A DYNATRON OSCILLATOR

AUG. 15 1931

RADIO WORLD

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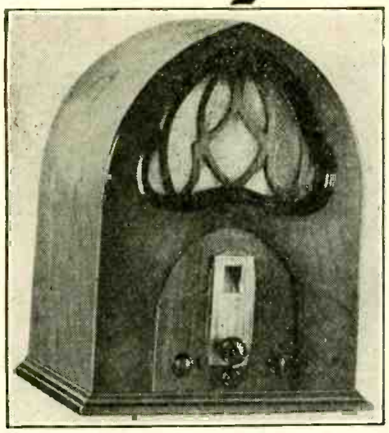
RAPID TROUBLE SHOOTING

RADIO WORLD, Published by Hennessy Radio Publications Corporation. Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager, all of 145 West 45th Street, New York, N. Y.

JAPAN AND EUROPE DIRECT!



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Latest Circuits and News

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RADIO WORLD, owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.; Roland Burke Hennessy, editor; Herman Bernard, managing editor; J. E. Anderson, technical editor; L. C. Tobin, Advertising Manager

Rapid Trouble Shooting

Rules for Success and Advice on Remedying Faults

J. E. Anderson

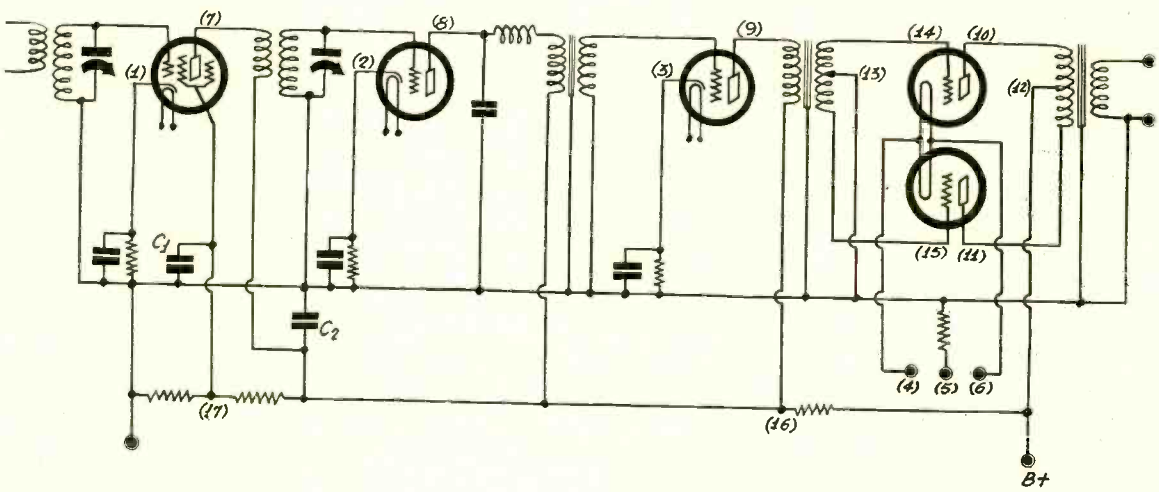


FIG. 1
Most A-C receivers are built on the principle indicated in this circuit and methods of trouble shooting in this applies to all receivers.

WHEN something goes wrong with the radio receiver a service man is usually called in. If he is familiar with the particular set he often finds the trouble quicklq, for he has met it many times before. Every receiver has its own peculiarities and weaknesses and the experienced service man knows about them. But sometimes a trouble is met which defies all ordinary tests and then it may take a full day to locate the trouble, even if the service man is experienced.

The first rule of success of a service man is: *Know the circuit.* If the service work is done in the home of the set owner the service man cannot very well pull out a diagram of the circuit for if he does he creates a bad impression. The customer thinks that he does not know his work. The customer does not understand that with the aid of a diagram the work could be done much more quickly and certainly even by an experienced man.

The second rule of success is: *Know the principles on which receivers work.* If the service man knows the principles thoroughly he does not actually need to have the diagram, either on paper or in his mind, for all circuits are in general the same, but of course having the diagram saves time. These diagrams, by the way, are published in manuals.

Method of Servicing

All trouble shooting is a matter of elimination. Suppose the circuit does not work at all. That is usually the simplest case of trouble shooting even if the cure of the trouble is costly and cannot be effected immediately. The first thing to do is to test all the tubes and the circuits, either with a complete circuit tester or with an independent meter. Do the tubes light when the power is on? If none lights, the trouble is general and is to be found either in the filament winding or in the primary of the power supply transformer. If the tubes do not light and there is plate voltage, the trouble is in the filament winding. If there is neither filament nor plate voltage, the trouble probably is in the primary.

If some of the tubes light and others not, there may be more filament windings than one, and the defective one is that associated with the tubes that do not light. The trouble may be an open winding or it may be a shorted winding. If the tubes do not light because there is a shorted filament winding much current is drawn from the power transformer and there is likely to be a lot of heat present, possibly so much that the insulation burns or melts.

The quickest way to test is by use of a circuit tester, one that shows the filament voltage, the plate voltage, and the plate current. If all of these are normal many possibilities are eliminated at once. If one tube shows abnormal values the search is limited to that tube and its associated circuit.

Interpreting Abnormal Values

Suppose the plate current is zero. This may be caused by a dead tube. Put in one known to be good and note the effect. The trouble may be caused by lack of plate voltage. This will be indicated on the voltmeter. By means of a jumper provided with clips short-circuit various parts in the plate circuit. For example, connect the short from the plate to B plus. If the current appears, the open causing the trouble has been closed and one step has been taken nearer the location of the trouble. By moving one end of the short-circuit jumper nearer the other every part in the plate circuit can be eliminated until the defective part has been located. For example, it may be found that the open is in the primary of an audio transformer, or a radio transformer. Do not forget to short circuit the grid bias resistor, for this, too, is in the plate circuit.

The plate current may be zero also because the grid bias is grossly excessive. Short circuit the grid bias resistor. The plate current should increase.

The plate current may also be excessive. If this is the case the indicated plate voltage is likely to be sub-normal. A positive or zero bias may be the reason.

Defective Grid Circuits

The receiver may fail to function at all because there is a defective grid circuit. This cannot be found easily by the short-circuiting method because when a grid circuit is shorted nothing comes

(Continued on next page)

A Key to Solution of Baffl

Intermittent Reception One of the Hardest

(*Continued from preceding page*)

through and no change is effected as far as the output is concerned. But when the set fails to function entirely because of a defect in the grid circuit it is either because there is an open on the grid side of the input transformer or other coupler or because there is a dead short of the entire secondary. If the open is on the ground side the set may continue to play in a way, but there is almost certain to be hum or other noises. Likewise, if there is an open on the ground side of the coupling device the grid bias is very uncertain and there will be no change in the plate current when the bias resistor is shorted, for shorting does not change the bias since the circuit is open to the grid.

Shorted Windings

Shorted windings in the audio transformer, which kill a receiver, can be found by the short-circuit test. If the winding is intact there should be a small increase in the plate current and also in the indicated plate voltage when a short circuit is put across the winding. If there is no change the probability is that the winding is shorted. A shorted secondary cannot be discovered in this way, but it is always possible to connect a battery and a voltmeter in series with the winding. If the secondary is shorted the reading of the meter should be the same as when the voltmeter is connected across the battery directly. If the winding is intact there should be a considerable drop in the voltage, in the case of an audio transformer.

Shorted windings in the radio and intermediate frequency circuits are more difficult to locate because the resistance in the winding when the secondary is intact is so low that it does not cause an appreciable drop in the indicated voltage. Very often a short can be located by inspection.

Intermittent Breaks

Troubles of an intermittent nature are more difficult than any other to locate. Very often all tests with meters show up normally, yet there is a continuous frying noise in the output of the receiver. Ordinarily these disturbances are due to intermittent breaks in the leads, breaks which are not of long enough duration to cause a diminution of the meter readings.

Intermittent breaks may occur anywhere in the circuit and wherever they occur they produce about the same type of noise. To get an idea of the noise break, any lead, such as one of the leads to the loudspeaker and rub the terminal against the binding post. Sometimes the noise is referred to as scraping or boiling noises. There is practically no other way of locating these defective contacts than making substitution of parts. For example, if the filter condensers are suspected, one at a time can be removed and a good condenser substituted. If the noise disappears when the good condenser is connected there is reason to suppose that the one removed was defective. But due to the intermittent nature of the trouble, hasty conclusions should be avoided.

In a similar way the chokes, audio transformers, bias resistors, and voltage divider resistors should be substituted.

Cause of Intermittent Breaks

Intermittent breaks are caused by corrosion of leaks and by overheating of insulation. Sometimes they are caused by voltage surges which puncture the insulation, usually of the secondary of audio transformers. Excessive heating not only melts insulation and thus paves the way for punctures and deterioration of the insulation, but it also promotes corrosion.

As an example of the way this trouble starts, suppose that an audio frequency transformer is overheated for a considerable time so that the insulating wax melts. Adjacent turns then may come very close together without sufficient insulation between them. The voltage between the turns may then be sufficient to break the insulation during surges. Just ordinary voltage may be sufficient to cause sparking between the points, and this sparking gives rise to the frying noise.

