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655th Consecutive Issue — Thirteenth Year

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Oct. 13th 1934

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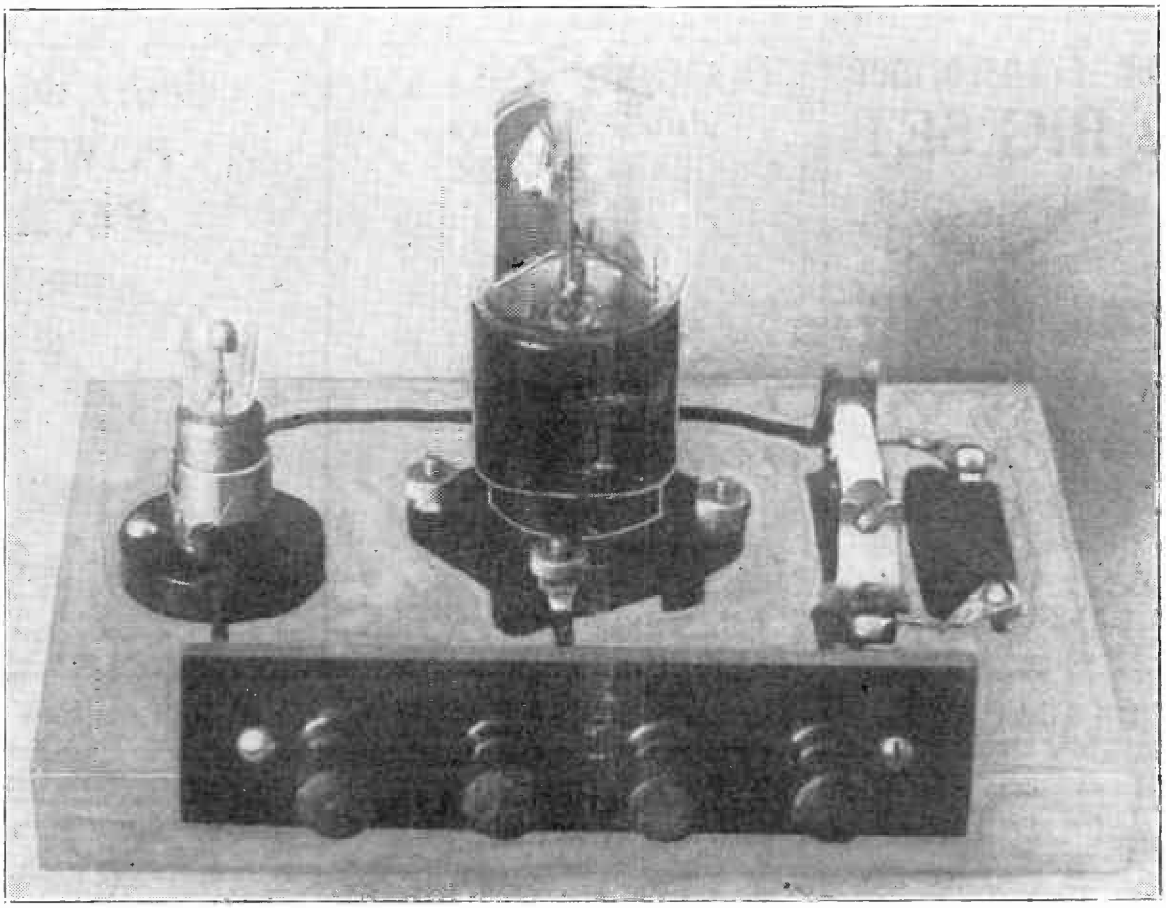
Uses for Neon Tubes

NOVEL AUDIO OSCILLATOR



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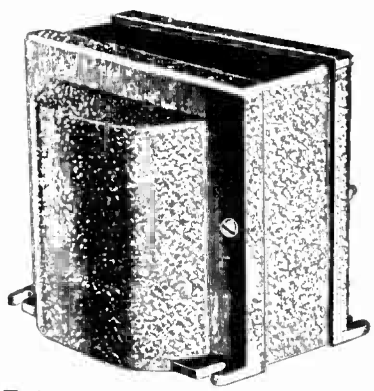

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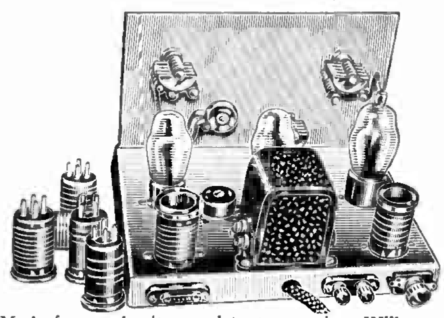

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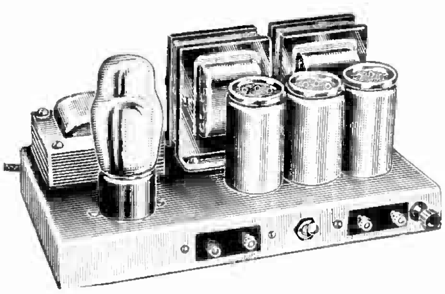

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A Novel Audio Oscillator

Photo-Electric Glow-Discharge Combination Used

By Melchor Centeno V., E.E.

IN the December 16th, 1933, issue of Radio World was published an article entitled "A New Combination of Glow-Discharge Oscillator and Photo-Electric Cell" in which I described the development of an oscillatory device characterized by varying its frequency with variations in the radiation acting on the photo-electric cell, the frequency and the radiation being so related that an increase (or decrease) of the latter generated a corresponding increase (or decrease) in the former. In other words, the frequency of that device varies in the *same direction* as the incident radiation varies.

The present article deals with a device of the same class, but in which the frequency and the radiation are related in an inverse manner, the frequency varying in the *opposite direction* of the variations in the incident radiation. This new device is much more sensitive than the one described in the previous article and possesses other interesting characteristics which will be described presently.

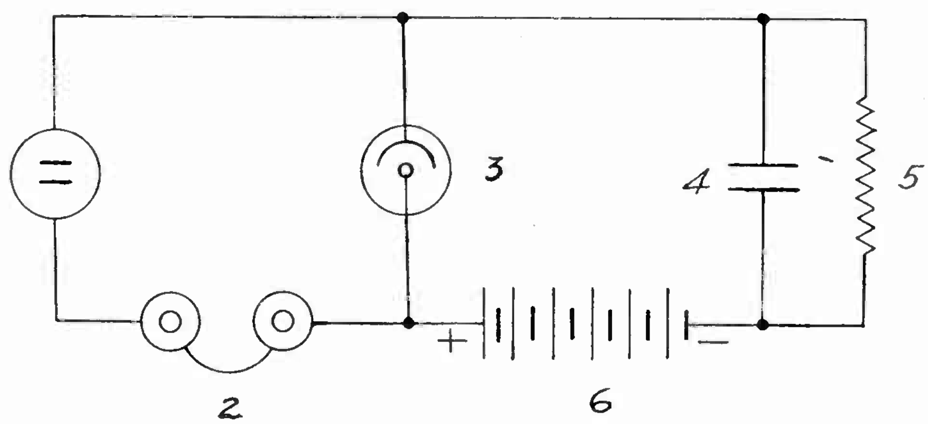


FIG. 1
Diagram of the photo-electric glow-discharge oscillator.

Converted Radiation

Generally stated, the apparatus is a converter of radiation into oscillating electrical currents, the frequency of said currents being determined by the radiation and related to it in such a manner that a change of the latter will produce an opposite change of the former.

Fig. 1 is a diagramatic representation of one of the many practical forms of the apparatus. Numeral 1 indicates a glow-discharge device connected in series with the headphones 2, this series arrangement being connected in parallel with the photo-electric cell 3. A condenser 4 and a resistance 5 are connected together in parallel and then in series with a source of electrical energy 6, this series arrangement being connected across the photo-electric cell 3, as shown. The condenser 4 might be connected across the cell 3 instead of across the resistance 5 without appreciably affecting the characteristics of the device, provided the resistance of source 6 is relatively low. Both types of connections, which might be termed *series* and *parallel,* respectively, are electrically equivalent.

The glow-discharge device 1 may belong to any of the many types of such devices, which are distinguished by possessing the ignition or starting potential of higher value than the extinction or stopping potential. The neon-glow lamps, the familiar spark-gap and the grid-glow tube are typical examples.

Cell Selection

The cell 3 may be of any of the usual types, photo-emissive like the cesium-oxide cells, photo-conductive like the selenium bridges, and photo-voltaic like the "sandwich" cells. In general, for use in this type of oscillators, the electrical impedance of cell 3 must be relatively high, which might be inherent to the cell or secured by means of an external impedance (usually a resistance).

The power source 6 may be of any suitable type, such as batteries, battery eliminators operating from the alternating or direct current mains, et cetera.

Headphones 2 are, of course, not essential for the device to operate. As shown, they serve the purpose of making the oscillations perceptible to the ear. The electrical output from the apparatus may be obtained in other manners and from other places. It may be obtained, for instance, by connecting a suitable reproducer, such as the input side to a thermionic amplifier, across device 1 or across a portion or all of the resistance 5.

Condenser 4 is not essential for the circuit to be operative, since other elements of the apparatus have capacitance. This is particularly notable with respect to device 1, which usually has a relatively large capacity effect caused by the space-charge between the electrodes. The use of condenser 4 is, therefore, a matter of convenience for adjusting the frequency of oscillation at a suitable value for observation.

The photo-electric cell may be connected directly across device 1 instead of as shown, without appreciably affecting the characteristics of the apparatus.

Greater Sound Output

Although the headphones could be connected in series with resistance 5 instead of in series with device 1, the connection illustrated gives the greater sound output of the two, since the initial current through device 1 is usually much larger than the current through resistance 5.

Resistance 5 does not have to be a pure resistance. It might contain capacitance or inductance, either in lumped or in distributed forms. Therefore, numeral 5 stands for an element in which the electrical resistance predominates, although it might be an ele-

(*Continued on next page*)

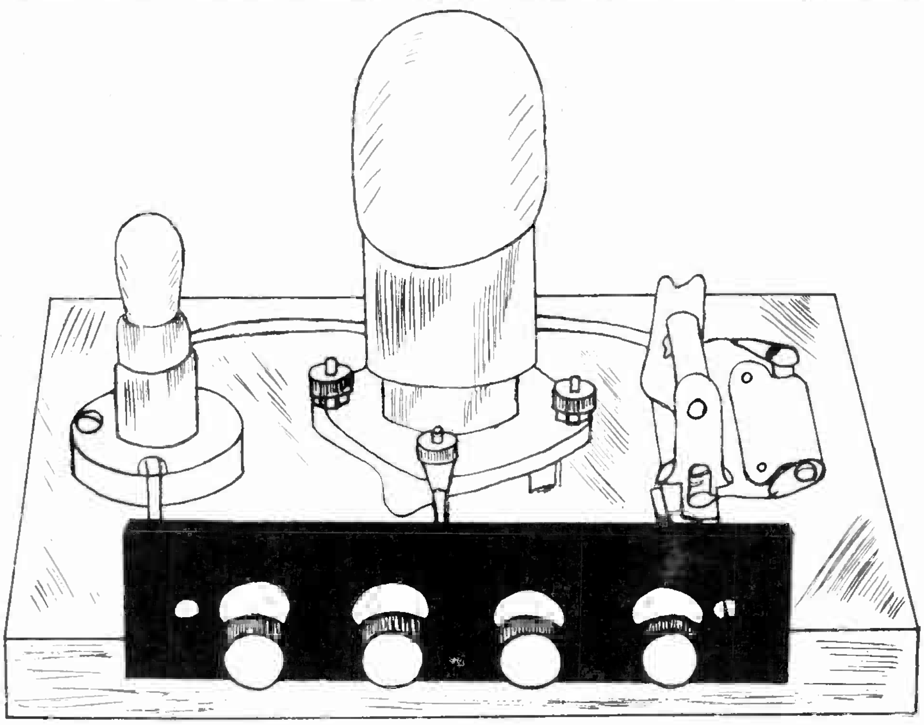


FIG. 2

Set-up of the author's experimental apparatus.

(*Continued from preceding page*)

ment consisting of resistance and capacitance, resistance and inductance, or both. Whatever it be, it must conduct direct current.

The apparatus illustrated in Fig. 1, minus the photo-electric cell 3, constitutes the well-known type of glow-discharge oscillator, whose frequency of oscillation is determined by the values of the resistance 5, the condenser 4, the potential of source 6 and the characteristics of device 1. The introduction of the photo-electric cell 3 in the circuit at the place indicated will affect this frequency of oscillation, since the potential across the cell and, hence, across the device 1, is a function of the radiation incident on said cell. The higher the radiation values, the lower will that potential be and, in consequence, the lower will be the frequency of oscillation.

Layout Explained

For the purposes of studying the characteristics of the apparatus, the following values were taken for the elements of Fig. 1: a photo-emissive cell "Visitron" Type 71A (manufactured by the G-M Laboratories, Inc.), a neon-glow lamp Type S4½ without protective resistance included within its base (manufactured by the General Electric Vapor Lamp Company), a 27.0-megohm resistor, a 100 mmfd. condenser, a pair of 2,350-ohm headphones (with an inductance of approximately 0.5 henry), and standard batteries. The neon-glow lamp possesses an ignition potential of 80.3 volts, an extinction potential of 59.7 volts and a maintenance current for the glow of approximately 0.090 milliamperes.

A photograph of the experimental set-up is shown in Fig. 2. Of the four binding posts at the front, two are for the power supply and the other two are for the headphones. The photo-electric cell is seen at the center of the device, with the neon-glow lamp at one side and the capacitance-resistance parallel combination at the other side. The simplicity of the apparatus is apparent.

Characteristics Summarized

The general characteristics of the oscillator may be summarized in the following seven points:

(1)—The frequency of oscillation varies roughly in inverse proportion to the time constant of the circuit, i. e., to the product of the values of resistance 5 and condenser 4, as is the case with the common glow-discharge oscillator.

(2)—The frequency of oscillation decreases with an increase in the radiation falling on the photo-electric cell. The form of this characteristic is dependent upon the type of photo-electric cell being used. With photo-bolic. With selenium cells the relation is apparently parabolic. This characteristic, for the apparatus studied, is given in Fig. 3. The slight curvature of the characteristic should be noted.

(3)—The ratio of the frequencies produced at different radiation values, is independent of the value of the condenser 4, provided the latter is not too small.

(4)—Within certain limits, the same frequency ratio is obtained for different values of the resistance 5, if the products of these values and the corresponding values of the changes in radiation required for securing that frequency ratio, are maintained approximately constant.

(5)—The sensitivity of the apparatus, i. e., the rate of change of frequency with respect to radiation, increases as the potential of source 6 is decreased. This relation is not a simple one, since the sensitivity under fixed potential is a function of the radiation.

(6)—For any set of values of the potential of source 6 and of the resistance 5, there is a maximum limiting value of radiation which, if surpassed, stops the oscillations. This fact also establishes a limiting value to the maximum frequency change. Increasing the applied potential or decreasing the value of the resistance 5, increases both the limiting value of radiation and the maximum frequency change and, therefore, decreases the sensitivity.

(7)—There is a minimum value of the resistance 5 below which the oscillations cease. This is the usual case with the glow-discharge oscillators.

Figures Explained

Fig. 4 illustrates the characteristics indicated in point (6) with respect to the applied potential. It is clearly seen that as the potential increases, the corresponding values of the frequency ratio (N), decrease, indicating a greater frequency change. The frequency ratio (N) is the ratio of a given frequency to the frequency under zero illumination. A very interesting curve is obtained by joining the values of the frequency ratios (N) at the limiting values of radiation at different voltages. This curve, indicated in Fig. 4 as the envelope of limits, is very nearly an equilateral hyperbola.

Fig. 4 also shows that the sensitivity decreases as the potential is increased, as stated in point (5).

Fig. 5 illustrates the relation between the limiting values of radiation and the applied potential. The relation is a straight line. This is to be expected, because the current through the photo-electric cell is proportional to the radiation.

The curve shown in Fig. 6 indicates the relation existing between the minimum frequency ratios (No) and the applied potential. The curve is an equilateral hyperbola with asymptotes at 0.225 for No and 79.5 volts.

All the given curves apply to a value of 27.0 megohms for the resistance 5 (Fig. 1).

Nearly Equal Products

The characteristic indicated in point (4) is brought out in a striking manner by the following determinations: with an applied potential of 139.2 volts, in order to decrease the frequency to 75 percent of its value under zero illumination, and with 27.0 megohms value for the resistance 5, it is required an illumination of 0.198 foot-candles, as obtained from Fig. 4. With the same voltage of 139.2, but with a resistance value of 11.9 megohms, the required illumination for the same decrease in frequency (to 75 percent of the dark value) is of 0.439 foot-candles. Under the same conditions, if the resistance is further lowered to 9.2 megohms, the required

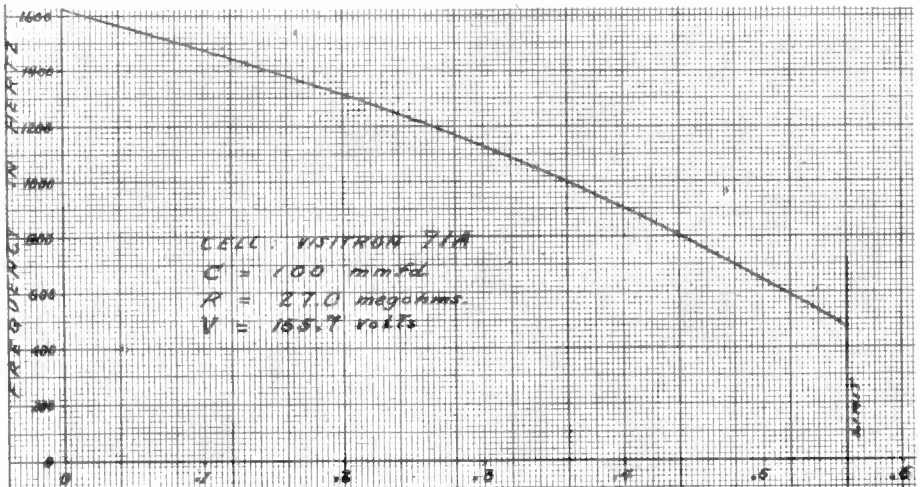


FIG. 3

There is only slight characteristic curvature when frequency is plotted against illumination.

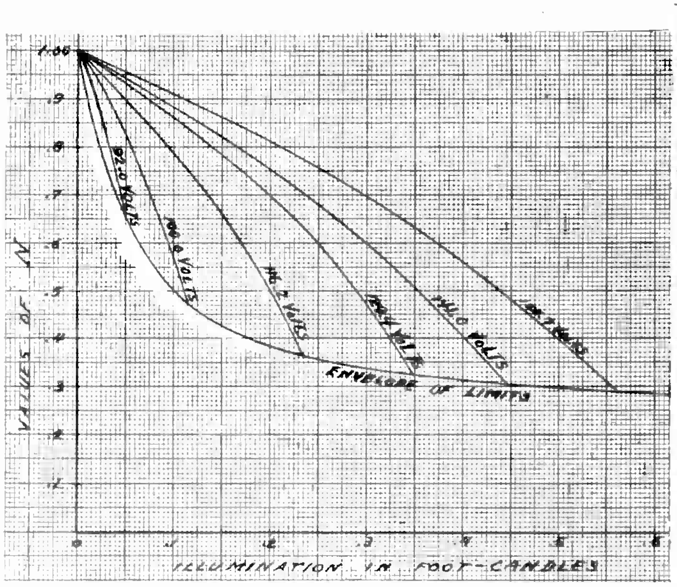


FIG. 4

Characteristic as affected by applied potential, giving values of N and illumination.

