RADIO'S LIVEST MAGAZINE

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May

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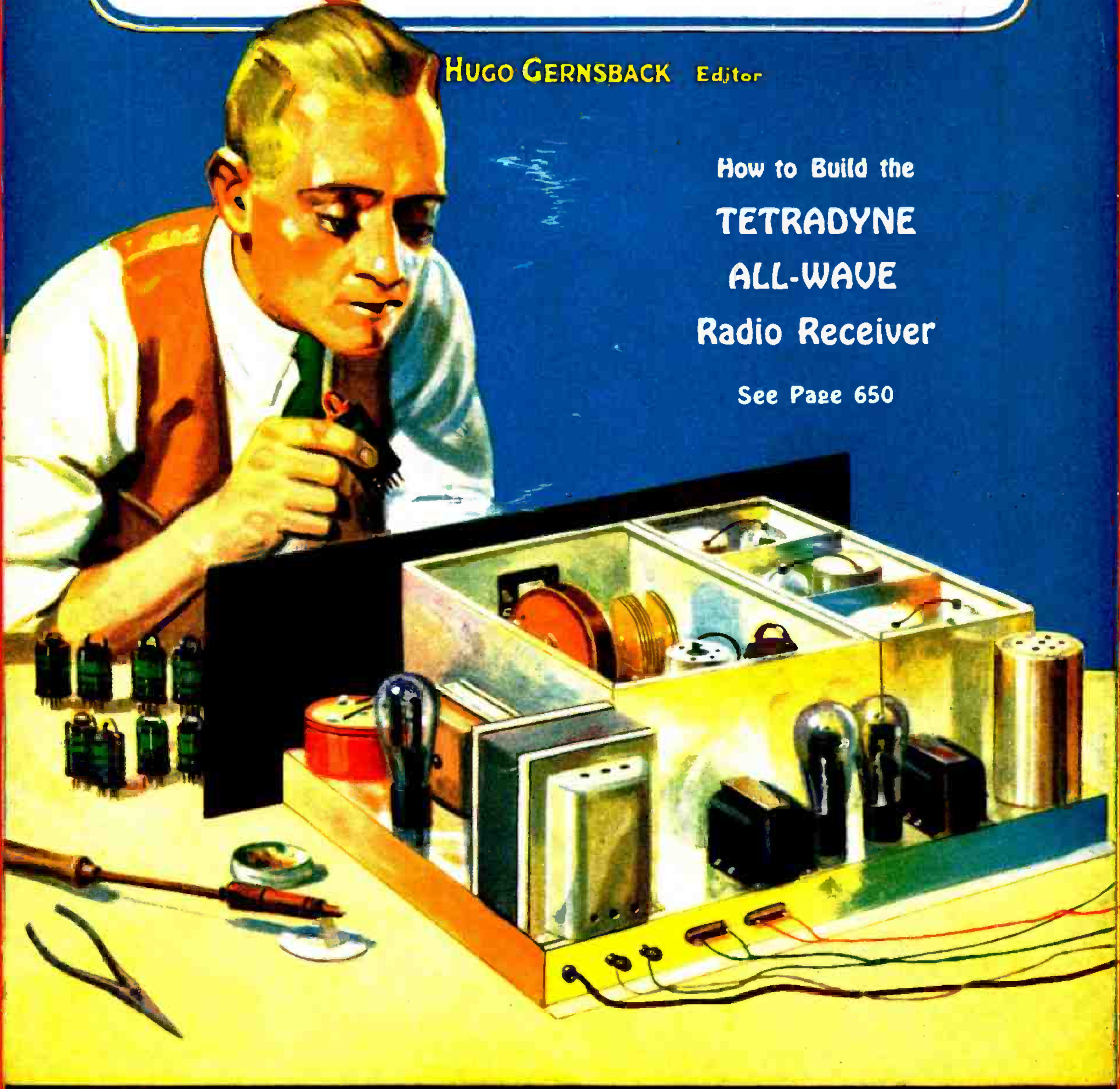
Radio-Craft

HUGO GERNSBACK Editor

How to Build the

TETRADYNE ALL-WAVE Radio Receiver

See Page 650



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FOR THE SERVICE MAN · DEALER · RADIOTRICIAN

HUGO GERNSBACK, Editor-in-Chief

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Technical Editor

LOUIS MARTIN
Associate Editor

VOLUME III
NUMBER 11

MAY 1932

Contents of This Issue

In Forthcoming Issues

PICTURES BY WIRE. In this interesting article the author describes the processes involved in sending pictures, almost instantaneously, to remote points.

A NOVEL SHORT-WAVE ADAPTER. To eliminate the faults in powerizing previous designs of short-wave adapters, the author designed a novel and efficient system of connection which is described in detail.

RE-RANGING METERS. Numerous articles describing the procedure in re-ranging meters have appeared. None of them, however, have contained the technical "meat" that the Service Man will find in this treatment of an important subject.

A SELECTIVE CRYSTAL RECEIVER. Radio receivers which depend upon the "natural rectifier" for operation may be built with "band selection" as described in detail in this article.

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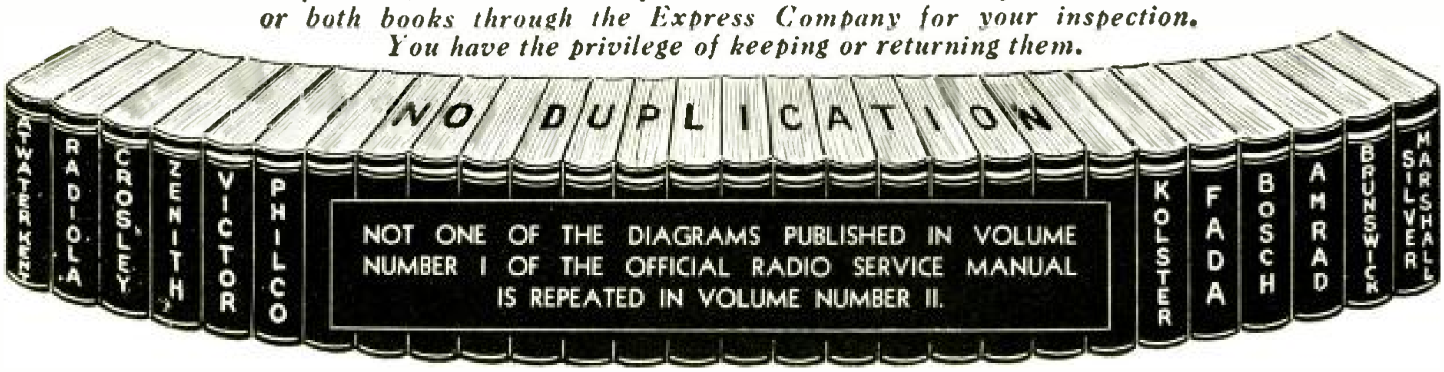

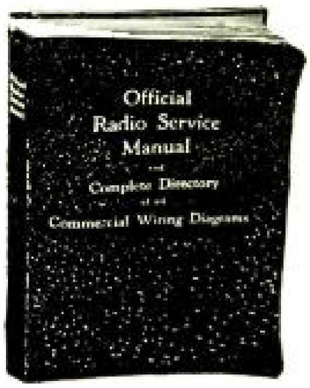

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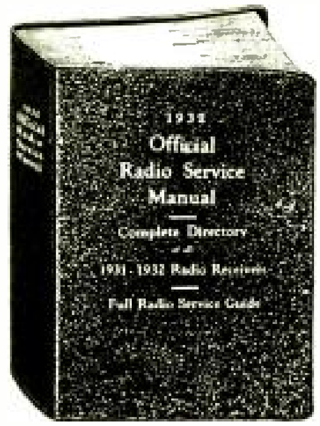

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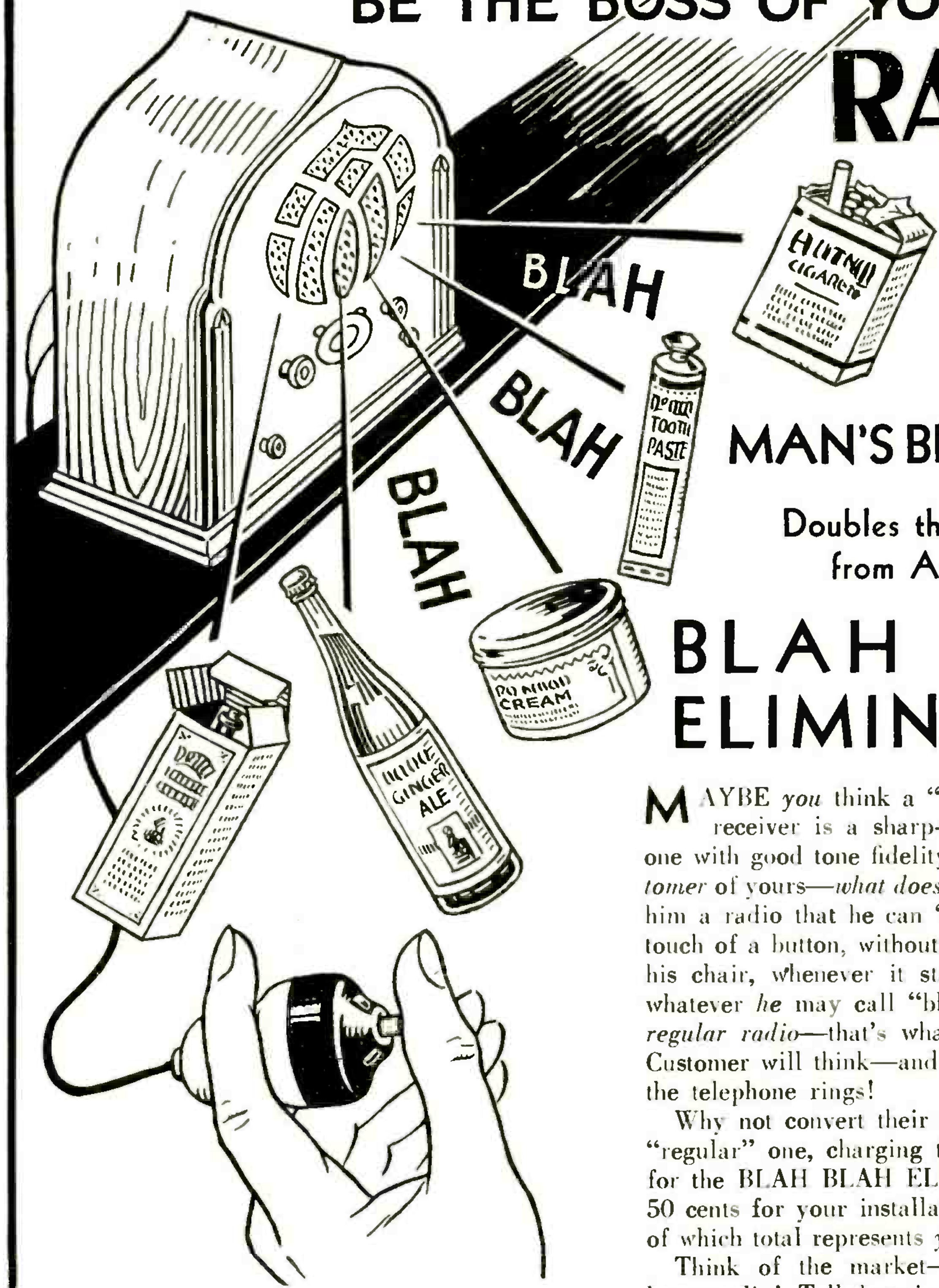

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HUGO GERNSBACK
Editor

MODERNIZING ELECTRIC SETS

By HUGO GERNSBACK

SINCE the advent of the electric set in 1927, approximately 15,000,000 of such sets have been produced.

Of these, 10,000,000 may be said to be antiquated because they operate with old-fashioned equipment, and are still utilizing the magnetic type of speaker instead of the modern dynamic type.

The old sets have no tone control, and as a rule, compared to a modern receiver, they have little power, or as it is said in the vernacular, they have "no pep."

Yet, millions of such sets are in use every day for various reasons. One reason, perhaps the main one, is the present economic depression; the owners have a real investment in their sets, (having bought them when high prices prevailed, at an average of over $100.00 apiece) and are, therefore, loth to throw out the set which, after all, still gives some service.

Another reason is that some of the sets of the vintage of 1928-29 were housed in very expensive cabinets; the latter often representing more than 50% of the total cost. The cabinet that now houses an antiquated radio is a piece of furniture that the owners are not willing to discard immediately, and for that reason they put up with the admitted deficiencies of the old radio.

Although these are excellent reasons, they should not deter the aggressive Service Man from selling efforts, because they open up a hitherto-untapped gold mine.

It probably has not entered into the head of the present owners, of these antiquated sets, that these may be modernized and brought up to date for a very modest sum of money. The changeover of such sets to dynamic speakers, pentodes, variable-mu tubes, etc., is not a difficult one; and it enables the Service Man to reap a real harvest, if he only knows how to go about it.

If the Service Man who has serviced such sets in the past knows what he is about, the situation reveals itself as one of comparative simplicity. All he needs to do is to call the attention of the owner to it by personal visit, telephone or letter, telling him that his set is now woefully antiquated, and that it needs to be brought up to date. If you once get "under the skin" of the owner, and make him realize that he has an antiquated radio set (which may be compared to a Model "T" Ford car) the owner will usually be persuaded to consider the proposition of having the set modernized.

Of course, the owners of fine cabinets, nine times out of ten, fail to realize that a changeover will not mar or affect the appearance of their prized cabinets, and this point should be pressed with due emphasis.

Naturally, no two cases will ever be exactly the same, so it is possible only to give general advice on the subject; but, as a rule, it has been found in practice that a little salesmanship properly applied works wonders with the average set owner.

Most important, however, from the standpoint of the Service Man, is the fact that once the job has been done, it will be found that the owner's attitude towards the set has entirely changed. The improvement has, so to speak, put new life into him, speaking from a radio standpoint. He will use the set more; he will be more likely to show it to his friends, because he can again feel proud of the set, just as when it was new. It can, indeed, be described by him as an "up-to-date set," because that is exactly what it is.

Just as an operation has made a new man out of many an invalid, so a "set operation" makes a new receiver out of an antiquated "wheezer," and will be a source of more business for the Service Man. Once the set owner has been shown that a Service Man has done him a real turn, he will call the same Service Man in again when the need comes, either for servicing or if he finally decides to buy a new set. And we know of many cases where Service Men have closed a number of nice set sales in this way.

And have you, as a Service Man, ever considered the multiple-speaker installation?

Practically every set owner has use for more than one speaker. Whether he lives in an apartment or in a house, the case remains the same. As a rule, the radio set will be found in the living room. What about the dining room? What about the childrens' room? What about the bedrooms?

If the owner can be convinced that, for a moderate sum of money, speakers can be installed all over the house, with switches and volume controls so that they may be turned off and on at all outlets; many attractive sales can thus be made. We know of a number of Service Men who have worked this as a specialty, and found it exceedingly profitable; particularly in suburban or country houses, where the need of extra speakers is acute.

Of course, in this instance too, an old set operates poorly, because more power is required to supply a number of speakers. The extra speaker, as a rule, need not be a dynamic; it may be of the magnetic type, as the wiring is simpler and the power demand less. With the coming of the summer, loudspeaker installations on summer porches is a worth-while undertaking for Service Men who complain of poor business.

One Service Man always carries an extra speaker with him, to demonstrate on the spot the advisability of extra speakers. He reports that six out of eight owners order at least one extra speaker.

How to Build the TETRADYNE ALL-WAVE RECEIVER

By HARRY HILL

THE writer has always had a liking for the superheterodyne receiver ever since building the Ultradyne designed by the late R. E. LaCault. With the advent of screen-grid tubes, however, he has always felt that the extra grid could be put to good use by using one tube as a combined oscillator and modulator (first-detector). Consequently, about a year ago, the writer set about designing a receiver, using the superheterodyne principle, that incorporated the idea mentioned above. As a result, the set pictured in Figs. A, B, and C was developed. It is called the "Tetradyne" Model 112 merely because the combined oscillator—first-detector is a four-element tube.

The Oscillator—First-Detector

Figure 1 shows a detailed schematic circuit of the first tube. It will be seen that one side of the oscillator tuning condenser C2 is connected to the positive side of the high voltage through the oscillator coil L3, which is connected in the plate lead of the tube. Since the other terminal of the condenser is grounded, the high voltage is applied directly across the condenser. This may not be regarded as "good engineering" practice, but the writer has operated this receiver for eight months without any harmful effects. It will be noticed, by reference to the schematic diagram of the completed receiver shown in Fig. 2, that a small Christmas-tree lamp is connected in the high-voltage line; if a short should occur, the lamp will burn out, thus protecting the "B" supply unit from possible danger.

Referring again to Fig. 1, it will be seen that a grid leak and grid condenser is used in the input circuit. This is optional, as the circuit works very well without it; it does, however, seem to add a little sensitivity to the receiver. If it is used, the grid condenser should have a value of 150 mmf., and the grid leak a value of 250,000 ohms. The cathode bias resistor (R2 in Fig. 2) may have a value of from 500 to 1,000 ohms; it is not very critical—in fact, in one case, the writer used 1,500 ohms with very good results.

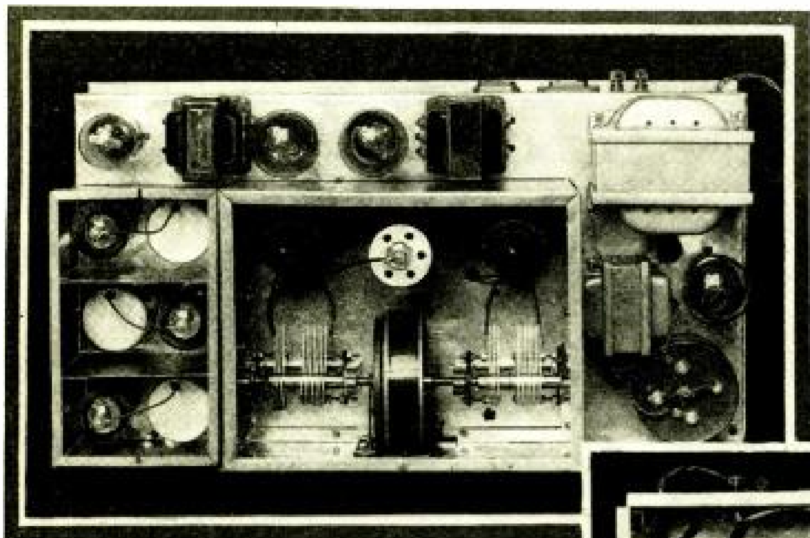
A further examination of Fig. 1 will show that the input to this tube is tuned in the conventional manner, even though the plate circuit is a little out of the ordinary. There is about 30 percent coupling between the screen and plate circuits, the exact amount depending upon the value of plate voltage used. This value has nothing to do with the construction of the receiver; it being given for the interest of certain "technically-minded" men.

A particular point of interest is the fact that the screen-grid is used as the output element. This grid has its current modulated (varied) by the plate current fluctuations; it being in this manner that the coupling is secured.

The voltages on the screen-grid and plate are not at all critical, but, as a general rule, the plate voltage should be about one-third the value of the screen voltage—which is the same for any dynatron oscillator. However, the voltages specified on the diagram have been found best for all practical purposes.

The writer has found one feature that may be of interest. Using one particular tube with 180 volts on the screen, the plate-voltage supply lead could be disconnected entirely from the set, and the tube would keep on functioning as usual. Once the set was shut off by means of the power switch, the tube would not oscillate again when the set was turned on unless the 180-volt lead were momentarily applied. This may be food for thought for some detailed experimenter.

The two circuits (first-detector and oscillator) are prevented from "pulling in" by the plate resistance of the tube. Thus, under no conditions do the oscillator and broadcasting station mix at any but the I.F. frequency.



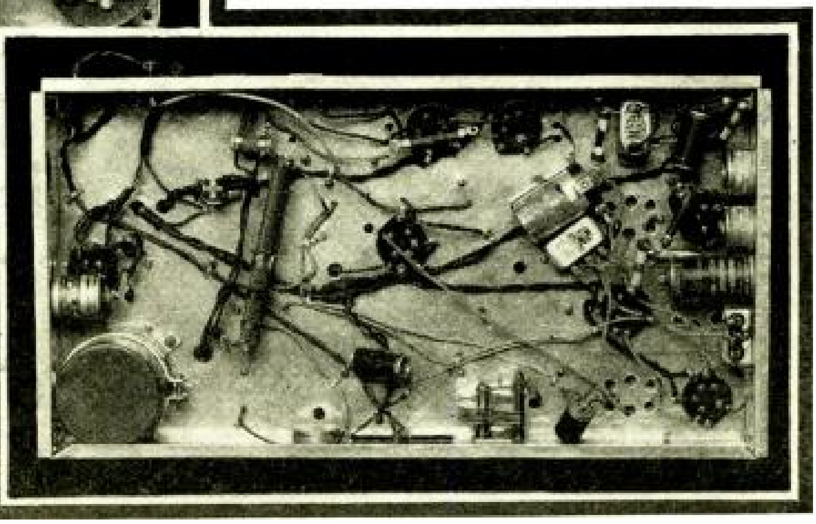


Fig. B, above. *Top view of the Tetradyne's chassis.*
Fig. C, right. *Under-chassis view of the receiver.*

It will now be instructive to discuss the tubes used in the set and then proceed with its construction.

Both the '24 and '35 (the latter a variable-mu type) tubes have been tried in the oscillator—first-detector stage. From the writer's

Many all-wave receivers have been described heretofore; but the Tetradyne, discussed by the author, has some very novel features that warrant the close attention of set-builders, Service Men, and Experimenters.

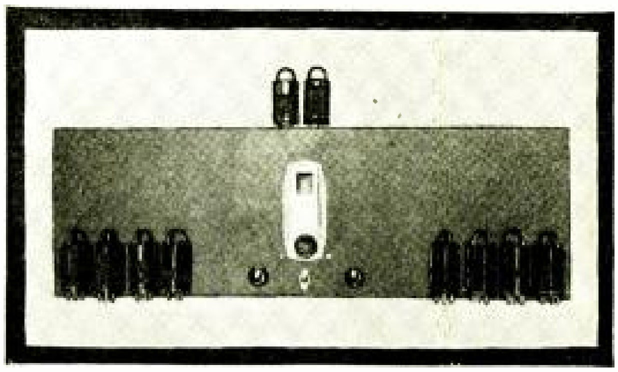


Fig. A
Front view of the Tetradyne Model H2 receiver.

experience, the '35 has been found to give better results on the lower waves while the same reception was secured on the broadcast band. For this reason the '35 type tube was selected for this purpose as well as for the two stages of I.F. A '24 was used as the second-detector which is resistance-coupled into a '27 first audio which, in turn, feeds into two '47 pentodes connected in a push-pull arrangement.

The Tuning Condensers

Now, referring to Fig. 2 and also to the photographs, it will be seen that the tuning condensers are of the two-stator type. They are National type E.C. 4 which originally had a capacity of .0004-mf. However, several plates have been removed from each section so that now the smaller section is composed of three plates and has a capacity of .0001-mf. (Condensers C2 and C5 in Fig. 2.) The larger section has seven plates and a capacity of .0002-mf. (Condensers C1 and C4 in Fig. 2.) This results in a total capacity of .0003-mf. in each section, which is used to tune the broadcast band. The smaller sections are used only for the short-wave bands, and are automatically connected in the circuit by means of the plug-in coils illustrated in Fig. 3.

Condenser C3 is shown in Fig. 2 as connecting directly across the entire tuning unit; but, in reality, it is connected only across the smaller or .0001-mf. section; this connection also being shown in the coil data of Fig. 3.

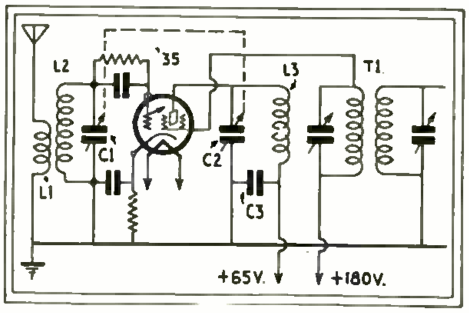


Fig. 1
Detailed diagram of the oscillator.

The main tuning condensers are ganged on one dial and C3 is manipulated by means of a separate knob on the front panel. Its use on the broadcast band is not at all necessary; but on the shorter waves, it helps to tune in the weak stations. Condenser C6 is an equalizing condenser of about 50 mmf. and is permanently connected to the broadcast-band coil; once adjusted, it should not be touched again.

This condenser is also shown in the coil-data illustration of Fig. 3. It should be studied very carefully.

One thing that will be noticed in examining Fig. 2 is the absence of R.F. chokes and complicated filter systems in the plate and screen-grid leads. They may be used if so desired, but the writer does not see the necessity of them—in this set, at least. Nothing is used that does not improve results at the loudspeaker, for that is where the merits of a set are judged. They were tried and, while they may be theoretically O.K., the writer did not notice any improvement with their use, and consequently discontinued them.

It will be noticed that the second-detector, while it is a '24 type tube, has its screen-grid and plate connected together—it being used as a regular three-element tube. In this manner, greater amplification is secured than if a '27 were used.

Different set-constructors have their own ideas on how a set should be shielded. I have found the following to be successful.

Shielded wire is used on this receiver; the shield being grounded. It was found necessary to completely shield the first I.F. transformer and tube from the rest of the set, so all three I.F. transformers and the two I.F. tubes were enclosed in a separate three-section shield. The modulator-oscillator tube, the tuning condensers and coils are all placed in one large shield-box; and contrary to the usual custom, the coils and condensers are *not* shielded separately. However, the '35 tube is shielded separately. None of the leads from the coils to the control-grid caps are shielded—just plain rubber-covered wire is used.

The complete receiver, including the power supply, is mounted on a sheet of 14-gauge aluminum, 11¼ ins. wide, 21 ins. long, and 2½ ins. high. The modulator-oscillator tube, the coils, tuning condensers, and dial are mounted in an 18-gauge aluminum shield-box, 10¼ ins. long, 6 ins. high, and 8¼ ins. wide.

The shield-box for the I.F. and second-detector is 8¼ ins. long, 5 ins. wide, and 6 ins. high. It is divided into three equal compartments, the material also being No. 18-gauge aluminum.

Home-built tuning coils wound on commercial forms have been used throughout as they have been found to be inexpensive.

Figure 3 illustrates the manner in which the tuning coils are to be wound. While Pilot coil forms were used, they may be con-

(*Continued on page 682*)

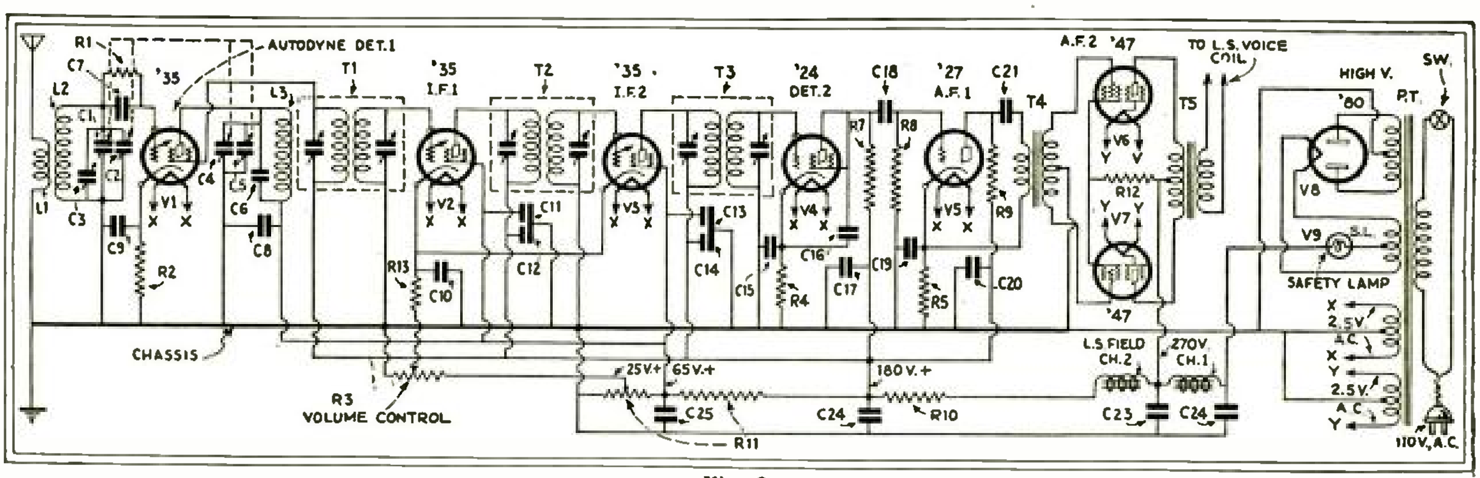
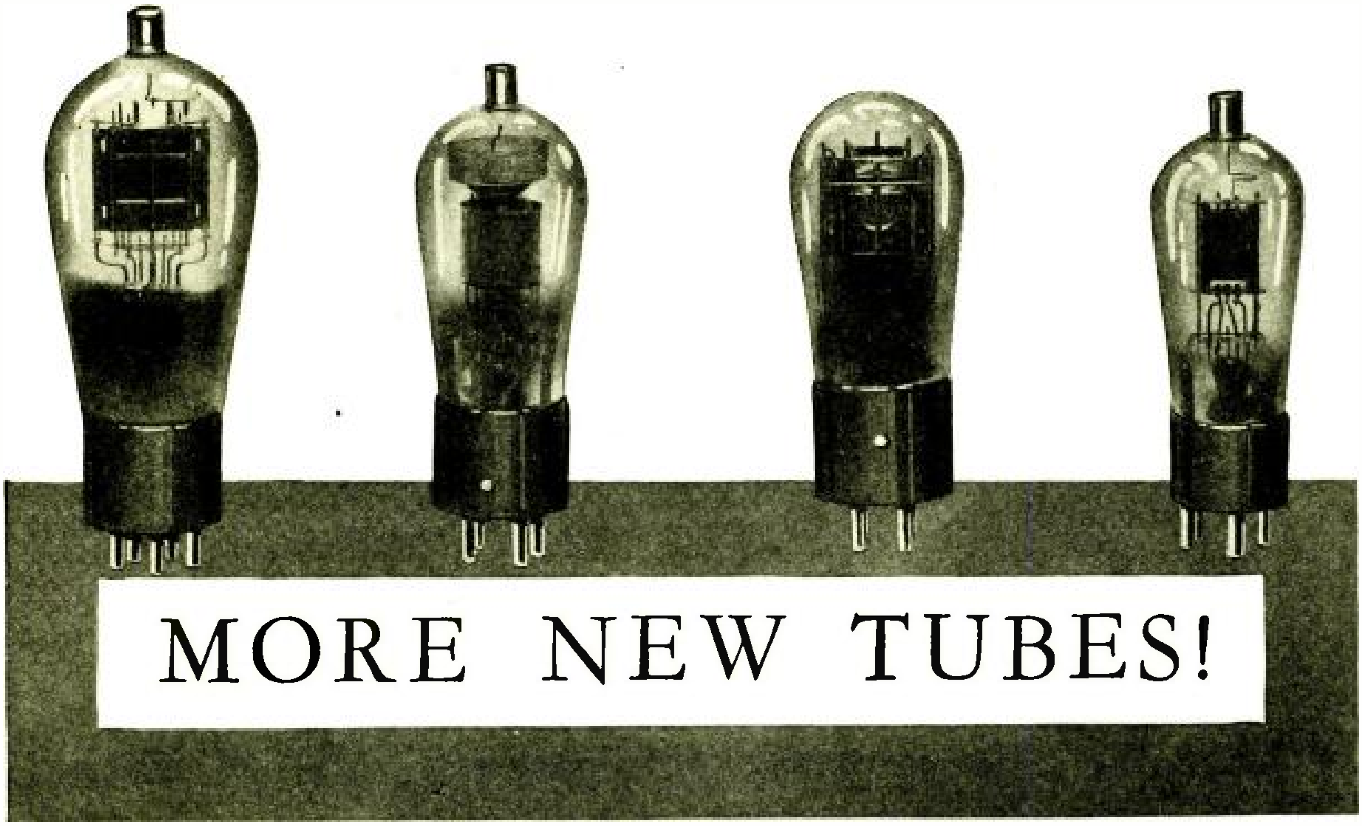


Fig. 2
Complete schematic circuit of the Tetradyne receiver. The exact connections of the input tuning circuit is shown in Fig. 3.



MORE NEW TUBES!

By LOUIS

HERE we are again this month with a line of eight new tubes; each one being prematurely announced in these pages so that the set builder, experimenter and Service Man may be in a better position to formulate any plans he may have had for the future. It might be well to state that it is impossible at this time to specify the type-number of these tubes inasmuch as they have not yet been established at this writing.

It is probable that even one of the tubes discussed in this article will have its physical construction changed slightly, but this should not hamper the reader inasmuch as the electrical characteristics will be identical with those given here.

A New Type Output Pentode

In Fig. A we have shown a new type of output pentode which is capable of delivering 3.5 watts of undistorted output with a load resistance of 7000 ohms. Probably the unique feature about this tube is the fact that, unlike other output tubes, it has a heater; in other words, it has a cathode emitter which is similar to the '27 type tube. This new feature results in a much lower hum output than has been heretofore possible in power output tubes. For instance, consider Fig. 1.

This curve shows the hum-voltage output when the grid and plate-return-leads are not brought to the center tap of the filament. In other words, the '47 type tube has a hum output of one volt when the center tap is but 1.5 percent off center; the new pentode has an output of but one-tenth of a volt with the return leads 1.5 per cent off center. An examination of this latter curve will readily show how quiet this new pentode is expected to be.

Figure 2 shows the relation between plate voltage and plate current. The vertical line at the 250-volt mark is the rated plate voltage of the tube. As with other pentodes, the familiar "bump" at low plate voltages is absent. This, of course, is due to the insertion of the fifth element in the tube. The curves in Fig. 2 are each taken with different values of grid biases; at the rated bias of -16.5 volts, the plate current is seen to be approximately 33 milliamperes.

Figure 3 is a very interesting curve; it shows the relation between the load resistance and the power output of both the second and third harmonics. The small scale to the right indicates the percent distortion. The second-harmonic output is a minimum with a load resistance of 7000 ohms; it is for this reason alone that the value of 7000-ohms for the load resistance was chosen.

Figure 4 illustrates the variation of amplification factor, mutual conductance, and plate resistance of the tube with various grid biases. As in the other curves, the vertical line indicates the rated bias of this new tube.

It may be well to remark that the curves as given above have been supplied by the manufacturer of the tube.

The following are the characteristics of the tube; heater voltage, 2.5; heater current, 1.75 amperes; plate voltage, 250; screen voltage, 250; grid bias, -16.5; load resistance, 7000 ohms; amplification factor, 100; internal plate-impedance, 31000 ohms; mutual conductance, 3300 micromhos; plate current, 34 ma.; output power, 3.5 watts.

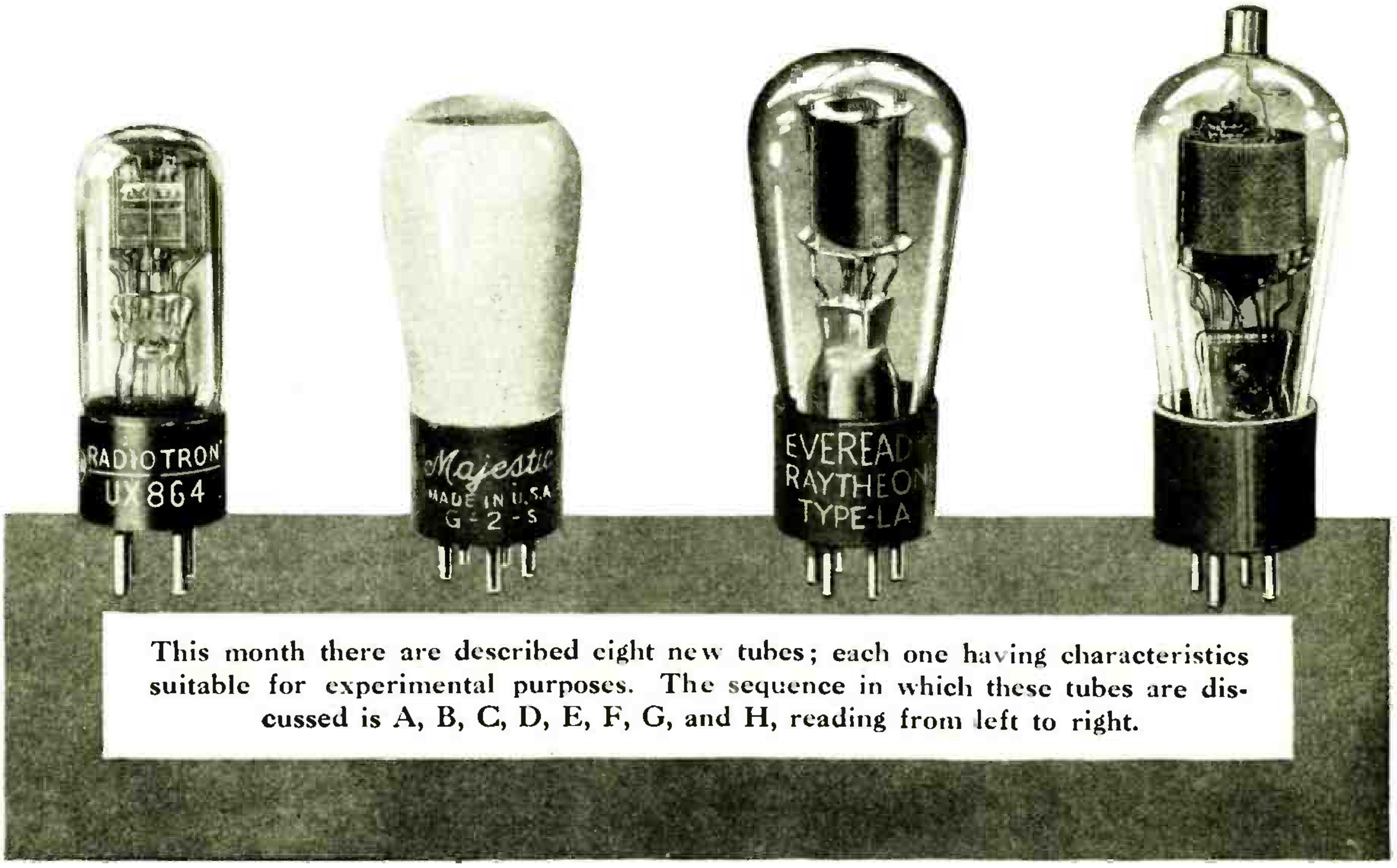
It is seen that the characteristics of this new tube are very similar to that of the '47. In fact, it may directly replace the '47 tube; the only circuit change necessary is the rewiring of the socket as per the diagram, Fig. 5.

The addition of this tube to any receiver will result in a greater power output with less distortion than could be secured with the '47. In fact, the author predicts that this new tube will completely replace its older brother within a short time after it

FOR the fifth consecutive month,* RADIO-CRAFT *is scooping the field by being FIRST to announce new and vital radio tubes. In practically every case, these new tubes have been published several months ahead of any other radio publication in the country.

Because new tube developments are considered important, and inasmuch as every new radio development is fully dependent upon new and better tubes,* RADIO-CRAFT *has always taken the initiative to be the FIRST to bring the latest developments along these lines to its readers.

The present article is a climax in this respect, as the developments of the entire radio industry, during the next twelve months, will revolve around these tubes.



This month there are described eight new tubes; each one having characteristics suitable for experimental purposes. The sequence in which these tubes are discussed is A, B, C, D, E, F, G, and H, reading from left to right.

MARTIN

is obtainable in the open market.

A Combination Oscillator First Detector

Very few people deny the fact that the superheterodyne is the most popular circuit in use today. The only possible objection that one could have to its use is the necessity for having an *additional* (oscillator) tube. While circuits have been designed that have combined the oscillator and first detector, they have not proved very satisfactory, especially when made on a production basis, so that almost every one who has designed such a circuit has eventually changed it so as to use the additional tube.

Figure B shows what the author considers a tube of radically new design—a combination oscillator and first-detector built into a single glass bulb.

The diagram of Fig. 6 shows the rather unique mode of connection. As may be seen, the tube has two plates, a pentode-grid, a screen-grid, a control-grid, a cathode, and a heater. While physically it has seven elements, nevertheless colloquial use will probably change it to a *sextode*, inasmuch as the cathode and the heater may be considered as a single element.

The operation of this tube is not unlike that of the familiar dynatron oscillator. Refer to Fig. 6. The coil L1 and condenser C1 constitute the oscillator tuning circuit; the coil L2 and condenser C2 the secondary circuit of a standard R.F. transformer. Circuits L1 C1 and L2, C2 are detuned by an amount equal to the intermediate frequency. The transformer and condensers shown within the dotted outline to the right of the diagram is the first I.F. transformer. For convenience in explaining the operation of this circuit, the elements of the tube have been labeled in the diagram as P1, P2, G1, G2 and K which corresponds to the socket connection given in Fig. 7. All voltages shown in Fig. 6 are obtained from batteries in order to simplify the diagram. The theory of operation, however, is the same when operated from a power unit.

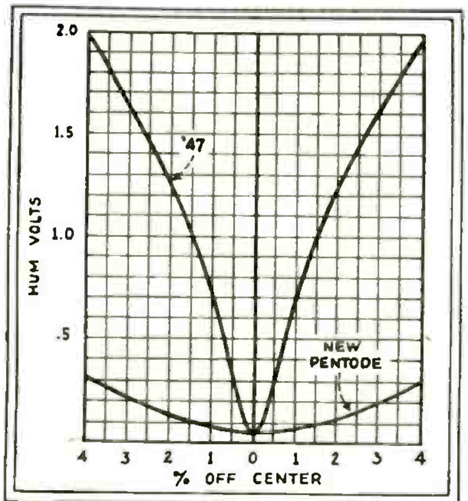


Fig. 1

Hum-volts output of the '47 compared to the new heater-type output-pentode tube, as position of center-tap is varied.

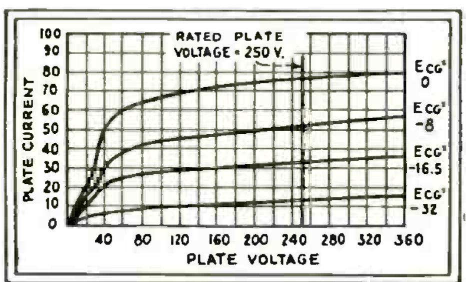


Fig. 2

Curves showing the relation between plate-current and plate-voltage of the new heater-type pentode.

