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Power Detection With Grid Leak

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Grid Leak Power Detection

Theory Developed for First Time and is Verified

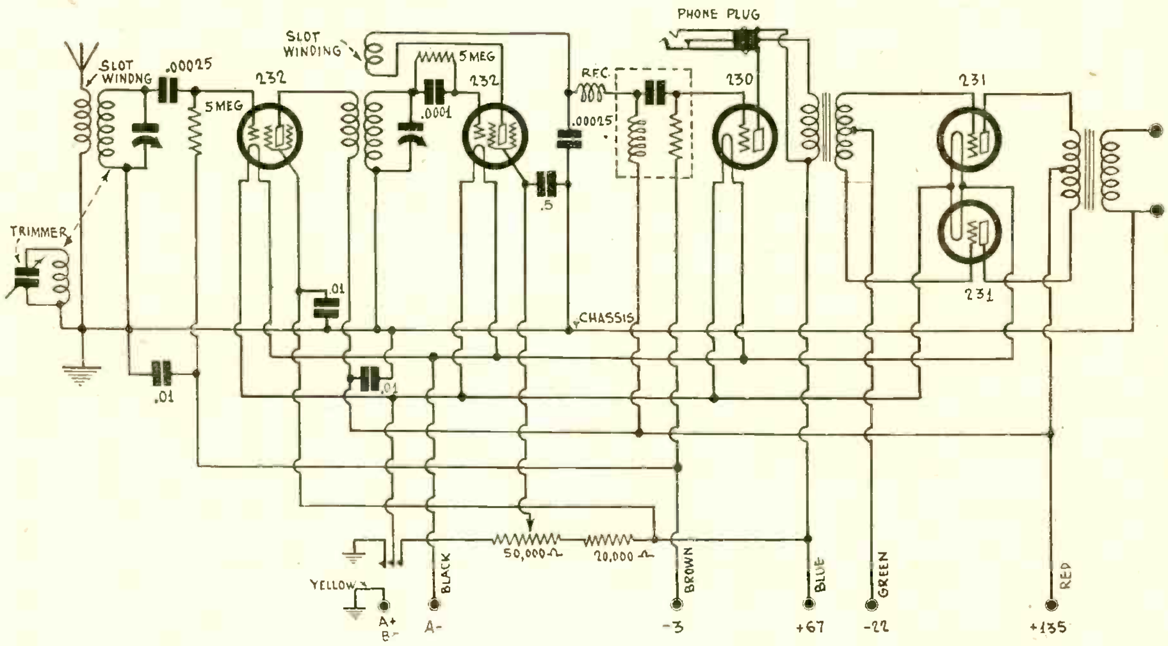


Fig. 1
In this short-wave receiver grid leak detection is employed but the customary value of the grid leak. This becomes a power detector when the leak is changed from 5 megohms to about one quarter megohm.

Grid leak and condenser method of detection is used in this receiver, but for weak signals. To convert to power grid leak detection reduce grid leak.

IT IS generally said that grid leak and condenser detection cannot be used for detecting high signal voltages because when detection of such is attempted serious distortion results. Therefore all power detectors are either of the grid bias type or simple diode rectification type.

That grid leak and condenser detection may be used even when the signal voltage is high has been proved theoretically and demonstrated experimentally by Prof. Frederick Emmons Terman and Nathaniel R. Morgan, of Leland Stanford Jr. University, California.

They have shown that to use this form of detection for high voltage signals it is only necessary to choose the correct values of grid leak and condenser in order to avoid distortion. The grid leak resistance, the grid condenser reactance, and the degree of modulation must bear a certain relation, which is that the ratio of the reactance to the resistance should be greater than or equal to the ratio of the degree of modulation to the square root of the difference between unity and the square of the degree of modulation.

Theory of Detection

This relation can be expressed more simply in trigonometric terms. Suppose X is the reactance of the condenser and R the resistance of the leak, then X/R is the tangent of the phase angle of the condenser and the resistance. Call the phase angle T. Then $X/R = \tan T$. Now if we define another angle, M, such that the degree of modulation $m = \sin M$, the condition for no distortion, as expressed in words above, may be expressed as follows:

$$\tan T \geq \tan M$$

The sign between these two is to be read "is greater than or equal to."

The theory of power detection by means of grid leak-condenser is exactly the same as the theory given for weak signal detection. That is, the condenser charges up during that part of each carrier frequency cycle when the grid is positive and when grid current flows, but it discharges through the grid leak during the part of the cycle when the grid is negative. The condition for distortionless detection given above requires that the leakage be at least as fast as the charging so that the actual grid voltage at any time of a modulation cycle is proportional to the degree of modulation, or such that the actual voltage follows faithfully the modulation envelope.

The limit of the grid leak power detector, according to these investigators, is the point where plate rectification becomes appreciable, that is, when the straight line part of the plate characteristic is exceeded.

Explanation of Values

The theory developed indicates that the maximum carrier voltage a grid leak power detector will handle is slightly less than one-half the input voltage that the tube will handle as a properly adjusted amplifier operating at the same plate voltage, and that the maximum undistorted audio frequency output voltage of the detector is in the neighborhood of one-third the output voltage developed by the corresponding amplifier. The equivalent input resistance of a grid leak power detector is shown to be greater than one-half the grid leak resistance.

The effective grid condenser capacity is the actual capacity

(*Continued on next page*)

A New Aspect of Detection

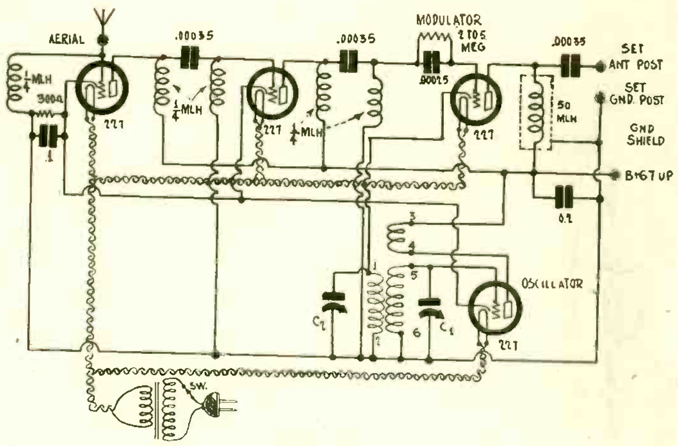


Fig. 2

In this short-wave converter grid leak detection is used, weak signal values being used. To convert this to a power grid leak detection change the grid condenser to .0001 mfd. and the grid leak to 250,000 ohms. Overloading by the oscillator is thus prevented.

(Continued from preceding page)

of the grid condenser plus the input capacity of the tube, as this input capacity is affected by the reaction by the plate circuit load. With ordinary receiving tubes a grid condenser capacity of 50 to 100 mmfd. is about right, according to the Prof. Terman and Mr. Morgan. With the grid capacity fixed in this way the corresponding values of grid leak for good reproduction of speech and music are 20,000 and 50,000 ohms.

Distortion increases rapidly with degree of modulation, but for the values given it is negligible up to about 1,000 cycles. Since most of the important speech and music frequencies are below this frequency distortion is not serious. Moreover, the degree of modulation at the higher frequencies is very small in comparison with that at the lower frequencies, first because the higher frequencies exist mostly as harmonics of the lower frequencies and the harmonics are always considerably smaller than the fundamentals, and second because even the amplitudes of the fundamentals of the high frequencies are small compared with those of the lower frequencies. Therefore the condition for distortionless detection does not impose limitations so severe as at first appears.

Experimental Results

The authors of the paper reporting the work on grid leak power detection give a set of experimental data obtained on a 327 tube for the conditions X/R equals .71, R equals .31, and m equals .35. Comparing tan T and tan M we note that the first is .71 and that the second is .374, so that the condition for distortionless detection is well satisfied, one being nearly twice that of the other.

The graph covers RMS carrier voltages up to 5 volts and gives the output voltage across a resistance of 10,000 ohms as well as the percent second harmonic. When the input voltage is 3 volts the output voltage is about 4 volts and the percent second harmonic is 3. This is for a plate voltage on the tube of 86 volts. The same graph gives the detection by the grid bias method when the plate voltage is 86 and the negative bias is 9 volts. When the input voltage in this case is 3 volts, RMS, the output voltage is only 1.4 volts and the second harmonic is one percent.

Again, the same graph gives the results for power detection when the plate voltage is 44 volts. At an input of 2 volts, when the output is near maximum, the output voltage is 1.5 volts and the second harmonic is as high as 2.5 percent.

Linear Detection

When the input voltage is low the detection is practically linear for the grid leak detector. In the corresponding region for the bias detector the output curve departs considerably from a straight line. For the higher input voltages the grid leak power shows a strong departure from linearity while the grid bias detector improves. The linear portion of the grid leak power detector curve can be extended by increasing the plate voltage. However, for low mu tubes the plate voltage that may be safely used is limited by the high current that flows in the plate circuit when the grid bias is zero. From 80 to 90 volts are about the maximum that can be used with a tube of the —27 type.

One method of circumventing this effect is to put a resistance in the plate circuit in series with a high plate battery voltage. With the values of grid leak and condenser and modulation factor given above and a voltage of 180 volts in the plate circuit, the effect of varying the resistance is shown. When the resistance is 5,000 ohms and the input voltage is 4 volts, RMS, the output voltage across 10,000 ohms is nearly 7 volts, and there is very little distortion, the percentage of second harmonic being less than one percent. With higher resistance the conditions are not quite as favorable.

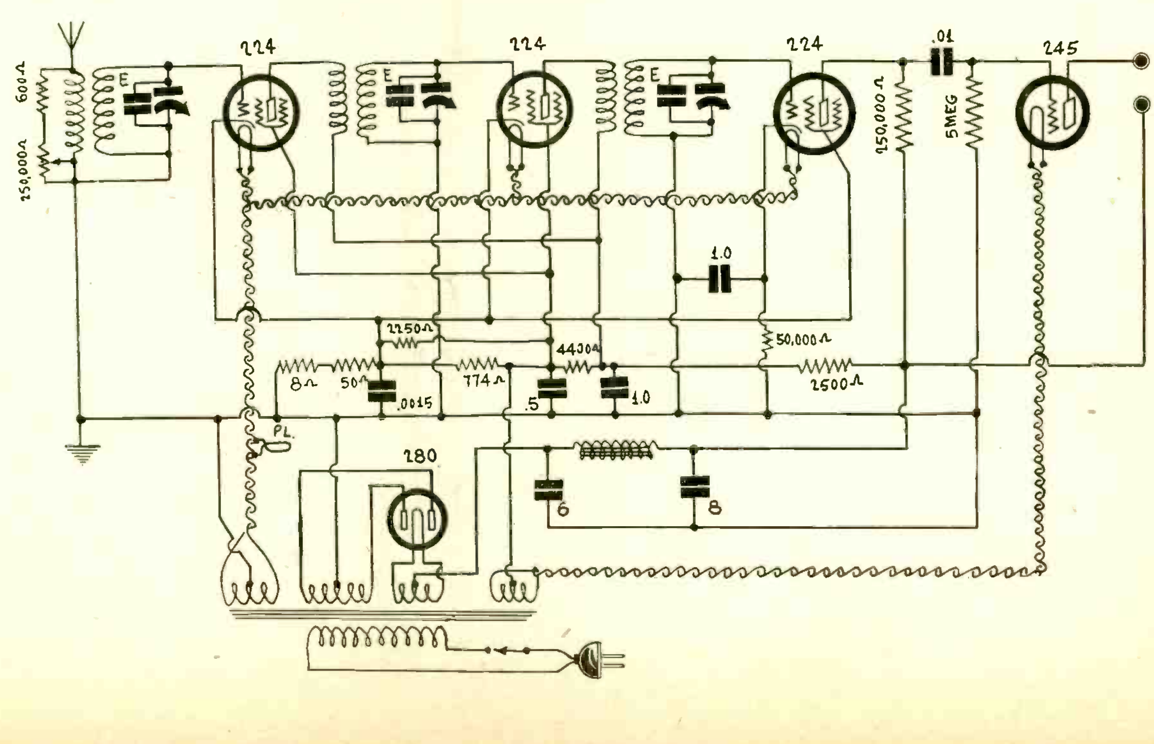
Curves are also given for the 224 screen grid tube. The values of X/R, R, and m are .71, .31 and .35, respectively, the plate voltage 180 and the screen voltage 72 volts. The grid bias for the plate rectification curve is 5 volts.

The curves are similar to the corresponding curves for the 227 tube but the grid leak curve shows to much greater advantage. When the input voltage is 1.5 volts, for example, the output voltage for the grid leak detector is 2.5 volts while at the same input to the bias detector it is only .6 volt. The second harmonic distortion for the grid leak detector is about 6 percent, while for the other it is about 9 percent. Thus the grid leak detector is several times more sensitive and it does not distort nearly so much as the other detector.

Results for other tubes like the 326, 112A and 201A are similar to those for the 224 and the 227. These are given in the December issue of "Proceedings" of the Institute of Radio Engineers, in which the two men publish their report on grid leak power detection.

Fig. 3

This circuit employs a 224 grid bias detector. To change it to grid leak power detector short-circuit the 50,000 ohm bias resistor and put in a grid leak of 250,000 ohms and a grid condenser of .0001 mfd. The resistor and the condenser should be in shunt and connected in the lead to the control grid.



A Novel Band Pass Filter

It Is Used in a New Version of the Diamond

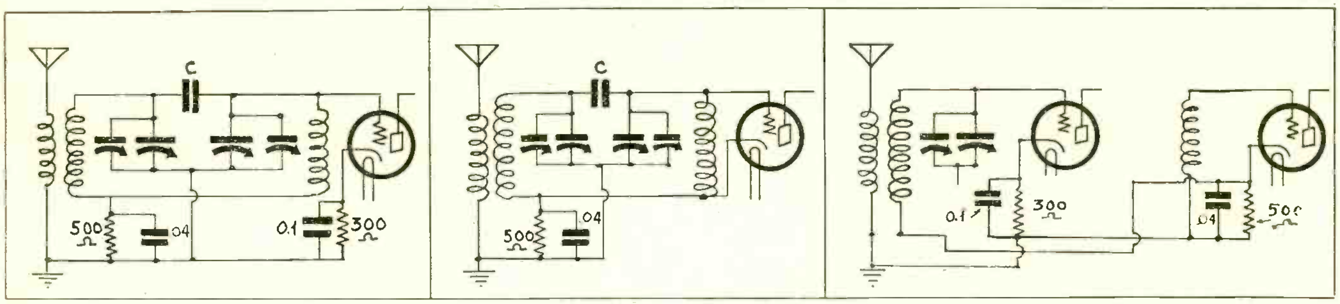


Fig. 1A
A conventional band pass filter, with coupling through the 500-ohm resistor, the .04 mfd. condenser and C.

Fig. 1B
The band pass filter constants are used also for biasing the tube, which is assumed to be a 224 screen grid tube.

Fig. 1C
The tuned circuit of the first stage run through the biasing resistor of the second stage, thus uniting the two

THE band pass filter circuit with tubes between components is seldom seen. Usually there is a pre-selector circuit, of which Fig. 1A is an example. Two tuned circuits, coupled through a series circuit consisting of a condenser and a resistor in parallel, are familiar, with a tiny additional condenser, C, for additional coupling sometimes included. The accepted values for the resistor-capacity section are 500 ohms and .04 mfd. for a proper admittance band. C may be as small as 1 mmfd.

Since the values 500 ohms and .04 mfd. are suitable for the biasing resistor of a 224 tube and the resistor's bypass capacity, the cathode may be connected to this circuit, to avoid including an additional set of parts to accomplish bias. The combination used is shown in Fig. 1B.

That method is an approach to introducing the band pass filter circuit into the tube circuit. The next step, and one believed not shown previously in any radio publication, is to constitute the band pass filter tuned circuit as an interstage coupling device as well.

Fig. 1C shows how this is done.

Aside from the transmission band, which is not changed no matter which one of the three forms of Fig. 1 is used, there is the question of feedback. Normally the feedback through the biasing resistor common to a pair of tubes is negative, but by reversing the connections on the primary or secondary of the first interstage coupler, the feedback may be made positive. The difference is so slight as to require little attention, as the condenser bypasses considerable of the radio frequency.