Corrosion of the conductors may work in the same manner, but in this case it is usually due to a direct break in the circuit. The two ends of the broken wire are so close together that during high voltages there may be sparking. Sometimes after a very high voltage has been applied the two ends weld together imperfectly and the receiver may function satisfactory for a short time.

Similar trouble occurs in resistors, especially vitrified voltage divider resistors. The break may occur because the material on which the wire is wound expands more than the wire. After the break has occurred the circuit functions all right as long as the voltage divider is cool, but when it has been heated up the break occurs again. At the break there is a lot of sparking and frying noise. After the break has occurred the resistance and the form cool and ultimately the circuit is closed. Then the process is repeated. The break works like a thermostat keeping the voltage divider at a certain temperature where makes and breaks occur in rapid succession, and the racket is more or less continuous. A test on a voltage divider of this type always shows it to be all

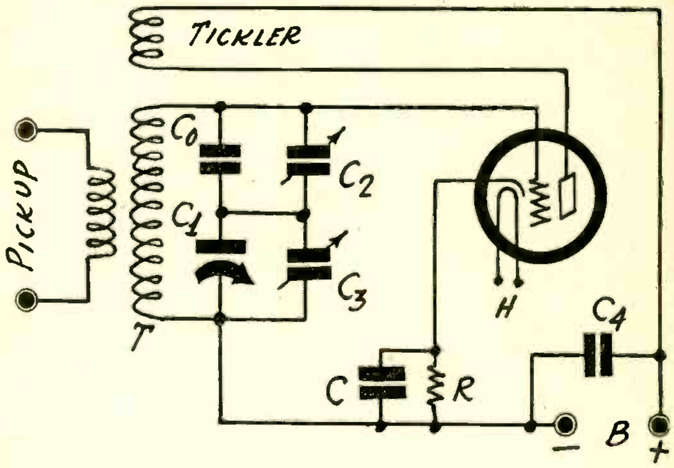


FIG. 2
The circuit of a typical oscillator as used in up-to-date superheterodynes.

right. Hence, substitution of a new one is the only way of convicting the defective one. It is clear that similar troubles may develop at many points in a receiver.

Surges and Their Effects

Surges, which often cause break-down of insulation, are extremely high momentary voltages. These sudden surges seldom come from the power line, although rather high voltages may exist in the line. They come from breaking a circuit carrying current when there is no load on the circuit to absorb the energy. When a choke or a transformer secondary carries direct current there is a certain magnetic field in the core. This field was built up by supplying energy. When the circuit is broken the field collapses because the current ceases. The voltage induced is proportional to the inductance and the rapidity with which the current dies down. If there is no resistance across the coil the current stops with extreme rapidity and the voltage developed instantaneously is tremendous. Where the current was of the order of 5 milliamperes and the inductance 100 henries, the voltage can easily rise to several thousand volts. If the current is broken in the primary of an audio

Short-Wave

Roundabout News

Can you imagine turning on your radio set and learning for the first time from a South American radio station that your country is torn by revolution?

That's what happened to an engineer at Jan Jacinto, Peru. In a letter recently to WGY's short wave station W2XAF, Schenectady, N. Y., acknowledging appreciation for the stock market quotations and news items received nightly from the air, he explained that mail and newspapers reach him only once every two weeks. Tuned one night to KDKA during the Literary Digest program of Lowell Thomas he learned for the first time of revolts in Peru and the revolution in Spain.

* * *

Proof of Tubes' Strength

From Napier, New Zealand, in the heart of the territory stricken by earthquake a few months ago, WGY received several snapshots of the ruins from Dr. W. D. Fitz Gerald, a dentist. Dr. Fitz Gerald reported that the outer front wall of his home collapsed in the first few seconds of the quake, leaving the rooms of his home exposed. His short wave receiving set went down with the walls and was buried in the debris. Later workmen recovered the set, with every tube intact.

* * *

Retaliation

Chester Vedder, one of the announcers of WGY, has recently heard himself as England hears him. G. E. Jackson, of Westcliff-on-Sea, Essex, England, recorded a program of

ing Problems in Servicing

Troubles to Shoot, But Causes Are Cited

transformer the voltage in the secondary may rise to even higher values, unless the insulation breaks down. To prevent such voltage rises the primary circuit should never be broken while current is flowing, but the current should be allowed to die down gradually by turning off the power supply. Another preventive are resistances across the windings. A leak across the secondary will prevent excessive voltage both in the primary and the secondary.

Typical Amplifier

In Fig. 1 is a portion of a typical receiver. Suppose the set does not work and we are required to find out why, using nothing but a voltmeter. First turn on the power and note whether the filaments light. It is possible to tell by the light whether the filament voltage is right, remembering that some tubes normally glow a dull red while others glow almost white. If the filaments light the next step should be in observing the tubes for a blue glow. If one has a blue glow that tube should be replaced, for it is undoubtedly gassy and unsuitable.

Next measure the various d-c voltages on the elements. Connect the negative of the voltmeter to ground or B minus and leave it there. Then connect the positive terminal of the meter to points (1), (2), and (3) in succession. At each point there should be a reading on the meter. If the voltmeter is a sensitive one, say 1,000 ohms per volt, the indicated reading in each case is very nearly equal to the grid bias.

Also connect the positive terminal of the meter to (4), (5), and (6). At each of these about the same voltage should be obtained, and that voltage is the bias on the tubes in the push-pull amplifier. Next put the positive terminal of the meter of the screen of the first tube, or at (17). This indicates the screen voltage. If there is a large difference between the readings at the screen and at (17) there is a high resistance in the screen lead and a low reading at the screen should not be interpreted as a defect. The effect of the resistance will be greater the lower the sensitivity of the voltmeter used. No reading indicates an open and points out where a replacement should be made, or possibly only where a soldering iron should be applied.

Voltage on Push-Pull

Next measure the plate voltages. Connect the positive of the meter first at (16) and note the reading. Then connect it to (8) and (9). The voltages at (8) and (9) should be less than that at (16) because of the drop in the primaries of the transformers. In case there is no voltage on one of the plates, connect the positive of the meter at different points in the defective circuit. At one side of the defect there will be a reading, at the other none.

Next connect the positive of the voltmeter to B plus. This should indicate a high voltage. Next connect it to (12). The reading should be the same. Then connect in turn to (10) and (11). The voltage should be less, but it should be the same at (10) as at (11).

Check the grid circuits for continuity by connecting the positive of the voltmeter to the cathode, or the mid-point of the filament (5), and the negative to the grids. On the first tube the voltage reading should be the same as the bias voltage previously obtained. Likewise on the second tube. In the first audio tube there should be a lower reading when the continuity test is made because there will be a considerable drop in the secondary of the transformer. If there is no drop there is undoubtedly a short in the secondary. To compare directly first connect the negative to the grid and then to ground. The ground connection should give the higher reading.

Test the grid circuit of the push-pull tube for continuity in a similar way. Connect the positive of the meter to (5) and the negative to (13), (14), and (15). At (13) the voltage reading should be the bias on the push-pull tube and at 14) and (15) it should be lower, but equal for the two tubes. Equality at the three points indicates a short in one of the windings.

Shorts

If it is found that a grid bias resistor is shorted, the most likely place to look for it is the condenser across it. A possible short in the external leads can be found by inspection to find a short in a condenser. To find a short in a condenser it is necessary to remove the connection on the cathode side and measuring the voltage across the resistance. If there is voltage now the condenser was shorted.

A short in a filter condenser such as C1 and C2 can be found in a similar way. If there is a short between (17) and ground there is no voltage between these points. If that is the case the positive side of C1 should be removed as a test. If voltage appears as soon as the lead is opened the condenser was shorted. If the short persists it must be located by inspection of the external leads. C2 is tested in exactly the same way. If it is shorted there is no voltage between (16) and ground. Moreover, there is likely to be evidence of the short in the rectifier tube, the plates of which might be red hot. As before, if removing the positive lead of the condenser does not open the short, it must be found in the wiring.

A short in one of the radio frequency windings can best be found by inspection or by substitution of parts known to be good. If there is a short in one of the tuning condensers, this also can be found by either of these methods. But, as a rule, a short in a tuning condenser occurs only at certain settings of the condenser. Scratchy noises will be heard on make and break as the condenser is turned.

Superheterodyne Trouble Shooting

The superheterodyne is built on the same general principles as other types of receivers and the methods of trouble-finding apply to both types. However, in the superheterodyne there is an oscillator which must be tested. This part of the receiver is so important that if a superheterodyne fails to work the oscillator should be checked first. Essentially this tube is an amplifier and should be so tested. The tube in the oscillator socket must be in good condition or oscillation may not occur, and if it does not, no signals can be heard.

In Fig. 2 is a typical oscillator circuit such as those used in up-to-date superheterodynes. It has a tickler winding, a tuned winding T, and a pick-up winding. The by-pass condenser C4 is somewhere in the circuit, but it may be used for by-passing other tubes as well. The bias resistor R and the condenser C across it may be used when the tube is operated as an amplifier. If used, the values should be the same as if the tube were used as a radio frequency amplifier. Sometimes a grid condenser and a grid leak are used instead, in which case the grid leak maintains the grid at the proper operating potential.