Condensers C3, C4 and C5 are the familiar control-grid, screen-grid and plate bypass condensers. C6 is used as a bypass condenser for the plate-voltage supply of P2.

Referring to Fig. 8, it may be seen that the tube operates on the portion of plate-resistance curve which changes very rapidly. Thus, any change in grid-bias will result in a very large change in plate resistance. Now when a signal is applied to the control-grid (G1), the plate currents of both P1 and P2 vary in accordance with this signal voltage, while at the same time, the plate current of P2 is varying at a frequency determined by the size of L1 and C1. The result is that the change in the control-grid voltage is determined not only by the signal voltage but also by that induced in the grid coil L2 from plate coil L1. Here is where plate P1 comes into use: Its current is the result of both voltages, whose frequency is the *difference* between the two; that is, equal to the intermediate frequency. It is for this reason that the I.F. transformer is connected to P1. Stated in another way, the tube has two plates; through one (P2), the oscillating current flows, and through the other, the resultant of both the signal and the oscillator plate current.

The relation between control-grid voltage and plate current is also shown in the same figure. A peculiar fact, as may be seen by referring to Fig. 9, is that the plate of P2 is at a potential of but 30 volts and that of P1, 250 volts.

This tube has some very interesting possibilities, and it would be well for the ex-

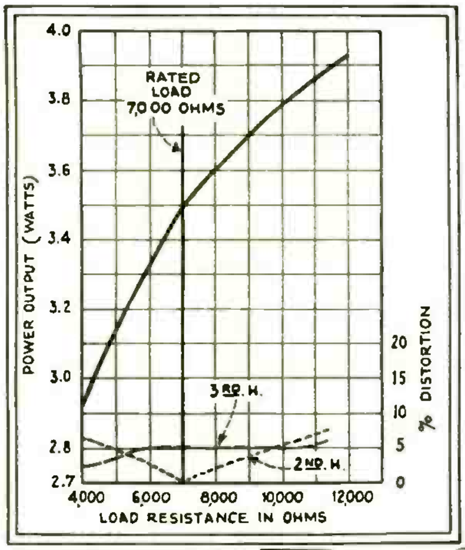


Fig. 3
Power output and per-cent harmonic-distortion curves of the new output pentode.

perimenter and set builder to obtain one and see what can be done with it.

The P. J. 11 Pliotron

A vacuum tube more sensitive than its predecessors in the measurement of minute voltage was announced recently by the vacuum-tube engineering department of the General Electric Company. This new "low noise" vacuum tube, illustrated in Fig. C, is technically designated as the type "P. J. 11 Pliotron," differs particularly from the usual tube in the degree of vacuum that has been attained. In the ordinary tube, the gas pressure is of the order of a millionth of an atmosphere (an atmosphere being 14.7 pounds per square inch); the new tube has been exhausted to a billionth of an atmosphere!

The "low noise" tube makes it possible to detect voltages of the order of 1/10,000,000 of a volt. It has been possible to do this at radio frequencies for some years, but when attempts were made to amplify voltages whose frequencies were less than 1000 cycles per second, it was found that voltages of less than 1/10,000 of a volt were completely masked by large random disturbances. When these disturbances are made audible by a loudspeaker, they appear as a loud crackling noise. Because of the fact that this new tube reduces this noise between a *hundred and a thousand-fold*, it is possible to measure voltages as small as a *millionth of a volt* and to detect voltages *ten-times smaller at all frequencies* up to about one-million cycles per second.

Laboratory investigations show that random disturbances are caused by any or all such happenings as insulation in or near the electron path, irregular filament emission, gas, positive-ions emitted by the filament, and insulating foreign deposits on grid wires. The construction of this new tube is such as to minimize these disturbances to an extent that will permit the measurement of the small voltage mentioned above.

The characteristics of this new tube are as follows: Filament voltage, 5; filament current, .25-amperes; plate voltage, 135; plate current, .45-ma.; control-grid voltage, -.5; amplification factor, 30; internal plate resistance, 10,000 ohms; mutual conductance, 3000 micromhos; grid-plate capacity, 9.6 mmf.; grid-filament capacity, 4 mmf.; plate-filament capacity, 2.3 mmf. For a resistance coupled amplifier, the following constants should be used: "B" voltage, 180; grid voltage, -3; load resistance, 500,000 ohms. With the above, the plate current will be .1-ma. and the amplification factor 20.

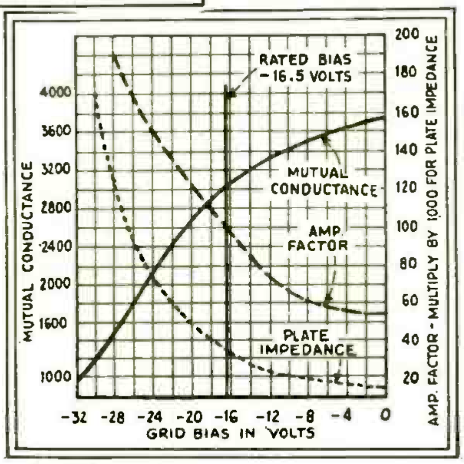


Fig. 4, above.
Variation of amplification factor, mutual conductance, and plate impedance with grid bias.

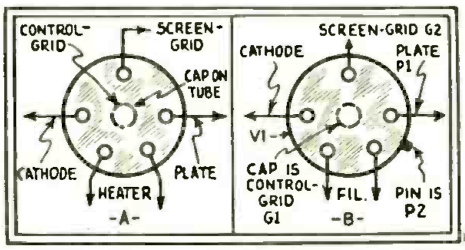


Fig. 5, right.
At the left (A), socket connections of the new heater pentode.

Fig. 7, right.
At the right (B), socket connections of the new oscillator—first-detector.

The Wunderlich Tube

There will be announced very shortly a new type of detector tube which is novel, inasmuch as it may be used not only as a second detector but also as an automatic volume-control and amplifier. This tube is illustrated in Fig. D, and the diagram of its connections in Fig. 10.

As may be seen by an inspection of this figure, there is no bias on the tube itself. The coil L1, and capacity C1, is the usual secondary circuit that feeds the second-detector (of course, if the receiver is of the T.R.F. type, the second detector is the only one there is, and consequently the information given regarding this tube is valid for such receivers also). Its theory of operation is relatively simple. Consider Fig. 11. The signal voltage shown as A is impressed across grids G1 and G2 of the tube; one (G1) being positive and the other (G2) negative. The plate current, due to G1, does not rise very much even though the grid is positive because of the unusual shape of the plate-current — grid-voltage curve shown in Fig. 12. The grid G2 being negative causes a large decrease in plate current as shown in C Fig. 11; when the cycle reverses, G1 causes a decrease in plate current while G2 hardly rises at all. The resultant plate current flowing through the resistor R of Fig. 10 is shown at D of Fig. 11. In other words, full-wave rectification is secured, and the voltage drop across this resistor may be taken in order to obtain A.V.C. action. The elements of the grid as labeled in Fig. 10 are connected to the socket as shown in Fig. 13.

This tube was designed by Dr. Wunderlich, and is undergoing production at the present time.

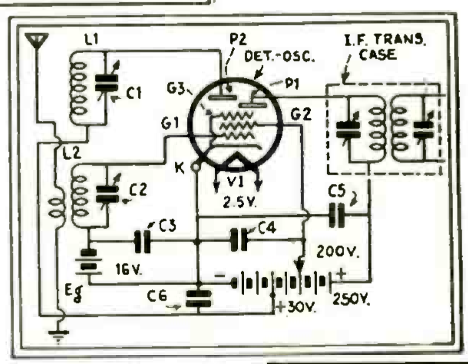


Fig. 6, left.
Diagram of connections of the oscillator—first-detector.

A New Two-Volt Pentode

At this time, tube manufacturers announce a new super-control pentode in the two-volt series for use as an R.F. or I.F. amplifier or as a first detector in superheterodyne circuits. It corresponds to the '35 or '51 in the A.C. series and the '39 (which was described in the February, 1932 issue of RADIO-CRAFT) in the automobile series).

The characteristics of this new tube (which is designated as the '34) are as follows: Filament potential, 2 volts D.C.; filament current, .06-ampere; plate voltage, 180 (max.); screen-grid voltage 67.5 (max.); control-grid voltage, -3; plate current, 2.8 ma.; screen-grid current, 1 ma.; internal plate-resistance, 1,000,000 ohms; amplification factor, 620; mutual conductance, 620 micromhos.

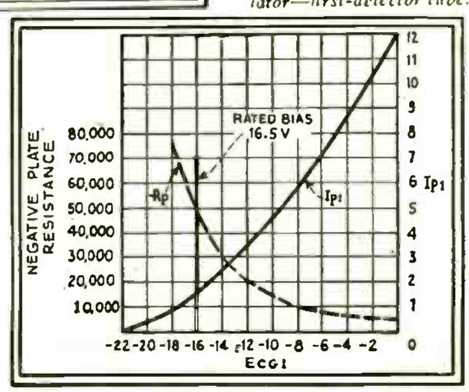
This tube is ideally suited to short-wave use, especially for portable receivers. When used with the '32 screen-grid tube as a detector, and a '33 tube as an output tube, a higher degree of sensitivity and volume are obtainable.

The socket connections of this tube, as shown in Fig. 14. Fig. 15, shows the control-grid voltage—plate-current curve of the tube and also the mutual conductance curve. Fig. 16 shows a family of plate-current—plate voltage curves. See Fig. H.

A Detector-Amplifier

As the sixth tube on the list we present a new detector-amplifier designated

Fig. 8, below.
Variation of negative plate-resistance and plate current with grid voltage for the oscillator—first-detector tube.



as the '64. It is designated as a three-electrode tube of general-purpose type construction for use under conditions where freedom from microphonic disturbances is required. It is specially applicable as a detector-amplifier or oscillator to battery-operated equipment which may be subjected to either impact or continual vibration. This tube is illustrated in Fig. E and has the following ratings and characteristics: Filament voltage, 1.1 (D.C.); filament current, .25-ampere; plate potential, 90 volts (max.); grid voltage, -4.5; plate current, 2.9 ma.; amplification factor, 8.2; internal plate-resistance, 13500 ohms; mutual conductance, 610 micromhos; plate-grid capacity, 2.3 mmf.; grid-filament capacity, 5.4 mmf.; plate-filament capacity, 3.5 mmf.

The "G-2S" Duodiode

For several years past, the detector-circuit of the radio receiver has received less technical attention than any other circuit from the standpoint of fidelity and overload characteristics.

The earliest type of vacuum-tube detector—the diode—consisting simply of a thermionic cathode and a plate, was discarded chiefly because of its lack of gain; or, in other words, due to the fact that it was not particularly sensitive. It has become increasingly more apparent, during the last few years, that the two-element tube, *or diode*, has several advantages as a detector which more than compensate for its low gain and lack of sensitivity, and several modern circuits have appeared in which the usual *triode*, or three-element tube with two of the elements electrically connected, have been used as a diode detector. It is well known that it is practically impossible to overload such a detector, since it has the ability to handle any amount of power up to the point of destruction of the tube itself without overload distortion. The circuits associated with this use have frequency characteristics which are inherently better adapted to detectors than are the common detectors in use today. In fact, the diode detector is often known as the "linear detector" as contrasted with the more usual "square-law" type.

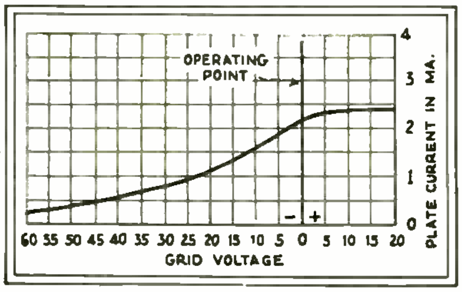
The advantages of "push-pull" operation are well understood in the radio art today. The great advantage of push-pull lies in the fact that this mode of operation automatically cancels out the objectionable even harmonics.

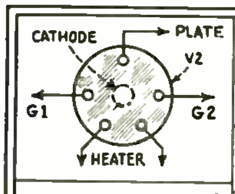
It has remained for Grigsby-Grunow engineers to incorporate in an entirely new tube and a new circuit, the combination of these two developments, that of the diode or linear detector, and at the same time the push-pull operation.

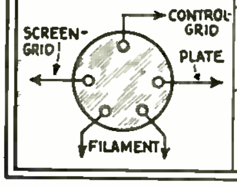
The "G-2S" is constructed with a standard heater type cathode operating at a heater terminal potential of 2.5 volts and a heater current of 1.75 amperes (average). It utilizes two small plates, concentric with the cathode, with a spacing of about one millimeter between them at the center of the cathode. The two plate leads are brought out separately to the standard plate and grid prongs of a standard five-prong base. The tube operates in Majestic circuits with no D.C. plate voltage, only the radio- or intermediate-frequency signal being impressed on the plates.

An important feature of the "G-2S," when operated under these conditions, lies in the fact that an extremely long life may be expected. At the present time, it is impossible to say what the actual life may be, but it is certainly safe to say that it will be far in excess of any of the commercial triodes or tetrodes now standard in the industry.

The information given above is reproduced with the courtesy of Dr. C. Marvin Blackburn of the Grigsby-Grunow Co. A photograph of the tube is reproduced in Fig. F.







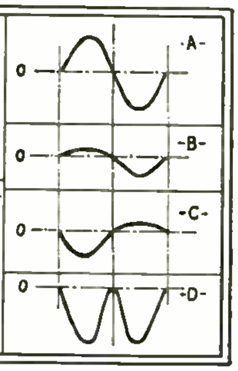


Fig. 11, left. *Action of the detector tube.*

Fig. 12, above. *Plate-voltage — plate-current curve of the new detector.*

Fig. 13, upper left. *Socket connections of the detector tube.*

Fig. 14, lower left. *Socket connections of the '34.*

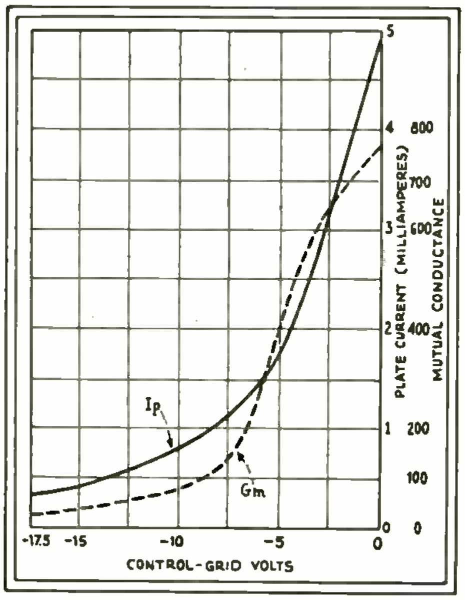
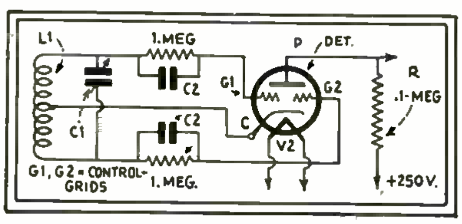


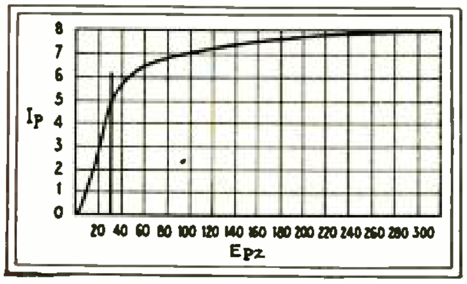
Fig. 15

Curves showing the variation of plate-current and mutual conductance with grid-bias. The former is represented by the solid and the latter by the dotted curve. It should be noted that with the rated grid voltage of —3 volts, both the plate current and mutual conductance vary considerably with grid bias. This tube cannot be used in the output stage.

Fig. 9, below. *Plate-voltage — plate-current of the detector-oscillator.*

Fig. 10, right. *Circuit diagram of the new detector. Condensers C2 may be made equal to .00025-mf.*





A New Output Pentode for Automobile Receivers

One of the most important problems in automobile receivers is that of supplying sufficient audio output. The signal level should be high enough so that driving noises will not interfere. The first sets employed fairly sensitive magnetic speakers so that an output of a few-hundred milliwatts was sufficient. However, with the recent trend to small dynamic speakers of poor efficiency, the power tubes are required to give a much higher output.

The plate-supply power is very limited. Dry batteries of 135- and later of 180-volts have been generally used as "B" supply. Also the "B" eliminators introduced recently are designed to give only 30-35 ma., because they operate on the car battery already loaded up to maximum capacity. Allowing about 10 ma. for the other tubes in the set, this leaves a maximum of 25 ma. for the output tubes. After subtracting the bias voltage, about 4 watts "B" power remain and must be used economically. It is easy to see that 2 watts of audio power is the highest possible output under these conditions.

Another requirement imposed on the output tubes as well as on all the other tubes in the set is that of maximum sensitivity. Conventional triodes are, therefore, practically eliminated, pentodes being far superior in this respect.

There are some tubes for this purpose on the market already; the '38, for instance, having been designed especially for automobile receiver operation, has proven quite satisfactory. In some cases, a tube with higher power output and power sensitivity is desirable. The plate dissipation, however, at 165 volts on the plate is rather high for the size of the tube.

The "33" would be quite suitable for this application in some respects. However, the

(*Continued on page 683*)

The Latest in RADIO EQUIPMENT

A PORTABLE SOUND REPRODUCER

A NEW portable and completely self-contained unit for reproducing records through radio sets and power amplifiers has been recently announced.

Housed in the leatherette carrying case are an electric phonograph motor and turntable, and a sensitive electro-magnetic pickup. A carrying case in the cover provides for storage of several records without danger of breakage.

The Operadio reproducer.

This unit is adapted for use with all radio sets and amplifiers having provision for connection to either high or low impedance pickups. Adapters are available for connections to most other radio sets.

Available with either high or low impedance pickup, and with 78 or 33-1/3 R.P.M. motors, for 25 or 60 cycles, 110-volt power supplies. It is a product of the Operadio Mfg.Co.

A NEW BATTERY RECEIVER

IN THE accompanying illustration is shown a new 8-tube superheterodyne (Model K O C) designed to operate from a 110-volt D.C. source.

The Fada Model KOC.

It uses four type F-236-X variable-mu tubes for the R.F. stage, first-detector and two I.F. stages; two type F-236 tubes for the second-detector and oscillator; and two type F-257 tubes for the A.F. stage. It has a band-pass input circuit and a small dry battery for "C" bias.

It is manufactured by F.A.D. Andrea, Inc.

A SMALL DRY RECTIFIER

THE H. T. 8 rectifier shown in the illustration is suitable for supplying the plate current of receivers consuming 60 ma.

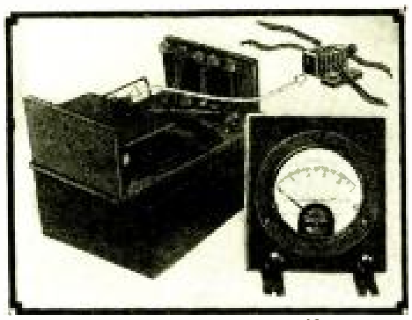
The voltage doubler.

It may also be used for battery charging and for supplying field-current for dynamic speakers.

It is manufactured by Westinghouse, Brake and Saxby Signal Co.

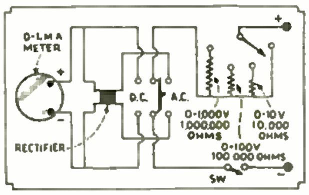
A SMALL METER RECTIFIER

THE use of output meters for testing purposes is becoming increasingly popular. The small rectifier shown below

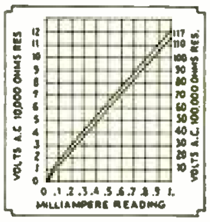


A set-up using the rectifier.

was designed to work in conjunction with a 0-1 ma. D.C. meter. For voltage measurements, the series resistor necessary may be



Left, manner in which multipliers are connected. Right, Calibration curve.



determined by merely multiplying the range by 1000. Thus, shown below is the connection of a meter for three ranges, 0-1,000 volts, 0-100 volts and 0-10 volts. A calibration curve is also shown.

This unit is manufactured by the Taussig Research Laboratories.

BULOVA RADIO SETS

RADIO sets and electric clocks go together like hand and glove, but the newest models have a degree of utility not obtained in earlier models of such "combination" instruments. One of these newer radio receivers is illustrated below.

A particularly interesting new feature is the Bulova electric clock which is built into the set. Besides giving the correct time, the clock (together with its time relay) automatically turns the radio "on" and "off" at any desired time. Just pick out the program you desire to hear, set the clock, and when the time comes the radio automatically turns itself on and starts to play.

The Bulova "midget."

There are five models in the Bulova line: a five-tube T. R. F. midget (illustrated here); a seven-tube superheterodyne midget; a seven-tube console; a seven-tube Grandfather Clock; and a ten-tube deluxe console.

The dynamic speaker has been set back from the front of the cabinet a number of inches and a shorthorn introduced, acting as an acoustic load. This greatly improves the quality of reproduction from the midget models.

The clock operates continually, always indicating the correct, electrically perfect, synchronized time. The radio set can be operated either automatically by the clock or manually in the ordinary manner.

These sets are the first to be put on the market by the Bulova Watch Company.

Its diagram of connections will be published in a future issue.

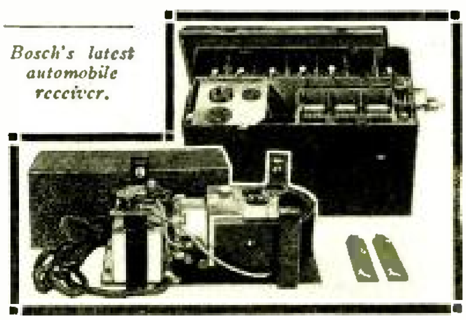
AN A.C. AUTOMOTIVE RECEIVER

THE New York and Chicago Automobile Shows occasion the announcement of a new superheterodyne motor car radio receiver. It is manufactured by the American Bosch Corp. and is designated as the Model 9:20, because of 20 outstanding features, 9 of which are engineering features combined for the first time in automotive radio.

One of the features is the Magmotor, an instrument used for the elimination of "B" batteries. This device is a single armature, double-commutator machine, with a permanent magnet field and operates from the car battery. The receiver may be operated either from the Magmotor or from 135 volts of "B" batteries.

Seven of the new automotive tubes are used including one used as a "diode-triode." Full automatic volume-control regulates the signal level to counteract the varying field strength as the car moves along the road.

Bosch's latest automobile receiver.



The receiver utilizes the roof type antenna now being installed at the factory, or it may be operated with a new plate antenna designed by the Bosch company. It is suspended to the under-side of the car frame parallel to the road.

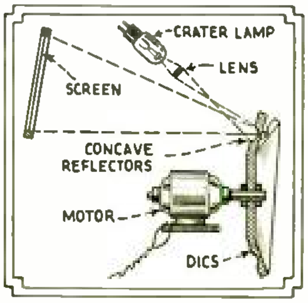
A Complete Television Receiver

The television receiver

AT last, with the announcement of a television receiver shown at the left and right, the public is beginning to get a glimmering of the particular corner around which television has been hiding for the last few years.

The set is a product of the Hutton Television - Radio Corp. and bids fair to find an excellent market. It incorporates, aside from the television receiver, a broadcast receiver so that the reception of sound and image may be made simultaneously.

The set has two main features: First, the disc is stamped from a single sheet of metal, and is slotted radially, so that each section between two slots may be bent at different angles; second, the crater lamp is so placed with respect to the screen that a long beam-length is secured in a very short space.

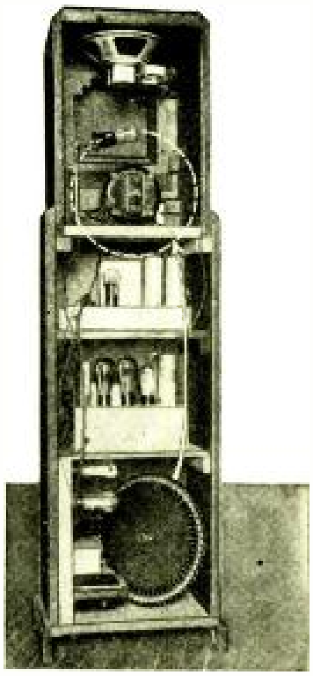


Schematic of lens system.

These two points are illustrated in the drawing reproduced here. In each of the sections mentioned, a concave indentation is stamped and its surface polished. The crater lamp is so focused that the diverging beam of light from the lamp strikes the disc and is reflected to the screen. Thus, all of the light is utilized and a picture 5 x 6 inches is secured in a cabinet whose depth is only 11 inches.

• The photograph at the right shows the 60-line disc removed from its motor in order to illustrate the respective location of the crater lamp and its associated parts.

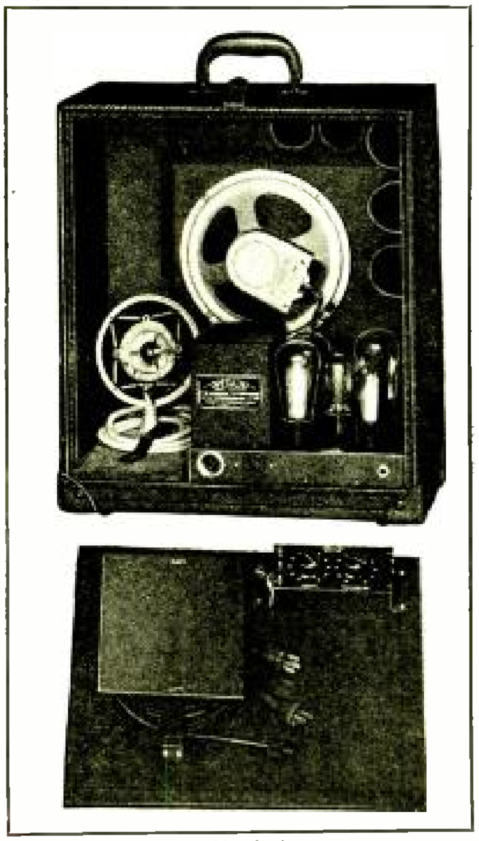
Sound is emitted from the loud speaker at the top of the grandfather type console illustrated. Clyde Fitch is the inventor.



Rear view of the combination television and broadcast receiver.

NEW PORTABLE "P.A." SYSTEM

THE latest thing in portable public-address equipment is illustrated here. The complete unit is carried in a single, balanced carrying case, the front of which is utilized as a baffle for the self-contained dynamic speaker. Complete with tubes, microphone, and all accessories, the weight is only 40 lbs.



The portable P.A. system

The input from the two-button microphone that is supplied, or from any 200-ohm phonograph pickup, is raised by the three-stage amplifier to a volume level sufficient for addressing a group of people that may be assembled in a room 1,000 feet square. The amplifier operates from 110 volts 60 cycles, A.C., and supplies power for all accessories including the dynamic speaker and two-button microphone.

A control panel is provided with separate volume controls for microphone and phonograph input, and a changeover switch for shifting the amplifier to either input. The cover provides stowage for a 50-foot rubber-covered microphone lead and a 25-foot A.C. line cord. A jack is provided that allows from one to four additional A.C. dynamic or magnetic speakers to be operated without affecting the output of the main speaker.

This type of unit finds wide application for use at meetings and luncheons where overflow crowds are located in a second room, and as a paging system during conventions. They are often carried by speakers on tour who wish to make certain that they are easily heard by their whole audience.

This instrument is manufactured by The Operadio Mfg. Co.

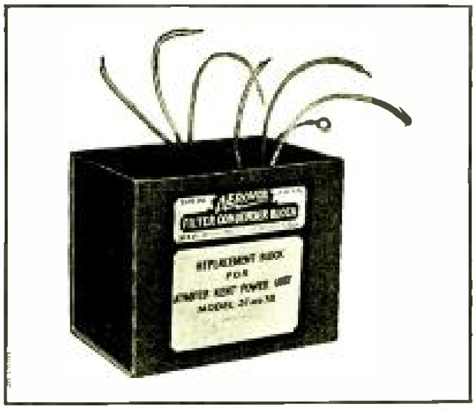
NEW REPLACEMENT CONDENSER BLOCKS

THERE have recently been announced replacement units for the Majestic "9-P-6" and "7B-P-6," and Atwater Kent models "37" and "38" power supply units.

The replacement unit for the Majestic "9-P-6" power supply consists of three 2-mf. sections of 400, 500 and 600 D.C. working voltages and 1-mf. section of 300 D.C. working voltage with a choke connected in series with the latter.

The replacement unit for the Majestic "7B-P-6" power supply consists of two 2-mf. sections of 300 and 600 D.C. working voltages, and two 3-mf. sections of 300 and 400 D.C. working voltages.

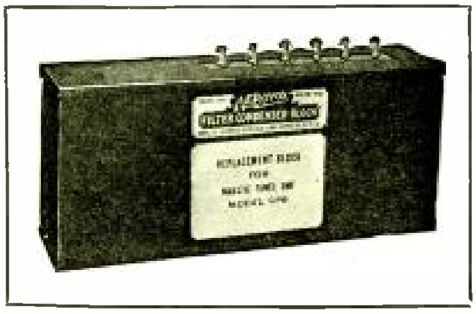
The condenser sections used in the construction of these blocks are non-inductively wound, thoroughly impregnated and dehydrated and use high grade materials. They are mounted in metal casings, fully sealed with moisture-proof filling compound and provided with convenient soldering terminals on an insulating strip through the top of the unit as shown.



Replacement unit for Atwater Kent Models 37 and 38 power units.

The replacement units for Atwater Kent models "37" and "38" power supply units consist of two .5-mf. sections, two 1-mf. sections, two filter chokes and a speaker choke. The condenser sections and chokes are mounted in heavy metal containers filled with sealing compound and provided with colored wire leads.

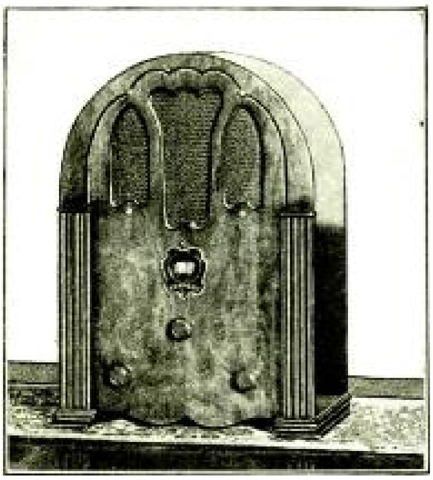
The above units are products of the Aerovox Wireless Corp.



Replacement unit for the Majestic Model 9-P-6 power supply. It consists of three 2-mf. sections and a 1-mf. section with a choke.

A 5-TUBE SUPERHETERODYNE

By the use of the "autodyne" principle of operation, it has been possible to produce a 5-tube superheterodyne, the Crosley "Litlfella," illustrated.

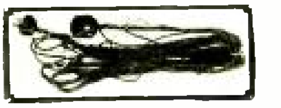


The Crosley "Litlfella."

A "QUICK-SERVICE" ANTENNA

THE "Tennacord" illustrated has been developed by the Holyoke Co., Inc., to meet the demand for simple antenna equipment suitable for modern, high-power receivers.

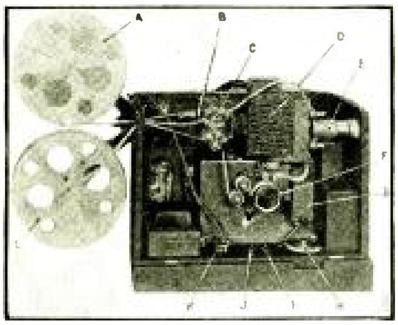
This device incorporates a 25-ft. "antenna" lead, 10 ft. of which is capacity-coupled to a light-line lead 10 ft. long (one end of which plugs into the power outlet, while the other receives radio set's plug); the remaining 15-ft. length is permitted to dangle conveniently as added pickup.

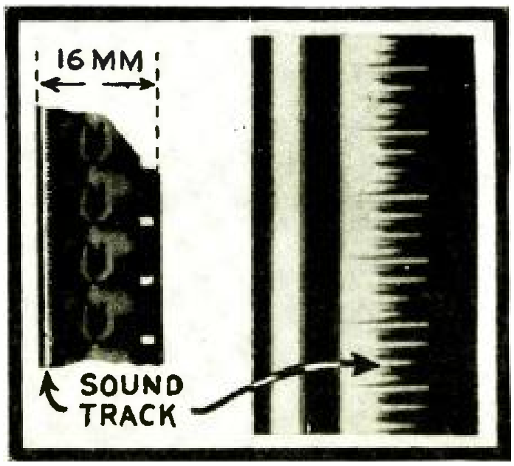


The antenna.

"SOUND-ON-FILM" HOME TALKIES

A PRODUCT of RCA Photophone, Inc., the 16 mm. Photophone Junior Portable now makes available for home, office and shop a complete little "theatre,"—and without recourse to the machinery required for turntable-and-disc operation. The equipment weighs 43 lbs.; it measures 14½ x 13½ x 8¼ ins.; it is complete with loudspeaker and 110 V., A.C. power equipment and is reproduced below.

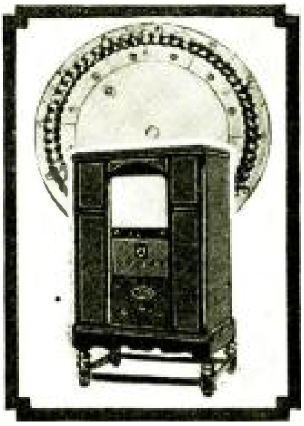


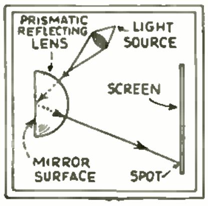


Above, A to L, feed reel, takeup, feed, proj. lamp, optical system, sound drum, exciter, proj. sw. and amp. vol. control, amp. sw., compensator sw., speaker plug, takeup reel. Right, normal size of 16 mm. film and enlarged sound track.

REFLECTOR-LENS TELEVISION

NEWEST in television is the "prismatic reflecting lens" system of television developed by William Hoyt Peck. Light, instead of going *through* the scanning disc, is reflected by the mirrored back of the lens and thence to the screen; the resulting focal length makes convenient, *in small depth* a picture 12 ins. square, or more. In the cabinet shown are the usual sound and sight units.





Above, Peck television receiver (and in back, enlarged view of inset prismatic reflecting lenses). Left, arrangement of the Peck optical system. Light from the neon crater lamp "light source" passes to the mirrored plane surface of the special lens.

NEW ELECTROLYTIC CONDENSERS

SMALL-SPACE electrolytic condensers now being manufactured by Dubilier Condenser Corp. are particularly suited to the requirements of high capacity and low impedance; and D.C. working voltages of 25 (available in units of 8, 10, and 20 mf.); 50 (4, 6, and 8 mf.), and 125 (10 and 15 mf.).

Metal-container type measures ¾ x 2-3/16 x 1¼ in.; cartridge type, 2¼ x 1 in. in diam. for 125 V. units, and 2¼ x ⅝-in. in diam. for the lower voltage units.

Above, Dubilier type, and, right can type of compact electrolytic condensers.

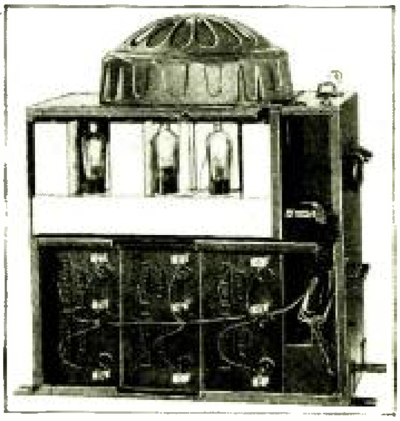
A LIGHT-OPERATED RELAY

AN inexpensive light-operated device is the new LuxTron supersensitive selenium cells and relay which operates from a 22½ volt current source. The manufacturer is Lux-Tron Devices Co.

The light operated relay.

POLICE RADIO SETS

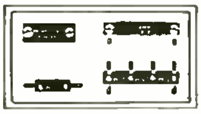
THE new types D-2175 (1712 kc. band) and D-2166 (2410 kc. band) Stromberg-Carlson Police Receivers illustrated below are manufactured by Stromberg-Carlson Tel. Mfg. Co. These superheterodynes incorporate A.V.C. and pentode A. F.



The Police Radio Set.

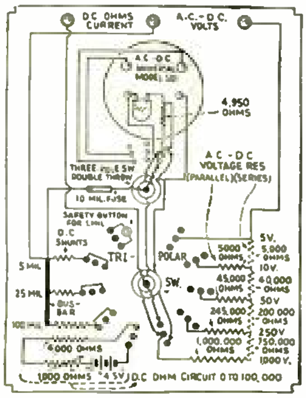
METER SHUNTS

SHUNTS of special alloy wire for multiplying meter readings are illustrated below. Manufacturer, D. L. Van Leuven. Circuits, and multi-scale dials for standard meters are available.



A schematic circuit of a "universal" meter is shown below.

Above, Van meter shunts; and right, measuring 100,000 ohms; 0-5, 0-25 and 0-100 ma.; and, 0-5, 0-10, 0-50, 0-250, and 0-1,000 volts.



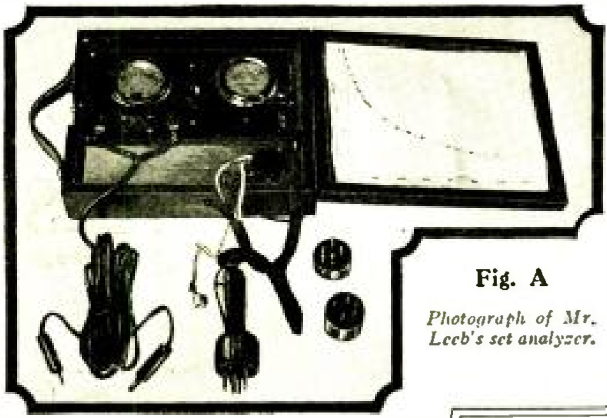


Fig. A

Photograph of Mr. Leeb's set analyzer.

Constructing a SIMPLE SET TESTER

By JOSEPH LEEB, E.E.

EMERSON once said, "If eyes were made for seeing, then beauty is its own excuse for being." This bit of philosophy can be applied to articles describing set analyzers as well as flowers. The test set illustrated in Fig. A was built because of its extreme compactness, simplicity and low cost, although it is not lacking in symmetry.

The size of the instrument panel is only 4¼ inches by 8 inches, while the outside dimensions of the carrying case are 8½ inches long by 6¾ inches wide by 2½ inches deep. A sewing machine tool box was pressed into service to house "the works." These boxes may be obtained for almost nothing at any sewing machine dealer's. If a box of this type cannot be obtained conveniently, any other case of suitable size may be substituted.

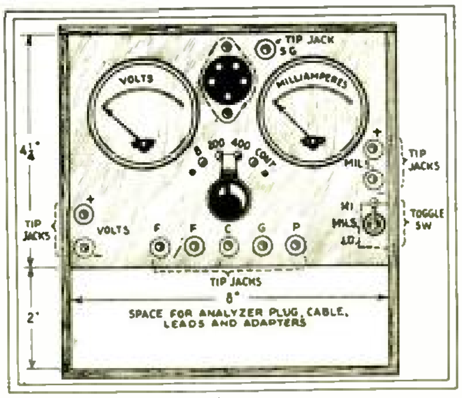


Fig. 1

Suggested panel layout for the tester. Miscellaneous material may be kept in the side compartment.

Description of Analyzer

Figure 1 shows the panel layout. As will be observed, only two meters are used; a D.C. voltmeter and a D.C. milliammeter. The A.C. voltmeter was purposely omitted, for two reasons. A third meter would add considerably to the bulk of the test kit, and is not used often enough to make it absolutely essential. The most important readings are obtained on the two D.C. instruments. If A.C. readings are desired, the Service Man can carry a separate portable meter in his tool kit.

A five-prong flush-mounted socket is placed as shown. The use of a four-prong adapter obviates the necessity for a four-prong socket on the panel, tending further toward conservation of panel space. Tip jacks are used for the tube-socket terminals, screen-grid clip, and external posts of the voltmeter and milliammeter. *This procedure brings all parts of the circuit right out on the panel, where the tests can be made directly.* Complicated switching arrangements are thus done away with.

The meters used in this tester are of the two-inch flush-mounting type. Weston Model 506 was the make selected. The voltmeter in this case had two scales, 0-8 and 0-200. A 0-400 scale was added by the inclusion of a multiplier in the circuit. The resistance of the multiplier is equal to the resistance of the meter at the 200-volt range, in this case 25,000 ohms. The milliammeter is a 15 ma. instrument with an additional shunt connected through a toggle switch for the 150 ma. range. The shunt is easily made by connecting the milliammeter in series with another milliammeter (of about 150 ma. range), a variable resistance, and a battery. Various lengths of resistance wire (from an old rheostat) are connected across the terminals of the 15 ma. meter until its reading (multiplied by 10) corresponds to the reading of the higher-range meter. When the proper length of wire has thus been determined experimentally, a piece of spaghetti tubing is slipped over it and lugs carefully soldered to the ends. We now have our shunt for the "HI" range of the meter. The toggle switch takes this shunt out of the circuit when the "LO" range is required.

Associated with the voltmeter circuit is a four-point selector switch for 8, 200, or 400 volts, or for continuity testing. Reference to the wiring diagram (Fig. 2) will show how this is accomplished. It will be noted that with the testing battery connected as shown, it is impossible to short-circuit it, should the switch happen to rest upon two adjacent points. The worst condition possible is a short through the two external multiplier resistances—49,000 ohms—which is not very serious. This condition occurs when the switch lever happens to rest upon the two right-hand points.

The handle of a round "stippling" brush, together with the base of a burnt-out '27 tube, serves admirably as an analyzer plug. One end of the cable connects to the socket prongs and the screen-grid cap on the side of the handle. The other ends of the wires go to the respective tip jacks on the panel.