Such an intertube band pass filter is used in the Band Pass Filter Diamond of the Air, which is diagrammed as to general circuit in Fig. 2. There are three tuned circuits, using a three-gang condenser, with untuned coupling to the detector, broadly peaked around 600 meters, to make for uniform amplification throughout the broadcast band, avoiding the unevenness characteristic of tuned radio frequency amplification. The three radio frequency amplifiers, as well as the detector, are 224 tubes, and since the 224 may be worked as detector at a high enough load to produce 100 volt fluctuation in the output, the coupling to the power tube is simply resistance coupling. By this method it is possible to load up the 245, since that tube requires a bias of 50 volts, and the input fluctuates 50 volts on either side of the zero axis.

The radio frequency amplifier is standard, except for the novelty in the band pass filter placement, while the detector is the now familiar 224 high-gain power detector, with a resistor in the screen lead, to remove the skirts from the screen current curve, that is, make the plate and screen currents and voltages work in step. This produces a form of steadiness not usually stressed, and peculiarly enough it is a better method for this purpose than introducing a steady voltage on the screen.

The circuit does not impose any great burden on the pocketbook, as the parts should not cost much more than $30, not including tubes, speaker and cabinet, even though most attractive parts are used, including National drum dial and Hammarlund condensers.

* * *

[Details concerning the construction of the Band Pass Filter Diamond will be published next week in the January 24th issue.—Editor.]

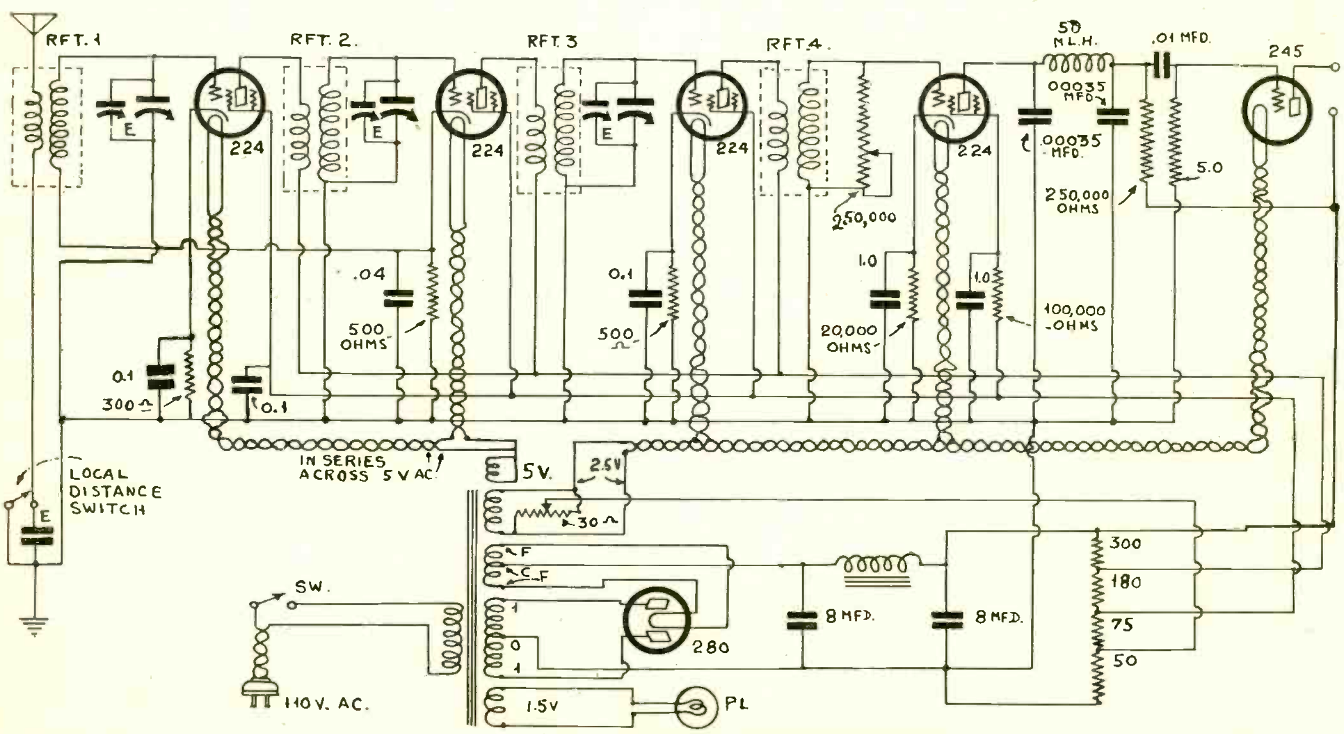


Fig. 2
General circuit of the Band Pass Filter Diamond of the Air.

Will 1931 DX Beat 1930?

Sunspot Devotees Insist That This Year Will Lead

IT'S a fortunate thing, isn't it, that in Winter, when most of us don't go in for outdoor activities, happens to be the very best time of the whole year for radio reception?

The sun is at its greatest distance from the earth, and radio waves are reflected back, especially at night, toward the earth's surface from great distances.

Scientists believe that the activities of radio waves are affected to a notable degree by sun spot action, and they believe that in a year or so radio conditions again will be what they were in the early days of broadcasting—1922 and 1923. That means, this Winter should be much better than last Winter for long distance radio reception.

Other Factors

Besides this, other reasons may be pointed out showing that a better radio Winter is here. Fewer stations operate at the same time on the same frequency. Many "cleared channels" are in effect, making possible coast-to-coast reception without interference, and the skillful listener will "travel" via his lightly touched radio dial to the far corners of the United States, and beyond.

Stations are using higher power. More scientific locations and installations enable them to reach farther even with the same power. And we have so far overlooked the improvements found in the present-day receiving sets—with their superior tuning abilities, more sensitive screen-grid tubes, etc.

Four Suggestions

So, to assure yourself of utmost radio enjoyment this Winter so far as "DX" is concerned, here are some timely suggestions:

(1)—Provide yourself with a new and up-to-date list of station calls. The stations should be listed in at least three different ways. The most important list is that arranged by frequencies. Then you should have a list arranged alphabetically by call letters, and one arranged by States. With this information, as up-to-date as possible, you will be better able to locate and indentify new and distant stations and can determine in advance almost exactly the proper dial setting for any station even though you have not heard it as yet.

(2)—Check up on your aerial and ground installation. Be sure there are no unsoldered joints in the aerial, that it is well insulated by clean insulators and that it is placed high and free as possible from other wiring or objects. Be sure the ground connection is a good one, too.

(3)—Have all the tubes tested. The radio frequency tubes and the detector, particularly, must be good ones if you are to "get in on" long distance receiving. Your dealer will test them for you.

How to Get DX

(4)—Learn how to use your set so as to get distant stations. The right knack or touch on the dial is helpful, and it can best be learned by practise in tuning in faint stations to a point of clarity and volume. Generallv speaking, the dial is moved very slowly and carefully, and at the sound of voice or music, the dial may be moved back and forth a few times over a space of only one or two degrees, with the movement gradually narrowed down to the exact spot. It takes a quick movement, over a very limited space, for the ear to catch the volume changes which indicate the correct tuning spot.

Headphones may prove helpful, but with today's good loud speakers, the headphone is usually needed only for persons hard of hearing, even when faint and distant stations are sought. Everything possible must be done to minimize interference from electrical sources, for this class of interference is very serious when you try to receive DX stations.

Dynamic Must Have Baffle or Cabinet

THE dynamic type loudspeaker is widely employed in radio sets nowadays. It most satisfactorily handles the amount of volume delivered by the modern receiving set, and even at high volume, reproduces clearly.

If full advantage is taken of its tone possibilities by a good assembly and installation, results are above the average.

Many dynamic speakers are sold in the "chassis" form, just the essential units and the vibrating cone, without a baffle board or cabinet. If the speaker is used in this form alone, its quality will not be very good, because only the higher pitched tones can be brought out properly. The interaction of the air between the front and rear surfaces of the cone prevents proper vibration for the low tones, which require hundreds of times the power necessary to reproduce high notes.

To stop this air interaction, the air path between the front and rear surfaces of the cone must be greatly lengthened, and this is done either by a cabinet or by a baffle board.

The larger the baffle board, the lower, in general, will the tone range descend, so that very large baffles are used where strong bass is wanted—as with organ music, or for dancing (drums keep the time). For average use, a box-like frame about 6 feet high and 3½ to 4 feet wide may be used, with the front covered with a sheet of non-resonant substance. A shelf is located near the center, and the dynamic chassis stands on this. A hole is cut in the front board or baffle, to be placed against the speaker cone. A decorative finish may be added by hanging a coarsely woven cloth or tapestry over the entire front of the board. It is safest to protect the opening by covering it with a wire screen.

The speaker should be located cross-corners in the room, or away from the wall. A good amplifier, with good tubes operated at the proper voltages, is necessary. If the speaker hums, a condenser may be connected to the terminals of the energizing or field coil of the speaker, in addition to the one already possibly incorporated in it. Additional condensers in the B supply may also be necessary.

Placement for the Set

By Brainard Foote

ASSUMING that you have a good aerial and a good ground arrangement, and that you have a good set, what more can you do to assure yourself of maximum possible results?

Apparently, the location or wiring in the room does not matter much. Actually, however, you can influence reception considerably in this way, for you can arrange your radio installation with the following in view: (1)—sensitiveness; (2)—reproduction; (3)—convenience; (4)—economy; (5)—enjoyment.

The item of sensitiveness will prove of greatest interest, no doubt. We are all supposed to depend mainly upon stations nearby for our radio entertainment, but most of us like to hear from the far-off fellows, too.

Room Losses Decrease Volume

Electrical losses in the room may decrease the volume from distant points, and many ordinary installations suffer from such losses. Where the lead-in wire follows a devious path around the picture moulding, for example, 25 or more feet from the window to the set, there are bound to be losses by "capacity," for some of the energy will jump directly to the wall. Also losses by resistance will result, due to the wire length. Leakage, due to imperfect insulation of the wire, will drain energy. So run your aerial wire from the window directly to the set in a straight line, if you can. Place the set near enough to the window for this.

Also be sure the set is in a direct line between the aerial wire and the ground point, and run the ground wire through holes in the flooring as straight as possible to the water main or other ground. This matter deserves your careful attention, if you like to tune in on DX.

Tone quality is affected by reverberations from the walls, by closeness to the listener, and by general room acoustics. If the set has a seperate speaker, locate the speaker across the room from the set, so that you can sit close to the set for convenient operation, but at a distance from the speaker. If the loudspeaker is part of the set, place the set a little away from your usual chair or divan. Don't place the speaker (or set, if the speaker is part of it) close against the wall, or echoes may prove annoying. Across a corner is a good placement. This is highly important with open-back sets or speakers, where much of the sound comes from the rear.

If the set is not within handy reach, install a seperate volume control with an extension cord. This is a regular stock item, as are extension cords for loudspeakers.

Precautions to Take

Place the set where you can easily get at it, or can reach inside it, without having to disconnect anything. Your service man will save time if you do. If batteries are used, put them out of sight, or better yet, in the cellar on a shelf, with the wires passing through holes in the floor boards.

Test the house voltage, and if it varies, exceeding 110 volts at times, be sure to set the voltage regulator in the set at a low enough point to compensate, or purchase a seperate voltage regulator. Preferably buy one that is equipped with an adjustment knob and a voltmeter, so you can see when it's right. Excess voltage does not improve the tone quality, and it lights the tubes too brightly, greatly shortening their period of useful service. New tubes do cost something, so be economical.

Avoid dampness, heat or cold, as may occur too near windows, radiators or outside walls. Heat is harmful, for it simply adds to the normal heat generated within the set, further shortening the lasting powers of vital parts. Be especially careful that heat and cold and dampness cannot reach the speaker, and shield the latter, where necessary, against damage by children.

Enjoyment

Radio pleasure is somehow enhanced by having a colored lamp to illuminate the speaker or set, and by having your other lights off or dimmed. The attention is then focussed, naturally and without effort, on the radio program, and you get more real pleasure out of it. A good idea is to plan your programs, and not to let your set run all the time, just to have something "going on" in the house. Too many of us use our radio that way. There are real programs on the air, and we'll like them better if we attend the ones we like rather than just twisting the knob till we hear something!

Bypass and Filter Condenser Problems

IN your radio receiver, the fixed condensers play a highly important role. Unless properly built, they may prove defective in several ways: (1)—breakdown; (2)—inductive effect; (3)—vibration; (4)—wrong capacity; (5)—moisture leakage.

Where high quality paper is not used for the insulation of the condenser, it may have weak spots which will be punctured sooner or later. Or, the paper may deteriorate with age, and the condenser is doomed then. If the unit is not rigidly assembled and well impregnated with the right type of compound, the parts may vibrate under the normal electrical strain, and eventually break. If the size (that is, the capacity) is not correct, the set may not perform correctly. Accuracy in manufacture is essential.

Where the inductive style of construction is used, a magnetic field will be set up which may reach other parts of the set and cause a hum. The general characteristics of this type of condenser are poor, although they are cheaper to make. In the inductive type, the long strips of metal foil are narrower than the paper which separates them, and the contact is made by strips of metal which touch one end of the foil. In the non-inductive type, the foil and paper strips are the same in width, but the foil is placed a little to one side, so that one edge overhangs on each side of the paper. In this way, contact is made all along the edge, instead of only at one end.

The impregnation also keeps out moisture, most important for lasting qualities. In buying a set, or in purchasing condensers, place confidence in a well-known maker of condensers. Don't buy unlabelled units. Money spent for "dark horses" in the fixed condenser line is usually wasted anyway. If the maker is proud of his product he usually labels it.

Hunt for Blamed Scratching Often Baffling

THOSE unaccountable rasping and scraping noises your radio sometimes gives forth are troublesome because they are so hard to locate. Where removing the aerial does not stop them, showing that they originate within the set, the grid leak may prove to be the source of trouble. The grid leak is in a vital spot, where even the slightest variation in electrical resistance causes a change that is amplified thousands of times, and a good grid leak is a necessary adjunct to a good set.

Sometimes the resistance material, which may be carbon deposited on a strip of paper or glass rod, becomes crystalline, or poor contact may develop at one end, or a part break occur. This causes an unsteady grid current. It's a good idea to have a spare grid leak and try it on such occasions. Metallized leaks are preferred.

With Turntable and Pickup You Have Phonograph

THE owner of a radio set, who does not possess a phonograph, need not buy a costly phonograph in order to enjoy perfect record reproduction. If he owns a good radio set and loudspeaker, all he needs is a device to rotate the record, and a pick-up.

Manufacturers are now featuring neat little electric phonograph cases, even smaller than the customary portable phonograph, for this special demand. The case contains an electrically operated turntable, a speed control, and an electric pick-up. It is not necessary to wind this type, for it is operated by an electric motor. A unit of this kind is a good investment, as an accessory to the radio set. When you want some special music, want to dance and find nothing you like "on the air" just play a record—and the new electrically-recorded selections are as good, if not better, than radio reproduction itself!

A good pickup is essential.

A Calibrated, Mod

By J. E

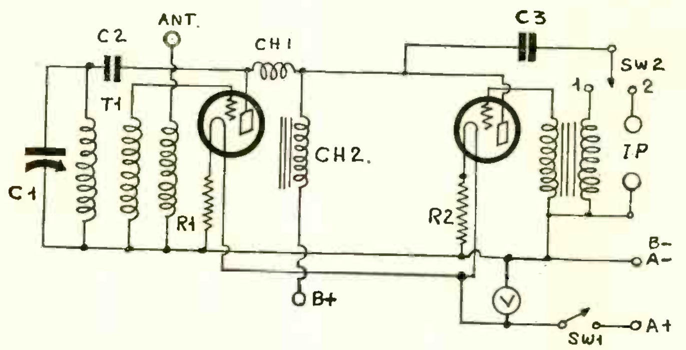


Fig. 1

This is the circuit diagram of a modulated oscillator with plug-in coils to cover a wide band of frequencies. The modulator tube may be used as audio oscillator or amplifier.

A MODULATED oscillator is so simple to construct and so useful in the laboratory that no radio experimenter should be without one. It can be used as an aid in adjusting receivers for greatest sensitivity and selectivity, for lining up trimmer condensers in superheterodyne intermediate amplifiers, for testing the efficiency of receivers, for comparing sets of different designs, for testing audio amplifiers, for testing short-wave converters and receivers, and for countless other purposes.