The pick-up winding is the main connection between the rest of the circuit and the oscillator. Sometimes the pick-up is connected in the grid circuit of the first detector, sometimes in its cathode circuit, sometimes in its plate and sometimes in its screen circuit, depending on the tube used for detector. There are also direct forms of coupling in which no pick-up coil is used, but a common resistor. The circuit in Fig. 2 is probably the most common, the pick-up being connected in the grid circuit of the first detector.

Condenser Arrangement

When the tuning condenser arrangement is as shown in Fig. 1 the condensers in the circuit are put on one control. C1 is on this control and the other condensers are used simply to line up the oscillator with the other tuners. There is little chance of anything going wrong with the oscillator tuning condenser except the settings of C2 and C3. They are both adjustable. The two should be adjusted so that the circuit is in tune at 600 and 1,200 kc., or two other frequencies near the ends of the tuning range. If they are properly adjusted at two such frequencies the circuit is very nearly in tune at all other frequencies in the band. To make the adjustment, of course, it is necessary that the circuit be otherwise in a good operating condition.

Snatches

W2XAF on a home built recorder. He sent the records to the station so that engineers and announcers might know how well the signals are getting across the Atlantic. The record was made on an aluminum disc and a fibre needle was supplied to assist in the reproduction.

* * *

Rapid Translation

Herman Reyes, Spanish announcer of WGY's short wave station, W2XAW, is a rapid translator.

Reyes, wearing headphones, heard Graham McNamee's blow-by-blow description of the Schmeling-Stribling fight, coming from Cleveland, and gave his South American listeners an immediate blow-by-blow story in Spanish, through W2XAW. It was probably the first time anywhere that anything of the sort had been attempted and WGY waited anxiously for reports from Latin-America on the experiment. Within a few days the letters began to come in, many of them via air mail, and in every case the Spanish-speaking people were delighted with the service.

Because of the great interest in the fight in Germany, W2XAF, the 31.48 meter station generally used for South American coverage, used an antenna directed to Europe, and a German, at the ring-side, gave a blow-by-blow story for his countrymen. However, Latin Americans are keenly interested in boxing, particularly as they have several promising condidates for championship honors in various divisions. WGY put another transmitter, W2XAW, on 34 meters, into service and Mr. Reyes translated and rebroadcast the English story of McNamee for over an hour.

Requirements for a Reactive

How An All-Wave Tuning System May

By Henry

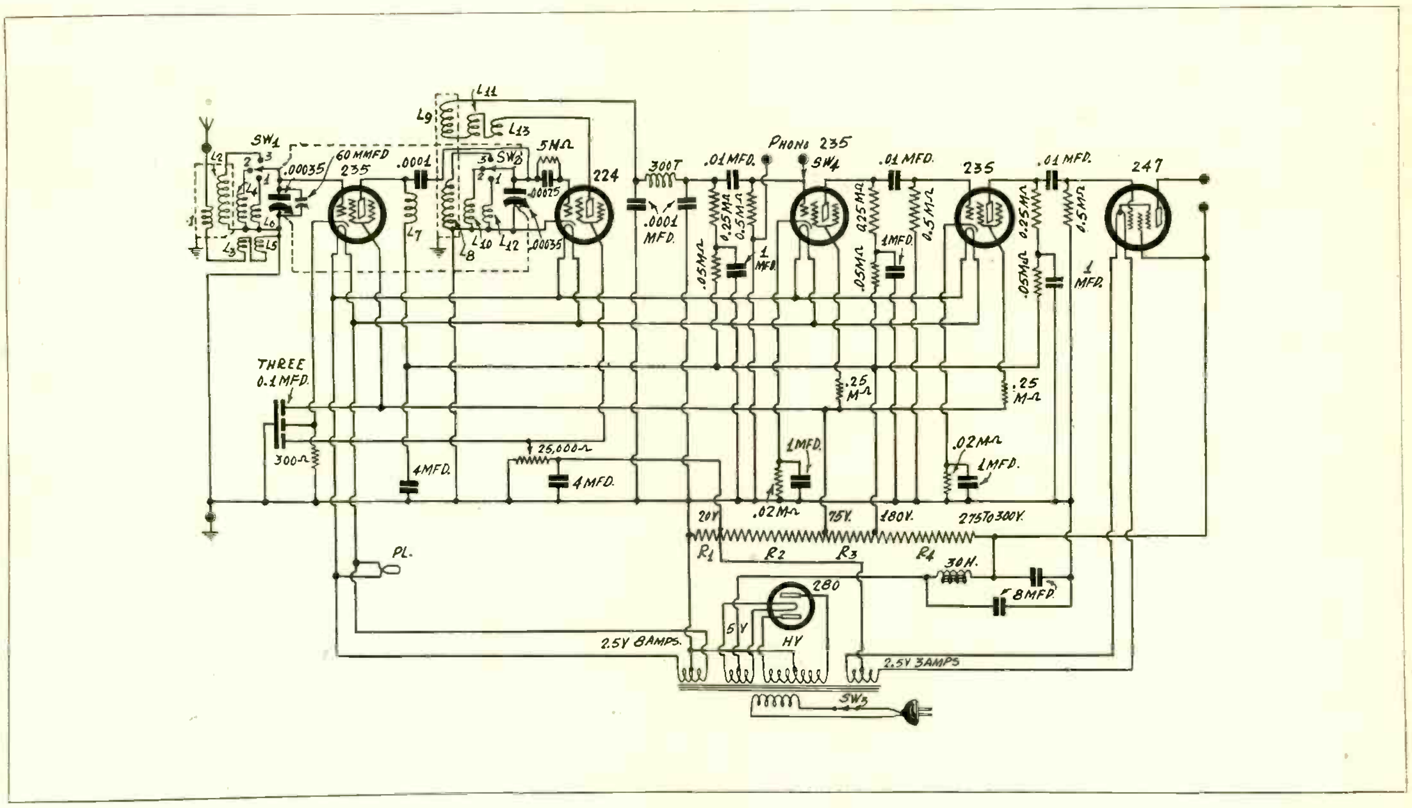


FIG. 1

A finely filtered audio amplifier. Ahead of it is an all-wave tuner. This is an A-C circuit with vari-mu and pentode tubes.

FOLLOWING up the discussion of resistance coupled audio frequency amplification, published last week, let us see a circuit that maintains stability and yet provides excellent gain, so that there will be a big kick in the output even if the signal emanating from the detector is feeble. Such a requirement is particularly advisable if short-wave reception is to be included, since a good many of the signals will be quite weak, and will need considerable building up before they attain good loudspeaker volume. Incidentally, the coil switching arrangement for short waves, to constitute the receiver an all-wave affair, should prove interesting.

The audio channel has high resistance plate loads, with an extra resistance of 0.05 meg. (50,000 ohms) interrupting the return to B plus 180 volts, a bypass condenser of 1 mfd. across the smaller resistor removing the signal therefrom, and constituting the combination a resistor-capacity filter. The object is to help keep the audio feedback within bounds.

Effective Load Impedance

There is certain to be some feedback in such a resistance-coupled amplifier, with or without filters of this sort, and indeed it is said by some that were it not for the feedback present the volume attainable from resistance coupling would be less than what we enjoy today. Nevertheless when the feedback becomes greater than a certain amount, the audio circuit becomes definitely oscillatory. Under such conditions we have motorboating, blasting, constant high-pitched whistle, continuous howl, or other forms of interference.

Rather, we have always the same form, regeneration in the audio amplifier, but the frequency is different in the cited instances. The frequency may be altered by changing load values or bypass and filter condenser values, or substituting a B supply choke of a different direct current resistance. Of course, the only thing to do is to get rid of the trouble entirely, which Fig. 1 does.

It will be seen that 180 volts are supplied to the detector, but the effective plate voltage will be considerably less, in fact, the drop in the load resistor with leak-condenser type detection will be greater than the drop in the tube. If the proportion is 2-to-1, then the effective plate voltage would be 60 volts and the drop in the load resistor of 0.25 meg. (250,000 ohms) and the filter resistor, of 0.05 meg. would be 120 volts. This would make the plate current 0.4 milliampere, which is a reasonable expectation under these voltage, bias and load conditions. The direct current resistance of the plate-to-cathode circuit would be 150,000 ohms. The effect of 0.25 and 0.5 meg. in parallel (as the plate load and following leak are, in respect to the signal voltage) would be about 167,000 ohms load effective on the signal, which meets the requirement of having the load as high as practical. A limiting factor on the practical height of the load resistance is that if it were twice the present value in the plate circuit the higher audio frequencies would be cut down in intensity quite markedly.

In the grid circuit the leak is connected from grid to ground without filter, simply because the leak itself is grounded.

Limiting Detector Screen Voltage

The plate circuit loads and voltages determine the screen grid voltage desirable, but since we have a potentiometer in the detector screen voltage for control of regeneration, we have a device for introducing considerably changeable values of direct current resistance in the tube, hence for changing amplification and detecting efficiency. It must be borne in mind that a detector tube of the three or four-element type amplifies, for if it didn't it could not be regenerated.

Despite the variation of screen voltage, we must have a limiting factor, and it is advisable to tap off the voltage divider so that no greater than a certain voltage ever can be applied to the detector screen. To insure regeneration under these conditions it may be necessary to put a larger number of turns on the fixed tickler than would be necessary were a general purpose tube used as detector.