A pair of flexible leads should be made with phone tips on one end and test prods on the other. The positive lead may be marked with some red thread or other device. For testing screen-grid tubes, a short lead is made with a phone tip at one end, a screen-grid clip at the other. The tip of this lead is plugged into the tip

(*Continued on page* 691)

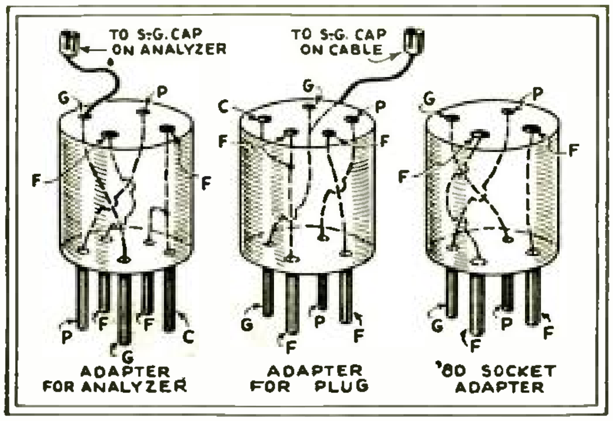


Fig. 3

At the left, an adapter for the plug-end of the analyzer cable; center, the adapter for the socket in the analyzer; and right, an adapter for testing '80 rectifiers.

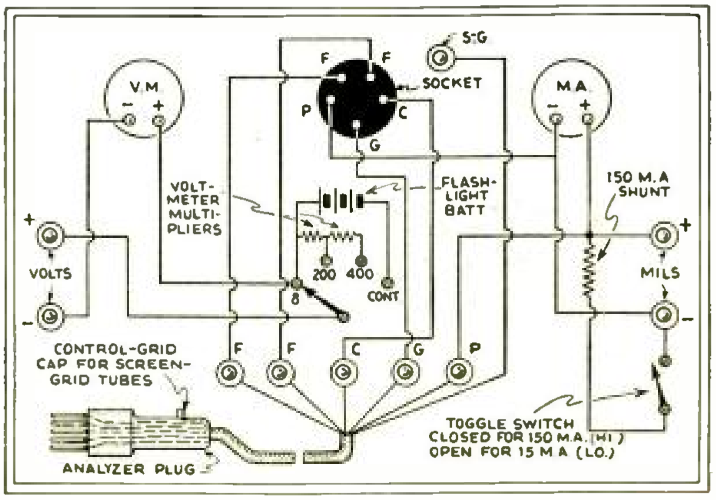


Fig. 2

Complete schematic diagram of the tester. Voltage measurements are made at the socket terminals of the analyzer by the voltmeter leads which are inserted in the left-hand terminals.

Table 2.

Fundamental frequency in c. p. s.	Harmonics 2nd leng. miles	3rd leng. miles	4th leng. miles
40	583	388	291
100	233	155	117
500	47	31	23
1000	23	15	11.5
2000	11.5	7.7	5.8
3000	7.8	5.2	3.9
4000	5.8	3.9	2.9
5000	4.7	3.1	2.3
6000	3.9	2.6	1.95
7000	3.3	2.2	1.66
8000	2.9	1.9	1.45
9000	2.6	1.7	1.3
10000	2.33	1.65	1.17

The Theory *and* Volume Controls, Matching

(PART

By

IN ANY well-designed voice transmission circuit, such as telephone lines, radio-broadcast speech equipment, public-address systems, "talkie" apparatus, etc., will be found resistance networks, or attenuators, more commonly called "pads." The proper use and design of these pads make for an efficient transmission system, from which the maximum output of energy with the least distortion may be obtained, and which, if these pads were not used, could not be realized. It can be said that pads find their way into practically every phase of voice transmission where quality reproduction is the prime requisite.

It is the purpose of this article to make clear the methods by which these pads are designed, to show their application in transmission circuits, and to discuss the problems encountered in transmission circuits where pads are used.

Purpose of Pads

In voice-transmission circuits, where energy is being transmitted over a line to a load located at the far end of the line, it is necessary that some means be employed to control the magnitude of the energy entering the load. It is for such purposes that pads are used. These networks are always used between a source of energy and a load. The source of energy might be any of the following:

(1) Output of a speech amplifier, such as a normally high-level amplifier which is feeding another amplifier located at a remote point;

(2) Output of a high-level amplifier (power amplifier);

(3) Output of a low-level amplifier, such as a condenser-microphone amplifier, which is feeding a speech amplifier located at some distant point;

(4) Output of microphone circuits, etc.: The load may consist of a transmission line carrying the energy and terminating in an impedance located at the far end of the line. This load impedance might consist of any of the following:

(a) Primary side of a line-matching transformer (line to line transformer);

(b) Input circuit of a speech amplifier;

(c) Loud speakers located at distant points from an amplifier;

(d) Mixing circuits, etc.

The attenuator imposes a constant impedance upon the transmission line, thereby controlling the level (magnitude) of the energy being transmitted into the far end of the line. The attenuator or "pad" maintains this level *by introducing a loss in energy between the source and the load,* at the same time causing no impedance misnatch to the impedances between which it is working (source impedance and load impedance).

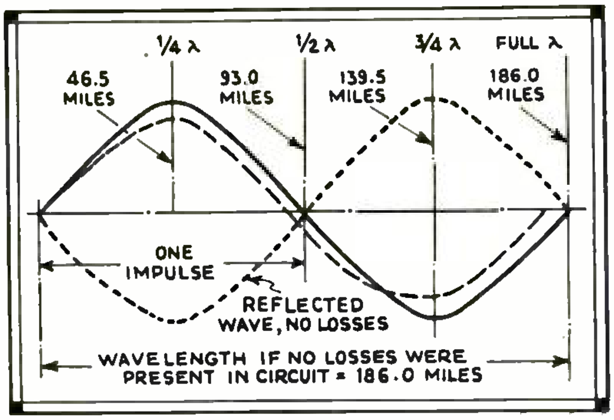


Fig. 4

Initial and reflected waves in a circuit with and without losses.

To illustrate the statements given in the preceding paragraphs, a typical case showing the use of such networks will be given. The complete design and calculation of the pads will be shown, and the problems arising in circuits in which these pads are used will be discussed. It is hoped that by obtaining a complete understanding of the subject matter given in these papers, any problems relating to the design and use of pads in voice transmission circuits will be materially lessened.

Let us assume we have a radio amplifier whose output voltage is 1.5 (effective value of alternating current). This voltage is to be fed over a transmission line, at the far end of which is located the primary side of an input transformer, whose secondary is in the input circuit of an amplifier (see Fig. 3). Let us also assume that it is also necessary to reduce the voltage impressed across the primary side of the transformer to approximately .15 volts (R.M.S.). It can be seen, therefore, that it is necessary to interpose a network of some sort between the input source of 1.5 volts and the primary side of the input transformer in order that the voltage will be reduced to the desired value, *at the same time introducing no impedance mismatch between the source and the load.*

In voice transmission circuits, this network is composed of non-reactive resistances so arranged that they will cause the desired loss between the input and output terminals of the pad. By "non-reactive" is meant resistances whose impedance remains practically constant to alternating current. This is accomplished by constructing the resistances so that their inductance and capacitance is negligible throughout the frequency band in which they function. (The construction of the resistances for use in the pads will be given in a forthcoming article).

For most purposes, this frequency band can be taken as the audio spectrum of 40 to 10,000 cycles per second. The resistances used in networks must be non-reactive in order that the attenuator maintain constant impedance characteristics throughout the audio band to the impedances between which it is working, so that straight line frequency attenuation will be obtained without frequency distortion in the transmission circuit, which would hinder the intelligibility of the signal.

The change in voltage between the source and the load is expressed as the *logarithmic* ratio between the two voltages. At this point a brief resumé on the transmission unit or *decibel* will be given, so that those not familiar with this unit will have a clear understanding of how it is used in transmission circuits.

In electrical circuits carrying energy which is either being amplified or attenuated, the question arises: What is the relationship between voltage, current, and power on the input side of an amplifier or an attenuator, to the voltage, current, and power on its output side? The engineer signifies this ratio between two voltages,

Construction of Line Filters *and* Transformers

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HY LEVY, B.S.

two currents, or two powers, by the number of *decibels change* taking place between the input and output terminals of the amplifier or the attenuator.

The Decibel

In any electrical circuit carrying energy, the product of the common logarithm *of the power ratio multiplied by ten*, or the product of the common logarithm of the *current or voltage ratios multiplied by twenty* determines the change in decibels.

As an example of this principle, let us assume that in a certain circuit the voltage has been decreased from 3.0 volts to 1.0 volt, or to one-third of its original value. Then from the definition as given above, the voltage ratio is 3 to 1, or 3. The common logarithm of three is 0.4771 (which may be obtained from a table of common logarithms). This means that 0.4771 is the power to which ten must be raised to give three. Then, multiplying 0.4771 by twenty, we get .9542 decibels change:

$$\text{i. e., decibels change} = 20 \log \frac{V_1}{V_2}$$

where V_1 = input voltage
and V_2 = output voltage

$$= 20 \log \frac{3.0}{1.0}$$
$$= 20 \log 3.0$$
$$= 20 \times 0.4771$$
$$\text{decibels change} = 9.542$$

The above simply means that if the voltage in the circuit has been decreased to one-third of its original value, we have caused a change of 9.542 units or decibels to have taken place. (See table in November, 1931 issue of RADIO CRAFT—*Editor.*) This change in decibels is expressed as a *loss*, as the voltage has been *decreased*. Similarly, if the voltage had been *increased* to three times its original value, the resultant change in decibels would also be 9.542, only in this case the result would a *gain*. Therefore, if the voltage has been increased or decreased to three times its original value, the resultant change in decibels is the same in both cases, or 9.542. The only difference in the two cases is in the method of expressing the results obtained.

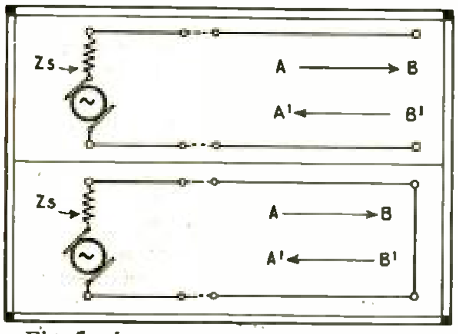

Fig. 5, above. *Open-end transmission line.*
Fig. 6, below. *"Shorted" transmission line.*

When using the formulae shown below, the change in decibels obtained depends on the type of circuit involved. In an amplifying circuit, the relationship between the voltage, current, or power ratios is expressed as a gain in decibels. In an attenuator, the relationship between the voltage, current, or power ratios is expressed as a loss in decibels. In the circuits to be taken up, attenuators (resistive networks) will be discussed, and a decrease in energy will be incurred between the terminals of the pad, and therefore all results will be given as a *loss* in decibels.

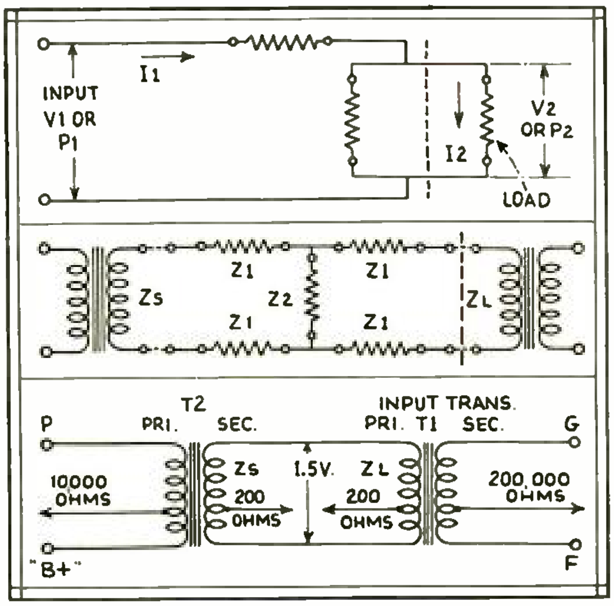

Fig. 1, above. *Circuit illustrating current distribution.*
Fig. 2, center. *Schematic diagram of an "H"-type pad.*
Fig. 3, below. *Impedance relations in a typical line.*

Thus by expressing current, voltage, and power ratios in decibels, one has an accurate description of the changes in energy taking place in the circuit.

From the definition of the decibel as given above, we can write the following formulae:

$$\text{Change in decibels} = 10 \log_{10} \frac{P_1}{P_2}$$
$$= 20 \log_{10} \frac{V_1}{V_2}$$
$$= 20 \log_{10} \frac{I_1}{I_2}$$

where P_1 = input power
P_2 = output power
V_1 = input voltage
V_2 = output voltage
I_1 = input current
I_2 = output current

This is shown in Fig. 1.

Also if we *know* the number of decibels change, and it is desired to determine the voltage, current, or power *ratios*, we can write:

$$\frac{P_1}{P_2} = \text{antilog} \frac{\text{change in decibels}}{10}$$
$$\frac{V_1}{V_2} = \text{antilog} \frac{\text{change in decibels}}{20}$$
$$\frac{I_1}{I_2} = \text{antilog} \frac{\text{change in decibels}}{20}$$

To illustrate this method, assume we wish to introduce a 15 decibel loss into the circuit, and it is desired to know what voltage ratio will give this loss. Then from above:

$$\frac{V_1}{V_2} = \text{antilog} \frac{\text{change in decibels}}{20}$$
$$\frac{V_1}{V_2} = \text{antilog} \frac{15}{20}$$
$$\frac{V_1}{V_2} = \text{antilog } .75$$
$$\frac{V_1}{V_2} = 5.62$$

which means that if the voltage ratio is equal to 5.62, a 15 decibel loss will be maintained in the circuit.

Returning now to our own problem, it was determined that a network is required to cause a loss in voltage between its terminals.

(*Continued on page 690*)

Table 1.

Fundamental frequency in c.p.s.	Length of circuit in miles to produce resonance
40	1165
100	466
500	93
1000	46
2000	23
3000	15.5
4000	11.6
5000	9.3
6000	7.8
7000	6.7
8000	5.8
9000	5.2
10000	4.7

USING Crater Lamps

Because crater lamps will undoubtedly displace the flat-plate neon lamp for television work, the author discusses their methods of connection.

By CLYDE FITCH

WHILE the following circuits were used with a crater-type neon lamp and a projection set using a concave mirror disk, it is quite possible that they could be used equally well with a flat-plate neon lamp and a pinhole disk. Therefore, they should be of interest to all television fans. Lacking definite electrical characteristics of the various lamps, such as A.C. and D.C. impedances which manufacturers fail to supply (lamps of the same make and type varying considerably), it is impossible to give exact data on the best circuit for a given lamp. The following circuits were tried by using ordinary radio parts such as will be found in the average experimenter's laboratory. While excellent results were obtained with some of them, improvements could still be made by proper design. For the present, the "cut and try" method will suffice; and any one who has patience is bound to obtain better reception.

We may start with the information generally supplied by the tube manufacturers. As a rule, parallel output tubes, such as two type '45's, are recommended as they more nearly match the impedance of the neon lamp. The lamp is then usually placed directly in the plate circuit, as in A, Fig. 1, and nature left to take its course.

A simple comparison between the lamp circuit for picture reception and a loud-speaker circuit for sound reception will show how ridiculous it is to expect good images from such a circuit. In the plate circuit of the tubes, both D.C. and A.C. (from the received signal) are flowing. When a loud-speaker is used, only the A.C. component produces a response; the D.C. is silent, and no matter how strong it is, no sound is produced. Furthermore, no matter how weak the A.C. is in proportion to the D.C., it produces an effect on the loud-speaker diaphragm and can be heard.

When a neon lamp is connected as in A of Fig. 1, the results are entirely different. In this case, the *direct current* as well as the *alternating current produces light*, which can be seen. Therefore, when the received signal is weak and the A.C. component small in comparison with the D.C. component, the light caused by the D.C. is so strong that the faint picture can hardly be seen. Only the strongest of stations can be tuned in properly. In other words, to obtain the best images, the lamp *must be 100 per cent modulated*. This means that we must have a method for controlling the amount of D.C. passing through the lamp so that it can be adjusted to be in the proper proportion to the A.C. signal.

Before trying any of these circuits, it is well to add a switch to the detector circuit for changing from positive to negative images; some of these circuits give negative images, and to obtain an accurate comparison of the various circuits the detector switch should be thrown to reverse the image. The simple method of reversing a transformer winding will not reverse the image. The best method is to connect the detector switch so that either grid-bias detection or grid-condenser-and-leak detection may be used.

Since the simple circuit at A is not satisfactory for general use and is only good when the incoming signal is very strong, we will discard this together with various versions of it employing combinations of series and parallel resistors, and look for something better.

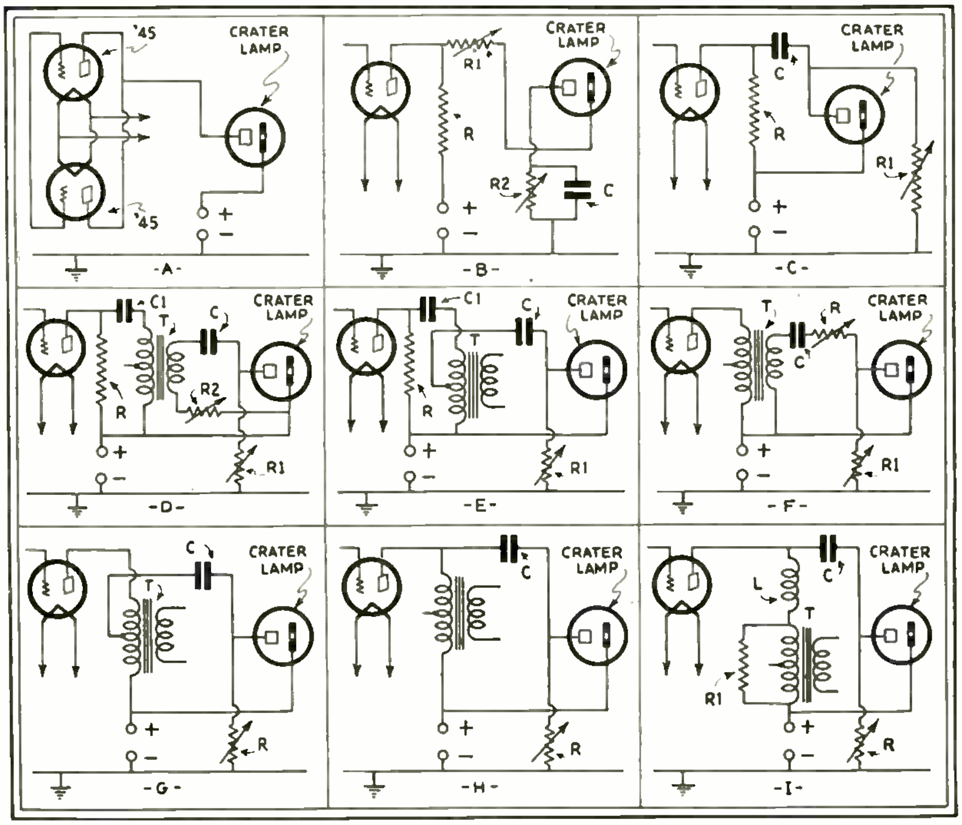

Fig. 1
Circuit diagrams of crater-lamp circuits. They are discussed in detail by Mr. Fitch.

Description of Circuits

We have shown that the circuit of A, Fig. 1, is only good for receiving very strong signals; weak images being blinded out by the intense light caused by the D.C. component of the plate current. Note that two output tubes connected in parallel are shown in this circuit. Two parallel output tubes are recommended in all of the following circuits but are left out of the illustrations for clearness.

Figure 1B shows one method of controlling the amount of D.C. flowing through the crater lamp. The resistor R is placed in the output circuit and should be of a value equal to the impedances of the output tubes (depending upon the type of tubes used) so as to give maximum power output. The crater lamp is connected between the plate and ground—the amount of D.C. passing through the crater being regulated by the variable resistor R2, which is shunted by the 1.mf. condenser C to allow for the passage of the alternating current. The resistor R1 may or may not be used. Its purpose is to increase the load impedance so as to more nearly match that of the resistance R. As a rule, the A.C. impedance of a crater tube is only a few hundred ohms, although its D.C. impedance may be a few thousand ohms. Resistor R1 may have a range of from 0 to 10,000 ohms and, once adjusted, may remain fixed. Resistor R2 may have a value of from 0 to 50,000 ohms and should be mounted on the front of the receiver panel so as to be accessible, as its adjustment varies with each

(*Continued on page 688*)

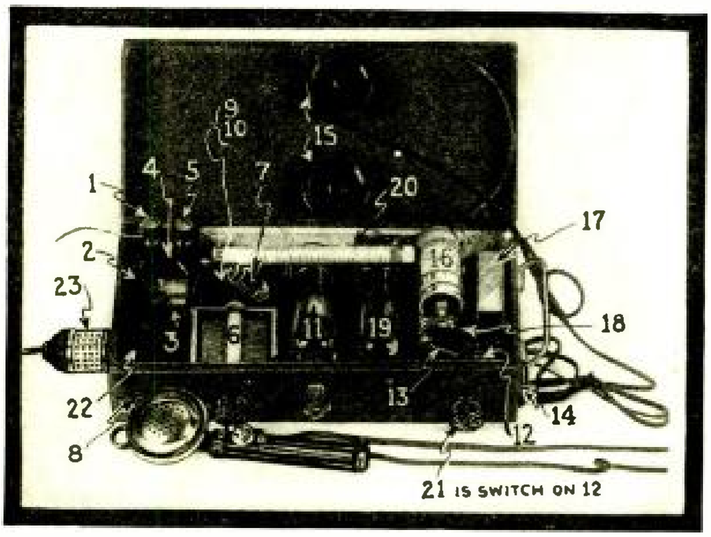

Fig. A
The numbers above correspond to those given in the diagram below.

The A.C.-D.C. "CASH BOX" *Receiver*

By H. G. CISIN, M.E.

HERE'S a little radio set that's a true "pal." This A.C.-D.C. portable is possibly the smallest, lightest power-operated portable in the world. It has surprising volume, is fairly selective and still, it fits into a case only a bit larger than a camera.

The portable, which is illustrated in Fig. A, makes a splendid traveling companion. It is also ideal for sick-bed use, for convalescents in hospitals, and for other shut-ins. It is admirably suited to the use of people who are hard of hearing. In fact, by plugging a microphone in terminals 8, it serves as an excellent "hearing aid" when not being used for radio reception. Those who like to listen to radio late at night can do so with this set, without disturbing the neighbors, or without even bothering anyone sleeping in the same room. Used in conjunction with a new type of short-wave converter (police adapter), this portable set will bring in exciting police messages and also other interesting programs and calls on the short-wave band between 80 and 200 meters. No change in wiring is necessary to use the S.W. adapter.

This versatile receiver may be plugged-in any place where electric lights are used, *regardless of whether the current is alternating or direct*. This universal feature adds to the desirability of the little receiver. Incidentally, this circuit, which is shown in Fig. 1, may also be made available for battery use, and hence for automotive work, with only a few small changes.

No aerial is necessary, although provision has been made for the use of one when distance-reception is desired. The circuit employed is ingeniously simple. In reality, the "Cash Box" receiver is essentially a one-tube set, since the second tube is used merely as a rectifier. The new Arcturus "M" filament, quick-heating, cathode-type 137A tubes are used. These are especially designed for interchangeable use on either A.C. or D.C. and they are the only tubes available for use in this circuit, which will give the desired degree of humless operation.

Discussion of Circuit

The filaments of both tubes are in series and a wire-wound resistor is also in series with the same circuit, so that the 115 volts supplied by the line is reduced to the 12.6 volts (6.3 volts per tube) required by the two tubes. The first tube 11 acts as a combination detector and amplifier. Tube 19 serves to rectify A.C. to D.C. for use on the plate of tube 11. Filtering is accomplished by means of the audio-choke 17, which is bypassed by the electrolytic condensers 16 and 18. A "conoid" antenna coupler is used at 3. A tickler coil has been added, not only to increase the distance range, but especially to improve the selectivity of the set, so that broad-tuning local stations may be separated through the use of the regeneration control. The tickler coil is wound on a small cardboard form and placed within the shielded case of the "conoid" coil. The secondary of this coil is tuned by means of a featherweight variable condenser. Conventional grid-leak detection is used, employing resistor. The small fixed condensers 2 and 4 serve to protect the tubes from short circuits through the ground connection to the power line. Condenser 7 isolates the metal box from the line, while condenser 13 helps to prevent hum.

An automatic line-voltage regulator constitutes an important feature in the design of this set. It protects tubes, 'phones and other components against damage due to voltage fluctuations and surges, thus prolonging the life of the tubes and stabilizing the operation of the set. It also acts as a fuse in the event of a short circuit.

Construction Details

In order to make the set as compact as possible, every available bit of space within the carrying case is utilized. Most of the parts are mounted on a wood strip which fits against the inside rear wall of the case. Before fastening the components on the board, variable condenser 6 and choke 17 are placed in the approximate positions they are to occupy. The board is then put against the rear wall of the case and the locations of coil 3 and of the two tube-sockets are noted. The coil must clear the condenser on one side and the socket must clear it on the other. The two electrolytic condensers are located, one above the other, between socket 19 and choke 17. The conoid coil, the tube sockets, and the electrolytic condensers are then mounted on the baseboard in their proper positions. The coil is mounted vertically by means of a small right-angle bracket fastened to its cover. Resistor 20 is next mounted on the baseboard as indicated. The grid condenser 9 and grid leak 10 are mounted on the board between the conoid coil and the socket. A composition binding-post strip, carrying posts 1 and 5, is fastened to the edge of the board, at the left, by means of three small wood screws.

Mounting holes are drilled in front of the carrying case at the left for the variable condenser, which rests on the bottom of the case. Holes are also drilled at the left front for mounting the twin jack 8. At the right front, a hole is drilled for mounting the Electrad combination regeneration control and switch. Holes are drilled at the right side for mounting the twin jack 14 and at the left side for the outlet 22. Holes are also drilled at the bottom of the case for fastening the choke 17, and at the back, for bolting the wood base securely to the case. All parts which mount on the case are then fastened in position.

It is preferable to start wiring

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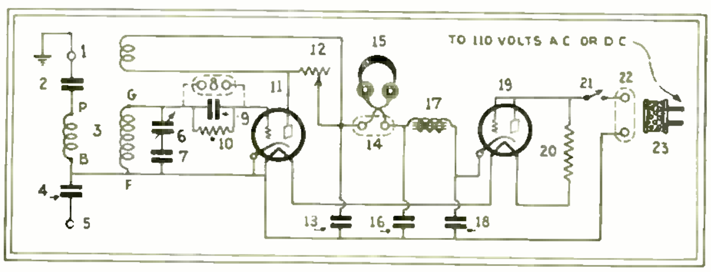
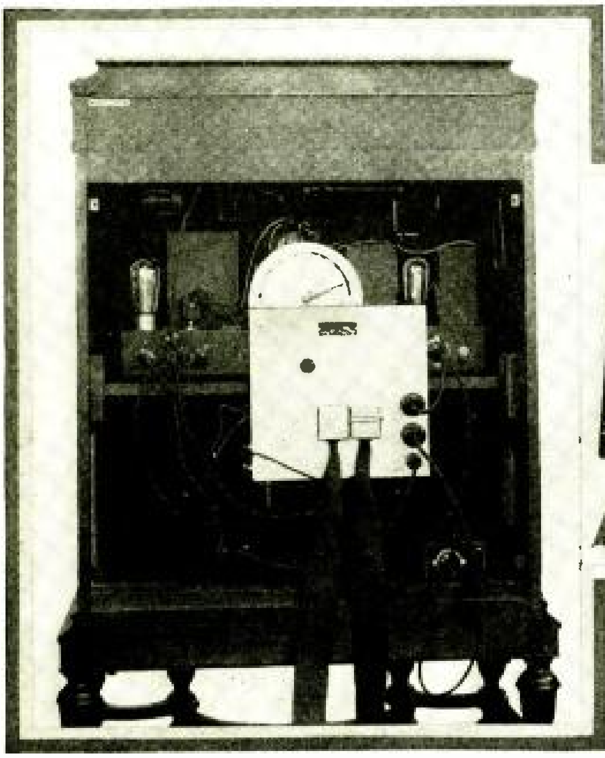


Fig. 1
Circuit diagram of the "Cash Box" receiver.

TELEKTOR—The Radio Robot



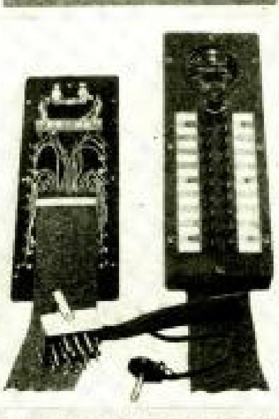
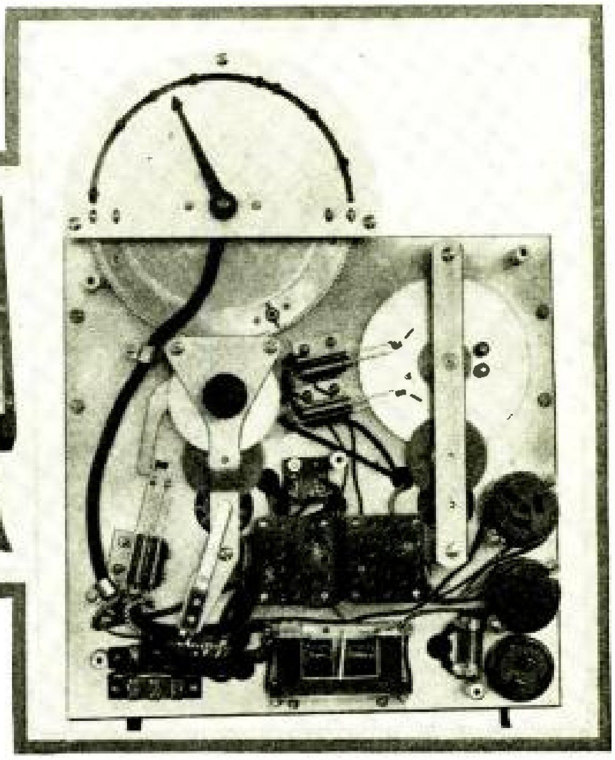


Fig. C. below. *The remote tuning box of the "Telektor."*



Figs. A and B, left and right. *The motor unit of the "Telektor" system.*

An interesting description of the manner in which "Stromberg-Carlson" obtains complete remote control operation of modern radio receivers.

BY the very nature of his existence, man is lazy. From time immemorial, he has continually striven to minimize his daily work. Our scientists call this type of advancement "progress," although the definition of the word "progress" is relative. Whether laziness is a desirable characteristic or not depends entirely upon the individual.

In the early days of radio broadcasting, a man would return from his daily labors, turn on his radio receiver, test his storage battery, turn three or four dials until a desirable station was tuned in, and then listen quietly to a conglomeration of noise which, at that time, was called music. However, we have "progressed;" there are few batteries in use today, and receivers have but a single dial, making the tuning-in of distant and local stations a relatively simple matter. But still man is not satisfied. He not only finds it desirable, but at times necessary, that he completely control the tuning and adjusting of his radio receiver from many convenient points distributed about his home. This latter refinement marks another step in the "progress" of radio.

The device to be described is manufactured by the Stromberg-Carlson Telephone Manufacturing Company, and although it is designed to work in conjunction with their own receivers, it may easily be applied to any other receiver having somewhat similar characteristics.

This device, called the "Telektor," consists of a combination of motors and relays mounted at the rear of a radio receiver, as indicated in Fig. A; a detailed view of the Telektor is shown in Fig. B. This Telektor motor unit may be removed from a receiver at any time without affecting the operation of the radio set. It must always be used with a "Telektor Box." When so used, it performs remote starting or stopping of the radio receiver, remote control of volume, and remote control of the tuning dial. Certain Telektor systems are also designed to control, in addition to the above, an automatic record-changing phonograph and four loud-speakers which may be used in a sound distributing system. As stated previously, each of the above may be controlled from any of the remote points selected.

As noted from the Telektor Box, illustrated in Fig. C, twenty push-buttons are available. Eight of these control relays and the remaining twelve control motors. The buttons that control relays need only be pressed for an instant, as the relays operate immediately the circuit is closed. These buttons are the six nearest the pilot lamp and the two at the bottom; that is, there are four speaker buttons, the radio button, the records button, and off and on buttons. (See Fig. C.)

Operation of the Telektor

The operation of these relay-controlled push-buttons is as follows: When the "ON" button is depressed, the system automatically connects to the A.C. line and is ready for operation. It should be remembered that pressing the "ON" button will also turn on any loud speaker in the system that is connected for use as a "Master" speaker. You may, of course, press the proper push-button to start any of the extension speakers you may care to use, provided none of them is connected at the time.

You will then hear a program of radio or phonograph music, depending upon whether the radio or records button was last pressed. If you are not sure whether you are hearing a program of records or radio music, then press the button for whatever type of entertainment you wish at the moment. The set, however, is usually installed in such a manner that all the extension speakers will turn off automatically whenever the "OFF" button is pressed, which, of course, turns off the radio receiver as well.

Thus, suppose it is desired to shift the program from one extension speaker to another. The sequence of operation is to press the "OFF" button. This turns off the speaker to which you have been listening and also turns off the radio receiver. Immediately press the "ON" button, and then press the button labeled for the particular speaker you wish to place in operation. This procedure is necessary because in certain installations all the extension speakers draw current from the A.C. line, and it is therefore necessary to disconnect this speaker from the line in order to

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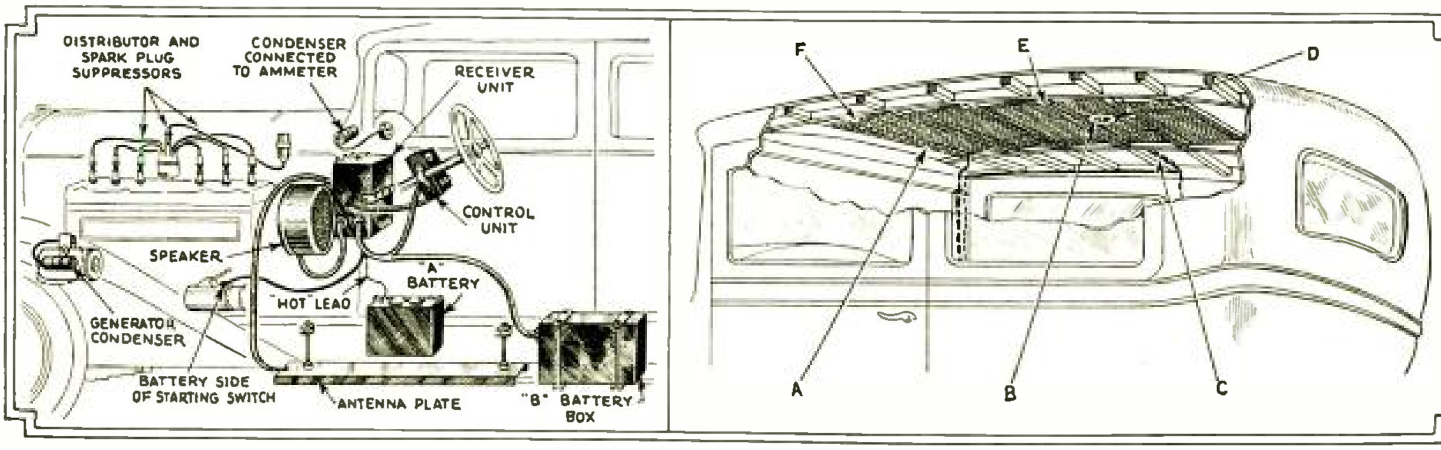


At the left is shown a typical car installation and at the right is shown a typical car antenna. At A are shown stagger tacks to permit listings on head lining, to be tacked over screen; at B, dome-light; at C, dome-light wiring; at D, a hole which is cut to clear the dome-light—the edges of the screen are soldered; at E, the antenna screen—use bright copper or bronze wire only; at F, edges of screen—they must be soldered.

CASH *in Automotive Radio*

Here's an analysis of a new field, right at your backdoor, where the grazing is very good now, and will get better as summer comes.

By ARTHUR H. LYNCH

JUST a few short years ago, a meeting of important radio manufacturers was called in New York City to consider the possibilities of making a profit from the sale of automobile radio receivers and accessories. That was before Crosley and National and Atwater Kent had given the subject any more than the most casual consideration. It was before Transitone was taken over by Philco and before the R.C.A., or any of the tube manufacturers, gave any consideration to the manufacture of special tubes, batteries, cables and the like, for automobile-receiver use. There was a live interest shown at that meeting; but there were plenty of misgivings, as there always are when anything off the beaten track of radio merchandising is up for consideration.

But the purpose of this article is not so much to review auto-radio's history as it is to indicate that there is a market for receivers of this nature right at this minute. It is increasing by leaps and bounds, and it is bringing an entirely new field of effort and profit into existence for the Service Man. Before you read another paragraph, may I suggest that you give the idea a bit of thought from this point of view.

Regardless of the size of your town, I'll wager that there are at least three automobile dealers in it. In all likelihood, two of them are kicking about business being poor, and they are the two who are doing nothing about it other than waiting for something to happen and for things to take a turn for the better. Have any of them ever thought of the idea of giving a good auto radio with every car? Did you ever talk this over with them? Business is to be had—plenty of it—if you will use your head for something in addition to making a satisfactory resting place for your hat. You may be interested to know what other fellows are doing along this very line. It may give you a hunch or two and enable you to rake in a lot of the loose "shekels" which are just waiting around for you. Furthermore, if you handle the job properly, it can be made of great advertising value to your regular service business.

Service Systematized

Unlike the ordinary type of radio business, auto-radio servicing does not begin after the receiver has been in operation some time and begins to require attention. Auto-radio service begins when the dealer makes the sale. The installation of an auto-radio receiver is no mean job. It is usually different for every make of car as well as for every different model of every make. It is not easy, except for the Service Man who specializes in it. For the man who does, there is a virgin field with much more than the ordinary amount of profit waiting.

Just think this over: At the last radio show in New York, the Chief Engineer of a very large company told me that his company made and sold about five thousand auto receivers this year—not counting short-wave receivers sold to various police departments—and the company is now working on a production schedule of five thousand a *week!* Even supposing it did not carry on that type of production for a long while, it is an indication of the business already at hand. When the meeting of manufacturers was held in New York there were only five makers of auto-radio receivers. Now there are more than sixty. At that time, there were no makers of special tubes for auto-radio use. Now there is not a single tube maker of any importance who does not include these tubes in his line. There were, at that time, practically no batteries made especially for this service, and the ordinary type of storage battery did not give a very suitable account of itself when the drain of several tubes was added to the drain caused by the starter and so forth. Nor did the "B" batteries, designed to sit quietly in some place or other until they were exhausted, perform too well when they were bounced over hundreds of miles of rough roads.

There arose a howl for service—and a new kind of service—which required a very fair knowledge of automobiles and their engines. Automobile companies were not too slow to realize the importance of auto radio—after some of them went so far as to suggest that the radio would be a menace to driving, only to have it proven to them that they were cutting off their noses to spite their faces. Then the manufacturers of receivers and tubes began to wake up to the fact that here was a market which they had been ignoring. Then some of them went into it blindfolded. Sales managers saw millions of dollars in it and sold the idea to their directors; and printers' ink and radio-advertising time were devoted to this new venture with more than ordinary prodigality. Then the kittens came home to the mama cat. There was weeping and gnashing of teeth. This was not true of all the auto-radio manufacturers, but there were very few exceptions.

Then it became recognized that systematized service was an absolute necessity, if auto radio was to give the customer satisfaction. And there are still a few receiver manufacturers who hold the opinion that it is good business to deliver a customer at least a portion of the claims made for their products. Where were the Service Men who could save the day for them? They were few and very, very hard to find; in most instances they have not been able to find half enough of them. In the final analysis, no auto-

(*Continued on page 693*)

The Service Man's Forum

Where His Findings May Benefit Other Radio Technicians

"RADIO SERVICE—CODE"

Editor, RADIO-CRAFT:

I have read with interest your article, "Radio Service and the Electric Code." Let me say that when a reliable radio set is sold and properly installed as a rule the Service Man's battle is over. I have seen quite a few "Handymen's" installations and the result was—numerous service calls!

Each state should require an examination of Service Men and, license the men who pass this test. It goes without saying that *a man must have good tools to do good work.*

A Service Man should refuse to make an installation which would not conform with the National Electric Code, simply because the customer wants a "cheap job."

What do you say fellows? Lets hear from you.

PAUL J. SHAFFER,
Terra Alta, W. Va.

RADIO-CRAFT AND THE SERVICE MAN

WE are in receipt of the following bit of interesting data from Mr. Omer Benson of Willis, Kan., and the illustration we reproduce in this issue.

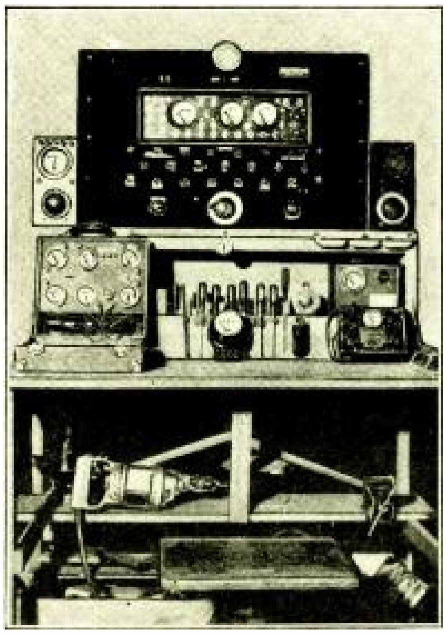
As can be seen by reference to the figure, the main part of our service bench is a Supreme 400-B Series N Diagnometer with Shop Test Panel; the other service instruments are built around this unit. To the right is a small panel, and a test oscillator; the small panel at the left is part of a direct-reading ohmmeter and output meter combined. It is built up with a Jewell 0-1. ma. milliammeter, using the scale published in the July, 1931 issue of RADIO-CRAFT (pg. 51) for the ohmmeter, together with a resistance and dry cell to give full-scale readings. This scale matches the other meter scales so closely that it is almost impossible to tell that it has been replaced with the new paper one. This makes an ohmmeter always ready for use without disturbing the Diagnometer and without disconnecting the radio receiver under test from the light socket.

The output meter has an audio transformer and fixed crystal to rectify the output current of a radio set, and a variable resistor to vary the needle reading; it also has large fixed condensers in the circuit to protect the meter.

Other instruments on the bench are set analyzers, tube testers, etc., for portable use.

On another work bench not shown in the picture is a stand for the electric drill, together with a buffing wheel, grinding wheel, and special tools for holding the work.

I live in a small town but have a large amount of service work brought in as I have been in this field since the start of broadcasting. I have every copy of RADIO-CRAFT on file, from Vol. 1, No. 1, *and they are not for sale!* Of course, I have my copy of the *Official Radio Service Manual;* I



could not do without it.

