest, or television coils, were 2 inches long, the 20 meter forms being 1 inch long.

Both band-pass filters are made exactly alike. The oscillator has only one form on which is placed both plate and grid coils. The plate coils are wound close to the lower end of the forms.

For the sake of ease in construction, the mounting bases for both band filters and oscillator may be made alike. Care should be taken when drilling for the contact pins and sockets to see that they all match up, otherwise the coils may not fit. General Radio Company coil contacts and jacks are recommended although pin jacks also may be used.

In the diagram of the mounting strip, it will be noted that the sockets are numbered. The coils should be wound and the leads connected with the numbers corresponding to those in Fig. 1.

A table is given for the coil windings. These are experimental values and will not apply in every case due to the impossibility of every constructor making the leads exactly the same. No. 30 d.c.c. wire is used throughout and the turns are not spaced on any of the coils.

COIL TABLE

Band	L	L1	L2	L3	L4	L5
20	5	5	5	5	5	4
40	11	11	11	11	11	6
80	22	22	22	22	18	8
Tel.	38	38	38	38	30	14

On top of each of the band-pass filter coils is mounted a small compression type of condenser having a maximum of approximately 35 mmfd. If the gang condenser were provided with individual compensators, these could be adjusted for only one set of coils. Therefore, each coil is provided with its own compensator to adjust all four tuned circuits to resonance. The oscillator does not require any. In the case of the 20 and 40 meter bands, the compensators are also used to help in providing the proper beat frequency.

Before proceeding further, it would be well to mention one trouble which may develop, and its cure. On loud signals, the i-f. amplifier may act directly as a signal frequency amplifier (although very inefficiently) and not as a true superheterodyne. The cure for this is an r-f. choke connected in the output circuit of the crystal first detector as shown in Fig. 1. This choke may consist of 2000 turns of fine wire, about No. 36, on a form ½ inch in diameter, and from 1000 turns tapped every 200 turns in order to adjust to a point where nothing except the beat frequencies can reach the i-f. amplifier. The turns should be "scramble" wound.

Good shielding is a necessity as in any other multi-stage receiver. In the short-wave circuits box shields will be needed, one for r-f. and one for first detector. A tube shield will also be required for the r-f. tube. Shielding for the oscillator, while of some benefit, is not absolutely necessary.

The i-f. tubes should be shielded and the resistor-condenser couplers also. The latter may be enclosed within small shield cans. If these cans are sufficiently large the crystal second detector can be placed in the one which shields the last resistor coupler.

The operation and adjustments of this super are not difficult. Start with the television coils and adjust the individual coil trimmers to maximum signal strength and then set the second detector biasing potentiometer to best value. The trimmers for the 80 meter coils are also adjusted in like manner.

As the oscillator coils for the 20 and 40 meter bands are wound with tuned circuits having the same number of turns as the band filter coils, it will be necessary to adjust the trimmers to very nearly maximum capacity to provide the proper difference in frequency.

The results obtained with this circuit have been more than satisfactory. On television, eastern stations have been brought in in Michigan through heavy interference from the Chicago 45 line stations and with exceptionally fine detail.

Insulator developments point to noiseless a-c. tubes

By Henry L. Crowley

Introduction of new material eliminates so-called tube mirror and reduces noise level to lowest value yet attained in practice

THE story of the development of a-c. radio tubes is closely coupled to that of insulators. Tube successes and failures have often been based on corresponding successes or failures of insulators employed in the cathode construction. Therefore, the story of a new insulator of remarkable properties is practically the promise of new and better a-c. tubes of particular interest to radio tube and set manufacturers.

To understand what has been accomplished of late in providing improved insulators, it is necessary to review briefly the development of insulators for a-c. tubes. The development of the first non-porcelain insulator, many years ago, was the first step towards a practical a-c. heater type tube. This was followed by the development of an alkali-free material, which at the time was considered an important improvement over previous materials. Then the first so-called magnesia insulators were developed, following exhaustive studies and tests on many other materials including aluminum oxide, zirconiathoria, etc. Due to the particularly severe operating conditions encountered in tubes, the other materials were found unsatisfactory. Meanwhile, the magnesia insulator produced a body with a far higher melting point, and, compared with previous developments such as the alkali-free formula, produced a material which was also relatively non-reactive to tungsten.

Late Improvements

Many important advances in the tube-making art have taken place of late, calling for much finer and better tube characteristics. Recent developments and marked improvements in set sensitivity have made still more important the question of tube characteristics, particularly with regard to noises and to uniformly maintained characteristics during a long service life. The magnesia insulator, while quite desirable in comparison with previous insulators, has had to be developed to a much higher degree, through a series of important refinements. Indeed, until now there has been too much tendency to accept the magnesia insulator as the panacea for all tube troubles.

Magnesia

Fundamentally, the chemical characteristics of magnesia in relatively pure state give rise to certain undesirable tube conditions which apply even more definitely to alumina, zirconia and other oxides. During long operation, tubes using the insulators heretofore available deposit a black coating for some of the oxides employed, and a mirror-like coating for magnesia oxide insulators. These deposits, while usually observed at the top of the bulb, may naturally be found in other parts. Such deposits are just as serious to the proper operation of the tube whether readily discernible as a mirror or less noticeable as a slight discoloration.

The reason for the mirror or discoloration is that the insulators vaporize slowly under the influence of intense heat, leading to a chain of chemical changes that may affect all parts of the tube. The metallic deposit resulting from the vaporization of the insulator has been found to increase tube capacity, while increased gas content results in a raised noise level. It is mainly the deposits on spacers and other insulating parts that give rise to serious noise. The chemical reaction with the filament wire often results in a change of tube characteristics, particularly by way of making the tube especially sensitive to vibration.

The correction of the foregoing conditions has required an intensive study of the fundamental chemical structure of the insulator, and, in fact, its molecular structure. The writer has devoted much time to this study, in search of a more satisfactory insulator. The final result is the development of an insulator of fundamentally different chemical composition, possessing unusual properties.

The new insulator formula has been in use in some tubes and for considerable periods of time, for a sufficiently thorough test of its practical worth. Lately, it is receiving more attention than heretofore, due to the increasingly rigid requirements of set and tube manufacturers, especially with regard to noises and changes in tube characteristics during life. Extensive tests, including severe overload voltages even as high as 4½ volts for the -24 and -27 types, for example, have disclosed no trace of mirror or other deposit after many hundred hours of operation. On the usual accelerated voltages of say 2¾ volts for the -24 and -27 types, let alone normal operating voltages, no deposits and no changes in characteristics have occurred. Also, the noise factor has been much improved, not only through the almost total elimination of electrical leakage but also from microphonic causes.

Spacers

As the development of the new insulator has proceeded, it has become increasingly obvious that the usual spacer could in itself be the cause of much noise. Hence, no little work has been devoted to spacers. It was first assumed that if the spacer could be so made that leakage readings were zero, noise due to the spacer would disappear. It was found, however, that if the development resulted in spacers to give zero readings on leakage, noise still persisted to some extent. As a result of further research, it has been found that the residual noise is due to the physical structure of the material, and it has therefore been necessary to work out a material having a physical structure that eliminates this residual noise and at the same time maintains leakage readings of approximately zero. This development has been finally completed in the last few months, and insulator spacers are now available which permit the elimination of the noise difficulties.

These insulators are in volume use at present, in certain makes of tubes. These filament insulators are of particular value in the automobile type tube and the new 56-57-58 types. As a further advantage, the new filament insulators reduce heating time to an appreciable extent.

Treasury interprets radio tax at RMA conference

IMPORTANT guidance for the radio industry, in connection with the new federal radio tax law, was given by treasury department officials at a conference on June 20 of the radio manufacturers arranged by the RMA. Taxable and exemption provisions of the new law, and their application to all radio manufacturers, were explained at the conference by W. E. Dodge, chief, manufacturers' excise tax section of internal revenue, in charge of administering the radio tax law. The new treasury regulations, which will be available soon at local internal revenue collection districts, will be sent to RMA members. The regulations and treasury rulings are subject to revision and are being changed as new facts are presented.

The RMA delegation at the June 20 conference represented about thirty members and was headed officially by Fred D. Williams, of Indianapolis, president of the RMA; Captain William Sparks, of Jackson, Michigan, acting chairman of the RMA receiving set group; S. W. Muldowny, of New York, chairman of the RMA tube group; Mr. Scott, RMA legislative counsel, and Bond Geddes, RMA executive vice-president.