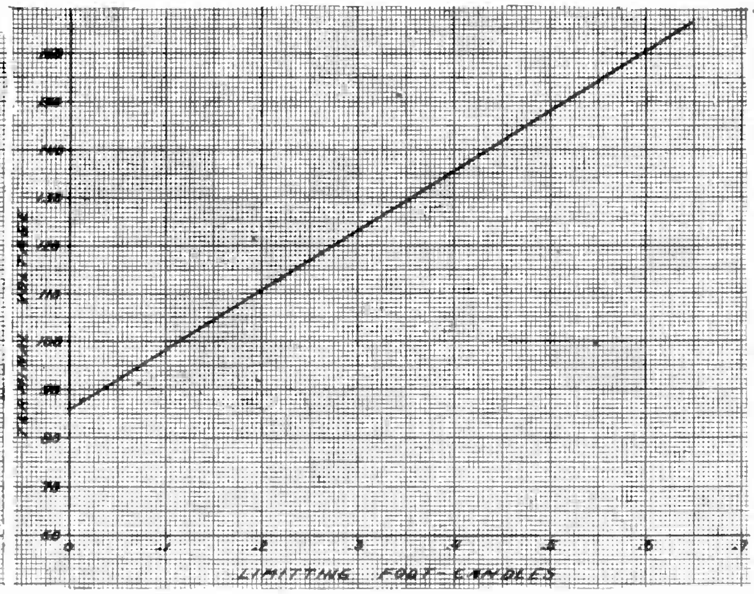


FIG. 5

Relation between limiting values of radiation and applied potential, terminal voltages against limiting foot candles.

illumination for N = 0.75 is of 0.576 foot-candle. Therefore, we have, as suggested in point (4):

$$27.0 \times 0.198 = 5.35$$
$$11.9 \times 0.439 = 5.23$$
$$9.2 \times 0.576 = 5.30$$

The three products are very nearly the same, the maximum difference being of less than three percent, well within the experimental and empirical errors.

Straight-Line Results

With *constant* illumination on the cell, the relation between the frequency of oscillation and the applied voltage is, for this particular apparatus, very nearly a straight line. Therefore, the characteristic indicated in point (1) is only roughly approximate, the time constant of the circuit not being the only determining factor of the frequency of oscillation.

The device studied, due to its interesting characteristics, particularly because of its high photo-frequency sensitivity, lends itself to many practical applications dealing with a variety of subjects, such as relay work, television, talking motion pictures, photometry, colorimetry, etc. One of its most useful practical applications is to a reading apparatus for the blind, which follows the same general rinciples and form set forth for a similar device described in the December 16th article.

The apparatus might be made extraordinarily sensitive and, therefore, adaptable to very delicate radiation measurements, by impressing the output of the oscillator on to a resonating meter, either electrical or mechanical, preferably of the latter type.

A suitable meter for the purpose consists of an electromagnet working on a series of resonating steel rods, such as the meters that are used in determining the frequency of the alternating current supply. With such a meter consisting of, let us say, fifty reeds so tuned that their frequencies differ by one cycle per second or a fraction of one cycle per second, the lowest frequency being of the order of one-hundred or so hertz, we would obtain an extremely sensitive device adapted to measure very minute differences in radiation within a certain radiation range.

Has Delicate Possibilities

In other words, with the oscillator working in a restricted portion of its frequency-radiation characteristic, we would secure by means of the vibrating reed frequency meter, a considerable amplification of the photo-frequency sensitivity over the already large photo-frequency sensitivity of the oscillator itself.

A very crude and relatively insensitive device, built by the writer along these lines, was capable of detecting an illumination *difference* of one-hundredth of a foot-candle at an illumination level of one-fifth of a foot-candle. Obviously, with an appropriate design of the instrument, the sensitivity may be increased many times. The device, therefore, has possibilities in delicate photometric and colorimetric measurements.

The range of frequencies covered by the oscillator is usually restricted to the audio-frequencies, although it is possible to increase that range into the lower radio-frequencies by using suitable glow-discharge tubes, preferentially of the thermionic type provided with means adapted to diminish the space-charge effect between the electrodes. With two-electrode devices such as the familiar spark-gap in rarefied air, the upper frequency limit is of about 150 kc, under certain conditions. With the common neon-glow lamps it is difficult to obtain frequencies higher than about 40 kc.

Modulation Is Practical

If the radiation acting on the photo-electric cell is itself modulated, the output from the oscillator will be frequency-modulated, since the amplitude of oscillation is practically constant. This presumes, of course, that the oscillator's frequency is higher than the frequency of modulation. The frequency-modulated oscillations may be demodulated by means of suitable filters, thereby securing an electrical image of the modulated radiation.

Such an arrangement could be adapted to talking-motion pictures, thus providing a considerable simplification of the problem of amplifying the minute light changes obtained from the sound track. Perhaps the problem of amplifying the television signals might be successfully attacked along the same lines.

TUBES BETTER, CHEAPER

Vacuum tubes are made much better these days than ever before, and cost much less than formerly. Since last January the reduction in price has averaged about 25 per cent. If only the most popular tubes are considered, the reduction in price is a much greater percentage.

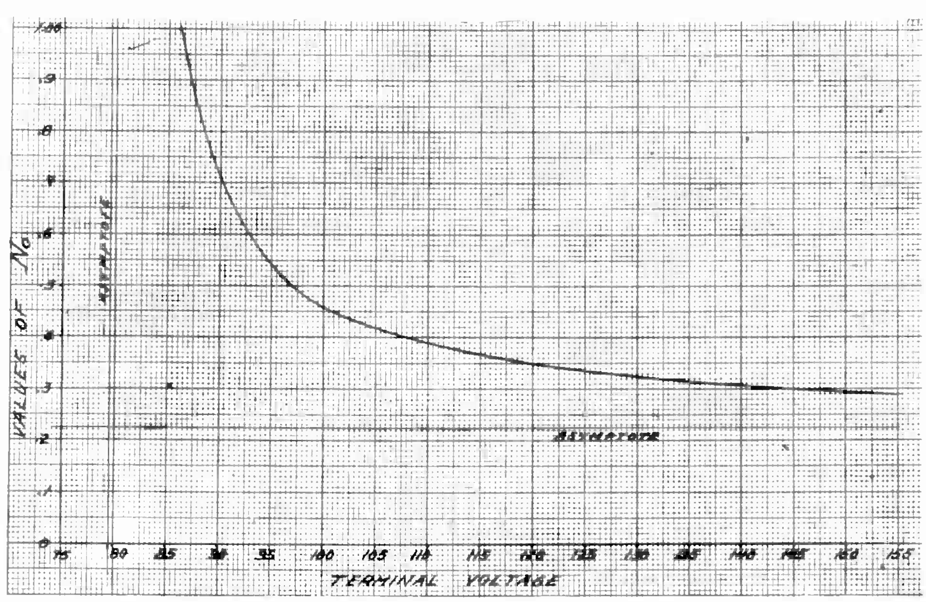


FIG. 6

Relation between minimum frequency ratios (No) and the applied potential.

Micro-Wave Circuits
For the New 955 "Acorn" Type Tube

By Harvey Sampson

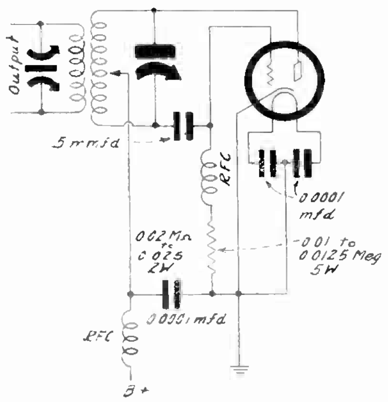


FIG. 1
A Hartley oscillator for the new tube. By-passed earphones may be put in the plate leg for listening, and some regeneration control introduced. Otherwise this is simply a generator.

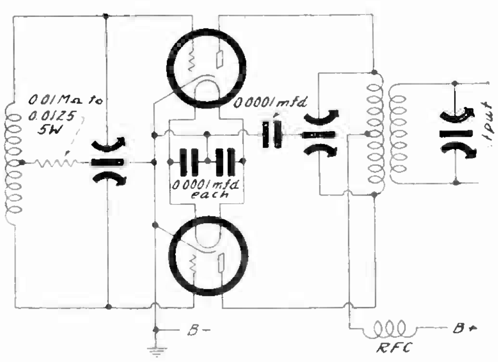


FIG. 2
A push-pull circuit, although requiring two tubes, permits the omission of some parts found in the one-tube model. The push-pull circuit has a lower harmonic content. In fact, when balanced, the even-order harmonics are assumptively suppressed, a general statement applicable to push-pull.

THE introduction of the 955 tube opens up the field of ultra-frequency or micro-wave experiments, using a triode conventionally. This small tube is intended for work on wavelengths below 5 meters, and is supposed to oscillate down to 0.5 meter. Some foreign tubes have offered this service, and of course domestic tubes of the receiver type have been pressed into compulsory service, both as standard-circut oscillators, and as special forms of oscillators, such as the Barkhausen-Kurz and the Gill-Morrell.

The trouble with the special oscillator circuits has been that the power output was extremely small and the tube life was greatly shortened, due to the large grid current. Moreover, stability is lacking. These "specials" use a positive voltage on the grid and a negative or zero voltage on the plate, and oscillate by virtue of the tube geometry or the voltages applied or, more likely, a combination of both.

In the Barkhausen-Kurz oscillators the maximum amplitude obtains when the frequency of oscillation is the same as the frequency of the load circuit, which may consist of parallel wires with a shorting strap across them (Lecher wires), though, as stated, the frequency is not determined by the load circuit. Later developments include circuits without load, voltage-tuning being exclusive.

The 955 Is Welcome

Due to the limitations and also somewhat the difficulties of the electron oscillators, the 955 is most welcome for experimental and amateur use. It is not intended for and should not be used in lower-frequency receivers, where the regular tubes fill the need abundantly.

The 955 is most interesting, of course, as an oscillator, for it will generate waves of extremely small length, due in part to the small inter-electrode capacities. For instance, the grid-plate capacity is 1.4 mmfd., the grid-cathode capacity 1.0 mmfd., and the plate cathode capacity only 0.6 mmfd. A typical example of an ordinary tube is a plate-cathode capacity of 12 mmfd., or 20 times as great.

The capacity is small but the distance between elements is not, in a relative sense. Therefore it is obvious the tube is a small one, since if a capacity is to be small, and the distance between plates is not small, the plate area will be small, for given conductors and dielectric. Not only the small capacity but the small distance between elements permits the oscillation at very low wavelengths, or even a small fraction of a meter, for a limitation on how far down one can go is also the time of transit of the electrons from cathode to plate. And the smallest capacity is that between cathode and plate.

"Short Leads"

The tube serves as a detector, of the grid-leak-and-condenser or the fixed negative-bias type, also as an r-f and a-f amplifier (Class A) and as an r-f amplifier and oscillator (Class C).

The reason for using it as an audio amplifier probably is not made clear, as none of the special features of the tube is required for audio purposes.

This tube is not stuck in a socket like other tubes, but has a special terminal mounting of its own. With this mounting, connections are made direct to the pins extending from the side of the base. No soldering should be done, and friction contact therefore has to be made, for the heat of the iron might crack the glass.

For years radioists have been hearing the warnings about making leads short, but comparatively they "haven't heard nothin' yet" on that topic, because at wavelengths as low as those under consideration the shortest lead used in standard radio sets is a long lead. Therefore it is suggested that the bypass condensers be built into the tube's external assembly accommodation, using a grounded copper sheet, and using mica spacers. Then any "adjacency capacity" becomes a useful bypassing capacity. The system is used also at the heater.

It would be possible to connect the tube to the terminal mounting with heaters to intended grid and plate connections, except that a stopping plug is a part of this mounting, being ¼ inch high, preventing the wrong connection because of the cathode terminal being interfered with by this plug.

Whenever a new tube comes out the manufacturers try to give all the proven information they have, but of course the experiences of thousands of users count, too, and therefore as time goes on no doubt special data and new tricks concerning the tube will become known. Almost certain is it that many will report generation of waves below 0.5 meter (above 600 mgc). This is a confident prediction because the tube manufacturers underrate the new tube. Adding some ingenuity, it should be easy for experimenters to excel results contained in the implied promise of the manufacturers.

A Glimpse at "Micros"

The frequencies or fractional-meter waves concerned are in the region where waves behave quasi-optically. It is sometimes stated that these waves are quasi-optical because they are so near the frequencies of light, but they are enormously lower than light-wave frequencies, and the comparison concerns the behavior, not the relative frequencies.

Micro waves, as they are also called, are subject to reflection and refraction, as are light waves, but very seldom are reflected from the ionosphere. Since the reflections of waves from the ionosphere is what makes DX possible, and since here we have no such reflection, we have no DX. Instead, as expected, we find that the penetration is equal to about the range of vision, or the horizon distance. By having the transmitting aerial at a high altitude, to communicate with a lower altitude, of course the distance of traverse is increased, for the horizon is more distant. Nevertheless, not too much reliance should be placed upon this understood limitation, as curvatures and refractions, as well as earth-bound attractions, might be expected to carry the waves as bent formations around the horizon.

What Type of Coils

The frequencies being so high, the ground wave is of very short life, practically quitting only a small distance from the transmitter. Hence there are inherent losses to be overcome, due to absorption by ground capacity, and also of course to serious radio-frequency resistance in the circuits used.

Various types of coils have been tried. Amateurs seem to favor hollow copper tubing, sometimes silver-coated copper, for the waves travel on the outer surface of the wire, and the silver covering is supposed to reduce the radio-frequency resistance. However, the skin effect will be large, and eddy currents and other considerations become serious. Photographs shown by representatives of RCA-Radiotron Co. when some inkling about the tubes was broached at the Century of Progress Exposition showed small-diameter coils used. Since the turns are few, the axial length of the winding is short, despite spacing, and the smaller the winding diameter, the smaller the distributed

Generators of Ultra Frequencies

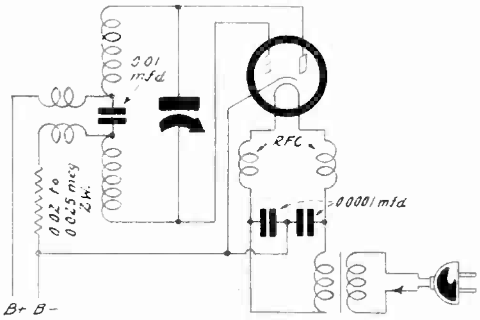


FIG. 3

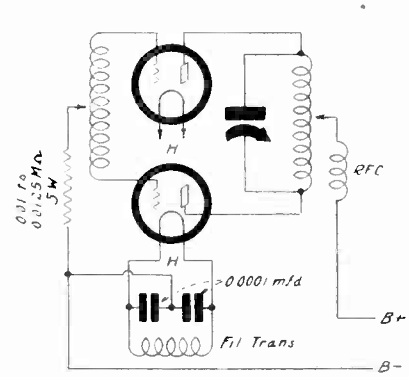


FIG. 4

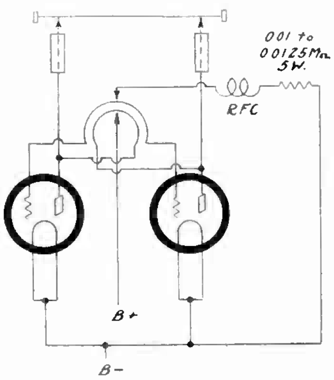


FIG. 5

Other circuits that may be used for the ultra frequencies, including one for fixed frequency generation.

capacity, for coils of axial length not greater than the winding diameter. The separation of the turns, or pitch of the winding, further decreases the distributed capacity. Hence a good coil is requisite, but what is the best coil probably isn't known yet, as there are many, many mysteries about the micro waves, and perhaps coil considerations are among them. At least do not be surprised to find many experimenters using what they term small coils—because the size is small—although the inductance will be the same, for the same waves or frequencies to be covered with any one capacity variable condenser.

Some instruments that concern micro waves have appeared on the market that have circular-plate tuning condensers. This type of condenser tends to crowd the stations, so to speak, and the low-capacity end of the dial, or higher frequencies. While the displacement is small in capacity, maximum to maximum, if the 5-to-10 meter band is covered, the frequency ratio is still 1-to-2 and the capacity ratio is 1 to 9. The idea small changes tend to produce linear results, which applies to much, much smaller changes than those considered, should not prove confusing. The semi-circular plate condenser years ago was discarded for tuning in broadcast-band stations, and for the same or greater reason should not be used in micro-wave receivers or transmitters for adjustable-frequency use, particularly as now the frequencies are so much higher.

The following information is quoted from RCA-Radiotron Company's bulletin on the tube (copyright, 1934):

955

Detector, Amplifier, Oscillator

(Acorn Type)

The 955 is a heater type of triode designed primarily for radio amateurs and experimenters working with wavelengths between 0.5 meter and 5 meters. Operation at these short wavelengths is made possible by means of an unconventional tube structure having small size, close electrode spacing, and short terminal connections.

Tentative Characteristics

Heater voltage (a.c. or d.c.)..6.3 volts
Heater current ....0.16 ampere
Amplification factor 25
Grid-plate capacitance.........1.4 $\mu\mu f$
Grid-cathode capacitance......1.0 $\mu\mu f$
Plate-cathode capacitance .....0.6 $\mu\mu f$
Bulb (for dimensions, see diagram).J-4
Terminal mountings (see diagram) Special

Maximum Ratings and Typical Operating Conditions

As R-F or A-F Amplifier—Class A

Typical Operation

Plate Voltage Maximum Allowable Is 180 Volts.

Heater voltage	....	....	6.3	Volts
Plate voltage	90	135	180	Volts
Grid voltage*	—2.5	—3.75	—5	Volts
Plate current	2.5	3.5	4.5	Milliamperes
Plate resistance	14700	13200	12500	Ohms
Mutual conductance	1700	1900	2000	Micromhos
Load resistance	....	....	20000	Ohms
U. P. O.	....	....	135	Milliwatts

***The d-c resistance in the grid circuit should not exceed 0.5 megohm.**

As R-F Power Amplifier and Oscillator—Class C

Plate Modulated or C.W.

D-C plate voltage......180 max. volts
D-C plate current.8 max. milliamperes
D-C grid current..2 max. milliamperes

Typical Operation:

Heater voltage ....6.3 volts
D-C plate voltage...........180 volts
Grid voltage (approximate).—35 volts
D-C plate current......7 milliamperes
D-C grid current (approximate) 1.5 milliamperes
Power output (approximate)** 0.5 watt

**At 5 meters. Only moderate reduction in this value will be found for wavelengths as low as 1 meter. Below 1 meter, the power output decreases as the wavelength is decreased.

Installation

The *terminals* of the 955 require a special method of mounting by means of clips supplied with each tube. The clips may be fastened to a supporting insulator of glass, mica, or other suitable low-loss material, but for minimum losses, it is desirable to clip circuit parts directly to the grid terminal and to the plate terminal. Since the tube terminals are located symmetrically, a stop of insulating material should be placed between the grid and plate terminals so that the cathode terminal will prevent insertion of the heater terminals in the grid and plate clips. This stop is identified on the Terminal Mounting Template as Alignment Plug. *Do not attempt to solder connections to the terminals.* The heat of the soldering operation is almost certain to crack the bulb seal.