We are of the opinion that a better job can be done at less cost and in less time at the shop than it can at the customer's location; consequently, we believe that it is only a matter of time until nearly all radio repair work is done in well-equipped service shops.

BIG BUSINESS IN TOONERVILLE TOWNS

Editor, RADIO-CRAFT:

I read with interest Ralph J. Whitter's letter in December RADIO-CRAFT and I agree with him that there do not seem to be very many letters from Service Men in small towns and cities.

I am located in a small "town" of about 700 population. Within 10 miles there are seven other towns of about the same population as the one I work in. I also maintain an office in a village of 4000 people, 15 miles away. I have worked in this territory for about eight years and I would advise Mr. Whitter not to get discouraged with his first two months business. Better try it for about 1½ years before making any decisions. *I have found that there are more jobs and profit in small towns than in large cities,* also that one can give lower prices due to lower overhead.

In order to get business in small towns, it is necessary to advertise. I cover all my territory at least every two months with different forms of advertising. Most of my copy is the result of reading other service concerns' advertising and arranging to suit my needs.

Consistent advertising plus good work will bring all the work you want. It will take time, of course, but you will get it.

Most small cities and towns have their local newspapers. A single column, one-inch ad is usually enough, for it keeps your name before the publics' eye just as well as a larger one.

Let's hear from some other "small city" men now and see what they have to say.

FREDERICK E. BARBER,
Camillus, N. Y.

(Due to Mr. Barber's frankness, we are able to find out *why* he has been able to make his radio business pay, even though he lives "in the sticks." He studies the publicity and advertising material of foremost organizations, and applies the best parts of each to his particular requirements.—*Technical Editor.*)

A "GROUND-ANTENNA" IN THE MOJAVE DESERT

Editor, RADIO-CRAFT:

We would be very glad to hear from any Service Man or technician who may have experienced the peculiar difficulty which we find in our locality—an increase of signal strength when we connect aerial and ground to the *ground and antenna posts, respectively!*

We have found that in 85% of our installations this is true.

You will understand that we are located in the center of the Mojave Desert. The summers are very hot—with no rain and lots of static; the winters have quite a bit of rain, no snow, and the temperature seldom goes below freezing. Altitude, 485 feet, and mountains on all sides, ten to fifty miles away; very sandy soil.

We have been building and servicing sets in this town for eight years. Have had good reception as far north as Regina, Sask.; south to Cuba, and, east to New York and Atlantic City. We might add that we never experienced the above trouble with a battery set.

We have a rather small power plant here, generating 2200 volts; poor voltage regulation, and considerable disturbance at times due to leaky insulators and other troubles too numerous to mention. Santa Fe telegraph causes lots of disturbance, due to radiation from points on their repeaters.

In connection with the above question, we might add, we recently built an aerial for a customer owning a Crosley "Band Box" which we overhauled for him, giving him daylight reception (which he never before had experienced), using the ground only, on the aerial post. He was very much pleased and wanted us to build an aerial immediately. We built him an aerial as follows: Forty-foot poles built from 2 x 3 inch pine lumber and then painted. One pole is located directly at the window where the set is; the other, on the back of the lot. The aerial wire is seven-strand, enameled, with no joints between the distant end and the

(*Continued on page 696*)

SHORT CUTS in *RADIO SERVICE*

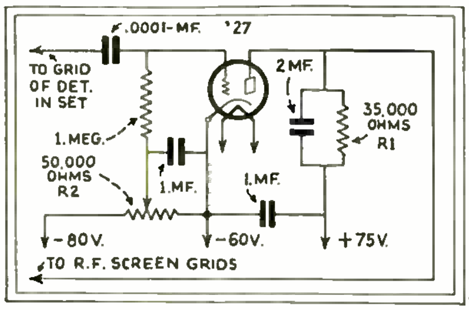


Fig. 1

(PRIZE AWARD)
AN AUTOMATIC VOLUME-CONTROL FOR SCREEN-GRID TUBES

By Wm. Hryzink

A SIMPLE automatic-volume-control arrangement which can be used in existing receivers employing '24 type screen-grid tubes is shown at Fig. 1. This employs a '27 type tube whose function it is to automatically vary the screen-grid voltage applied to the '24 type tubes used in the R.F. amplifier.

It is connected to the receiver by simply breaking the screen-grid voltage supply lead at the R.F. tubes and connecting the wire, as shown in Fig. 1, instead. The top wire is tapped on the grid of the detector tube.

In order to control the volume properly, the screen-grid potential must be made variable over a considerable range. Manual variation under this system is achieved by adjusting the bias of the volume-control tube by means of the 50,000 ohm potentiometer R2 provided. The plate current passing through the resistance R1 in the plate circuit provides the necessary drop to vary the voltage over the required range.

The voltage on the screen-grids, and in consequence the volume, is thereby reduced. A signal applied to the grid of the control tube reduces the bias and consequently increases the plate current, providing an automatic decrease in gain. The constants of the circuit must be so proportioned as to function rapidly, but the electrical inertia must still be great enough to avoid any possibility of "swamping out" low-frequency modulation, as these are slow changes in the amplitude of the signal.

Since the volume-control tube must have its plate at the same potential as the screen-grids of the R.F. amplifier, it is necessary, in order to obtain the correct plate voltage on the '27 volume-control tube, to take off voltage taps at -60 and -80 volts on the power-supply unit. This puts a potential of approximately 135 volts on the plate with respect to the cathode.

$10 FOR PRIZE SERVICE WRINKLE

Previous experience has indicated that many Service Men, during their daily work, have run across some very excellent Wrinkles, which would be of great interest to their fellow Service Men.

As an incentive toward obtaining information of this type, RADIO-CRAFT will pay $10.00 to the Service Man submitting the best all-around Radio Service Wrinkle each month. All checks are mailed upon publication.

The judges are the editors of RADIO-CRAFT, and their decisions are final. No unused manuscripts can be returned.

Follow these simple rules: Write, or preferably type, on one side of the sheet, giving a clear description of the best Radio Service Wrinkle you know of. Simple sketches in free-hand are satisfactory, as long as they explain the idea. You may send in as many Wrinkles as you please. Everyone is eligible for the prize except employees of RADIO-CRAFT and their families.

The contest closes the 15th of every month, by which time all the Wrinkles must be received for the next month.

Send all contributions to the Editor, Service Wrinkles, c-o RADIO-CRAFT, 98 Park Place, New York City.

CHANGING THE PHILCO MODEL 511 TO OPERATE A DYNAMIC SPEAKER

By C. E. Tinney

THE speaker I had on hand for this job was an Oxford with an eight-inch cone. It was equipped with an input transformer to use the '71 type tube and a 2,500 ohm field. For the field circuit, I used the field coil in place of the choke marked CH.1 in the diagram of Fig. 2. The resistance of this choke is far less than that of the field coil, so I was forced to remove the choke winding from its iron core, and use it as the field coil of the speaker. The removal is simple, but the choke is wound on a square core and the field coil on a round core.

After heating the coil in the oven for several minutes, I was able to work its shape somewhat round. While the coil was still warm, and after removing some of the cardboard form from the inside, I was able to slip the choke winding coil over the core of the speaker field. This is somewhat difficult to do, and my advice to any one would be to measure the resistance of the choke with an ohmmeter, and order a speaker with a field resistance as near to this as possible. As my diagram shows, the set is built with an output choke to protect the magnetic speaker from the heavy plate voltage. This must be removed as well as the bypass condenser C1 which is used with it. The primary side of the input transformer on the dynamic speaker is used in the place of this arrangement.

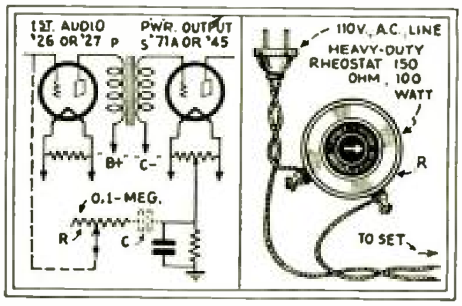


Fig. 3

If you conduct grid-bias tests on this set, you will find that there is no negative bias on the '71 tube. Thus, the receiver has distortion which the magnetic speaker did not reproduce; but which the dynamic speaker, being more sensitive, will emphasize.

I therefore inserted a 2,000 ohm one-watt resistor in series with the lead from the center tap of the '71 filament winding on the transformer. This gives nearly 40 volts negative on the grid and clears up the output considerably.

After all this is done one will find that the tone is far too brilliant to be pleasing. So I connected a .002-mf. bypass condenser between the grid of the '71 tube and ground. The corrected diagram is shown at the right of Fig. 2.

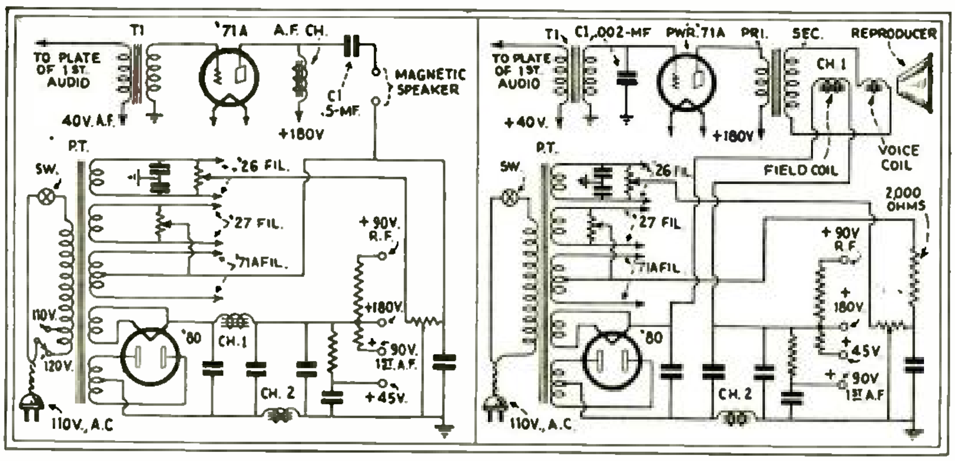


Fig. 2

A SUCCESSFUL HUM FILTER

By Elden L. Cherry

IN the older types of electric sets, a certain amount of hum was considered more or less of a necessary evil, and even in sets of comparatively recent production, the A.C. is often quite noticeable. The owner of such a set is likely to become more critical on this point after hearing some of the cur-

(*Continued on page 697*)

Operating Notes

The Analysis of Radio Receiver Symptoms

By D. C. McCALL

Sparton 210

I HAVE caught up with all outside jobs, but have plenty to do in the shop. The first machine to draw my attention was a Model 210 Sparton Midget, which performed well until it had heated thoroughly, and then it broke into oscillation. The usual check of voltages and a new set of tubes failed to show anything wrong. I then checked the resistor values with the set "cold" and also after it had thoroughly

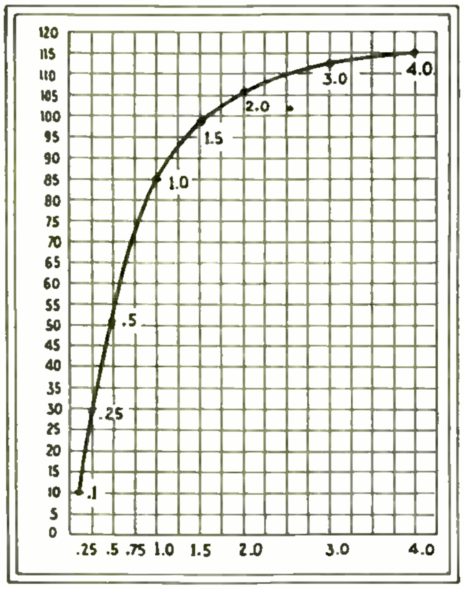


Fig. 1
Calibration curve of the A.C. voltmeter used in the Jewell 199 set tester for capacity measurements.

heated. Frequently resistors change values considerably after heating, and the voltage rises surprisingly. However, this set uses wire wound resistors of good quality that did not change appreciably.

Finally I checked the bypass condensers for open circuit, but they all gave a deflection on a D.C. meter. Then I began to add more capacity to the various points. The oscillation stopped immediately when a tenth microfarad condenser was placed so as to bypass the cathode bias resistor to ground. Although there was already a condenser in this position, evidently it was not quite sufficient and the set would break into oscillation on strong signals.

This experience taught me the value of having some method of measuring capacity so I determined to calibrate my A.C. voltmeter (Jewel pattern 199) for values commonly used in filter and bypass condensers. I measured the line voltage first and found it to be 118 volts. Then I took a number of condensers of known value and read the voltage with a condenser in series with the meter. The following values were obtained:

4 mf.	115 volts
3 mf.	112 volts
2 mf.	106 volts
1.5 mf.	98 volts
1.0 mf.	85 volts
.5 mf.	50 volts
.25 mf.	30 volts
.1 mf.	10 volts

These values were plotted on graph paper and the curve drawn with the aid of a French curve. (Both the graph paper and the French curve can be obtained at most five-and-ten stores). See Fig. 1.

In the future when I have a set that is erratic and oscillates at irregular intervals, the first thing I shall check will be the bypass condenser values. (R.F. bias resistors and plate leads should have capacity bypasses of .1- to .25-mf. and screen-grid leads .5- to 2 mf.).

Majestic 20

The next set needing attention was a Model 20 Majestic. This set had a short in the plate circuit of the R.F. end. By the process of elimination this short was found in the second I.F. transformer. This transformer may be removed and replaced without taking off the bottom of this set entirely, which saves quite a bit of time, as much of the power pack, etc., is fastened to the bottom plate of the chassis. Simply remove the end section near this transformer and loosen the drive screws in the bottom section so that it may be pulled open a little. Take out the two screws holding the transformer and unsolder the four leads.

Invariably I have traced the short in this unit to the .1-mf. condenser bypassing the plate lead. To repair this unit cut the rivets holding the I.F. unit in the metal can and pull the leads out of the holes in the can. Carefully warm this can until the wax softens; then the assembly may be lifted out. The shorted condenser can then be cut out and a midget type bypass put in its place or it may be left out of the can and a larger size condenser put outside the can and under the chassis. Then the set is aligned with a 175 kc. oscillator.

Clarion Midget Model 40

The third number coming up for attention was a Clarion Model 40 Midget. This set behaved erratically when the volume control was moved. (Since then I have had several of this model with bad volume controls and they all seem to be affected differently according to what defect was in this unit. Hence it is well to check this unit when servicing this model.) This control is rated at 4,100 ohms and is used as a part of the voltage divider. The potentiometer arm is used to vary the bias on the grids of the variable-mu tubes. In substituting here it is well to use a value of resistance as close as possible to the value mentioned, but 5,000 ohms can be used. I found it a good idea to put a small resistor (100-200 ohms) between this unit and ground so that the voltage applied to the grids never goes to zero. See Fig. 2.

Audiola Jr.

The next "pain in the neck," was caused by an Audiola Jr. which failed to function at all. The circuit in this set is the prize puzzler of the past season, namely, direct-coupled. The resistors in this set have given me plenty of trouble and the first thing to check in this model is these resistors. In Fig. 3 a pictorial drawing shows the location of the different resistors and their value. In different sets I have found defective resistors of each value, but the one that goes bad most frequently is the 400-ohm section on the black unit. Notice the 50,000 ohm tap (green) used as a series resistor for the R.F. screens. I have cured several complaints of the set "having no pep and no volume" by cutting this resistor out and substituting one of lower value, thereby raising the screen-grid voltage.

Apex Midget

The last one on the bench is an Apex midget of the 26P series. Many complaints have been registered by customers about the volume control "jumping" from loud to soft or vice-versa. I determined to locate this trouble and brought this set to the shop for that purpose. All tests and visual examination show these units in good shape but they do justify a complaint that their regulation of volume is not smooth. So with

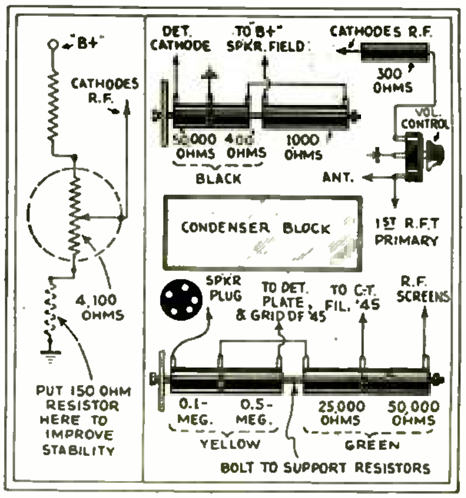


Fig. 2, left. *Diagram showing location of additional 150 ohm resistor.*
Fig. 3, right. *Diagram showing the location of the resistors in the Audiola Jr. receiver.*

a strong magnifying glass and a strong light on the unit I proceeded to play the set and watch what happened. Suddenly I found the explanation!

This volume control was wire-wound with a spring slider that made contact on the inside of the resistance circle. The magnifying glass showed that as the slider pushed around the resistance strip the turns of wire were loose and the slider pushed a number of turns together. This continual movement had worn out the enamel insulation between turns and the result was that as the slider pushed around it forced a number of turns together and shorted out an appreciably large amount of resistance suddenly. Replacement of this type with one having a carbon strip and smooth acting contact relieved this complaint. This volume control is rated at 8,000 ohms.

So finished a typical day in the shop.

ZENITH MODEL 52
By Joseph Leeb

THE writer was recently confronted with the problem of removing hum from a Zenith Model 52 radio. After checking the set over, it was decided that the cause of the trouble was in the electrolytic filter condenser. With the set turned on, each terminal of the condenser was momentarily shorted to the chassis by means of a metal screw driver. This procedure completely removed the hum. The same method was tried on sets of various other makes, with great success.

PHILCO MODEL 112X
By Joseph Reily

A FEW of the early production of the model 112X Philco receivers had an input transformer with the letter "A" after the part number on the terminal board. These transformers should have a .0008-mf. condenser connected across the entire secondary. Later production models have the input transformer without the letter "A." These should be equipped with a 49,000 ohm resistor across the secondary.

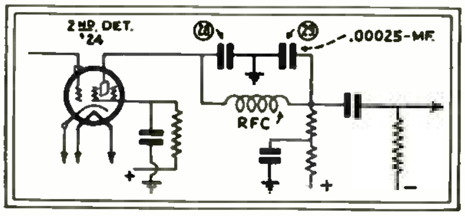


Fig. 5
The .00025-mf. condenser in the detector circuit causing the howl.

On some of the first production model 112X receivers, the wires from the plates of the pentodes to the two lower terminals of the speaker socket in the chassis were wired as shown dotted in Fig. 4. This "dressing" tends to produce a high pitched whistle if the tubes are slightly unbalanced. This condition is readily eliminated, however, by changing the dressing of the wires as shown by the full lines in the same figure. All new production models are now wired in the same manner. If it is found necessary to make this change, be sure that the polarity of the wires after reconnection is the same as before. In present production, red and black wires are used, but in earlier models two red wires were used.

In some few cases in this model receiver, a slight whistle may be heard. This may be eliminated by moving the two plate wires away from the compensating condenser.

CROSLEY MODELS
By R. P. Haviland

IN most of the Crosley models, the various filament center-tap resistors are arranged in tiers. In damp weather these strips sometimes buckle, producing a short that causes a bad hum.

Many sets have the volume control connected as a potentiometer from B+ R.F. to ground. Carbon-strip resistors in this position soon become noisy. Only wire-wound resistors should be used.

Some sets have the chassis built in two parts. A faulty connection between these two parts will cause the set to stop operating.

When reproduction from phonograph pickups becomes bad, it is probable that the damping rubbers between the armature and the pole pieces have become hard. Replacing these with new rubber dampers will better the quality.

CROSLEY MODEL 124
By James R. Garcia

IN servicing the new Crosley Model 124 receivers, considerable trouble has been encountered with the "biasing" of these new sets; the trouble usually showing up after 30 to 90 days of operation with high control-grid bias on the R.F. and I.F. tubes.

The biasing of all tubes, excepting the pentodes, is accomplished by resistors in the emitter circuits. The pentodes obtain their bias by returning their grids through the ground to a flexible resistor which connects to their filament center taps. The volume control varies the biasing resistance in the emitter circuits of the R.F. and I.F. amplifier tubes and also varies the resistance between antenna and ground.

The correct control-grid voltages on the R.F. and I.F. stages is 1.5 to 2.5 volts negative. Various 1/4-watt resistors are used in these sets and it seems their value varies slightly after being placed in service. To overcome this, and also to "pep-up" these receivers, place a 400 to 750 ohm resistor on the volume control to ground, placing it on the opposite contact arm from the antenna and first R.F. coil.

Check all quarter-watt resistors very carefully, as they are a continual source of trouble. When touching the antenna post with the aerial lead and plenty of loud "clicks" are going through the speaker, and yet there is no reception, check your 2000 ohm flexible resistor across the oscillator-tube cathode to ground, as this is the usual trouble, being open.

PHILCO MODEL 70
By R. L. Young

WHEN the tone control on a Philco Model 70 receiver is turned to the right-hand position, that is, the modified tone position, the set will function properly; but, when turned to the left-hand position, the set will have a distorted tone something like a loud howl or a microphonic noise. In most instances, this noise will be noticeable even when the set is not tuned on a station. At first thought, the tone control was suspected, but glancing at the diagram, it can be seen that when the tone control is turned to the left-hand position, *it is not connected in the circuit.*

Referring to the diagram of Fig. 5, it can be seen that there is a phone condenser of .00025-mf.-capacity, identified by having a *yellow dot* on one side, connected to the plate lead of the second-detector next to the choke coil. Should this condenser become open or change in capacity, the above mentioned trouble will be noticeable in the receiver. Therefore, replacing this condenser with one having the correct value will remedy the trouble.

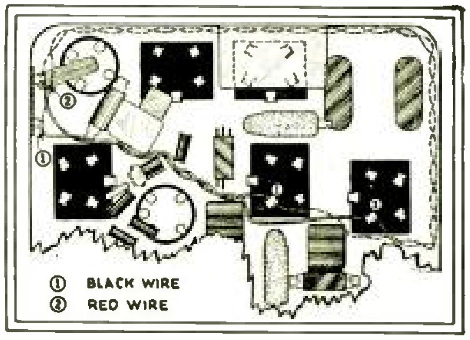


Fig. 4
Suggested changes in wiring of the Philco Model 112X.

CROSLEY "BUDDY" AND "CHUM" MODELS
By Lloyd R. Brown

IN the Crosley "Buddy" and "Chum" receivers, the 10,000 ohm wire-wound resistor that furnishes voltage to the screens and R.F. plates may register continuity and still be open, if you make the test with a meter and battery.

If time is valuable, a 10,000 ohm carbon resistor can be shunted across the present wire-wound unit without taking the old one out, as it is braided to the chassis. But shunting a resistor across another is not to be practiced, unless the open one is certain never to make contact again while the receiver is in operation.

Brunswick A.C.-10—Columbia C-31

THE Brunswick A.C.-10 and Columbia C-31 are midget receivers of the same design, but placed in different cabinets. If you have a call on one of these receivers, and after taking analyzer readings no fault is revealed, but when the set is in operation you get just faint reception, you can look to the speaker for the trouble. A good way to tell where the speaker is defective is to remove it from the cabinet and, with the receiver in operation, press lightly on the cone with the fingers. If reception becomes normal, there is an open in the voice coil. This coil can be repaired, but extreme care must be used, since both the field coil and cone are braided to the speaker case.

It will be necessary to take a cold chisel and hammer, and knock off the braids holding the cone; which may then be repaired.

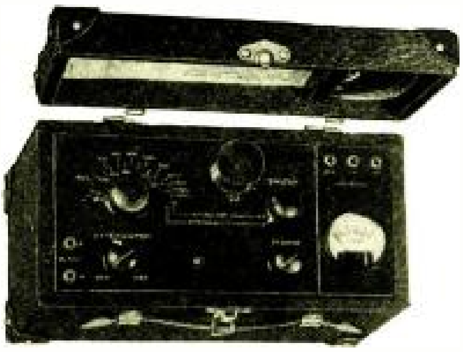


Fig. A
The Readrite No. 550 Service Oscillator.

SERVICING MODERN "SUPERS"

In masterly fashion the author takes his readers through a series of tests representing actual conditions encountered by radio Service Men

By H. G. CISIN, M.E.

THE rapid march of progress in radio receiver design, calls for constant study on the part of the radio Service Man. Having mastered the technique of servicing the tuned-radio-frequency receiver, he finds himself facing newer and more difficult problems in connection with superheterodynes.

A receiver of this type that needs balancing and readjustment will lack selectivity; it will not bring in the distant stations that it should; and its dial readings in kilocycles are generally off more than 20 k.c. Quite often, there will be squealing and howling on certain sections of the dial, indicating that adjustments are necessary. Weak reception and poor selectivity at the high-frequency end of the dial, indicate incorrect adjustment of the oscillator "high-frequency trimmer"; at the low end of the dial, the need for "low-frequency trimmer" adjustment. It is useless to attempt to readjust a superheterodyne without correctly designed, accurate equipment.

Fortunately, the modern Service Man has at his disposal up-to-date, versatile test instruments, capable of handling any type of receiver no matter how complicated or advanced in design.

Those who have never used the modern equipment now available for this purpose will be amazed at its utter simplicity and at the ease with which all necessary readings and adjustments may be made. In performing the tests outlined in this article, using one of the new Readrite No. 550 audio-modulated R.F. oscillators (with panel output-meter), it was found possible to realign all the tuned circuits of a 9-tube Philco superhet. in but seven minutes,—from start to finish, including the removal and replacement of the chassis.

The tuning control of this service oscillator operates over two separate scales, which results both in wide divisions, and in accuracy. One scale is provided for the broadcast range, 550 to 1500 kc.; the other scale, for the I.F. band, 120 to 175 kc. Other intermediates, such as 260 kc., 262 kc., etc., are obtained by using the second-harmonic; and 475 kc. (for "all-wave" superheterodynes) is obtained by means of the third-harmonic. These harmonics give just as sharp signals, in this instrument, as the fundamentals. When testing 260 kc., using the I.F. band, the service oscillator selector switch is set at the "intermediate" reading of 130, resulting in a sharp second-harmonic signal.

Re-calibrating the Oscillator

To *re-calibrate* the No. 550 service oscillator, a procedure that may at times become necessary (due to mechanical jars, etc.), set its selector switch to the "broadcast" position, and tune to the wavelength of a signal from a crystal-controlled station previously selected on the radio receiver. If the reading of the oscillator dial does *not* check with the known figure for the station, make corrections on the auxiliary scale which is furnished especially for such comparison purposes. Proceed with other stations and settings of the oscillator, making notations of any changes. Should there be any appreciable changes in the broadcast range, it may be possible to determine the *cause* by comparing the hand-drawn scale with the one on the oscillator. (If the control knob has moved slightly on the shaft, this can be determined readily by comparing the hand-drawn and oscillator scales.)

After finding the correct calibration for the *broadcast* band, proceed to adjust the service oscillator's trimmer-condenser for the *intermediate* frequencies.

The first step is to select, on the radio set, a broadcast station of known frequency,—say, 700 kc. Next, turn the service oscillator selector switch to the "intermediate" position and again prepare to adjust its trimmer condenser.

With the radio receiver thus set at 700 kc., adjust the service oscillator pointer to an I.F. of 175 kc.; this will produce the fourth-harmonic of 175 kc. at the receiver setting for the broadcast station selected. Adjust the service oscillator trimmer condenser until the oscillator signal is received strongest with the oscillator pointer set at exactly 175 kc.; then proceed to make the same check with the receiver set for stations at 875 kc. and 1050 kc., these being exactly 175 kc. apart. The dial will now track when the oscillator knob is moved over the "intermediate" scale.

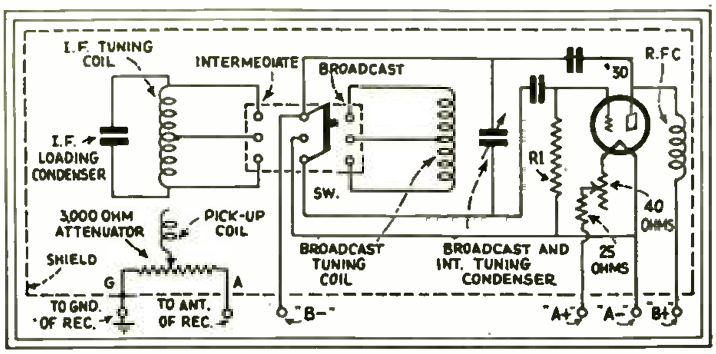


Fig. 1
Schematic circuit of the "No. 550" service oscillator. The value of R1 determines the frequency of the A.F. modulation

The Harmonic Chart may be referred to in calibrating at other intermediate frequencies. Thus, for calibrating at 260 kc., a broadcast station on 650 kc. is selected; this is the fifth-harmonic of 130 kc.

Adjusting a Philco Superheterodyne

The procedure to be followed in adjusting a Philco superheterodyne is representative of all superheterodyne receivers of the same general type.

The first step is to check the service oscillator and if necessary recalibrate it as outlined above, (especially at 175 kc. and 260 kc.), a fibre wrench is required.

The adjustment of the I.F. compensating condensers in this type of superheterodyne is performed as follows:

(1) Connect the G jack of the service oscillator to the GND terminals of the radio set;

(2) Connect the A jack of the service oscillator to the grid of the first-detector tube, with the tube shield in place and first-detector grid clip removed;

(3) Connect the output meter jacks to the primary of the receiver output transformer. (A Philco plug-in adapter may be used at the speaker socket to obtain this connection. Two tipped wires are furnished with the output meter for these connections);

(*Cont. on page 695*)

HARMONIC CHART

Harmonic	Frequencies						
(1)	130	140	150	160	170	175	180
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	560	600	640	680	700	720
5	650	700	750	800	850	875	900
6	780	840	900	960	1020	1050	1080
7	910	980	1050	1120	1190	1225	1260
8	1040	1120	1200	1280	1360	1400	1440
9	1170	1260	1350	1440	-	-	-
10	1300	1400	1500	-	-	-	-
11	1430	-	-	-	-	-	-

Fundamental (1) and harmonic frequencies, in kc. Additional harmonics may be similarly calculated.

The Design of a New TUBE TESTER

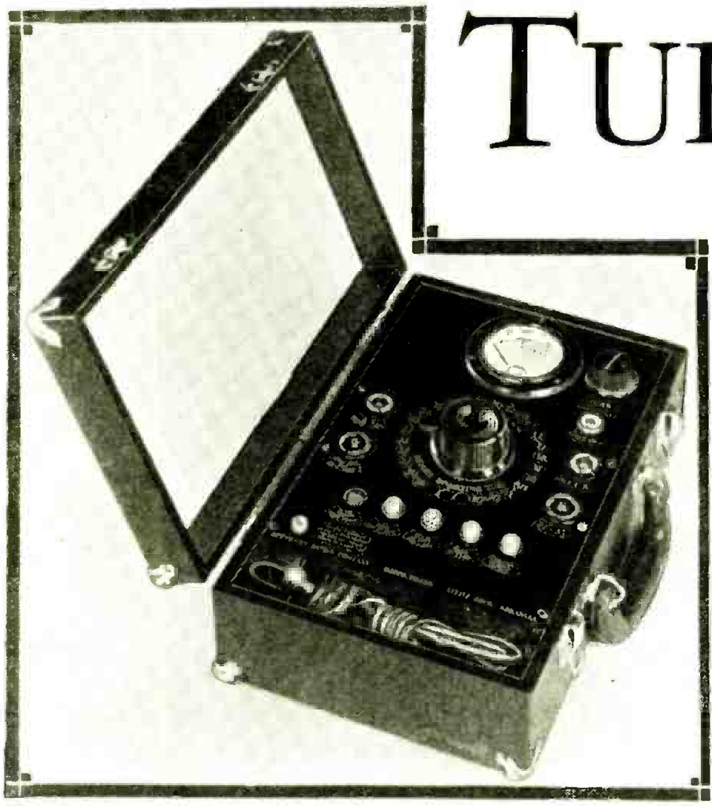


Fig. A
The Confidence "English-reading" Tube Tester

First published description and diagram of the newest type of tube tester. It indicates directly in words the relative merit of every type of tube on the market.

By B. J. R. WILLIAMS*

UNIQUE in the field of test equipment is the tube checker illustrated in Fig. A. A schematic diagram of the instrument, simplified for easy reference, is shown in Fig. 1. Its outstanding feature is its "English-reading" indication of the worth of a vacuum tube in terms of "good," "bad," or "gas." To better appreciate the superiority of this type of test unit, let us gloss over past history.

Early types of tube checkers met the requirements of five or six years ago by furnishing only a "plate current" indication; the meter indications were checked against a table of evaluations for satisfactory characteristics. Increased public interest in the tube's inherent bearing on tone, volume, sensitivity, and selectivity resulted in the development of "oscillation" testers which gave a better indication of merit. Lately, "mutual conductance" (zero set) tube checkers have been offered as portable equipment for the Service Man; and as "counter" models for the mutual reference of the radio dealer and his store trade,—still, however, requiring the use of a reference table for correlating meter readings and desirable tube characteristics.

To most of the tube-buying public, these figures were just so much Greek; and while impressive, they were not convincing. It was to provide a more simple device that would be "plain English" to the customer, that the "Confidence," Direct-Reading Tube Tester was developed; its single meter scale indicates the suitability of a tube in words, —"good," "bad," or "gas."

Although design work on the "Confidence" tube tester was started in 1928, it was some time before all the "bugs" could be ironed out;—since there is considerable complexity to the multi-shunt switching mechanism necessary for successively applying the correct potentials to each type of tube solely by rotating a single knob.

One Meter—Four Sockets

In this type of instrument four sockets are used, into which all known tubes are inserted according to their connection requirements. This means that all 4-prong UX tubes such as '10, '50, '81, '71A, '12A, '01A, '00A, '20, '99, '45, '31, '30, '26, '82B and '83 are inserted in one socket; and other types in the remaining three sockets.

Assuming it is desired to test a '99 tube, the one selector knob of this multi-shunt device, is turned to the position marked "99," and the tube placed in the UX socket. Two buttons are pressed; one reading "Grid Action" and the other "Plate Action." If the

(*Continued on page 689*)

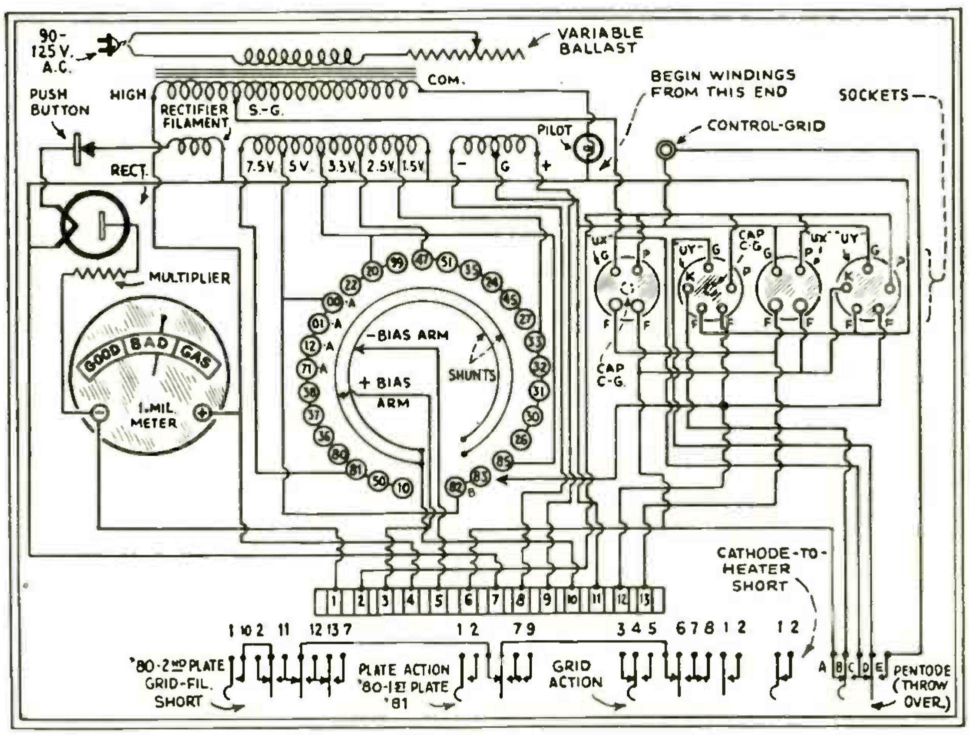


Fig. 1
Schematic circuit of the "Confidence" Tube Tester. Two sets of resistors, represented by the lines marked "shunts," adjust the circuit for correct test of any type of tube.

*Chief Engineer, Apparatus Design Co.

STROMBERG-CARLSON No. 29, 9-TUBE SUPERHETERODYNE RECEIVER

What is probably the first receiver to derive its designation from the number of its design features is the "29" receiver of Stromberg - Carlson Telephone Mfg. Co., Rochester, N. Y. These features, as furnished by the factory, are listed below (where their position in the circuit is not evident from the wording, a more detailed description of the nomenclature is given):

1. Optosynchronic (Visual) Tuning, with sensitive meter for accurate setting of the station-selector dial;
2. Mono-Vision Dial and Tuning Meter, for quick, accurate tuning;
3. Large Baffle Area Cabinet, for full, smooth range of musical and voice tones;
4. Manual Volume-Control, for pre-setting to desired audio volume and for increasing sensitivity on extreme distance;
5. Level-Action Automatic Volume-Control, to maintain the predetermined volume over an extremely wide range of signal strength;
6. Detectomatic (Duo - Diode) Detector, for most efficient demodulation action;
7. Adjustable Automatic Clarifier, to allow hand adjustment of high-frequency reproduction to meet receiving conditions; (R15-C27);
8. Antenna Aligner, for obtaining maximum results with any particular size of antenna;
9. Image Suppressor, for giving a very high discrimination (over 100,000 to 1) against "cross-talk"; C1-C2-C3, L1-L2-L3;
10. Isolated Oscillator Tube and Circuit, for correct control of sensitivity;
11. Bi-Resonator Radio-Frequency Tuning System, for better selectivity; C1-C2, L1-L2, C;
12. Tri-Resonator Intermediate Amplifier, providing high selectivity;
13. Triplex Audio System, employing screen-grid first audio, and push-pull output;
14. Variable-Mu (Super-Control) Screen-Grid Tubes, for long range of action;
15. Triode Push-Pull Output, for best audio quality;
16. Four-Gang Tuning Condensers, for super-selectivity;
17. Non-Glare Dial, with wide-spaced markings for easy and accurate tuning;
18. Phonograph Key, for switching from radio to records;
19. Telephone Cabling, grouping of wires in neat, insulated cables for quiet operation;
20. Full-Size Chassis, avoids crowding units and provides accessibility for servicing;
21. Highly Efficient, Large Size Electro-Dynamic Speaker, to give ample undistorted sound output;
22. Karvart Panel of Airplane Fuselage Construction, giving ornamental carved design of real wood;
23. Precision-Selected Tubes, sealed in sockets, the style of tubes used having been picked for best over-all results;
24. Non-Radiating, avoids disturbing, with heterodyne squeals, neighboring radio receivers;
25. Super-Sensitivity, the highest compatible with clarity of reception;
26. Flexibility of Volume, from a whisper to auditorium volume;
27. Oscillograph Aligned, Tested and Sealed, to assure laboratory performance in every set;
28. Telephone-Built, by a manufacturer with more than 37 years experience;
29. Heavy Genuine Walnut Veneer Cabinet, for beauty and permanence.

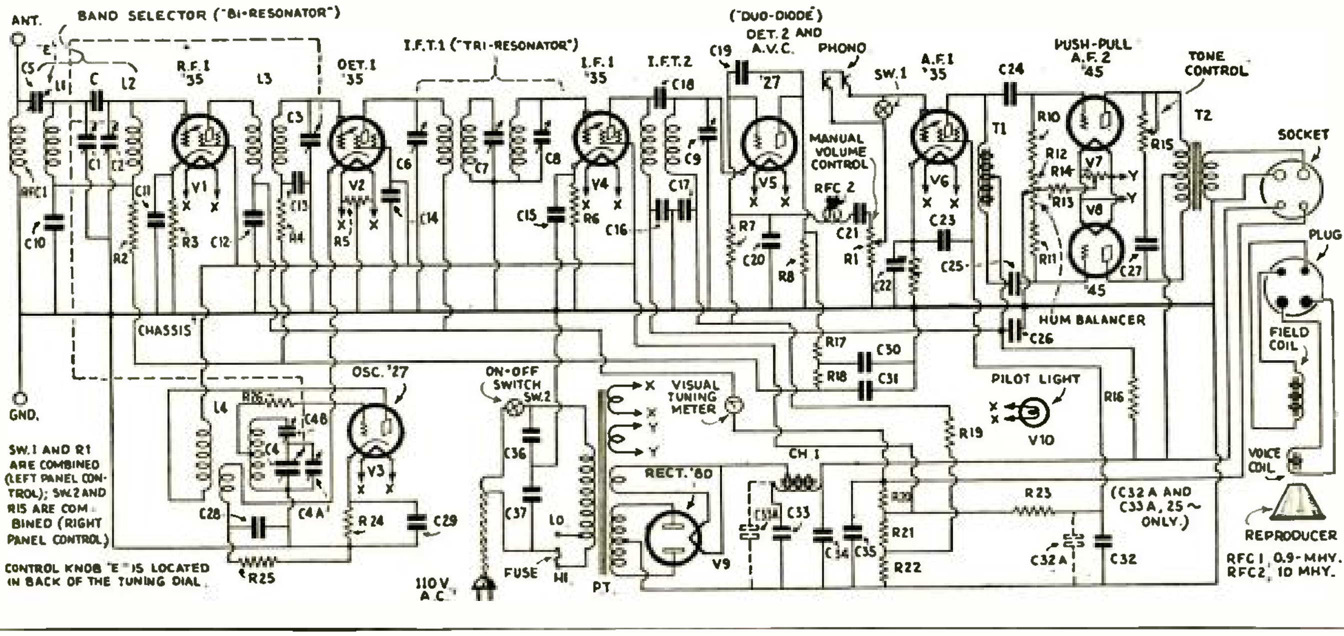
Taking these points in their numerical order, the following comments are made in further explanation. Number 6 refers to the new type detection circuit by which a single type '27 tube is made to function approximately similar to two separate two-element, or diode tubes; here the grid and cathode of V5 function as a diode type of second-detector (or "demodulator"), while its plate and cathode function as a diode type of automatic volume-control detector. Since V5 must serve a dual purpose, it is essential that exceptional care be given to the selection of a tube for this position; for the tube must possess characteristics which will meet the requirements of dual service. The audio output of V5 appears across load resistor R7; the degree of input to the audio system is under control by variation of the setting of the arm of potentiometer R1, the manual volume-control ("No. 4").