Following the conference lengthy paid telegrams were sent to RMA members affected by the new tax provisions. No recommendations of practice or policy were made by the RMA. Such practices and policies are left entirely to manufacturers. The RMA has confined itself to securing and transmitting all information possible on the new tax law. The RMA forwarded recommendations of receiving set and tube manufacturers attending the conference with the internal revenue officials. The receiving set group attending the conference recommended that list prices be increased to cover the tax and no mention made in advertisements of the tax. The tube group advised tube manufacturers to avoid double taxation of tubes by billing tubes to set manufacturers on the certificate plan, leaving payment of the tax to the set manufacturers. Warnings to manufacturers, jobbers and dealers against pyramiding the tax or increasing it beyond the exact amount paid to the government also were sent.

The set manufacturers recommended that new list prices be established for advertising purposes by adding to present list prices an amount equal to the total excise tax. They recommended that no mention whatever of the radio tax, either as included or as an extra charge, be mentioned in any advertising or literature or sales promotional work. They recommended that jobber or dealer discounts be applied to existing list prices to be used as "base" prices for billing purposes only, with invoices to jobbers and dealers to indicate the amount of the tax as an addition to the net amount of the invoice. This plan was recommended by the set group so that existing discount plans might not be disturbed. These recommendations, made by the set group, and not by the RMA, were advisory, leaving complete freedom of decision on business policy to all manufacturers.

Law Interpreted

Following is a summary of the treasury interpretation of the radio tax law thus far made, also the questions and answers at the RMA conference. To insure accuracy this summary, together with the questions and answers, in typewritten form, was submitted to W. E. Dodge of the treasury department and was amplified and approved by him for release. The treasury officials gave the following interpretations to portions of the new radio tax law:

"A complete radio receiving set is not taxable as a set. The new tax law specifically imposes the tax on the manufacturer's selling price of chassis, cabinets, tubes, reproducing units and power packs. It also imposes a tax on the other parts and accessories of a radio receiving set when such other parts and accessories are sold on, or in connection with, the sale of a radio receiving set.

"Tube rectifiers are taxable if suitable for use in connection with articles enumerated in Section 607—rectifiers, other than tube rectifiers, are not taxable if sold separate from a receiving set.

"Repair parts, other than those enumerated in Section 607, for sets and phonographs are not taxable when sold separate from sets or phonographs.

"Electrical transcriptions are taxable unless it can be proven to the satisfaction of the treasury department that such transcriptions are not phonograph records. In the discussions of this item by committees of congress, transcriptions were included and were considered to be taxable.

"No tax will be imposed on export shipments. The proof of such export shipment by bill of lading as provided in 1926 tax law will apply to the new tax law. It will appear as Section 1121 in the new law.

"Aerials and wire are not taxable when sold separate from a receiving set.

"Loudspeakers are taxable.

"B and C batteries are not taxable when sold separate from receiving sets.

"Tubes used, or suitable for use, in radio receivers are taxable. Not those for laboratory, transmitting or other purposes.

"Headphones are taxable when sold as part of receiving set. When sold separately the treasury is uncertain, but will consider same taxable until it is proven that they are not reproducing units. Advise paying tax and applying for refund, when sold separate from set.

"Volume controls, fixed resistors, switches, sockets and similar articles, when sold separate from a receiving set, are not taxable.

"Condensers, either fixed or electrolytic, are not taxable when sold separate from receiving set.

"B eliminators are not taxable when sold separate from receiving set.

"Phonograph mechanisms are taxable, but not a phonograph.

"Remote control of a receiving set is not taxable if sold separately and so invoiced; otherwise it is taxable.

"An automobile receiving set is taxable under Section 607. It is possible that this ruling may be changed so as to permit sale thereof for further manufacture, tax free under Section 620.

"Receiving sets for police cars are not taxable providing they are sold directly to the state or municipality, but not through an intermediary. A sale to the United States Government is taxable.

"Receiving sets, sound equipment, amplifiers, etc., sold directly to a state or municipality, for use in state or municipally controlled hospitals, schools or for other state or municipal purposes, are not subject to tax.

"Sound equipment, amplifiers, etc.,

sold to privately operated hospitals, schools, hotels, etc., are taxable as an entire system unless the parts specified in the law as taxable are segregated on the invoice. If separately invoiced then the tax applies to the parts mentioned specifically in the law, but the tax does not attach to other parts used, such as wire, switches, plugs, sockets, etc. The billings must be divided to secure exemptions of such items not enumerated in the law.

"Receiving sets leased are subject to tax.

"Receiving sets, sold or leased for marine, aviation or communication services appear to be subject to tax. However, it is suggested that pending definite ruling to the contrary that tax be paid and refund claimed.

"If merchandise is sold to a subsidiary, the selling price must be the fair market price or the tax will be based on the fair market price. If it is a bookkeeping transaction the tax may be paid by the manufacturer at the fair market price, or the subsidiary may pay the tax based on the subsidiary's selling price.

"Bonus, cash and other discounts when actually earned and taken may be deducted in determining the manufacturer's selling price. If such discounts are taken after the manufacturer has made his monthly return to the collector of internal revenue, he may carry such discounts as a rebate or credit claim on his next monthly return. The manufacturer must be careful to note on his books exactly what discounts are claimed for rebate or credit and why, in order that such information may be readily available to the field inspectors.

"Freight charges are deductible in determining the selling price, providing the invoice carries freight charges as a separate item, but if invoice bills at a price which includes freight the tax is computed on the whole amount. If the manufacturer's selling price at the factory is the same as that at distant points delivered, freight included, then the freight charges are not deductible. If the manufacturer attempts to make a profit on his freight charges, then such profit is considered a part of his sale price and is taxable.

"Royalty charges are not deductible in determining the tax. They are part of the overhead, same as factory building, and are part of the cost of the product.

"Pyramiding or exacting or attempting to exact, as a tax, an amount greater than the actual tax imposed is an offense punishable by fine up to one thousand dollars for each separate offense. If the tax is not specifically carried in the invoice no tax can be added or imposed by subsequent sellers. Only the exact amount of the tax can be passed on to the purchaser in any transaction. Dealers having stock on hand before the law became effective are prohibited, under possible fine up to $1,000 on each transaction, from adding or collecting from purchaser any tax on such goods.

"The manufacturers of tubes, speakers, reproducing units or power packs have the option of paying the tax on these articles or selling same tax free under certificate. In the latter case the tax will be paid by the set manufacturer under Section 620 of the new tax law."

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Directive radio beam channel to guide pilots

A WELL defined path of dots and dashes on which a pilot can fly as true as a homing pigeon, day and night, even if the landscape is blotted out, has resulted from the installation of Department of Commerce directive radio beam on most of the established airways over which the mail-passenger planes fly. How pilots listening to the radio beacon signals maintain their course is described in a bulletin of United Air Lines, whose planes fly a million miles a month with the aid of this almost uncanny directive beam.

The radio beacon stations, spaced approximately 150 miles apart, transmit dots and dashes. Dot-dash means one side of the line of flight and dash-dot the other side; but a steady stream of dashes means "you are on the direct course." The "on-course" signal comes to the pilot over his headphones as a steady hum, much like the whine one occasionally gets over the radio at home, broken only by the identification characteristic of the particular station transmitting the signals. As the pilot approaches a station, the signal strength increases and he knows when he is directly over the radio station even if he cannot see it, as he will receive no signal because the station does not transmit signals vertically.

The beacon is invaluable when visibility is such that the pilot cannot orient himself by distinguishing landmarks.

The radiophone head set used by pilots of United Air Lines enables them to receive the long wave radio beacon signal, the Department of Commerce weather report broadcast, and also the two-way short wave radio telephone enables them to converse with ground stations, never more distant than 100 miles, and with pilots of other planes in flight. A tuning device, like the handle of a coffee grinder, enables the pilot to accentuate or diminish the intensity of both long and short wave signals or conversation he gets through his earphones. He can also shut out entirely either the directive radio signals or the conversation over short wave.

Every twenty minutes the "radio fence" signals, which keep the pilot on his course, are interrupted momentarily to allow the broadcasting of long wave weather reports. However, if any pilot telephones down that it is vital that the beacon signals continue without interruption, the beacon beam will be kept on. The man on the ground will then broadcast the weather to pilots aloft on another frequency and the pilots receive it just as the person at home can get a different station by dialing.

The world's longest airway with directive radio beacon service is the New York-Pacific Coast line, 2766 miles, pilots following "the hum" from the Golden Gate to the Statue of Liberty.

RADIO RECEIVERS IN CANADA

REPORTS indicate that there are approximately 548,350 radio receivers in operation in Canada for which the owners have procured government licenses. 75,240 of these are owned in Toronto and 68,150 in Montreal.

Last year 223,228 receivers were manufactured in Canada, 17,082 being made entirely of materials and parts produced in Canada. About 10,000 of the receivers are battery operated models.

It is generally understood that there are perhaps hundreds of thousands of receivers in operation throughout the Dominion for which government licenses have not been taken out.