The *heater* is designed to operate on either a.c. or d.c. When a.c. is used, the winding which supplies the heater circuit should operate the heater at its recommended value for full-load operating conditions at average line voltage. When d.c. is used on the heater, the heater terminals should be connected directly across a 6-volt battery. Under any condition of operation, the heater voltage should not deviate more than plus or minus 10% from the normal value of 6.3 volts. Series operation of the 955 is not recommended.

The *cathode* of the 955 operated from a transformer, should preferably be connected directly to the electrical mid-point of the heater circuit. In the case of d-c operation from a 6-volt storage battery, the cathode circuit is tied in either directly or through bias resistors to the negative battery terminal. In circuits where the cathode is not directly connected to the heater, the potential difference between them should be kept as low as possible. If the use of a large resistor is necessary between heater and cathode in some circuit designs, it is essential that this resistor be bypassed by a suitable filter network or objectional hum may develop.

R-F grounding by means of condensers placed close to the tube terminals is required if the full capabilities of the 955 for ultra-high-frequency uses are to be obtained. Conventional by-passing methods and grounding, such as are employed in broadcast receivers, are not adequate. The grounding plate of the chassis should be of heavy copper. Fig. 6 illustrates one form of by-passing where the ribbon leads to the terminal clips are insulated from the grounding plate by mica spacers to form r-f by-pass condensers right at the tube terminals.

Application

As an *amplifier*, the 955 is applicable to the audio- or the radio-frequency stages or short-wave receivers, especially those operating in the band between 0.5 meter and 5 meters. Typical operating conditions for this service are given under the corresponding heading above.

For a-f amplifier circuits utilizing resistance coupling, typical operating conditions are as follows: Plate-supply voltage, 180 volts; grid-bias voltage, minus 4.5 volts; plate-load resistor, 250,000 ohms; and plate current, 0.42 milliampere. The grid resistor may be made as high as 0.5 meg. With these values an undistorted voltage output of 45 volts r.m.s. may be obtained. The voltage amplification is approximately 20.

As a detector the 955 may be of the grid-leak-and-condenser type or of the

(Continued on next page)

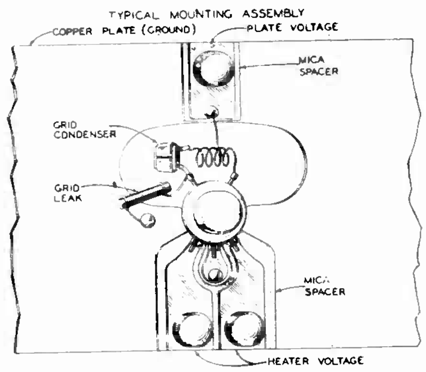


FIG. 6
Mounting suggestion. A mica spacer is put between a copper plate and a small conducting strip for the other plate to form the condenser.

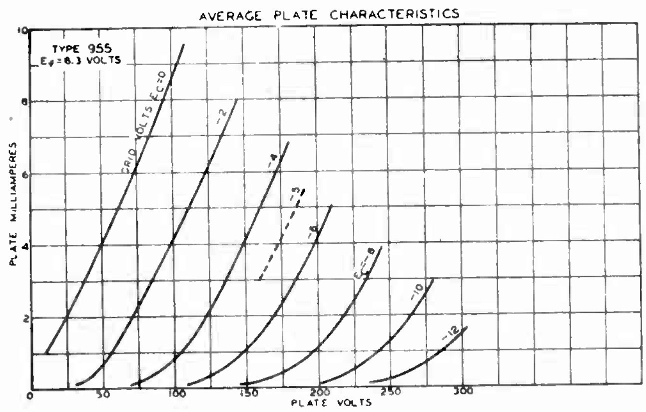


FIG. 7
The characteristic curves of the 955 tube. The plate current is shown at left, read upright. The plate voltage is read on horizontal. The various negative grid bias values are on the curves to which they apply.

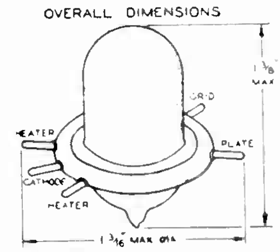


FIG. 8
Five pins stick out from the sides of the new acorn tube, which is 1⅜" high.

(Continued from preceding page)
grid-bias type. The plate voltage for the grid-leak-and-condenser method should be about 45 volts. A grid leak of from 1 to 5 meg., with a condenser of 0.00025 mfd. capacity, is satisfactory. For the grid-bias method of detection a plate-supply voltage of 180 volts may be used, together with a grid-bias voltage of approximately minus 7 volts. The plate current should be adjusted to a little less than 0.2 milliampere with no input signal voltage. The grid-bias voltage may be supplied from the voltage drop in a resistor between cathode and ground. The value of this self-biasing resistor is not critical, 50,000 ohms being suitable.

As an oscillator or r-f power amplifier (Class C), the 955 should be operated as shown under "Maximum Ratings and Typical Operating Conditions." Typical oscillator circuits are shown in Figs. 1 and 2. When bias is obtained by means of a grid resistor, a value of 20,000 to 25,000 ohms may be used. The use of a choke in series with this resistor is required in a single-tube oscillator circuits to increase the r-f impedance of the input circuit. In push-pull oscillator circuits the choke is not required.

In miscellaneous applications, as in the laboratory, such as vacuum-tube voltmeters, the 955, because of its small size, can be placed at the point of measurement. This feature, combined with that of low input capacitance, makes possible vacuum-tube voltmeter measurements with a minimum effect on the constants of the circuit under measurement.

The circuits do not give the coil data, nor the condenser capacities, where these take part in frequency determination, because it is not known at what frequency or in what range of frequencies the experimenter desires to work. The tube should oscillate of course even on single-turn coils, for even the 56 has been made to do this, using ⅜-inch diameter hollow copper tubing, about 3 inches winding diameter, spacing ¼ inch, around 6 meters. The new tube, of course, easily will go to one-tenth the wavelength, and, as already set forth, waves lower than 0.5 meters surely will be generated, and we suspect that amateurs will be doing it.

Other Circuits

Besides the two circuits offered by RCA Radiotron Co., Figs. 1 and 2, others are shown. The one with the r-f choke coils in the heater legs uses a split coil, each half equal to the other, with a relatively large stopping condenser between, so it will present negligible impedance, in fact, be equivalent to a short, or no voltage drop.

The heater-leg chokes are a subject of dispute. Some scientists report that these chokes do not change the frequency, neither do they seem to make any difference if in or out. They are included merely to show those who want to try the coils where they are to be placed. It must be remembered that the heater current, 0.3 ampere, flows through them, hence the wire of which they are wound should be large enough to stand that current. The chokes might consist merely of a few turns of relatively large wire, say, No. 18 enamel, or even bell wire, on a small diameter.

The r-f chokes intended to present a high impedance to the grid circuit should be larger than those described for the heater circuit, that is, should have much more inductance, and could even be honeycomb coils of the small type.

In all the diagrams the feed to the heater may be a.c. or d.c., and if d.c. the polarity is not important, being indicated in a given way just for definition.

Push-Pull Circuit

The tuned-plate push-pull generator, having what are shown as sliding contacts on untuned grid and on tuned plate, may consist of spaced bare wire, strong enough and thick enough to be self-supporting, that is, requiring no form, the tap location determined by experiment, and then soldered connection made. One thing to watch for, besides assurance of oscillation, is presence of true balance, and that may be sufficiently determined by having the same current in the plate leg of one tube as in the plate leg of the other. A bypassed current meter, put in one plate leg, is moved to the next plate leg, for comparison, and either plate or grid d-c potential tap adjusted until equalization of current prevails.

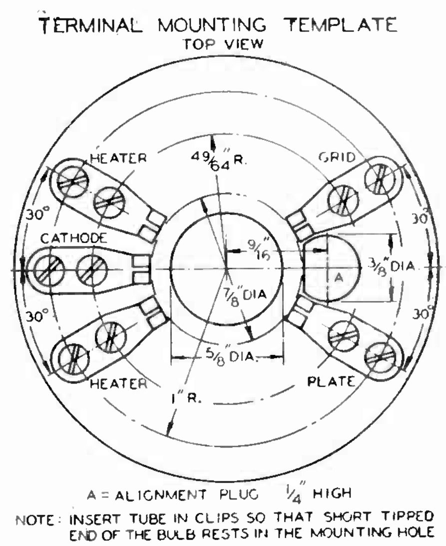
Another diagram shows a so-called unity coupled circuit. Here a turn of hollow copper tubing is used, perhaps ⅜ inch diameter, and inside the hollow a thick insulated wire is passed, or bare wire with spacers so that shorting is avoided. Here the frequency is assumed to be fixed and so high that no variable tuning capacity is needed, especially as, for the frequency concerned, there will be abundant capacity between the two single-turn coils.

The method of connection to the antenna is through a transmission line consisting of two hollow copper tubings, the outside of which may be grounded, the inside used as the "hot" conductor, shown in dotted lines through the outside copper tubing. Both the B plus and the grid return coil connections for d.c. are experimental, as are the connections to the antenna, which is of course a very short stretch of wire.

Vacuum-Tube Voltmeters

In connection with the use of the tube as vacuum-tube voltmeter, either of two methods may be pursued. One is that of

FIG. 9
The physical details of the new 955 tube for ultra-frequency use. The stopping stud that prevents wrong connection is identified.



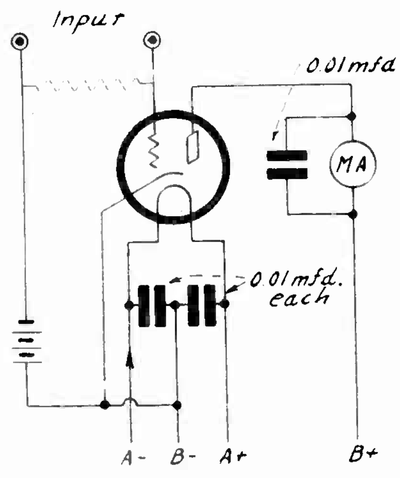


FIG. 10

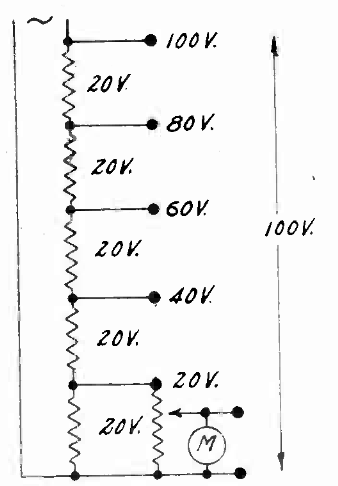


FIG. 11

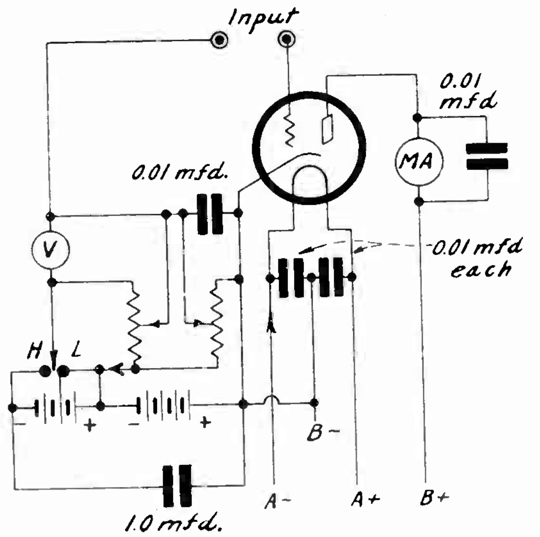


FIG. 12

At left a simple vacuum-tube voltmeter, in center a potential divider, and at right a slideback VTVM. H and L represent high and low negative bias.

using a fixed negative bias on the tube, and then introducing the alternating voltage across the input, assuming that there is a conductive path in the source. If not, a high resistance should be used across the input, 0.5 meg. suggested.

The calibration of the instrument may be on the basis of either peak volts (crest voltmeter) or r.m.s. volts, or if one, the calibration is on one basis and the other may be computed. The peak value is equal to 1.41 times the r.m.s. value, while the r.m.s. value is equal to 0.707 peak value.

The milliammeter sensitivity in part determines the negative bias used. Accepting some plate voltage, say 180 volts, the negative bias may be made high enough to yield a reading on the milliammeter, say at its first even bar. Any a.c. introduced will increase the plate current, and the amount of increase is calibrated in terms of the input voltage.

The line frequency makes a satisfactory standard, being almost a sine wave. The calibration to be made will be accurate for future tests only if the same type of wave form as was used for calibration is used for measurement, and subsequent measurements are really assumed to be sine wave potentials unless definitely known not to be so, when the VTVM is good only for relative indications.

To the right of the first VTVM diagram is shown a method of obtaining the low voltages for the range of the instrument. Equal resistors are used in series, so that the voltage drop across them will be equal. Say, five equal resistors are used across 100 volts. Then each resistor will drop 20 volts. Ten resistors would be more acceptable, forming a decade of familiar practice. So by adjusting the input to 100 volts, either through a series rheostat or parallel potentiometer, each step would represent 10 volts. Ordinarily 10 volts would be a good range, and the a-c meter terminals would represent the input voltage to the VTVM posts. Though the proportion is upset a bit by including a potentiometer to derive the voltage values, the voltage actually is what the a-c meter reads. As stated, if the meter itself is calibrated in peak volts, the calibration of the VTVM will be in like terms; or, if the meter is calibrated in r.m.s., the calibration of the VTVM will be in r.m.s.

Either the potentiometer arm may be set to even voltage values, say, 0.5 volt, and the current read, or the even current values may be derived, and the equivalent voltage read on the meter, as the arm of the potentiometer is moved. Then a calibration curve is run on cross-section paper.

There is no difficulty until one desires to get small differences. These may prove baffling. Moreover, many a-c meters do not give any calibration for perhaps 5 per cent. of the full-scale deflection of the needle. That is, a 0-100-volt a-c voltmeter may be blank for values below 5 volts.

However, the same division principle is used, so that the low-range a-c voltmeter picks up a 10-volt potential difference, ten equal resistors are put across this, or two resistors, one nine times as great as the other, and by the resistance ratio the voltage ratio is known. So the potential difference is 1 volt, while the meter reads 10 volts because the meter is across the entire 10-volt difference. The 1-volt drop may be similarly subdivided for 0.1-volt values. These values are important, especially as the curve is spread out for low values of input to the VTVM.

Potentiometers and the like should be large compared to the resistances across which they are put.

This simpler VTVM is serviceable, but the range is limited, except that one may continue to increase the negative bias, for larger input a-c values, to limit the current, but that means a separate calibration each time.

Slideback Method

A way of avoiding this is to use a slideback method. This is shown in the diagram of the more comprehensive VTVM. This is a peak voltmeter only. The general principle is the same, that the characteristic curve of the tube, or its variable resistance function in respect to bias voltages, is measured, and the calibration is in terms of volts, but the operation is quite different.

Here we have the tube negatively biased almost to the cutoff, or to closest one can read to cutoff. There is some dispute as to which is the better method. Some say that you can not determine well the cutoff point, because if you overstep the mark cutoff still continues, whereas the subsequent readings due to excessively negative bias might be false. Therefore they favor the starting point being the current reading at the first bar next to zero on the milliammeter (in practice, a 0-1 ma). Others say it makes no difference, provided compensation for the a-c voltage can be accomplished within range. The latter contention seems more acceptable, as will appear.

First the potentiometer to left is set so as to short out the d-c voltmeter (move arm all the way up). The potentiometer to right is slid until the selected starting point is reached, as determined on the plate meter scale. Say it represents Bar 1 on the scale, the first division that is on the scale, next to zero. That is the starting point. Now the unknown a.c. is introduced at the "Input" terminals. If the conductive path is not supplied by the input impedance, then a resistor of 0.5 meg. may be put across the input terminals, or a resistor of larger value may be used, so long as there is no grid current.

Now that the current in MA has risen, the arm of the left-hand potentiometer is slid down until the current reading on MA is what it was at the start. Then the voltage is read on the d-c voltmeter V, and the answer is the peak voltage of the a-c input.

By this method, it can be seen, the determinations are based on only two readings of the milliammeter for any and all voltages read: first, establishment of the datum current; second, after the a.c. is introduced, reduction to that same current by battery potential compensation, to the original starting value. Hence for different bias values no separate calibrations are necessary; in fact, there is no need for any calibration, and the instrument may be properly described as direct-reading. No chart is prepared.

The range of vacuum-tube voltmeters in general is very small. The present method is somewhat simpler for extension of the range, and a single-pole double-throw switch may be used, to pick up extra biasing voltage, for higher a-c evaluations. Thrown to the left, this switch picks up the lower extra biasing voltage; thrown to the right it adds more battery voltage in series. The only precaution necessary is that the switch be not set for reading low voltages when a high voltage is put in, and by high is not meant a value anywhere near even 50 volts.

Object of a VTVM

The outstanding value of a vacuum-tube voltmeter is that it does not draw any current from the measured source. Moreover, it is practically independent of frequency. This is in line with the idea that the same tube that will generate 600,000,000 cycles a second also will generate 1 cycle a second, or less.

There are vacuum-tube voltmeters that draw grid current, and the grid-current condition becomes a part of the calibration, but in the examples cited in the diagrams herewith it is assumed there is no grid current. That is, the a-c voltage to be measured is sensibly lower than the effective negative bias. In other words, if the bias is 22.5 volts negative, the a-c voltage to be measured must not be 22.5 volts, but should be held to 20 volts, for instance. During part of the positive cycle there may be a slight flow of grid current, but this exception does not matter at all.

Crystal Control of Frequency

Constancy Results of One Wave Value—Harmonics May Be Used

By Leonard Richardson

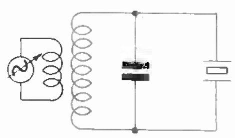


FIG. 1
Frequency of input is varied and crystal's natural period is obtained by noting current flowing in the secondary circuit. The tuned circuit does not determine frequency.

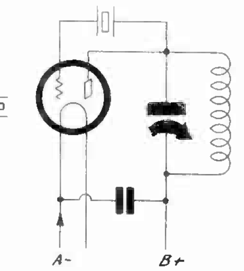


FIG. 2
Connection of crystal between grid and plate of a generator. The capacity, both internal and external, between elements is used.

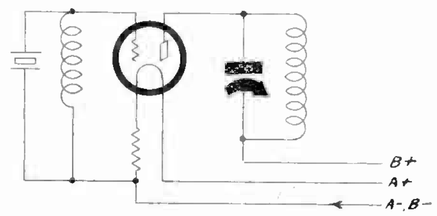


FIG. 3
The crystal placed in parallel with a grid coil. The plate circuit is tuned. The tank circuit should be a bit off the resonant frequency of the crystal. There are inductance, capacity and resistance in the crystal.

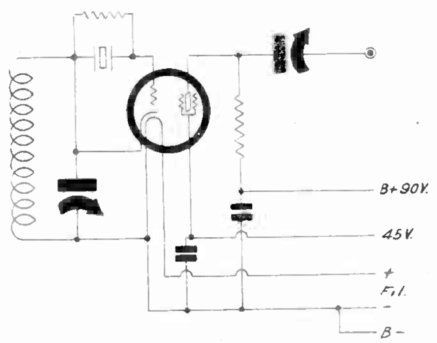


FIG. 4
Here the grid leak is placed across the crystal and the crystal parallel circuit thus formed is across the grid-plate elements of a screen grid tube. This circuit might be applied to the 955. The upper right-hand condenser varies the output.