The antenna aligner, No. 8, is variable condenser C5 in the diagram; its control knob is located on top of the R.F. coils' shield can, and close to the front edge of the chassis, between the tuning knob and the off-on switch and tone-control combination knob. Tune in a weak signal at the high frequency (1500-kc.) end of the dial, and adjust this antenna condenser knob (marked E in the diagram on the label in the rear of the receiver) until maximum volume is obtained. Leave this knob set at the position of maximum response. If the antenna or ground wires are changed at any future date, this knob must be readjusted. For this purpose a very weak signal should be used, in order to obtain the best over-all sensitivity. If the signal is strong enough to operate the visual tuning meter, adjust the knob E, for greatest swing after tuning the station selector for best reception. The I.F. is 175 kc., peak-tuned.

All resistor and condenser values are as follows: Resistor R1, variable, 0.5-meg.; R2, R4, R18, R19, 0.1-meg.; R3, R6, R9, 600 ohms; R5, 3 ohms; R7, R10, R11, 0.25-meg.; R8, R15 (tone control); R17, 0.5-meg.; R12, hum balancer (center-tapped), 400 ohms; R13, 750 ohms; R14, 10 ohms; R16, R23, 10,000 ohms; R20, 2,174 ohms; R21, 2,080 ohms; R22, 340 ohms; R24, 6,500 ohms; R25, 4,000 ohms; R26, 500 ohms.

Condensers C1 to C9 include the tuning, coupling, and trimming condensers; C10, C19, .04-mf.; C11, C13, C30, C31 .05-mf.; C12, C14, C15, C17, C28, 0.3-mf.; C16, C27, 0.1-mf.; C18, C20, C29, 100 mmf.; C21, C24, C25, C36, C37, .01-mf.; C22, C35, 1. mf.; C23, .45-mf.; C26, C32, C34, 2 mf.; C33, 6 mf.

Operating current and potential values are taken with a line potential of 110 volts and the fuse in the "LO" position. It is necessary to use the meter scales specified (in parentheses) for each reading: (1), 0-4 V., A.C.; (2), 0-8 V., A.C.; (3), 0-10 V., D.C.; (4), 0-250 V., D.C.; (5), 0-750 V., D.C. Filament potential, V1 to V8, and V10, 2.48 V., (1); V9, 4.9 V., (2), Cathode-to-chassis potential, V1, V4, V6, 3 V., (3); V3, 16 V., (4). Control-grid bias, V7, V8, 50 V., across R13, (4). Plate-to-chassis potential, V1, V2, 170 V., (4); V3, 87 V., (4); V4, 220 V., (4); V6, 192 V., (4). Plate potential, V5 (measured as the voltage drop across resistor R22), 12.5 V., (4). Plate potential, V7, V8 (measured between either tube plate and the center-tap of resistor R14), 250 V., (5). Screen-grid potential, V1, V2, V3, 87 V., (4). The potential across the field coil is 127.5 V., (4); the A.C. plate-to-chassis potential of V9 is 340 V.



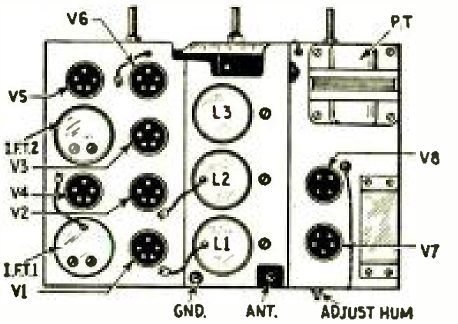
MAJESTIC MODELS FAIRFAX AND SHEFFIELD 8-TUBE SUPERHETERODYNES

(Model 200 Chassis; with automatic volume control and duodiode detector)

New radio receivers are adding responsibilities to the Service Man, but if he knows his business he will experience no difficulty in clearing the normal troubles he may find in such sets. He must merely acquaint himself with the design variations of each new model. For instance, the Grigsby-Grunow Company's Majestic Model 200 chassis uses a new type of tube in the dual role of second-detector and automatic volume control. This is indicated in the schematic circuit.

The parts values are: Resistor R1, 7,000 ohms; R2, 3,500 ohms; R3, 3,000 ohms; R4, 110 ohms; R5, 180 ohms; R6, R8, R13, 0.1-meg.; R7, R9, 0.25-meg.; R10, R11, R12, R18 (manual volume control), 0.5-meg.; R14, 0.3-meg.; R15, 1. meg.; R16, 0.2-meg.; R17 (hum balancer), 20 ohms; R19 (tone control), 50,000 ohms; R20, 700 ohms.

Condensers C1, C4, 0.1-mf.; C2, C3, C5, .25-mf.; C6, C11, .05-mf.; C7, C8, C12, C-13, C14, C15, .01-mf.; C9, .03-mf.; C10,



.005-mf.; C16, 50 mmf.; C17, C19, 4 mf.; C18, 500 mmf.; C20, 8 mf. Condenser C is the oscillator padding component.

The tubes specified for this receiver carry the following Majestic numbers: Type G-35-S spray shield multi-mu screen-grid tube, as R.F. amplifier V1; Type G-35-S spray shield multi-mu screen-grid tube as first-detector V2; Type G-27-S spray shield tube as oscillator V3; Type G-35-S spray shield multi-mu screen-grid tube as I.F. amplifier V4; Type G-2-S spray shield duodiode tube as second-detector and automatic volume control V5; Type G-35-S spray shield multi-mu screen-grid tube as first A.F. V6; Type G-47 pentode as second A.F. power tube V7.

To obtain correct balance in the filament circuit, to reduce hum, there is provided a hum balancing potentiometer R17. Adjust this, right or left, by means of a screw-driver, for minimum hum. It is seldom necessary to readjust this unit unless pentode V7 is replaced.

The length of the antenna recommended for various receivers varies with the design of each model; the Model 200 chassis is designed to work best with an antenna of about 30 to 40 feet, for normal urban localities, and a somewhat greater length, up to 100 feet, in rural sections.

Due to the fact that the diode second-detector V5 also forms part of an automatic volume-control circuit, the tube ordinarily required for this service is eliminated. Since there is an A.V.C. circuit in the Model 200 chassis, and a visual tuning meter has not been provided, it is *essential* that stations be tuned in for maximum volume and clarity; if the tuning is slightly off the correct point, noise and poor tone will result. In fact, it is best to carefully note the dial marking while tuning in a desired program, to rock the dial back and forth until the signal drops out at equal points on either side of good reception, and then to leave the dial at a position halfway between these two settings.

Looking at the front of the set, the knob on the left controls the combined tone control ("static modifier and acoustic control") R19 and off-on switch SW-1, and the one on the right varies the manual volume control, R18. Note that the automatic volume-control action is independent of the other portions of the circuit, being adjusted to operate at a volume level pre-determined in the design of the chassis. The manual volume control only varies the audio input to the voltage-amplifier V6, and the succeeding power-amplifier pentode V7.

The duodiode full-wave rectifier V5 is used specifically because of its increased sensitivity over the diode (or "two-element") half-wave connection ordinarily employed. Its sturdier construction, better fidelity, better definition on the higher frequencies, and its ability to handle more power. The duodiode is a full-wave rectifier, as compared to the diode, which is a half-wave rectifier.

A tone control is included in the instrument, not as a means of correcting faults in the receiver design, but to accomodate variations in conditions external to the radio set. For instance, as a means of matching the acoustic properties of the room, in order to obtain the most realistic reproduction; also, to reduce the proportion of static and background noise during local electric storms or when receiving distant programs.

The output of the oscillator is coupled into the cathode circuit of first-detector V2 by means of a small coupling coil which forms part of inductnce L3.

The Model 200 chassis is used in the Sheffield Model 201 receiver and the Fairfax Model 203 receiver. The power consumption is 85 watts.

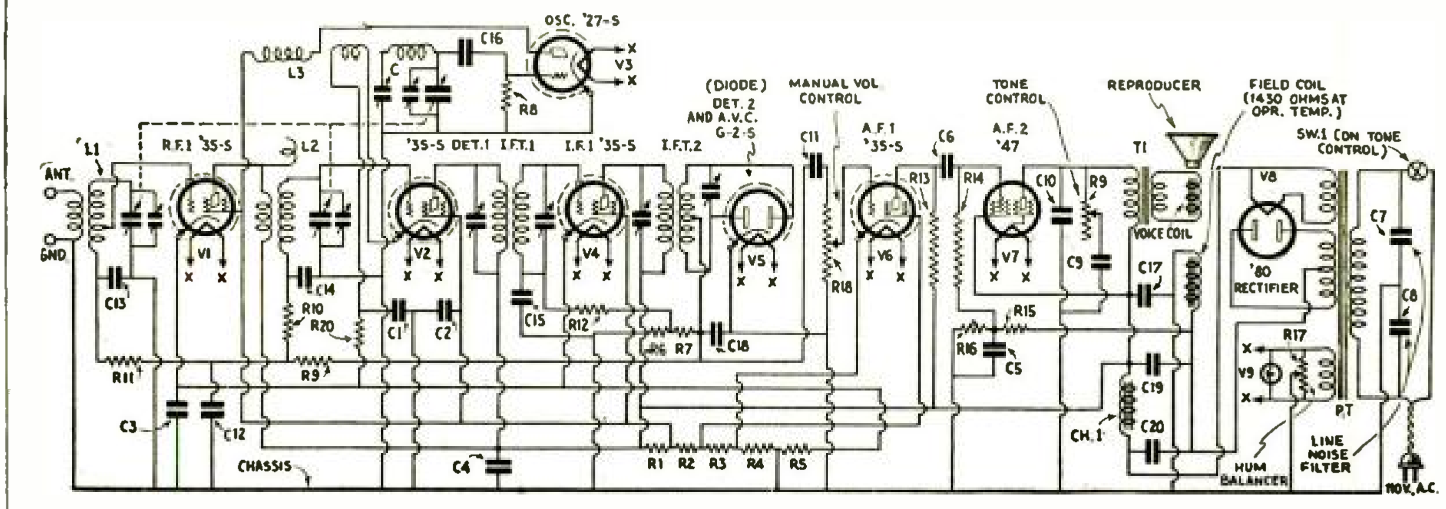
Line-filter condensers C7 and C8 prevent clicking sounds in the loud speaker when electric lights on the same circuit are turned on or off, and also reduce noises incidental to the operation of other electrical devices on the same line.

MODEL 200 CHASSIS

TABLE OF VOLTAGE AND CURRENT READINGS

All D.C. Voltage Readings are to Ground.

Tube Purpose	Type Tube	Filament Voltage A.C.	Plate Voltage D.C.	Filament To Ground D.C.	Cathode To Ground D.C.	Plate Current M.A. - D.C.	Screen Voltage D.C.	Screen Current M.A. - D.C
R.F. Amp.	G-35-S	2.5	255	.5	3	5.	96	1.
1st Det.	G-35-S	2.5	255	.5	11	4.	96	.4
Oscillator	G-27-S	2.5	98	.5	0	9.5	—	—
I.F. Amp.	G-35-S	2.5	255	.5	3	1.	96	.8
2nd Det.	G-2-S	2.5	0	.5	0	0	—	—
1st Audio	G-35-S	2.5	100	.5	2	2.	44	.4
Power Amp.	G-47	2.5	250	.5	—	25	260	6.
Rectifier	G-80	5.	—	290	—	75 Total	—	—



The RADIO CRAFTSMAN'S Page

The Bulletin Board for Our Experimental Readers

COMMENTS ON THE CONDENSER-RECTIFIER

Editor, RADIO-CRAFT:

Our attention has been called to the article in your December, 1931 edition of RADIO-CRAFT, on the use of an electrolytic-condenser-rectifier. We find that, on using the hook-up shown, with a transformer intended for use with a BH tube (and which, with an Elkon "BH" type dry tube-substitute, supplies actually about 240 volts no-load rectified D.C. voltage across the terminals of the voltage divider, and "B" current enough for a set using three, type '26 tubes; one '27 tube; one '24 tube; and one '71-A tube), the no-load D.C. voltage (measured with a 1000 ohms per-volt meter) is about 75 volts, *and no more.*

The transformer, moreover, instantly heats up to the point where the insulating wax begins to flow upon switching on the supply current, when the condenser is used as a rectifier, though the condenser seems to operate O.K. in the conventional power pack hook-up.

A discussion of this data in your columns would no doubt interest others who perhaps are obtaining similar unsatisfactory results with the published hookup.

C. M. DELANO,
Box 663, Lincoln, Nebr.

(This article, "A Novel Power Pack Design Including Only a Transformer and Electrolytic Condensers," created considerable attention. As pointed out by Mr. Jarowey, the idea at the present time is recommended particularly for the attention of laboratory workers; later, the scheme may be perfected for commercial use. Following, we print the explanation for the effects noted by Mr. Delano.—*Technical Editor.*)

MR. JAROWEY REPLIES

Editor, RADIO-CRAFT:

There are several interesting points in your letter, Mr. Delano, concerning your difficulties with the condenser-rectifier.

To begin with, the present conventional sizes of electrolytic condensers are too large to be used with a transformer that has been designed to operate with a thermionic or a gaseous rectifier tube. The size of winding in such a transformer would operate well with about 2 mf. per section, and to prove it we will examine the reactance (A.C. resistance) of the condenser: the reactance—the reciprocal of 6.28 x 60 x .000008 = 331 ohms, which will prove that *the heating of the transformer was due to this overloading charging current,* and hence the drop in D.C. voltage.

Now, I will illustrate an ideal design verbally as follows: Let us suppose that we need 170 volts of D.C. Therefore, we will wind the transformer secondary to have maximum voltage across the outside terminals equal to the rated condenser voltage, that is, 480 x .707 (the *effective* value of A.C.) = 339.6 volts; to this value the drop due to the load may be added, by actual test, you will find that you can obtain the required 170 volts D.C.; provided, however, that the electrolytic-condenser capacity does not exceed the current capacity of the transformer. On the other hand, if you have 25-cycle current, the A.C. resistance, or rather impedance, of the condenser will increase tremendously. That is, the frequency plays a very important part in A.C. circuits, whether they be R.F. or A.F.

To prove that this idea is correct, you may make a test for yourself any time as follows: If you have access to a 110- or 220-volt A.C. line, connect the two positive terminals of the condenser sections to the line, and connect the two filter chokes or bellringing transformer primaries in series also to the line (that is necessary to obtain an inductive neutral point); then connect a good D.C. voltmeter of suitable range between the two chokes and the negative side of the condenser, and you will have a D.C. voltage of one-half of the value you may apply to the condenser; no filter is necessary to this arrangement, Fig. 1, for the current is non-pulsating.

I hope that this will explain the behavior in your case; and those of others who may have experimented with this extremely simple and radically new power pack design.

P. M. JAROWEY,
815 Merchant Street, Ambridge, Pa.

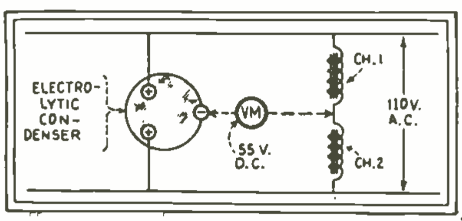


Fig. 1
Circuit illustrating Mr. Jarowey's theory.

A BUDDING INVENTOR

Editor, RADIO-CRAFT:

While reading about the "Autoverter" in the January, 1932 issue of RADIO-CRAFT, I got a few ideas; here are three of them.

I looked through my automobile junk-box and found a Dodge high-tension transformer, a distributor head with a six-point cam, and an old electric horn.

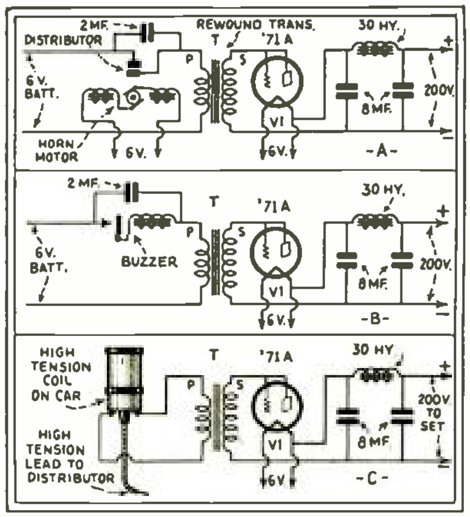


Fig. 2
The circuit diagram after Mr. Palmer's ingenious changes.

The transformer I rewound—100 turns of No. 22 D.C.C. wire for the primary and about 4000 turns of No. 32 enamel-covered wire for the secondary. The horn I dismantled, throwing away the horn bell, diaphragm and cam. Onto the shaft of the remaining horn motor I fastened the shaft of the distributor. (I used four pieces of strap iron to hold these two contrivances rigid.) The six-point cam makes and breaks the electrical circuit six times per revolution. Across the breaker points I soldered a 2 mf. condenser. The resulting circuit is Fig. 2A.

Another method is to use the same Dodge transformer, same primary and secondary winding, and then connect a buzzer in series with the primary and a 6-volt battery, as shown in Fig. 2B.

I have a six-cylinder Chevrolet, and when I connect the above transformer to the primary binding posts on the high-tension coil in my car, I get the same results as in the first wrinkle, excepting that I use the distributor in the car. It is exactly the same idea as the first wrinkle; the circuit, however, is as shown in Fig. 2C. The car distributor already has a condenser shunted across the breaker points. The only drawback to using this system is that the car must travel at least 20 miles-per-hour in order for the circuit to be broken enough times per minute to maintain the required high voltage.

FRANK C. PALMER,
1472 Jay Street, Edgewater, Colo.

(The ideas tried by Mr. Palmer are very interesting. If these were de-

(*Continued on page 699*)

An Ultra-Short-Wave Super-Regenerative 5-Meter Receiver

By E. P. HUFNAGEL (W2BUK) and
GEO. J. HERRSCHER (W2APW)

ULTRA-SHORT-WAVES, first investigated in the classic manner by one Heinrich Hertz, have crashed the commercial field with both the installation of 3- to 8-meter transmitting equipment as stations W2XF and W2XF atop the Empire State building in New York City, (which towers 110 stories into the air), and with the manufacture of compact receiving sets of suitable design for operation at these "quasi-optical" wavelengths.

The foremost characteristic of 5-meter radio reception is that its waveform, like that of light ("quasi-optical"), travels in a straight line and, so far as known, is not deflected in the manner we are accustomed to associate with the propagation of the higher wavelengths: instead, reception is limited by the curvature of the earth, while hills have shielding effects which tend to reduce volume. Thus, the "DX" range of W2XF-W2XK may be only about 80 miles (unless later experiments show that under certain conditions reflection or refraction may take place, and thus increase this figure; incidentally, many amateurs' 5-meter transmitters are located in *cellars*); with the result that the millions who reside within this theoretical radius of sight may be able to have reliable reception—since fading is not experienced in this, the "graveyard" end of the wavelength spectrum.

Frequency and Wavelength

It is interesting to note that the frequency range encompassed by "all-wave" or 15- to 545-meter radio sets, lies between 20,000 kc. and 550, or a total frequency band of 19,450 kc. Figuring on the basis of 10 kc. as the required "foot-frontage" (to borrow a term of the realtor) of a broadcast station, or 100 kc. for television requirements we find that, by simple division, in the former case there would be (theoretically, at least) provision for 1,915 broadcast stations, and in the latter 194 television stations; which leads us to the following step.

Between 3 meters (100,000 kc.) and 8 meters (37,500 kc.), there is a frequency band width of 62,500 kc. Applying the same principle of arithmetic as previously, we make the startling discovery that in this relatively small *wavelength* range it is possible to fit 6,250 broadcast stations, or 625 television stations! In other words, our entire and supposedly enormous "all-wave" tuning range of 15- to 545 meters, would fit into the "3- to 8-meter" band, *and leave enough room to fit in about two more bands just like our present one!* No wonder the "big boys," who know what it is all about, are gobbling up all the little wavelengths in sight—and the smaller they are the better they like 'em!

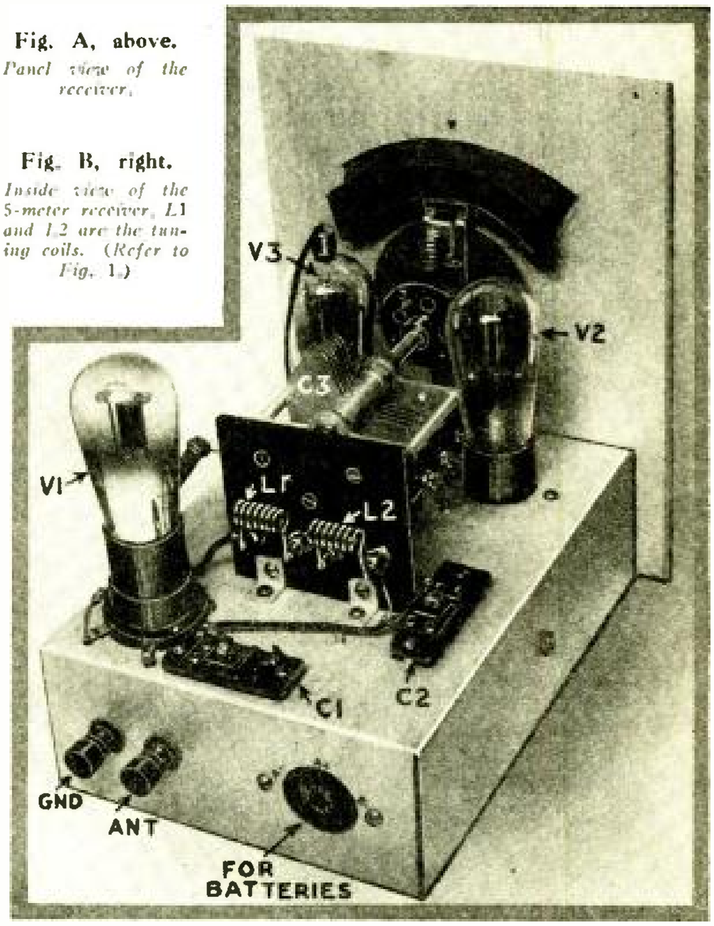


Fig. A, above.
Panel view of the receiver.

Fig. B, right.
Inside view of the 5-meter receiver. L1 and L2 are the tuning coils. (Refer to Fig. 1.)

Although transmitters operating at these ultra-high frequencies are few and far between, it would seem that in a fairly short time the countryside will be dotted with them; duplicating in other centers of population the coverage now offered by W2XF-W2XK nearly a quarter-mile in the air, in New York's Empire State building.

And, the power requirements are astonishingly small, to wit: experiments (which have proven the value of this type of operation) between fire towers in northern New Jersey indicate that reliable communication can be maintained with powers as low as 0.8-volt (input, to two 2-volt '30's; the entire transmitter) supplied by two dry cells and three "B" batteries.

Since the length of the best possible aerial used in the reception of a 5-meter signal would not exceed 8 ft., the adaptability of

(*Continued on page 684*)

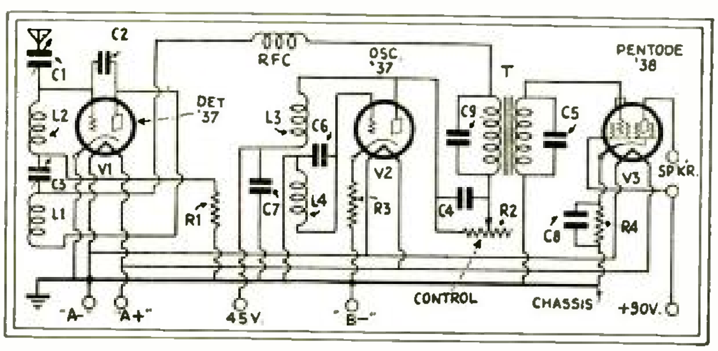


Fig. 1
Schematic diagram of the receiver which operates in the quasi-optical frequency band.

USING the V.T. VOLTMETER

(PART I)

By BERYL B. BRYANT

In a series of articles, of which this is the first, the author will discuss the various uses of vacuum-tube voltmeters, with particular reference to radio servicing and measurement.

IN response to the many requests received by the Editors of this magazine for information concerning the *use* of vacuum-tube voltmeters, such as the gooseneck V.T. voltmeter described in the February, 1932 issue of RADIO-CRAFT, the writer has been asked to prepare an article setting forth the methods of measurement and procedure in which the instrument may be employed.

As in all measurements, the accuracy of the measured result depends upon the accuracy with which the instrument has been calibrated, and the care with which the measurements are conducted.

Radio-Frequency Measurements

To conduct measurements by which the gain of an R.F. amplifier of one or more stages may be determined, a modulated R.F. oscillator, having the frequency range over which the amplifier is to be measured, is required. It is customary to modulate the R.F. signal with an audio signal of 400 cycles at 30 percent modulation. The signal from the modulated oscillator is induced into an artificial antenna of known constants; the set-up of the oscillator, the artificial antenna, and the amplifier to be measured is shown in Fig. 1. The mutual inductance between the coupling coil Lo of the oscillator and the 20-microhenry inductance La of the artificial antenna is determined by a method to be described in a later paragraph. Having determined the mutual inductance between Lo and La, the current through Lo may be measured by connecting the V.T. voltmeter across the 500-ohm resistance in series with Lo; this is shown in Fig. 1 at R.

The resistance R1 may be a 200-ohm potentiometer, and is used to control the output of the oscillator.

Having determined the voltage drop across R and knowing the resistance of R, the current may be determined by the application of Ohm's Law. The peak-voltage drop across R must be converted to effective volts by dividing the peak-voltage by 1.4. The voltage (effective) induced in the artificial antenna may now be determined by the formula:

$$Ea = 6.28 \times I \times M \times f$$

Where Ea is artificial antenna voltage, I is the calculated current through Lo, M is the mutual inductance between Lo and La, and f is the frequency in cycles.

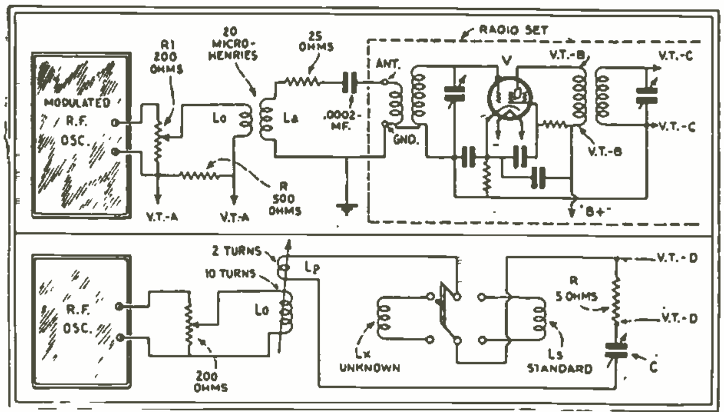


Fig. 1, above. *Oscillator, dummy antenna, and V.T. voltmeter.*
Fig. 3, below. *Substitution method of measuring inductance.*

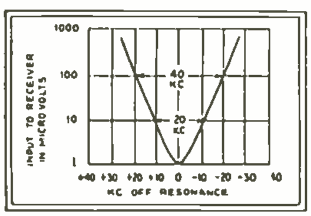


Fig. 2
Typical selectivity curve.

The R.M.A. standard artificial antenna consists of a coil of 20-microhenries inductance in series with a 25-ohm resistance and a .0002-mf. condenser. This, during the measurements, is connected directly across the antenna and ground binding posts of the receiver or R.F. stage to be measured.

Gain Measurement

Having provided a means of knowing the exact voltage input into an R.F. stage or amplifier, the gain may be measured by placing the V.T. voltmeter terminals across the plate-load of the single stage or the output of the amplifier whose gain is to be measured.

If the voltmeter is applied across the plate primary as shown at V.T.-B in Fig. 1, it is necessary that care be taken to insulate the V.T. voltmeter at all points from the chassis of the receiver; otherwise, a short will exist, as the V.T. voltmeter in this position is above ground potential by an amount equal to that of the plate-voltage of the amplifier stage.

In measuring the gain of tuned R.F. amplifiers, the induced voltage into La must be constant for all frequencies. It is therefore necessary to adjust the input to a predetermined peak value before each frequency measurement is made.

The gain of a single stage, or of the entire amplifying system is the ratio of the output voltage to the input voltage, and is determined by dividing the output by the input voltage. These voltages should be in effective values.

If it is desired to plot *sensitivity* and *selectivity* response curves of an R.F. amplifier, the measurements should be made in conjunction with the A.F. amplifier of the receiver. The sensitivity curve is the input in microvolts plotted against the radio frequency in cycles. *The output of the receiver is kept constant at .05-watt, with the input frequency varying from 1500 to 600 kc.* The R.F. oscillator is adjusted to 400 cycles at 30 percent modulation during these measurements.

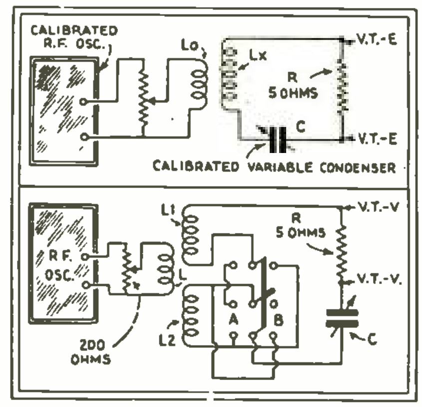


Fig. 4, above. *Measuring distributed capacity.*
Fig. 5, below. *Another measuring circuit.*

The sensitivity of a receiver is determined by a signal (input) that will produce a standard output of .05-watt from the receiver (a 10-ohm resistor connected in place of the voice coil of a dynamic speaker should have .707-volt across it for .05-watt output.) When plotted as a curve this is interpreted as follows: An input signal at any frequency will produce a standard output

(*Continued on page 686*)

RADIO-CRAFT KINKS

Practical hints from experimenters' private laboratories.

(PRIZE AWARD)

MEASURING SMALL CAPACITIES

By Edgar J. Smith

THE set builder, as well as the Service Man, never knows when he may be called upon to determine with fair accuracy the capacity or capacity range of a condenser. The method used by the writer for checking the capacity of small units, between the values of 50 and 1,000 mmf., may be of interest to the readers of RADIO-CRAFT.

Since most Service Men possess a grid-dip oscillator which covers the broadcast frequencies it is possible to construct this rig out of parts from the junk box.

The condenser C1 and C2 shown in the schematic circuit, Fig. 1A, is a double condenser having two sections of 500 mmfs. each. This condenser must be of the *straight-line capacity* type and of good construction. The two rotors are connected to a S.P.S.T. snap switch so that the condenser may be used as a 500 or 1000 mf. unit.

The tapped coil is not of critical construction and any coil at hand similar to it will be satisfactory. A pick-up coil, wound over or at the common end, is necessary for coupling to the oscillator.

A S.P.D.T. snap switch is provided for changing from CX (unknown capacity) to the calibrated condenser (C-1 C-2).

The process of checking a condenser is as follows: Place the condenser between the clips at CX. The snap switch is thrown to "TEST" position. The pickup coil on the inductance is connected to the pickup coil on the oscillator. With the oscillator turned on, the oscillator condenser C3 is varied until a dip is noted in the milliammeter MA; or, if no dip is noted, the inductance switch is changed to another tap and the operation is repeated until a dip is noted. The S.P.D.T. switch is then thrown to the

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The judges are the editors of RADIO-CRAFT and their decisions are final. No unused manuscripts are returned.

Follow these simple rules: Write, or preferably type, on one side of the sheet, giving a clear description of the best radio "kink" you know of. Simple sketches in free-hand are satisfactory, as long as they explain the idea. You can send in as many kinks as you wish. Everyone is eligible for the prize except employees of RADIO-CRAFT and their families.

This contest closes on the 15th of every month, by which time all the Kinks must be received for the next month.

Send all contributions to Editor, Kinks Department, c-o RADIO-CRAFT, 98 Park Place, New York City.

"CHECK" position and C1 is turned until a corresponding dip is noted on the milliammeter; if CX is larger than 500 mmf. it will be necessary to use C1 and C2 by closing the S.P.S.T. switch.

When the dip is found on C1 note the dial reading; if, for instance, the reading is 10 degrees, you will have 10% of 500 mmf.; that is, CX will equal 50 mmf. If it reads 50 degrees, you have 50% of 500 mmf. or 250 mmf., and so on. If C1 and 2 are used and you obtain a reading of 0 degrees, you will have 60% of 1000 mmf. or 600 mmf.

By substituting a pointer in place of the dial, and shellacing a white paper onto the panel, a direct reading may be plotted on the paper as shown in Fig. 1B; the outer circle being used for the 1000 mmf. condenser and the inner for the 500 mmf. No markings are made on the outer circle between 0 and 500 mmf., as these readings may be obtained more accurately on the 500 mmf. condenser.

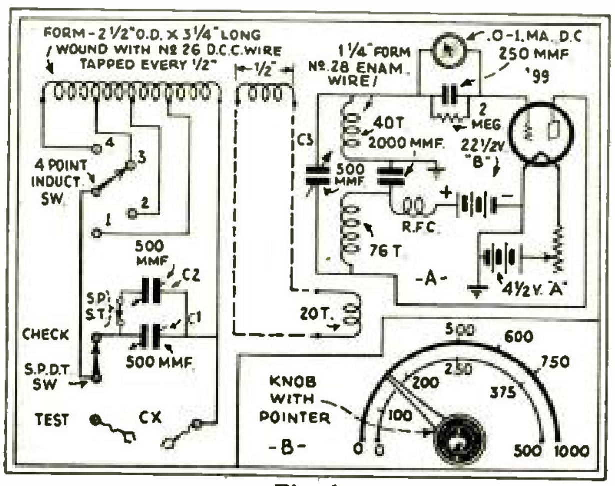

Fig. 1
Circuit for measuring capacities from 50 to 1,000 mmf.

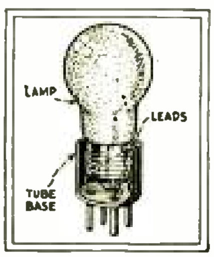

Fig. 2
A convenient lamp mounting.

One word of warning—do not make the test leads to CX any longer than necessary, to insure as much accuracy as possible.

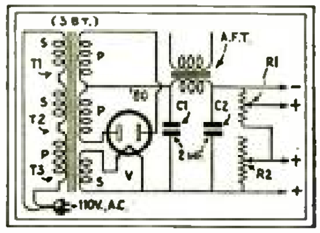

Fig. 3
An emergency "B" eliminator

The range of capacities may be increased by using fixed condensers of known value in either series or parallel connection with the unknown capacity.

The limiting factor of this device is the requirement that the unknown capacity across the inductance, or any section of the inductance, must have a resonant frequency within the range of the grid-dip oscillator.

SPARK COIL TONE GENERATOR

By Cal Brainerd

EXPERIMENTERS who wish to practise the telegraphic code may be interested to know that an ignition coil from an automobile may be very conveniently used to obtain the high audio frequency that is so pleasing when heard in a pair of head phones connected to the output of a smooth-operating, vibrator-brake type of current generator system.

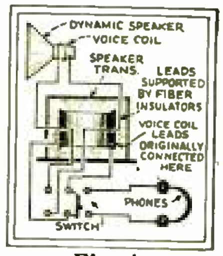

Fig. 4
Connecting head-phones.

The schematic diagram is Fig. 5. In this circuit, transformer T may be an ignition coil of the type used in Model T Fords. By bending the lower vibrator bracket to increase the tension on the armature, fairly high-speed interruption of the primary circuit may be obtained.

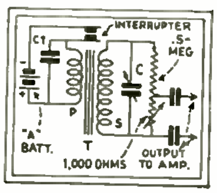

Fig. 5
A code practice unit.

With a 4-volt "A" battery, the secondary voltage will be from 5,000 to 10,000 volts; to handle this potential a book-type condenser is easiest to make and use.

The natural period of the secondary coil is in the audible frequencies, it will be found that a small capacity as C will give considerable range in tone. An ordinary variable condenser in series with two metal plates about 6 x 8 in. square, separated about 1/4-inch can be tried.

(Continued on page 685)

Radio-Craft's Information Bureau

SPECIAL NOTICE TO CORRESPONDENTS: Ask as many questions as you like, but please observe these rules:

Furnish sufficient information, and draw a careful diagram when needed, to explain your meaning; use only one side of the paper. List each question.

Those questions which are found to represent the greatest general interest will be published here, to the extent that space permits. At least five weeks must elapse between the receipt of a question and the appearance of its answer here.

Replies, magazines, etc., cannot be sent C. O. D.

Inquiries can be answered by mail only when accompanied by 25 cents (stamps) for each separate question. Other inquiries should be marked "For Publication," to avoid misunderstanding.

ZENITH MODEL 103—CROSLEY MODEL 127

(155) Mr. Carlson J. Parker, Owosso, Mich.

(Q. 1) In the March, 1932 issue of RADIO-CRAFT, page 541, Data Sheet No. 61, is described the Zenith Model 103 receiver, and

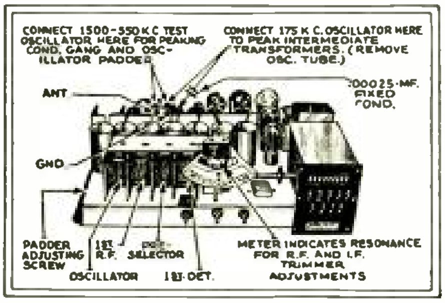

Fig. Q.155A

Chassis layout of the Zenith 103 receiver.

mention is made of a "chassis layout," but it does not appear on the page. Please show this parts layout, if it is available.

(A. 1) The parts layout for the Zenith "Hyperheterodyne" receiver mentioned is shown in Fig. Q 155A.

(Q. 2) In the same issue, page 550, appears the diagram of the Crosley Model 127 "Happy

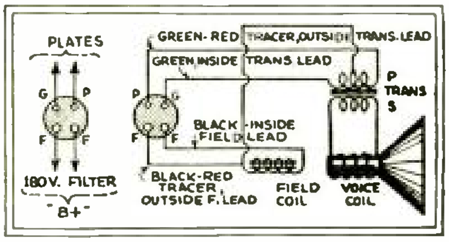

Fig. Q.155B

Dynamic speaker plug and socket connections.

Hour" and "Tenstrike" receiver, as Fig. Q. 151, but only the socket for the dynamic reproducer is shown. What are the lead connections from the dynamic reproducer to the plug which fits into this socket?

(A. 2) The plug connections of the dynamic reproducer used in this chassis is shown in Fig. Q. 155B.

RCA-VICTOR MODEL M-30 CAR RADIO—MUTUAL CONDUCTANCE METER

(156) Mr. Barrington Fox, Needles, Ariz.

(Q. 1) What are the antenna requirements for the RCA-Victor car radio set?

(A. 1) Considerable detail, including the schematic circuit, is given in RADIO-CRAFT Data Sheet No. 64, which appeared in the April, 1932 issue.

A roof antenna for the Model M-30 receiver is required only in districts where the average signal-intensity level is very low. For an antenna installation the following equipment may be required: Long-nose, gas, and diagonal pliers; small Crescent, and No. 4 Spintite wrenches; small, large, and thin-shank 6-in. screw drivers; tin shears; medium and heavy-duty soldering irons; resin and acid-core solder; electric drill (with set of drills up to ½-in.); reamer (¾-in., max.); seat and door protectors; sheet copper; and a supply of ½-in. Belden Braid.

(Q. 2) Can you suggest any way of reducing interference, in addition to the use of spark-plug circuit series resistors? The use of these does not entirely eliminate interference from the motor.

(A. 2) Apparently bypass condensers have not been applied to the several radiating circuits of the ignition wiring in the car.

Two bypass condensers, one on each terminal, at the ammeter may reduce certain forms of car interference. The receiver should not be located near the car's ignition coil, due to its strong field. Interchanging its primary connections may reduce interference. Whether the antenna lead-in shield should be grounded to reduce interference should be determined by test.

(Q. 3) What is the schematic circuit of the Sterling direct-reading mutual conductance meter?

(A. 3) Several models of this type of instrument were manufactured by the Sterling Mfg. Co. The Model R-517 Meter is illustrated and described in detail in the book, "Radio Set Analyzers," by L. Van der Mel. The "Bridge" of the same manufacture is illustrated in Figs. Q. 156A and B. The meter is calibrated 0-3000 mhos., 0-30 ma., and 10-60 ma.; available data appears in this diagram.

The "A," "B," and "C" voltages for the tube to be tested are adjusted first, and the reading of the meter balanced out by means of the lower left-hand knob. The mutual conductance value is then obtained by reading the meter, which is graduated directly in micromhos; this is the rate of change in plate current for a given grid voltage change.

This device is equipped with four sockets, one for pre-heating and three for testing.

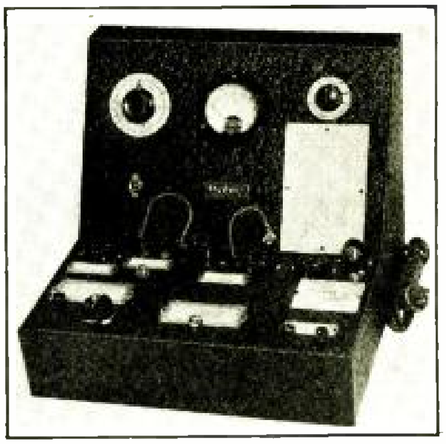

Fig. Q.156A

The Sterling R-517 mutual-conductance meter.

MAJESTIC MODELS 25, 25B, AND 35

(157) Mr. Harry Sauterine, Kenosha, Wis.

(Q. 1) I have a Majestic Model 25 superheterodyne which does not seem to be connected the same as diagrammed in Data Sheet No. 59, which appeared in the February, 1932 issue of RADIO-CRAFT.

My set incorporates automatic volume control: tapped-choke input to the push-pull pentodes, instead of transformer coupling; a potentiometer controls the audio input to the push-pull pentodes. There is also a "local-distance" switch which is not shown. Please explain this.

(A.) The chassis in the receiver described was changed at the factory, and does not carry the number, "Model 25"; the correct number is the "Model 25B"; and in the Collingwood and Abbeywood cabinets the chassis is "Model 35."