Ten million volts

TEN million volts of electricity, five million greater than ever before produced by man in electrical laboratory experiments and approximately one-tenth the voltage of a flash of lightning, was shown in the high voltage engineering laboratory of the General Electric Company at Pittsfield, Mass., recently.

This enormous voltage, which is capable of producing an arc of 60 feet, was made possible by a new fifty million kilowatt generator, F. W. Peek, Jr., chief engineer, explained. The exact characteristics of the 10,000,000 volt discharge are still unknown, as it was but two days previously that this high voltage was attained for the first time. Likewise, the fields in which the new high voltage will be used, experimentally or otherwise, are yet to be determined; but it will be used in the continued research being conducted by electrical engineers in the study of natural lightning, its effects on electrical generating and transmission apparatus, and ways of protecting such apparatus from damage by lightning. With the increased voltage now available in the laboratory, it becomes possible for the engineers to approximate more closely the effects of natural lightning, he said.

Whether or not this high voltage will produce cosmic rays or split the atom, as scientists have predicted, Mr. Peek said that only time will tell. "It may be possible to do these things," he said. "We haven't had time to investigate them yet."

A laboratory demonstration of this 10,000,000 volt artificial lightning was broadcast that night by WGY of Schenectady and the NBC-WEAF network. The day happened to be the 180th anniversary of Franklin's kite experiment, and the program was in commemoration of that epochal event.

While the limit of voltage directly produced by man has now been increased to ten million volts, the voltage indirectly produced as a result of reflection is a doubling of the ten million volt impulse at the ends of a transmission line, according to Mr. Peek. In this respect the voltage is like a water-wave, which upon striking a wall doubles upon reflection.

Mr. Peek said that natural lightning is of the order of 100,000,000 volts (10 times that of laboratory lightning) and 200,000 amperes, and that the discharge occurs in a few millionths of a second.

"Mastery of lightning problems has been removed from the realm of the 'medicine man,'" Mr. Peek said. "While there is still much to learn, lightning may be said to be now at least on an engineering basis, since it is expressed numerically in volts and amperes.

"The following indicates how rapid the progress has been: The wave shape of lightning has been pictured by the cathode ray oscillograph, or high-speed camera; the time required for a cloud to discharge has been measured by the same oscillograph; the attenuation of lightning waves traveling on a transmission line has been determined: natural lightning waves have been reproduced in the laboratory, where their effects on transmission lines, insulation, insulators, and transformer and protective apparatus have been studied at will.

"It is now possible to design transmission lines free from lightning troubles or interruptions as well as lightning-proof transformers and other electrical apparatus. It has also taught us how to build efficient protective devices to guard other electrical apparatus from lightning disturbances."

In 1913 Peek built his first lightning generator and learned that the most accurate measurements of lightning values could be obtained not when the electrical discharge occurred between needle-like points of metal, but when it took place between metallic spheres. Today aluminum spheres six feet in diameter and placed several feet apart provide the terminals for the gigantic streak of man-generated lightning, the means for measuring such high voltages. Mr. Peek's first generator, operated at 200,000 volts, was followed in 1917 by a second which showed 500,000 volts in its gap discharges. A few years later Steinmetz, at Schenectady, was also working with synthetic lightning, having designed at the time of his death a generator of the same capacity. Peek's work continued at Pittsfield, Mass., the voltages constantly creeping upward—1,500,000 in 1923; 2,400,000 in 1927; 3,600,000 in 1928; 5,000,000 in 1929, and 10,000,000 volts today.

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It is wise to use a good antenna†

NEVER has it been so important as it is now to give customers the best possible aerial installation with new receivers. The new models offer outstanding advantages, and you cannot afford to lose part or all of these advantages through a careless installation.

In the past, sales have been lost through improper performance of the radio during the demonstration or the initial period in the customer's home. Many of these cases could be traced directly to excessive noise and weak signal strength caused by a faulty aerial. The radio set was perfect in every detail, but its performance ability was lessened by the inefficient aerial.

An outdoor aerial which has been in use on a previous radio should never be taken for granted. It is far better to assume that such an aerial is wrong at the outset and that it must be fixed, rather than take a chance. A good appearing outdoor aerial with an inconspicuous intermittent joint is worse than a small indoor aerial. You do not have to install an outdoor aerial free of charge with every sale—charge the customer for such work if necessary. The important thing in keeping a set sold is to have the installation right. See that the aerial is of the proper height and length; see that it is free from badly corroded or unsoldered joints; and that it is properly insulated. See that the lead-in wire is properly insulated and that a good ground connection is made to a water pipe or radiator pipe.

It is true that satisfactory reception can often be obtained with an indoor aerial instead of a good outdoor aerial, but you know that the best performance—that which leaves you in no doubt as to whether the set will stay sold—is obtained when you have the best possible installation. The customer buys a modern radio because he wants better performance than he obtained from his old set. He should not be made to lose the advantages which modern radio offers because of an old and inefficient aerial installation.

In these times of economy and efficiency efforts must show positive results. You cannot afford to do anything but a 100 per cent job. When you install a receiver, do it thoroughly, and the chances are that the set will stay sold because of its outstanding performance superiority.

†*The foregoing is good advice from the engineering department of Philco.*

WIRELESS TELEPHONY FOR SMALL VESSELS OFF COAST OF GREAT BRITAIN

WHILE the scheme is still in the process of development, orders have been placed by the General Post Office for the installation of wireless telephone equipment in stations about the coast of Great Britain for use by yachts, fishing vessels and other small craft, in keeping in touch with the shore. The apparatus which will be installed on the vessels is designed with the greatest simplicity. The wireless stations at Wick, Fishguard and Humber have had telephone equipment for some time, but the present temporary scheme will provide a chain around the coasts of Great Britain and Ireland. If the idea proves a success it will be continued on a permanent basis by the Post Office. The new stations so equipped will be Cullercoats, North Foreland, Niton, Land's End, Seaforth, Port Patrick, Malin Head and Valentia. It is stated that already there has been great activity at the fishing ports of Hull and Grimsby in having wireless equipment in trawlers. According to a report, 45 of these installations have been completed for various owners within the past few weeks. A British company is offering two types of small telephone installations, one of 300 watts power, and one of 60 watts. Messages sent by telephone to the coast stations will be transmitted as telegrams to their destination on land.——(*George Lewis Jones, Clerk to Commercial Attache, London, England, May* 18, 1932.)

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RADIO SHORT COURSE UNIVERSITY OF FLORIDA

RADIO servicemen from all over Florida and adjoining states assembled at the University of Florida, Gainesville, Fla., on the sixth of June to study the latest developments in their chosen field. This was the third annual short course for radio servicemen held under the auspices of the general extension division and the college of engineering of the University of Florida, at which dealers, distributors, servicemen, and factory representatives meet for one week to discuss their mutual problems in the radio game.

Professor Joseph Weil, head of the department of electrical engineering and chairman of the short course faculty, in addition to men from his own department, employed radio engineers of national prominence and representatives of the various manufacturers of radio receiving sets and equipment.

The course of study organized to include lecture and laboratory work augmented by displays and demonstrations of the newest models in receiving sets and allied equipment now being manufactured, was carefully graded to meet the requirements of several classes of students varying in knowledge and experience.

Radio distributors all over the state of Florida worked with the University to encourage a record attendance at this third annual short course for radio servicemen on the campus of the University of Florida.

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PRINTED PAGE BY RADIO

THE radio transmission of whole newspapers is brought a step nearer by the success of recent experiments carried out between Zurich and the Norddeutscher Lloyd express liner *Bremen* on a recent voyage to New York. A system known as the "Radiotype" was employed to transmit pictures in the form of printing blocks, the method being described as "a combination of television and telephotography." Its sponsors are the Radiotype Company and the Debeg Radio Company of Berlin.

It is claimed that by means of the "Radiotype" it will soon be possible to transmit in the space of a few seconds over a great distance complete newspaper sheets ready to be printed. A short wave was used for the recent tests and success was attained in sending a poster of the Norddeutscher Lloyd express service over a distance of 2,500 miles.

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CHARACTERISTICS OF ELECTROMAGNETIC RADIATION FROM AIRCRAFT IN FLIGHT

DURING 75 flights made in the vicinity of Wright Field, Dayton, Ohio, during 1931, data have been collected to determine the intensity of electromagnetic radiation from aircraft in flight. The radiation from the airplane was recorded by a field-strength measuring set located in a frame building. Attenuation was found to be a function of altitude and frequency, while absorption is a function of frequency and the time of day. The occurrence of fading is shown to be determined by these factors.