When Screen Has Zero Bias

We find that the output tube is a pentode, and we know that for 250 plate volts applied the bias should be 16.5 volts negative on the grid, therefore the total voltage across the divider would be the sum of these two, or a 266.5 volts. Of course, this is not critical, and differences as small as 0.5 volt never are reckoned with in designing voltage dividers or power transformers, where the total runs into the hundreds of volts. We can even use a power supply intended for the 245 tube, where the total voltage is 300

Resistance Audio Channel

Be Placed Ahead of Each Amplifier

Herman

volts direct current across the voltage divider. The bias on the pentode then may be 20 volts.

So, on the assumption of 20 volts or thereabouts, for negative bias, we may use this voltage as the maximum positive bias on the detector screen, by connecting a high resistance potentiometer across the 20-volt section of the divider. (Fig. 1.) Assuming 20 milliampere bleeder, there would be about 50 milliamperes through this section, so to drop 20 volts R1 would be 400 ohms. If we use a potentiometer of at least 50 times as great resistance as this section, we may ignore the effect of the potentiometer on the voltage divider section, it is so tiny.

If the effective plate voltage is 60 volts and the maximum screen voltage is 20 volts, we have a good condition for operation of a screen grid tube, since for amplification the ratio of the effective voltages should be 3-to-1 in the noted direction, whereas for detection we may use even a higher ratio, and since we have a potentiometer we may make the screen voltage anything, from zero to 20 volts maximum.

The question of why a zero bias on the screen ever should be permitted may be raised, since the tube at zero voltage on the screen does not amplify or detect. The reason is that a phonograph connection is included in the diagram, and since it is well for retention of the same direct current voltages to have the radio frequency and detector tubes in circuit even when the phonograph is played, it is necessary to have some means of keeping out the signal then. The potentiometer, set for zero screen voltage, stops the signal from going through.

Where Meters Won't Measure Voltage

The voltage drop across the fixed resistance represented by the extremes of the potentiometer is the same of course as across the divider section represented by R1, and it does not change. The voltage on the detector screen is altered simply by taking off different values of voltage from the fixed drop.

The usual meters will measure this voltage, since the current is large through the R1 section of the voltage divider. However, the voltage across the plate and filter resistors in the detector and subsequent audio stages, and across the screen load resistors in the two audio stages, cannot be measured with the usual meters, because the current in the measured source is so much smaller than the current even through a voltmeter of 1,000 ohms per volt.

When you connect such a meter, you get a reading something like 5 volts, but really what you are principally reading is the meter error. The effect is something like that obtained if you shorted the resistor across which voltage measurement is attempted, and used the meter as a current indicator in series with the circuit.

The voltage could be measured, however, with a vacuum tube voltmeter, or may be computed.

The current in the plate circuit could be read on a 0-1 milliammeter and the value of the load resistors measured.

Computation of Voltage

The total voltage source, B plus to B minus, could be measured by an ordinary meter, and the drop in the load resistor or resistors computed, since the voltage in volts equals the current in amperes multiplied by the resistance in ohms. The drop could be subtracted from the total voltage, the remaining voltage being that dropped in the tube, which is the effective plate voltage plus the negative bias voltage. Subtracting the bias voltage, computed the same way, from the tube drop voltage, gives the effective plate voltage. The same can be done with the screen circuit. In that way you can determine whether the screen voltage is, and it should be, less than the plate voltage, the proportion of 3-to-1, screen to plate voltage, being favored.

The 247 pentode tube requires a five-prong socket. What would be the cathode socket terminal for 227, 224, 235 and similar tubes is here the suppressor grid, so-called because it suppresses the secondary emission. This connection is made to the same potential as the plate return for the 247, that is, B plus maximum, except that if the load is a transformer primary or an audio choke of high direct current resistance—say, more than 400 ohms—a resistor should be placed in series with the suppressor grid line to B plus, to make the effective plate voltage and the effective suppressor grid voltage the same. The rest of the connections are standard. The filament connects to the secondary of the power transformer, no extra connection being necessary for the screen grid attached to filament, as this connection is made in the manufacture of the tube. The control grid is the G post of the socket and the plate is the P post.

The Tuning System Explained

We shall now take up the tuning system.

Since there is a demand for all-wave coverage, and also a preference by some for omission of plug-in coils, so that band shifting may be done from the front panel with a single switch knob, the circuit shows a good way of accomplishing this. The first requisite is to have a dual switch of the rotary type, with shaft insulated (three point double throw). That means that the shaft is of insulating material and connects to nothing electrically, serving only a mechanical purpose. Few switches are thus constituted, as even dual types often have one of the moving arms connected electrically to a bushing or a metal shaft extension. If a metal chassis is used the arm and the points to which it contacts are grounded, and one of the tuned circuits is shorted, hence you obtain no reception. Even if an insulated chassis or subpanel is used, with a similar front panel, there would be body capacity in tuning, and in working the switch, because of the conductive shaft or bushing at grid potential so close to the hand.

Two coils are shown as being shielded, represented by the dotted lines. All shields should be grounded, and even if not so stated expressly. However, the diagram carries the ground symbols.

Coil Construction

The shielded coils are usual radio frequency transformers. For use of small aluminum shields, 2½ inches in diameter, and slightly less in height, the coils may be wound on forms of the tube base type, or on a close equivalent tubing of 1.25 inch diameter, consisting of 95 turn secondaries, using No. 32 enamel wire. The antenna winding is 20 turns, the tickler 30 turns. The space between adjoining windings is ⅛ inch.

The ends of the secondaries intended for grid go to the taps on the switch, to be picked up by the pointer that is connected to grid and to stator of the tuning condenser.

The coil system with secondary at tap 2 would consist of 32 turns of No. 28 wire, with primary 13 consisting of 8 turns and tickler L11 consisting of 12 turns, the same kind of wire. The separation between adjoining windings is ¼ inch.

The last coil would consist of 12 turns of No. 18 wire, with primary of 6 turns of No. 28, and the tickler of 10 turns of No. 28. The separation between windings is ½ inch.

Effect of Shielding

A total of six forms is needed, as there are six different coils. Only the broadcast coils are shielded. The other coils, if an aluminum chassis is used, as supposed, would be subject to eddy current effects, due to the chassis, of about the same degree as if they were totally shielded, and the number of turns is given with this idea in mind since the inductance for a given number of turns is reduced by shielding or equivalent.

The shields can be placed close to each other, at right angles, on the right-hand side underneath the chassis. This leaves room to dispose of two of the remaining coils in the same general area, while the two other coils would have to be to the left of the centered tuning condenser.

The primaries carrying the antenna current are in series and so are the tickler windings. This avoids the use of another bank of switch taps. In the antenna circuit there is no problem in this respect. In the detector stage one possible problem is that if the tickler turns on the broadcast coil are too many they may act as a choke coil, and thus tend to retard or prevent regeneration. The number of turns cited is near the limit, but regeneration resulted. If regeneration fails reduce slightly the number of tickler turns.

Where Potential Directions Are Important

The manner of connection of coils terminals is suggested in the diagram. The grounded or approximately grounded terminals of the primaries in the antenna circuit adjoin the ground connection of the secondary. Regenerative connections for the detector inductors are to have the terminals of the tickler at plate or approximately plate radio frequency potentials adjoin the grid terminals of the secondaries. Regeneration also will result if the adjoining terminals are B plus end of the tickler and ground of the secondary.

In the detector strict observance of these polarities is important. In the radio frequency amplifier it is unimportant.

The manual trimming condenser is located in the antenna stage. This may raise the point about antenna capacity being in this stage already, hence the trimmer might better be in the detector stage. But it will be recalled by all who have built tuned radio frequency receivers, using gang condensers, that the equalizing condensers across the main capacities have to be so set that the detector's trimmer is virtually at minimum capacity, or at least it must introduce less capacity than the other equalizers. This is because there is a high input capacity with the grid leak type of detector, so the location of the manual trimmer in the other stage is sound practice.