If the oscillator in the circuit is arranged for plug-in coils it is possible to have a miniature transmitter with which to do all these things and which will operate on any frequency from down in the intermediate frequency region up to the highest frequencies used for communication at this time. And each coil can be calibrated against an accurate dial so that any frequency may be selected at will by simply setting the condenser at the point indicated by the calibration chart for the coil that is used.

Calibrating Coils

For some reason, the suggestion of calibration is terrifying to many experimenters who have no hesitancy whatsoever of building a superheterodyne that is really "one-spot," or ganging a large number of tuned circuits, or trying some equally difficult or impossible thing. Yet the work of calibration is one of the easiest tasks that can be undertaken in the laboratory, and the subsequent use of the calibration is easier than tuning in a one-control radio receiver.

The easiest frequency range to cover by the calibration is the broadcast band. Suppose we put a coil in the oscillator that has sufficient turns to cover this range with the condenser C1 in Fig. 1. If the oscillator is working there will be a squeal as the tuner passes through the carrier of every broadcast station. Find the point where the squeal frequency is zero. Find the frequency of the station causing the squeal by identifying it and looking up the frequency in a station list. Note the condenser setting and enter the frequency and the dial setting and the number of the coil on a graph, that is, on a sheet of cross section paper. It is convenient to plot the dial settings along the horizontal and the frequencies along the vertical, although the opposite method of plotting is just as good.

In the same manner find the dial settings for as many stations throughout the broadcast band as can be identified. This ought to be at least one for every channel, especially if the work is done in the central point of the country. However, if only one out of every five can be located and identified, that is sufficient. When all the points have been located and transferred to the graph, draw a smooth curve through all the points. This is the calibration curve for the particular coil. Now even those frequencies which have not been located can be obtained from the curve for it is only necessary to run along the frequency scale on the graph to the desired frequency and find the corresponding dial setting. If the condenser is set as indicated by the graph the oscillator will generate the desired frequency. If this happens to be a frequency on which a distant broadcast station is operating a faint squeal should be audible.

Where to Listen In

The circuit in Fig. 1 does not show any place for listening in for detecting the heterodyne. If the calibration is to be accurate it is well not to connect the head phones in the oscillator circuit at all but to set up a radio receiver somewhere near the oscillator and setting the receiver into operation. The squeal can then be heard in the loudspeaker, or in a headset connected in the place of the speaker. If this method of detecting the squeal is used the calibration will not be affected by the head phones. Moreover, the sensitivity of the detector will be greater and the chances are that all broadcast frequencies can be located anywhere. Again, the calibration on the receiver will help in identifying the stations causing the squeal. For example, suppose the receiver is set so as to receive WEAF. When the oscillator dial is turned, there will be one point where the squeal is very loud. In the centre of the heterodyne region the pitch will be zero. The dial setting on the oscillator corresponding to this should be marked with the frequency of WEAF. In the same way other frequencies may be located.

Calibrating Other Coils

The calibration of other coils covering different frequency ranges can be done in exactly the same way, but the work is not quite so easy because it is more difficult to identify the frequency of a station that is causing the heterodyne. The surest way, perhaps, is to use the harmonics of broadcast stations. Take WEAF as an example. It uses a frequency of 660 kc. When the oscillator is set at twice that frequency, that is, 1,320 kc., there will be another squeal caused by that station. This happens to be in the broadcast band so that a check may be obtained on the calibration of the broadcast band coil. Using the second harmonics of the broadcast stations, a frequency band from 1,100 to 3,000 kc. can be covered.

The coil next to the broadcast coil will not cover this band, perhaps, but it should cover the band from about 1,400 to somewhat above 3,000 kc. Harmonics can also be used to go higher with the calibration. For example, there will be a squeal when the oscillator is set at the third harmonic of the broadcast frequencies. Thus we have a means of covering the band from 1,650 to 4,500 kc. Even higher harmonics may be used if the auxiliary receiver is sensitive and if it is not placed too far from the oscillator, or if the oscillator is not placed too far from the antenna serving the receiver.

Calibrating Large Coils

Harmonics can also be used for calibrating coils larger than those required for the broadcast band. In this case, however, harmonics of the oscillator are used to compare with broadcast frequencies. For example, if the oscillator is set for a frequency one half as great as some broadcast frequency a squeal will be heard in the auxiliary receiver. In this manner it is possible to cover the band from 275 to 750 kc. It is also possible to compare the third harmonics of the oscillator with the broadcast frequencies. In this way it is possible to cover the band from 183 to 500 kc. In fact, it is possible to use the broadcast frequencies to calibrate as low as 10 kc. The only thing to make sure of is the harmonic of the frequency used, but this is not very difficult if the frequency of the broadcast station is known, and this is known if the experimenter is at all familiar with the broadcast receiver.

In plotting the curve when, say, the third harmonic is used and the assumption is made that it is actually the second harmonic, the plotted point will not fall on the graph. The graph will either be all wrong or all right for any mistaken point will fall far off the line. To determine whether all are right or not use must be made of the fact that there is considerable overlapping at the ends of the graph. That is, the same frequency will appear as fundamentals and second harmonics or as second and third harmonics. A little thought will clear up any ambiguities.

Building the Oscillator

Now that we have discussed calibration briefly, let us discuss the construction of an oscillator to calibrate.

The left tube in Fig. 1 is the oscillator. It is tuned by condenser C1, which should be a moderately large tuning condenser. If it is made large, only a few coils will be needed to cover the band from about 175 kc. to 30,000 kc. but it will be difficult to calibrate the smaller coils accurately because a very small change in the condenser will result in a very large change in the frequency. If the condenser is small, a large number of coils will be needed to cover the same frequency range but the calibration will be more accurate throughout.

Whether a large or a small condenser be used it is essential to have a first rate dial on it, one that does not slip on the shaft of the condenser and also one that may be read very accurately. A suitable dial is the National Vernier dial which is characterized by a true vernier scale enabling the user to read the settings to one tenth of the finest division. There are 100 divisions on the scale so that it is possible accurately to read one thousandth of the scale. This is a very important feature in an oscillator that is to be calibrated accurately. Suppose, for example, the broadcast coil covers the band from 500 to 1,500

ulated R F Oscillator

Anderson

kc. The dial will then cover a band 1,000 kc. wide, and since the dial may be read to one point in one thousand, it is possible to read the frequency to 1,000 cycles. This is probably more accurate than the accuracy of the oscillator itself, for its frequency may change from time to time by a greater amount, unless extreme precautions are taken to stabilize its frequency.

The oscillator in Fig. 1 is of a type generating a relatively stable frequency, and the frequency may be stabilized still more by putting a high resistance between the condenser C2 and the plate of the tube. This resistance is not included in the circuit because it would have to be made different for the different coils. Moreover, for most practical purposes it is not necessary that it be used.

Tune Plate Oscillator

It will be noticed that the tuner is in the plate circuit rather than in the grid circuit. The construction is such, however, that the rotor of the condenser C1 is grounded. Both the grounding of the condenser and the tuning of the plate circuit are in the interest of frequency stability. The condenser C2 is used to enable the tuned circuit to be placed in the plate circuit. Its value depends on the lowest frequency that the oscillator is to generate. If it is small the circuit will not oscillate on the low frequencies. If the lower frequency limit of the oscillator is to be 175 kc. approximately, the condenser may have a value of .01 mfd. A recommended value of C1 is 350 mmfd., although condensers of 500 or 250 mmfd. may be used provided that the coils are made to fit them.

The oscillator coil has three windings. The tuned winding in conjunction with the condenser C1 determines the frequency generated. The grid winding may have the same number of turns as the tuned winding, and the third winding is used only as a means for picking off the oscillation. One side of this coil terminates in a binding post marked "Ant." This does not mean that this should be connected to the antenna, although for some applications it may be. In other cases it may be connected to the grid of an amplifier tube, or a modulator. It should be remembered that if it is connected to the antenna after the calibration of the circuit has been done, the frequency will change somewhat and the calibration is not accurate.

Picking Off Oscillation

Whenever this winding is used it should always be connected to a high impedance circuit. For example, if it is connected to the antenna there should be a small condenser in series, and this condenser should be smaller the higher the frequency generated. If it is connected to the grid circuit of a tube the impedance is high enough and no special precaution need be observed. In any event, the number of turns on the third winding should be small relatively to the tuned winding on the same form. For the smallest coil in a set, for example, it may be sufficient to have a single turn, or even less than one turn.

When the circuit is used for lining up tuning condensers in a broadcast receiver, this third winding might be connected to the antenna post on the set. In this case it is well to connect a variable high resistance between the winding and the antenna post for otherwise the receiver might be badly overloaded. A resistance of 500,000 ohms is not too high. However, it is left out because other values may be desirable in some instances.

Modulation of Oscillation

The right tube in Fig. 1 is a modulator tube connected to the oscillator according to the Heising scheme of modulation. The choke coil Ch1 is used to prevent the radio frequency from escaping through the choke Ch2 and through the condenser C3. Since Ch1 must be effective at all frequencies which may be generated by the oscillator it should have a relatively high inductance and no distributed capacity. To meet these conditions it may be made up of two coils connected in series, one a 50 millihenry choke and the other one of about ¼ millihenry. The larger of these is commercial and the smaller may be made by winding No. 30 enameled wire on a wooden dowel ⅜ inch in diameter and about 2.5 inches long. The winding itself should be about 2 inches.

Modulation Choke

Choke coil Ch2 might be called the modulation choke for it is the means of impressing the modulating frequency on the oscillation. It should be a choke of about 30 henries, or it may be either the primary or the secondary of an audio transformer.

The second tube may be used either as an amplifier or as an audio frequency oscillator. When used as an oscillator the switch Sw2 is set on point (1). When so set the second tube is exactly the same type of oscillator as the first, except that it may be either tuned plate or tuned grid, or a combination of the two. T2 may be an ordinary audio frequency transformer, preferably with the secondary connected in the grid circuit. When the switch is set on point (1) a frequency will be generated, the value of which will depend on the distributed capacity. Just what this will be depends on the transformer. For most purposes it does not make any difference what it is just so it is audible. It is certain to be that, for of many transformers so connected the generated frequency ranged from about 300 to 5,000 cycles. In most cases the frequency was around 2,000 cycles.

The frequency of oscillation may be lowered if it is too high and unpleasant by connecting a condenser across one of the windings. The larger this condenser the lower the frequency generated will be. It is usually possible to obtain oscillations as low a 50 cycles by using a condenser large enough. To get a frequency of this value it is best to connect the condenser across the secondary, or the larger of the two windings.

LIST OF PARTS

C1—One .00035 mfd. tuning condenser
C2—One .01 mfd. fixed condenser.
C3—One 2 mfd. by-pass condenser.
R1, R2—Two 17 ohms ballast resistors.
Ch1—One 50 millihenry and one ¼ millihenry choke in series.
Ch2—One 30 henry audio frequency choke.
T1—One set of plug-in coils, each containing three windings.
T2—One audio frequency transformer.
Sw1, Sw2—Two single pole, single throw switches.
V—One 0-7.5 voltmeter.
Three binding posts.
Three UX sockets.
One National precision dial with true vernier attachment.
One 90 volt B battery
One 3 volt A battery.
One metal box to house entire apparatus.

Use of Tube as Amplifier

When switch Sw2 is set on point (2) the right tube is an amplifier and any signal of audio frequency that is impressed on the terminals IP are amplified and then impressed on the radio frequency oscillator. The signal to be impressed across IP may be obtained either from a microphone or a phonograph pickup unit. If an average pick-up unit or a carbon type microphone is used it is not necessary to interpose another stage of amplification because a very strong modulation will be impressed on the oscillator frequency.

The circuit has been designed for the new 2-volt tubes, both 230s. With these tubes the resistors R1 and R2 should have 17 ohms when the A battery voltage is 3 volts. Two dry cells will be enough to operate the circuit. The B battery voltage need not be higher than 45 volts, although greater output will be obtained if it is 90 volts.

It is very important to keep the filament and plate voltage constant because if either changes the high frequency will change. The more constant the voltages the more constant the generated frequency. It would not do, for example, to calibrate the oscillator at 45 volts on the plates and later use 90 volts. Normal changes in voltage due to temperature changes and use of the batteries are not important for ordinary applications of a circuit of this type. Still it is well to avoid exhausted batteries.

Adjustment of Filament Voltage

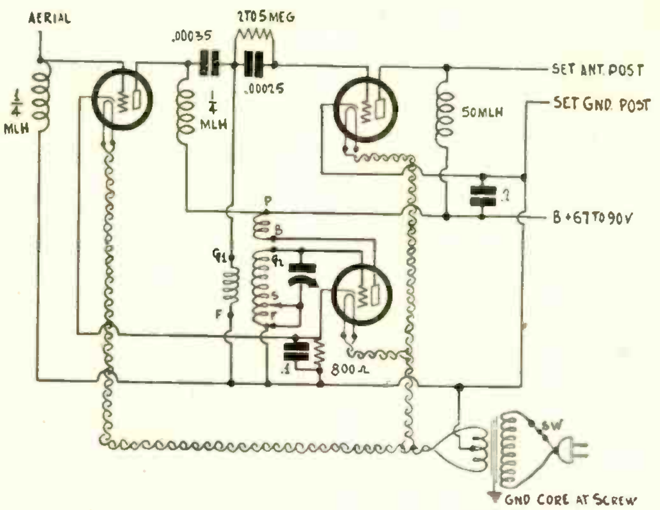
A filament voltmeter is shown across the filament circuit. A rheostat should be put in series with the battery and adjusted until the meter reads the same as it did when the calibration was done. If the two ballast resistors have the values given the meter should read 3 volts. If the rheostat is high enough it is possible to use the circuit on a battery of six volts, when the rheostat resistance should be 25 ohms. A 30 ohm rheostat would then be sufficient.

It is well to put the circuit as a whole in a metal box and to ground this box. If dry batteries are used both for A and B, it is well to make the box large enough to hold them also. No other shielding is necessary and there should not be any other shielding round the oscillator coil.

If the batteries are placed inside the metal box only two leads need be brought out, one for "Ant" and the other for the live side of IP. The box itself is the other terminal for both "Ant" and IP.

An Insight Into Working

By Herman



Single tuned circuit type of short-wave converter, using three 227 tubes and leak-condenser modulator. If the filament transformer has a center tap, ground the tap. Center-tap is not vital.

BY the use of a short-wave converter a broadcast receiver is made to reproduce short-wave reception. The chief purpose of the converter is to change the frequency. This it does by the mixing process, whereby the incoming short wave is made to beat with an oscillator, and the difference between the two frequencies is delivered to the broadcast receiver. This difference frequency, therefore, to gain any response from the receiver, must be one to which the receiver may be tuned. Normally this means some frequency within the broadcast band, but as some sets will tune either higher than the highest broadcast frequency or lower than the lowest broadcast frequency, or exceed both maxima, the range of selection in some instances will be a little larger.

The broadcast receiver performs its usual functions. Given a frequency to amplify, it amplifies that frequency, delivers it to the detector that detects it, and amplifies the detected signal at audio frequencies so that the strength will be great enough to work the reproducer.

Performance Depends on Set

Under these conditions it necessarily follows that the performance of the combination depends mostly on the performance of the receiver itself. What the converter will do, how far it will reach out, how selective it will seem to be, and other attributes, are affected by the sensitivity and selectivity of the receiver, besides some tuning skill by the operator. Not the same degree of skill is necessary with a converter as with a short-wave set that has a regenerative circuit with its tricky control, since there is strong oscillation in the converter all the time, and it is not manually controlled, whereas in regenerative circuits the feedback requires delicate adjustment for each different frequency.

The choice of the intermediate frequency may affect the sensitivity, since most receivers are not equally sensitive all over the dial, yet that choice is limited to channels on which there is no broadcast reception. Suppose an intermediate frequency of 1,400 kc were chosen. If there were a station operating within sensitivity range, on that channel, the station would be received directly, and perhaps more loudly than would be the short-wave signal. You could hear both at once. So some "clear channel" should be selected, and preferably it should be one of a frequency that is amplified greatly by the set.

Effect on Dial Settings

So there is an advantage in having a receiver that exceeds the 1,500-550 kc spectrum of broadcasting. Most of the good receivers do that at both extremes. Cheap or poorly designed receivers often miss out, and when that is so the manufacturers prefer to slight the frequencies at the higher end. Therefore the set may not tune higher than 1,400 kc, although it will reach 550 kc. The only resort then is to some frequency within the tuning charactertistic that affords the best sensitivity consistent with non-reception of broadcast radiation on that frequency.