Among the conclusions which may be drawn from these data are that for ground distances of 0.4 mile or less the field strength decreases with altitude; while at 1 mile there is comparatively little change in field strength with altitude; and for ground distances of 4 miles or more the field strength increases with altitude. There was no difference between the night tests and the daylight tests, provided that the same conditions obtained as to power, antenna, frequency, and altitude, except that the distances free from fading were much less by night than by day. The results of various tests in which fading was encountered at distances under 60 miles lead to the conclusion that the absorption undergone by the reflected or refracted ray is independent of the angle or distance traveled by that ray. —*A.I.E.E. paper by J. C. Coe and T. C. Rives, Wright Field, Dayton, Ohio.*

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SPAIN TO AMERICA BROADCASTS

FOR the past four months Transradio Espanola S. A. has been carrying out broadcasting tests through its short-wave station EAQ, which has been erected in Aranjuez (Madrid). This station is of Marconi "Beam" type 20 kw. power, and works on a wavelength of 30.4 meters, corresponding to 9,868 kc.

The transmissions thus effected have been successful and are received by listeners-in throughout the world, but mainly in the United States, England, Canada and Central America.

In view of the gratifying results obtained, Transradio Espanola has decided to create a Department of Radiodifusion Ibero Americana which has this month begun the task of improving and lengthening the programs broadcast, in accordance with requests from radio enthusiasts all over the world.

The principal object of the Spanish activities in the field of broadcasting is to convey to other lands some idea of the artistic and intellectual life of Spain and for this purpose arrangements have been made for outstanding personalities of Spain to speak on subjects in which they are specialists. The musical programs will be carefully chosen from the universal masters, preference naturally being given to the Spanish composers. All the artistic treasures of Spain will be described and explained and, in short, all matters pertaining to Spain will be adequately treated in a series of lectures.

Transradio Espanola is broadcasting daily programs intended for America, between 12:30 and 2:00 a.m. (G.M.T.).

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MAGNETIC PROPERTIES OF ELECTRODEPOSITED NICKEL

FILMS of nickel about 130 mu thick (deposited on brass tubes) are found to attain a magnetization of about 380 c.g.s. units in a field of 200 gausses; the value is about equal to that shown by bulk nickel. The coercive force of the electrodeposited metal is high. E. P. T. Tyndall and H. E. Malmstrom. —"Magnetization of Electrolytic Nickel Films." *Chemical Abstract,* Sept. 10, 1931, p. 4452 (from *Proc. Iowa Acad. Sci.,* 1930, XXXVII, 312-313.)

announcing

The SAMSON JUNIOR PAM-O-PHONE

the "mite-y" marvel

AGAIN Samson soars to success . . . this time with a Sound Distributing System complete in one case as a portable unit weighing 60 lbs. and measuring 22" x 18" x 22". This PAM-O-PHONE embodies the many exclusive ideas of the Samson craftsmen . . . originators of the A-C operated sound systems. Samson is now celebrating its 50th anniversary.

Compare the features of this unit with any like instruments . . . obtain our prices complete or in part. You will find more value per dollar here . . . and by far superior appearance, quality of construction and reproduction. Write for full data and prices given in our Bulletin PE20.

• • • NOTE THESE UNUSUAL FEATURES • • •

1. All a-c operation; no batteries of any kind required.
2. Will play standard 78 R.P.M. phonograph records or the new long-playing 33⅓ R.P.M. records.
3. Variable scratch filter allowing operator to eliminate as much or as little of the higher frequencies as desired.
4. Over three watts power output — sufficient to adequately cover audiences up to 500.
5. Independently adjustable volume of either phonograph or microphone reproduction.
6. A mixer circuit allowing the voice to have a background of music or to fade from voice to music or vice versa.
7. Complete set of Cunningham tubes.
8. A broadcast-type, double-button microphone.
9. An extensible microphone desk stand.
10. A 25-foot shielded microphone cable and plug.
11. A full page dynamic speaker mounted in back of a silver-plated grille in the cover which forms the baffle. The cover and speaker are self-supporting wherever located.
12. A 25-ft. (Tyrex) speaker cable and plug which allows the speaker to be operated fifty feet away from the microphone. Extension cables may be purchased to increase the distance when necessary.
13. All connections are made externally by means of polarized plugs at one end of case.
14. May be purchased without microphone accessories. Later these accessories may be added and attached without any change in the original unit.

Main Office:
Canton, Mass.

Samson Electric Co.
MANUFACTURERS SINCE 1882
MEMBER R.M.A.

Factories:
Canton and Watertown, Mass.

R.M.A. OFFICERS

THE officers of the Radio Manufacturers Association, Inc., elected at the annual election for 1932-33 are:

F. D. Williams, president; first vice-president, Harry A. Beach; second vice-president, Meade Brunet; third vice-president, Leslie F. Muter; treasurer, E. N. Rauland.

Four new members of the board of directors to serve for three years were elected as follows:

W. S. Symington, president of the Colonial Radio Co., Buffalo; S. W. Muldowny, chairman of the board of the National Union Radio Corporation, New York City; C. B. Smith, president of the Stewart-Warner Corp., Chicago; and Franklin Hutchinson, president of Kolster Radio, Inc., Newark, N. J.

One hundred and forty-four radio manufacturers are members of the association.

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WCAU TO USE DEAD END AND LIVE END STUDIOS

THE studios of the new home of WCAU, Philadelphia, Penn., have been designed to feature certain acoustical characteristics. This is the first attempt made in this country to construct or to broadcast from what is known as a "live" and "dead end" studio. From one-half to two-thirds of each room, depending on the size of the studio, will be lined with sound absorbing material to form a "dead end" where the microphones will be properly placed to receive every note and part of the program which will be in progress at the opposite, or "live end" of the room. The "live end" walls will be constructed with a hard material that will reflect the sound waves to the receiving, or "dead end."

Another innovation is the zigzaging walls of the two larger studios. These studios are constructed with "V"-shaped walls, which will break up the sound as it strikes the sides and will deflect it at various angles and prevent the reverberations of the notes from striking the opposite walls.

In order to minimize the transmission of extraneous sounds, special walls, floors and ceilings are being constructed. The walls have no direct connection with any of the outer walls for support or suspension except through intricate "insulators" which serve to break all sound connections. The floors which are known as "floating floors" are also free from contact with other surfaces. The studios will virtually be rooms within rooms. The ceilings will be suspended in the same manner.

Each studio will be entered through a vestibule which will also decrease the possibility of any sound entering the studio during a broadcast. Special heavy-duty soundproof doors are being used throughout.

The acoustical treatment in all the studios will include a one and one-half inch rock wool blanket placed against the soundproof wall and another blanket of the same size and style placed in front of it with a two-inch air pocket between the two blankets. The outer blanket is covered with perforated metal. Tests have shown that this method will produce an ideal broadcasting studio.

Each studio and control room window will be composed of a triple sash, and three panels of glass measuring ¼ inch, ⅝ inch and ⅜ inch respectively. Each section of the sash and glass will be insulated inside and outside to stop sounds that might be carried through the framing. The heaviest glass, the ⅝ inch, is placed between the lighter as an added guard against sound waves caused by vibration between the panels.

The entire WCAU system of studios will be air-conditioned eliminating all windows, thereby safeguarding against the entrance of extraneous noises.

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COSMIC RAYS

GENERAL ELECTRIC engineers are studying the flow of cosmic rays in an endeavor to learn more about this mysterious and most penetrating of all known radiations. It is hoped that by studying these new rays some practical application can be found for their unique properties.

In the present investigation which is being made by Chester W. Rice, a Geiger-Muller counter is used as a detector. The counter tube consists of a small nickel cylinder with a fine tungsten wire stretched along the axis, all enclosed in a glass tube at reduced air pressure. As the rays pass into the space between the wire and cylinder, they initiate corona discharges and the resulting electrical impulses are fed into an amplifier and then to the loudspeaker of a new-type radio receiver so that they can be plainly heard as distinct clicks. In series with the speaker is a small relay which is also actuated by the impulses, making possible an accurate count of the bombardment. With this small detector cylinder, which is about two inches long and three-quarters of an inch in diameter, the cosmic ray count is approximately eight per minute.

To make relatively certain that only cosmic rays are received, the detector is shielded by a lead housing four inches thick. This, according to Mr. Rice, is sufficient to keep out the effects of all known radioactive material.

There are two schools of opinion. One holds that these rays are the birth of new matter in the process of creation, and another that they are the death rattle of matter which is being annihilated.

"An interesting result which has been obtained from our study of Geiger-Muller counters is that the count is not directly proportional to the intensity of radiation falling on the counter," Mr. Rice explained. "At least this appears to be true in the case of the gamma ray radiation obtained from radium after passing through three-quarters of an inch of lead. If the same result applies to cosmic rays it means that data obtained by the use of such tube counters will require correcting."