Short Wa

Three and Four Tube Models,

By J. E. Anderson

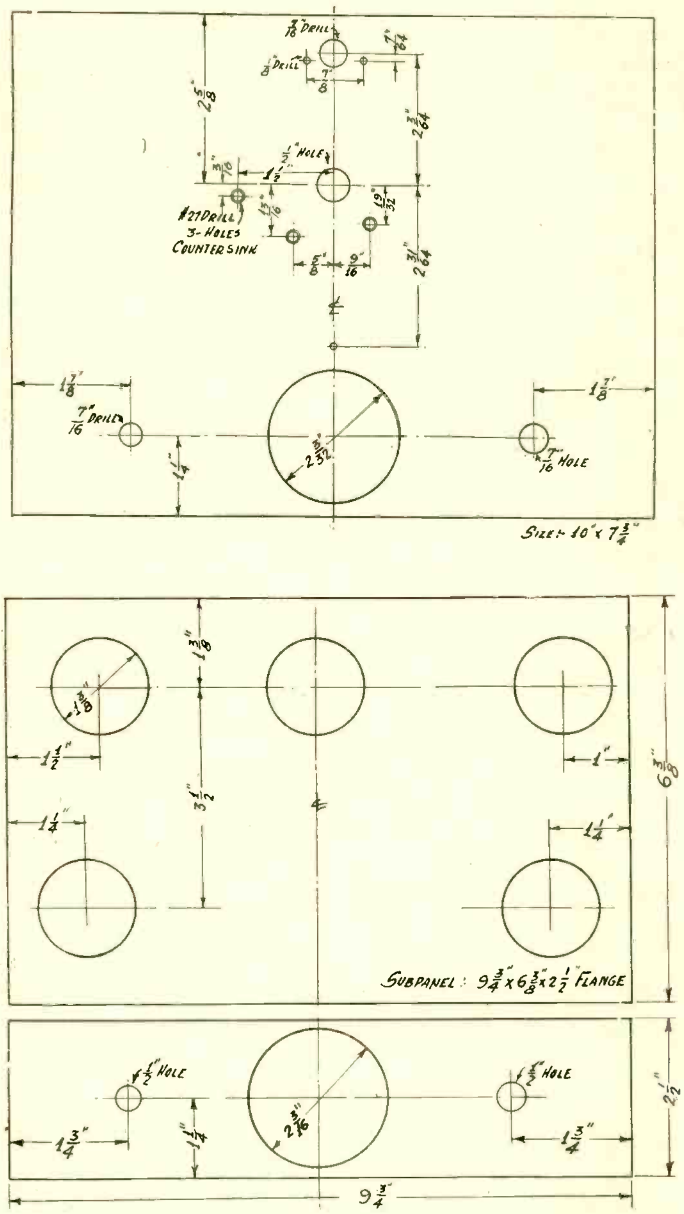
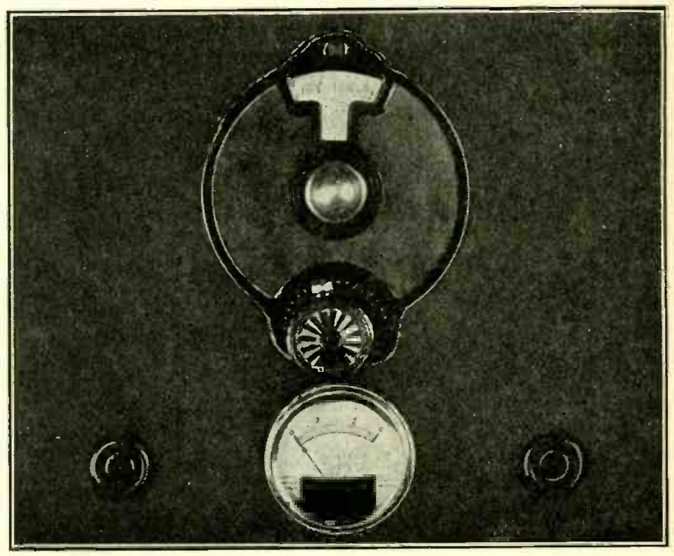


FIG. 14
Dimensions for the front panel (top) and for the chassis of the three-tube circuits



Appearance of the front panel, when the panel is made according to FIG. 14.

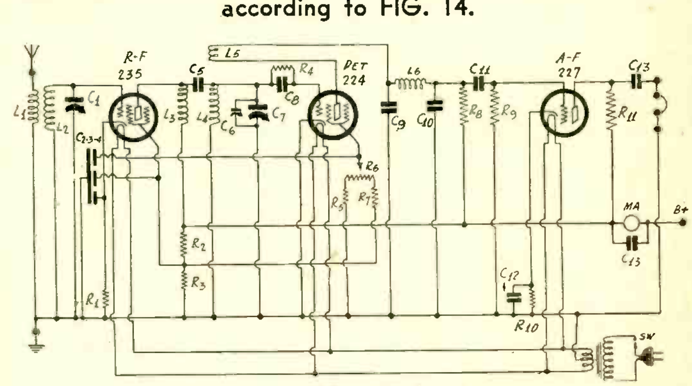


FIG. 15
Where an external B voltage is available, the filament transformer may be built in, as there is room under the chassis top, and AC tubes may be used. See list of parts on page 17.

[*This is one of a series of articles.*]

THE same front panel and chassis dimensions may be used for building any of the three-tube sets previously discussed, including the battery-operated ones, using 2-volt or other tubes, with filaments or heaters in parallel or in series, as well as for a set to be described, with filament transformer included, where the B voltage to be obtained externally.

The dimensions are given in Fig. 14. The front panel is laid out to accommodate a vernier dial, two knobbed shafts and an inexpensive meter.

In the case of the battery-operated sets using 2-volt tubes with heaters in parallel, where the voltage source is 3 volts and the critical value of 2 volts on the filament must be attained, the rheostat for partly governing the voltage, to compensate for differences arising from the battery condition, is located at rear, as the adjustment has to be made but seldom. The regeneration control, a potentiometer with switch attached, occupies one of the knob positions, while the manual trimming condenser occupies the other. The A battery line switch then is built into the cable that connects the set to the battery. This switch is of the "follow through" type.

The other models satisfy requirements with the front panel parts, that is, the switch on the potentiometer is used for the line or A battery, while the manual trimmer is in the opposite opening.

The next step is the consideration of a three-tube set that has filament transformer included, but where the B voltage is obtained either from a block of B batteries or from a power amplifier or a broadcast receiver. To obtain such B voltage it is necessary to interconnect the negative lead of the short-wave set with the negative lead of the B voltage source. This is usually done by joining with an insulated wire the ground posts of the two devices. In nearly all receivers and power amplifiers the negative B lead is grounded.

There is room inside the chassis, directly beneath the tuning condenser, for a small 2.5-volt filament transformer. If the secondary is center-tapped, then connect this tap to the ground side of the short-wave set. If the transformer's secondary is not center-tapped, it is not necessary to put a center-tapped resistor across the secondary and ground the center.

When the 2.5-volt transformer is used one may select any type tubes of the heater variety that require such voltage, for instance the 227, 224 or 235. Since the 227 as radio frequency amplifier will have no advantage over the 224 or 235, and since the 235 in particular is not critical as to bias values and has other good points, we may select the 235 for this position. It may also be used as the detector, because of the selection of leak-condenser type detection. Were negative bias detection used the 235 would not be highly suitable, since it is designed to have non-detecting characteristics over a wide range of negative bias voltages. However, either the 224 or the 235 may be used as detector in this circuit, Fig. 15, the 224 being shown in the diagram.

The output or first audio tube should be a 227, because earphones may be used, and the 224 or 235 would not give as good results, due to the relatively low impedance of the phones.

Only one B voltage need be introduced, and that is the plate

ve Circuits

Battery and A-C Operated

and Herman Bernard

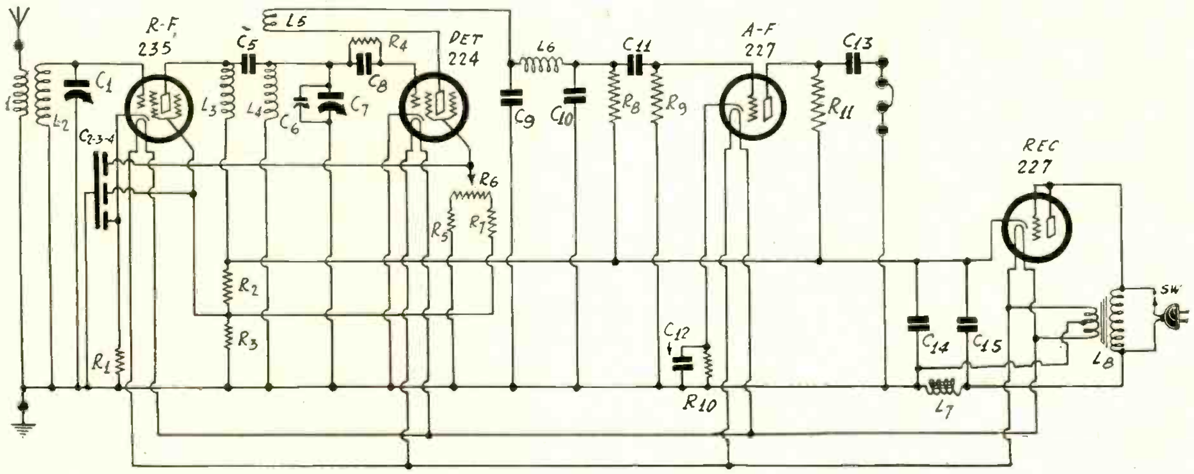


FIG. 16

A simple rectifier is used in this model, so that the circuit is entirely powered from the alternating current line, except for aerial and additional ground connections.

voltage, since the screen voltage is provided by a voltage divider in the set (R2 and R3).

The voltage to apply may be from 100 volts to 180 volts, and if you have 180 volts available it is suitable to use that. The same voltage, in its entirety, is applied to the detector, and it is not too high, because the plate load is a high resistance (R8 is 0.25 meg.), and the effective plate voltage is nearly the recommended effective voltage for grid-leak type of detective. Moreover, the high applied voltage here is handy as an aid to insuring regeneration.