ONE of the outstanding things about generators in the past year has been the growth of the use of quartz crystals as standards of frequency. As a counterpart, the more useful development toward the same end, has grown enormously, that is, the stabilization of generators of the variably-tuned type. To such circuits, of course, crystals do not directly apply.

What one desires from the crystal is the generation of a definite, single, unvarying frequency. This end it fulfills well. "No variation of frequency" really means no variation beyond that which can well be tolerated. The matter of degree is settled by several auxiliary means, including use of a temperature oven, a mechanically-rigid installation, etc.

So with the crystal we desire—or, rather, all we can get—is a single accurate frequency, though we may use multiples of that frequency by harmonic production. With alternative stabilization, introducing any of the authenticated means, we get perhaps something less in the way of stability, but continue to tune in different frequencies, which is necessary.

Therefore it probably will follow that variably-tuned generators will some day also have fixed-frequency checking, using a low-frequency crystal in a harmonic-generating circuit.

Due to the Curies

To J. and P. Curie, the French scientific couple of radium fame, is due discovery of the fact that certain crystals suffer separation of charge when mechanical strain is introduced; or, conversely, if an electric field affects them, the physical dimensions of the crystals will change. Thus if the field is alternating current, the crystal will vibrate mechanically at the frequency of elasticity (assuming the supply is close in frequency to the crystal's period).

When the crystal is used in a quartz-oscillator circuit, a holder is usually employed, to give the crystal a firm place of repose, but not with enough pressure on the crystal to introduce a strong mechanical resistance to the intended mechanical oscillation. It may be called mechanical, but since it is due to an electrical source, and as the property of contraction and expansion enters, the more popular name is piezo-electric oscillation.

The crystal holder has two brass plates that contribute the small capacity represented by the flanges above and below the crystals in the diagrams. The tuning condenser and coil are there as aids to the crystal feed, but not as frequency determinants. The size, density and elasticity of the crystal will determine the frequency.

Ground Carefully

If the a-c input to the primary of the coupling coil is one frequency, and the current through the secondary is read, instead of the usual resonance curve obtaining when the heavy-plate condenser is tuned, there will be a very sharp and abrupt rise when the feed is close to the resonance of the crystal. Or, instead of varying the condenser, leave that fixed, and vary the input frequency as from a generator, and the same abruptness will be noticed, for the critical frequency of the crystal.

The quartz crystals are cut and then ground to size, the grinding being a process requiring extreme care. First coarse carborundum may be used until the desired frequency is almost obtained, then finer and finer powder, for closer and closer approach to the desired frequency. This frequency can be predetermined by using the desired one of three different "cuts" and grinding to the thickness or length required for producing the desired frequency.

Has All Three Constants

Quartz crystals as found are hexagonal, with ends irregular, and will oscillate on three axes, 120 degrees to one another, and the cut is made on the desired axis. For a longitudinal cut the thickness does not matter, only the length. The axes are known as X, Y and Z axes, and have various advantages over one another for various purposes, and the selection of the cut in a way represents the weight attached by somebody to a certain performance.

The crystal of course has all three electrical quantities—capacity, inductance and resistance. At the critical frequency the resistance will be more than otherwise, referring to the crystal alone, but not the r-f resistance necessarily, as there is auxiliary capacity, besides the the crystal's own capacity. The crystal may be viewed as an almost ideal tuned circuit, but the crystal has to be driven, and a generator will do that.

The second diagram shows such a generator, also the method of connecting the crystal from grid to plate. Even as a triode this circuit should oscillate, as the crystal capacity and holder capacity are added to the tube's grid-plate capacity for grid coupling from plate. In the third diagram the crystal is placed across a grid coil, while the plate is tuned, and the oscillation will take place due to the capacity coupling. The electric field acts upon the crystal. The oscillation is noted to be stronger when the tank circuit frequency is a bit different from the crystal's natural period.

The fourth diagram shows a circuit that might be applied to the 955 tube, the new "acorn" variety bulb for very short waves. Here the crystal is in parallel with the grid leak. The variable condenser leading from the plate resistor is for control of output.

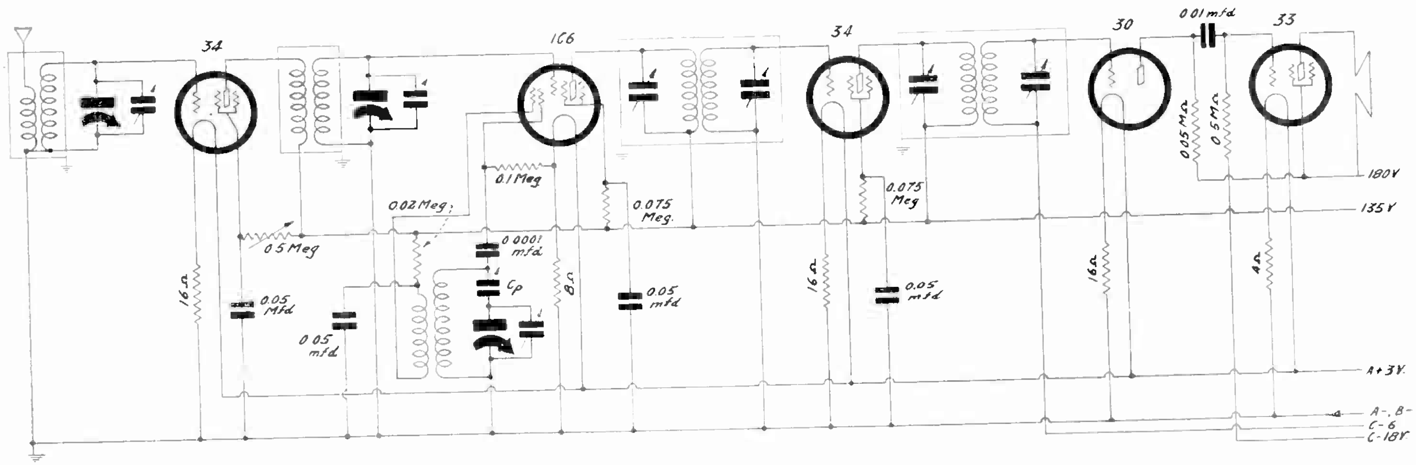
Kay Introduces Knobs Of Pearl for Car Sets

The Kay Company division of Kay Products of America, Inc., 1001 Bedford Avenue, Brooklyn, N. Y., announces special processed pearl knobs for remote control heads on car radios. These knobs are made in several colors, including ivory, mahogany and silver. Last spring the Kay Company introduced a dash panel to enable dealers to instal radio remote control heads on the dashboard, in the ash-tray openings, or on glove compartments.

A Battery-Operated Super

Satisfactory Performance for a 5-Tube Set

By Carl L. Munder



Only five tubes in this battery-operated super, yet the performance is entirely satisfactory for city or rural use. Care must be taken to provide an A supply of adequate rating. The circuit is shown for 3-volt A supply, but if a 6-volt storage battery is to be used, the filament limiting resistors should have four times the resistance indicated.

USING five tubes, quite a respectable superheterodyne can be built for broadcast reception, battery operation. In particular, old-style five-tube or six-tube t-r-f receivers may be rebuilt according to the diagram herewith.

The standard method is applied to the tuner and intermediate amplifier. The second detector is a 30 tube, negatively biased, the bias being shown as 6 volts negative from the battery, but there is a 1-volt drop in the filament resistor, so really the negative bias is 7 volts, high enough.

Those who so desire may try the 34 tube as a second detector in this circuit, with a limiting resistor in the screen leg of 0.5 meg., bypassed to grounded B minus by a condenser of 1.0 mfd. However, the 34 is not usually recommended for negative bias detection in this manner, which is not to say that it does not work. The 30 is satisfactory and some will prefer it, as the circuiting is simpler and the tube cheaper.

Watch the A Current

The output tube can be loaded up either way, assuming a maximum signal input to the detector of 6 volts peak, the gain in the 30 need be only 3 to load up the output tube, which is a 33.

This output tube has a five-pin base and will stand 180 volts on screen and plate, with negative grid bias of 18 volts from a C battery. Somewhat less gain, but smaller B drain, results if the full bias from a 22.5-volt battery is used.

The circuit will draw considerable A current. The power tube takes a bit more than a quarter of an ampere, and the 1C6 takes 0.12 ampere. These two tubes alone require 0.38 ampere, the three other tubes 0.18 ampere, total for the five tubes, 0.56 ampere. That means that at least four No. 6 dry cells should be used, each pair in series, and the two series pair in parallel. These cells are rated at 0.25 ampere, so by paralleling the 3 volts the rating is 0.5 ampere, only sightly exceeded by the actual drain.

A three-gang condenser is used, and the two r-f coils would be for 0.00035 mfd. tuning, the oscillator coil would have a smaller inductance, how much smaller depending on the intermediate frequency. If the popular i-f of 465 kc is used, then the oscillator coil may have a secondary inductance of 110 microhenries. Commercial coils are obtainable that exactly fit these needs.

Hold Up the Output

Instead of introducing numerous r-f chokes and bypass condensers, the B voltage was put at somewhat less than the maximum allowed. That is, instead of 180 volts, only 135 volts are used, as these suffice entirely for the purposes of this receiver. However, the detector should have the maximum, and by the way the plate current through the tube is adequately limited by the plate load resistor. And of course the power tube, a pentode, takes the maximum voltage. It is well to keep the voltage that high for the output, although the extra 45-volt B battery is required. It might be dispensed with, in a pinch, so far as the detector is concerned, but the power tube must have its voltage or the power output capabilities seriously diminish.

The padding condenser Cp in the oscillator circuit, for 465 kc, would be between 450 and 400 mmfd., and since adjustable, is set at the value that yields maximum response at 600 kc. Directions for taking care of this requirement, and doing other lining up, will be found in the instructions regarding the 334-A Signal Generator, on pages 21 and 22 of this issue.

The volume control is a satisfactory one for a battery set such as this, and when the receiver is turned off there is no current drawn from the B battery by the volume control. Such current flows in some battery sets because the designers did not watch the point that B plus is connected to A minus through the B battery, and through the A supply, on account of the tube filament, even when the set is turned off. This current is small for a high resistance, nevertheless B batteries being what they are, the point has to be watched.

Such a receiver as this is capable of greater performance than most persons accustomed to t-r-f battery sets will realize. It is admitted that battery sets haven't been given maximum attention in the past by design engineers and others, and also that numerous circuits for such use were deemed to be for the folk in the country, where there was little trouble from local interference. Hence selectivity was not as high as it ought to have been. But here we have abundant selectivity, and the receiver will be operable without trouble due to even a local station 10 kc removed from a distant station one wants to hear.

Long Antenna

The only suggestion about selectivity and interference that need be made is that if one uses a very long antenna, although it is theoretically advisable to put a great deal into the first tube, to hold up the signal to noise ratio, there is a distinct limit, and if there is any image interference or similar trouble one should insert a series condenser of 0.0001 mfd. or smaller capacity between antenna post of the receiver and the extreme of the leadin intended for the set.

MILKY WAY SHRINKS

Electron devices are proving a boon to science. One of the latest improved uses is that of studying the celestial nebulae by spectral analysis, photo-electric cells changing the light values to current values that are amplified for easier determinations. In this way by studying the color of the planets and stars, their temperatures, constitution and also their group sizes are noted. Thus it becomes known that the Milky Way is only half as big as it was supposed to be. One philosopher remarked: "Maybe only half as big as it used to be, on account of the depression."

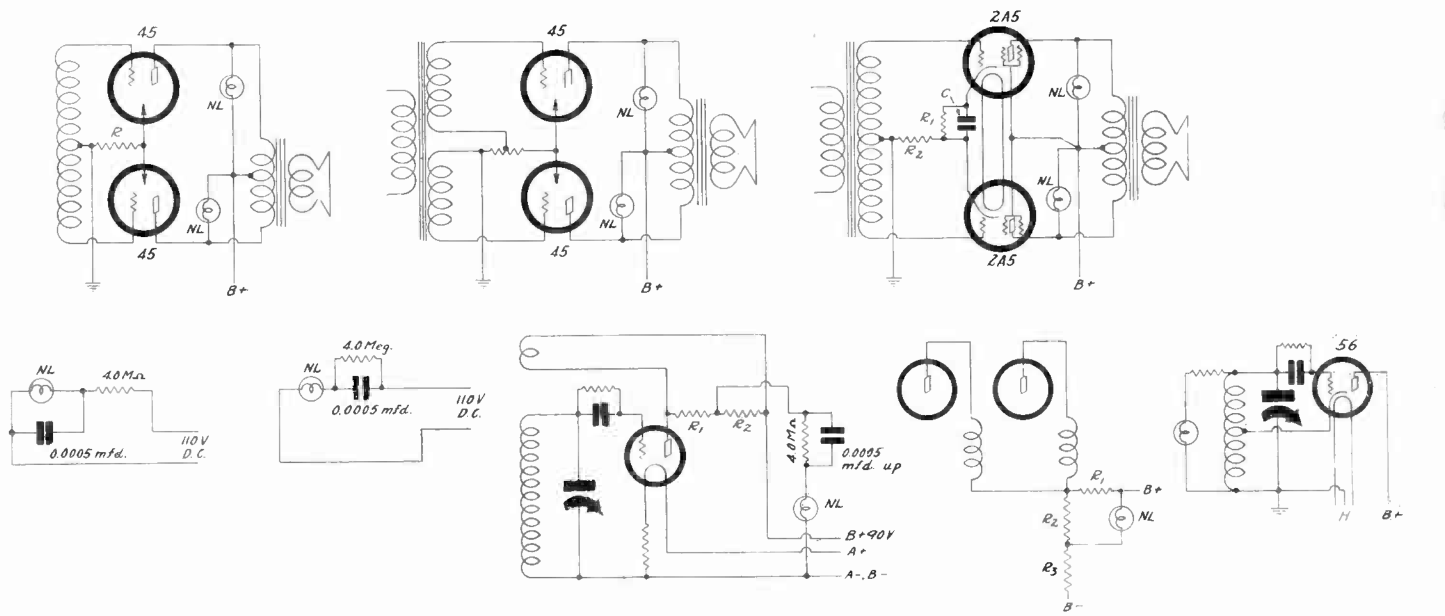
RAIN HARMLESS TO RADIO

Raindrops might be expected to have a bad effect on radio reception, because taking energy that the antenna or set ought to have, but DX in the rain is a common thing, and aside from leakages due to wet joints in antennas, etc., rain seems to do no harm at all to sensitivity or reception.

VALUABLE USES F

Audio Oscillation, Balancing, Resonance I

By Mich



Top row, neon lamps used for balancing push-pull circuits. Bottom row, left to right: audio oscillator, using neon tube with condenser across the tube; audio oscillator with condenser across the resistor; introduction of the audio oscillation into an r-f generator; resonance indication; amplitude measurement of a generator.

THE small neon tubes, the size not mattering much, find numerous applications in radio work. Some of the purposes fulfilled are hardly duplicable in any other convenient or inexpensive way. The uses include balancing of push-pull circuits, audio oscillation, resonance indication, stability determination, condenser testing and tube leakage testing.

The importance of balance in a push-pull stage is well recognized. In fact, unless there is balance there is no strict push-pull, for a push-pull circuit must be symmetrical.

In the first diagram are shown two 45 push-pull tubes, though they might be any others of the filament type. The biasing resistor is R. Two neon lamps are used, one across one half of the primary, the other across the other half of the primary. No limiting resistor is shown, as only signal current lights the lamp. The d-c drop is applied in the half-primary as part of the voltage, of course, but being only around 15 volts may be neglected. The system as shown has been worked successfully, although no doubt it is advisable to include the limiting resistor, which may be 50,000 to 100,000 ohms. The resistance limits the current through the lamp, but does not determine whether the lamp will light or not, within wide limits of resistance selection.

Checking the Lamps

Now, to enable the use of two lamps this way it is of course necessary that some preliminary check be made on the equality of illumination for a given voltage. Otherwise, let us say, one lamp may be considered more sensitive than another, and therefore the lamp difference would be indicated, when in fact the two voltages might be equal, resulting in a false indication. However, the test is easily made by connecting two lamps in parallel across one source. For instance, the conection for the lower neon lamp NL could be moved also to the upper plate, a signal put in the set, preferably from a signal generator, because then the modulation is steady and the lamp illumination does not wobble. The two lamps should glow with equal brilliance, and if they do not, selection of two is made that meet the requirement, and these lamps should be marked some way, as with an indicating paster, that they are matched. Since the ultimate test is one of visual observation, the matching on the basis of visual indication is sufficient. In fact, it can be done with a closeness greater than some persons might imagine.

If the circuit is constituted as shown in the first diagram, then there seems hardly any remedy to apply. Suppose the illumination is unequal when the lamps are restored to the respective circuits? Then a state of balance does not exist. Then we haven't push-pull but a form of detection, a softer word for distortion. This is one common reason for distortion in push-pull circuits.

Battery Remedy

Now, we have two things to consider: the static balance and the dynamic balance. The static balance has to do with the tube characteristic as determined by d-c values, that is, as the bias would be changed from a battery, or the plate voltage changed. The dynamic balance has to do with alternating current, that is, the signal.

It is practically beyond the capabilities of the experimenter to do anything directly about the dynamic balance, but since many of the audio frequencies concerned are low, and indeed the tests may be made with a signal generator having 60-cycle modulation, the dynamic balance may be assumed to be included in the static balance, and so if we find that the lamp in one circuit lights more brightly than the lamp in the other circuit, we can apply practically the only remedy, that of altering the bias by battery insertion. To cut down the illumination of one lamp to that of the other, the negative bias on the output tube concerned would be increased, so the grid connection would be opened, negative of a battery put to grid, positive to coil terminal that had been removed from the socket grid spring. Since only a few volts normally would be concerned, a 4.5 or 7.5-volt C battery would be sufficient, in point of range. If it is not practical to get just the right voltage because the gradations are in 1.5-volt steps, a larger battery voltage could be used in series with the plate, with negative to plate and positive to coil terminal that was removed from plate, to cut down the illumination.

If it is deemed preferable to bring up the illumination of the weaker showing to that of the stronger, the same method may be used with reversal of battery polarities.

Separate Secondaries

If the push-pull input transformer has two separate secondary windings, then the returns obviously may go to different places. So, if there is a biasing resistor, all one need do to equalize the illumination is to return the coil for the output tube circuit showing the weaker illumination to a point on the biasing resistor nearer cathode (filament). This is shown in the second diagram.

In the case of heater type output tubes,

'OR A NEON TUBE

ndication and Condenser Testing Included

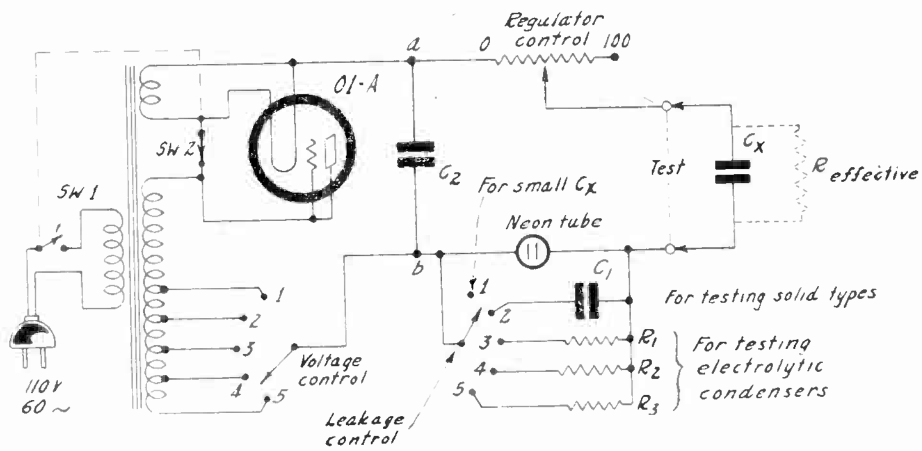
ael Blan

such as the 2A5's illustrated in the third diagram, the equalization may be introduced by supplying some additional bias to the tube that causes the neon indicator to light more brightly. This resistor is R1 and must be bypassed. The capacity C1 should be as large as practical, and the 50-mfd. electrolytic condenser will be satisfactory indeed.