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A NEW ZERO BIAS OUTPUT TUBE

(Concluded from page 11)

tube, such as the 231 or the ER-49 under class A conditions, as the driver stage. More plate current and more input voltage will be required for the driver tube with these tubes, however. The Ip-Ep curves of the 230 tube are shown in Fig. 4.

The results obtained with a 49 output stage fed through a 230 driver stage are shown in Fig. 5 for two-turn ratios of the interstage transformer. The ratio given refers to the ratio of the primary to one-half the secondary. The dotted lines show the effect of shifting the center tap. The full lines show the harmonics obtained with the turn center tap. The results are very good with the 1¼ ratio, but the power is only 1.75 watts. The power for a 1 1/3 ratio is 2.4 watts, but the per cent harmonics are also somewhat higher for power readings above 1.75 watts. The percentages of harmonics for the higher levels are still tolerable, however. It can be seen from the curves herewith that some ratio between 1¼ will be satisfactory both as regards power output and distortion.

We can obtain appreciably more power output with the ER-49 tubes than with the 230 push-push stage. The distortion is about the same in each case. If we can supply more driver power the ER-49 stage will supply about three times the power output of the 230 stage. Theoretically the limit should be twice because we have twice the filament in ER-49 than the 230 tube has. Due to the difference in geometry of the tubes, the 49 tube has its power output with three-quarter the resistance of the 230 tube, so that the theoretical power is 3 times that of the 230 tube, considering, of course, a reasonable limiting value of distortion.

Progress in tubes

THE Hygrade Sylvania Corpn., Emporium, Penna., has announced several new tubes. In addition to the types 56, 57 and 58 described in the May issue of RADIO ENGINEERING, these are:

Type 41 is an intermediate power pentode comparable in performance with the 238, but with increased power output of the order of 1.2 watts as against 725 milliwatts for the 238. When compared with type 47 or other filament type pentodes, hum is greatly reduced and cathode leakage is extremely low because of the special cathode construction employed. More commonly used in automobile sets, the 41 will enjoy some service in a-c. and d-c. line receivers.

Type 42 is similar to the 41 except for higher plate rating (250). Output is 3 watts as compared with 2.5 for the 47.

Type 44 is a five-element tube with more remote (cutoff) variable new features for a-c., d-c. line and automobile service with improved features over 235 and 551—because of the use of a suppressor grid.

Type 46 is a tube of new construction, its outstanding point being that when operated in "push-push" as class B amplifier the power output for two tubes is of the order of 16 watts with a power efficiency of about 60 per cent as compared to 27 per cent for the average pentode. Used as a class A amplifier with power output of 1.25 watts, it will be frequently used as a "driver" for a stage of class B amplification.

Type 82 is a full-wave mercury vapor rectifier with tube voltage drop of 15 volts, regardless of amount of current used in load, thus assuring proper regulation and making the tube especially suited for class B work.

Type 866 is a half-wave mercury vapor rectifier which takes very high peak current and will operate efficiently at a much higher inverse peak voltage (7,500 volts).

Sylvania Type 41 is a special 6.3-volt cathode type power output pentode designed especially for use in automobile receivers, d-c. line receivers and any other applications where considerable output is desired if not more than 180 volts is available. It is not recommended to apply more than 180 volts to the tube since excessive temperatures will result because of the small bulb size and the tube will be damaged. The 42 should be employed where more than 180 volts is available.

The 41 is considerably different in construction than is the SY-238 and cannot be used to replace the 38 since the 41 is equipped with a six-prong base.

When operated self-biased with 180 volts applied this tube is capable of delivering 1.2 watts to a load of 11,000 ohms with minimum second harmonic.

Circuit Requirements

Filament. The filament is intended for a-c. or d-c. operation at 6.3 volts and requires .65 ampere. An indirectly heated cathode is used in this tube permitting series operation of filaments without any loss in effective voltage supplied to the plate.

The normal voltage range encountered in automobile service will not appreciably change the operating characteristics of the tube making it unnecessary to employ series resistors in the filament circuit.

Base. The 41 tube employs a medium 6 prong base. The prongs are arranged in a similar fashion to those of a 5-prong base except that two pins instead of one are located opposite the filament pins. The filament pins are the two large pins. Looking at the bottom of the base and going in a clockwise direction from the filament pins, the connections are as follows: plate, screen, control grid, and cathode. A standard 6-prong socket is used to accommodate the tube.

Grid resistor. The 41 will find general application as an output tube, resistance coupled from either the detector tube or the first audio stage if diode detection is used. If resistance coupling is used the grid resistor must not exceed 250,000 ohms in value. This value should be employed *only* when the tube is operated entirely self-biased. If the tube is operated with a fixed bias or partially so, the resistor should not exceed 100,000 ohms.

The recommended load resistance should be used if possible in order to keep the second harmonic at a minimum. If, however, the tubes are used in push-pull class A somewhat lower third harmonic in the output may be obtained by employing a lower load for both tubes than normal since the second harmonics will cancel in push-pull.

Tentative Rating and Characteristics

Heater	Coated uni-potential		
Volts	6.3		
Amperes	.65		
Plate volts	180	maximum	
Screen volts	180	maximum	
Grid bias volts	-12.5		
Operating conditions and characteristics:			
Filament voltage ..	6.3	6.3	volts A-C. or D-C.
Plate voltage	167.5	125	volts
Screen voltage	167.5	125	volts
Grid voltage	-12.5	-10.0	volts
Amplification factor	215	210	
Plate resistance ...	120,000	150,000	ohms
Mutual conductance	1800	1400	micromhos
Plate current	16.5	11.0	ma.
Screen current	3.5	3.0	ma.
Load resistance	11,000	13,000	ohms
Max. undistorted power output	1.20	.65	watts
Interelectrode Capacitances:			
Grid-plate capacitance	.5	uuf.	
Input capacitance .	7.5	uuf.	
Output capacitance.	8.6	uuf.	
Overall length (maximum)	4 11/16"		
Maximum overall diameter	1 13/16"		
Bulb	S-14		

▲

Cunningham C-57 Triple-Grid Amplifier Detector

THE C-57 is a triple-grid amplifier detector tube recommended especially for service as a biased detector in a-c. receivers employing the C-56 and/or C-58. In such service this tube is capable of delivering a large audio-frequency output voltage of good quality at relatively small input voltages. Other applications of the C-57 include its use as a low signal input screen grid amplifier tube and as an automatic volume control tube. The C-57 is characterized by the small overall size, the dome-top bulb, the internal shield in the dome, the rigidity of construction, and the fifth electrode or "suppressor" with its own base pin terminal. Equally significant among its electrical features are its relatively low heater consumption, its sharp plate current "cutoff" with respect to grid voltage, and its adaptability of electrode combinations to unusual circuit applications.

This tube is not interchangeable with any other Cunningham tube.

Design Structure Considerations

The suppressor grid employed in the design of this tube is placed between the screen and the plate and has its own pin connection. The suppressor may or may not be connected to the cathode terminal depending upon receiver design requirements.

When these two terminals are connected directly together, the suppressor is effective in eliminating the secondary emission effects which limit the voltage swing permissible in the usual screen grid tube at low plate voltage, that is, at a plate voltage approximately equal to the screen voltage. The suppressor, therefore, makes possible the efficient operation of this type at a relatively low plate voltage, that is, at a plate voltage approximately equal to the screen voltage.

When the suppressor is not connected directly to the cathode it may be utilized in a number of ways for obtaining modified tube characteristics and for application of the tube to special circuits.

Rating and characteristics of the 57 are as follows:

General

Heater voltage ....2.5 volts a-c or d-c.
Heater current ....1.0 ampere
Direct interelectrode capacitances:
Effective grid-plate..0.010 uuf max. (shield can)
Input ....5.2 uuf
Output ....6.8 uuf
Overall length ....4-19/32 to 4-27/32 inches
Maximum diameter............1-9/16 inhes
Bulb ....ST-12 (dome shape)
Cap ....Small metal
Base ....Small 6-pin

Amplifier (Class A)

Operating conditions and characteristics:
Heater voltage .... 2.5 volts
Plate voltage .... 250 volts, max.
Screen voltage .... 100 volts, max.
Grid voltage .... —3 volts
Amplification factor:
Greater than 1500
Plate resistance:
Greater than 1.5 megohms
Mutual conductance ......1225 micromhos
Grid voltage for cathode current cut-off .... 7 volts, approx.
Plate current .... 2.0 milliamperes
Screen current .... 1.0 milliampere, max.

Detector

Operating conditions as biased detector:
Heater voltage .... 2.5 volts
Plate voltage .... 250 volts, max.
Screen voltage .... 100 volts, max.
Grid voltage .... -6 volts, approx.
Plate load—250,000 ohms or 500 henry choke shunted by a .25 megohm resistor. For resistance load, plate supply voltage will be voltage at plate plus voltage drop in load caused by specified plate current.
Plate current—Adjusted to approximately 0.1 milliampere with no a-c. input signal.