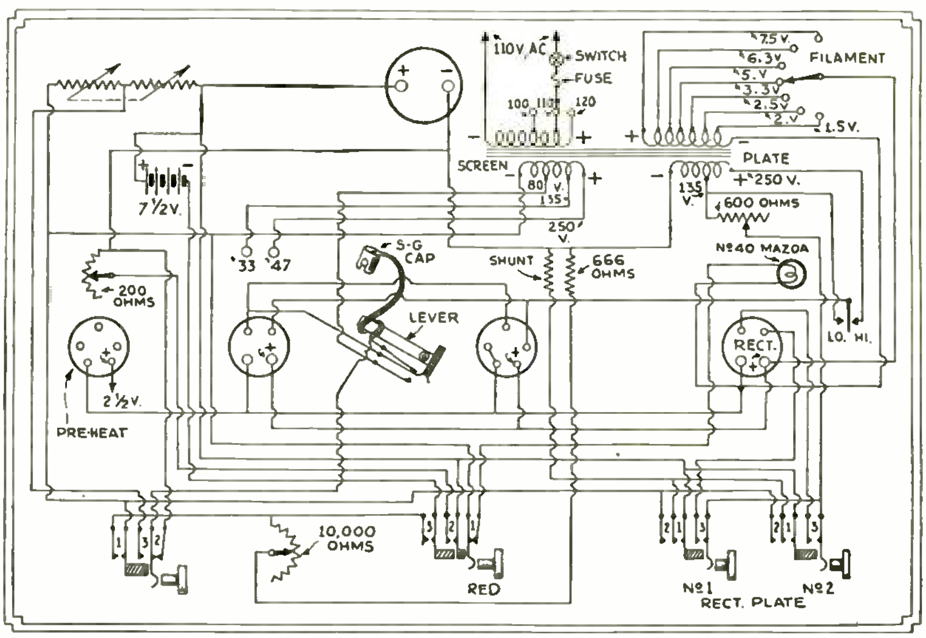

Fig. Q.156B

Schematic circuit of the Sterling Model R-517 mutual-conductance meter.

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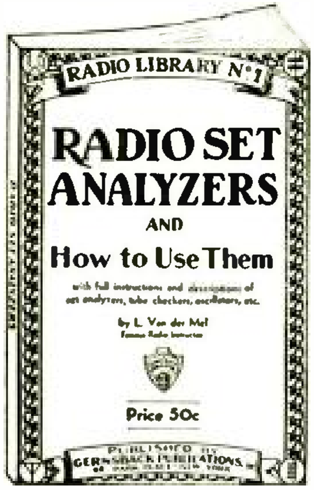

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By L. VAN DER MEL

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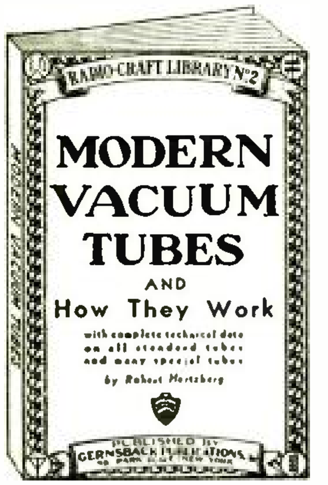
MODERN VACUUM TUBES



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Here are some of the chapters: The Edison Effect and The Electron Theory; Electron Emitters and the Ionization Effect; The Three-Electrode Tube; Vacuum Tube Characteristics; Four- and Five-Element Tubes; Light Sensitive Cells and Other Special Tubes.

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How To Get Started and How To Make Money In Radio Servicing

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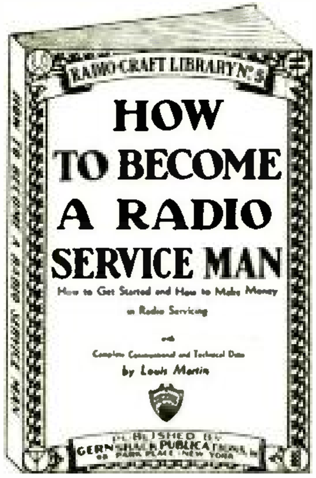
Here are the chapters: The Small Independent Service Man; Advanced Commercial Aspects; The Radio Set; Semi-Technical Considerations; Advanced Service Data. Each chapter is again subdivided to bring out in minute detail every point of importance.



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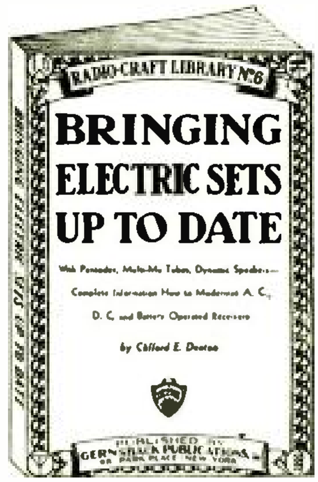

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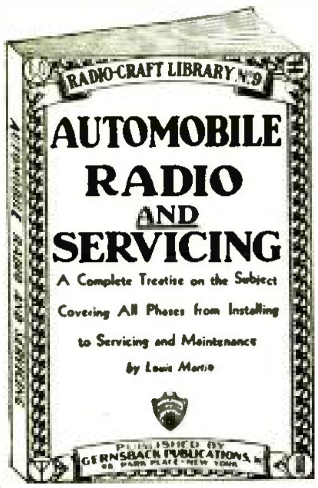

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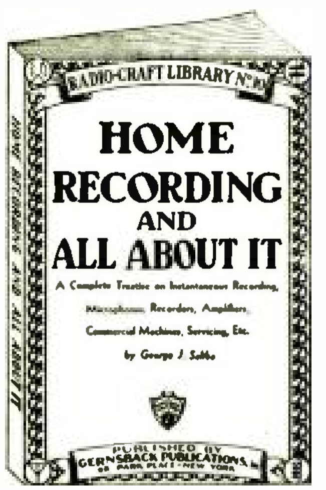

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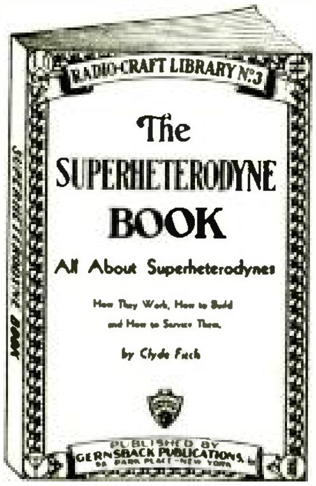

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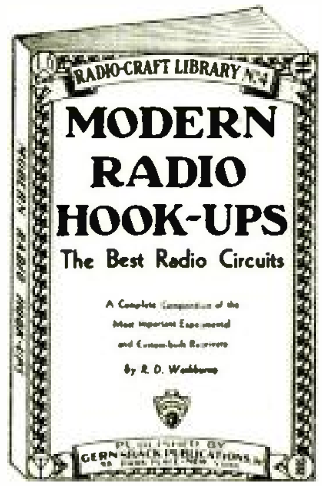

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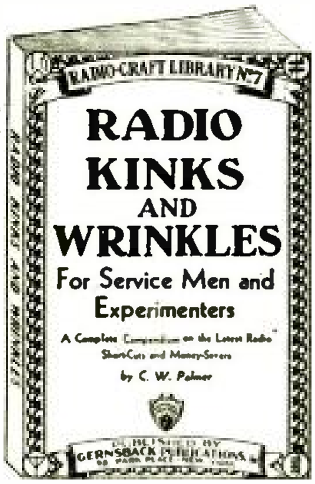

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This book is a compilation of important radio kinks and wrinkles; the entire contents of the book has been selected with great care in order to discuss only such items as are constantly used today.

Here are some of the more important chapters: Introduction; Servicing Short-Cuts; Testing Equipment and Meters; Vacuum Tubes and Circuits; Volume-control Methods; Amplifiers and Phonograph Reproducers; Power Supply Equipment; Coils and Tuning Circuits; Short Waves; Loud Speakers; Tools and Accessories.

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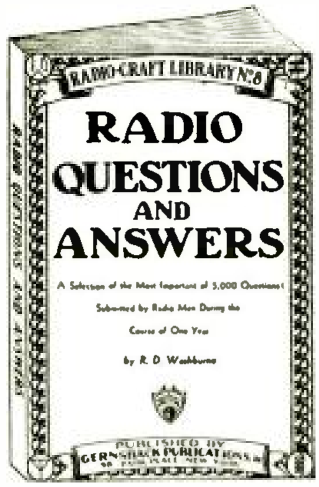

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THE TETRADYNE RECEIVER

(Continued from page 651)

structed at home by winding the coils on a tube 1½ ins. in diameter. The following specifications are given:

The 200- to 550-meter broadcast band: L1, 20 turns, L2, 98 turns; L3, 66 turns. L1 and L2 are wound on the same form (on all the different wave-band coils), are separated by 1/16-in., and are wound with No. 28 D.S.C. wire.

The 80- to 205-meter band: L1, 14 turns; L2, 57 turns; L3, 58 turns. L1 and L2 are separated by ⅛-in., and are wound with No. 24 D.S.C. wire.

The 40- to 85-meter band: L1, 10 turns; L2, 22 turns; L3, 21 turns. L1 and L2 are separated by ¼-in., and are wound with No. 24 D.S.C. wire.

The 20- to 45-meter band: L1, 8 turns, L2, 10 turns; L3, 10 turns. They are separated by ¼-in., and are wound with No. 24 D.S.C. wire.

For wave lengths up to 25 meters: L1, 4 turns; L2, 6 turns; L3, 6 turns. L1 and L2 are separated by ¼-in. and are wound with No. 24 D.S.C. wire. The lowest wavelength that is received is determined by the capacity of the wiring and the internal capacity of the tubes. The writer has been able to tune in stations as low as 15 meters without any trouble.

Figure 3 shows complete construction details of the coils. The left-hand coil is the first-detector or modulator, and the right-hand coil is the oscillator coil L3. The connections of the coil to its prongs are shown above, while the socket connections are shown below. Notice that the .0001- and .0002-mf. condensers are connected together in the broadcast coil only, thus leaving only the .0001-mf. section of the tuning condensers for the short-wave band. The same method is used for the oscillator coil.

The I.F. Transformers

Any good 175-kc. transformer may be used for the I.F. stages. However, for the man who desires to construct them himself, the following data are given: Refer to Fig. 4. The primary is "jumble" wound, having 152 turns of No. 28 enameled wire; the secondary is spaced from the primary by ⅜-inch, and is wound with 213 turns of No. 28 enameled wire. The spacing and sizes of the windings are shown in the diagram.

It is desirable to first enclose the I.F. transformers in a shield and then mount them on the chassis. (For more details on I.F. transformer design, the reader is referred to the article by Clifford E. Denton in the April, 1932 issue of RADIO-CRAFT. *Editor.*)

With the information as given, together with the diagram of connections, the constructor should have no trouble in making this set work to his complete satisfaction.

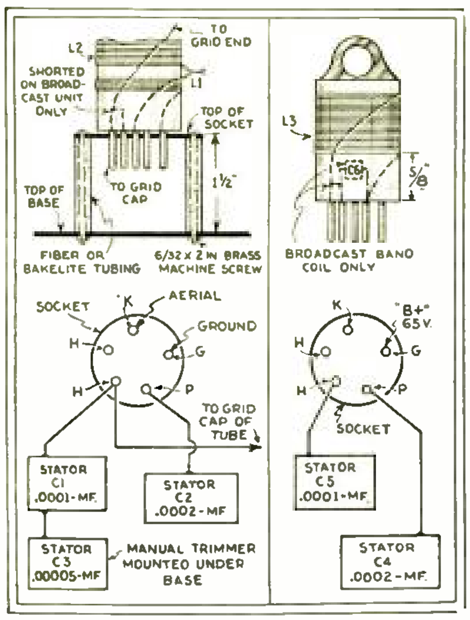


Fig. 3

At the left, the tuning, and at the right, the oscillator coil and socket connections.

Results

This receiver has great sensitivity, good selectivity, very good tone quality, and is capable of giving enormous volume which may be easily controlled by the resistor R3. The writer would like to say that for real quality, he prefers a good, long, air-column horn with a dynamic speaker. It is true that a 9- or 10-foot horn, when coiled up, takes more room than a standard dynamic unit, but it is the writer's choice for real quality.

If the constructor is located very close to a powerful broadcasting station, then it may be desirable to connect R3 to a 40-volt tap on the bleeder resistor R11 rather than on the 25-volt tap as it now is. This change will allow

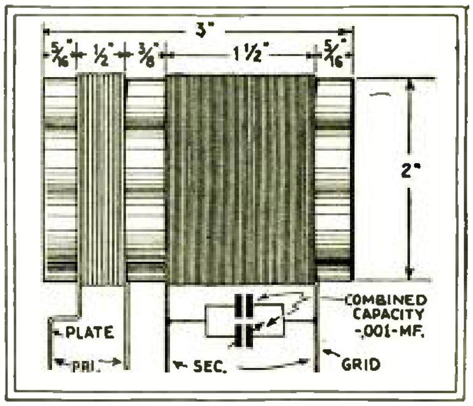


Fig. 4

I.F. transformer coils.

the sensitivity of the receiver to be lowered to a sufficient extent to reduce interference to a minimum.

The writer lives in a section of high noise level and poor-reception conditions, but has had some very good results on both the short-wave and broadcast bands; short-wave stations having been received from halfway around the world. As for the broadcast band, 100-watt stations have been received from California and 500-watt stations from Mexico (the writer is located in Wisconsin).

Short waves are very erratic, so do not expect too much from them and you will not be disappointed. The number of turns for the lower wavelengths may vary a turn or so, especially on the 25-meter coil.

Parts List

Two National Type E.C. special 2-stator condensers, C1 and C2, C4 and C5;
One 50-mmf. trimmer condenser, C3;
One Hammarlund equalizing condenser, 4 to 70 mmf., C6;
One Aerovox .00015-mf. mica condenser, C7;
Three Aerovox 0.1-mf. bypass condensers, C8, C9, C10;
Two Polymet 0.1-mf. condensers, C11 and C12, C13 and C14;
Two Concourse 5-mf. dry electrolytic condensers, C15, C19. (These are the 35-volt type.)
One Aerovox .0005-mf. mica condenser, C16;
Two Concourse 4-mf., 400-volt dry electrolytic condensers, C17, C20;
One Aerovox 0-1-mf., 400-volt condenser, C18;
One Aerovox 0.25-mf. condenser, C21;
One Aerovox filter type 1-mf., 600-volt condenser, C22;
One Aerovox 8-8-8 mf., 475-volt dry electrolytic condensers, C23, C24, C25;
One Lynch 250,000-ohm pigtail resistor, R1;
One Electrad 1,000-ohm grid resistor, R2;
One Carter 5,000-ohm potentiometer, C. P. 5 M., R3;
One Lynch 25,000-ohm pigtail resistor, R4;
One Lynch 6,000-ohm pigtail resistor, R5;
One Electrad 200-ohm resistor, R6;
Two Lynch 0.5-megohm pigtail resistors, R7, R8;
One Lynch 100,000-ohm pigtail resistor, R9;

(Continued on page 696)

MORE NEW TUBES

(Continued from page 655)

low-wattage 2-volt filament in this tube is not rugged enough to stand the rough treatment of an automobile tube, nor would it give good life performance with the high current drain at 165 volts. Its power sensitivity is somewhat better than that of the '33.

A new tube called "ER-LA" has been designed to meet the very severe requirements of automobile output-tubes, outlined above, combining the advantages of the '47 and '33 with the filament rating of the '38 and has proven very suitable for this service.

A filament type had been selected because of the better mutual conductance obtainable. Previous experiences with '71A and '21A tubes had proven that a coated filament of similar rating may be used successfully in automobile receivers.

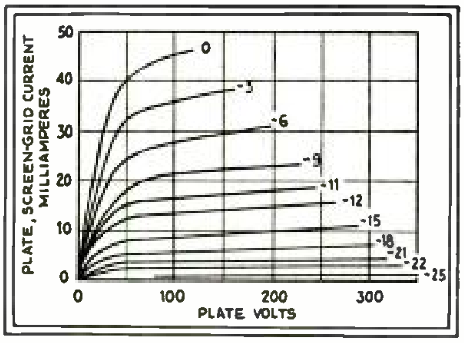


Fig. 16

The rating and characteristics of the ER-LA are as follows: Filament voltage, 6.3 (D.C.); filament current, .30-ampere; plate and screen-grid voltage, 135 to 165 volts (max.); control-grid voltage -9 to -11 volts; plate current, 12 to 17 ma.; screen-grid current, 2.5 to 3.5 ma.; amplification factor, 100; mutual conductance, 1900 to 2100 micromhos; power output 700 to 1200 milliwatts; load impedance, 9500 to 8000 ohms, overall dimensions: Length, 4-11/16 inches; diameter 1-13/16 inches; base, 5 prong.

It was found that the most economical and distortionless operating conditions resulted from the use of two tubes in push-pull with a self-bias higher than normal (class B amplifier) though the *total* power is somewhat less than from two tubes with normal bias. Two equal tubes will balance their even harmonic distortion due to the push-pull arrangement. By selecting proper values of bias resistor and load impedance, the curvature of the dynamic (plate-current—grid-voltage) curves will balance also, and the third-harmonic distortion disappears much the same way as the second-harmonic does in a single pentode. The self-bias eliminates a difficulty usually encountered in class B amplifiers; the plate-current fluctuations are not very much higher than in ordinary class A amplifier.

The distortion balance is maintained with all input voltages up to the value at which grid-current starts. It wil be noted that the "ER-LA," under these conditions, gives much better sensitivity than the '38 and approximately the same power as a '47. Remarkable under these conditions is the value of 70 percent for the efficiency of the plate circuit of the "ER-LA," not counting the screen-grid current and grid bias losses. Taking these into account, the efficiency is of the order of 45 percent. These values compare favorably with plate circuit efficiencies of 40 to 45 percent in pentodes undee normal operating conditions.

SIMPLIFIED COIL CALCULATION

By C. H. W. NASON

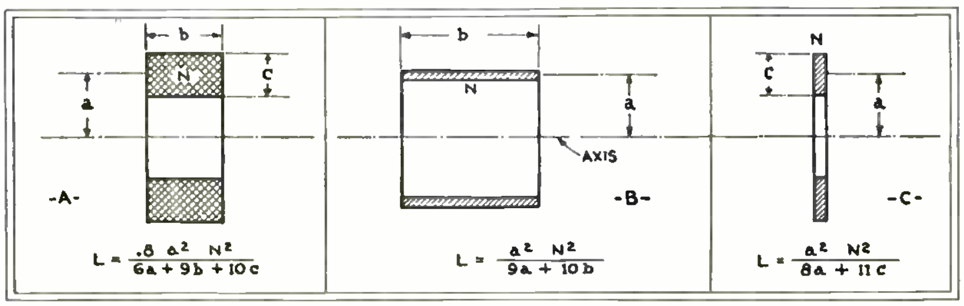
THE archaic method of calculating inductances involves a formula taking into account, not only the actual dimensions of a winding and the number of turns of wire, but a form factor "K" dependent upon the ratio of length to diameter of the form on which the coil is wound. (*See page* 109, *August* 1931 *issue*.) While these formulas are no doubt, accurate to a minute degree in capable hands, the errors possible are manifold; and rarely, if ever, does a coil so designed come within a reasonable degree of the desired inductance.

A considerable simplification of the design problem was evolved several years ago by Harold A. Wheeler of the Hazeltine Laboratories, who is responsible also for the multiplex detector and automatic volume control used by Philco, Fada, and other Hazeltine licensees.

In the illustrations, herewith, three types of windings, which cover practically every case within the needs of the experimenter or Service Man in his daily work are shown. First, we have a multi-layer winding, such as might be employed in the intermediate-frequency transformers of a superheterodyne receiver. Second on the list is a simple solenoid of the type used in the tuned circuits of broadcast receivers. The last is a helical (spiral) winding such as might be used either as a coupling coil in a band selector, as an antenna coupling coil, or as a primary winding for an R.F. transformer. The equations for calculating the inductance are given with each sketch. All dimensions are to be taken in inches and the answer will be obtained directly in microhenries.

The method compares quite favourably with Nagaoka's formula as to accuracy, and is many times easier to use than the older method, in which the form factor had to be taken into account. Accuracy to 1% is obtainable in the case of the multi-layer coil, when the three terms in the denominator (below the line) are nearly equal. The accuracy in the case of the simple solenoid is also to 1% when the length of the winding is greater than four-fifths times the diameter. In the third case, this degree of accuracy is obtainable when the dimension "c" is greater than one fifth the dimension "a".

In no case will the error be greater than is possible with the more tedious method formerly used, when the most exacting care is taken. All that is necessary for the calculation of inductance values is a ruler, a pencil and a copper wire table giving the diameter of various wire sizes, so that the space occupied by a given winding may be known. (*See page* 186, *September* 1931 *issue*).



$$L = \frac{.8\,a^2\,N^2}{6a + 9b + 10c}$$

$$L = \frac{a^2\,N^2}{9a + 10b}$$

$$L = \frac{a^2\,N^2}{8a + 11c}$$

5-METER SET

(Continued from page 675)

such a receiver to moving vehicles becomes evident.

After noting one more technical consideration, that of sensitivity, we will be ready to proceed with the discussion of a practical receiving set design.

Experimenters who have specialized in work below 200 meters are familiar with the difficulty which exists in obtaining "pep" at the lower wavelengths. Now, it so happens that a phenomenon of "super-regeneration" is its increasing efficiency, as a "sensitizing" agency, with decreasing wavelength. In fact, a super-regenerative receiver may be made to operate very nicely at 1 meter.

A Practical Receiver

In Figs. A and B are illustrated United Radiobuilders' custom-constructed super-regenerative receiver, which covers a wavelength range of roughly 3 to 8 meters (more nearly, 3.7 meters to 7.2); its schematic circuit is Fig. 1. In Fig. 2 are shown two details of construction; at A, the coils of the suppressor-frequency inductance L3-L4, and; at B, the end-plate which serves to hold the short-wave inductances L1-L2 and at the same time support one end of the tuning condenser C3. By plugging in a different inductance unit as L1-L2, the minimum wavelength pickup may be reduced to 1. meter; adjustment of C1 and C2 will increase the maximum wavelength pickup.

Following are the electrical values of all the parts used in this receiver: Condensers C1, C2, 30 mmf. (each), "compensator" type; C3, Cardwell Type 404-B, 105 mmf.; C4, 0.5-mf.; C5, .00025-mf.; C6, .0025-mf.; C7, 0.1-mf.; C8, 1. mf.; C9, .005-mf. Resistor R1, 2 megs.; R2, variable, 50,000 ohms; R3, R4, 2,000 ohms (carbon). Radio frequency choke R.F.C. is space-wound with 40 turns of No. 36 S.S.C. wire on a form ¼-in. in diameter. Coils L1, L2, each consist of 6 turns of No. 16 bare copper wire air-wound to a diameter of ⅝-in.; L3, 800 turns of No. 40 S.S.C. wire; L4, 1,500 turns, No. 40 S.S.C. (core diameter, ½-in.). Transformer T has a ratio of 3½ to 1.

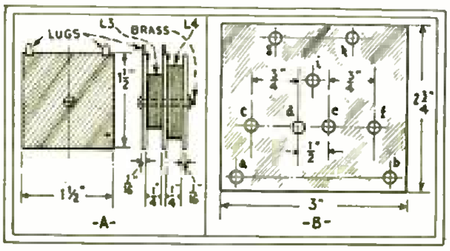


Fig. 2

Parts construction data.

In Fig. 2B, holes A and B are for the angle brackets; holes C, D, E, and F and for General Radio tip-jacks; and G, H, and J, mounting holes for the end-plate of the tuning condenser.

An Acme 30 kc. I.F. transformer may be used in place of a home-constructed unit for L3-L4.

Batteries are connected to this set by means of a battery cable, one end plugging into the 5-prong socket which appears in the illustration. The chassis measures 6 x 8 x 2½ in. deep; the front panel, 7 x 9 in.

Super-regeneration contributes the greater proportion of the sensitivity in this type of set, the receiver illustrated developing a gain of about 80 DB; consequently, volume and sensitivity control may be combined in the operation of a single knob to vary the value of resistor R2. (Further information on this type of reception is contained in the article, "The Short-Wave Superregenode," by Clifford E. Denton. This description appeared in the August, 1931 issue of RADIO-CRAFT. See also the July, 1931 issue of QST magazine.—*Technical Editor.*)

The design of suppressor-frequency coils L3-L4 is not critical; except that the frequency must be kept outside of the broadcast band, and near as possible to the audio end of the

(Continued on page 694)

RADIO DECOUPLING FILTERS

NO doubt you are all familiar with the methods shown in Fig. 1 for the purpose of eliminating coupling between stages by means of filters composed of chokes and condensers or resistance-condenser combinations. The question often arises as to what values these components should have and as to the relative merits of the two systems.

An empirical rule may of course be given in which we state that the condenser should be of such value as to offer a short path to ground for all currents involved as compared with choke or resistance. Of course, in circuits carrying current there will be a voltage drop through the filtering resistors, and where this current is high it is most economical of voltage to employ R.F. or A.F. chokes as the circuit may dictate. For an example: in a

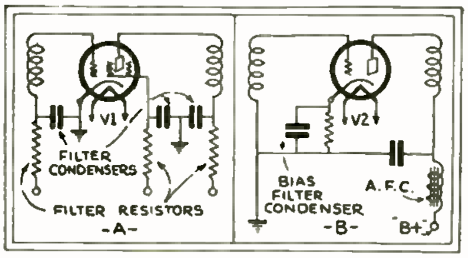


Fig. 1

circuit employing '71A tubes in the output, the maximum voltage available is not much in excess of 200 volts, and should we require a plate voltage of 180 for an R.F. amplifier tube, the drop created through a high filter resistance would be prohibitive. If we are using '45 output tubes we have 300 volts available and can waste 120 volts in the filtering resistance if desired. The filter then can act in the double capacity of filtration and voltage reduction. The value will now depend upon the resistance required to drop the plate voltage of the R.F. amplifier tube to the required value and the filter bypass condenser will be chosen so that it effectively short circuits all stray currents to ground.

Resistance Filter in R.F. Circuits

There is a reason for employing a resistance type of filter in R.F. circuits employing the screen-grid tube which has escaped the attention of most writers and which really prohibits the use of R.F. chokes in this connection. Let us suppose that two filters are to be compared. The first employs a resistance of 100,000 ohms in conjunction with a .1-mf. condenser, which has a reactance of about 1.6 ohms at 1000 kc. This condenser will effectively short circuit the resistance at all frequencies within the broadcast band and also will be effective as far as any harmonics present in the plate circuit of the tubes are concerned. Let us assume that the other filter has an R.F. choke in place of the resistance which has a reactance of the order of 100,000 ohms at all frequencies involved. The efficiency of these two systems is about equal so far as normal conditions are concerned, the only difference lying in the fact that the resistance of the R.F. choke will be but a few ohms and the voltage drop across it will be negligible.

Filtration with the resistance remains effective at all frequencies at which the reactance of the condenser is substantially smaller than the resistance employed. Thus with a resistance of 100,000 ohms and a 1-mf. condenser, which has a reactance of 16,000 ohms at 100 cycles, the filtration would still be quite effective. It is thus evident that, except in the case of the new variable-mu tubes, it is essential that the resistance-capacity type of filter be employed to avoid interaction due to coupling between stages in the power supply circuits.

In A.F. circuits it is much cheaper to employ resistance filters than to use A.F. chokes of equal filtering ability. In most cases the maximum voltage available for the power tubes is sufficient to absorb the voltage drop entailed. It might be noted that no de-coupling filters are required in push-pull circuits, as the signal voltages do not appear in the common circuits. There is a certain amount of second harmonic present, but not enough to make necessary the use of filter circuits or a condenser to bypass the biasing resistance. In push-pull amplifiers employing '50 tubes it is sometimes necessary to employ a small choke in series with the common "B" supply, as these tubes are gassy and oscillation is likely to take place. Such an attempt at oscillation on the part of the tubes is easily suppressed by the use of a small choke in the plate supply lead.

(The reader is referred also to the article, "The Effective Use of Bypass Condensers and Resistors," by P. M. Greeley, which appeared in the August, 1930 issue of RADIO-CRAFT.—*Tech. Ed.*)

RADIO KINKS

(Continued from page 677)

(It is important to remember that an ordinary condenser of low capacity will offer more resistance and develop a higher voltage across its plates than a larger condenser.)

The primary coil will have two audio frequencies of its own, at times; also, the vibrator may be set at from 300 to about 1000 cycles. There is a 2 mf. condenser across the primary coil, which will resonate it at high audio (or low radio) frequencies.

It will be seen that, ordinarily, the secondary can be tuned, so that a harmonic of its frequency will be the same as the fundamental of the primary. Also, that the period of the vibrator can be some fraction of the secondary fundamental.

The 5 meg. and 1000 ohm resistance, are used to *load* the secondary; and also, as a voltage divider and output connection.

Either headphones or the input of an audio amplifier system may be connected to the posts marked, "output."

EMERGENCY "B" UNIT
By Chas. A. Schuldt

I HAD an emergency need for some high voltage D.C. and not having a "B" eliminator handy, I built one in a short time from "junk box" materials, consisting of the following; three, 110V.-to-4V. bell ringing transformers T1, T2, T3; a 4-prong socket and an '80 tube, V; an old audio transformer, T4; and two "Telephone" condensers, C1, C2. The diagram of connections shown in Fig. 3, was very satisfactory.

This unit might be made as a shop "B" eliminator, by inserting a few variable resistances, R1, R2, across the plus and minus, to obtain the several voltages needed.

A NEAT BALLAST TUBE
By C. L. Small

TO mount a lamp bulb on a panel with an ordinary socket looks very cumbersome, so the writer evolved the kink illustrated in Fig. 2.

The lamp bulb was fastened in an old tube base and wires run out to the prongs. This, then, could be placed in a sub-panel socket, and used as filament ballast for a tube in an oscillator.

A sealing compound held the lamp securely in the (ex-) tube base.

HEADPHONES REPLACE THE DYNAMIC REPRODUCER
By Alvin C. Porter

HOSTILITIES will cease for the late listener if headphones are used instead of the speaker; here's how.

Disconnect the voice coil leads from the output of the speaker transformer. The output is then wired to the center terminals of a small. D.P.D.T. switch, as shown in Fig. 4. The voice coil leads, which should be fastened to the fiber insulators for support, are connected to two of the switch terminals. Connect the phones to the two remaining terminals.

In operating, the switch is thrown in one position for the speaker; the other, for the phones. The switch is mounted in the set, together with the necessary binding posts.

THE V. T. VOLTMETER IN RADIO

(*Continued from page 676*)

from the receiver when this input signal has a local field strength equal to the input in microvolts, as indicated on the curve directly above the frequency of the signal; thus, to determine the sensitivity of the receiver in *microvolts-per-meter* at any point (assuming an antenna 4 meters in height as standard), a selected point along the curve (in microvolts) is divided by 4.

The selectivity curves are plotted with field-strength ratios (input microvolts) as the ordinates, and the kilocycles *off* resonance as the abscissas. The first quadrant of the graph (to the right of the center or zero line) is plotted in minus kilocycles off resonance, while the second quadrant (to the left of the center resonance line) is plotted in plus kilocycles off resonance.

The field strength ratio at any frequency is the input in microvolts compared to the input at resonance. The *selectivity* rating of a receiver is defined as the width of the resonance curve when the input signal strength is both 10 and 100 times that at resonance. Thus, in Fig. 2, the selectivity is 20 kc. at 10 times normal and 40 kc. at 100 times normal. (Normal being the input to the receiver at resonance.)

Measurement of R.F. Inductance

The measurement of inductance cannot be accomplished directly with the voltmeter. The instrument is used as an indicating device only.

Two dependable methods are given in the following paragraphs. The set-up for the substitution method is given in Fig. 3, while that of the known frequency-capacity method is given in Fig. 4.

In the substitution method, the only known factor necessary is the calibration of the variable-inductance standard. The condenser C need not be variable. The coupling between Lo and Lp should be very loose. The oscillator is tuned to a frequency which need not be known, but must be in resonance (indicated by the maximum deflection on the V.T. voltmeter) with the oscillatory circuit formed by the unknown inductance, the 2-turn pickup coil Lp, the condenser C, and the resistance R which should be about 5 ohms. When the maximum indication is obtained on the V.T. voltmeter, connected at V.T.-D, the standard inductance is substituted for the unknown inductance. A convenient means of doing this is with a D.P.D.T. switch as shown.

Care should be taken that the settings of the oscillator, pickup coil, or any portion of the wiring are not disturbed. When the standard inductance has been substituted for the unknown, it is then varied until maximum indication is obtained on the V.T. voltmeter. The calibration of the standard inductance at the maximum indication is now determined. This value is the exact inductance of the unknown coil.

In the known frequency-capacity method shown in Fig. 4, the oscillator is adjusted to some *known* frequency; coupling between the oscillator inductance Lo and the unknown inductance Lx is made as loose as possible.

The calibrated condenser is then varied until the circuit is brought into resonance with the known frequency of the calibrated oscillator as indicated by the maximum deflection of the V.T. voltmeter which is connected across the 5-ohm resistance R (shown at V.T.-E).

By calculation, the inductance Lx may be determined by the following formula:

$$Lx = \frac{LC}{Ct}$$

Where LC is the oscillation constant of the frequency, and Ct is the capacity in microfarads of the calibrated condenser C.

The oscillation constant for the frequency may be obtained from the LC table given by Mr. Denton on page 55 of the July 1931 issue of RADIO-CRAFT.

If the operator does not have access to such a table the inductance may be calculated by the formula given below:

$$L_x = \frac{\left(\frac{V}{f}\right)^2}{K^2 \times C}$$

Where V is the velocity of propagation (299,800,000 meters per second), f is in cycles per second, C is the capacity in microfarads, and K is 1882 (if the inductance is expressed in microhenries).

Measuring Mutual Inductance

The set-up for the measurement of mutual inductance is given in Fig. 5. As in the case of measuring other inductances, this cannot be measured directly.

The resistance R is of 5 ohms and the condenser C may be fixed or variable although the variable is preferable. The inductances L1 and L2 are *arranged in the exact manner in which they are to be coupled in the receiver.* If possible, they are attached together as, for instance, the primary and secondary of the ordinary R.F. tuned transformer. The triple-pole double-throw switch is convenient although not necessary. In any event, the inductances are first connected so that their fields aid or add. The true inductance of the combination is then measured. This corresponds to position A of the switch. The inductances are then arranged so that their fields oppose or subtract: this corresponds to position B of the switch. The true inductance of the combination with the fields opposing is now measured.

From the formula following, the mutual inductance M may be determined:

$$M = \frac{La - Ls}{4}$$

Where La is the inductance of L1 and L2 adding; Ls with their inductance subtracting; and M is the mutual inductance in microhenries.

True Inductance

It is thought pertinent at this time to describe the determination of true inductance, although this has no direct bearing on V.T. voltmeter measurements. However, to determine mutual inductance it is necessary that the true inductance of the coils be known.

All inductances have distributed capacity which in reality is in shunt with the inductance of the coil. The true inductance and the distributed capacity give us the apparent inductance of the coil.

When the apparent inductance of a coil is known (the latter measurement is described in a following paragraph), the true inductance may be determined with the following formula:

$$Lt = \frac{La}{\left(1 + \frac{Cd}{C}\right)}$$

Where Lt is the true inductance in microhenries, La is the apparent inductance, Cd is the distributed capacity, and C is the tuning capacity with which the apparent inductance of the coil was determined.

Distributed Capacity of Inductances

Distributed capacity of inductances may be determined by either of the two methods described here. Both will give accurate results. The setup in each instance is the same as that given in Fig. 4.

The inductance, of which the distributed capacity is to be determined, is connected as Lx in the figure. A minimum of four readings at different frequencies with different capacities of the calibrated condenser C are made. These readings of the calibrated condenser are plotted as abscissas, against the wavelength squared as ordinates, on cross-section paper. The result will be practically a straight line. This line is continued to the negative value of capacity which is on the *left of the zero capacity point.* The distance between the point of intersection with the horizontal line and the zero point will be the distributed capacity of the coil.

The second method is somewhat easier. The condenser C is adjusted to about 75 per cent of its total capacity. The coil to be measured is again Lx: call this capacity C1. The oscillator is now brought into resonance by using the V.T. voltmeter as previously described. The capacity of the calibrated condenser C is now reduced to a value about one-quarter of its total capacity, until a maximum indication is obtained on the V.T. voltmeter at resonance with the *second-harmonic* of the oscillator. *The oscillator is not disturbed from the original setting.* The capacity of the standard condenser at this setting is designated as C2. The distributed capacity Cd is determined by calculation from the formula:

$$Cd = \frac{C1 - (4 \times C2)}{3}$$

Measurement of Variable and Small Fixed Capacities

The measurement of variable and small fixed capacities up to approximately .006-mf. is easily accomplished using the same set-up of apparatus as given in Figs. 3 and 4. The positions of the standard inductance and the standard variable capacity C are interchanged; the unknown capacity being placed in the position formerly occupied by the inductance under test. The maximum indication on the V.T. voltmeter is obtained in the same manner as for the inductance tests. The oscillator is brought into resonance with the oscillatory circuit which is tuned by the unknown capacity. The calibrated standard capacity is next substituted for the unknown after which the oscillatory circuit is brought into resonance with the oscillator by its use. The capacity of the calibrated condenser will then be the same as the unknown capacity, the value of which is determined from the condenser calibration curves.

When the set-up given in Fig. 4 is used for the determination of unknown capacities, a standard fixed inductance is used. This is placed in the circuit with the unknown capacity as shown in the figure and the calibrated oscillator brought into resonance with the oscillatory circuit as indicated by the maximum deflection of the V.T. voltmeter. Knowing the value in microhenries of the standard inductance and the frequency of the calibrated oscillator, the capacity may be determined by calculation from the following formula:

$$Cx = \frac{LC}{L1}$$

Where LC is the oscillation constant of the frequency, L1 is the inductance in microhenries, and Cx is the value of the unknown capacity in microfarads.

If the LC table is not handy, the capacity may be determined from the following formula:

$$Cx = \frac{\left(\frac{V}{f}\right)^2}{K^2 \times L}$$

Where V is the velocity of propagation (299,800,000 meters per second), f is in cycles per second, Cx is the capacity in microfarads, and K is 1882 (a constant), and L is the inductance in microhenries.

ELECTRICIAN ADDS CAT TO KIT

RADIO-CRAFT reproduces below a little yarn that might well be applied to Service Men attempting to install an antenna in a tough spot.

Paul Long, Kingston electrician, recommends that every electrician carry a cat!

Long had the job of running a cable through the top of a house, but between the roof and ceiling there was hardly room for him to squeeze in and the distance was eighty feet.

Then he had an idea. He cut a hole in one end just under the roof, tied a string to a cat's tail and shoved it in. Then he closed the hole, leaving an inch-wide opening and cut another hole where he wanted the other end of the cable. He had a long wait, but the cat finally appeared at the second hole. Long tied his cable to the string and completed the job.

CRATER LAMPS

(Continued from page 662)

station. Note that this and the following circuits are so arranged that the variable resistor is always connected on one side to ground. Thus, no high-potential parts are placed on the control panel.

The disadvantage of this circuit is that variations in the control resistor (R2) vary the voltage drop across the plate resistor R, and hence change the plate voltage and alter the tube's characteristics. Furthermore, the maximum amount of D.C. voltage available for the crater is only that between the plate of the tube and ground; and is less than the value supplied by the power pack, due to the drop across the resistor R. One way of overcoming this disadvantage is to use an iron-core choke coil in place of the resistor R. Even then, the total current passed through the choke is large and may affect its characteristics by saturating the core.

In the diagram of Fig. 1C, the disadvantages of the one of Fig. 1B are overcome by making the D.C. supply to the crater tube independent of the output tube. The D.C. for the crater is obtained directly from the plus "B" power supply, and the amount of current is controlled by the 0- to 50,000-ohm variable resistor R1 mounted on the front of the receiver panel.

The A.C. signal current obtained from the load resistor R passes through the 1.-mf. condenser C to the crater lamp.

This simple circuit gives unusually good results with most crater lamps and is highly recommended. The use of resistors throughout gives faithful response over a wide frequency range, resulting in good picture definition.

While the A.C. impedance of a crater lamp varies with the size of the crater, it is usually much lower than the impedance of the usual power tube. For this reason the output tubes are connected in parallel instead of in push-pull. Even with this connection the impedances do not match, and the efficiency of the circuit is low.

Because of the wide frequency response necessary for good picture definition, iron-core matching transformers have been considered impractical by television authorities and consequently few have tried them. But when we consider that the lowest frequency required at 20 pictures per second is 1,200 cycles, it is well within the realms of possibility to design a very efficient transformer having sufficiently flat characteristics between 1,200 and 40,000 cycles for excellent picture detail.

In the circuit of Fig. 1D, an ordinary dynamic loud-speaker output transformer, having a center-tapped primary (for push-pull connection) and a secondary to match the usual voice coil, was employed; and amazingly good results were obtained. This circuit is in other respects the same as that shown in Fig. 1C, the transformer being inserted to match the impedances more nearly and obtain brighter images. *And it works.* Condensers C and C1 are each 1.-mf. capacity; T is the transformer; R1 the 0- to 50,000-ohm control resistor; and R2 a 0- to 10,000-ohm resistor which usually is not required in the circuit, but helps to prevent flickering of the lamp in some cases. It will be noted that no D.C. flows through the transformer windings.

The circuit of Fig. 1E is similar to that of D, except that the primary of the transformer is used as a center-tapped choke, giving a 2-to-1 step-down ratio. It works better than that in D with some crater lamps.

In these transformer circuits, negative images were at first obtained. These were reversed by changing the method of detection, as previously explained.

Figure 1F is somewhat similar to that shown in D except that the matching transformer is connected directly in the plate circuit of the tube. The advantage is that the tube gets a higher plate voltage, and the disadvantage is that the transformer core may become saturated. A push-pull output circuit, with the proper transformer, may give excellent results. Resistor R1 controls the D.C., and R the A.C. through the lamp. In most cases, R may be eliminated.

(Continued on page 696)

TELEKTOR—THE RADIO ROBOT

(*Continued from page 664*)

prevent wasting power while the speaker is not in operation.