In a push-pull circuit usually no condenser is put across the common self-biasing resistor. This is because there is, or should be, no signal current through the resistor. Since the circuit is assumed symmetrical, the voltages due to the signal, taken at any point on the resistor except center, are equal and opposite. Take one extreme. When that voltage is positive by a value of E1, then the other extreme is negative by a value of E1, only a.c. considered, or the values are +E1 and —E1, and the difference is zero. There is no signal voltage across the resistor.

This is carried out fairly in the third diagram, because the balance has been established so as to make the signal as nearly equal in both legs of the center-tapped coils as is practical. In fact, the signal is the only thing that we are measuring, and the remedies always are applied when the signal is present. This sort of compromises for the inability to attack the dynamic problem separately. With the signal put in, some rectified component of the signal figures in the balancing.

This Circuit Spots Faulty Condensers



A condenser-testing device, using a neon tube. Electrolytic and solid-dielectric type condensers may be checked for their usefulness in radio and other circuits. Shorts show up, also intermittency, opens, high leakage and other defects, as well as absence of defects.

Audio Oscillation

A very handy use for the neon tube is as an audio oscillator. Depending on the quality of the parts used, the audio oscillation may be fairly stable or not. Resistors that change their resistance considerably, increase or decrease, due to even small current flow, or change their resistance from time to time, due to meteorological effects, naturally change the frequency. However, the condenser also plays an important part in the determination of frequency, and if a mica condenser is used there will be small trouble, if any, due to change of the frequency caused by capacity variation:

The resistor is in series with the lamp, and the voltage is introduced across the series circuit. To insure or support oscillation the neon lamp should be of the type that has no limiting resistor built in, as a very large resistor is to be used anyway, and it must be a resistor with both terminals accessible, so you can put the condenser across it, or, if the condenser is to go across the lamp instead, access to both terminals of the lamp would be necessary or highly advisable. This access to either the limiting resistor terminals, or the lamp terminals, is denied if the resistor is built into the lamp structure, as is usually done. However, some radio and electrical stores have the lamps without the limiting resistors. The lamp may be smaller than your finger-nail. And the oscillation intensity may be quite large.

If the condenser is across the resistor the intensity is several times as great as if the condenser is across the lamp.

Reading the Current

Earphones may be connected in series with the line, and the tone heard. Insertion of the phones may change the frequency a little, so if any calibration of the frequency is to be made, it should be on the basis of the circuit as it is to be used. By making the condenser variable, a considerable range of audio tones will result. That is, one has an audio oscillator, and it may be calibrated, although from time to time it is advisable to check up on the resistance value or current when any measurement is to be made, following calibration, as well as checking the voltage. Remove the resistor and increase the voltage sufficiently to afford a suitable reading on any current meter you have, say, 0-1 milliammeter, though the current through the resistor should be kept low. The current at 100 volts would be 2.5 microamperes through 4 meg., too small to be read on any instrument the reader is assumed to have, but the voltage may be made high enough to give a clear reading. If this reading is taken just before the calibration is made, the resistance itself need not actually be determined, but the current read. Then for use of the calibration, check up to determine that the current is the same when the voltage applied is the same as before. Then the resistance is the same, whatever it is.

Sometimes the values shown will not produce oscillation. Then the condenser may be increased. If the capacity is made large enough the frequency will be so low that the flicks of the lamp may be counted. In this way capacity can be measured visually.

Keep Modulation Moderate

When the audio tone is to be introduced into a radio-frequency oscillator, the method of coupling becomes important. First, the r-f oscillator has a certain amplitude, and the audio amplitude should be less, in other words, 100 per cent. or more than 100 per cent. modulation must be avoided. Any modulation above 100 per cent. is distortion and causes the r-f oscillator to give responses for actually the same frequency at two settings close together, with a silent spot between. So the test is a very simple one. Do not introduce such a large voltage from the audio oscillator as to cause these double-response points.

Also, it is noted, the oscillation amplitude is much smaller when the condenser is across the lamp, instead of across the resistor. Therefore the condenser position may be shifted for any case of too much modulation. Another way is to use a limiting resistor in series with the audio-oscillating circuit, connected to the r-f circuit. This is the method shown in the modulated signal generator diagram in lower center. The limiting resistor is R1, and should be small compared to the main limiting resistor (4.0 meg), but large in comparison to the impedance of the tickler circuit. R1 at 0.1 meg. is satisfactory usually.

Maintenance Current

R2 may be added if it is desired to steady the effect of R1, although this is not important. R2 may be equal to R1.

In any event, R1 is a further limiting resistor, and if R1 and R2 are used, they are together further limiting resistors, because the positive voltage is derived through them.

It is necessary that the voltage applied to the lamp be high enough for striking. Another way of stating the situation is to say that for oscillation to exist there must be at least a certain minimum maintenance current. For all the lamps under consideration the striking voltage is less than 90 volts, therefore two 45-volt B batteries may be used, as suggested in the generator diagram, instead of the 110-volts assumed to be derived from a d-c line. It

(Continued on next page)

(*Continued from preceding page*)

should be remembered that voltage changes the frequency, therefore if any calibration of the audio tones is to be made, care must be taken also to duplicate the voltages that obtained when the calibration was run.

The d-c voltage, taken as 90 volts for example, may be aided or bucked by the tickler r-f voltage, and if bucked may result in failure of oscillation. The R1R2 scheme gets away from this bucking effect. If there is a load resistor somewhere connected with the circuit to which coupling of the audio tone is made, then inconstancy of the r-f generator may cause a reduction of the applied voltage, due to the increase of current through such a load reducing the voltage at the plate or other element, and if connection of the audio oscillator is made to this point, there will be tone on some radio frequencies, not on others.

Resonance Indicator

Indirectly this is a disclosure of the instability of the r-f oscillator.

One ready remedy is to select the modulation connection and circuit for that r-f amplitude that leaves the lowest net voltage at the element to be used for conductive return of the audio oscillator circuit. Then the voltage will be equal or higher at other settings of the generator and audio tone maintained throughout.

The neon tube may be used as a resonance indicator. It is well to have the current through as many r-f and i-f receiver tubes as possible affect the voltage on the neon lamp. This works the lamp the right way, so that resonance indication is consistent with brighter illumination, instead of with dimming or extinction, but the voltage drop across the resistor R1 scarcely ever would be large enough to cause the lamp to strike at all. Therefore two resistors may be used between the common B return of the affected radio circuits, e.g. R2 and R3, selected until the lamp strikes dimly at no carrier, whereupon the carrier will cause increase of illumination. R2 is the usual limiting resistor, which may be built into the lamp, and R is large enough to permit only dim illumination.

Proportionality Given

With circuits not subject to automatic volume control the change in plate current through the radio tubes is not so much and the comparative change in illumination is small, though not too small for observation.

If there is a.v.c. the phase may change, so that the increased carrier amplitude, or resonance condition, causes the current in the radio tubes to decrease, when the neon lamp may be connected from common return of the coils to ground through the built-in limiting resistor, or even with extra resistor added. All instances include the series resistor for the radio tubes, the one through which the current changes to affect the illumination, and this current and the current change must be large compared to the current in the auxiliary neon-tube network.

At extreme lower right of the same circuit series is the diagram of a 56 oscillator tube, which, however, may be any cathode-type tube hooked up, as this is, as a Hartley oscillator. The reason for citing this is that the Hartley is such a strong oscillator. With coupling arranged so that tap is about one-quarter the number of turns up from the ground end the oscillation is strong enough to make the neon lamp strike. The limiting resistor may be one built into the tube, but it is also practical to use the tube here without any limiting resistor.

The glow intensity determines the relative oscillation intensity, and by tuning from one end of the dial to the other, and noting the glow, the stability of the generator can be checked. This should be pretty good for the lower frequencies of the range, at least. When the oscillation becomes less the illumination becomes less, and finally the lamp may go out. Also, if the lamp goes on and off at any particular setting of the tuning condenser, the r-f oscillator is decidedly wobbly. Another test automatically made at the same time is whether the tube is oscillating. If it isn't the neon tube won't light.

Condenser Tester

A condenser-testing device is shown in another diagram. Here the neon tube is used principally as a relaxation oscillator, the same method used in the audio oscillators previously discussed.

The a-c line voltage is stepped up to various values to the maximum value required for the maximum d-c potential from a 201A rectifier, and there are four tap positions for lower voltages, so that the calibrated d-c voltages are set as required for the voltage rating of the condenser to be tested.

The load circuit is open, or there is no load, unless a condenser is placed at the position marked Test. This condenser is Cx, and it has an effective resistance. A regulator control, a high-resistance rheostat, permits closer adjustment of the voltage, and serves as a limiting resistor in case the Test posts are closed on short, as when Cx happens to be a shorted condenser.

The second arm is a leakage control, which is put at position 1 for measurement of all small capacities, Position 2 for all solid-dielectric type condensers, and at positions 3, 4 and 5 for electrolytic condensers. The solid types are principally paper-dielectric condensers, though oil and mica types would be included in this group.

For testing low-capacity condensers, 0.00005 mfd. (50 mmfd.) to 0.05 mfd., the leakage control is set at Position 1, when the circuit is not that of a relaxation oscillator, but there are discharge currents and leakage. At Position 2 the solid condensers are tested in relaxation oscillator service, because C1 is across the lamp, and the regulator control is the limiting resistor. Hence if no strike occurs in the neon lamp the control can be adjusted until strike does appear.

The resistors R1, R2 and R3 are made high enough to prevent relaxation oscillation when electrolytics are tested, hence the illumination of the lamp determines the leakage, or, if the condenser tested happens to be shorted, then the lamp will burn with a strong orange glow. The leakage control is calibrated in approximate capacity rating of Cx, hence set for the rated capacity of the condenser under test.

Safety Switch

The regulator control helps to establish the voltage at which the condenser is rated, or acts as a vernier on that voltage, but wouldn't be of much use for voltage disclosure unless a means were provided for measurement of the voltage. At least the regulator is a limiting resistor.

The switching arrangement in the line circuit and rectifier is a simultaneous affair that opens one circuit when it closes the other, so that when the device is turned off, the condenser C2 is discharged. This prevents any "ill feeling" on the part of the operator due to electric shock. Having a condenser discharge a high voltage through one's body suggests too much to the imaginative person. Hence the protection is doubly wise.

The condenser-testing device is similar to one manufactured by Tobe-Deutschmann, and uses an old circuit to a new purpose.

National Union's Bounty Comprehends 30,000 Pieces

More than 30,000 pieces of service-dealer equipment have flowed through the National Union organization to radio service-dealers located in every state in the Union. This equipment has included tube testers, set analyzers, oscillators, servicing tool kits and radio service manuals.

Vice-President H. A. Hutchins stated: "Several years ago National Union set as a definite objective a program which would lead to a higher degree of efficiency in the radio servicing industry in the United States. We determined to make available to service-dealers all types of equipment and service information which would put them in a position to render better radio service and more of it in the communities which they served."

National Union estimates that by the end of 1934 the number of pieces of equipment flowing through their hands to the service-dealer trade will exceed the 50,000 mark.

NOISE-REDUCING ANTENNAS

Noise-reducing antenna systems are the vogue these days. They are particularly useful for short-wave and all-wave sets. They have a special antenna, and some form of transmission line for leadin, so that the noise, the source of which is near the ground, is not picked up by the leadin. The leadin of other days picked up about as much of everything as did the horizontal portion of the antenna, except that the leadin picked up more noise, if anything.

TELEVISION WITHOUT SCANNING

Parlor scientists are talking about television without scanning. They mention the mirage. From such talk as this something occasionally emerges that is worth while.

New Alloy Can Be Welded to Glass

A new metal-to-glass seal has been developed by the Research Laboratory of the General Electric Company which, because of the certainty with which tight and reliable joints can be made between glass and the alloy called Fernico, has opened up many possibilities in the development of various classes of vacuum tubes and other devices wherein leading-in wires or conducting parts must pass through gas-tight insulating seals or themselves form part of a gas-tight chamber.

Fernico can be machined, forged, punched, drawn, stamped, soldered, copper-brazed, and welded with a facility equal to that with which these operations can be performed on a high-grade nickel-iron.

The physical characteristic of Fernico which makes possible its successful fusion with glass, is its expansion curve, which coincides almost exactly with that of certain glasses. For this reason, no stresses are set up in either the glass or the alloy when cooling from the fusion temperature. This lack of initial internal stresses in the completed glass-Fernico seal makes the seal permanently tight and unusually sturdy. Furthermore, no more care in cooling the combination is necessary than in dealing with glass alone.

Higher I. F. for Short-Wave Sets

TASTES differ in radio as in everything else, and choice sometimes is dictated by possessions. For instance, if a man has a nice console he might want to buy only a kit and speaker, or a wired chassis and speaker. Or if he has a power pack he would want perhaps only a tuner. Also, he may have a broadcast set and desire to use a converter with it, or to have a separate short-wave set.

Particularly to those desiring a separate short-wave set these remarks are addressed.

It is well known that the intermediate frequency as used in all-wave and skip-band sets has to be lower than the lowest broadcast frequency, so we find i.f. values of 465 to 480 kc, no higher than 480 kc being selected because of possible interference due to direct pickup on the distress wave of 500 kc.

Better Image Suppression

But for short-wave use it is well known that a higher intermediate frequency would be preferable from one viewpoint, that of better image suppression. If one used an i.f. of 1,620 kc, for instance, then 1,620 kc would be the constant difference established between the carrier frequency and the local oscillator frequency. Images would be separated by twice the i.f., or 3,240 kc. The related fact is the simple one that any tuned circuit will discriminate better between two frequencies widely separated than between two close together. That is, the rejection of the frequency far off resonance is more pronounced.

If this were all there were to it, no doubt some sets would have two intermediate frequencies, one for the broadcast band and lower, another for short waves. Something like this may come to pass finally, but meanwhile for multiband tuning, with wide coverage in frequencies to include the broadcast band, low i.f. will prevail. The reason is that the low i.f. applies to all the bands (save for a small misout purposely introduced to avoid putting in a signal at or quite near the i.f. itself). The i-f selectivity is higher and voltage put into the i-f channel is higher, for low i-f.

Stability Important

So we find that there is a distinct advantage in the use of a high i-f, such as suggested, accompanied by some disadvantages: reduction of sensitivity, reduction of selectivity. Of course any reductions can be subjected to compensation, and besides all modern receivers of the better grade include different types of reduction purposely introduced. Automatic volume control is one of them, being a system that tends to level the response, despite the differences in the amplitudes of various carriers, this levelling being of course at the expense of sensitivity.

So, to gain concrete advantage, the disadvantages may be considered the form of payment.

Stability of the i-f amplifier becomes a more trying consideration as the i-f is increased, but there is nothing defeating about the problem. The primaries can be as loosely coupled as circumstances require, and the cathodes have very large capacities across their biasing resistors, 2.0 mfd. paper-dielectric condensers being suggested. The primaries need not be tuned. Loose coupling of primary to tuned secondary can give sufficient selectivity.

Output Voltage

As the i-f is increased it becomes more and more difficult to build up a sufficient output voltage, that is, harder to put enough into the i-f channel. One reason is the output capacity of the tube becomes more and more effective as a bypass of the very frequency desired to be passed. Of course the effect of this capacity on the carrier frequency, or transmitting frequency of the station, or on the local oscillator frequency as presented to the modulator, in the set, is a beneficial one, because it is not desired that either of these frequencies get by, for any amplification or back coupling. Another reason is that the gain in the circuit itself becomes less as the frequency increases, due to the losses in general becoming larger. Also, some consideration has to be given to increased noise.

Not a Folly

While these adverse conditions have to be considered and acknowledged, as stated, they are not such as to render the adoption of a high intermediate frequency as folly by any means. When one considers that a tuned antenna input and a tuned oscillator provide better image suppression at such a high intermediate frequency than do two stages of r-f and tuned oscillator (considering mechanical and other difficulties and losses associated with the use of numerous coils and switching operations), it can be seen that much may be gained. Therefore it is recommended to experimenters who want to build a short-wave set that they try an i-f around the frequency suggested, remembering that for such an i-f the oscillator would have to be padded for all bands, which is only another way of pointing out that the frequency difference between the modulator and the local oscillator is always helpfully large.

Are High-Fidelity Sets Worth While?

HIGH-FIDELITY receivers are simply sets of good radio-frequency and audio-frequency quality. From that fact it might be assumed that good quality has not been the rule in the past. Indeed, that is true. And good quality means that the audio frequencies from, say, 50 cycles to 8,000 cycles, are faithfully reproduced; also that the radio frequencies are not so sharply tuned that the high audio frequencies modulatively present in them are attenuated.

The question naturally arises: What is the sense of a high-fidelity receiver, if no stations are modulating their carriers with tones from 50 to 8,000 cycles? Are we not trying to receive something that isn't sent?

Manufacturers Lead Way

It is a fact that hardly any stations use such quality modulation. It is also a fact that one or two stations have announced their immediate intention of doing so. It is a still further fact that from 1,500 to 1,600 kc reservations have been made for licensing experimental stations, spaced 20 kc apart instead of 10 kc apart, so that modulation frequencies practically to 20,000 cycles could be introduced. Therefore, while at the moment the high-fidelity set is fishing for fish that do not exist, the fish are on their way, and the high-fidelity hook will get them.

It is foregone that the larger stations will turn to greatly improved modulation methods so that they can gain the prestige and render such service as high excellence carries with it. Moreover, anybody interested in a set, especially one that is not in the lowest-price field, wants one that will be suitable for the anticipated improvements, and the high-fidelity set is such an instrument. Here the manufacturers are forcing the stations to do better. Somebody has to make the decision and apply the pressure of progress.

Moreover, any who have heard the new high-fidelity sets must realize that they are vastly superior to their predecessors, and impart a new pleasure to listening, even to the modulation that we have been accustomed to, for old sets did not pay enough attention to what was being sent, missed or distorted many of the tones, and gave further evidence of the fact that price was too strong a factor, and quality put far behind, in much of the commercial effort. The different attitude beginning to show itself now is important to the enjoyment of radio reception by the listener and also to the ultimate success of the radio receiving industry as a whole.

Can Improve Selectivity

The receivers as now being made have the capabilities of high fidelity reception, but usually include a sensitivity control, so that the receiver may be made more selective. This is new confrontation of the designer by the old necessity of compromise between selectivity and fidelity, and the compromise is the most satisfactory one, whereby the user has either the high selectivity or the high fidelity, and at different times he will want one or the other.

Take the popular pastime of listening to local programs. Surely no great selectivity is required for this. What one desires most is the nearest possible approach to perfection of tone. Therefore, the selectivity control is set to the extreme position, which produces minimum selectivity, yet sufficient of course for separation of an interfering distant station at a channel close to that occupied by the local.