Installation

The *base* of the 57 is of the small 6-pin type. Its pins require the use of a standard six-contact socket which may be installed to operate the tube either in a vertical or in a horizontal position. For horizontal operation, the socket should be positioned with its heater pin openings one vertically above the other.

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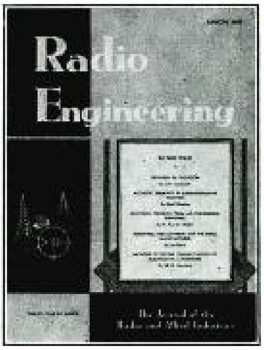
Three Tubes in One—The 55 Arrives

RADIOTRON RCA-55 and Cunningham C-55. This new a-c. heater type tube is in reality three tubes in one—two diodes and one triode employing a common cathode sleeve, but each operating independently of the other. The 55 is capable of performing simultaneously the functions of detection, amplification, and automatic volume control of the input signal.

The design features of the 55 permit of unusual flexibility in its application to receiver circuit design. Numerous compact designs with excellent performance capabilities are thus made possible by this new type.

The 55 is an a-c. heater type of tube consisting of two diodes and a triode in a single bulb. It is recommended for service as a combined detector, amplifier and automatic volume control tube.



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MEISSNER BUYS RADIO COIL AND WIRE

In an interview with W. O. Meissner, president of the Meissner Manufacturing Company, 2815 West 19th Street, Chicago, Mr. Meissner announced that his company has purchased the business, equipment, patents, patent applications and good-will of the Radio Coil & Wire Company, formerly located at 847 West Harrison Street, Chicago, Illinois.

Mr. Meissner, one of the pioneers in the component parts business, made the following statement:

"It is significant in view of the present times that we have purchased the second largest coil company in the middle west. The combined facilities give us complete equipment for the efficient manufacture of any type of coil used in the industry.

"We have completed the removal of the equipment and records and are immediately in a position to serve the former customers of Radio Coil & Wire Corporation as well as our own.

"Coming, as it does, when the industry is at its lowest ebb, this purchase establishes our faith in the future of the radio industry.

"With our increased facilities and with our advance into other fields, it is natural for us to augment our organization. We are pleased to announce the appointment as sales manager of G. V. Rockey, formerly general sales manager of P. R. Mallory & Company, Inc., of Indianapolis, and until its purchase by us, general manager of Radio Coil & Wire Corporation."

There are no other changes in personnel. Mr. Meissner remains as president. James T. Watson, vice-president, and J. C. McGinley, treasurer.

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DUBILIER PRODUCTION NOW HEADED BY JOSEPH F. COOK

The production activities of the Dubilier Condenser Corporation are now headed by Joseph F. Cook, according to the announcement of the management. Mr. Cook, an M.I.T. man, comes to Dubilier from the RCA-Victor plant in Boston, where he has been identified with engineering and production activities mainly bearing on receiving and transmitting condensers. He is also recognized as an authority on centrallized radio technique. For five years prior to the acquisition of the plant by RCA-Victor, he was identified with the Wireless Specialty Apparatus Company.

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PARVOLT CONDENSERS

In order to meet the demand for a high quality product, the Acme Wire Company of New Haven, Connecticut, makers of the well-known Parvolt condensers, are consistently testing various raw materials in order to be able to give to the trade the very best they can in this type of condenser.

All raw materials used by this company are purchased to specification and all materials are given very rigid tests before they are passed on to the production department. The condensers are given many tests during manufacture, such as capacity, insulation resistance, power factor and breakdown. All of these tests are well within the R.M.A. standards.

In order to keep a check on materials and processes used, many units of different voltage ratings and capacities are kept constantly on life test. This company has furnished condensers to the electrical trade for many years where they have been used with success for many purposes, such as for the correction of low power-factor and in the radio industry.

Within the past year, the engineers of the Acme Wire Company have developed an oil-impregnated, oil-filled condenser for use on a-c. circuits. These units have proven satisfactory and many manufactured by this company are at present used for capacitor motor application. These units are made of the highest grade of paper obtainable and the individual condenser cartridges, which make up the complete unit, are held firmly together by a special steel clamp which assures a permanent fixed capacity during the entire life of the condenser.

The impregnating oil used in these units has been developed especially for condensers and has a high insulation resistance, low power factor losses and a high dielectric.

The complete units are housed in a metal can with double roll seams which are soldered. The containers are of uniform dimensions, varying only in height with different capacities and working voltages. Connections are made at the top of the cans; screw binding posts are used with terminal lugs and are insulated from the can by high dielectric insulators.

These units are leak-proof and will operate in any position. They are made to standard specifications. Estimates will be gladly furnished to special designs.

John G. Kreis is a member of the engineering staff of Acme.

▲

THOMASTON LABORATORIES

Associated with Thomaston Laboratories, Inc., 135 Liberty St., New York, are engineers and practical amplifier men whose combined experience has made possible better design, better workmanship, and better value than have been possible heretofore. These men are anxious to have every TomLab product, whether it is a power transformer, choke, audio transformer, condenser, resistor, speaker, microphone, meter or complete installation give perfect satisfaction.

Every TomLab product is guaranteed against defect in material and workmanship, and will be replaced free at the main office in the event of such defect, within 90 days of purchase.

CRYSTALS

Piezoelectric crystals for all radio and experimental purposes are available from the Scientific Radio Service, 124 Jackson avenue, University Park, Hyattsville, Md.

▲

TUBE TESTERS

A thoroughly dependable tube tester, with Jewell meter, is that now being supplied by the Apparatus Design Company, Inc., Little Rock, Ark. The instrument is called the "Confidence" and it has a direct reading scale indicator in terms of English words. This tester is a convincing sales help in furthering tube replacement.

▲

TRANSFORMERS

Forty years of leadership in the design and manufacture of audio and power transformers and choke units qualifies the Thordarson Electric Company, 500 West Huron St., Chicago, Ills., to design, or to supply from stock, transformers to satisfy all demands in the radio and sound industries.

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RESISTANCE UNITS

Dividohm units, manufactured by the Ohmite Mfg. Co., 636 N. Albany St., Chicago, Ill., are made in three sizes, 2-inch, 4-inch and 6-inch, which are rated at 30 watts, 55 watts and 75 watts respectively. The resistance values range from 1 ohm to 100,000 ohms, thus covering all standard voltage divider values. A complete list of values is found in the Ohmite Radio Resistor Bulletin No. 10.

The Ohmite vitreous enamel used on these units is classified by the Underwriters' Laboratory as a class C insulation. This is the highest rating given to any insulating material. In addition, vitreous enamel is one of the best known conductors of heat and offers a ready path for the dissipation of the heat generated in the winding. Thus the units may be used at their full rated values when installed where there is normal air circulation.

▲

HARDWICK, HINDLE MOVES

Hardwick, Hindle, Inc., announces the removal of its offices and manufacturing activities into a portion of the plant of National Lock Washer Company, located at 40 Hermon Street, Newark, N. J., where operations will be continued under the personal direction of A. H. Hardwick, assisted by the present supervisory and engineering staffs.

The greatly increased facilities will enable Hardwick, Hindle, Inc., to render an even broader, more cooperative and valuable service than has heretofore been possible.

BOMBARDERS

High frequency electric power converters for bombarding radio tubes, cells and lamps, in manufacture, have been developed to a high standard by the Lepel High Frequency Labs., Inc., 39 West 60th Street, New York.

In 1908 Egbert von Lepel was granted a basic patent covering the quenched spark gap method of generating electric high frequency energy, which up to recent years was the most popular high frequency generator for both high frequency power purposes and wireless telegraphy. Lately wireless telephony and radio broadcasting, which necessitates microphonic modulation, sinusoidal and continuous wave characteristics popularized the three element oscillator tube for that purpose. However, bearing in mind that high frequency inductive heating does not require these characteristics, the question of high frequency generator design for these purposes reduces itself to the following:

1. overall efficiency; 2. durability; 3. flexibility; 4. ruggedness; 5. initial cost; 6. maintenance cost; 7. a design and construction which will stand up under rough and continuous usage, which a tool or production machine is subject to.

The Lepel organizations have pioneered and closely followed the evolution of developments throughout the high frequency field; thoroughly considering the advantages and disadvantages of the numerous types of high frequency generators; present to the users of high frequency energy, other than wireless communication, equipment well capable of meeting the aforementioned requirements.