But if a receiver is very sensitive it will bring in stations, particularly at night, almost at any point on the dial. So sensitive a receiver is usually a very good set. Being well designed, it more than covers the broadcast band. Then you have a choice of an intermediate frequency at either the upper or lower frequency extreme, which may be, say, 1,540 kc or 540 kc. Choose the one that affords best sensitivity. In most sets it will be the higher extreme frequency.

The dial settings on the converter for bringing in a particular short-wave frequency will be different when different intermediate frequencies are used. Assume an intermediate frequency of 1,500 kc and then one 550 kc. This is the span of the broadcast band, or 1,050 kc. Suppose that, using the lower intermediate frequency, 550 kc, a short-wave station of 10,000 kc is tuned in. Without changing the coil or the condenser setting of the oscillator, but simply by turning the receiver dial so that the intermediate frequency is 1,500 kc, the converter is resonant to 8,950 kc, which is 1,050 kc lower than the 10,000 kc frequency.

If there were no broadcast stations on the air, short waves could be tuned in, over a scale of 1,050 kc, by leaving the converter intact, and simply turning the dial of the receiver itself. However, 1,050 kc is a small band, particularly when the higher frequencies of short-wave transmission are to be received. In the above example, the approximate difference in wavelength of the 10,000 kc and the 8,950 kc frequencies is the difference between 30 meters and 30.5 meters. As the incoming frequency is lowered, the percentage of frequency span due to the turning of the receiver throughout its scale is increased.

Vernier Action from Receiver

Thus at short waves the set itself is a rough tuner, and if vernier adjustment is desired to bring in a short-wave station more clearly, then the receiver dial may be resorted to, since this effectuates a tiny change in intermediate frequency, which is permissible. It does not disturb the converter dial setting enough to interfere with logging.

When a suitable intermediate frequency has been found, it should be used all the time. Then the dial settings of the converter will be standard, and the same short-wave stations may be tuned in at the same points on the converter dial, time and again.

In using the converter no hesitancy need be felt about introducing a long aerial. The antenna is connected to the converter, while the output of the converter is connected to the vacated antenna post of the receiver. The longer the aerial, the better, and no considerable volume on distant signals need be expected unless a long aerial is used. An outdoor aerial of 100 feet or so total length, including leadin, should be sufficient, but that is no reason why even a longer length should not be used. Do not put a condenser in series with the aerial to the converter.

Some peculiar situations develop in working the converter. The oscillator, for instance, will deliver an output of considerable magnitude, no matter what tube is used as oscillator, when compared with the amplitude of the incoming frequency. It is easy to overload the set. Since the incoming signal may be very small compared with the intensity of the oscillation, the broadcast receiver might be overloaded, even though no signal is being received at all, as well as when a signal is brought in. For this reason systems of coupling between converter and receiver are such that there is a relatively low transfer of energy, or weak impulse delivered to the receiver. and the building up of this impulse to proper magnitude depends on the receiver.

Volume Control Adjustment Important

The volume control of the receiver is usually a gain control, and should be set at the position for maximum volume. An exception exists in the instance of receivers that can regenerate. Then the rule is to operate the set just under the point of oscillation. Most modern receivers do not regenerate.

The volume control of the receiver plays an important part indeed. A slight shift of its knob at the intensity of the reproduced short-wave signal may drop 75 per cent., or the signal may disappear entirely. So in working a converter pay exceptionally careful attention to the setting of the volume control.

The simplest converter to work is one that has only one tuned circuit. Then there is only one dial or knob to turn. Otherwise there will be a dial for the main tuning condenser, and either another dial for the other condenser, or a knob for the second condenser to hide the actual presence of two individually and separately tuned circuits. This knob method is satisfactory, since the oscillator dial settings may be determined for various stations, and once known will constitute calibration, or a log, while the knob may be shifted to bring up the volume. On strong signals, the knob, no matter where positioned, may not kill off the signal.

All-wave Reception

There is no real necessity for two separately tuned circuits except where the converter is to be an all-wave converter. As it is possible to receive short waves, it is possible also to receive broadcasts. The only requirement is that the oscillator generate frequencies that, when they beat with the broadcast

Short-Wave Converters

Bernard

frequencies, produce an intermediate frequency to which the set responds.

Take as an example an intermediate frequency of 1,500 kc. The customary method of using the higher oscillator frequency is followed. Then to tune in 1,500 kc broadcasting station, the oscillator frequency should be 3,000 kc, while to tune in 550 kc the oscillator frequency should be 2,050 kc. With a given coil, even using only a .0001 mfd. condenser, a far greater frequency range than 950 kc can be covered, so the entire broadcast range will be tuned in over less than the full dial scale of the converter's oscillator dial.

This wide range, due to the higher frequencies involved in the oscillator's action, is best capitalized by a single-tuned-circuit converter, because while the oscillator frequencies change swiftly, even when lowest original carrier frequencies are concerned, the other tuned circuit, if present, would change slowly, in normal tuned radio frequency fashion. Hence before you were half through with the oscillator tuning you would be all through with the other tuning and would have to put in a new coil in the TRF socket, and the oscillator tuning would exhaust the second coil before the oscillator would require a new coil.

However, for broadcast reception there is some advantage in having the extra tuned circuit, because then image interference would not be a trouble. In any Superheterodyne—and all short-wave converters are the mixing circuit of a Superheterodyne, with or without RF—the problem of image interference may arise. This interference is due to the fact that the dial setting of the oscillator for bringing in a desired station is also the setting that brings in weakly some undesired station, which differs in frequency from the desired one by twice the intermediate frequency.

Suggestion for Dual Use

In other words, the undesired signal represents reception due to the oscillator frequency being lower than the interfering frequency by the amount of the intermediate frequency, whereas the desired signal represents a frequency higher than the original carrier frequency by the same amount.

This may be slightly troublesome on broadcast wavelengths, and the extra tuned circuit helps get rid of this, particularly over the short span of the oscillator dial where the image interference may be caused by another broadcast station. Over most of the dial this interference would be image reception of code.

Since it is of some advantage to have tuned radio frequency for broadcast reception by conversion, and of little advantage to have it for higher frequencies, a system that permits the use of such tuning where needed, and omits it where not needed, is helpful.

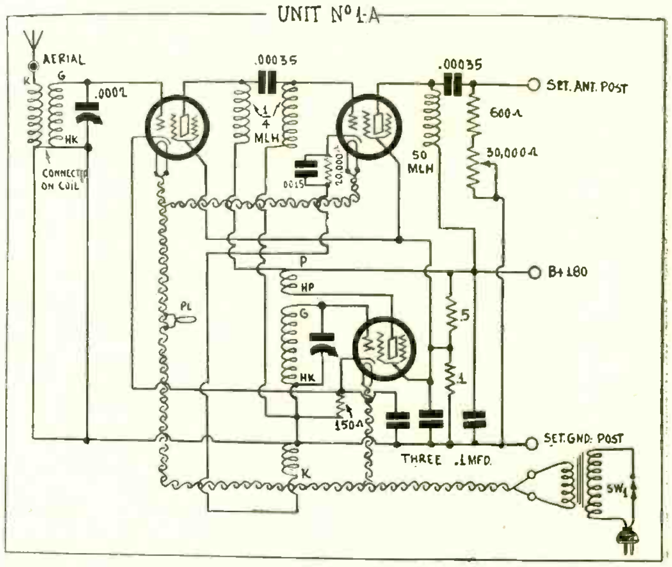
Due to the wide frequency range of the oscillator, if there is only one tuned circuit, it is possible to cover from 15 to 600 meters with only two coils. If there were two tuned circuits, plug-in coils for each, four coils would be required for the extra tuned circuit alone, a total of six coils, except that by using a consistent method of winding, so that an oscillator coil when not used as such may be used as the other coil, the actual number of coils is cut down, but not the actual number of uses.

What Will You Hear?

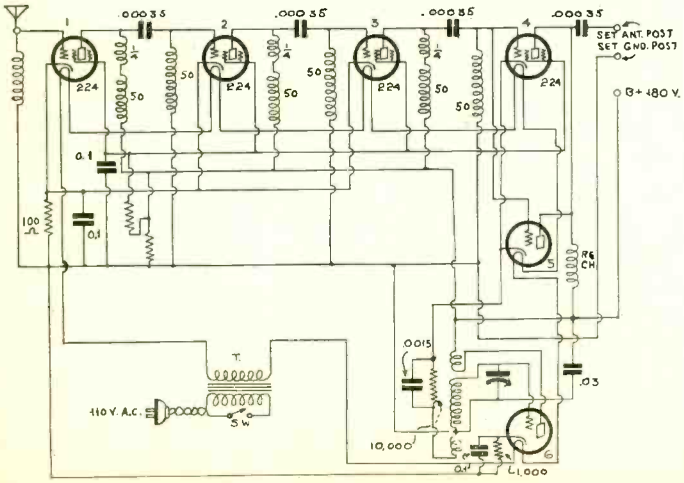
The wide range of the oscillator tuning characteristic permits the use of a single coil with a tap for shorting a larger part of the winding when higher frequencies are to be received.

Apart from the technical considerations of the converter itself, in its conjunctive use with a broadcast receiver, are the transmissions on short waves. There are about half a dozen broadcasting stations emitting their regular programs on short-wave relays, in the United States, besides some 19,000 amateurs, a dozen or so television transmitters, some police alarms and commercial traffic. The amateurs and the commercial traffic use both voice and code, while the police use voice, so one may expect to hear plenty of both. The number of program stations to be heard will be small in comparison to the rest.

While there are more than a hundred European and other foreign short-wave broadcasters sending programs, reception of these will depend first on ability to bring in domestic signals on short waves and second on tuning for European stations with close regard to the frequency used in transmitting, and knowledge of the hours on the air. The time, if not given in terms of your local time, will have to be converted by you to local time.



Design of a triple screen grid de luxe all-wave converter. For broadcast wavelengths tune with the dial and use knob on modulator condenser for fine adjustment.



A Six-Tube Converter

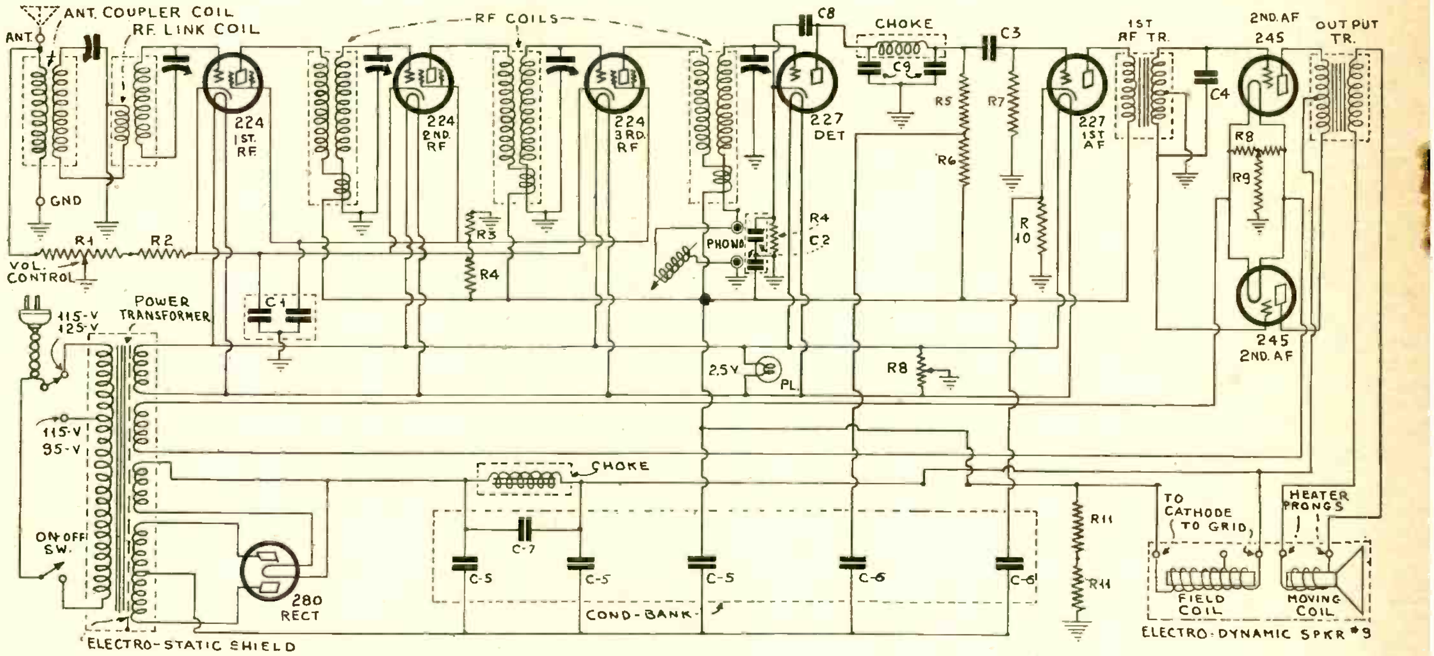
[During the past few weeks a de luxe model converter has been described, using two tuned circuits. The double tuning effect is desirable because the converter is of the all-wave type, 15 to 600 meters. But after the broadcast tuning is completed, the need of the extra tuned circuit is not considerable. Therefore a plug-in RF choke coil will serve from 1,500 kc up. Following is the list of parts for the de luxe model, known as Unit 1-A.]

Two plug-in tube base coils for oscillator. Coil 1 has 13-turn secondary, 15-turn plate winding, 6-turn pickup. No. 28 wire. Coil 2 has 23-turn secondary, 15 or so turns on tickler, 8-turn pickup.

Two plug-in coils for modulator. Coil 1 is an RF choke coil built into tube base form, condenser being set at zero or cut out. Coil 2 has 112-turn secondary, 20-turn primary, i.e., 132 turns tapped at 20th.

Two Hammarlund .0002 mfd. midline junior condensers.
Two 1/4-mlh RF chokes.
Two .00035 mfd. fixed condensers.
One .0015 mfd. fixed condenser.
Three 0.1 mfd. in one case.
One 50 millihenry RF choke.
One filament transformer, 2 1/2 v.
One 600-ohm resistor.
One 30,000-ohm potentiometer with AC switch attached.
One 0.5 meg. pigtail resistor.
One 0.1 meg. pigtail resistor.
One 150-ohm flexible biasing resistor.
One 20,000-ohm pigtail resistor.
One National modernistic dial, flat type, with pilot lamp.
One front panel.
One subpanel with four sockets.
Two brackets.
Four binding posts.
One AC cable and plug.

Diagrams of Lyric ar



THE All-American Mohawk Lyric receiver No. 96 contains three 224 screen grid tubes as radio frequency amplifiers, one 227 tube as power detector, one 227 as audio frequency amplifier coupled to the detector by means of a resistance coupler, two 245 audio frequency amplifiers in push-pull, and one 280 rectifier tube in the power supply. Fig. 1 gives the complete circuit diagram of the receiver. We note that there are five tuned circuits in the receiver, two of which are between the antenna and the first tube.

The volume control is worthy of special mention. It is made up of a 10,000 ohm potentiometer R1 connected between the antenna and the cathode returns of the three screen grid tubes. Between the cathode end of this potentiometer and the common cathode lead is a 500 ohm resistor R2 which determines the lowest grid bias on the screen grid tubes. The slider on the 10,000 ohm potentiometer is connected to ground. As it is moved resistance is added to the grid bias resistance and at the same time the resistance across the primary of the input transformer is reduced. Thus the bias is increased, thus reducing the amplification, and the shunt resistance is decreased, thus decreasing the input voltage. Therefore the volume control is double action and very effective.

Reducing Cross Modulation

When the grid bias is increased for the purpose of controlling volume the distortion in the radio frequency amplifiers increases and this gives rise to a certain amount of cross modulation. The variable shunt resistance across the primary greatly reduces the grid bias necessary to reduce the output of the amplifier to a given value, and thus it also reduces the cross modulation. This advantage is not present in many other commercial receivers. The double tuner ahead of the first tube helps to eliminate the cause of cross modulation for if there is much selection ahead of the first tube frequencies not desired are eliminated.

The heater tubes are served by a single 2.5 volt winding and it is shunted by a low resistance (20 ohms) potentiometer, the slider being connected to ground. The slider may be set where the hum is absent or a negligible minimum. There is also a potentiometer of the same value across the filaments of the 245 tubes, which are served by a second 2.5 volt winding. Between the slider of this potentiometer and ground is a 1,000 ohm resistance to maintain the grids of the power tubes negative with respect to the filaments.