If one is desirous of tuning in a distant station, the interference may be due to a station in Mexico or some other country, 5 kc removed from the channel occupied by the desired station. Hence the selectivity control would be set for the opposite extreme. DX listening is not, in general, consistent with best tone, nor need it be. In fact, a calm survey of the science indicates that there is no known or even likely method of enabling such close selectivity as "5 kc separation" and excellent tone, whereby 8 kc of audio will be passed. The reason is that 8 is greater than 5.

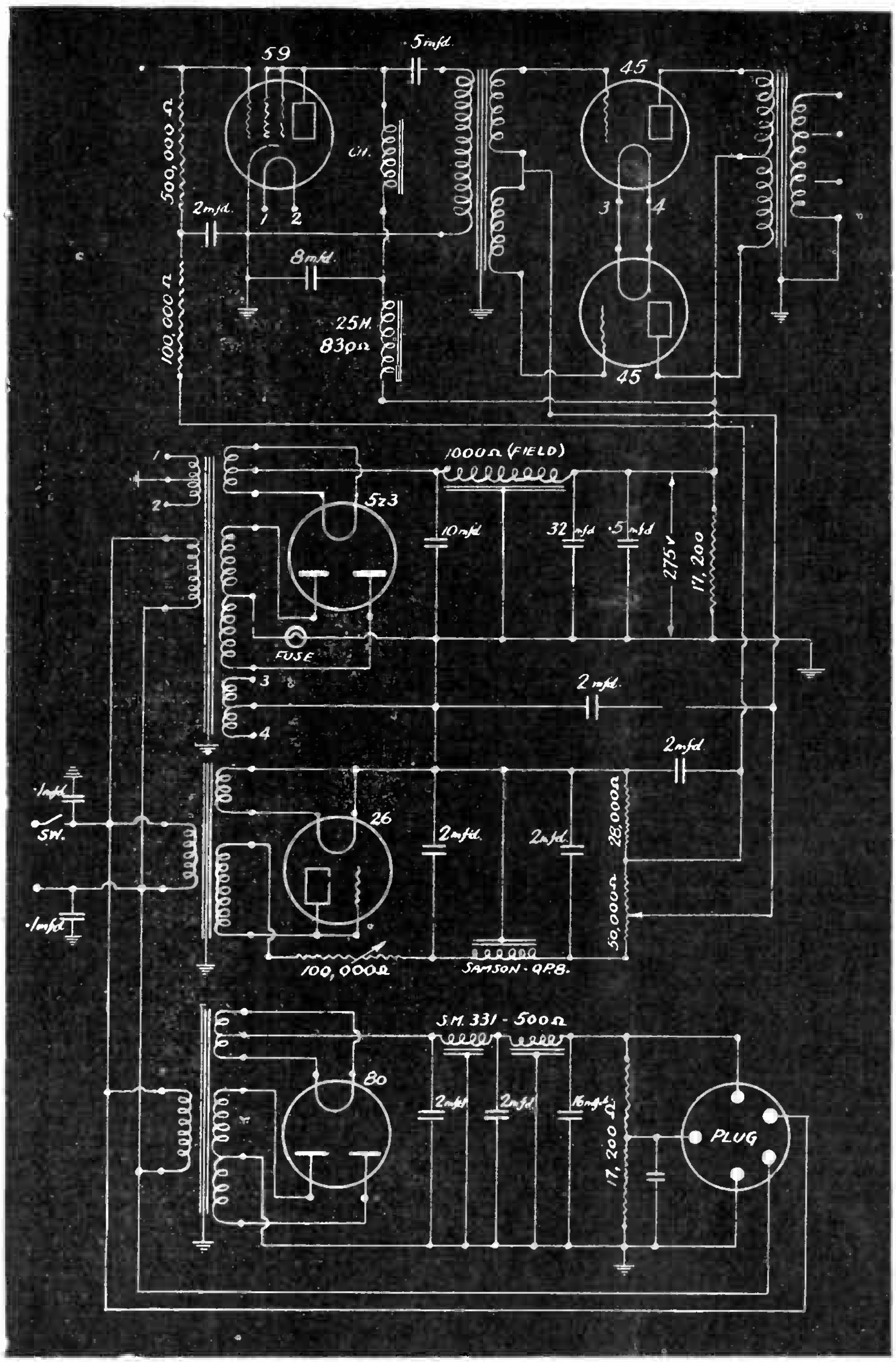
Compensation Practical

Such selectivity controls are continuously variable. One notices of course the change in tone as the selectivity is heightened. The higher frequencies become attenuated. If this is to be avoided, a special compensating device has to be introduced, to work automatically with the selectivity control, to reduce the intensity of the low audio frequencies while the high audio frequencies are being reduced by the increased selectivity. Whether such compensation, which is at the expense of volume anyway, need be included, is a matter of opinion, on which engineers differ.

A Power Amplifier

To Go With Valentine's De Luxe Superheterodyne Tuner

By B. G. Valentine



Audio amplifier, and power supply that takes care of the amplifier alone. The Valentine tuner used with this has its own power supply.

A DE LUXE superheterodyne tuner of my design was described in the September 15th and 22nd issues of RADIO WORLD, and herewith is shown the diagram of the audio amplifier and separate power supply therefor.

The tuner and the amplifier each has its own power supply. Having two transformers available, neither of which would by itself give the current and voltage desired, both were used; second, the preference for running the tuner with a power supply working well within its capacity and not subjected to sudden large fluctuations in current which might aid the stable operation of the tuner.

Here also large capacities are used, not entirely necessary, but they, too, were available and were therefore included with a view to giving a large reservoir for the power tubes to draw from when handling heavy sustained bass notes, etc. At the same time they do help in keeping the hum level very low for an amplifier capable of good amplification of the lower frequencies.

Three Ways Tried

The chief difficulty was to get fidelity in the higher register. As means for accomplishing this "lifting operation" three methods were employed. The first had to do with the value of capacity across the diode load the 500,000-ohm potentiometer in this case. Starting with a value of 0.0001 mfd. the capacity was reduced until there remained only the capacity between the resistance element and the grounded case of the potentiometer. This reduction in capacity improved reproduction of the higher frequencies, and at the same time reduced the a-v-c action. The latter is largely a matter of personal choice, however, and in this particular case the operation is as follows:

Overall amplification in the tuner is such that for all normal reception—stations up to say 1000 miles away giving fair field strength at the antenna—sufficient input to give a good signal-to-noise ratio, is obtained by using a piece of wire about six inches long—one end free, the other end plugged into the high end of the choke input to the first r-f stage. This wire is about fifteen inches distant from the antenna lead-in. With this pick-up, and the i-f gain control set at minimum, the amplifier can be well loaded up, using the volume control when receiving strong local stations.

Audio Coupling

Under these conditions the tuning meter shows a reading of about 2.5 mils, and will still respond sufficiently to allow of proper tuning, but a-v-c action is practically nil, so far as prevention of fading is concerned. The local stations which do fade, however, become mushy at the same time, and after all there is no pleasure to be gained by bolstering a mushy signal. When more i-f gain is used meter reads about 8 mills and volume is controlled by the control, a-v-c action being entirely adequate.

The second method pertained to the plate circuit of the 59 driver, and consisted of finding by repeated trial that combination of inductance of the parallel-feed choke, capacity of the coupling condenser, and inductance of the input transformer primary best for support of the high notes. The first two are variable, and the last a constant—in this case at least.

The third method dealt with a special cone and suitable voice coil impedance in the speaker. The impedance selected in this case was about 12 ohms.

The use of a 59 as driver in preference to a 56 was dictated more from consideration of current requirements for the speaker field than anything else. At the same time it can better handle the

(Continued on next page)

Foreign Short-Wave Time-Table

Call, Location, Wavelength, Frequency and Hours on the Air in EST—Letter "B" Denotes Entertainment Programs. Subtract 1 Hour for CST, 2 Hours for MST and 3 Hours for PST.

(Continued from preceding page)

signal which can be supplied from the parallel triodes of the 55's, than would a 56.

All precautions were naturally taken to prevent unwanted coupling in the audio and power supply components, by orientating at audio transformers and chokes before finally securing them in place. As in the tuner no attempt was made to economize in space when building the amplifier.

To safeguard against howling, both the tuner and amplifier are cushioned from vibration due to the speaker, by mounting them on strips of sponge rubber. The speaker baffle itself is attached to the top, bottom and sides of the cabinet in such a way as to prevent rattles from developing.

The speaker now used has a very large field coil (13 lbs. of wire), and replaces two which were used originally, and incidentally does the job much better. Cone diameter is 10½ inches and voice coil diameter 2 inches. As the speaker may be called upon to handle an output of about 14 watts, when working out of an amplifier such as the one described, it stands to reason that the speaker must be of adequate proportions. This does not necessarily mean that less than an enormous cone would do, but rather that the cone, whatever its size, be properly controlled.

The variometer shown in the circuit diagram is actually mounted in a shield box inside the cabinet, and directly under the tuner to which it is connected (when used) by a low capacity shielded lead. The reason for its inclusion is to increase the signal-to-noise ratio when receiving weak signals.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers should send a request for publication of their name and address. Address Literature Editor, RADIO WORLD, 145 *West 45th Street, New York, N. Y.*

Eugene P. Tetreault, Pascoag, R. I.
Alphonse Marquis, 120 Lowell St., Lawrence, Mass.
J. J. Black, 1773 Marks Ave., Akron, Ohio
W. P. Hewer, Greenstreet, Sask., Canada
M. E. Snyder, 1047 Gordon Street, Toledo, Ohio
George F. Seaman, 636 Monroe Place, West New York, N. J.
H. M. Donegan, Orangeville, Ohio
Alex. E. McCollum, 2329 Federal Ave., Seattle, Wash.
C. R. Anderson, 281 Orchard Rd., Springfield, Penna.
J. H. Van Nice, Radio Service, 7 Allamakee St., Waukon, Iowa.
Ralph Bowlby, 209 E. North St., Indianapolis, Ind.
J. W. Cullen, 249 Chadron Ave., Chadron, Nebr.
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Ed. Plaskka, Ed's Radio Shop, 167 W. Lincoln Ave., Oshkosh, Wisc.
Edward Moe, 5221 Third Avenue, Brooklyn, N. Y.
Peter McKinnell, 519 Mary Street (rear), Scranton, Penna.
Cleveland McDaniel, Route No. 1, Warrior, Ala.
G. R. Webber, P. O. Box 965, Plainfield, N. J.

Call	Location	Meters	Mgc.	Watts	Schedule
CR7AA	Mozambique, E. Africa	84.7	3.543	100	Mon., Thurs., Sat., 2:30-4:30
CT1CT	Lisbon, Portugal	80.0	3.750	500	Sun., 9 a.m.-1 p.m.
HCJB	Quito, Ecuador	75.0	3.998	...	8:15-10:15 p.m. daily
HCJB	Quito, Ecuador	73.0	4.110	150	8:15-10:15 p.m. daily
RWI5	Kharbarovsk, Russia	70.4	4.270	15.000	3-9 a.m. daily (B)
GDB	Rugby, Eng.	69.4	4.320	15,000	8-10:30 p.m. daily (B)
FIQA	Tananarive, Madagas.	52.7	5.690	500	4-4:45 a.m. (B)
HJ4ABE	Medellin, Colombia	51.2	5.860	...	Sat., 1:30-3 p.m.; Sun., 5:30-6 a.m. 6-8 p.m. except Mon. 7-11 p.m., Phone, 9:30-10:30 p.m.
HJ4ABE	Medellin, Colombia	50.4	5.952	...	8 p.m.-1 a.m. (B)
HJV	Vatican City	50.3	5.968	15,000	3-3:15 p.m.; Sun., 6-6:30 p.m. (B)
COC	Habana, Cuba	50.0	5.995	...	5-7 p.m.
EAJ25	Barcelona, Spain	50.0	6.000	...	Sat., 4:30-5:30 p.m. (B)
HIX	Santo Domingo, Dom. Rep.	50.0	6.000	...	8-10 p.m. (B)
RW59	Moscow, Russia	50.0	6.000	...	5-7 p.m. (B)
VE9DN	Montreal, P. Q., Can.	49.96	6.005	2,000	11:30 p.m.-1 a.m. (B)
VE9DR	Montreal, P. Q., Can.	49.96	6.005	2,000	7:30-12 a.m. Sun.; 12:30-11:40 p.m.
ZHI	Singapore, Straits Sett.	49.90	6.012	90	Mon., Wed., Thurs., 6:40-9:10 p.m.; Sat., 1:10-2:10 a.m.; Sun., 11:40 a.m.; Mon., 210 p.m. (B)
DJC	Koenigswusterhausen, Germany	49.83	6.020	8,000	10 p.m.-12:30 a.m.; 1:30-3 p.m. (B)
GSA	Daventry, Eng.	49.59	6.050	20.000	4-8 p.m. (B)
VQ7LO	Nairobi, Kenya	49.50	6.060	1,250	11 a.m.-2 p.m. (B)
ZL2ZX	Wellington, New Zealand	49.50	6.060	180	2-6:30 p.m.
VEGCS	Vancouver, B. C., Can.	49.42	6.070	7	12:30-1:45 a.m.; Sun., noon-midnight (B)
OXY	Skamlebak, Denmark	49.40	6.070	500	2-6 p.m., irreg. (B)
OER2	Vienna, Austria	49.41	6.072	20	Tues., Thurs., 9:30 a.m. 5 p.m. (B)
YV5BMO	Maracaibo, Venezuela	49.39	6.072	...	7-10 p.m. (B)
CP5	La Paz, Bolivia	49.30	6.080	...	8-11:30 p.m. (B)
VE9BJ	St. John, N. B., Can.	49.29	6.090	...	7-8:30 p.m. (B)
VE9GW	Bowmanville, Ont., Can.	49.26	6.090	...	3-12 p.m., Mon to Thurs.; 8-12 p.m., Fri. and Sat.; 12-9 p.m., Sun. (B)
VUC	Calcutta, India	49.10	6.110	500	Fri., 10:30 a.m.-2 p.m.; Sat., 11:30 a.m.-5 p.m., 11:45 p.m.-3 a.m. (B)
YV1BC	Caracas, Venezuela	49.10	6.110	...	12-2:30 p.m.; Sun., 10 a.m., 12:30 p.m., 3-7:30 p.m., 8:30 p.m.-12:30 a.m. (B)
VE9HX	Halifax, N. S., Can.	49.10	6.110	200	Sat., Sun., 5-11 p.m.; Mon.-Fri., 9:30-12 a.m. and 4-11 p.m. (B)
PKIWK	Bandoeng, Neth. India	49.02	6.120	...	5-6 p.m.
ZTJ	Johannesburg, Union So. Africa	49	6.122	5,000	12-1:30 a.m.; 10 a.m.-4 p.m.; Sun., 9-11:15 a.m.; 1:30-3 p.m. (B)
ZGE	Kuala Lumpur, Federated Malay States	48.9	6.135	1.200	Sun., Tues., Fri., 7:40-9:40 a.m. (B)
YV3BC	Caracas, Venezuela	48.78	6.150	...	4:30-9:30 p.m. (B)
TGW	Guatemala City, Guatemala	48.50	6.180	...	1:30-2:30 a.m.; 5:00-midnight
HJ3ABF	Bogota, Colombia	48.00	6.250	...	7-11 p.m.
HIZ	Santo Domingo, Dom. Republic	47.50	6.320	10	4:40-5:40 p.m. (B)
HJIABB	Barranquilla, Colombia	46.51	6.450	300	11:45 a.m.-12:45 p.m. (exc. Mon.); 7-9:30 p.m.; Mon., 2-6 p.m.; also 6.580 K.C. (B)
HJSABD	Cali, Colombia	46.30	6.480	100	6-11 p.m. (B)
HJIABB	Barranquilla, Colombia	45.59	6.580	...	11:45 a.m.-12:45 p.m. (exc. Mon.); 7-9:30 p.m.; Mon., 2-6 p.m. See 6,450 K.C.
PRADO	Riobamba, Ecuador	45.31	6.620	10,000	Fri., 10 a.m.-12:40 p.m. (B)
BC2RL	Guayaquil, Ecuador	44.93	6.676	...	Sun., 6-9; Tues., 10 p.m.-1 a.m.
HAT2	Szekesfehervar, Hungary	43.86	6.840	20,000	3-6 p.m.
EAR110	Madrid, Spain	43.00	6.976	...	Tues., Sat., 6 p.m. (B)
LCL	Jeloy, Norway	42.92	6.990	1.000	11 a.m. to 6 p.m. (B)
LU5CZ	Buenos Aires, Argentina	42.37	7.080	...	11:30 p.m. to 2 a.m. (B)
OA4B	Lima, Peru	42.00	7.160	...	12-1 a.m. (B)
HKE	Bogota, Colombia	41.55	7.220	...	Tues., Fri., 8-9 p.m. (B)
HJ3ABD	Bogota, Colombia	40.55	7.400	...	9-12 p.m. (B)
HBP	Prangina (L. of N.) Switzerland	38.48	7.797	20,000	Sat., 6:30-8:15 (B)
CNR	Rabat, French Morocco	37.33	8.035	12.000	Sun., 4-5 (B)
PSK	Marapicu, Brazil	36.65	8.185	12,000	6-7:30 p.m. (B)
PRA3	Rio de Janeiro, Brazil	36.65	8.186	...	8-8:30 a.m. (B)
PNI	Makassar, Netherland India	34.19	8.760	...	5 p.m. (B)
PLV	Bandoeng, Netherland India	31,86	9.415	...	6-8 p.m. (B)
PLH	Bandoeng, Netherland India	31.65	9.480	...	6-8 p.m.
YV3BC	Caracas, Venezuela	31.56	9.500	...	9:30-10:30 p.m. (B)
VK3ME	Melbourne, Australia	31.55	9.510	3,500	Wed., 6-7:30 a.m.; Sat., 6-8 a.m. (B)
GSB	Deventry, United Kingdom	31.55	9.510	20,000	5:15-7:15 a.m.; 1:45-10:30 p.m. (B)
OXY	Shamlebak, Denmark	31.51	9.520	500	2-6:30 p.m. (B)
W2XAF	Schenectady, N. Y. (U.S.A.)	31.48	9.530	40.000	6:40-10 p.m. (B)
DJA	Konigswusterhausen, Germany	31.38	9.560	5.000	7:45-10:45 a.m.; 6-9 p.m. (B)
W1XAZ	Millis, Mass. (U.S.A.)	31.35	9.570	10,000	7 a.m.-1 a.m. (B)
VK3LR	Lindhurst, Australia	31.32	9.580	20.000	4:15-8 a.m. (B)
GSC	Daventry, United Kingdom	31.30	9.585	20.000	11 a.m. to 6 p.m. (B)
VK2ME	Sydney, Australia	31.28	9.590	16 000	Sun., 2-4 a.m.
PCJ	Hilversum, Netherlands	31.28	9.590	12,000	6-10 a.m.; 10:30 a.m.-1 p.m.; also 15.220 K.C. (B)
W3XAU	Newton Square, Pa. (U.S.A.)	31.28	9.590	1.000	12-6 p.m. (B)
HBL	Prangins, Switzerland	31.27	9.595	20,000	Sat., 6-6:45 p.m. (B)
CT1AA	Lisbon, Portugal	31.25	9.600	...	Tues., Fri., 4:30 p.m.-7 a.m.; also 15,350 K.C. (B)
XETE	Mexico City, Mexico	31.25	9.600	...	9-11 p.m. (B)
T14NRH	Heredia, Costa Rica	31.00	9.680	...	7-8 p.m.
EAQ	Aranjuez, Spain	30.43	9.860	10,000	6:30-8:30 a.m.; Sat., 2-4 p.m.; see 6,045 K.C. (B)
LSN	Buenos Aires, Argentina	30.03	9.990	...	12-6 p.m. (B)
ORK	Ruysselede, Belgium	29.04	10.330	11,000	1 p.m. (B)
LSX	Monte Grande, Argentina	28.99	10.350	12,000	4-5 p.m. (B)
FYB	Paris, France	28.36	10.578	...	Time signals at 5:26 a.m. and 6:26 p.m.
CT3AQ	Funchal, Madeira	26.83	11.180	50	Tues., Thurs., 6-10:30 p.m. (B)
VE9JR	Winnipeg, Man., Canada	25.60	11.715	2.000	8-11:30 p.m. (B)
GSD	Daventry, United Kingdom	25.53	11.750	20,000	5:15-7:15 a.m.; 6 p.m.-1 a.m.
DJD	Konigswusterhausen, Germany	25.51	11.760	5,000	10-12:30 a.m.; 1:30-3 p.m. (B)
W1XAL	Boston, Mass. (U.S.A.)	25.45	11.790	5,000	6-7:30 p.m.; see 6,040 K.C. (B)
12AO	Rome-Prato Smeraldo, Italy	25.40	11.811	9,000	11 a.m.-2 p.m.; 5-7:30 p.m. (B)
W2XE	Wayne, N. J. (U.S.A.)	25.36	11.830	5,000	3-5 p.m.; see 6,120 K.C. (B)
GSE	Daventry, United Kingdom	25.28	11.865	20.000	1:45-5:45 p.m. (B)

Radio University

Standard Definitions

WILL YOU PLEASE give me standard definition of a master oscillator, sense finder, thermionic tube and electron emission?—W. S. A.