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VACUUM TUBE TRANSFORMERS AND CHOKES

The Delta Manufacturing Company, Cambridge, Mass., is a reorganization of electrical engineers and manufacturers who for more than twenty years have been engaged in the development and production of many types of electrical apparatus. For the past twelve years the greater part of their attention has been given to the design and construction of complete devices and accessories for use with vacuum tubes. The complete devices comprise in part, amplifiers, rectified a-c. power units of all types, filters, and photo-cell devices. The accessories consist of power transformers, audio coupling transformers, and choke coils. Many of these items are in use by the U. S. Government, broadcasting chains, theatres, colleges, commercial laboratories, and as component parts of the products of well known manufacturers.

The knowledge and experience gained from making these products over this long period is now made available to all users of vacuum tubes.

▲

DUBILIER CONDENSERS FOR BROADCAST TRANSMITTERS

In the several 50-kilowatt Western Electric broadcast transmitters to be installed in various parts of the country for improved broadcasting service, Dubilier condensers are employed throughout, according to the engineering department of the Dubilier Condenser Corporation. The mica condensers are designed for the highest voltages to be encountered in service, as well as for lowest losses, thereby contributing liberally to the reliability and efficiency of the high-power transmitters soon to go on the air.

MICA INSULATOR COMPANY

The Mica Insulator Company of 200 Varick Street, New York City, announce that effective June 1 they will have their own branch office in the Schofield Building, 9th Street and Euclid Ave., Cleveland, Ohio. E. H. Maypother will be the branch manager. This office will serve a large section of Ohio, and will carry a comprehensive stock of all kinds of electrical insulations.

▲

NEW AND IMPROVED SUPERIOR TUNGSTEN

An improved and superior tungsten rod and wire has recently been perfected. This new product will be known as type 600 WH tungsten. The process and ingredients are such as to give a finished product having desired qualities necessary to make Callite tungsten the ideal material for radio tube, incandescent lamp and neon sign applications.

An expert technical staff maintains rigid control of all raw materials as to physical structure and chemical purity. Careful control of the proper grain structure of the bar, uniform operating conditions of swaging and drawing, specially designed dies—all these factors insure a finished product of uniformly high quality.

Special ground finish tungsten rods, free from surface and longitudinal cracks and fissures are particularly well suited for sealing in to hard glass, giving maximum current carrying capacity and low percentage of rejections due to faulty seals.

Filament wire for cathodes now has a slower rate of recrystallization, thereby maintaining its ductility, particularly during and after processing.

Tungsten support wire can now be furnished to any desired temper best suited for the particular tube and filament design.

This new product is announced by the Callite Products Company, Union City, N. J.

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A. D. STRATHY, FACTORY REPRESENTATIVE

A. D. Strathy, for the past six years with KenRad and with Cable Radio Tube Corpn., has now established headquarters at 110 West 42d St., New York, carrying on a sales organization as factory representatives for Manhattan, Brooklyn and Long Island.

▲

NEW REMOTE CONTROL FOR RADIO

For use with radio receivers in the home the Federal Telegraph Company, Newark, N. J., announces a new remote control device.

The Federal remote control is the result of many years of extensive research and development work on various types of remote control devices, electrical and mechanical. The unlimited facilities of the laboratories of the Federal Telegraph Company—one of the world's foremost institutions devoted to precision work—have been employed in perfecting the Federal remote control for use with radios in the home and for automobile radios.

By means of the Federal remote control you can start and stop your radio set; you can "tune-in" on any broadcasting station; you can re-dial; you can regulate the volume control; you can sit in one room and control your radio set in another room, and you can do all this while seated in your chair or lying in your bed, without having to go near the radio set. But if you wish, you can also do this from the radio set because the remote control operates independently of the controls on the radio set.

The Federal remote control has a vernier adjustment which allows the most critical tuning. It has a pilot light illuminating the dial which can be read at a glance. It is supplied with 25 feet (about 8 meters) of cable which includes the control cable and the electric conductors. Longer cable can be supplied upon specification.

The Federal remote control is mounted by means of a pin which is inserted into a hole in the condenser plate of the radio set, and held by a set screw to the shaft of the condenser. After connecting the wires to the pilot light and to the volume regulator, the remote control is ready to operate. An "off and on" switch is provided to be used instead of the switch on the radio set and this switch is operated either at the set or at the remote control when turned in zero position.

▲

MESH AND WIRE

The Gilby Wire Company, 150 Riverside Ave., Newark, N. J., are long established manufacturers of wire and plate materials, and special alloys for various purposes; Gilby processed carbonized nickel for plates; selvage mesh; nickel-chrome resistance wire and sheet.

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NEW TUBES DESCRIBED

New radio tubes described in recent issues of RADIO ENGINEERING include:

January, 1932—RCA 239, Arcturus 36, 37, 38; Sylvania 239.

February, 1932—Arcturus E766, E772.

March, 1932—Arcturus 136a, 137, 138, 139; Cable triple twin; RCA 234.

April, 1932—Wunderlich tube.

May, 1932—RCA 46, 56, 57, 58, 82; Arcturus 703a; Speed 256; Sylvania 56, 57, 58.

June, 1932—Arcturus 46, 56, 57, 58, 82.

July, 1932—Raytheon ER49; RCA 46; Sylvania 41, 42, 44, 46, 82, 866; Cunningham C-46, C-55, C-57.

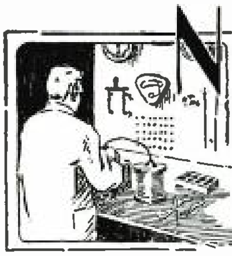
▲

CONSTANT SPEED GENERATOR WITH GOVERNING SWITCH

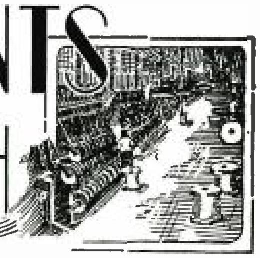
This machine will operate at constant speed, and when furnished as a self-excited a-c. generator, will deliver constant output voltage and frequency, when driven from a source of power, the speed of which is varying. It is particularly applicable to a-c. generators supplying power to sound amplifiers or talking moving picture equipment mounted on motor trucks. The generators may be driven from the automobile or truck engine, and will then provide a constant and reliable source of power.

The generator consists in a self-excited alternator, with d-c. windings for field excitation, which may also be used for charging the storage battery, if desired, and with a-c. windings delivering 60 cycles, a-c. A special centrifugal clutch has been developed for driving these generators. The working faces of the clutch are covered with a special lining which has a constant coefficient of friction throughout a very wide range of activity. The entire machine is furnished totally enclosed, with ribs on the clutch housing to dissipate the heat, and non-corrodible parts are used throughout. As a result a very constant output voltage and frequency is obtained and also the equipment is exceptionally durable.

The generator is being marketed by the Electric Specialty Company, Stamford, Conn.



NEW DEVELOPMENTS OF THE MONTH



MOTOR RADIO SUPPRESSOR HANDIPAKS

As a fitting companion for the Lynch Handipak of 10 assorted radio resistors, the Lynch Mfg. Co., 1775 Broadway, N. Y. City, offers to the trade in convenient and handy form the required suppressors for the successful operation of auto radio sets. The motor radio suppressor handipaks also contain a sturdy 1 ufd. ignition filter condenser fitted with a convenient assembly metal band and flexible lead. Each suppressor handipak contains complete information on the suppression of ignition noises and schematic assembly diagram. The suppressors are based on the Lynch metallized principle. The capacity is extremely low—less than 0.5 uuf. The resistance range is 15,000 ohms or optional. Lynch motor radio suppressor handipaks are furnished for 4, 6 and 8 cylinder cars.

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UNCASED CONDENSERS

Morrill & Morrill, 30 Church Street. New York City, who are United States distributors for the Siemens & Halske condensers and resistors are featuring a new uncased paper condenser which is designed to meet the requirements of American servicemen. These condensers are available in the following capacities: .1, .25, .5, 1, 2, 4 ufd. They are rated at 600 d-c. operating volts and are tested at 1,500 d-c. volts. They are completely dipped in pitch and covered with a special fishskin paper and are provided with rubber-covered leads about 5¼ inches long. These condensers are extremely compact, the 2 ufd. number being 2 inches by 1⅝ inches by ⅞ inch. These condensers are finding a wide acceptance among servicemen on account of their extreme reliability under exacting conditions of use. Morrill & Morrill will be glad to send a special circular covering these condensers upon request.

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A GOOD ANALYZER

Jewell Pattern 444 Radio Set Analyzer is a 2-meter analyzer for every type radio receiver and for testing full wave rectifier, variable-mu, output pentode, pentodes having a direct connected fifth element, and the new six-prong type tubes.

A-c. and d-c. circuit tests are controlled by separate rotary selector switches. In addition to set socket tests, twenty-four ranges are available at pin jacks—for external testing. Among these are three output meter ranges and three resistance ranges.