Electric Shield in Power Transformer

A feature of this circuit is an electric shield between primary and the secondary windings. This is used to prevent noises from the line getting into the circuit.

There is a .002 mfd. condenser from the plate of the detector to the cathode of that tube and in the plate circuit there is a filter consisting of choke and two condensers. The condensers are connected to ground on one side. Each of the condensers in this filter is .001 mfd. Thus the carrier frequency is well suppressed before it reaches the audio amplifier.

The possibility of motorboating is eliminated by a 25,000 ohm resistor R6 in series with the plate coupling resistor R5, which has a value of 70,000 ohms. A one microfarad condenser C6 is connected between the junction of these resistors and ground to make the 25,000 ohms resistance effective as a filter.

A .00025 mfd. condenser C4 is connected across the secondary of the push-pull input transformer to take out undesired high frequencies from the signal. In view of the effectiveness of the filtering in the plate circuit of the detector and this extra condenser there is no necessity of employing any other device for taking out high audio frequency disturbances.

Equipped for Phonograph

The circuit is equipped for playing phonograph records, and the pickup unit is connected in series with the tuning coil of the tuned circuit just ahead of the detector. This, of course, puts the pickup unit in series with the grid so that the detector acts as an amplifier of the voltage induced in the pickup unit. Since it is not desired to have the pick-up unit in series with the tuning coil when the set is used for radio, the terminals of the phono pickup may be shorted. Since the unit is on the low side of the coil there is no capacity disturbance due to the pickup unit, and it need not be removed when receiving radio signals.

Provision is made for different line voltages. There is one tap for cases where the line voltage lies between 95 and 115 volts and another for cases in which the line voltage is between 115 and 125 volts.

The filter choke in the B supply is shunted by a 0.1 mfd. condenser to tune it to the ripple frequency, that is, 120 cycles. The plate currents of all the tubes flow through this choke so it is a low inductance heavy duty choke. The second choke in the filter is the field coil of the electro-dynamic speaker. This carries all the plate currents, except that of the power tubes, and it also carries the bleeder current.

Values of Parts in Model 96

The resistors and condensers in Lyric No. 96 have the following values:

C1, 0.5 mfd. (2); C2, 0.5 mfd.. (2); C3, 0.1 mfd.; C4, .00025 mfd.; C5, 2 mfd. (2); C6, 1 mfd.; C7, 0.1 mfd.; C8, .002 mfd.; C9, .001 mfd.; R1, 10,000 ohms; R2, 500 ohms; R3, 25,000 ohms; R4, 10,000 ohms; R5, 70,000 ohms; R6, 25,000 ohms; R7, 0.5 megohm; R8, 20 ohms; R9, 1,000 ohms; R10, 2,000 ohms R11, 6,000 ohms.

Lyric Model D

The Lyric Model D is the latest of this line of receivers and contains many improvements over the previous model. Fig. 2 shows the complete circuit diagram.

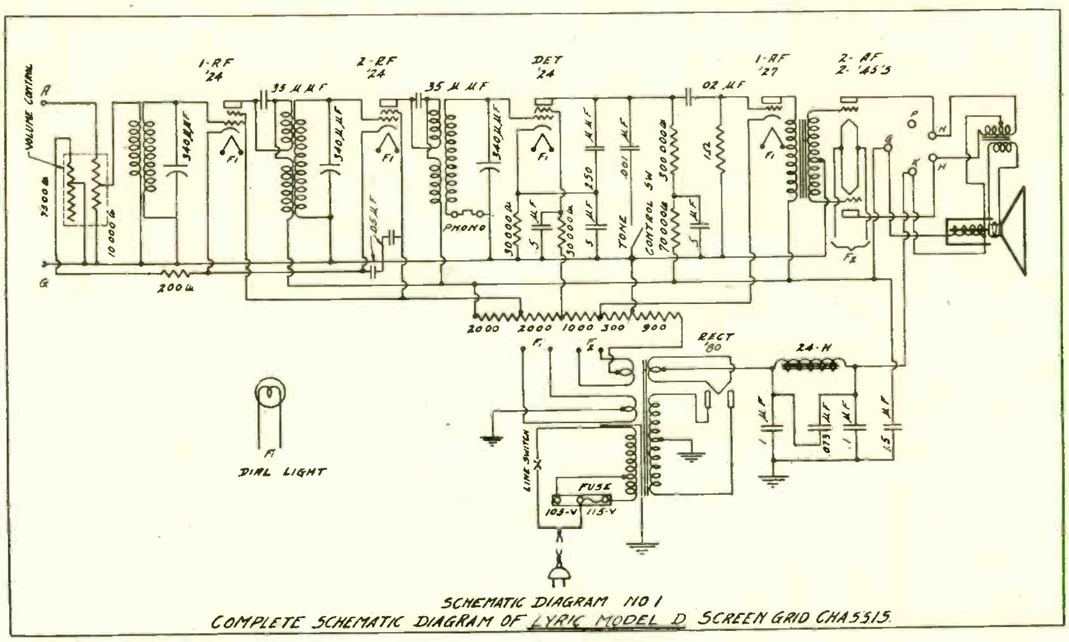
Starting at the beginning of the circuit diagram we note that the volume control is similar to that in Model 96 in that the bias resistance and the shunt across the input are varied simultaneously and in opposite directions, or so that both combine to decrease or increase the volume. In this case, however, there is only one tuned circuit in front of the first tube, and there are only three tuned circuits in all.

A portion of the primary of each of the second tuned circuits

nd Clarion Receivers

Fig. 1 (Left)
The circuit diagram of All-American Mohawk Lyric No. 96 receiver.

Fig. 2 (Right)
Circuit diagram of Lyric Model D screen grid receiver.



is shunted by a 35 mmfd. midget condenser. The object of this design is to make the circuit more sensitive at the low end of the broadcast band by forming a tuned circuit just below that band. The 35 mmfd. condenser in each case is placed so that the higher frequencies pass through it to the untuned portion of the primary. Hence the tuned part of the primary does not act as a choke to the higher frequencies.

The phonograph pickup unit is placed in exactly the same position in this circuit as in the preceding, namely, in series with the tuning coil in the grid circuit of the detector. Short-circuiting the phone terminals puts the circuit into receptive condition for broadcast waves.

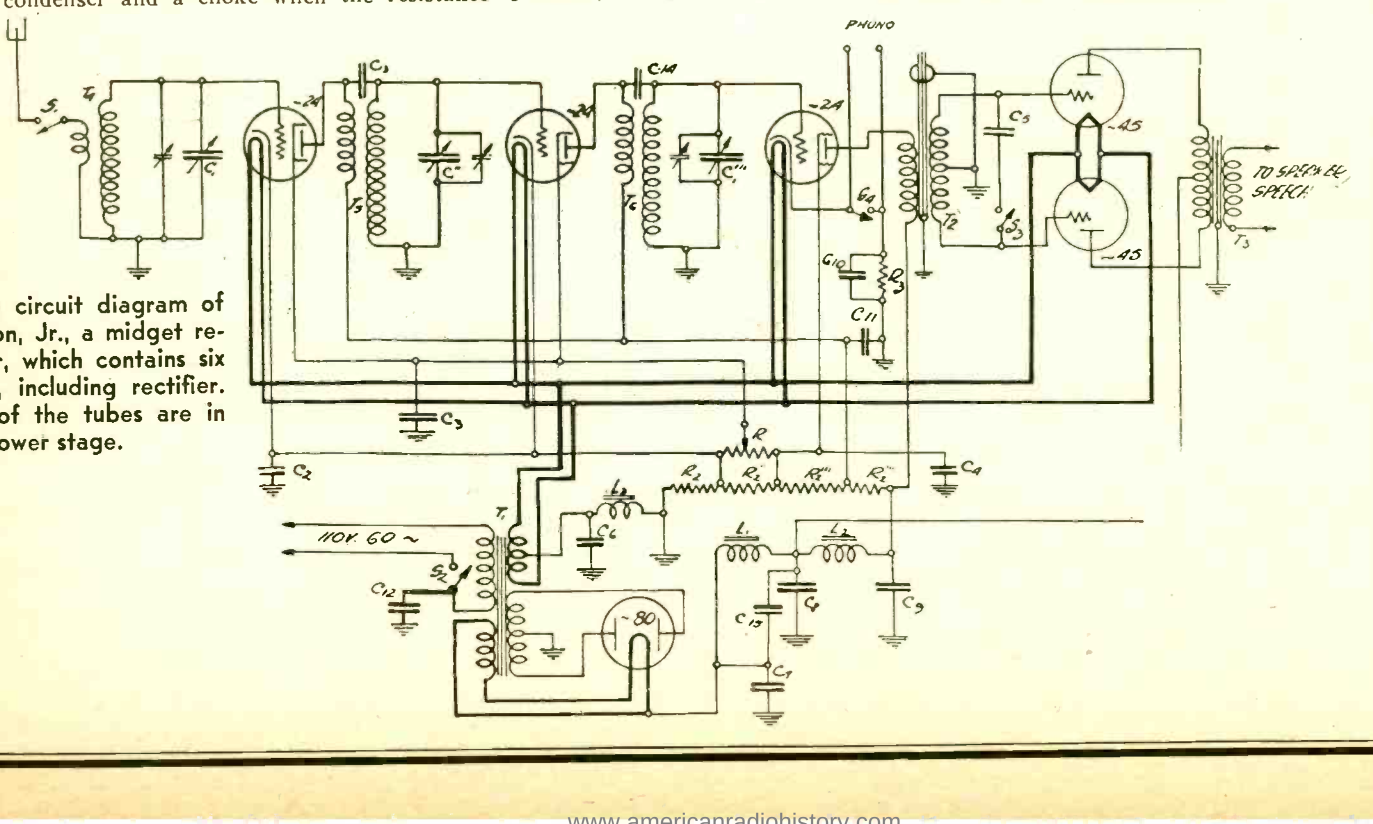
The bias resistor in the power detector is 30,000 ohms, contrasting with 10,000 ohms in the other model. The increased resistance is necessary because the resistance in the plate circuit is much higher than in the other model, and also because a screen grid tube is used as detector. The 5 mfd. condenser across the bias resistor insures against feedback at both audio and radio frequencies.

Note that no radio frequency choke is used in the plate circuit of the detector tube as is customary. This does not signify less suppression of the carrier, however, for the 250 mmfd. condenser from the plate to the cathode is much more effective when connected across a 300,000 ohm resistance than a somewhat larger condenser and a choke when the resistance is smaller.

A tone control is wired into the plate circuit of the detector and it consists simply of a .001 mfd. condenser which may be shunted across the line.

The filtering in the plate circuit against motorboating is more thorough in this circuit than in the other. The resistor is 70,000 ohms and the condenser across it is 5 mfd. There is in addition a 30,000 ohm resistance in the screen circuit and a 0.5 mfd. condenser from the screen to ground. The electric shield between the primary of the power transformer and the secondaries is retained. The primary is also tapped for different line voltages. Shifting the position of the line fuse connects the line to the proper tap.

The five volt winding serving the rectifier filament is center-tapped. Thus the circuit is balanced to eliminate the 60-cycle hum in the supply. The by-pass condensers in the filter are smaller than is customary. This is made possible by the fact that the choke is tuned to 120 cycles, the principal ripple frequency. The inductance of the choke coil under operating conditions is 24 henries and the capacity of the condenser across it is only .073 mfd. This combination resonates at 120 cycles so that the hum of this frequency is effectively blocked. The higher hum frequencies are blocked by the second choke, which is the field coil in the speaker, and they are also shunted out by the various condensers across the B supply circuits and across the various sections of the voltage divider.



The circuit diagram of Clarion, Jr., a midget receiver, which contains six tubes, including rectifier. Two of the tubes are in the power stage.

The New Audio in

By Brunsten

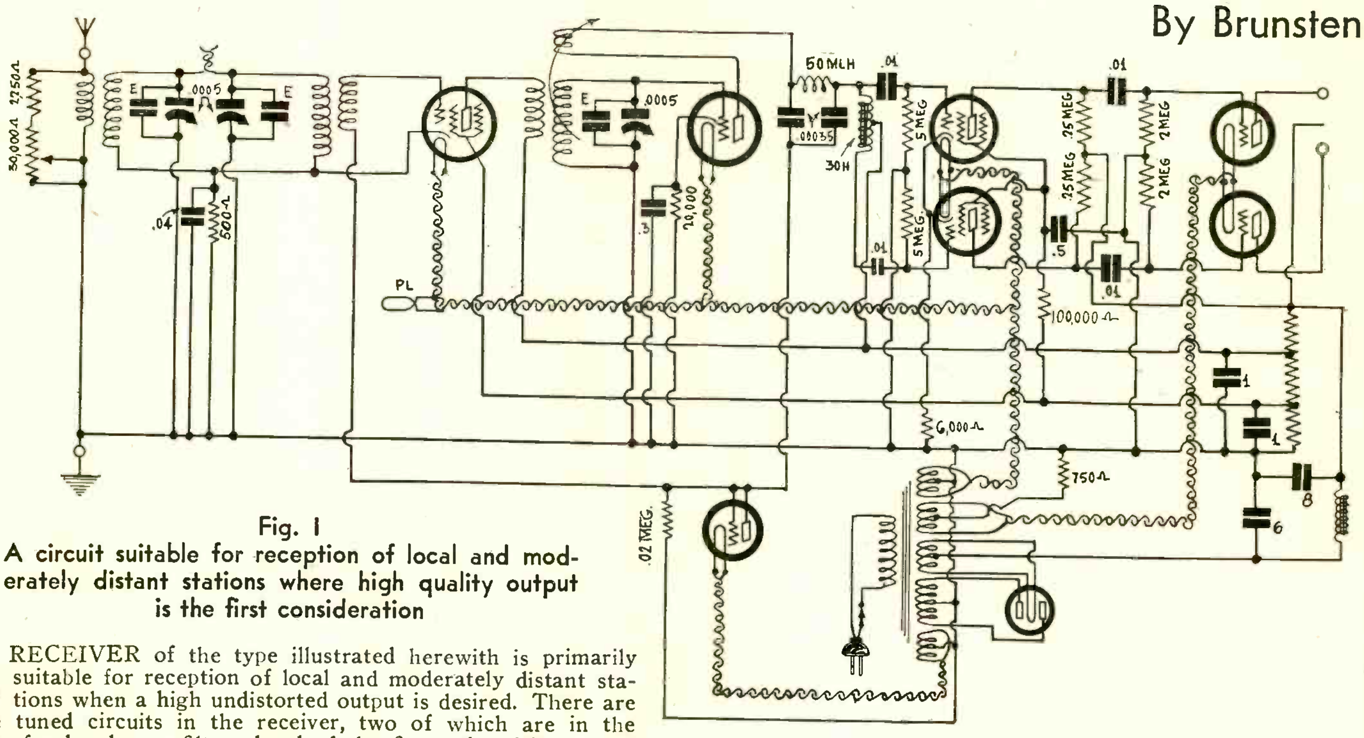


Fig. 1
A circuit suitable for reception of local and moderately distant stations where high quality output is the first consideration

A RECEIVER of the type illustrated herewith is primarily suitable for reception of local and moderately distant stations when a high undistorted output is desired. There are three tuned circuits in the receiver, two of which are in the form of a band pass filter ahead of the first tube. The second is an ordinary three circuit tuner with tuned secondary. Ample selection is secured ahead of the first tube to prevent cross modulation. The selectivity is materially enhanced by the regenerative circuit associated with the detector, and it is clear that the amplification is also greatly increased by this feature.

A high undistorted output is assured by the special push-pull audio frequency amplifier with two screen grid tubes in the first audio stage and two 245 tubes in the second and output stage. It might at first glance appear that direct coupling is used between the detector and the first audio stage and that consequently the lower side of the audio frequency amplifier would be inoperative. Closer inspection, however, will reveal that in reality the coupling between the detector and the following stage is by means of transformer. It happens to be an autotransformer and hence the appearance of direct coupling.