An oscillator is a non-rotating device for producing alternating current, the output frequency of which is determined by the characteristic of the device. A master oscillator is an oscillator of comparatively low power, so arranged as to establish the carrier frequency of the output of an amplifier. A direction finder is a radio receiving device which permits determination of the line of travel of radio waves as received. A sense finder is that portion of a direction finder that permits determination of direction without 180-degree ambiguity. A thermionic tube is an electron tube in which the electron emission is produced by the heating of an electrode. Electron emission is the liberation of electrions from an electrode into the surrounding space. In a vacuum tube it is the rate at which the electrons are emitted from a cathode. This is ordinarily measured as the current carried by the electrons under the influence of a voltage sufficient to draw away all the electrons.

* * *

Perplexed About Stations

CAN YOU AID ME in identifying the stations I heard on my short-wave set? (1) A program of music from Spain, accompanied by an announcement sounding like do-re on a wave around 92 meters; (2) around 40 meters, sound like Worcester, speaking Russian or German.

(1) Probably EDO, 92.6 meters, 3.24 mgc, Pozuelo del Rey, Madrid, Spain, power 5,000 watts; (2) experimental transmission from Koenigswusterhausen, Germany, on 39.42 meters, 7.17 mgc, power 5,000 watts.

* * *

Station List

I AM GREATLY in need of a highly-accurate short-wave station list of all the phone transmitters on earth, and was wondering if you could suggest where I might obtain one?—K. C.

Trade questions of any nature, and your question comes under this heading, should be addressed to Trade Editor, Radio World, 145 West 45th Street, New York, N. Y., and a stamped envelope enclosed, as such questions are answered only by personal correspondence, administered in our institution by an entirely different department than the technical department. Promptness of reply is assured.

It Is New

FOR ABOUT ten years I have been following radio technique very closely, and I have never found anywhere a suitable explanation of the relationship of harmonics, so that harmonics could be identified, and unlimited unknown frequencies higher than the fundamental determined, until the series of articles that recently appeared in Radio World. The examination of the subject by your staff disclosed a very simple series of relationships, and also pointed out the accuracy factors, and pitfalls, and I was wondering whether I had been asleep in not running across such material years before, or whether it's quite new.—J.C.S.

The revelation of the relationship of harmonics, and the use of it for determination of unknown frequencies higher than the fundamental of a generator, is new. We believe with you that it is an important contribution to radio technique, in that it makes existing low-frequency oscillators ever so much more useful, and eliminates confusion due to the harmonics. Previously there was some basis for the argument that use of harmoncs was not altogether safe in the hands of any save the expert, and even he got fooled once in a while, but now there is no need of anybody making a mistake. A review of the situation, with some new data, was published in last week's issue, dated October 6th.

* * *

Television Systems

IN COMPARING the results from the best cathode-ray system of scanning for television, with the best mechanical method, which would you say was the better?—I. H.

The scientists using the cathode-ray system have more interesting formulas, but the best mechanical system shows better pictures. Take your choice.

* * *

Ultra-Wave Computation

WHEN THE RADIO FREQUENCIES become very high, why is it that computation systems collapse, and that everything has to be experimental? Why does the nature of a constant change?—I.E.D.

The computation systems themselves do not collapse, in any real sense, but the data on which the computations would have to be based can not be obtained. The answer to the second part of the question will explain in part the meaning behind the answer to the first part. Take a tuning condenser of any type. At low frequencies, say, in the broadcast band, you would treat it simply as a condenser. At very high frequencies it no longer is just a condenser. The plates have length, they may be considered as flat pieces of wire, although in juxtaposition, and at these very high frequencies the inductance of the plates becomes a consideration. Take for example a generator for several hundred megacycles frequency. It would not be necessary to have any coil other than that comprised by the inductance of the tuning "condenser," that is, the mechanical object we are discussing is both the tuning capacity and the inductance across which this capacity is connected.

* * *

Effective Volume Control

IN MY SET the volume control has gone haywire and I was wondering if you could suggest a control that will absolutely cut off the signal, as well as afford maximum sensitivity at no attenuation?—P. L. H.

Connect cathodes of two consecutive r-f tubes together and connect one end of a biasing resistor to this common point, say, 150 ohms or so. Connect a 10,000-ohm potentiometer with one extreme from free end of this biasing resistor to ground. Connect a bypass condenser, any value, the higher the better usually, from cathode to arm of the potentiometer and connect arm of the potentiometer to aerial (primary of the antenna coil.) That makes an effective control such as you request.

* * *

Directions for 333-A

WILL YOU PLEASE give briefly the directions for using the Model 333-A Signal Generator scale? I recently bought the coil, condenser and scale, and am about to construct this Signal Generator. —I. K.

The fundamental frequencies covered by fundamentals are 83 to 99.9 kc, 140 to 500 kc, 540 to 1,600 kc, and 1,620 to 4,800 kc. Thus there are four stops for the switch. However, the low-frequency range also is calibrated on the direct-frequency-reading dial in wavelengths, 3,600 to 3,010 meters. An unusual point is that the spreadout at the lower waves of this band is enormous, so that between 3,010 and 3,015 meters there is 1-meter gradation. Since this band is the same as that for the lowest frequencies the same spreadout occurs in the frequency scale, 0.1 kc between 99.9 and 99.5 kc. There are four tiers on the scale, and two escutcheons are needed. Since there are four switch stops, and actually four bands, and as one band is represented twice—once for frequencies, again for wavelengths—one of the frequency calibrations must be subjected to double use. It is. The broadcast band calibration must be multiplied by 3 for the determination of the frequencies read from 1,620 to 4,800 kc. The scale for the broadcast band itself may be used as follows: From 540 to 1,100 kc, read as 10 kc separation. From 1,100 to 1,600 kc, use 50 kc separation. If closer readings—to 20 kc—are required for frequencies above 1,100 kc, get the approximate setting from the scale as shown, then turn back to half the desired frequency, read near the other end of the scale, and you have what you want as second harmonic. The illustration (Sept. 29th) hadn't the gradations of 10 kc between 1,000 and 1,100 kc, but these since have been added, and, as you know, are on the scale that you possess.

Station Sparks By Alice Remsen

WYNN, "SPIKES," SCUDDER

"SO-SO-O-O-O" — ED WYNN IS BACK. But he has changed his background—as a news commentator he's still a good comic. Have you heard his new series? Tuesdays, 9:30 p. m. WEAF. . . . "Thrills of Tomorrow," a new dramatic series for boys, dealing with mechanical and scientific inventions now in an experimental stage but likely to become practical in the near future, will be inaugurated over an NBC-WEAF network on Friday, October 19th, at 6:00 p. m. Walter Tetley will play the leading role of the boy hero, "Spikes Butler," and the dramas will be written by the NBC radio writer, Raymond Scudder. No fantastic or improbable feats will be presented, and each broadcast will deal with a scientific venture regarded as feasible by recognized engineers. Sponsored by the A. C. Gilbert Company. . . . Phil Harris has decided to give the radio audience a taste of the gaiety which precedes the sity campuses. For the next several weeks big football games on college and univer- his "Let's Listen to Harris" broadcasts over a nationwide NBC-WJZ network will emanate from a college campus on the eve of the big gridiron battles. Sponsored by the Northam-Warren Corporation. Each Friday at 9:00 p. m. . . . "Jewels of Enchantment," which brings Irene Rich to the microphone, has changed time from Wednesday at 7:30 p. m. to Friday at 8:00 p. m. NBC-WJZ.

MARY PICKFORD IS THRILLED

Mary Pickford, the original "sweetheart" of the screen, is thrilled with her radio work. She has a very charming speaking voice, which is heard to advantage in the new dramatic stock company she heads over an NBC-WEAF network each Wednesday at 8:00 p. m. Sponsored by the makers of Royal desserts. . . . Another new dramatic series will make its debut on October 14th, when Miriam Hopkins and John Boles recreate the famous stage and screen success, "Seventh Heaven," over an NBC-WJZ network. The radio rights to many of the most outstanding stage and screen productions have been secured for this series, sponsored by Lux, and emanating from the Radio City studios. Each Sunday at 2 p. m. So you can go for either soap or gelatine. You turns your dial and you takes your choice. . . . Programs for a Fall series have been mapped out in cooperation with the Department of Superintendence of the National Education Association, bringing noted educators to address American parents over National Broadcasting Company networks. Each Saturday at 5:30 p. m. over an NBC-WEAF network. . . . It seems to me that it rains every Saturday in New York, just for spite; I like to do my week-end shopping in the forenoon, and then settle down at my portable for a good old writing bee; but here it is noon and it's raining like the deuce; my plans are all shot again this week; but I'm getting hungry—so on go raincoat and rubbers, out comes the umbrella, and I'll leave you for a while! . . .

PARADE OF NEW PROGRAMS

Well, here I am back again! . . . And still the parade of new programs continues. . . . "The Land of Beginning Again," a Sunday afternoon musical series, featuring Ruth Everett, Harrison Knox, Rod Arkell and Louis Katzman's Orchestra, will be inaugurated over an NBC-WJZ network on Sunday, October 14th, at 4:30 p. m.; devoted to popular music of the melodic type, these half-hour broadcasts will be under the sponsorship of the Carlsbad Products Company. . . . Grantland Rice, famous sports authority, is again being presented as an added attraction on the Cities Service Concert each Friday evening. Mr. Rice discusses major gridiron contests for the radio audience. . . . Rudy Vallee is back in Hollywood and will broadcast from there for six weeks, while making another motion picture. . . . The Gothic Choristers, presenting the best in classical and contemporary church music, are back on the air, and are to be heard each Friday at 10:30 p. m. over an NBC-WEAF network. . . . The Kansas City Philharmonic Orchestra will present a new type of symphony program this winter. They will have De Wolf Hopper, famous stage and operetta star, as narrator. He will discuss each of the selections and guests soloists will be heard from week to week. Karl Kreuger will be the conductor. Each Sunday at 4:00 p. m., NBC-WJZ. . . . Another Metropolitan Opera star, James Wolfe, has joined the long list of stellar artists to be heard over the NBC networks this winter. . . . A story comes to my desk about Frederick Stock, conductor of the Chicago Symphony Orchestra. The other day he passed a golf practice place and decided to stop and do a little driving. He bought a pail of golf balls and began to work on his stroke. The fellow in charge watched him for some time and then came over to offer his idea as to what was wrong. "D'ye know what's the matter with you, mister?" he asked. "You ain't got no rhythm." . . .

WRIGLEY ROUTS WRINKLES

Over at the Columbia studios, "Soconyland Sketches" are in a new series, on a new day and hour—Saturdays, at 7:00 p. m. Arthur Allen and Parker Fennelly are starred, and are supported by well-known actors and actresses. The sketches are written by Ford Manley and Henry Fisk Carlton. John Knight is the narrator, Harold McGee the director. William Stickles and his orchestra provide the musical settings. . . . Setting up exercises for the face, arousing widespread interest in the field of beauty culture for women, is a feature of the new series of programs now being heard each Thursday, Friday and Saturday, at 6:45 p. m. over WABC and six other Eastern CBS stations. Margaret Brainard, former actress, and now a beauty specialist, will acquaint the listening audience with her system of face muscle exercises. Connie Gates will be heard on Thursday and Fridays, and Jerry Cooper on Saturdays, plus a string orchestra. Sponsored by William Wrigley, Jr., Company. . . . Abram Chasins, the eminent young American composer-pianist, has expanded his series of informal recitals known as "Piano Pointers" to a half-hour period; each Saturday at 12:30 p. m. WABC and network. . . . Carson Robison and His Buckaroos have a new day and time. They will now be heard on Mondays instead of Thursdays at 8:00 p. m.; sponsored by the Health Products Corporation. . . . The new Camel Caravan is on its way, with Walter O'Keefe, Annette Hanshaw, Ted Husing and Glen Gray's Casa Loma Orchestra. Sounds good! Take a listen on Tuesdays at 10:00 p. m. WABC and network. . . . The three-a-week Chesterfield series also should provide plenty of diversified entertainment. Grand opera singers; comedy skits; variety singers, and Andre Kostalanetz' Orchestra should be worth a dial-twist.

MICRO WAVES STUDIED

The effects of ultra frequencies are being studied in various directions, electrically, medically and biologically. One experiment has to do with accelerating the rate of growth of a plant by subjecting it to a constant, mild ultra-frequency voltage. If the voltage is raised sufficiently, vermin on the plant are exterminated but the plant left unharmed. If the voltage is entirely too high the plant dies.

A THOUGHT FOR THE WEEK

WE HAVE HAD ALL KINDS OF TECHNICAL SCHOOLS AND COLLEGES for these many years, but it is not so long ago since radio first became a part of the curriculum of various important institutions, technical and otherwise. It would appear from reports this year from various state Boards of Education that the season of school and college terms of 1934-35 will probably find more radio-minded youths —yes, and their elders, too—at seats of learning all over the country than ever before since the public began to be interested in all the things that make up radio interest in its practical and scientific and technical aspects. This is not by any means bad news for the radio trade in general, for after all parents don't laugh any more when their sons seek highly specialized knowledge in a field in which they have become enthusiastically interested.

All of which also indicates that broadcasting has done a good deal for educational urge and impulse, whether Joe Penner actually sells his duck or Kate Smith pulls the old moon over those peaks.

Quick-Action Classified Advertisements

7c. per word. $1.00 minimum.

TECHNICAL SCHOOL GRADUATE wants position in radio factory or laboratory. Factory experience. Write B. Mac-Holmes, Box 132, Corona, N. Y.

SPECIAL—500 business cards, $1.25. QSL cards, lowest prices. Cumberland Printing Co., Box 2145, Knoxville, Tenn.

½c RENEWS DRY CELLS. **Instructions 10c.** Mayer, 407 East 75th Street, New York City.

CAST ALUMINUM RADIO CHASSIS. Send 10-cent stamp for blueprint. Valentine, Stewartsville, New Jersey.

RADIO WORLD AND RADIO NEWS. Both for one year, $7.00. Foreign $8.50. Radio World, 145 W. 45th St., N. Y. City.

WE MAKE TO YOUR SPECIFICATIONS; chassis, shields, panels, test equipment. Chassis 10" x 12" x 3", $3.00. Constructors Supply, 303 Furman St., Schenectady, N. Y.

LOST KEYS are returned to you promptly when you use our service. **Full Ten Year Service** for $5.20. **Only one cent a week.** Send your order today. Velva Service Bureau, Dept. B, Box 546, Lima, Ohio.

PORTRAITS COLORED, 25c dull prints only. Leon C. Roffe, Laurens, N. Y.

"THE RADIO HANDBOOK," including Television and Sound Motion Pictures. By James A. Moyer and John F. Wostrel, both of the Massachusetts Department of Education. For engineers, designers, operators, service men, experimenters. 886 pages, 650 illustrations, flexible. Price, $5.00. RADIO WORLD, 143 West 45th St., New York City.

"RADIO TROUBLE SHOOTING," Second Edition, by E. R. Haan. Contains the latest on A.C. receivers, dynamic speakers and television. A practical book for practical men. Contains a special chart showing all possible radio troubles and the way to detect them. Size 6 x 9 inches. 361 pages, 300 illustrations. Flexible binding. Price $3.00. RADIO WORLD. 145 W. 45th St., New York City

RADIO WORLD AND POPULAR MECHANICS MAGAZINE—Radio World is $6.00 a year, and Popular Mechanics Magazine is $2.50 a year. Popular Mechanics Magazine does not cut rates, but Radio World will send both publications to you for one year for $7.00. Radio World, 145 West 45th St., New York City.

Instructions for Use of Model 334-A Signal Generator

I. Connections

Connect an insulated wire from the output post of the generator to the circuit to be measured.

Station-Frequency Levels—For lining up any receiver in any manner at station-frequency levels, disconnect antenna from the receiver, and connect the generator output to the vacated antenna binding post of the set.

Intermediate-Frequency Levels—Disconnect antenna from the receiver. Connect the output of the generator to the plate of the first detector. Sometimes the connection from generator may have to be made to the plate of the i-f tube ahead of the second detector, the input to the second detector adjusted, and the connection moved to the next preceding plate, for lining up the next preceding stage, and then moved to the first detector plate for final lining up the first stage input. In working on sensitive superheterodynes it is sometimes advisable besides to stop the local oscillator from oscillating, which nearly always can be done by shorting the tuning condenser, or always by removing the B voltage (opening B return of plate winding).

II. Measurements

There are two types of measurements. The first is setting an unknown to a known frequency, as when a channel is to be lined up at a predetermined frequency, e.g., 175 kc, 465 kc, 600 kc, 1,450 kc, etc. This is peaking or padding. The other measurement is simply determination of the frequency (or wavelength) of a station, where no alignments at all are to be made.

Peaking and Padding—These consist of establishing circuits at one frequency, or one circuit at a frequency different from that of the others by a required amount. When this difference is to be established it is more popularly called padding. "Lining up" applies to both operations.

Peaking a superheterodyne i-f channel—The i-f channel of a superheterodyne should be peaked first. This is done by selecting the desired or intended frequency, by setting the generator pointer to that frequency, and adjusting the trimming condensers on the i-f coils. If both primary and secondary are tuned, first adjust the plate trimmer, the one that has a high voltage between the trimmer and B minus, listening for maximum output (as the generator is constantly modulated) or watching an indicator of maximum response. In general, connection of output of the generator to plate of the first detector is sufficient. Leave the first detector tube in its socket. An insulated clip may be used for connection to the plate spring of that socket. This is the plate circuit in which the primary of the first i-f transformer is located. First tune the plate-circuit trimmer, then the grid-circuit trimmer, and once the grid-circuit trimmer is set, do not molest the plate-circuit trimmer. Then, leaving the generator connected as before, proceed to the next stage, and then to the next (if there are three coils, two stages), and repeat the adjustment process. In some instances it will be more expeditious to connect the generator output to plate of the i-f tube preceding the second detector, adjust the trimmers as before, but on the coil feeding the second detector, move the generator output connection to plate of the preceding tube, tune the coil fed by that plate, then finally wind up with generator connected to plate of the first detector. Then if any check is to be made for closer resonance, tune only the grid-circuit trimmers.