The instrument ranges are: a-c. meter. 0-4-8 amperes, 0-20-100 ma. and 0-4-8-160-800 volts; d-c. meter, 0-12-60-120 ma., 0-6-12-30-60-120-300-600 volts, 0-1,000-10,000-100,000 ohms and low-medium-high output ranges.

Accessories supplied: Test leads with insulated prods and molded pin-plugs, test leads with clips for speaker voice coil leads and molded pin-plugs, line plug and cord with molded pin-plugs and an adapter for output measurements at tube socket, instruction book. Dimensions: 12¾ x 12 x 4½ inches. Approximate weight, 10 pounds.

The instrument is announced by the Weston Electric Instrument Corpn., Newark, N. J.

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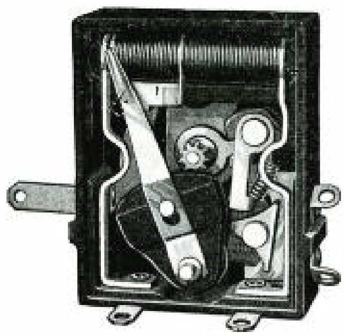
SOLID MOLDED RESISTORS

For automobile radios and for console models the solid molded resistors marketed by the Allen-Bradley Co., 126 West Greenfield Ave., Milwaukee, Wis., are meeting with general acceptance. The satisfactory operation of receivers depends to a large extent upon the accuracy of the fixed resistors employed.



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NEW FILAMENT RIBBON FOR TUBES

Walter Gilby, of Gilby Alloy Company, whose plant is located at 850 to 854 Mt. Prospect Ave., Newark, N. J., announced recently the addition of Charles Ruttenbach to his staff.

Mr. Ruttenbach, who perhaps has the distinction of having rolled more filament than any other individual in the industry, is to take charge of the filament and fine ribbon departments.

He has been associated with Mr. Gilby for over twenty-five years. First at Driver Harris and until recently with the Gilby Wire Company. During this time he specialized in the production of very fine ribbons.

In view of the tendency of radio tube manufacturers to work to closer limits, Mr. Ruttenbach is supervising the construction of new machines which will permit closer tolerances on filament ribbon. Mr. Ruttenbach stated that shortly his company will put on the market a new alloy filament ribbon to replace both pure and silicon nickel for all types of receiving tubes.

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NEW CINCH BINDING POST

In keeping with the trend and requirements of present-day conditions, a new, low cost binding post has just been announced by the Cinch Manufacturing Corporation.

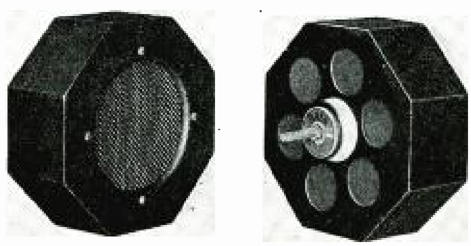
Two types are provided. One is a machine screw type; the other is provided with knurled head screws. They come with 1 11/16 inch standard mounting centers. Lugs are sturdily mounted in 1/16 inch thick Bakelite. Both lugs and screws are Cinch soldered coated to resist corrosion and oxidation. Any size wire is accommodated and a quick, dependable contact is assured.

For samples and prices, without obligation, write the Cinch Manufacturing Corp., 2339 W. Van Buren St., Chicago. Ill.

▲

NEW ROLA AUTOMOBILE RADIO SPEAKER

Rola's new automobile unit is a striking example of Rola's craftsmanship and engineering. Newly designed and improved, it offers those added features necessary to fit the needs of this particular field. It is light in weight, is in an octagon-shaped wood case, and has a single stud mounting for quick installation. Built in two sizes specially for hard service.



Front and back views of Rola auto radio speaker.

INDEX OF ADVERTISERS

● This startling NEW series needed no high powered sales campaign to get "over the top." Our sales methods are simple . . . make a BETTER product—PRICE it right—TELL' em about it.

● YOU will be interested in learning more about the product that made the Radio Industry" say it with orders."

CRC's 500 Series *socket*

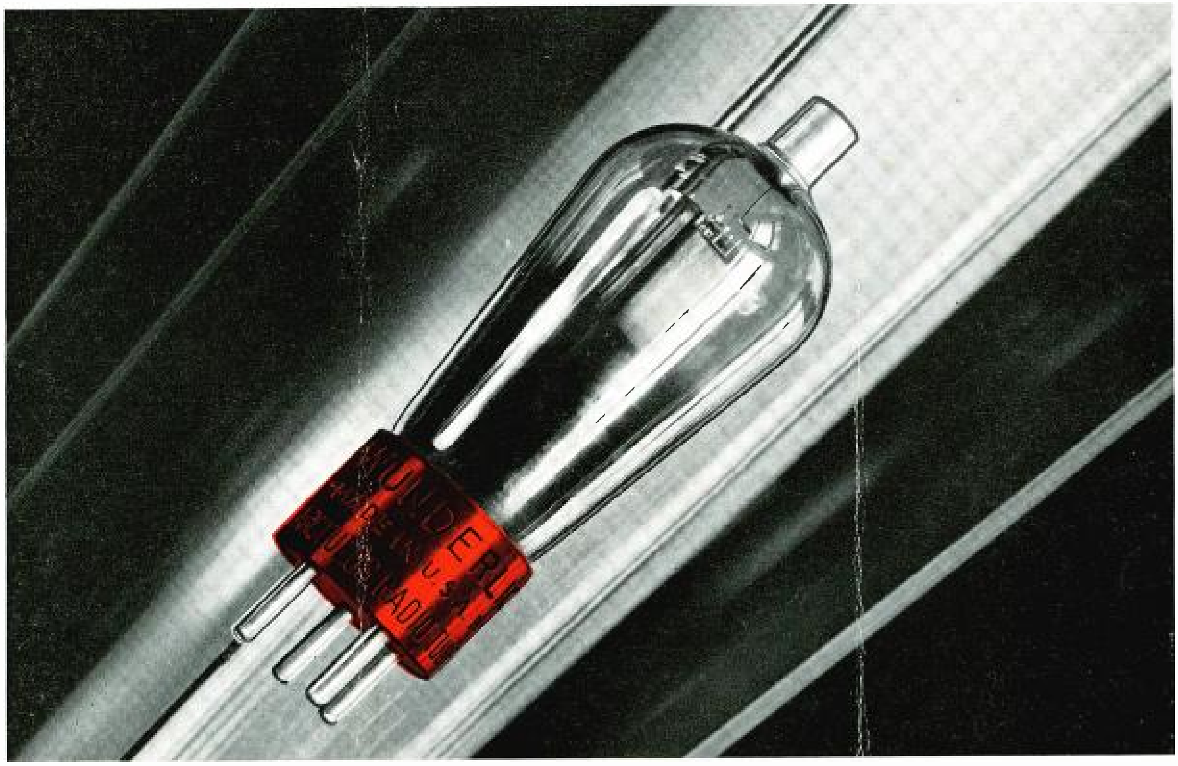
completes the CRC line, providing sockets well suited to present day price requirements. The ever popular 600 and 800 series with spring reinforced contacts will continue in production to take care of the demand for the best all around sockets obtainable. ● Send for blueprint showing various sizes and mounting center combinations available in the 500 series and the booklet entitled "NINE REASONS WHY."

CENTRAL RADIO CORPORATION
Beloit Wisconsin

CRC

Unmistakably Identified

by brilliant red Bakelite Molded base

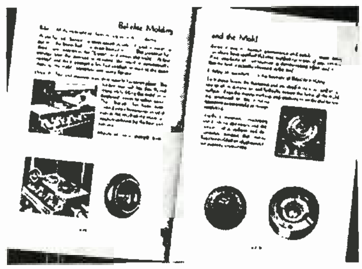


Wunderlich tube, manufactured by the Arcturus Radio Tube Company, Newark, N. J.

"WUNDERLICH", the new Arcturus tube is most effectively trade-marked by its brilliant red Bakelite Molded base. No need to look for the name—a glance identifies it.

The practical value of Bakelite Molded for radio parts is universally conceded by radio engineers and manufacturers. We invite you to consider the additional value that may often be obtained by adopting one or more of the many attractive colors of Bakelite Molded, for quick identification or for added beauty. There is a form of Bakelite Molded suitable for most radio insulation requirements. The ease and accuracy with which this material may be formed, its durable color and finish, and resistance to extremes of heat and cold, to moisture and most chemicals, make it ideal for radio purposes.

We invite you to enlist the cooperation of our engineers in adapting Bakelite Materials to your particular needs, and to write for a copy of interesting Booklet 12M, "Bakelite Molded", which fully describes this material, its properties and uses.



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