Autotransformer Coupling

It might be argued that the coupling between the detector and the upper tube of the first audio stage is direct, and as long as we confine our argument to this tube it cannot be gainsaid

(*Continued on page* 15, *column* 1)

LIST OF PARTS

Three .0005 mfd. condenser in one gang.
Three 20-100 mmfd. trimmer condensers.
One .04 mfd. by-pass condenser.
One .3 mfd. by-pass condenser.
Two .00035 mfd. fixed condensers.
Four .01 mfd. stopping condensers.
One .5 mfd. by-pass condenser.
Two 1 mfd. filter condensers.
One 6 mfd. filter condenser.
One 8 mfd. electrolytic condenser.
One 30 henry centertapped choke.
One 30 henry, 100 milliampere filter choke.
One 50 millihenry choke.
One fixed 2,250 ohm resistor.
One 30,000 ohm variable resistor.
One fixed 500 ohm resistor.
Two 20,000 ohm resistors.
One 6,000 ohm resistance.
One 750 ohm resistance.
Two 5 megohm grid leaks.
Two 2 megohm grid leaks.
One 100,000 ohm resistance.
One multitap voltage divider.
One three circuit tuner for .0005 mfd. condenser.
One antenna coupler for .0005 mfd. condenser.
One RF transformer for .0005 mfd. condenser and one-to-one ratio.
Four UY sockets.
Four UX sockets.
One power transformer one 110 volt primary, one 1.5 volt centertapped secondary, one five volt center tapped secondary, one high voltage centertapped secondary and two 2.5 volt secondaries both centertapped.
Three 224 screen grid tubes.
One 227 detector.
Two 245 power amplifiers.
One 280 rectifier.
One 226 volume control tube.

Right o

Questions

(1)—A fuse in the primary of a power transformer serving an AC receiver is no protection because even if it blows it does not open any of the secondary sircuits.

(2)—A receiver provided with a dynamic loudspeaker in which the field is obtained from a dry or vacuum tube rectifier often loses its sensitivity because the rectifier supplying the field circuit loses its rectifiying property.

(3)—If a superheterodyne of low intermediate frequency may be designed so that both the upper and lower oscillator settings may be tuned in.

(4)—If the intermediate frequency in a short-wave converter is 1,500 kc the region of image interference with broadcast stations is 3,550 and 4,500 kc.

(5)—A low pass filter in the plate circuit of the detector having a coil of 50 mh and two condensers of .00035 mfd. across the line on each side of the choke has a cut-off frequency of 53,750 cycles and therefore it is low enough to have a considerable cut-off effect on audio frequencies around 10,000 cycles.

(6)—A short-wave converter modulator of the screen grid type does not work efficiently into an ordinary receiver because the load impedance is too low for the tube.

(7)—When there is a steady whistle in the output of a receiver and when this whistle is independent of the setting of the tuning controls, the most likely trouble is a vibrating detector tube in the circuit.

(8)—A resistor rated at 10 watts consumes energy at this rate regardless of the current flowing through the resistance.

(9)—The wattage of a lamp or other electric device indicates the amount of electric energy that device uses per month.

(10)—High voltage alone is not dangerous.

Answers

(1)—Wrong. While a fuse in the primary does not open any of the circuits in the secondary when it blows it protects all the secondary circuits because it cuts off the source of power. It is simply an automatic switch which opens when the danger point is approached. An electromagnetic circuit-breaker serves exactly the same purpose.

(2)—Right. When there is much distortion in the receiver indicating that the tubes are overloaded, and if there is no improvement when the tubes are replaced, the chances are that the loudspeaker has lost its sensitivity due to a decrease in the field current because it is necessary to force the tubes to their utmost in order to get much out of the speaker, and what does get through the speaker is distorted before it gets to the speaker. If the speaker is all right it is not necessary to force the tubes and the quality is good.

(3)—Right. If the intermediate frequency is low it is prac-

a Quality Receiver

Brunn

push-pull will take care of any even order harmonics generated in those tubes. The power tubes can be operated to their limit without any appreciable distortion in the tubes ahead and hence the quality will be first rate.

Balancing of the Circuit

Five megohm grid leaks are used in the grid circuits of the two screen grid tubes. It is not easy to get two resistors of such high values that are exactly equal. It is important that they should be for if there is any difference between them the signal voltages will not be exactly equal and they will not be exactly 180 degrees out of phase. This is true even if the voltages across the two sides of the centertapped choke are equal and opposite in phase and if the two stopping condensers are exactly equal. Hence it is worth while to select two grid leak resistances that are as nearly equal as possible, at least within 5 per cent.

The proper grid bias on the two screen grid tubes is obtained from the drop in the 6,000 ohm resistance in the common cathode lead. It may be said that this is too high for screen grid tubes but it should be remembered that the plate current will be extremely small in view of the 250,000 ohm resistances in the plate circuits. Hence the drop in the 6,000 ohm bias resistor will not be excessive.

It will be observed that there is no by-pass condenser across the bias resistor. None is needed in a push-pull stage for there is not supposed to be any signal current flowing in it, only direct current, the sum of the plate and screen currents in the two tubes. If there should be any unbalance in the two tubes there will be some signal current in the bias resistance and there will therefore be some feedback, but this, fortunately, will be in such direction as to equalize the inputs to the two tubes. This advantage would not be present if there were a large condenser across the bias resistor. Hence by omitting the condenser we not only save in the cost of the circuit but we also get a better amplifier.

Voltages on Screens and Plates

When screen grid tubes are used in a resistance coupled circuit there is grave danger of causing distortion by having too high screen voltage for the plate voltage applied. To guard against this possibility a 100,000 ohm resistance is connected in the common screen lead and at the same time the return is made to the voltage divider at a point where the voltage is comparatively low. The resistance in the common lead will tend to maintain the voltage on the two screens constant as far as the signal is concerned but it will lower the direct screen voltage as required by the signal so that the effective screen voltage can never exceed the effective voltage on the plate. Thus distortion due to this effect is automatically avoided. When distortion does set in on extremely high signals it will occur in the power tubes. Long before this occurs the output will be so great that it will not be tolerable in a home.

Somewhat higher amplification will be obtained if the 100,000 ohm resistance common to the screen circuits of the two tubes be made 50,000 ohms, but then the stage will not support as high output signal voltage and it may be that distortion will occur in the first audio stage before it occurs in the output stage. This is not desirable in general, but it is a simple matter to try the lower resistance value. Or in case no 50,000 ohm resistor is available, or another 100,000 to put in parallel with the first, the same effect may be secured by returning the common screen lead to a lower voltage point on the voltage divider. It is well to try both higher and lower and retain that voltage which gives the best results, especially observing the effect on the very lowest audible notes that may be in the signal. The lowest notes should be observed because the amplitudes of them are greater and distortion will set in first.

The highest voltage available in the B supply is applied to the plates of the two screen grid tubes, which is done to prevent distortion and to get sufficient voltage to support the high signal voltage required for the power tubes. Since the power tubes require an amplitude of 50 volts the voltage swing across either grid leak ahead of the power tubes as well as the voltage swing across each plate resistance will be 100 volts and the variation in the DC volts on the plates must be considerably greater than this if there is to be no distortion. Hence the high applied voltage in the plate circuits.

Frequency Distortion

Frequency distortion in the circuit will be negligible up to the loudspeaker and what the set delivers will largely depend on the characteristics of the speaker and on the acoustics of its surroundings.

Factors contributing to the relative absence of frequency distortion are the high time constants of the grid leaks and the stopping condensers, high load impedance on the detector tube and low capacity between the plate and control grid of a screen grid tube. The time constant of each of the stopping condenser and grid leak is .05 second and of each in the second .02. The mean of these is high enough to insure full amplification as low as 30 cycles per second, which is lower than is necessary to get realistic response on orchestral music. The shunt capacity is extremely small so that the response on the high audio frequencies will be good.

A 226 type tube is used as diode for automatic volume control. The carrier frequency current in the plate circuit of the detector tube flows through the first .00035 mfd. filter condenser and the .02 megohm resistance and the tube. It can only flow in one direction through the tube and therefore there is a rectified current in the .02 megohm resistance. and the tube. It can only flow in the one direction through the tube and therefore there is a rectified current in the .02 megohm resistance. The drop due to this current in the resistance is used for controlling the bias on the first tube. If this feature is not wanted all that is necessary is to short-circuit the .02 megohm resistance and to remove the tube.

Band Pass Tuner

A band pass filter tuner is used before the first tube. The two circuits are coupled by means of a .04 mfd. condenser shunted by a 500 ohm resistance. Since this coupler is not as effective on the high broadcast frequencies as on the low, an additional coupler in the form of a very small condenser is used to connect the high voltage sides of the tuned circuits. This condenser is made by twisting together two insulated wires a few inches in length.

r Wrong

tical to tune the oscillator to the same frequency as the radio amplifiers and then to use an inductive trimmer in the oscillator circuit for picking out either the higher or the lower oscillator settings. This is not practical when the intermediate frequency is high for then the inductance cannot be reduced sufficiently to reach the higher oscillator setting.

(4)—Right. If the intermediate frequency is 1,500 kc the oscillator must cover the 2,050 to 3,000 kc frequency band to bring in the broadcast stations, using the higher oscillator setting. But when the oscillator has this coverage it also tunes in the band 3,550 to 4,500 kc, using the lower oscillator setting. Since there is code in this band, code may be heard as an interference to broadcast reception.

(5)—Right. There will be considerable cut-off of the higher audio frequencies because the shunting effect of the two .00035 mfd. condensers is considerable at 10,000 cycles. Such a filter would be suitable in an intermediate frequency circuit in which the frequency is 60,000 cycles.

(6)—Right. The load on the screen grid tube should be as high as practicable but when it is coupled to the input circuit of a broadcast receiver the load may be very low, especially when the antenna is normally coupled to the front tuned circuit by means of a small winding.

(7)—Right. The steadiness of the whistle indicates that it is not a heterodyne for this would vary in pitch when the condensers are turned and also when the frequency of the transmitting station varies, which it does as a rule. The fact that it appears on all settings of the dial indicates that the whistle does not originate in the transmitting station. If the whistle is due to a vibrating tube, usually the detector, it should build up in intensity gradually until it reaches a final intensity.

(8)—Wrong. If the statement were true it would use up energy at the rate of 10 watts even when it is not connected to anything. The wattage rating is only an indication of the maximum energy dissipation, or the normal energy dissipation in some instances. For example, a lamp rated at 40 watts, 115 volts, uses energy at the rate of 40 watts normally when it is connected on a 115 volt line but only 38.2 watts when connected on a 110 volt line. A resistor rated at 5 watts will dissipate energy at the rate of 5 watts safely but it will not dissipate as much when it is connected across a voltage such that the current is less than that corresponding to the 5 watt dissipation.

(9)—Wrong. It only indicates the rate at which energy is being taken from the line while the device is in use. Electrical energy is measured in watt-hours, or in kilowatt-hours.

(10)—Right. Voltage alone will not do any harm. It is electrical energy that causes the damage, and energy involves current, voltage and time. Voltage will cause a current to flow in a circuit, and the current is directly proportional to the voltage. But if there is no circuit there is no current and no damage, and the voltage is merely a potential danger.

Radio University

A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions sent in by University Club Members are answered. Those not answered in these columns are answered by mail.

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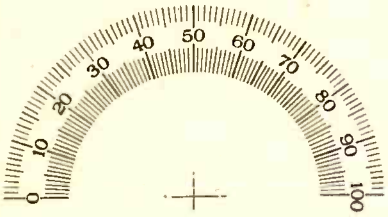

Fig. 874
This scale is clockwise because the numerals increase in the same direction as the numerals on the dial of a clock.

Placing Coils at Right Angles

HOW many coils may be placed so that their fields are mutually at right angles? I have been told that only three can be so placed but if the so-called neutrodyne angle is used I can see no reason why any number of coils could not be placed in this manner.—W. H. K.

Only three coils can be placed with their fields mutually at right angles for we live in a three-dimensional world. If you can place four or more straight lines mutually at right angles you can also place four or more coils that way. Don't waste too much time on the puzzle.

* * *

Anti-motorboating Device

HOW should a B supply be designed so that it will not cause motorboating when used to operate a resistance coupled audio amplifier? Is it possible to use large enough condensers to prevent motorboating, and if so how large should they be?—B. D. F.

A B supply should be designed so that there is no impedance at all between the B plus and B minus terminals. Of course, this is impossible. Therefore it is also impossible to design a B supply so that it will not cause motorboating in some instances. Practically, however, it is not necessary to have zero impedance to stop motorboating in ordinary circuits. If by-pass condensers of the order of 50 microfarads across the various output terminals of the B supply are used there is little danger of motorboating. But such condensers are not practical for they would be too large and too costly. Hence to insure against motorboating it is better to put individual filters in the plate leads of the audio amplifier and the detector. These filters may consist of a resistance in series with the plate lead with a condenser across it directly to ground, or they may consist of a choke coil with a condenser.

* * *

Repeats In Superheterodynes

WILL you kindly explain how a superheterodyne can be designed so that all repeat point troubles are eliminated? I have tested many so-called one-spot receivers but I have not yet seen one in which heterodyning was absent.—L. C. B.

Unfortunately we cannot explain how this may be done because theoreticaly it is not possible, and so far, as you have found out, theory and practice are in close agreement. There are two things that can be done to reduce the nuisance. One is to make the intermediate frequency high. This will throw the two normal settings at which a station comes in far apart so that the radio frequency tuner will suppress one of them. The other is to use several sharply tuned circuits ahead of the modulator to suppress the interference more. Most commercial superheterodynes now use an intermediate frequency of 175 kilocycles. Therefore two stations separated by 350 kc will interfere. But this separation is great enough to permit almost complete suppression of the interfering frequency, especially if the modulator and the oscillator are not too closely coupled. In case the interfering station is a strong local and the desired station is a weak distant one, there may be an audible heterodyne even in this case if the radio frequency tuner is not sharp enough.

* * *

Clockwise or Counterclockwise

CONDENSERS and dials are rated as clockwise or counterclockwise. How do you determine whether a condenser or dial is one or the other? There seems to be no unanimity of opinion on the subject. If you can throw some light on the subject that will decide the issue I would appreciate it very much.—V. L. McD.

Naturally, the clock contains the answer to the question. The clock dial is clockwise and a dial in which the numerals run in the same direction as they do on the clock dial is clockwise. The numerals increase in the direction one would turn a right-handed screw to tighten it up. On a counterclockwise dial the numerals increase when turning in the opposite direction. A clock dial viewed in a mirror is counterclockwise, if we forget that each numeral is reversed. A condenser is clockwise when it is necessary to turn its shaft in the clockwise direction to increase its capacity. It is counterclockwise when it must be turned to the left to increase its capacity.

The confusion of terms arises from the fact that sometimes a clockwise dial must be associated with a counterclockwise condenser, and vice versa. Some say that because a clockwise dial must be used with a counterclockwise condenser that the dial is counterclockwise also, while others contend just the opposite, that is, they contend that the dial determines the name that should be given the condenser. But the two, that is, the dial and the condenser, may be of either type independently of the other. If this independence is not recognized it would be impossible to decide the question because in some instances a clockwise dial must be used with a clockwise condenser and in other instances a clockwise dial must be used with a counterclockwise condenser. When the dial is attached to the condenser rotor and the index is fixed, the dial and the condenser must be of opposite type. When the dial is fixed and the index moves with the condenser, the condenser and the dial must be of the same type. The dial illustrated herewith is clockwise because the numerals increase in the same direction as the numerals on a clock dial. If the 100 were at the left and the zero at the right the dial would be counterclockwise.

* * *

Current Square Meter

IN many articles on radio measurements reference is frequently made to current squared meters. What kind of meters are they and how are they used? In what respect do they differ from ordinary current meters?—B. F. L.

A current square meter gives a deflection which is proportional to the square of the effective value of the current flowing through it. It is one in which the deflection is caused by heating of the element that produces the deflection of the needle. A thermocouple in conjunction with a sensitive galvanometer or milliammeter or microammeter is one type of current squared meter if the scale over which the needle moves is divided into equal divisions. A hot wire instrument with a similar scale is also a current squared meter. Meters operating on the moving coil principle give readings which are directly proportional to the current. They are the most common and are used for direct current measurements. Current squared meters are used for measuring alternating current. When measuring decrements or the selectivities of tuned circuits the square of the current enters into the formula and if a current square meter is used the readings may be used directly for the squares of the currents.

* * *

Superheterodyne Adjustments

IN several of the commercial superheterodyne circuits which you have published there are four different condensers associated with the oscillator, one fixed and three variable. Why are so many used?—B. L.