The next step takes us to Fig. 16, which is substantially Fig. 15, with a simple rectifier and a good filter circuit built in. The rectifier circuit requires no special power transformer, but uses instead the filament transformer primary, with the alternating current (usually 110 volts, 50-60 cycles) across it. The voltage at the output of the rectifier, with the load on the circuit, that is, the three tubes in the set proper being supplied with plate current, is about the same as the root mean square alternating current voltage. Thus, for a 110-volt line the direct-current voltage at the filter output is about 110 volts. In fact, the reading is so close that it is practical to measure the output voltage from cathode to negative, on the ground side of the B supply choke L7, to obtain the approximate value of the alternating current voltage of the line.

When the alternating current voltage of the line is applied to the rectifier tube, the source is available for rectification. The 227 rectifier tube is used as a two-element tube, or diode, which is done by tying the grid and the plate together to constitute the anode, while the cathode remains the cathode. Thus we have a tube hooked up as a single-wave rectifier, and to keep the hum down to the allowable limit of 5 per cent. ripple voltage, and also to hold up the B voltage at the rectifier tube, large capacities are needed for filtration. Two condensers of 8 mfd. may be used, and this high capacity is compactly afforded by electrolytic condensers.

If the B supply choke is put in the negative lead, then the case of

(*Continued on next page*)

List of Parts for Fig. 13

Coils

Four plug-in coils for antenna coupler (L1, L2)
Four plug-in coils for interstage coupler (L4, L5)
One 50-turn honeycomb coil (L3)
One 300-turn honeycomb coil (L6)

Condensers

One two-gang 0.00035 mfd. tuning condenser (C1, C7)
One small variable condenser, about 60 mmfd. (C6)
One block of three 0.1 mfd. condensers (C2, C3, C4)
Three 0.0001 mfd. condensers (C5, C9, C10)
One .00035 mfd. fixed condenser (C8)
Two 0.01 mfd. fixed condensers (12, C13)
One 2 meg. pigtail resistor (R6)
One 1.0 mfd. bypass condenser (C11)

Resistors

One 5 meg. pigtail resistor (R1)
One .005 meg. = 5,000 ohm pigtail resistor (R2)
One 25,000 ohm potentiometer with switch (R3, SW1)
Two 0.25 meg. = 250,000 ohm pigtail resistors (R4, R5)
One 0.1 meg. = 100,000 ohm pigtail resistor (R7)

Other Parts

Two binding posts (Antenna, Ground)
One output twin jack assembly for phones
One 7¾ x 10 inch front panel
One subpanel with three UX sockets and two UY sockets
One vernier dial (pilot lamp PL optional)
One follow through switch (SW2)
One 0-25 milliammeter
One dozen 6/32 machine screws and one dozen nuts
One dozen lugs
One roll of hookup wire
Two 232 tubes and one 230 tube
Batteries: One 6 volt storage A battery, three 45 volt B batteries

List of Parts for Fig. 16

Coils

Four plug-in coils for antenna coupler (L1, L2)
Four Plug-in coils for interstage coupler (L4, L5)
One 50-turn honeycomb coil (L3)
One 300-turn honeycomb coil (L6)
One 15 henry B supply choke (L7)
One 2.5 volt filament transformer

Condensers

One two-gang 0.00035 mfd. tuning condenser (C1, C7)
One small variable condenser, about 60 mmfd. (C6)
One block of three 0.1 mfd. condensers (C2, C3, C4)
Three 0.0001 mfd. condensers (C5, C9, C10)
One .00025 mfd. fixed condenser (C8)
Two 0.01 mfd. fixed condensers (C11, C13)
One 1.0 mfd. bypass condenser (C12)
Two 8 mfd. electrolytic condensers (C4, C15)

Resistors

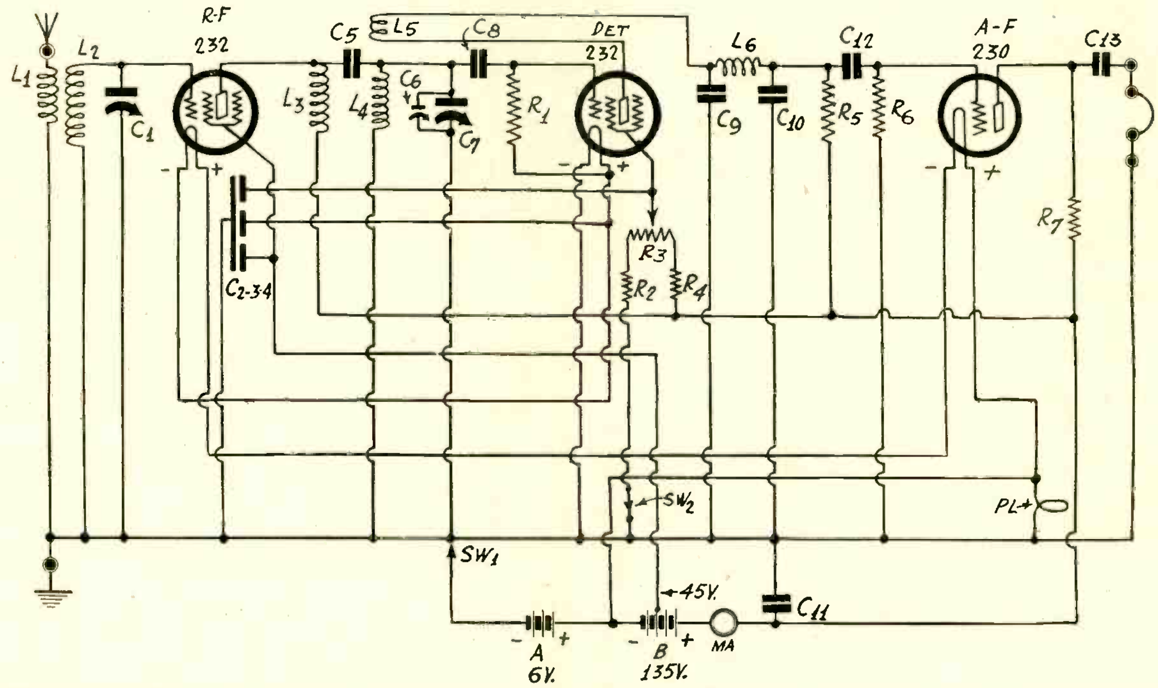
One 5 meg. resistor (R4)
One .005 meg. = 5,000 ohm pigtail resistor (R5)
One 25,000 ohm potentiometer with switch (R6, SW)
Two 0.25 meg. = 250,000 ohm pigtail resistors (R7, R8)
One 0.1 meg. = 100,000 ohm pigtail resistor (R11)
One resistor 0.01 meg. = 10,000 ohms (R10)

Other Parts

Two binding posts (Antenna, Ground)
One output twin jack assembly for phones
One 7¾ x 10 inch front panel
One subpanel with six UY sockets
One vernier dial (pilot lamp PL optional)
One 235, one 224 and two 227 tubes
One 300 ohm flexible biasing resistor (R1)

Series Filament Circuit

The 2 Volt Tubes in a Short-Wave Hookup



This circuit (FIG. 13) to which applies a list of parts printed on the preceding page. This circuit was discussed last week, issue of August 8th.

(*Continued from preceding page*)

one electrolytic condenser, if a metal chassis is used, so recommended, must be insulated from the chassis. Special insulators are obtainable for this purpose.

No matter in which direction the plug is inserted in the line there is no danger of a short-circuit, since the only unusual effect would be to put the B supply choke across the line. This would constitute a load of sufficient impedance so there is no danger.

But it is true that in some locations there is a little sensitivity in polarities of plug connection, due to the line being effectively grounded at the convenience outlet, or close thereto, so that by connecting the plug in a particular direction volume is a little greater and stability assured. So try both connections, and if there is a difference, see that the better one is used.

The diagram reveals that there are two effective connections across the line: one is that comprised of the pair of resistors, R2, R3, and the other is that comprised of the tube circuits. The three tubes may be regarded for this purpose as three resistors in parallel, and that of the audio tube, with load, about 110,000 ohms. The parallel connection makes the effective resistance accounted for by the tubes to be around 19,500 ohms.

It can be seen how the alternating-current voltage of the line is impressed on the rectifier, through a series coil, the primary, with the filter system's choke interrupting the actual connection to ground, or being in parallel with the transformer primary when the plug is inserted in the opposite direction. The voltage divider, R2, R3, is simply two pigtail resistors of small wattage. Since any tube will where the direct-current resistance of the radio frequency tube is around 20,000 ohms, that of the detector, with load 270,000 ohms, pass only direct current, we need make sure now that the direct current circuit is completed. A glance at the two resistors, R2 and R3, shows that they complete the circuit, for the connection is from cathode to ground. Therefore the direct current would flow inside the tube from the anode to cathode, and outside the tube from cathode through the two resistors to ground, and then through the choke coil L7 and the primary of the filament transformer back to anode.

A Projection Scheme Needed for Television

By Hollis S. Baird

Chief Engineer, Shortwave and Television Corporation

TELEVISION is very much in need of a new invention which, strangely enough, is neither a light nor a scanning mechanism. It is an obvious requirement for projection purposes and yet little if any work has been done on this. Thus a new challenge to inventors is flung, and they need not be electrical men to work it out, for the needed invention is a screen which will give good results for the projection of television images.

It is obvious that television must be projected on a screen to interest the general public. Projecting any image on a screen means some loss of light and as television works with very closely-gauged light sources it cannot afford any waste of light. Even ordinary motion picture machines do not waste light as witness their use of glass-beaded screens during the past year to reflect back to the audience as much of the received light as possible.