The twelve push-buttons that control motors are a little different in operation, as they must be pushed down and *held down* until the desired condition is attained. The operation of these motor-controlled buttons is relatively simple. These buttons are divided into two sections, a "LOWER CHANNEL" and an "UPPER CHANNEL." The lower channel push-button turns the dial continuously toward the 550 kc. (No. "55" on the dial) end of the scale, as long as the push-button is depressed. The "HIGHER CHANNELS" push-button likewise turns the dial continuously toward the 1500 kc. (No. "150") end of the dial. These two push-buttons may be used for cruising or hunting for stations. When a desirable station is located, the finger is immediately removed from the button; for instance, in tuning toward the shorter wavelengths, the "HIGHER CHANNELS" button is depressed until a desirable station is located, at which time, as stated above, the finger is removed. If closer tuning is desired, then the "LOWER CHANNELS" button is depressed which turns the dial in the reverse direction. With a little practice, however, it is a relatively simple matter to tune in an unknown station by means of these two buttons. It is convenient to figure that the motor unit, driving the tuning dial of the radio receiver, travels at an average rate of six channels per-second when operated on a 110 volt, 60 cycle line, or about five channels per-second on a 50-cycle line. (A channel is 10 kc. wide.)

The "INCREASE VOLUME" button, when held down continuously, increases the volume until a maximum point is reached. The "REDUCED VOLUME" button continually lowers the volume as long as the button is depressed, until minimum volume is reached.

These buttons operate the same for the phonograph as for the radio, provided a phonograph relay has been installed.

Tuning of Favorite Stations

Every person has a number of stations to which he listens more than others. To make the tuning of these stations more convenient, the remaining eight buttons are used. It is really here where the Telektor is a true Radio Robot. Each of these eight buttons controls a contact which is mounted on a commutator arrangement in the motor unit. Suppose, for instance, that one of these buttons has been set by the installation engineer for 800 kc. In other words, one of your favorite stations is operating on a frequency of 800 kc. When this particular button is depressed and then released, the dial continuously rotates until the station is tuned in, *and then it stops.* Thus, it is possible to control the tuning of eight different stations at any of the remote points that were wired during the installation.

Different Systems

There are three different Telektor systems available. The type "X" is for wiring in walls to extension Telektor Boxes and controlled outlets in which there are no relay-controlled extension speakers. The type "Y" system is for wiring in walls to loud speaker outlets and built-in dynamic speakers when there are no extension control positions. The type "Z" system is for wiring in walls for extension loud speakers and control position. In all of these systems, a visual tuning meter is located on the Telektor Boxes, as shown, so as to provide accurate tuning without actually listening to the station itself.

It might also be mentioned at this time that the radio set may be controlled manually even though the Telektor Motor Unit is attached. In fact, the manual operator may take control of radio tuning radio and phonograph volume and "ON-OFF" switch functions away from Telektor Boxes so that he retains sole or "Master" control of the system, although persons in distant rooms are still free to turn on and off the loud speakers that are controlled by relays.

A MODERN TUBE CHECKER

(*Continued from page 671*)

tube is normal the meter reads in the center of "GOOD" for both tests. If one or the other button test reads in the "BAD" section or in the "GAS" section, it indicates the tube may have misplaced elements, incorrect plate impedance, incorrect emission, incorrect space-charge properties, or ionization from the presence of gas. This same interpretation will be given for a '50 or any other UX tube placed *in the same socket,* the only operation required being the turning of the selector knob to point to "50," or any other number that corresponds to any other type of tube under test.

Tubes having high mutual conductance will read higher in the "GOOD" section, until a point is reached where the tube is not high mutual conductance, but has gas content. The meter then reads in the "GAS" section.

This instrument will also indicate on one jeweled pilot lamp all plate or screen-grid to control-grid, filament or heater shorts immediately the tube is inserted in a socket. If the test buttons should be pressed when such a shorted tube is in the test socket, or if the tube is shorted from plate or screen-grid to cathode, it will not injure the indicating meter, (but the pilot lamp will light or remain lighted).

Rectifier tubes such as the '80 and '81 and all screen-grid and pentode tubes are tested in the same manner.

Voltage Ballast

To secure this simplicity it was first necessary to design an electrical circuit for placing separate meter shunts and tube voltages in proper relation when the one selector knob was moved; to provide means for adjusting the transformer to different line voltages; and to indicate the proper setting, and all at minimum cost in apparatus. These conditions were met by using a rectifier tube and marking the meter scale at a determined point. Thus, when the input voltage is to be adjusted, a button is pressed, connecting the rectifier into the meter circuit and if the needle of the meter does not point to the mark, the ballast control knob is to be adjusted.

The transformer output current at certain voltages at times reached high limits, due to short circuited tubes creating a completely closed circuit, which, if the current was not held within definite limits, would destroy the shunts, burn out the current-limiting pilot and injure the meter. Also, the transformer current and voltages had to be held to close limits in order to maintain constant values on the 56 different meter shunts; and to control the meter calibration.

The main problem encountered in this respect, after transformer design, was the effect on the input current by use of the usual variable resistance or "ballast" in series with the primary. With the definite output limitations, a variation of line voltage would necessitate adjustment of the ballast, which in turn would alter the amount of resistance in the series circuit. This variation of resistance would effect the current input and in turn effect the output current—a "vicious cycle."

To overcome this defect, the ballast was discontinued and the transformer primary tapped to a rotary adjustment switch, but the same mechanical operation was retained. That is—the adjustment of line voltage requires pressing a button to throw the rectifier in circuit and then turning the small knob to bring the meter needle to the mark. This operation is required only where line voltages vary. (For convenience, the "ballast" type of control is illustrated in Fig. 1.—*Technical Editor.*)

It was then found necessary to slightly alter the shunting system to make any variation in tube test reading correspond proportionately only to the variation in line voltage.

THEORY AND CONSTRUCTION OF ATTENUATORS

(Continued from page 661)

from 1.5 volts, on the input side, to .15 volts, on the output side. This loss expressed logarithmically is as follows:

$$\text{loss in decibels} = 20 \log \frac{V_1}{V_2} = 20 \log \frac{1.5}{.15} = 20 \log 10.0 = 20 \times 1.0$$
$$\text{loss in decibels} = 20.0$$

or, a 20 decibel loss is to be incurred between the input and output terminals of the network to be designed. This is the same as saying that by reducing the voltage from 1.5 volts to .15 volts, or in the order of ten times, a loss of twenty decibels has taken place.

The first problem to be considered is what type of network shall be used to cause this loss in voltage.

In communication circuits, two types of networks used for this purpose are:

(1) "H"-type pad
(2) "T"-type pad

The H-type pad will be discussed first, and a complete discussion will be given showing the method of obtaining the desired twenty decibel loss by the use of this pad in our own problem.

The H-type pad is so called because it is composed of five resistances taking the form of the letter "H". This pad is designated as a balanced network, in that an equal number of resistances (Z1) are used in the series arms on both sides of the line as shown in Fig. 2. In some circuits, the shunt arm Z2 may be divided into two equal parts, with the mid-point grounded. This balances the entire network with respect to ground.

At this point an investigation of certain factors which must be considered in transmission circuits will be given in order that an understanding of the problems encountered in voice transmission will be had. It is of the utmost importance that a general knowledge of the circuit characteristics be obtained, so that when the design of the pads is taken up, maximum efficiency may be obtained from the transmission line in which the pad is to be placed.

In Fig. 3 is shown the output circuit of an amplifier feeding a transmission line, at the far end of which is located an input transformer T1.

The transformer (T2) used in the output circuit of the tube is called a tube-to-line transformer or output transformer, in that it transfers energy from the tube to the transmission line. The secondary side of this transformer is called the *source* impedance of the line, for the energy induced in this winding is the energy transmitted along the line. This transmission line, we can assume, terminates in the primary side of an input transformer (T1), whose secondary side is in the grid circuit of a vacuum tube. This transformer is called a line-to-tube transformer or input transformer, as it transfers the energy from the line into the tube. The primary of this transformer is known as the load or terminating impedance, as the transmission line can be considered as ending at this point, for the primary side completes the transmission line, and the secondary side is considered in another circuit.

In communication circuits the source and load impedances of the transmission line have been standardized in most cases to 200, 500, and 600 ohm lines. Therefore, if ZS, the source impedance, equals 200 ohms, then the load impedance ZL must also equal 200 ohms in order to prevent so-called "reflection" losses from being set up in the circuit. It is these reflection losses that will now be discussed.

Reflection Losses

The speed with which electromagnetic waves travel is the same as that of light, or approximately 186,000 miles per second. This speed is attained only in a circuit having zero losses, which of course is not obtainable in practice. All circuits have some losses, and in transmission lines these losses increase as the frequency increases. The speed of the transmitted waves is retarded slightly by the losses of the line, and by what is known as "skin effect" of the line conductors. (Skin effect is the forcing of the current to flow along the outer surfaces of the conductors.) As the frequency increases, the inductance inside the conductor (mostly in the center) increases, thereby offering a greater opposition to the flow of current within the conductor, and consequently the current is forced to travel along the outer surface of the wires. The relationship which exists between inductance, capacitance, and the velocity of light is:

$$LC = \frac{1}{V^2} \text{ or } V = \frac{1}{\sqrt{LC}}$$

where V = velocity of light in miles per second
L = inductance in henries
C = capacitance in farads

If a frequency of 100 cycles per second is impressed upon a circuit of infinite length (no end), at the end of $\frac{1}{1000}$ of a second the wave will have traveled $\frac{186000}{1000}$ or 186 miles. A part of such a wave is shown in Fig. 4. This circuit is said to have a full wavelength for the frequency of 1000 c.p.s. (cycles per second). In this circuit, when the first part of the waves arrives at a point 186 miles distant from the start of the transmission line, the end of the sa e wave is at the start of the circuit. This is assuming zero losses in the line. The actual wave would be slightly retarded due to the losses of the circuit . This is shown in the dotted lines of Fig. 4.

If now an alternating-current wave is impressed upon a transmission line, it will travel along the line with the speed of light, until it reaches the far end of the line, where, if the far end is open (infinite impedance), the wave will be *reflected* back to its origin with the same velocity, but will gradually decre..se in magnitude as it approaches the starting point of the line, due to the losses of the line which it encounters. If at the moment this wave reaches the starting point another wave is sent *into* the line, that which was left of the first wave adds itself to the second wave and therefore increases the second wave. If, at the moment that the returned *second* wave reaches the starting point, a third wave is sent into the circuit, that which was left of the second wave adds itself to the third wave and so on as the number of waves increases: with the result that an accumulative effect of energy is developed in the circuit. The magnitude to which this reflected energy can rise is determined by a characteristic of the line conductors known as the *"surge impedance."*

The surge impedance of a conductor is the impedance which the conductor offers to these free oscillations of energy at the high frequency limit. (This condition is greatest at the highest frequency that the circuit passes.) This building up of reflected energy in the circuit is known as *"quarter-wave resonance,"* or merely as the resonant frequency of the line. To produce such a condition, it is necessary that the alternating-current impulses occur at intervals of time equal to the time necessary for the energy to travel the length of the line and back. In other words, for one *complete* cycle (*two* impulses) the energy would have to travel the length of the line four times between successive impulses in order to create resonance. Expressed as a formula:

$$\text{frequency} = \frac{46587}{\text{length in mi. 1}}$$

$$\text{or; length in miles} = \frac{46587}{\text{frequency}}$$

It can be seen, therefore, that as the frequency increases the length of the circuit becomes shorter in order to produce the resonant condition. In table 1 is given the length of circuits in miles to produce resonance throughout the audio band.

At this condition of resonance, the magnitude of the reflected energy reaches a maximum, and abnormal voltages and currents are set up in the circuit. This reflected energy, if present in a circuit in which vacuum tubes are employed, *will cause incorrect voltages to be applied to the grids of the tubes, which in turn will cause distortion of the wave-form of the original signals*, with the result that harmonics will be generated in the circuit. As these harmonics increase, the resonant period of the circuit is decreased. This is shown in table 2, where the resonant periods of circuits due to harmonics being set up in the line are given. It can readily be seen that as the harmonics increase, the length of the line necessary to produce resonance is decreased.

Now in practical circuits, such as the transmission lines encountered in everyday sound work, the resonant condition may not be theoretically reached as the fundamental frequencies used are not high enough to produce resonance for the length of the lines ordinarily used, which in most cases are comparatively short. Nevertheless, if the lines are not properly terminated, the reflected energy which is set up produces distortion of the wave-form of the original impulses, which in turn will create harmonics. *These harmonics are multiples of the fundamental frequencies, and as these harmonics increase, the frequency of the circuit increases, thereby approaching the resonant frequency of the line. Consequently, as the resonant period of the line is approached, extreme distortion of the sig als arises, with the result that the quality is atrocious.*

Mechanical Analogy

The analysis of reflected electrical waves is analogous to that of water flowing in a canal. If the near end of a canal is struck a blow, a water-wave will be set up which will travel to the end of the canal, where it will be *reflected* back to the origin. As it travels back toward the starting point, its amplitude will decrease slowly, due to resistance encountered in the canal. If, at the instant the wave reaches the origin, another blow is struck, a second wave will flow to the end of the canal and return. This second wave will be composed of itself, plus that which was left of the first wave. This effect increases as the number of waves is increased, and reaches a maximum when the losses due to resistance prevent the amplitude of the waves from increasing further.

If a gate or obstruction of some sort is inserted at the end of the canal, any waves traveling down the canal will strike the wall and bank up to a height determined by the potential energy of the wave. When the potential energy equals the kinetic energy impressed on the wall, the wave will have reached its maximum height. It can be shown that in certain cases the waves will rise to a height twice that of the original wave striking the wall, and then will be reflected back at a slowly decreasing amplitude as the starting point is approached.

Similarly, in electrical circuits, when an electromagnetic wave reaches the end of a transmission line, and the line is open at the far end as shown in Fig. 5, the wave is reflected back to the source; the current is zero, and the voltage at the load reaches a value equal to twice the peak value of the origin .l voltage.

Also, if instead of open circuiting the far end of the line, it is short circuited, the wave is reflected with a current value twice the value of the starting current, and the voltage becomes zero. This is shown in Fig. 6.

A SIMPLE SET TESTER

(*Continued from page 659*)

jack marked "S.G.", and the screen-grid clip, of course, on the cap of the screen-grid tube. The voltmeter leads can be used on the milliammeter, if it is desired to use that instrument externally.

The milliammeter, being connected in the plate circuit of the tube, gives plate current readings directly. *The voltmeter, however, must be applied to the various points in the circuit by means of the test prods on the ends of the voltmeter leads.* As mentioned above, this arrangement eliminates the necessity for a complicated mess of switching devices. It also makes possible tests between otherwise inaccessible points of the circuit.

In order to realize the full usefulness of the test set, several socket adapters will have to be made, or purchased. The most important are a 4-to-5 prong adapter for the panel socket and a 5-to-4 prong adaptor for the end of the analyzer plug (Fig. 3). The current delivered by the second plate of an '80 rectifier tube can be measured by using a special socket adapter constructed as shown in Fig. 3. It will be noted that the grid and plate wires are reversed; that is, the grid connects to plate, and the plate to the grid. This arrangement connects the milliammeter into the second plate of the rectifier tube, enabling the user to determine if the tube is delivering a balanced output. A bad case of hum can often be traced to an unbalanced rectifier tube.

Besides being useful for continuity tests, the voltmeter can easily be calibrated to read directly in ohms. Many external uses can also be found for the milliammeter.

A "BARBEROUS" ENTHUSIAST

A radio experimenter of Newcastle (England) was not satisfied with the selectivity of his simple one-tube receiver. He installed small variable condensers made of ordinary razor blades, and reports that the tuning is now very *sharp!* Keen young man, what?

"CASH-BOX" SET

(Continued from page 663)

the parts on the baseboard. Connect the filament terminals (heaters) in series with the resistor 20 and connect the other end of the resistor to the plate of socket 19. Then connect the plate terminal to the grid terminal. Make all conoid coil connections, soldering the fixed condensers 2 and 4 in position. Wire in the grid leak and grid condensers. After the wiring of the parts on the baseboard has proceeded as far as possible, rest the baseboard on the lower inside portion of the carrying-case cover and complete the wiring between the parts on the board and those in the case. The tickler coil is wound according to the directions given in the list of parts. It is placed within the shield of coil 3. The two ends are brought out through holes drilled in the coil-shield cover. Great care should be taken to avoid short circuits at these points. The stator of the variable condenser 6 is connected to the "G" terminal of the coil. One side of fixed condenser 7 is soldered to the grounded rotor and the other side is connected to the "F" terminal of the coil and also to the cathode terminal of socket 11 and to one of the heater terminals. The three condensers 13, 16 and 18 are also connected to the same negative return lead, which goes to one side of the outlet. The wiring is then completed to the tickler coil, regeneration control, choke, switch, twin jacks, etc. The baseboard is finally slipped into position and fastened to the back of the case.

Before making the connection with the 160-volt line, check over all wiring carefully. If possible, test the set on A.C. first. Use the Clarostat at all times. It will save plenty of money in case of trouble. It will probably be found more convenient to use it at the baseboard lamp outlet, instead of at the set. Turn the current on and rotate the variable condenser and regeneration control. If no regenerative whistles are heard, it will be necessary to reverse the tickler-coil connections. If the set does not play on D.C., reverse the plug at the outlet. Tube 11 should show a plate voltage of about 57 volts on A.C. and about 100 volts on D.C. To use the Police Thriller, simply remove tube 11 from its socket and insert the plug of the Thriller in its place.

One Electrad regeneration control, type RI-232P, 12, with Power Switch, 21;
One Electrad Truvolt wire wound resistor, 75-watt, type D-4, 20;
One Cardwell .000365-mf. "Midway" Featherweight variable condenser, type 407-B, 6;
One Aerovox .00025-mf. mica condenser, type 1460, 9;
Two Aerovox .0005-mf. mica condensers, type 1460, 2, 13;
One Aerovox .006-mf. mica condenser, type 1460, 4;
One Aerovox .01-mf. tubular condenser, type 280, 7;
Two Aerovox 1-mf. dry electrolytic condensers, type E-51 small, 16, 18;
One shielded "conoid" antenna coupler with special tickler consisting of 70 turns of No. 29 enameled wire-wound on 1-in. dia. cardboard tubing, ¾ in. long.
One I.R.C. 2-meg. metallized resistor (Durham), type M.F. 4, 10;
One Trutest Lightweight "Super-Sensitive" headset, 15;
Two Trutest twin jacks, type SA-196, 8, 14;
One Trutest 30-henry choke (small) type 1892-A, 17;
Two five-prong Eby sockets, type SA-178, 11, 19;
Two 137-A Arcturus Universal A.C.-D.C. Tubes, 11, 19;
Two binding posts, type SA-187, 1, 5;
One Hubbell 115-volt depressed outlet (prongs are on outlet instead of on plug), 22;
One special plug for Hubbell outlet, 6 ft. lamp cord, one attachment plug;
One metal box (inside dimensions of box, 11¾ x 5¼ x 2⅝ ins.; inside dimensions of cover, 11¾ x 5¼ x 11 ins.);
One 3-ply wood strip 11¼ ins. long, x 2⅜ ins. high x ¼-in. thick;
One Clarostat automatic line-voltage regulator, type "50-Watt," 23;
One Universal single-button "Handi-Mike," model No. 50;
One Bud Police Thriller, model No. 2701.

CASH IN AUTO RADIO

(*Continued from page* 665)

radio receiver will stay sold unless it is properly installed and properly watched by the Service Man. The regular Service Man can learn to handle the job but, in most instances, he has failed to do so.

How much do you know about the requirements for installing any type of auto radio on a Buick Eight, 1932, five-passenger sedan, for instance? Do you know the difference in the performance of the same receiver when properly installed in a Ford De Luxe Phaeton? I'll bet that more than eighty-five percent of the men who read this article couldn't answer those two questions satisfactorily. But that only emphasizes the opportunity there is for you.

Several of the leading manufacturers have gone about the installation and service job in a systematic manner and the results have been very gratifying. For instance, Philco, the maker of Transitone Radio, has made an arrangement with suitable auto-battery and ignition-service stations all over the world, which assures them the proper type of installation and upkeep at a modest charge to the purchaser. The same thing is true of Crosley and one or two others. In some instances, these manufacturers have made arrangements with organizations of national or even international proportions, but in others they find it advisable to utilize the services of a local specialist. It is this phase of the situation which should be so very profitable to the man who is already recognized in his neighborhood as a radio Service Man of more than ordinary ability.

A Premium for Service

In New York City, and the same thing is true in other places to a proportionate degree, several of the large department stores offer auto radios for sale at regular intervals. Instead of permitting the customer to have his pet "expert" make the installation, the store sets a flat figure for the installation charge, or includes it in the price of the receiver, and insists upon having it installed in one of the several authorized service stations with which it has working arrangements. In this way, the customer is well protected; and there is an increasing amount of this business being turned over to the service stations which have had the foresight to make a thorough investigation of the special requirements which this type of installation demands. There is still plenty of room, at the top. Even though there may be a very satisfactory station in your town (and investigation among the manufacturers indicates that this is not likely to be true), there are always reasons for the establishing of competition.

A radio installation on a good car should bring the service organization at least ten dollars, when it is done on a contract basis for the radio or automobile dealer. It should bring more, if it is a single job being handled for an individual. Do you happen to know of any other service job which is brought right into your shop, which brings you that much money? There are exceptions, of course, but at least ten "bucks" a throw is a pretty fair average. And no consideration has been given to the repeat business which is becoming less and less in connection with ordinary receivers.

"B" batteries are still fairly high in price, and there is almost as much profit in a set of them as there is in the sale of a complete midget receiver and a set of tubes to go with it. Then, too, you know that the batteries are not going to last as long as the midget. Give your auto-radio customer the proper kind of attention, and you will be amazed at the rapidity with which you will be developing business which should be yours and which has been slipping through your fingers. The manufacturers want you, the sales organizations want you, and the customer certainly wants you. And all three are willing to be more than ordinarily liberal.

A Few Examples

You may want some concrete examples of just how all this can be made to fit into your business. All I can do is let you in on the backstage operations of several service organizations which are typical. From them you will have to draw your own conclusions.

In a western city, a young friend of mine was in the employ of a large radio dealer. He ran the service department and his salary was fifteen dollars a week. When radio was on the increase, the dealer was doing a "land-office" business and was making a pile of money. Then things began to happen; several cut-rate stores opened up on the same block. The dealer would not cut his prices, nor would he utilize some of the sales devices which are now generally recognized as necessary to meet competition. He said he would go broke before he would cut the prices of his high-class lines. He did; I mean he went broke. My young friend was out of a job. He tried sending out post cards to the clientele of the store, letting it be known that he would service receivers for the store's old customers. For some reason or other, the idea did not "click" and the business he was getting was not enough to meet his modest demands for a livelihood.

Then he went to a company which specialized in auto-ignition and battery repairs. He told the manager that he wanted a job where he could learn about ignition systems. He got the job, with very little pay. He let it be known that he was able to take care of the installation and servicing of auto-radio receivers. The result was a deal between the proprietor and himself, where he was to get a commission on all the jobs of that nature which the ignition station would take care of. Some small ads were placed in the local papers and it was not long before the man who was taken on to learn the ignition business was the manager of the radio department. Within a short time, the representative of one of the radio manufacturers visited the station and arranged a contract which brought all the installation and service work from three large stores right into the ignition shop, and it became necessary to put on additional Service Men and take more space. Now this company is doing a fine bit of work and has been able to make special arrangements with a local automobile upholsterer who takes care of the antenna installation. By this method, the inside roof is taken off, the antenna wires put in place and the covering replaced without the antenna being visible; and the job is so well done that there is no appearance of the covering having been removed.

There is a great deal of conjecture about this sort of thing and there is but one real way to get at the facts and that is to get right into the job. There is no branch of service work which is so highly specialized and in which there are so many loopholes. For instance, a great many auto manufacturers are now advertising provisions for radio. You would imagine—and a great many dealers have been fooled, from the manner in which they tell their story—that all you have to do is to get any auto-radio receiver and that the car has been made ready to drop the receiver in. It is not as easy as that, not by a deuce of a shot. Experience with quite a number of such cars indicates that, in many instances, it is necessary to cut the top of the car open, take the so-called aerial out altogether and put a new one in. In other instances, the wire netting which is used comes so close to the metal sides of the body that the pickup is terrible. In further instances, it has been found that some of this wire is actually short-circuited to some part of the body frame.

Easy When You Know How

In this business, just like all others, the fellow who knows what he is about can be away in the lead; while the fellow who undertakes auto-radio installation and service without knowing his "book" is likely to lose a lot of time and money, to say nothing of the confidence, of his patrons. But the bright spot in the whole picture is the fact that this is the time to get on the job and find out what it is all about. If you don't think this is true, just drop around to some of the service stations in your neighborhood and ask a few questions about the installation of these receivers. You will find that in nearly every case, there is little or no system and that the installation is put in on a "cut and try" basis. Here's what can happen when you know what it's all about.

I was in a shop, on Long Island, where they specialize on auto-radio installations. The one in my own car needed a new set of batteries and they were being supplied. A lady drove in and said that she was having trouble with her receiver. It did not seem to get the distance she thought it should. A few questions brought out information to the effect that local stations came in beautifully, but just as soon as she turned the volume control up high enough to get the distant stations—she could get many of them if she did not have the motor running—the stations seemed to fade out and there was a continuous roar in the loud-speaker. The Service Man lifted the hood and made a few passes over the generator. A few minutes later he had installed nothing more than a single fixed condenser. The whole operation took less than five minutes and the "special" ignition condenser brought a dollar and a half. If the same sort of condenser had been dropped into an ordinary receiver, it would have brought one third that amount. Furthermore, the lady got a bargain.

It transpired during a chat that I had with her afterward, that she had taken her car to a number of places and had paid quite a little, at each of them, for the assurance that "there would be no more trouble now," only to find that nothing much had been accomplished. A radio dealer, some few miles from the shop in question, had told her of the service station where I met her and she had driven past more than a hundred similar stations on her way to the Long Island place. The receiver she had was a very good one. The mechanical installation was excellent and nearly every other detail was satisfactory, but the receiver was not doing its stuff. What was needed was a working knowledge of the solution of ignition problems.

Business Building

While I was at the station, three other cars came in and there was a total of more than fifteen dollars' worth of business in considerably less than half an hour. It was all happening in a shop where just one man was doing this particular work and he told me that they were not always so busy, but he counted that day as poor when he did not take in seventy-five dollars. He also told me that he had a very good idea of his operating costs and, from his figures, it was easy to see that he was making a profit of more than thirty dollars after all his expenses had been paid. And all his business was on a cash basis, with one exception. The exception was one of the best auto dealers in the territory who had taken on a line of auto-radio receivers *which he was having installed in all the cars which were traded in for new cars,* as well as making sales of receivers with the new ones. *By installing the receivers in the old cars, he was able to get a much better price for them and was able to get a great deal of publicity which would not have been possible otherwise.*

5-METER SET

(*Continued from page* 684)

frequency spectrum. In fact, when the set is operating correctly it is usual to hear a "hiss"; this disappears when the station carrier is fully tuned in, and by the use of certain reproducers, such as the Radiola Model 100, it may be entirely eliminated.

Stations W2XF and W2XK together constitute the pioneer high-power ultra-high-frequency transmitter in greater New York. Pictures (sight) go out on one frequency band, *and the accompanying sound* on another; simultaneous experimental transmissions sometimes go out on the 40-to-43 megacycle (about 8 meters) band, and the 60-to-80 megacycle (about 4 meters) band, sight and sound being interchangeable. Television *with* 128 *lines per inch* is readily accommodated on either band.

The writers will be pleased to hear from experimenters interested in developing ultra-short-wave operation; and will be glad to answer any inquiries concerning the ultra-short-wave (5 meter) superregenerative receiver.

SERVICING MODERN "SUPERS"

(Continued from page 670)

(4) Connect the power cord of the receiver to the electric power outlet, after all other connections have been completed;

(5) Turn on the radio set and the switch on the service oscillator, adjusting the tube filament power of the latter to about one-third normal;

(6) Turn the service oscillator switch to the I.F. band (making certain the switch is turned all the way);

(7) For Philco models of the "70" and "35" series, set the control knob of the service oscillator to the "130 kc." position (this being used for testing 260 kc.). For models of the "111," 11A (see RADIO-CRAFT Data Sheet No. 45, in the July, 1931 issue), "112," "90" and "51" series, the control knob of the service oscillator should be turned to the "175 kc." position. When adjusting sets with a "Normal-Maximum" switch, the switch should be placed at the "Normal" position;

(8) Turn the radio set volume control to maximum, and set the dial between 60 and 65 on the Philco scale. For maximum sensitivity the indicating needle of the output meter should not be allowed to go much beyond the center of the scale. To keep the output needle at this point, make use of the "attenuator" knob on the service oscillator;

(9) By means of the fibre wrench adjust the various I.F. condensers, one at a time, to obtain maximum reading on the output-meter. It is desirable to start with the last I.F. compensating condenser in the circuit (second I.F. secondary, in the model "112") and finish with the first. (It may be necessary, while the adjustments are being made, adjust the attenuator from time ot time, to keep the output meter readings within the scale range.) After these adjustments have been completed, remove the service oscillator connection from the grid terminal of the first-detector tube and restore the grid clip connection to the terminal.

The "coupling condenser," in the model "51" is adjusted at 175 kc, in the same manner as the I.F. condensers.

Balancing the Receiver's Oscillator

In adjusting the "high-frequency" trimmer condenser, in the set's oscillator circuit, make connection from the A jack of the service oscillator to the ANT terminal of the radio set, leaving all other connections the same as for the I.F. adjustments. The control knob on the service oscillator is set at "1400," with the switch turned from "intermediate" to broadcast." The dial on the receiver is set exactly at 140 (1400 kc.), with the volume control set at maximum. The service oscillator is turned on and its attenuator is again adjusted until a one-half scale reading is obtained on the output meter; if the receiver is badly out of adjustment this may be difficult to obtain, requiring the use of headphones in place of the output meter. The high-frequency trimmer condenser in the set is carefully adjusted for maximum reading on the output meter; or for maximum volume in the 'phones. After making the adjustment, turn the station selector slightly, noting whether any increase in volume can be obtained by this procedure. If so, then the R.F. and first-detector trimmer condensers must be adjusted (as described below), followed by a final readjustment at 1400 kc. of the set's oscillator high-frequency trimmer condenser.

The set's oscillator "low-frequency or "padding condenser adjustment is made with the same connections as when making the "high-frequency" adjustments. In this case, the Philco dial is set at 70, and the oscillator control knob at 700 kc. The low-frequency padding condenser is now adjusted for maximum reading in the output meter. If the service oscillator signal comes in stronger at a position off 70 on the set scale, adjust the padding condenser for maximum output on the meter at this "off kc." position of the set dial. Now retune the set slightly to obtain any further possible increase, adjusting the padding condenser and retuning the set dial each time so as to bring the point of maximum output as near 70 as possible. Then reset the set dial to exactly 140 and readjust the set's high-frequency trimmer condenser, since it is possible that the adjustment of the low-frequency padding condenser has affected the high setting of the dial, somewhat.

The adjustment of the R.F. and first-detector trimmer is done at 140 on the receiver dial, exactly as for its oscillator high-frequency trimmer adjustments.

BOOK REVIEW

TELEVISION, by Edgar H. Felix. Published by McGraw-Hill Book Company, Inc., New York, N. Y. 5 x 7¾ inches, 272 pages, cloth.

Television has been made the subject of so much hysterical writing that it is a pleasure to read a sane, unbiased book that contains digestible information instead of disguised publicity. The author has refrained from smothering existing difficulties in the art with rosy predictions and expressions of blind enthusiasm, but rather treats them with the utmost frankness in the belief that they will be overcome through accurate understanding and comprehending research. His purpose in writing this book has been to develop a clear understanding of how existing television systems work, the basic processes involved, the standards of performance essential to a commercial service, the limitations of certain features of existing methods standing in the way of the attainment of commercial performance standards, and the nature of the developments still necessary to bring performance of public-service quality.

Mr. Felix has written an admirable book in clear, understandable language. Parts of it are technical, but still well within the knowledge of radio constructors and Service Men. After reading it, one can give intelligent answers to the numerous questions that people everywhere are asking about the new wonder of the radio industry. R. H.

RADIO SERVICING COURSE, by Alfred A. Ghirardi and Bertram M. Freed. Published by Radio Technical Publishing Co., New York City. Cloth bound, 182 pages, 124 illustrations, size 5 x 7½ in.

A practical, concise text on the use of modern radio service instruments; and the rapid and systematic attacking of radio service problems.

This book is admirably suited to the need of those who wish to have a handy reference for radio service procedure under practical demands. Even the beginner in the field need not feel a bit uneasy about delving into its pages; since it has been prepared in textbook fashion, with numerous review questions closing all but the last chapter.

These chapters are: (1), Introduction; (2), Electrical Measuring Instruments; (3), Simple Electrical Tests; (4), The Set Analyzer and the Receiver; (5), Trouble-Shooting the Receiver; (6), The Service Test Oscillator; (7), Interference, Noise, and Its Elimination; (8), Vacuum Tube Checkers; (9) Useful Information for Service Men. An exceptionally fine Index closes the book; there are about 360 separate listings.

Particular note should be made that there are 28 circuits of test instruments included in this volume,—which is one of a series constituting a "course."

The amount of technical "meat" which the authors in collaboration have succeeded in cramming into this relatively small space is considerable. Most Service Men will possess a certain proportion of the knowledge contained in "Radio Servicing Course," merely as a result of study and practical experience in the field; nevertheless, much of the book will be new to practically every Service Man, due partly to the wide experience of the authors and their diversified viewpoint of the Service Man's requirements.

SERVICE FORUM

(Continued from page 666)

set, and one stand-off insulator holding it well out from the house, and glass insulators on each end of the aerial.

The ground is No. 14 rubber covered, clamped to the cold-water pipe, near the lead-in end and tied in with a galvanized iron pipe driven in the ground six feet for the lightning arrester. He keeps the ground wet around this pipe. As above stated, the volume decreases when he uses the aerial. We have tried to give you all the information possible regarding the above question.

"RADIO LOUIE"

Box 716, Needles, Calif.

THE TETRADYNE

(Continued from page 682)

One Electrad 15,000-ohm Type D resistance, 75-Watt, R10 and R11;
One 2,000-ohm resistor, R12;
One Electrad 200-ohm grid resistance, R13;
Three 175-kc. transformers, T1, T2, T3;
One Thordarson input push-pull transformer Type 2408, T4;
One Thordarson output push-pull transformer Type 4831, T5;
One Polo power transformer, '45 type, PT.;
One Polo 30-henry choke, CH. 1;
(Choke coil No. 2 is field coil of dynamic speaker;)
One 110-volt A.C. switch, SW.;
One National Type H drum dial with knob;
Two knobs 1-in. diameter for C3 and R3;
One miniature lamp and socket, S.L.;
Three sliding clips for R10, R11;
One aluminum base, size 21 x 11¼ x 2½ ins.;
One aluminum shield-box, size 10¼ x 8¼ x 6 ins.;
One aluminum shield-box, size 8¼ x 5 x 6 ins., with two partitions;
One Pilot tube shield for modulator—oscillator tube;
Ten ft. of Belden shielded wire;
Five ft. of Belden rubber-covered wire;
One molded-bakelite twin jack marked "Field";
One molded-bakelite twin jack marked "Speaker";
Two Eby binding posts, "Aerial" and "Ground".

CRATER LAMPS

(Continued from page 688)

The circuit of Fig. 1G resembles that of Fig. 1E and, like Fig. 1F, the transformer is connected directly in the plate circuit of the output tube. Only one variable resistor R is required in this circuit. As in the other circuits, its value should range between 0 and 50,000 ohms. Excellent results are obtained with this circuit.

One of the best and simplest of circuits is shown in Fig. 1H. Here the transformer primary is used as a choke and the lamp is independently fed with D.C. controlled by the variable resistor R (ranging up to 50,000 ohms). Condenser C is of 1-mf. capacity. For all-round work with crater tubes up to .030-in. in diameter and up to 100-ma. capacity, this circuit is highly recommended.

In the circuit of Fig. 1H, the frequency response may not be flat enough over the whole range to give the theoretical ideal desired. Therefore Fig. 1I has been arranged to overcome any defects which may exist in Fig. 1H. The basic circuit is the same. It has in addition, however, a resistor (about 5000 ohms) R1 connected across the choke to flatten its characteristic curve. The choke may be peaked at 8000 or 10,000 cycles, and the resistor has the effect of cutting off the peaks.

Another point is that the choke may not respond to the highest frequencies due to distributed capacity. For this reason, an air-core choke L is connected in series. This should resonate or be peaked in the neighborhood of 30,000 cycles. A winding from an old audio transformer (removed from the core) may be employed; or a number of large honeycomb coils, tuned with a large variable condenser, might improve results.

SERVICE SHORT CUTS

(Continued from page 667)

rent models, in which it is difficult to detect any trace of this former annoyance.

If the Service Man can inform the owner of such a set that the hum can be "balanced out" at a small cost, he is quite likely to be told to "go ahead." Most independent Service Men have long since learned that these little extra jobs often make his work far more profitable. However, eliminating hum that is due to the original design of the set is not a simple matter, but the solution of the problem as presented here has proved successful and practical of application to a large variety of sets.

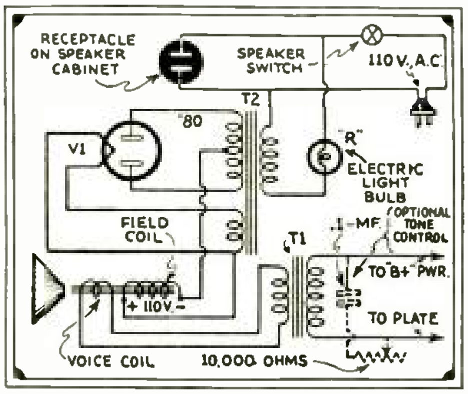


Fig. 4

It is particularly suited to the type of receiver most likely to give trouble of this kind: the conventional T. R. F. receiver, having a '26 or '27 first audio and a single '71 or '45 output tube. The writer has also applied it to other types such as screen-grid sets having push-pull output circuits, with satisfactory results. The method is simple and practical and does not require any changes in the set or its wiring. Despite its simplicity, however, it was only evolved after a great deal of experimental work based on the idea of introducing "bucking hum" into the audio circuit.

In brief, the idea consists of coupling the grid of the first-audio tube to the "C" bias circuit of the power output tube through a high resistance, as indicated at the left of the diagram, Fig. 3. It does not affect the grid bias of the first audio tube, as might appear at first glance, and has only a slight effect on the tone quality, the result being a little lower pitch in the music.

If it is a strong hum that is to be reduced or eliminated, it may be necessary to lower the resistance R to the point where the volume will be slightly reduced. Ordinarily, however, the hum will entirely disappear without producing any noticeable effect on the volume. The method will prove effective in most cases on sets on which all of the usual remedies have been tried without reducing the hum to a satisfactory level. It should not be necessary to add, however, that the method is not recommended as a cure all for poor tubes or defects in the set. It is particularly recommended for use on sets that have plenty of volume and a normal amount of hum, which it is desired to reduce to the level of the best of the new sets. It is also very useful in battery sets that have been converted to electric operation and that have an excessive amount of hum which cannot be reduced otherwise.

Owing to the simplicity of the device, no directions for its installation are necessary other than the diagram. For most sets the variable resistance should have a value of about 100,000 ohms.

A note on hum reduction that is worth mentioning here, since many Service Men may not be familiar with it, is the effectiveness of a variable resistance used to reduce the line voltage going into the set. A 150-ohm heavy duty rheostat connected in one side of the A. C. supply line, as shown at the right of Fig. 3, will often work wonders not only in reducing hum, but many line noises and disturbances that originate in the lighting circuit as well. As most of the more experienced Service Men know, a certain line voltage will give the best results and any increase above this value results in a large increase in hum, line noise, and noises within the set without any gain in performance.

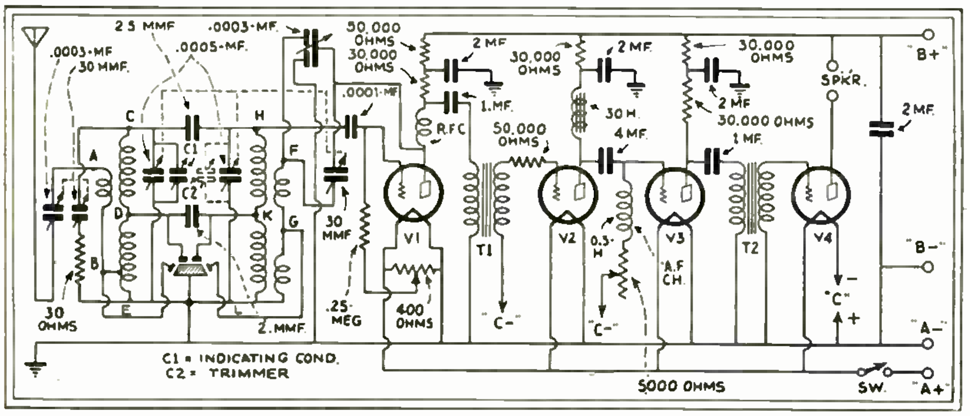
FOREIGN REVIEWS

BRITISH radio constructors are evincing considerable interest in the "Autotone," a new receiver sponsored by and described in *The Wireless World*. The basis of the arrangement consists in extremely high selectivity regardless of loss of quality due to side-band cutting, followed by correction in the audio-amplifier circuit to reinstate the missing frequencies in their proper proportion. This idea seems to bear a close resemblance to the Stenode receiver of Dr. James Robinson, which was the subject of heated controversies in technical circles on both sides of the Atlantic.

The essential circuit of the "Autotone" is shown in the accompanying diagram. The desired high degree of selectivity is obtained merely by the use of a very loosely coupled two-stage band-pass tuner, which feeds directly into the detector tube. If the absence of preliminary R.F. amplification seems strange to Americans, please remember that broadcast conditions in Great Britain and Europe are altogether different from what they are in the United States. Great sensitivity in receivers is not necessary, as the transmitting stations are powerful and numerous. In fact the entire British broadcasting system is designed to provide satisfactory results in even the simplest crystal sets!

The audio "correction" is obtained by a simple control consisting of a .3-henry choke and a 5,000-ohm variable resistance connected in the grid circuit of the second tube of a three-stage amplifier. The set certainly looks interesting, and seems to accomplish the purpose of the much-disputed Stenode with less apparatus. American radio experimenters who want to bite into a real design job might adapt the circuit to domestic parts and tubes.

—R. H.



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On this page are listed booklets, catalogs, pamphlets, etc., of Manufacturers, Schools, Institutions, and other organizations, which may be of interest to readers of RADIO-CRAFT. The list is revised each month, and it will be kept as up-to-date and accurate as possible. In all cases the literature has been selected because of the valuable information which the books contain. If you are interested in subjects not listed on this page, write us and we will try to serve you.