By connecting one condenser of suitable value in series with the main tuning condenser and another of suitable value across the condenser, it is possible to adjust the circuit so that the oscillator is exactly in tune at two points on the dial. That is, at two points the modulator circuits are tuned to the signal frequency and the oscillator to the signal frequency plus the intermediate frequency. The points selected are generally 1,400 and 600 kc. If the oscillator is adjusted in this manner it is practically in tune at all other settings also but not exactly. The adjustment is so close there there is no noticeable decrease in the sensitivity by virtue of detuning. Since it is not practical to attempt to get a fixed condenser that has the exact value required a trimmer is connected across it. Thus the four condensers are accounted for. The main tuning condenser is to tune the circuit, the fixed condenser to obtain an approximate value of the series condenser to line the circuits up at one setting, the trimmer across this condenser to get the exact adjustment of the series condenser, and the trimmer across the tuning condenser to get an exact value of the required shunt condenser.

* * *

Plate Circuit Modulation

IN the Jan. 3rd issue you published the circuit diagram of a superheterodyne in which the pickup coil is connected in the plate circuit of the screen grid modulator tube. Is this as good a method of modulation as that when the pickup coil is connected in the grid circuit or in the screen circuit?—W. H. C.

It makes practically no difference where the pickup coil is connected just so the coupling between the oscillator and the modulator is right. If the pickup coil is connected in the grid circuit, or in the cathode circuit, which amounts to the same thing, the pickup coil should be smaller than when it is connected either in the screen or plate circuits, or the mutual inductance between the oscillator and the pickup coil should be smaller. If the pickup coil is connected in the screen circuit the size of the pickup coil or the closeness of the coupling should be about

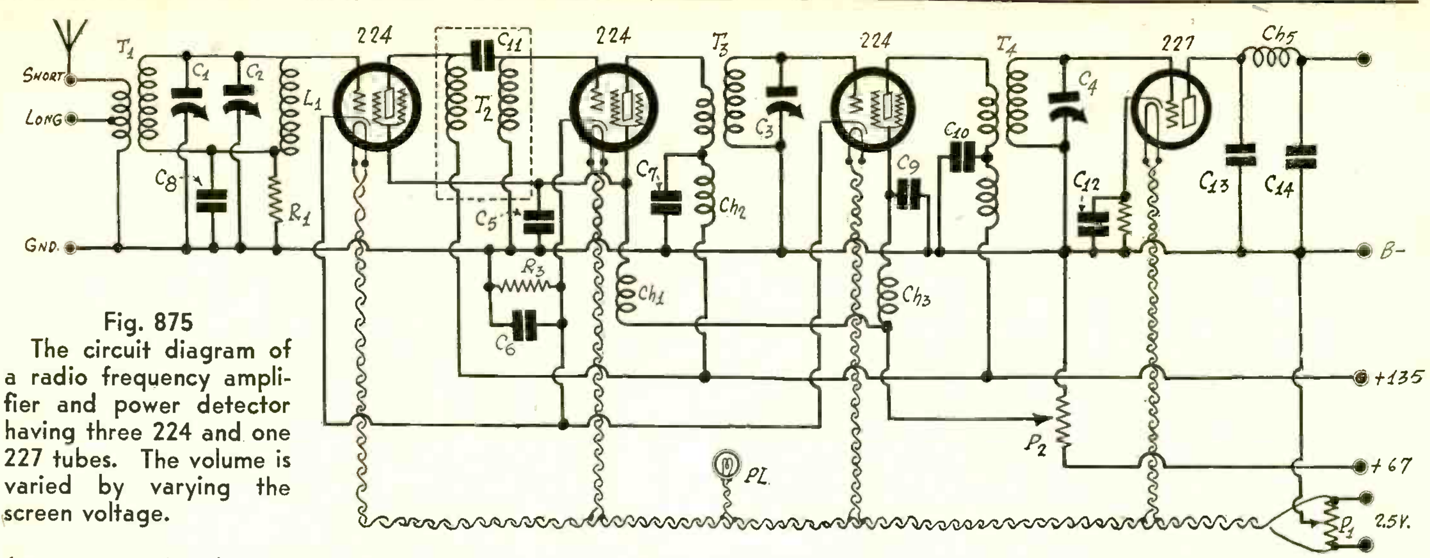

Fig. 875
The circuit diagram of a radio frequency amplifier and power detector having three 224 and one 227 tubes. The volume is varied by varying the screen voltage.

the same as when it is connected in the plate cricuit. Plate circuit modulation is regarded as the best in transmitting circuits, especially when it takes the form of the Heising method. The one thing to guard against is overloading of the modulator by the oscillator. If there is overloading, which will be evidenced by a roar or by very rough signals, it is only necessary to reduce the turns on the pickup coil or to move the pickup coil so as to reduce the mutual inductance between the oscillator and the pickup. The movement may be either a turning of the pickup or translation away.

* * *

Heater Tubes on 32 Volt Battery

WE have a 32-volt storage battery on our farm and I have been wondering if it would not be possible to use this battery for heating heater type tubes from it by connecting the heaters in series. Would it be possible to rewire a seven-tube set so as to operate it on the storage battery? All the tubes would be of the 224 and 227 types with the exception of the output tube which would be of the 245 type.—C. F. J.

It is quite feasible to connect the tubes in the manner you suggest. Since you have seven 2.5 volt tubes the total voltage required would be 12.25 volts. The total current from the battery for the heater circuit would be 1.75 amperes. Since the power tube requires only 1.5 amperes it would be necessary to connect a shunt resistance across its filament to pass the extra quarter ampere. Ten ohms would be required for the shunt resistance.

* * *

Tune Choke in B Supply Filter

I HAVE noticed in many B supply circuits that a tuned choke is used to eliminate the principal hum frequency. What are the best values of inductance and capacity to use in such circuits?—J. C. S.

There is no best combination of values except that the inductance and capacity should be so related that the frequency of the circuit is twice that of the line frequency, if the rectifier used in the circuit is of the full-wave type. When the line frequency is 60 cycles the tuned circuit should be adjusted to resonate at 120 cycles. If the inductance is expressed in henries and the capacity in microfarads the product of L and C should be 1.76. This may be obtained by using a large coil and a small condenser or a large condenser and a small coil. However, if the condenser is too large it will pass into the line the higher harmonics which are generated in the circuit and they may be strong enough to be audible in the output of the amplifier. Hence it is best to select a moderately large condenser and to choose the coil to fit. The condenser might be one microfarad, when the coil should be 1.76 henries. Or the condenser may be only 0.1 microfarad, when the coil should be 17.6 henries. Of course, intermediate values may be used.

* * *

Coupling Push-pull to Detector

IN the Jan. 3rd issue of RADIO WORLD you published a Unitary All-Wave Set in which the push-pull audio frequency amplifier is coupled to the detector by means of a center-tapped choke coil. In many of your earlier issues you have emphasized the statement that it is not possible to couple a detector to a push-pull amplifier by means of choke coils and resistors. Have you changed your opinion or is there an error in the circuit referred to?—B. L. F.

The statement that a detector cannot be coupled to a push-pull amplifier by means of choke coils and resistors is true, but nevertheless there is no error in the diagram in the Unitary All-Wave Set. The push-pull amplifier in this case is not coupled to the detector by means of a center-tapped choke coil but by means of a balanced auto-transformer. The upper tube in the push-pull amplifier is coupled to the detector by means of the upper half of the centertapped choke but the lower is coupled inductively. The grid of the lower tube in the push-pull amplifier is not grounded, as it would be if a choke or resistance were used to couple the detector to the amplifier, but it is at the same potential quantitatively as the grid of the upper tube, but the two grids are always 180 degrees out of phase. That is the condition for correct coupling.

* * *

Neutralization Versus Reverse Feedback

IS there any actual difference between reverse feedback and neutralization in respect to preventing radio frequncy oscillation in an amplifier?—W. H. J.

The difference is largely one of point of view. In reverse feedback energy from the plate circuit is fed back to the grid in such phase as to buck the effect of the feedback through the plate to grid capacity. In most neutralizing schemes exactly this is done. When the neutralization is done by means of a bridge arrangement an attempt is made to balance the direct and reverse feedback so that it is independent of the frequency so that if balancing is done at one frequency in the tuning range it is also done at all other frequencies.

* * *

Four-tube Tuner-Detector

I SHOULD like to have a diagram of a four tube tuner in which a bandpass filter is used between the antenna and the the first tube, untuned coupling between the first and second tubes and tuned coupling in the other stages. I would prefer a volume control of the type that varies the screen grid voltage on the tubes.—A. L. B.

Fig. 875 depicts such a circuit. It contains three 224 screen grid tubes as radio frequency amplifiers and one 227 as power detector. For power detection the resistance across C12 should be about 20,000 ohms.

* * *

The band pass effect is secured by condenser C_8, which is common to the two tuned circuit. C_8 should be of .04 mfd. and R_1 500 ohms.

* * *

Push-Pull Test

HOW can I tell if both of the power tubes on my radio are O.K.? They are connected push-pull.—S. A. D.

A rough method is to pull out one of the tubes while the set is working. If the tone quality becomes worse, the removed tube has at least been partly good, if not entirely so. Then try the other one. Where there is no change noticeable, try a new tube instead.

* * *

Milliammeter Denotes Distortion

IS there any way to determine whether a tube in my set is distorting? The tubes all test correct at the dealer's tube tester, and he claims any failure to amplify correctly must be due to something in the set. I have a voltmeter, milliammeter, etc.—L. L. J.

Insert the milliammeter in series with the plate circuit of the tube in question. A good place is between the B plus lead and the primary of the audio transformer, or between the P terminal of the socket and the transformer. The needle should not show more than about 10% variation in movements, with a strong station tuned in at the maximum loudness. If the needle tends to jump violently downward on louder tones, the C voltage is too high. If the needle jumps violently upward on loud tones, the C voltage is too low. If the needle jumps violently, but equally, in both up and down directions, the tube is being overloaded.

* * *

Dry Battery Test

WHAT is the better way to test a dry battery, with a voltmeter or with an ammeter? We disagree.—S. L. D. and J. M. L.

The ammeter gives the more reliable test, because it shows the amount of current that can be drawn on "short-circuit." However, a voltmeter, if accurate, will also serve the purpose, provided it is used while the set is in operation.

NEW FREQUENCY CHECK OF HELP TO THE PUBLIC

Washington.

Dr. J. E. Dellinger, chief of the Radio Division of the Bureau of Standards announced the inauguration of a new standard frequency transmission service, the purpose of which is to prevent interchannel interference caused by broadcasting stations deviating from their assigned frequencies.

The new service also will be available to the general public who can check the dialing of their receivers in the broadcast spectrum.

The first transmissions will occur on a weekly schedule, and will be put on the air from the Bureau's Station, WWV. The new service is in addition to present monthly frequency service from the Bureau's station.

Mostly all the broadcasting stations of the country use piezo-electric automatic frequency control, but it is necessary to have its accuracy checked. The ultimate objective is to provide this frequency-checking service on a daily basis, for the use of all who use the ether.

Information on how to receive and utilize the signals is given in Bureau of Standards Letter Circular No. 280, which may be obtained by applying to the Bureau of Standards, Washington, D. C. Even though only a few frequencies are received (or even only a single one), persons can obtain as complete a frequency meter calibration as desired by use of harmonics.

The frequency transmissions are from a transmitter of 150 watts power, which may be increased to 1 kilowatt. They occur every Tuesday except in those weeks in which the monthly transmissions are given. The monthly transmissions are from a transmitter of ½ to 1 kilowatt power. They are given on the 20th of every month (with one exception).

5,000 Kilocycle Transmissions

1:30 to 3:30, and 8:00 to 10:00 p. m. E. S. T.

Jan.	Feb.	Mar.	Apr.	May	June
..	3	3	7	5	3
..	10	10	14	12	9
27	24	24	28	26	16
..	..	31	..	..	30

Monthly Transmissions

P.M.	Jan. 20	Feb. 20	Mar. 20
10:00......	1,600 kc.	4,000 kc.	550 kc.
10:12......	1,800 kc.	4,400 kc.	600 kc.
10:24......	2,000 kc.	4,800 kc.	700 kc.
10:36......	2,400 kc.	5,200 kc.	800 kc.
10:48......	2,800 kc.	5,800 kc.	1,000 kc.
11:00......	3,200 kc.	6,400 kc.	1,200 kc.
11:12......	3,600 kc.	7,000 kc.	1,400 kc.
11:24......	4,000 kc.	7,600 kc.	1,500 kc.
P. M.	Apr. 20	May 20	June 22
10:00......	1,600 kc.	4,000 kc.	550 kc.
10:12......	1,800 kc.	4,400 kc.	600 kc.
10:24......	2,000 kc.	4,800 kc.	700 kc.
10:36......	2,400 kc.	5,200 kc.	800 kc.
10:48......	2,800 kc.	5,800 kc.	1,000 kc.
11:00......	3,200 kc.	6,400 kc.	1,200 kc.
11:12......	3,600 kc.	7,000 kc.	1,400 kc.
11:24......	4,000 kc.	7,600 kc.	1,500 kc.

The frequencies in the 5,000-kilocycle transmission are piezo controlled, and are accurate to a few parts in a million. Frequencies in the monthly transmissions are manually controlled, and are accurate to a few parts in a hundred thousand.

Clearer Pictures for Television

London.

Engineers of His Master's Gramophone Co. of this City, have announced that they are engaged in the development of a new type of television system by means of which exceptional definition may be obtained.

The experiments thus far have been restricted to the transmission of motion picture films. The new system is said to possess unusually good resolving powers. Private exhibitions of transmissions of motion pictures over long distances have been given for the benefit of a technical audience. The distance was reported to be in excess of 200 miles in one instance.

The system is not related in any way to existing ones, such as the Baird or the Alexanderson.

The British Company is associated with the Radio Corporation, which uses both of the other methods.

SOME SIGNALS WEAK AT NIGHT

Washington.

The Bureau of Standards maintains a standard frequency transmitter here that transmits at specified times a 5,000 kc. signal from WWV. During the past year a number of field intensity tests was made at varying distances from Washington, both during the daytime hours and at night.

The Bureau announces that it would like to receive reports of the reception of the signals from individuals who may have observed these signals.

Particular interest is in the constancy of fading, and also the time of observed peak signal intensity, and as to whether the nature of the signals was satisfactory for frequency checking purposes.

The reports sent in by the field engineers for daytime field intensity at a point about 400 miles from Washington was 100 microvolts per meter, fading being in about the ratio of three to one. Between that point and Chicago the signal strength fell off 10 microvolts more or less per unit of distance, with the fading at the same approximate ratio as in the first instance.

The night transmission signal intensity at 75 to 150 miles from Washington was 200 microvolts per meter, the measurements being made around 8 o'clock. In some areas the night signal intensity was reported too weak to measure accurately.

The above report is at variance with the customary behavior of radio signals at night with respect to daytime transmission.

Commercial Television Not Yet, Says Bell Man

Atlantic City, N. J.

The Atlantic City Rotary Club was recently addressed by a representative of the New Jersey Bell Telephone Company on the subject of two-way television. The representative, J. D. Peters, said that the recent experiments of the Bell Laboratories have shown the possibility of the system, but that for the present there was no immediate prospect of its becoming commercially practicable.

HOTELS FLOCK TO RADIO AS GUESTS INSIST

BY LEWIS WINNER

The extreme excellence of radio is being realized with marked rapidity by hotels and apartment-hotels to-day.

At first considered a luxury, a radio is now acknowledged as essential a part of the fittings of the room as the telephone, electricity outlets, etc.

It has been found that direct outlets or provision for a set are a potent factor towards increasing patronage.

Of the 25,000 hotels and apartment hotels in the United States, approximately 7,500 or 30%, have radio installations.

To cope with the many contrasting desires, which exist in the larger hotels, their being those who are contented with local station reception, and those who are multi-station enthusiasts, combination "direct" and "indirect" installations are made in the rooms.

Wall Used As Baffle

The so-called "direct" installations are those which have a group of radio sets controlled at a central source and tuned in to the most popular programs, emanating usually from no more than four stations in the immediate vicinity. The rooms are outfitted, in this case, with small panels, mounted flush in the walls, and containing a volume control and a station control. The volume control has a knob, while the station control comes with either a knob or push buttons. A loudspeaker is also mounted in the wall in flush manner. The wall is thus used as a baffle, affording excellent reproduction.

In the "indirect" installation, antenna and ground outlets are provided, so that the roomer can use an individual set. The non-transients constitute about 90% of those who require such installations. Many hotels supply sets upon request, either simple or multi-tube outfits being obtainable.