R-F Levels of Superheterodynes—Two operations are necessary for lining up superheterodynes for coverage of any one band, such as the broadcast band. First, for the broadcast band, the generator is set with pointer at 1,450 kc, and the receiver dial is turned until the response is heard near minimum capacity. Then the trimmers on the r-f sections of the gang tuning condenser are adjusted for maximum response, then the trimmer is adjusted on the section of the gang that tunes the local oscillator of the superheterodyne. Next set the generator with pointer at 600 kc, and turn the receiver dial to the extreme low-frequency end, and then back toward higher frequencies, until the response is picked up. Now "rock" the receiver dial to and fro about this point to determine if there are two responses, one usually much more pronounced than the other. If there is only one response the series padding may be accidentally correct. At least, adjust the padding condenser until response is maximum, then check to see that there are not two responses a few degrees apart for dial settings as the rocking process is repeated after each tentative adjustment. When the setting is satisfactorily established this way, only one response point for say, 10 degrees of the set dial, return to the high-frequency end of the band, reset the generator at 1,450 kc, and readjust the local oscillator trimmer (not the padding condenser that is in series with the main tuning condenser) to see whether response can be improved. Leave the adjustment where output is largest. For any other bands the same method is applied, except that for high frequencies in short-wave bands, say, below 10 mgc, there may be no series padding condenser, and only the parallel local oscillator trimmer is adjusted, at the or near the high-frequency end of the band. If any receiver has frequency-calibrated dial, the work is facilitated, as the actual dial positions for the tie-down frequencies then are known. If the circuit can be lined up well at one end and not at the other the trouble is in the receiver, not in the generator.

Tuned-radio-frequency Sets—For peaking t-r-f sets the generator is turned to 1,500 kc, the receiver dial turned to near the minimum capacity setting, until response is heard, and the trimmers on the condenser gang are adjusted for maximum response. Only one adjustment is made. The low-frequency end can not be adjusted separately.

III. Use of Fundamentals and Harmonics

100-200 kc—For frequencies of 100 to 200 kc, use the fundamental by setting the pointer to the desired frequency, top scale. There can be no possibility of confusion, for if the frequency to be measured, or established, is lower than 100 kc there will be no response, and if it is on the fundamental there will be only one response, except that for an unknown of 200 kc there will be two responses, one at 100 kc (the second harmonic of which is 200 kc) and the other at 200 kc (fundamental).

200-400 kc—For intermediate frequencies from 200 to 400 kc the second harmonics may be used, and as there is no danger of confusion as to them, the pointer is set to read the desired frequency on the second tier from the top.

400-800 kc—For frequencies from 400 to 800 kc, including therefore the most popular intermediate frequencies, such as 450, 456, 465 kc, etc., set the pointer to the desired frequency on the third scale from the top, and line up the intermediate channel. Look at 100 on the top scale and the corresponding number on the scale you are using, which is 400. That discloses that the harmonic order you are using is 400/100 or the fourth. Hence for 465 kc the fundamental used is 116.25. To check whether you have really peaked the channel at 465 kc, divide 465 by the next higher or lower number. Suppose we select the next lower number (which is 4 minus 1, or 3), divide 465 by 3, equals 155 kc, so turn the generator pointer toward higher frequencies, and if the next response is at 155 kc you've lined up the channel at 465 kc, and at no other frequency. Such double-checking points are right on the dial, on a lower tier, for popular intermediate frequencies, thus requiring no calculation.

800-1,600 kc—Part of the third tier is in the broadcast band, 540 to 800 kc, and the divisions are 5 kc apart. All of the fourth tier from top is in the broadcast band, 800 to 1,600 kc, bars 10 kc apart. To eliminate any possibility of doubt, select pointer position of the generator for the desired frequency, then look at the low-frequency extreme of the top tier and the tier you are using, see the numbers 100 and 800, and note that the eighth harmonic is concerned. Therefore if the desired frequency is 1,600 kc, set the pointer to reach 1,600 kc, for the eighth harmonic, then divide 1,600 kc by 1 more or less than 8. If you divide 1,600 by 1 less than 8 (that is, by 7) the resultant frequency is higher than 200 kc (e.g., is 228.6 kc), hence use the factor of 1 higher than 8, or 9, get 1,600/9=177.7 kc, and after the lining up has been done at 1,600 kc pointer index, check for the correctness by turning to generator dial turned from 1,600 kc (or equivalent 200 kc of the fundamental) to lower frequencies, and for correct 1,600 kc this next point will be 177.7 kc. The second frequency need not be read closely, as the correctness is established even if the second frequency is approximated. Moreover, the second frequency often may be either higher or lower, as only at or near the ends is one confined to selection in a given direction.

As a further aid: Starting always at 100 kc, to make measurements in steps of 100 kc, the unknown frequency is as stated below when the first response is due to 100 kc and the next consecutive or second response is at a fundamental frequency as listed:

Second Response Frequency Is In Kilocycles	*When Unknown Frequency Is In Kilocycles*
200	100
150	300
133	400
125	500
120	600
116.6	700
114.3	800
112.5	900
111	1,000
110	1,100
109	1,200
108.4	1,300
107.6	1,400
107.1	1,500
106.6	1,600
106.2	1,700
105.9	1,800
105.5	1,900
105.3	2,000

For measuring any frequency higher than 1,600 kc, or in fact any frequency using harmonics of 100 to 200 kc, two consecutive positions of the generator dial may be used for creating responses in the receiver, and the unknown computed. Reading the two frequencies from the generator dial, multiply them together.

(*Continued on next page*)

Westinghouse Has Selective P-E Tubes

A new line of photo-electric tubes, sensitive only to definite bands of invisible ultraviolet radiations, has been announced by the Westinghouse Lamp Company to meet a demand growing out of an increasing use of ultraviolet radiating devices for therapeutic and germicidal purposes. They are available in various types with threshold values of sensitivity set at different points in the ultraviolet spectrum so that radiations can be studied qualitatively as well as quantitatively.

Some of the laboratory uses of these phototubes are: to test the transmission and absorption of various types of glass and solutions in different parts of the spectrum; to test ultraviolet output of different light sources in different regions of the ultraviolet spectrum. In industry the tubes are used in equipment for the control of irradiation by ultraviolet or certain products for the production of Vitamin "D."

Useful in Control Problems

The new line of electronic tubes also includes several of the Caesium oxide type, which are sensitive in the visible range as well as in the infra-red. Available in both the vacuum and gas-filled types, these types are particularly suitable for various control problems where the light of a tungsten-filament lamp is the activating agent. Other tubes of the Caesium oxide design approach eye sensitivity and, therefore, are particularly valuable in color matching and in photometrical work.

Grid-controlled rectifiers include cold-cathode tubes and a complete line of hot-cathode tubes in both mercury-vapor and inert-gas types. A direct current voltage-regulator, which is a cold-cathode gas-discharge tube and which depends for its regulating properties on a practically-constant voltage drop, is finding valuable use for the regulation of voltage for locomotive headlight lamps. A starting tip or "keep alive" electrode in this tube also permits its use as a d-c relay or a relaxation type of low-frequency oscillator.

A Stable High Resistance

Photometry of Mazda incandescent and ultraviolet lamps requires the use of a stable resistor as a grid leak in the phototube amplifier. To meet this need a resistor with a spiral of glass in a bulb filled with an inert gas was developed. A film of carbon is deposited by electrical discharge on the spiral of glass. The thickness of this film determines the resistance of the tube, which can be made any desired value from 10 to 1,000,000 megohms. This resistance is particularly useful in the various amplifier circuits for measuring small currents or for accurate measurements with an electrometer. It has a negative temperature coefficient of about .7 percent per degree centigrade.

Another interesting tube is one of the Pirani type. It has been developed for use in a calibrated instrument which gives continuous pressure readings on exhaust systems on the machines that assemble Mazda lamps. A continuous accurate reading, without the manipulation of any parts as with a McLeod gauge, is the chief advantage of this Pirani tube.

Tube Thermo-Couples

Miscellaneous designs in the Westinghouse line are the bulb-type thermocouples in different current ratings; protector tubes designed and used extensively for draining supervisory control lines of high-voltage induced charges but applicable to other types of high-voltage protection; and two standard cathode ray tubes, one for electromagnetic and the other for electrostatic control. In addition, a complete line of electronic tubes, consisting of high and low-power amplifiers, oscillators, rectifiers and grid glow tubes are available.

During the fifteen years that the Westinghouse Lamp Company has been manufacturing electronic tubes for radio communication, and more recently for industrial applications, special tubes have been developed from time to time for use in its own research laboratories. These tubes are now made available to research workers in industrial laboratories, universities, hospitals, and other fields where similar problems often arise.

Detailed information on the design, characteristics, and use of all special and electronic tubes has been compiled in an engineering manual by the Westinghouse Lamp Company, Bloomfield, New Jersey. Copies are available on request.

Detailed Directions for Use of a Generator

(Continued from preceding page)

Then subtract the lower frequency you read from the higher one you read. Divide this difference into the previous sum, and the result is the unknown frequency in kilocycles. This method permits measurements of any frequencies, limited only by sensitivity of the receiver and, the accuracy of the calibration and manipulation.

A better method is to divide the difference between two read frequencies creating consecutive responses, into either read frequency, to get the harmonic order of the *other* read frequency. Example: one setting of generator is 120 kc, other 128. kc. Difference is 8. Divide 120 by 8 = 15, the harmonic order of the other (128). Hence the unknown is 15 x 128 or 1,920 kc.

To measure high frequencies in steps of 100 kc, set the generator at 100 kc and gain a response in the receiver. Then traverse the full dial spread of the generator to 200 kc, carefully counting the number of responses, including the first and the last. Half the time there will be no response at 200 kc (because the unknown is not a product of 200 kc but of 100 kc), but go to 200 nevertheless, and remember the total responses. Then go back to the lower frequency that produced the next previous response, and multiply that lower frequency, read on the top scale (fundamental), by the number of responses. Example: At 100 kc the first response is heard, at 200 kc the fourth response. Move dial back to the next previous response point lower than 200 kc (only possible direction), and it turns out to be 150 kc. The total number of responses originally heard (4), times the next lower frequency than 200 kc (whether 200 yielded a response or not) is the unknown. Here the lower frequency response is 150 kc; x 4 = 600 kc. While a low-frequency unknown was cited for convenience, the system works out for high frequencies particularly well.

Wavelength Scale—The second from bottom scale refers to wavelengths of the fundamental. Some may desire values of the fundamental in wavelengths. Others may desire high frequencies in terms of equivalent wavelengths in meters. After an unknown high frequency is determined in frequency, say kilocycles, find some value on the fundamental frequency scale (top row) that easily is divided into the unknown. Suppose the unknown is 14,700 kc. What is the wavelength? Set the top pointer to 147, and remember that the actual frequency to be determined is 147 x 100. Read the wavelength on the pointer below as 2,050 meters (very nearly) and divide it by the number by which the top frequency was multiplied, e.g., by 100. Thus the unknown wavelength is 20.5 meters.

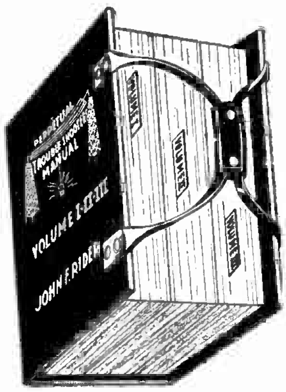
Degrees—The lowest scale is in degrees for precision checking or noting deviations from calibration.

A Thought for the Week

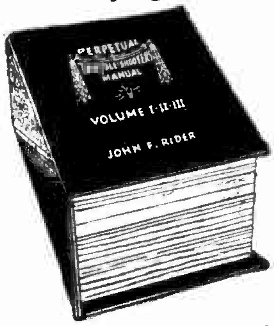
ALL-WAVE RADIOS won out at the third annual Radio-Electrical Show at the Madison Square Garden in New York City. Not only did the interest shown by the many thousands of visitors indicate that the public was becoming very much short-wave minded but also the sales of sets coming under the all-wave classification gave ample proof that there's plenty of money for those who have what is actually demanded. Incidentally, while the first two days of the show did not draw the crowds expected, the whole affair ended with a total attendance and booked orders that made everybody happy and optimistic.

RIDER'S COMBINATION "3 IN 1" MANUAL

NOW READY



The "3 in 1" manual with and without carrying handles.



It is much handier to use than three individual volumes and there is less chance of loss.

An allowance of $1.50 is allowed upon any service manual which is turned in when a Combination "3 In 1" manual, with or without carrying handles, is purchased. Naturally the limit upon such trade-ins is three manuals making a total of $4.50 allowance. This allowance is to be deducted from the selling price of the "3 In 1."

The established resale price to the Service Man of the Combination "3 In 1" manuals is as follows:

Combination "3 in 1" Manual without carrying handles $21.50.

Combination "3 In 1" Manual with carrying handles $25.00.

These Combination "3 In 1" Manuals are similar in contents to the three individual Manuals and come equipped with a cumulative index covering the contents of the Combination and with the Set Catalog.

Book Department

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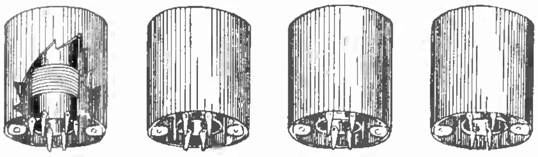
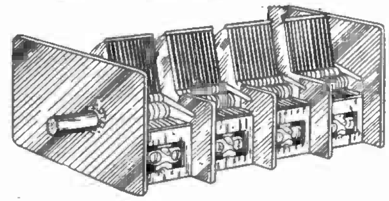
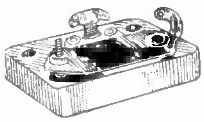


FOR broadcast eception, plus coverage to higher than 4,000 kc, thus yielding a total span of 540 to higher than 4,000 kc. We have an exceptionally precise combination, consisting of three r-f coils, one of which is used as antenna coupler, and one oscillator coil, also the necessary four-gang condenser and the correct padding condenser (Hammarlund adjustable type). The tuning coils for the r-f level have secondaries tapped so that the condenser stator may be switched from full inductance to just enough inductance to pick up the broadcast band where the full inductance left off. The oscillator coil is appropriately tapped, also, for this purpose. A four-pole, double-throw switch would be required (not furnished). Coils aluminum shielded, 2-1/16" outside shield diameter by 2.5 inches high. The four-gang condenser is very compact (5 x 2.25 x 2.75 inches). All material is specially made for this premium offer and is of highest calibre.

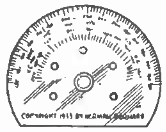


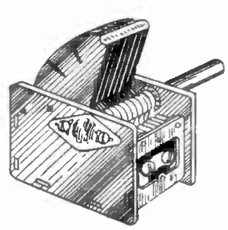


Order Cat. PR-BCTU-465 for use with 465 kc intermediate, and enclose $9 for 18-month subscription (78 issues, one each week), and four-gang condenser, four coils, and 350-450 mmfd. padding condenser, but no switch, will be sent, small transportation charges collect.

Same as above, same terms, except oscillator is for 175 kc and padder is 850-1,350 mmfd. Order PR-BCTU-175.

TUNING UNIT FOR TEST OSCILLATOR





HERE is your very first opportunity to get the parts for constructing a universal, modulated test oscillator to cover fundamentals from 135 to 380 kc, and read higher intermediate frequencies and the entire broadcast band, by harmonics, all imprinted right on the dial. That is, the oscillator will be direct frequency-reading. The parts consist of one metal-etched scale, one metal escutheon, one 0.000406 tuning condenser with trimmer built in, one oscillation transformer (secondary inductance accurate to 0.1 per cent.), and one knob for condenser. Circuit diagram supplied for universal model modulated test oscillator (90-120 volts a.c., d.c. or batteries, same oscillator works on all three). Instruction sheet for lining up at broadcast and intermediate frequencies included. Line up the oscillator with one adjustment on broadcast band, beating with some station on 1,200 to 1,400 kc. Whole dial then will track. Order PRE-TUTO and send $6.00 for one-year subscription for (52 issues). Sent postage prepaid.

MICA-DIELECTRIC Intermediate Transformers

For 465 kc or 175 kc i.f. we offer doubly-tuned transformers, with mica-dielectric condensers built in, all enclosed in 4-inch high aluminum shield, 2-1/16-inch diameter. Quantity is at left. Sent postpaid.

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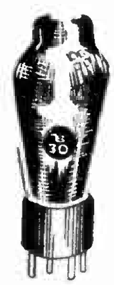

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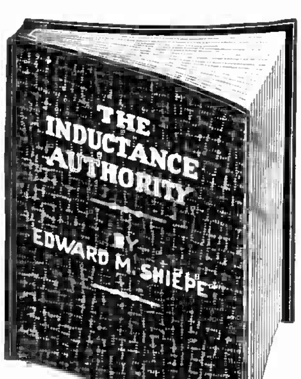

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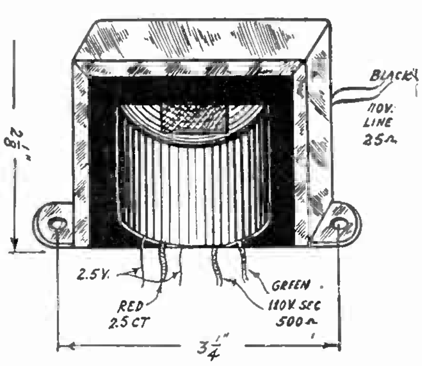

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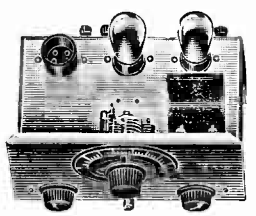

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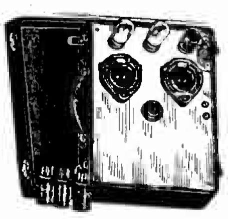

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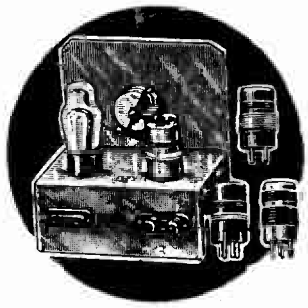

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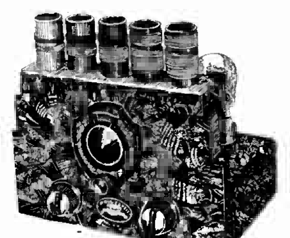

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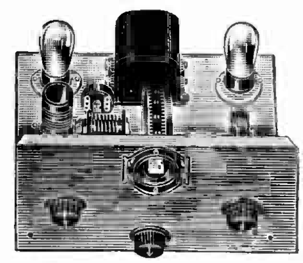

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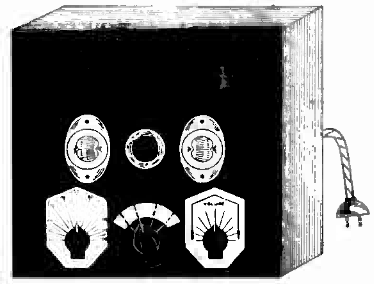

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