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Fill in and mail the coupon below; make sure that your name and address are included and are plainly written. Order by number only.

22. HOW TO TEST PENTODES. This is a reprint of an article of the same name that appeared in the September, 1931 number of RADIO-CRAFT, accompanied by descriptive matter on the adapters specified for the purpose. If you missed the original article study the reprint; it contains much useful data for owners of testers or analyzers not already equipped to test pentodes. *Alden Manufacturing Company.*

23. YAXLEY REPLACEMENT CONTROLS. Printed on heavy cardboard, 9 by 12 inches, this chart is intended to hang in the service shop as a handy source of information on replacement volume controls. Fourteen different circuit positions for such controls are shown in blue-and-white diagrams, and specific units for various commercial receivers are listed. Normally this chart costs twenty-five cents, but through the kindness of the Yaxley company copies will be sent free to readers of RADIO-CRAFT who make use of the coupon on this page. *Yaxley Manufacturing Company.*

24. HARTMAN SCANNERS. This is a catalog of supplies for television experimenters and constructors. It describes particularly a scanner with semi-automatic synchronization, which is put out in convenient kit form for home assembly. Other special items are rigid disc-mounting stands, framing levers, magnifying glasses, taper-face synchronizing pulleys, blank and drilled discs, and motors. *Dienelt & Eisenhardt, Inc.*

25. AEROVOX 1932 CONDENSER AND RESISTOR MANUAL AND CATALOG. This 48-page booklet is worth having and saving. In addition to very complete specifications on the full line of Aerovox paper, mica and electrolytic condensers, and vitreous enamel, carbon and wire-wound resistors, it contains a great deal of information and data on condensers and resistors in general which the Service Man and experimenter will be able to apply to his everyday problems. *Aerovox Wireless Corporation.*

26. CATALOG OF POLYMET PRODUCTS. Arranged especially for radio dealers and Service Men, and includes detailed descriptions of paper, electrolytic and mica fixed condensers, resistances, volume controls, power transformers, audio transformers and filter chokes. The very complete specifications of all the parts will be appreciated by Service Men, as they eliminate costly guesswork and uncertainty in replacement work. *Polymet Manufacturing Corporation.*

27. DUBILIER CONDENSERS. The name Dubilier being synonomous with condensers in the minds of many people, the latest catalog of Dubilier condensers is sure to be of interest to all classes of radio users. This 16-page booklet describes the entire line of receiving condensers and tells something of the historical background of the company. The special service kit and replacement units are recommended to the attention of Service Men. Included with the catalog is an instructive technical article dealing with electrolytic condensers. *Dubilier Condenser Corporation.*

28. HAMMARLUND PRECISION PRODUCTS. Midget variable condensers and their numerous applications in short-wave and broadcast receivers are discussed in a folder accompanying the complete catalog of Hammarlund variable condensers and coils. Some excellent circuit kinks are given. The catalog contains dimensional drawings of the popular Hammarlund midgets which may be of assistance to constructors designing small receivers. *Hammarlund Manufacturing Company, Inc.*

29. REL SPECIFICATIONS. There is much in this catalog to interest the transmitting amateur. High-grade transmitters ranging in power rating from 10 to 250 watts are described and illustrated, and several circuit diagrams given. Band-spreading short-wave receivers and many special accessories are also included. For the man who "rolls his own" there are coil forms and receptacles, band-covering variable condensers, special tube sockets, wavemeters, transmitting inductors and motor-generators. *Radio Engineering Laboratories, Inc.*

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30. UNIVERSAL MICROPHONES. Carbon-granule microphones of all types from midget "Baby" units to broadcasting studio models are described and their frequency response curves published in this interesting catalog. Thirteen diagrams show how single- and double-button "mikes" are used for different purposes. Other data are given on "mixers" and "faders" for combinations of microphones and phonograph pick-ups, and for hooking "mikes" into radio receivers. *Universal Microphone Company, Ltd.*

31. B-L SOUND MOTION PICTURE RECTOPACS. A four-page folder describing several power packs designed to convert ordinary line A.C. to direct current for the operation of sound-motion picture equipment of either the film or disc type. These units make use of dry metallic rectifiers rather than tube rectifiers of the gaseous type. *B-L Electric Manufacturing Company.*

32. BUD RADIO DEVICES. This is a handy and very complete catalog of radio parts and accessories for the Service Man and set constructor. The short-wave adapters and "police thrillers" in the front section are of particular interest to short-wave fans. Replacement power transformers are listed in convenient reference form, with their terminals marked and numbered for the assistance of Ser ice Men who use them in rapair work. *Bud Radio, Inc.*

33. GARDNER RADIO TRANSFORMER. This folder deals exclusively with power transformers and filter chokes coils for radio receivers and transmitters. Several dozen units are catalogued, and their input and output characteristics described. The available models take care of practically any radio outfit, from the smallest to the largest. *Gardner Electric Manufacturing Company.*

34. MACY EXPONENTIAL HORNS. Microphones, voice amplifiers, loud speakers, horns and other equipment for public address systems are illustrated and described in this catalog, which is punched for use in a standard three-ring, loose-leaf binder. *Macy Manufacturing Corporation.*

35. SHURE CONDENSER MICROPHONE. A very complete description of a high-grade microphone of the condenser type, designed for radio broadcasting, sound recording, public address and sound measurement purposes. The frequency response of the instrument is said to be comparatively flat from 40 to 10,000 cycles. *Shure Brothers Company.*

36. INSTALLING SHIELDED LEAD-IN WIRE. In locations where interference from outside sources is unusually bad, the use of a high aerial with a shielded lead-in helps alleviate the trouble considerably. This folder discusses the problem and tells the correct methods of installing both the aerial and the lead-in. *Belden Manufacturing Company.*

CRAFTSMAN'S FORUM

(*Continued from page 674*)

veloped further, and work started at a much earlier date, it is probable that any one of the three would have contained patentable features! As it is, several similar instruments, now in laboratories, will be put on the market in a short time; at least two of these will incorporate the buzzer idea, shown in a general way in Fig. 2B. It is interesting to note that by using T as a transformer with a secondary potential of about 110 volts, it becomes possible to operate a standard 110 volt A.C. receiver; rectifier V1, the choke, and the condensers are then unneeded.—*Technical Editor.*)

CONCERNING "UNEXPLORED RADIO"

Editor, RADIO-CRAFT:

I was glad to see in the March RADIO-CRAFT your editorial mentioning the crystal. This depression has stimulated interest in this "natural detector," more (here in the country where I live) than there was in 1922 when I built the prize-winning "Radio Gem" circuit, described in "Radio News" magazine, as my first set, and could, on occasion, hear a station in San Francisco, 400 miles.

I think you were too modest in placing the crystal range at only 300 miles. On my new DX crystal set, I have in the last three months received KFI, Los Angeles, distance 750 miles, with good headphone volume on an average of 5 nights a week; and at least hear them every night. I also hear KNX about three or four nights a week; KSL (600 miles), the same as KGW (120 miles), daylight every day; and many others, (always several each night). Also, I have heard XER, Mexico, once this winter (1,570 miles). I have had KFI on two separate nights on a speaker so loud as to be understood anywhere in a 16 x 14 ft. room; crystal only, (no extra power amplification); I used a Baldwin unit and an exponential horn. Also have had KOAC, 1000 watts, on a speaker, audible 10 feet in line of horn; (distance 40 miles), *daylight*, too!

A friend duplicates these distances with another crystal set in Eugene.

J. M. NIGHSWANDER
Route 3, Box 289, Eugene, Ore.

(As pointed out by Mr. Gernsback, in the editorial to which our correspondent refers, the *usual* range of a crystal is only about 15 to 25 miles, yet under certain conditions this may be extended to 300 miles. It is quite natural to suppose that under still other conditions all of the elements necessary to long-distance reception would, infrequently, conspire to hang up a nice, long air-miles range of reception from a certain group of stations. It is evident that Mr. Nighswander has given exceptional attention to the problem of obtaining the last bit of sensitivity from crystal detectors, since he has been working with them for over ten years. He is certainly to be congratulated in having obtained such remarkable results from "ye olde crystal."—*Technical Editor*).

INDEXES

Editor, RADIO-CRAFT:

Here is a suggestion which I am sure will be welcomed by Service Men, engineers, and anyone who has need of radio magazine articles for future reference. The suggestion is to include in every issue a perforated table of contents with stickum on the back. This would enable the reader to file away, in his own system of indexing, each article he desired; service hints and helps should have a perforated title for each hint. It would only be necessary to tear out this index along the perforations and paste it in his index-book, scrap-book, or what have you.

Hoping this suggestion may be of value to you, I am,

H. W. MALMSTROM
2511 *East Grand, Everett, Wash.*

(As pointed out some time ago in this department, it is extremely difficult to index some of the departments, particularly, "Operating Notes." However, stronger deterrents are the regulations of the U. S. Post Office Department, and the mechanics of magazine makeup. Admittedly, an extensive index would interest many readers.—*Technical Editor.*)

Hotel Directory of the Radio Trade

The Hotels on this page are Patronized by the Radio Trade. Make them your Headquarters.

IMPORTANT ANNOUNCEMENT!

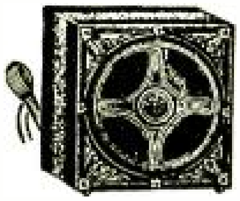
On pages 680 and 681 will be found a very important message telling of the new RADIO-CRAFT LIBRARY. Be sure to turn to these pages NOW and learn of the new and interesting books which are being published.

• Index to Advertisers

(While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.)

$100,000 SPEAKER SALE!

Included in this tremendous speaker sale are the products manufactured by leading speaker makers. Every speaker is brand new and shipped in original factory sealed cartons. They are sold far below their regular list price because they were bought in exceedingly large quantities and our purchase price permits us to give you the benefit of low cost.



DUO MAGNETIC

Duo Magnetic Speaker **$3.95**

Duo Inductor Dynamic Chassis **$3.95**

Similar to Farrand Inductor.

JENSEN

A.C.—D.8 Dry Rectifier **$14.95**

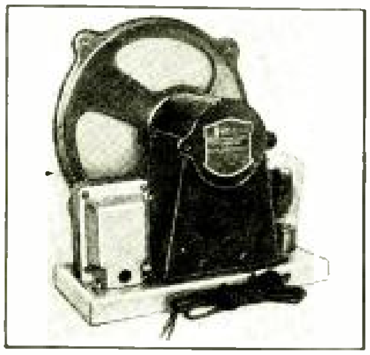
A.C.—D.7 Jr. Audit Tube Rect. **$12.95**

A.C.—D.15 Concert Jr. Tube Rect. **$8.50**

D.9—2500 OHM D.C. Field **$7.50**

D.7—2500 OHM D.C. Field **$8.50**

D.15—Midget Concert Jr. 2500 OHMS **$4.75**



ROLA

A. C. Models

Model O-90-C A.C. using 280 Rect. **$9.95**

Model K. Midget A.C. using 280 Rect. **$8.50**

D. C. Models

2500 ohm P.P. Output Trans.
1000 ohm P.P. Output Trans.
2500 ohm Single Pentode.
2500 ohm Push Pull 238.
1000 ohm Single 238.
1800 ohm Single Pentode 300 ohm Tap for Bias.

$4.25 Each Model

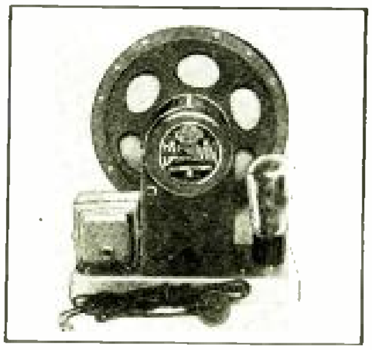
BALDWIN

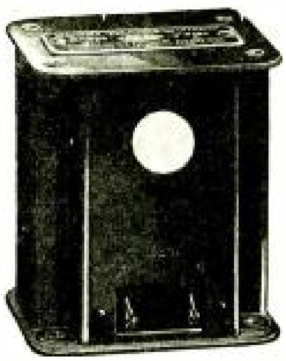
A. C. using 280 Tube Rect. **$7.50**

D. C. 2500 OHM—110 Volts **$5.50**

D. C. 2500 OHM—110 Volts Field Less Stand **$4.00**

D. C. 2500 OHM—110 Volts Field Less Output Trans. **$3.25**





SANGAMO TRANSFORMERS

Sangamo transformers are offered to the public for the first time at these reduced prices.

Sangamo A. X. Audio Transformer. Price **$1.75**

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All offers are F.O.B. New York, and subject to prior sale. Terms: A deposit of 20% is required with every order. Balance may be paid on delivery. Or, deduct 2% if full amount is sent with order.

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Radio. Audio. Ground Potential measurements. Hughes Induction Balances and other types.

Oscillators and amplifying systems are included.

We can supply all materials needed for building and operation of any of the recognized treasure finders.

WITH this apparatus you can locate buried treasures, metal war relics, mineral deposits, subterranean water veins, buried gas and water pipes, and lost outboard motors, tools and treasures sunken in water.

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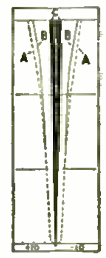
Build Your CUSTOMERS The Revolutionary STENODE

The Receiver That Is NOISE FREE on SHORT WAVES or BROADCAST



STENODE selectivity curve makes 10KC selectivity, so-called, look like broad tuning.

STENODE selectivity is compared, at left, to that of ordinary receivers. All background noise is contained in outer curve. Stenode's curve, shaded, contains but 1-10 the *total* noise.

STENOTUBE. Only one required in each Stenode. This heart of the Stenode circuit consists of a quartz crystal ground to 175KC frequency and mounted in tube form for easy handling. Standard UX socket base. Price $15.

Made in England

A STENODE demonstration will create more new custom set prospects than any radio receiver ever did before. People listen in amazement when they hear stations free of background noises and absolute silence between stations. When you tune out heterodynes and whistles and stations STAY IN strong and crystal clear, owners of all other sets gasp in astonishment. The former chief of wireless research of the British Royal Air Force, Dr. James Robinson has given an entirely new principal to radio in STENODE.

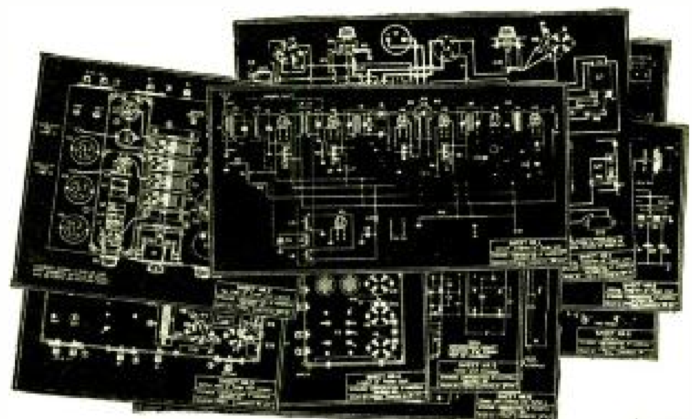
By the STENODE principal the highest selectivity ever attained as well as unprecedented tonal range is now made possible. All engineers agree that it is impossible with ordinary superheterodynes.

STENODE amplifies signals most and static least. That's why YOU want to build an 11 tube STENODE to work with a SHORT WAVE adapter when it is not used to log and listen with enjoyment to more broadcasters than can be heard on any other type of radio. STENODE selectivity is 5 to 1 greater than that of so called 10KC Supers. The noise does not get in along with the high audio frequencies, and the STENODE reproduces perfectly higher frequencies than ever heard on any other receiver giving

500% BETTER SELECTIVITY
1000% MORE FREEDOM FROM NOISE
INFINITELY BETTER QUALITY

None genuine without the inventor's signature.

James Robinson



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Increased demand for Stenode Data Book, Instruction Book and Blue Prints permits our cutting former price in half. Those who have already sent in full price will receive our check for $5. We are not interested in making profit from our engineering service. Our profits come solely from Royalties paid us by our licensees.

GERNSBACK PUBLICATIONS, Inc.
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The STENODE opens up new fields for short-wave and television work, as well as broadcasting. Full details of all sorts of applications are given in the STENODE Data Book. Nine full-sized diagrams show where to place every part. How to make every connection is clearly told in STENODE Book of Directions. Your finished STENODE will put you into a new field of radio. Fill in and mail the coupon with your money order for the biggest value ever offered custom set builders.

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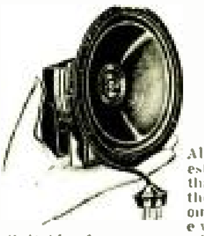
GERNSBACK PUBLICATIONS, Inc.
98 Park Place New York, N. Y.
SOLE SELLING AGENTS

IF IT ISN'T A STENODE IT ISN'T A MODERN RECEIVER

MAY SPECIALS!!

NOTICE our important New departure in announcing Special values. Every month we will show on this page certain *STAR* ★ items, which are NOT LISTED IN OUR CATALOG. These are all specials of which the quantities on hand are not sufficient to catalog them. *Once sold out, no more can be had.*

STOP SHOPPING. The lowest prices are right on this page. *No one undersells us.* We meet any price on ANY NEW Merchandise. Order direct from this page and save money. 100% satisfaction on every transaction. Take advantage of these special offers. ORDER NOW, TODAY.



NEW! "LITTLE GIANT" DYNAMIC SPEAKER

Absolutely the smallest dynamic speaker that will withstand the strain of modern output power tubes, ever manufactured. Suitable for use in midget, portable and automobile receivers. Measures but 6¾ in. long over-all, having a 1½ in. diaphragm and weighing but 4 lbs. The "Little Giant" has, under test, actually flooded a ten-room apartment with faithfully reproduced music of virtually original tone quality. Field winding has a resistance of 2500 ohms and may therefore be energized by using it as a filter choke in the power pack, thereby serving a double purpose. This last feature makes the "Little Giant" excellently suited for portable A.C. sets, since it does away with filter chokes and thus with considerable weight. Equipped with built-in output transformer to work from any standard output power tube arrangement. Specify the power tube or tubes used when ordering. Shipping weight 5 lbs. **List Price $6.50.**

No. 1549. LITTLE GIANT DYNAMIC SPEAKER. Your Price $2.50

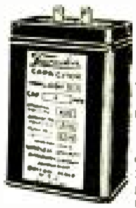
★UTAH A.C. DYNAMIC SPEAKER—Only a Few Left

110-volt, 60-cycle A.C. light socket supply for field excitation with Westinghouse dry rectifier. 9 in. high, 9¼ in. wide, 7½ in. deep. Speaker comes packed in wooden crate. Weight 19 lbs. It is one of the most powerful as well as best reproducers in the market. 9-inch cone.

List Price, $50.00.

No. S P. 1506—Your Special Price $7.45

★FARADON 4-MFD. FILTER CONDENSER



Here is just the condenser for constructing noise filters. In some cases one condenser connected across the line or instrument will be sufficient. However, in most commercial filters there are two condensers connected in series; the center-tap being grounded and the two remaining leads connected across the light line or the interference-producing apparatus. Put up in a neat, black-enameled case with tinned lugs for soldering connections. 2" high x 3½" wide x 2¾" deep. Working potential 600 volts D.C. Ship. wt 6 lbs. **List Price $7.50.**

No. S.P. 9062—Faradon 4 Mfd. Filter Condenser. Your Price $1.50

World-Wide Short-Wave Set

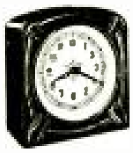
NOT A CONVERTER

NEW

A perfect radio short-wave receiver for use between 18 and 200 meters. To put into operation, connect antenna, ground, 15 volt "B" and two No. 6 dry cell "A" batteries, and headphones to the posts provided, plug in a type '30 tube, and tune in! An ingenious circuit makes possible a 1 coil single-winding plug-in design. This little instrument has the same **sensitivity** as many big, shielded short-wave receivers costing ten times as much. A power amplifier may be added for any degree of volume. Complete with 4 plug-in coils. Has fine vernier dial for precision tuning. **Never has a first class short-wave set sold for so little money.** This short-wave set measures 5½x7x1 in. high, over all. Ship. weight, 3 lbs. List price, $12.50.

No. 1666—World-Wide S.-W. Set. Your price $6.25

NEW! NEW! SYNCHROMATIC ELECTRIC CLOCK



Never was such a first class electric clock sold at such a ridiculously low price! An electric clock **using the famous synchromatic movement.** Naval observatory time right from your light socket! No spring to wind, no batteries. Never out of order. Lubricated for a life-time at the factory. The entire movement with its white-enameled dial and artistic numbering is enclosed in a dustproof and shockproof genuine molded Bakelite case. The case is of walnut brown finish with simple but catching design. For 110 volts, 60 cycle A.C. operation only. Complete with cord and attachment plug. Size 3⅞"x1¾"x1⅞". Weight 1 lb. Service men now sell these fine clocks by the hundreds. Be the first in your locality to handle them.

List Price $3.00.

No. 1689—Synchromatic Electric Clock. Your Price $1.00

NEW RESONANCE TUNING METERS

This ingenious device **INDICATES VISUALLY** when a station is exactly "tuned-in-on-the-dot." Receiver is tuned to its most critical resonance point for any given station when needle swings to farthest position. Servicemen profit by installing these meters in sets which are not so equipped. Have only scales and pointers visible through an escutcheon plate. Used in new Stromberg-Carlson sets.

EXCELLENT TUNING DEVICE FOR SHORT-WAVE RECEIVERS. The extremely sharp tuning short-wave stations are very easily detected by this visual indicator where the ear usually misses them. Easily installed on any receiver by placing it in series with the plate of the power tube. Shipping wt. ½ lb. Available in two styles.

TM-103—(Illustrated) Enamel finished dial—lighted from flat side of the case over the top of the dial.

TM-100—Translucent dial—lighted from rear window

List Price $1.50. Your Price $.90

Escutcheon Plate ....$.25 extra

Pilot light and bracket ....$.30 extra

FREE 76 Page Radio Treatise No. 24

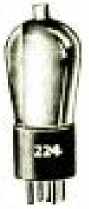
The new Winter edition of our RADIO SERVICE TREATISE, twice as large as our former one, has just come off the press. It is positively the greatest book in print—NOT JUST A CATALOG. It contains a large editorial section—a veritable book in itself—with valuable information **NOT FOUND ANYWHERE ELSE.** Among the wealth of new technical information listed in the editorial sections are the following: 1932 Complete Radiotron Characteristics **SHORT-WAVE TUNERS** and **PHONO-PICKUPS.**—Constructional Data of **SERVICEMEN'S TEST OSCILLATOR—ALL ABOUT TONE CONTROLS—SHORT-WAVE ADAPTERS AND CONVERTERS—CONSTRUCTING A 3-TUBE SUPER-HET SHORT-WAVE CONVERTER.—MODERNIZING OLD RADIO SETS.—LATEST TYPE MULTI-MU AND PENTODE TUBES.—ALL ABOUT DC RECEIVERS.—VACUUM TUBES TREATISE.**—And dozens of new radio experiments, hints to Servicemen, valuable tables of useful data, etc., etc.

This book is not just another catalog but a veritable mint of radio information which will be of infinite and everlasting value to you.

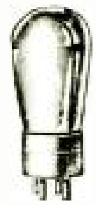
100 New Hook-Ups, etc. 675 Illustrations.

WRITE TODAY. Enclose 2 cents for postage. Treatise sent by return mail.

6 MONTHS GUARANTEED NEONTRON TUBES



Sold on a **6 MONTHS FREE REPLACEMENT GUARANTEE BASIS, PROVIDING TUBE LIGHTS!** All tubes are carefully tested before shipment, and carefully packed. Do not confuse these HIGH QUALITY tubes with any other "low priced" tubes—our low prices are possible because we do a VOLUME business!



Choice	Choice of	Choice	Choice	NEW Choice	NEW Choice
226	112A	245	222	230	235
227	200A-199X	280	210	231	247
171A	199UV-120	171	250	232	238
201A	224		281		236-37
					551
60c ea.	69c ea.	70c ea.	1.58 ea.	1.08 ea.	1.08 ea.

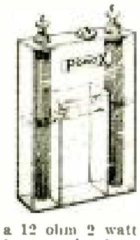
R.C.A. LICENSED TRIAD AND PERRYMAN TUBES

These nationally advertised tubes are guaranteed UNCONDITIONALLY for six months. The prices are slightly higher than our NEONTRONS because these tubes are of much better quality. See listing above for tube numbers.

Choice Price	Choice Price	Choice Price	Choice Price	Choice Price	Choice Price
63c	80c	75c	$1.76	$1.15	$1.15

★"POROX" 2-VOLT STORAGE CELL

5 Ampere-Hours—For 2-Volt Tubes



One such unit **will light a two-volt battery tube for 75 hours continuously.** Will handle two 2-volt tubes for 35 hours, etc. Put up in a transparent composition container with two non-corroding terminals clearly marked as to polarity. Easily recharged either directly from a 110 volt D.C. line in series with a 10 watt electric light bulb or from an "A" eliminator in series with a 12 ohm 2 watt resistor. Excellent for use in any circuit requiring a steady source of current. 3" wide x 4" high x ⅞" thick. Instructions included. Ship. wt. 2 lbs.

List Price $4.50

No. S.P. 9060—Porox 2 Volt Storage Cell. Your Price $.80

★6-VOLT BATTERY PHONO-MOTOR

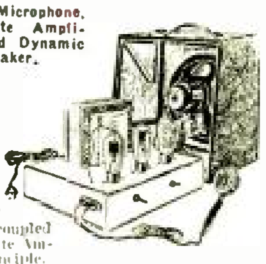
At last a **REAL** battery motor—designed especially to meet the needs of semi-portable and portable address systems especially installations on moving vehicles. It will easily and economically operate from 6 volt storage battery or the equivalent in dry cells. Draws very little **current. The entire motor is flexibly** pivoted upon a cast metal frame and is held taut at all times by a compensating spring, thus assuring positive contact of the friction drive gear against the inside rim of the turntable.

This arrangement was designed to overcome the effects of bumps and jars experienced by moving vehicles. The motor is sold complete with 10 in. turntable, mounting plate and motor switch and speed control. Shipping weight 10 lbs. **List Price, $15 00.**

No. SP9058—6-Volt Battery Phone Motor. Your Price $2.50

★VERSATILE PORTABLE PUBLIC ADDRESS SYSTEM

Comprises Microphone, Loftin-White Amplifier and Dynamic Speaker.



A recently completed all electric A.C. development incorporating all the features and advantages of the direct-coupled Loftin-White Amplifier principle.

The amplifier is a high quality two stage job, having some **RADICALLY NEW IDEAS IN AUDIO FREQUENCY AMPLIFICATION** and employing 1-'27, 1-'45 power tube and 1 '80 full wave rectifier. It is remarkably free from A.C. hum.

The design is adaptable to all purposes, i.e., microphone, radio and phonograph. Has an undistorted power output of approximately 3.5 watts; **SUFFICIENT TO OPERATE FROM 2 TO 3 ADDITIONAL DYNAMIC SPEAKERS.**

The portable address system is sold **COMPLETE WITH THE NEW R.C.A.-VICTOR HAND MICROPHONE;**—a sturdily constructed unit which will withstand a lot of rough handling.

Put up in a single compact and perfectly balanced carrying case, the front of which is utilized as a baffle for the self contained dynamic speaker. Complete with microphone and accessories the weight is only 30 pounds. For 50-60 cycles, 110-20 volts A.C. operation. Shipping weight 38 pounds.

List Price, $75.00

No. S.P.9063—Versatile Portable Address System. Your Price, complete with microphone $25.50

★R.C.A.-VICTOR HAND MICROPHONE

The most ruggedly constructed hand microphone ever manufactured. There is not another of its kind that is quite as sensitive. Designed especially for home recording and personal entertainment. Requires but a 22½ volt battery to operate. Easily connected to any radio or amplifier in a few minutes. This unit is essentially a single button carbon microphone — acoustically centered in a stout metal housing which serves the dual purpose of protection and noise shielding. **Responds indiscriminately to all speech and music frequencies.** Has a high D.C. resistance and may therefore be shunted directly across the grid and cathode of the detector tube without employing a coupling transformer. Sold complete with 5 ft connecting cable. Shipping weight, two pounds. **List Price, $10.00.**

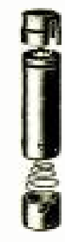
No. S.P. 9064—R.C.A.-Victor Hand Microphone. Your price $2.75

Screen Grid Cap Connectors

Newest SCREEN GRID CAP Small, neat in appearance and ruggedly constructed. A stark necessity in service work. Sold only in lots of 12 or more. Shipping weight 4 oz.

No. 1672—Screen Grid Cap Connector. Your price. . . . Dozen $.12

★Guaranteed 8-Mfd. Electrolytic Condensers



Judiciously used in many parts of any R.F. or A.F. circuits, in power packs, in dynamic speakers, **they will perform miracles in eliminating any trace of objectionable A.C. hum** or other incidental disturbances. These electrolytic condensers are particularly recommended for 250 power packs. Where the working voltage of the unfiltered A.C. is 800 volts, two electrolytic condensers in series will stand up indefinitely.

Easily mounted through the use of a bayonet socket base which is equipped with a "positive contact" spring. Totally shielded and protected by a copper cap. Shipping weight—1 lb. **List Price, $2.50.**

No. SP9054—Guaranteed 8 Mfd. Electrolytic Condenser. Your Price.... $.49

WE ARE A WHOLESALE HOUSE AND CANNOT ACCEPT ORDERS FOR LESS THAN $3.00.

If C. O. D. shipment is desired, please remit 20% remittance, which must accompany all orders.

If full cash accompanies order, deduct 2% discount. Send money order—certified check—U. S. stamps.

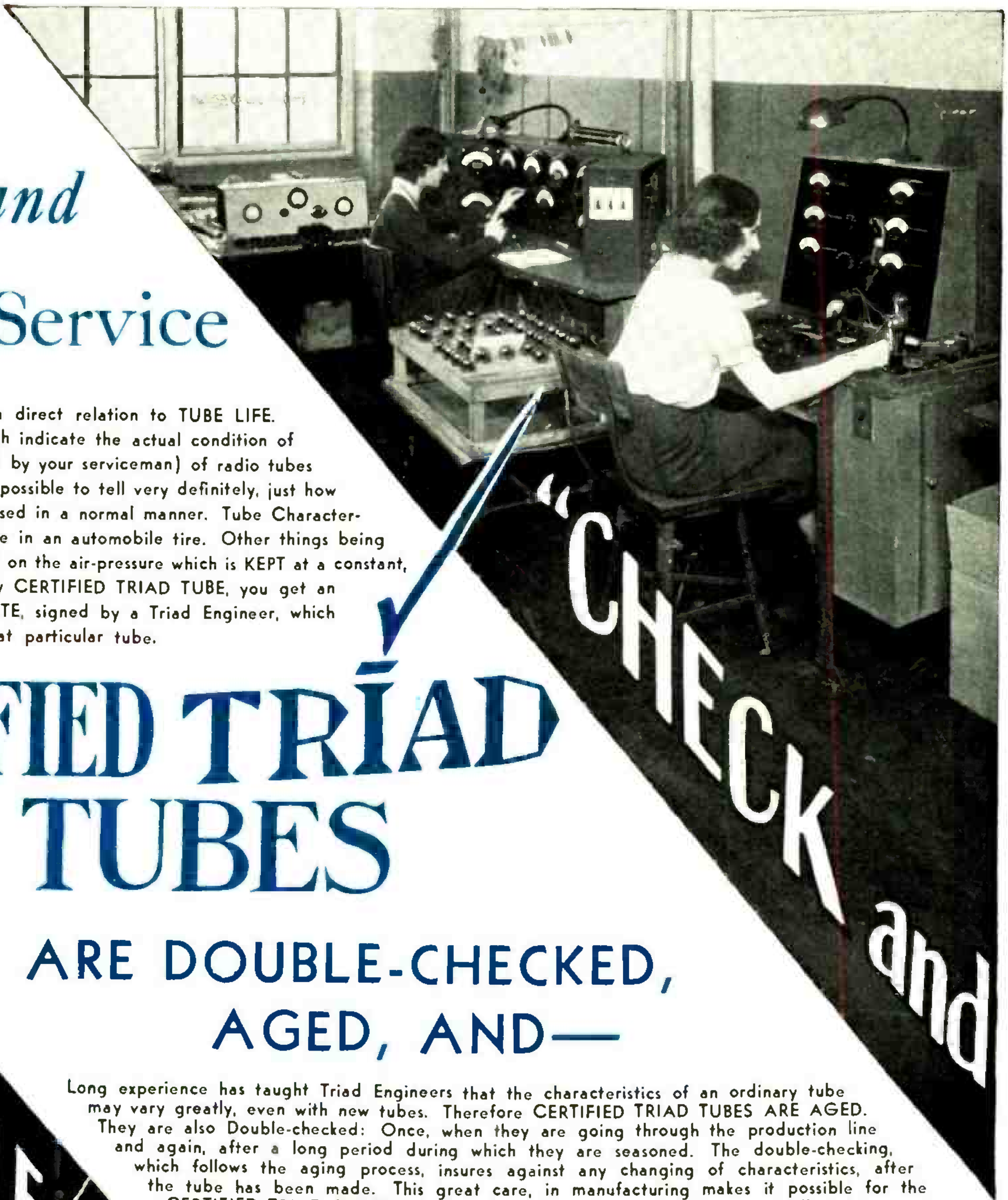
Radio Trading Co.
23 West Broadway
New York, N. Y.

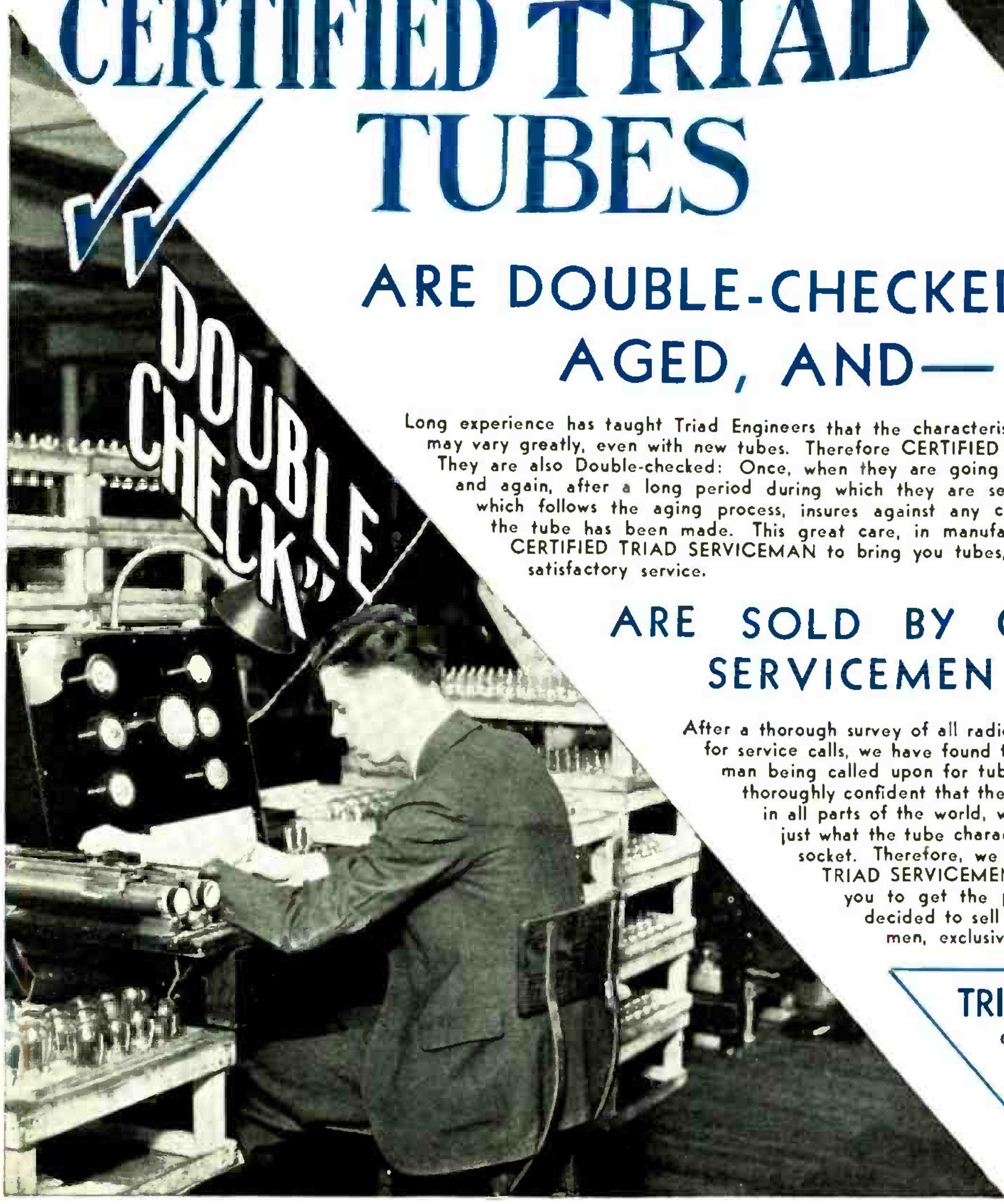
ORDER FROM THIS PAGE. You will find special prices from time to time in this magazine. Get our big FREE catalog for the greatest Radio Bargains.

Should you wish goods shipped by parcel post, be sure to include sufficient extra remittance for same. Any excess will be refunded.

NEW Tubes *and* a NEW Service

TUBE CHARACTERISTICS have a direct relation to TUBE LIFE. If the characteristics (Figures which indicate the actual condition of the tube and which are understood by your serviceman) of radio tubes are kept within certain limits, it is possible to tell very definitely, just how the tube will perform, when it is used in a normal manner. Tube Characteristics are somewhat like air-pressure in an automobile tire. Other things being equal, the life of a tire will depend on the air-pressure which is KEPT at a constant, pre-determined figure. With every CERTIFIED TRIAD TUBE, you get an ENGINEERING DATA CERTIFICATE, signed by a Triad Engineer, which shows the essential figures, for that particular tube.





CERTIFIED TRIAD TUBES

ARE DOUBLE-CHECKED, AGED, AND—

Long experience has taught Triad Engineers that the characteristics of an ordinary tube may vary greatly, even with new tubes. Therefore CERTIFIED TRIAD TUBES ARE AGED. They are also Double-checked: Once, when they are going through the production line and again, after a long period during which they are seasoned. The double-checking, which follows the aging process, insures against any changing of characteristics, after the tube has been made. This great care, in manufacturing makes it possible for the CERTIFIED TRIAD SERVICEMAN to bring you tubes, which he knows will give you more satisfactory service.

ARE SOLD BY CERTIFIED TRIAD SERVICEMEN *EXCLUSIVELY*

After a thorough survey of all radio tube sales and an analysis of the reason for service calls, we have found that more than ever before, is the serviceman being called upon for tube replacement and tube advice. We are thoroughly confident that there are thousands of intelligent servicemen, in all parts of the world, who understand the desirability of knowing just what the tube characteristics are, when the tube is put in your socket. Therefore, we are selecting and appointing CERTIFIED TRIAD SERVICEMEN in every corner of the globe, to enable you to get the performance you pay for. And we have decided to sell these special tubes through these reliable men, exclusively.

TRIAD MANUFACTURING CO.
TELEVISION MFG. CO.
Pawtucket, R. I.

Gentlemen:
Please send me complete information about your new Sales Plan for servicemen.
I have been a serviceman for........years.
I sell...............tubes per year.
I belong to the .... Serviceman's Association.

Name ....
Address ....
City.............. State.........
My letterhead or card is attached.

Super Power

insures *World-Wide Performance*-
15 TO 550 METERS-NO PLUG-IN COILS

If you have followed Lincoln's advertising, you will note we have never made statements of performance of our receiver. We have never claimed you can get foreign reception at all times as clear as a bell. As long as the atmosphere is used as a medium—subject to its varied conditions, and as long as radio is limited to local interference and absorption, *ALL RADIO EQUIPMENT* is handicapped.

Yet, in spite of these unavoidable conditions, Lincoln engineers have for years been the recognized leaders, and Lincoln receivers have been used by Arctic explorers, designing engineers of broadcasting equipment, for reception of press matter direct from the war zone of China and other special work where other receivers failed.

Lincoln owners are getting the full benefits of Lincoln's Super Power. Lincoln receivers, the world over, are known for what they actually do—just ask the Lincoln owner.

Super Power to Amplify Signals Not Heard on Ordinary Receivers

If you have not heard a Lincoln, you have no conception of what high amplification will do. Tune in a station on any other receiver, tune in the same station on a Lincoln with equal volume with regulation in low power then snap the high power switch, the tremendous blast of volume will startle you. This is what you must have to get weak signals with local volume.

Every Continent Logged in 2 Hours, 11 Minutes

QUOTE: "Sunday morning, Mr. Hollister, I logged every continent in two hours and eleven minutes. At seven AM, VK2ME came thru good, a few minutes later, GBU also Pontoise, France, and at seventy-thirty F31CD came thru with fair volume. At nine AM, LSN Buenos Aires and at nine eleven AM Rabat, Marroco, was tuned,—completely the five continents."

Extra Power Invaluable States Texas Owner

A recent letter received from a man with wide experience in all short-wave receivers states: "The gain is unbelievable to persons who have heard other SW receivers. I usually run any North American SW station I hear on local switch and have all of the reserve power for fishing on SW. Best of all, sensitivity seems absolutely uniform on all frequencies which cannot be said for all receivers, in fact, no other SW I have tried. Believe me, that extra power is invaluable in SW work if one hopes to hear foreign stuff to amount to anything."

This man is telling you just what to expect in Lincoln high powered receivers. He is verifying what Arctic explorers, broadcast engineers, and hundreds of Lincoln owners have proved without a question of a doubt.

From the tropical jungles of Colombia, South America, comes the following report. "I take pleasure in writing you that the Lincoln receiver ordered from you last December arrived in excellent order and that no trouble whatever was experienced in installation. It is giving the most wonderful reception and I wish to congratulate you on having produced a masterpiece. It brings in stations from extreme distances, with great volume and clarity, both American and European. Have listened to VK2ME Sidney, Australia, on Sundays with excellent volume which is something around 6,000 miles distant from this point. It is without a doubt the finest battery operated receiver to be had and again let me express my appreciation for your prompt and careful attention to my order." This man is in the worst location in the world near the equator where radio reception is ordinarily impossible.

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Finished in beautiful highly polished silver nickel.

You can own a high powered Lincoln—they do not cost as much as you think.

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