Room Volume Checked

To prevent loudspeaker disturbances, a method similar to the one used by broadcasting studios is used with the "direct" system. That is, the lines are padded with resistance and condenser banks in accordance with the height of the room, so that the volume is of actual room level.

Those hotels and apartment-hotels having the "indirect" outlets provide small meters which indicate room volume. This meter is inserted in the speaker circuit. The patron is requested to keep the volume to the level designated on the meter. For different size rooms, there are corresponding levels, these being noted directly on the meter. Phones are provided for those afflicted with difficult hearing.

Incidentally, where there are the "direct" or "indirect" installation, cards with the outstanding programs for the day from the local stations are provided to simplify tuning.

TRADIOGRAMS

The consolidation of the Radio Division of G. J. Seedman Co., Inc., and Sanford Radio Corporation, to operate as Seedman-Sanford Corporation, with general offices at 480 Canal Street, New York City, and a branch office at 765 Atlantic Avenue, Brooklyn is announced.

PUBLIC'S MAIL IS 'BIG STICK' TO STATIONS

The great American radio public has developed into a vast army of program critics, if the audience mail received by the National Broadcasting Company can be accepted as any criterion. Millions of letters are received yearly from listeners who more and more determine the type and quality of programs to be broadcast.

Not so many years ago broadcasting stations received floods of communications from crystal set radio "bugs." The usual comment was "Your program came in fine last night."

Mail Up 100% in 1930

Long since, the listener has ceased to find satisfaction in merely hearing sounds picked from the air. The dial twister has developed definite tastes in the selection of the entertainment which he wants served up in his home. He either likes or dislikes a program and has formed good reasons for it. He writes the broadcasters his approval or disapproval, and indicates in no uncertain terms what satisfies him and what doesn't.

Audience mail received by NBC's New York audience mail department increased nearly 100 per cent. during last year. A survey reveals that there has developed a strong demand for the better type of music, special events and drama, particularly of the serial type. Jazz, in general, either is losing favor or the jazz fans do not write to the broadcasters. The listeners seem inclined to divide popular dance music into two classes; jazz and "symphonic" jazz. They call symphonic jazz, which is approved, the form of music produced by Paul Whiteman, B. A. Rolfe, Vincent Lopez and the Ipana Troubadours.

What Music Lovers Like

Slumber Music, Walter Damrosch's symphony lectures and concerts, and Roxy's symphony receive the greatest praise from music lovers.

The non-musical programs which have achieved the greatest followings are those of a simple character and sentimental appeal, such as "Cheerio," "Seth Parker," "Rise of the Goldbergs," "Uncle Abe and David," and "Real Folks." These programs seem to have a more human and personal approach than any others.

Serials Liked

The reaction of listeners to several radio dramatic serials indicates that some day fictional radio characters may become almost as well known as Dickens' famous creations.

A major part of the letters are from small town inhabitants, who seem to take the greatest pleasure from radio.

Other listeners make requests that are impossible to grant; such as searches for missing persons, pets or lost valuables. Many of the requests are quite personal.

She Strives to Please

Those pessimists who deplore the girl of today as a selfish flapper might receive a shock from letters such as one received from Indianapolis. After asking for a cake recipe offered in a radio program the writer concludes "I am a little girl only thirteen years old and I am ready to go to high school. I expect sometime to be married and I want to please my husband. Thank you!"

NICE TO GET MONEY

(Harold Stein Photo)

A. Atwater Kent presents $5,000 checks to first-prize winners of finals of Atwater Kent foundation's fourth National Radio Audition in New York City. Left to right: Mr. Kent, Carol Deis, Dayton, O., soprano; and Raoul E. Nadeau, N. Y. baritone

SEES BIG SALES OF SETS AHEAD

Washington.

Former Federal Radio Commissioner Orestes H. Caldwell forwarded an estimate to the Federal Radio Commission with regard to the sales prospects for 1931.

The report estimates the total sales of receivers during the coming year at 3,500,000. During 1930 there were 2,750,000 sets sold, and there was a not inconsiderable carryover from the previous year, which this year is substantially reduced.

There are expected to be some sets of the midget type left over from the stocks of last year, but the increasing rate of replacements is expected to absorb the surplus easily. There are now estimated to be 13,000,000 receivers in use, and of this total it is expected that over 3,000,000 of them will be replacements. A new market is assured by the advent of the low filament drain battery tube, and the combination phonograph record and radio reproducer. There is every prospect, Mr. Caldwell concludes, that the 1931 peak will be 4,000,000 sets.

New Aerial Towers for WBBM on 50 KW

Chicago.

New antenna towers are being erected for the WBBM, 770 kc transmitter at Glenview, Ill.

It is said that this equipment, together with the increase of power to 50,000 watts recently granted this station by the Federal Radio Commission, will add to the already large service area of WBBM, giving it practically national coverage.

It is estimated that an audience of 12,000,000 or more will be within regular range, receiving WBBM programs clearly and easily, when the towers are completed and the new power in use.

GERNSBACH AS SEER PREDICTS RADIO FUTURE

Planes will fly from earth to moon, is the prediction made by Hugo Gernsback, speaking before the monthly forum of the RCA Institutes at its headquarters, 75 Varick St., New York City.

Mr. Gernsback, forstalled criticism by a brief review of predictions which he made some twenty years ago, which were at the time ridiculed, and which have since come true. In 1910 he wrote a book entitled "The Wireless Telephone," the first book on the subject, in which he said:

"The author predicts that in less than ten years every farmer will be able to operate his wireless telephone, when the instruments will be housed in a box a foot square."

And in 1920 broadcasting was inaugurated.

Television in "Few Years"

"During the next few years television will become as popular as aural radio is today," said Mr. Gernsback in his Institute talk, "although the ultimate solution of this science will lie in the use of a single wave, rather than the present use of a scanning disc and a multiplicity of waves. Moreover, television will be not only a form of home entertainment, but will be introduced in motion picture houses, where inaugurations, sporting events and explorations will be on view at the time of their taking place.

"I can see where a future polar expedition will hook up with the National Broadcasting Company and show us what is going on at the other end of the world."

The publisher predicted a television-controlled plane. on board which television cameras will flash to a screen at the airport views from all four sides, beneath and above the plane. These views on six charts will enable the controlling officer to direct his craft even beyond the horizon and see about him even better than a human pilot sitting in the plane itself. And the same will be true of submarines, according to the editor.

Discovery of Oil by Planes

Mr. Gernsback sees the continued specialization of radio, to that point where a single branch of the subject may have only the most negligible relation to another phase. The use of radio in medicine is an actuality today and its use in mining will develop to the point where "two or more airplanes, sending ultra-short waves earthward while flying over the country, can discover hidden ores or oil fields by a simple triangulation method."

The publisher forsees the use of radio to distribute power, in place of the present wire lines. He pointed to the tremendous amount of power which the sun sends us.

Perhaps his fondest dream concerns the possibility of interplanetary travel within the next two decades. Television-controlled airplanes without occupants, motivated by rockets, will send back television signals and even land safely on the moon, says he. Anticipating the possible objection that the Heavyside Layer cannot be pierced by radio impulses, Mr. Gernsback explained to his Institute's audience that although this phenomenon is true of broadcast waves, the very low waves or high frequencies behave differently and, as they approach the frequency of solar radiation, pass with little hindrance through the Heavyside Layer.

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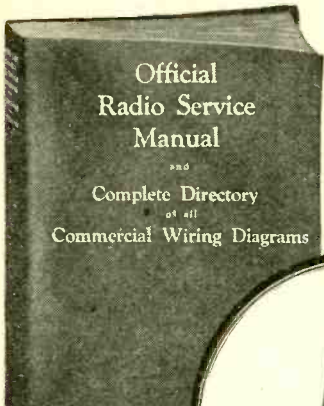

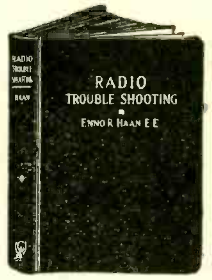

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The index to the commercial wiring diagrams takes up five pages alone. The index is an alphabetical array of the manufacturers' names, with model names and numbers stated.

"Radio Trouble Shooting," by E. R. Haan, passes over theory, tells what to do to cure troubles. 300 illustrations, flexible binding 361 pages 6x9". Order Cat. HAAN... @ $3.00

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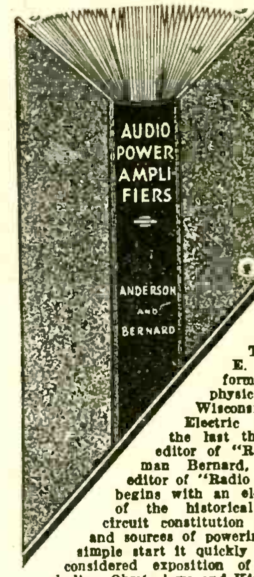

An understanding of audio amplifiers of all types, and of the use of tubes in audio channels, is a prerequisite today, when audio amplification is to the fore in radio, in public address systems and in the talkies.

"Audio Power Amplifiers" is the first and only book on the important subject. The authors are J. E. Anderson, M.A., former instructor in physics, University of Wisconsin, former Western Electric engineer, and for the last three years technical editor of "Radio World"; Herman Bernard, LL.B., managing editor of "Radio World." The book begins with an elementary exposition of the historical development and circuit constitution of audio amplifiers and sources of powering them. From this simple start it quickly proceeds to a well-considered exposition of circuit laws, including Ohm's laws and Kirchhoff's laws. The determination of resistance values to produce required voltages is carefully expounded. All types of power amplifiers are used as examples: AC, DC, battery operated and composite. But the book treats of AC power amplifiers most generously, due to the superior importance of such power amplifiers commercially. Tube characteristic tables and curves profusely included. Cloth cover, 193 pages. Order Cat. APAM ....@ $3.50

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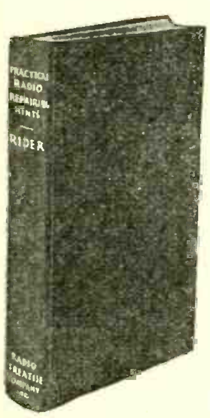

Two new books by Rider are:

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(2)—"Practical Testing Systems," the first complete collection of accurate and practical testing circuits of interest to the service man, professional se builder and experimenter.

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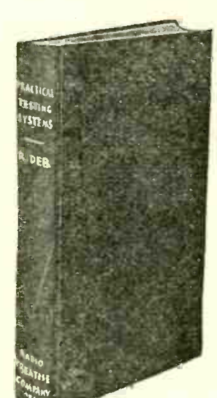
"Trouble Shooter's Manual," the first comprehensive volume devoted exclusively to the topic. It is not only a treatise for service men, telling them how to overcome their most serious problems, and diagramming the solutions, but it is a course in how to become a service man. It gives details of servicing and includes more than 100 actual factory-drawn diagrams of commercial receivers. 240 pages, 8 x 11," 200 illustrations. Order Cat. TSM .... @ $3.50



"Supplement No. 1," containing 115 diagrams of commercial receivers, supplementing the diagrams in "Trouble Shooter's Manual," but not duplicating any. These 115 diagrams are supplied loose. They are a necessary adjunct to those in "Trouble Shooter's Manual." Order Cat. SUPP-1 .... @ $1.20

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It illustrates various forms of oscillators and tells of the advantages of each. Different types of modulators and pick-up systems are explained and their advantages stated. Different methods of coupling in the intermediate frequency amplifier are shown.

Image inerference is discussed in detail and methods given by which it may be reduced.

A special method of ganging the oscillator to the radio frequency condensers is explained, a method which allows either the high or the low oscillator setting to be selected by means of a variometer in the oscillator circuit.

One section is given over to coil design fo the radio frequency tuners, the oscillator, and the intermediate frequency filter.

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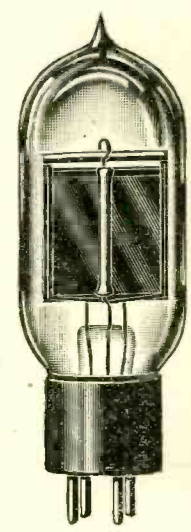
(Cat. RX-19)—201A switch type; if one filament burns out switch on the other	1.00
(Cat. RX-20)—112 switch type	1.00
(Cat. RX-21)—171 switch type	1.00
(Cat. RX-22)—226 adapter; for converting battery sets to AC	1.00
(Cat. RX-23)—227 adapter; for converting battery sets to AC	1.00
(Cat. RX-24)—171A adapter; for converting battery sets to AC	1.00
(Cat. RX-25)—WD12, detector, amplifier; dry cell operation	2.95
(Cat. RX-26)—250, power tube; for AC operation	2.00
(Cat. RX-27)—201A, shield tube, completely bakelite encased	2.10
(Cat. RX-28)—222, screen grid tube, for battery operation	3.85
(Cat. RX-29)—Telion television neon gas tube	4.50
(Cat. RX-30)—Photo-electric cell, 2 inches	2.95
(Cat. RX-31)—210, power tube; for AC operation	

RECTIFIER AND CHARGER BULBS

(Cat. RX-32)—125 milliampere gaseous rectifier; BH type	$2.00
(Cat. RX-33)—2 ampere charger bulb, old style; top connector	2.85
(Cat. RX-34)—2 ampere charger bulb; new style, base connector	2.85
(Cat. RX-35)—5 ampere charger bulb; top connector	4.95
(Cat. RX-36)—6 ampere charger bulb; top connector	4.95
(Cat. RX-37)—280 full wave rectifier	1.00
(Cat. RX-38)—281 half wave high wattage rectifier	2.95
(Cat. RX-39)—Rectifier for Freshman Master B Eliminator	1.00

Special 201A with UX base. Note the five prongs.

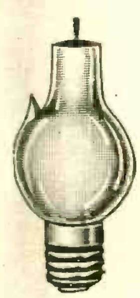


One of the most popular tubes for television is the Telion, a neon gas tube.

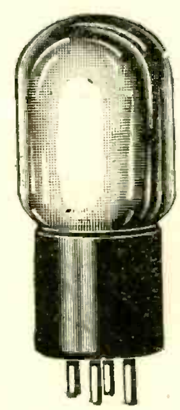
The AC adapter tubes permit changing a battery set to AC operation, as binding posts permit extra connections. For 226, 227 or 171A.

The 2-ampere charger, new type.

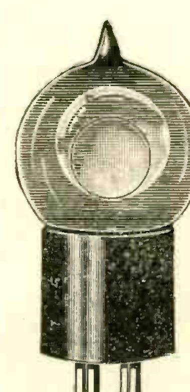
The 2-ampere charger, with a connector at top.



High capacity charger, for 5 and 6 amperes.



High-mu tube for battery operation, equivalent to the 240, but listed as 201A high mu.



2-inch photo-electric cell for television transmission and for film recording of sound.

GUARANTY RADIO GOODS CO.,
143 West 45th Street, New York, N. Y.

Enclosed please find $............ for which ship at once, on a 10-day money-back guarantee, the tubes checked off on list below:

☐ RX-1 @ $1.00	☐ RX-11 @ $1.00	☐ RX-21 @ $1.00	☐ RX-31 @ $2.95
☐ RX-2 @ 1.00	☐ RX-12 @ 1.00	☐ RX-22 @ 1.00	☐ RX-32 @ 2.00
☐ RX-3 @ 1.00	☐ RX-13 @ 1.00	☐ RX-23 @ 1.00	☐ RX-33 @ 2.85
☐ RX-4 @ 1.00	☐ RX-14 @ 1.00	☐ RX-24 @ 1.00	☐ RX-34 @ 2.85
☐ RX-5 @ 1.00	☐ RX-15 @ 1.00	☐ RX-25 @ 1.00	☐ RX-35 @ 4.95
☐ RX-6 @ 1.00	☐ RX-16 @ 1.00	☐ RX-26 @ 2.95	☐ RX-36 @ 4.95
☐ RX-7 @ 1.00	☐ RX-17 @ 1.00	☐ RX-27 @ 2.00	☐ RX-37 @ 1.00
☐ RX-8 @ 1.00	☐ RX-18 @ 1.00	☐ RX-28 @ 2.10	☐ RX-38 @ 2.95
☐ RX-9 @ 1.00	☐ RX-19 @ 1.00	☐ RX-29 @ 3.85	☐ RX-39 @ 1.00
☐ RX-10 @ 1.00	☐ RX-20 @ 1.00	☐ RX-30 @ 4.50	☐ C. O. D. desired

Name ....

Address ....

City .... State ....