In television the projection will be from a short distance away, since long distances require tremendous light sources. Thus, if the ordinary type of screen is used the television projector would be right in front of it, and in the way of the spectators. Another point is that the public is not likely to want a machine that requires the hanging of a screen at one side of the room and the location of a projector at the other. The ideal way is to have a large screen-like opening in the cabinet which would be fixed and around which any number of spectators could gather with ease.

This requirement obviously means that television projection must come from the rear, to be viewed on the opposite side of the screen. With such an arrangement the entire mechanism would be contained in a relatively small cabinet and the screen would be on the front of it. Then any number of persons could gather around to view it.

This idea has been applied in the new small newsreel theatres in New York where the pictures are projected from behind the screen for the same reason. In television projection work up to this time ground glass has been used for rear projection, the same as one sees in a large plate camera when looking at a picture actually coming through the lens of the camera to get correct focus before shooting the plate.

U. A. Sanabria used a huge screen made of sand-blasted plate glass in his big demonstrations of six and ten foot pictures.

Ground glass, however, is very inefficient, its loss being estimated at 50 per cent or more, which means that of the light coming through the projector carrying the picture and hitting the back of the ground glass screen only about half is actually seen by the spectator in front. I have tried out the screen used by the newsreel theatres in New York but this, too, is decidedly inefficient. Since these are the only two well-known possibilities, it is obvious that a fine field lies ahead for those who are inventively inclined, in finding something that will permit rear picture projection and still not lose very much light. Such an invention should have a tremendous market when television steps into its stride.

Television Probabilities

Progress to Date and a Prophecy of Uses

By Thomas Calvert McClary

[*Reprinted from August* 1*st issue of "Forbes."*]

THERE are fifteen thousand television receivers operating in American homes today. One year from now there will be around one hundred thousand.

Television stations offering synchronized audio-visual broadcasting on regular schedule are now in operation in New York, Chicago, Boston, Washington, and Coast cities. Other cities will have stations soon. License applications for experimental stations are flooding the Federal Radio Commission.

At least three manufacturers are marketing reliable receiving sets. It is safe to say that seven or more companies will form the nucleus of this infant industry by Christmas.

The majority of television receivers now show an image from 3 x 5 to 8 x 8 inches. The latter may be increased to 2½ x 2½ feet by a change of lens and projection of the light beam on to a larger screen. The increase in size causes a loss in definition and illumination, but the images are satisfactory.

Visual broadcasts now include all forms of entertainment which may be seen and heard at the talkies, although talking pictures themselves make up the main part of the program in most cities.

Stock Selling Undertaken

Almost all of the television equipment manufacturers are now selling or planning to sell stock. While some of the manipulation looks shaky, all are doing meritorious research and experimentation. The radio industry passed through the same phase. Not all of the companies were honest, but all contributed to radio progress.

The important thing is that, at last, television is here.

The present status of television is difficult to define. David Sarnoff, president of the Radio Corporation of America, says definitely that television is still in the laboratory stage. RCA's opinions are usually deserving of considerable thought, but in this case RCA has very definite business reasons for wishing to see 1932 a radio year. Not least among them, it may be surmised, is the fact that the company does not intend to market a television receiving set until the fall of next year. And the general upset to the National Broadcasting Company if television were declared here, before it has reached the point where commercialization is possible, may be imagined.

Independent companies such as the Western Television Corporation, Jenkins, and the Shortwave and Television Corporation are equally definite in saying that television is ready for the public at large, however. They do not claim that it is perfected, but they point out that entertaining programs may be broadcast and received sufficiently well to be termed enjoyable.

Radio editors and others who consider such questions from the public's standpoint agree.

A new light cell which makes possible a black-and-white picture on the screen, rather than one of pinkish hue, was recently demonstrated by Dr. Alexanderson of the General Electric Company.

Crude, Elementary Stage

As it exists today, visual broadcast and reception is in a crude elementary stage which is comparable with the early crystal set days of radio in '21 and '22.

RCA is basing its attitude largely on the public's preconceived idea that television programs will compare with talking movies. This is the average fan's notion as a result of too much publicity. Those who expect any such spectacle immediately will be sadly disappointed.

Some stations are broadcasting a 45-line screen, but the majority uses 60 lines. Sixty lines means that the television image is made up of thirty-six hundred little dots of varying light and shadow intensity. Actually, only one of these dots is brought to the eye at a time, but the eye retains the impression for one-twentieth of a second, during which time all other dots appear in their proper component position on the screen.

However, even the sixty-line image leaves much detail to the imagination. This problem will be overcome automatically when a receiver and broadcast equipment eliminating the necessity for moving parts is perfected. Progress in this direction has been made by a twenty-four-year-old youth on the Coast named Philo Farnsworth and by Dr. Vladimir Zworykin of the RCA-Victor Company, working independently of each other.

Both men are working to perfect the cathode ray tube system of scanning. Patent rights involving millions of dollars are at stake and the utmost secrecy is being maintained by both groups. However, it is known that Farnsworth is using a 400-line screen. U. A. Sanabria, another youth of twenty-five, recently demonstrated 3 x 3, 6 x 6, and 10 x 10-foot images. His system may have theatre possibilities, as the method of lighting which he uses is ample for large screen projection.

The place which television may occupy in business is less well known than its general possibilities. Speaking before the Cleveland Engineering Society last April, General James G. Harbord, chairman of the Board of RCA, gave an interesting picture of one way in which it may contribute to business speed. "A great corporation whose directorate is scattered across the continent, suddenly needs a meeting of its board of directors. Buzzers buzz, wires hum, and bells ring in a dozen distant cities. The call goes out. The hour is named. Switches are thrown and at the appointed time, say perhaps an hour after the call was issued, a quorum is assembled by electricity and called to order by the chairman."

The Actor in Business

At such a television meeting each man, sitting in his own office, would see and hear all of the other members of the group just as if they were present in the same room. The discussion ended, motions are put and carried. Copies are immediately typed and flashed to all the members involved. Each affixes his signature and facsimiles are flashed back to the chairman before the board adjourns.

Another way in which television will accelerate business will be to make purchasing easier. Great stores and manufacturers will have regularly timed displays of merchandise "on the air." Customers will tune in, watch the display of wares, and, with telephone beside them, be able to order within a few seconds of seeing the merchandise. Similarly, industrial or commercial corporations can speed their purchases by asking salesmen at a distance to display their wares before a television scanner.

The drain on every manufacturer, salesmen's transportation time, will be eliminated excepting in instances where the actual contact with the merchandise is necessary. Television personality will be at a premium. It is possible that the actor, so scorned by business for centuries, may become a highly important cog in the sales organization.

List of Stations Sending Television

Following is a list of active television transmitting stations, showing that of the 20 listed, 12 definitely subscribe to the 60-line method:

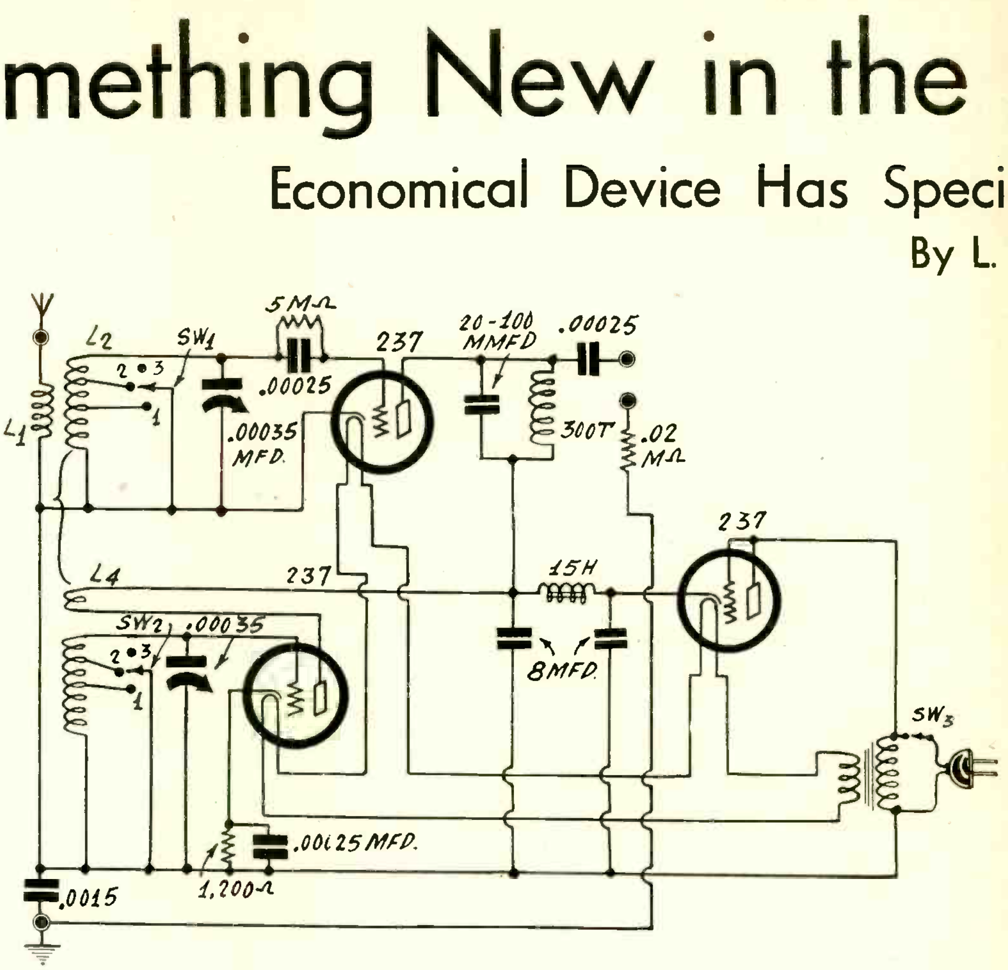
Call Letters	Company	Location	Power (watts)	Lines per Frame
2,000-2,100 k.c. (149.9 to 142.8 m.)				
W1XAV	Shortwave & Television Lab., Inc.	Boston, Mass.	1,000	60
W3XK	Jenkins Laboratories	Wheaton, Md.	5,000	60
W2XCR	Jenkins Television Corp.	New York, N.Y.	5,000	60
W2XAP	Jenkins Television Corp.	portable	250	60
W2XCD	DeForest Radio Co.	Passaic, N. J.	5,000	60
W2XBU	Harold E. Smith	Near Beacon, N. Y.	100	48
W9XAO	Western Television Corp.	Chicago, Ill.	500	45
2,100-2,200 k.c. (142.8 to 136.3 m.)				
W3XAD	RCA Victor Co.	Camden, N. J.	500	60
W2XBS	Nat'l Broadcasting Co.	New York, N.Y.	5,000	60
W2XCW	Gen. Elec. Co.	S. Schenectady, N. Y.	20,000	--
W8XAV	Westinghouse Electric & Mfg. Co.	E. Pittsburgh, Pa.	20,000	60
W2XR	Radio Pictures, Inc.	L. I. City, N. Y.	500	60
W9XAP	Chicago Daily News	Chicago, Ill.	1,000	45
W3XAK	Nat'l B'dcasting Co.	Bound Brook, N. J.	5,000	60
2,750-2,850 k.c. (109.0 to 105.2 m.)				
W2XAB	Columbia Broadcasting Sys.	N. Y. City	500	60
W9XAA	Chicago Federation of Labor	Chicago, Ill.	1,000	48
W9XG	Purdue Univ.	W. Layfayette, Ind.	1,500	..
W2XBO	United Research Corp.	L. I. City, N. Y.	500	..
2,850-2,950 k.c. (105.2 to 101.6 m.)				
W9XR	Great Lakes Broadcasting Co.	Downer's Grove, Ill.	5,000	24
W2XR	Radio Pictures, Inc.	L. I. City, N. Y.	500	60

Something New in the Sl

Economical Device Has Special

By L. Bruc

FIG. 1
Here is a fine-working converter that will bring in short waves when used on a broadcast set. In case of trouble in effecting coupling the special output option may be used to correct this. For a discussion of this phase see the last part of the text herewith.



ALMOST everybody interested in radio desires some device that will bring in short waves, but that does not necessarily mean the outlay of any considerable amount of money. In fact, a complete AC-operated short-wave converter, such as the one diagrammed in Fig. 1, can be built of parts costing around $10. The results will be good if the converter is properly wired and is properly connected to a broadcast receiver.

The two tubes at left constitute the mixer circuit, and about all that is required for short-wave conversion is a good mixer, as the broadcast set will take care of the rest, excepting the B voltage, which it is preferable to have in the converter. Here the B voltage is obtained from a little rectifier, one that serves the purpose abundantly, however, and which will be found to be utterly dependable.

One-Tenth Cent An Hour to Run

For continuation of the economy practiced in other directions, the operating cost will be very low indeed, since the total consumption will be less than 10 watts. Taking 10c per kilowatt hour as the base (which is about as high as is charged anywhere in the United States), the cost of juice would be only one cent for every ten hours of use! This includes A current and B current!

This is accomplished by using the new automotive series tubes, all three tubes being 237's. The tube is a good oscillator, a good amplifier (the two statements are really one), and a good modulator, as well as a good rectifier when hooked up as a diode with interconnected plate and grid elements.

The circuit is about as elementary as it possibly could be, and when it comes to short waves it is usually found that where the complexity is least the results are most.

Working the Band Shift

Here we avoid using plug-in coils, by having three pairs of binding posts, with leads brought from the ground side to permit shorting out turns of wire when higher frequencies are to be tuned in. This method takes the place of a costly dual selector switch.

The manner of working the band shifting this way is as follows. As two circuits are to be altered, there will have to be the equivalent of two switches, even though both switches have one side going to ground permanently. The supposition that a single switch may serve the double purpose is dispelled when one considers that the taps of two coils, hence two circuits, would have to be interconnected, and thereby the whole effect would be destroyed, in fact the reception of signals probably would be impossible, due to too tight coupling.

There are really only two taps for each coil. What seems to be a mistaken tap unconnected at each is simply the place to put the leads when not actually in use at effective taps.

The moving element is grounded, so if you have two tips from one ground lead the object is attained.

Since the desire is to receive short waves, it is not necessary to go into the problem of bringing in the broadcast waves also, for that would complicate the coil system, and also the broadcast receiver normally will give much better results in this band than would the converter.

Coils on One Form

The bracket denotes that there is some inductive coupling between plate of the oscillator and grid of the modulator. Thus the entire coil system may be built on one form. That is another simplifying and economizing consideration.

The rectifier is a familiar one to followers of short-wave converter articles bearing on the rectification subject, as it was especially invented for this purpose.

The theory of operation of the converter is that the modulator is tuned to the frequency desired to be received. The oscillator is tuned to a frequency differing from the other by the intermediate frequency. How much is that difference? Well, it depends on what intermediate frequency is used, that is, what frequency your broadcast receiver is tuned to, and that in turn depends on what region affords greatest sensitivity. Usually, in tuned radio frequency sets, the higher frequencies provide the greater sensitivity, which in a sense is unfortunate, because then there must be greater dissimilarity in frequencies between the two tuned circuits.

Due to this peculiar condition, not present in tuned radio frequency short-wave devices, but present in all superheterodynes, and the converter is the mixer constituting the combination a superheterodyne, it is well to have the two circuits separately tuned. The diagrams show that such independence of tuning actually is established.

Why Separate Controls

If it were certain that some particular intermediate frequency were to be used the coil design would be easy for single control with a gang condenser. As it is, with separate condensers, it is easy despite the uncertainty of what the intermediate frequency will be.

Under the circumstances it is well to use a rather large capacity condenser, considering the short-wave coverage, and therefore we select .00035 mfd. Two such condensers are used. We can then use bakelite tubing of 1.75 inch diameter, and wind No. 28 wire on it for all purposes. The modulator coil is easy. There should be 36 turns on the secondary, to get past 1,500

hort-Wave Converter Line

Output Circuit to Insure Good Coupling

e Farrow

kc., though not much past. The taps should be approximately on the basis of the frequency ratio of tuning. The 1,500-4,500 kc. coverage for one coil and the condenser (.00035 mfd.) has been checked and it is a fact the frequency ratio is 1-to-3 with that capacity. Therefore, since the number of turns is approximately proportionate to the frequency, tap (2) would be at 24 turns from the grid end, but we want to be sure to provide frequency overlap, therefore we will put the tap at the 20th turn from the grid end. Now we come to the only other tap (1), and that is located 30 turns from the grid end. So from (1) to ground there will be 6 turns. This will bring us down to around 30 meters.

Structure of Coil

The antenna winding will consist of 10 turns and the tickler winding L4 will consist of 14 turns. They are spaced ⅛ inch away from the secondaries with which they are associated.

The order of windings, then, would be: first, the antenna winding, 10 turns. Leave ⅛ inch, put on the secondary, with taps. Since the secondary should be connected with ground to the terminal adjoining primary, the taps should be read from ground, and are: 6th turn and 16th turn. Complete to 36 turns. Next leave at least 1.25 inches space, wind the oscillator plate coil of 14 turns. The beginning goes to plate, the end to B plus. Now start winding the oscillator secondary.

The winding has to provide not for the highest or the lowest intermediate frequency, but preferably for somewhere near the geometric mean of the two, 908 kc., so that by turning the oscillator condenser to one side or the other we can get results no matter what the difference from the mean may be. Let us use 900 kc. Then the oscillator coil should tune from 1,500 plus 900 kc., or 2,400 kc., the lowest frequency.

Now, we cannot use the full .00035 mfd. for that, for then we could not go to lower intermediates than 900 kc. (for instance 550 kc.), so we put on turns on the assumption that .00025 will be the maximum of the condenser used for 900 kc. intermediate. The frequency ratio for .00025 mfd. is about 2.5-to-1, which helps, because the oscillator begins at a higher frequency and quickly would outrun the modulator (e.g., 2,400 to 7,200 with .00035 mfd. compared to 1,500 to 4,500 for the modulator, and it is obvious the oscillator would be 3,600 kc. too high for any purpose of equality at the highest extreme, and the modulator could never "catch up with it," as the saying goes. This situation improves, fortunately, as the taps are used, because the higher the frequency desired to be tuned in, the smaller the percentage of difference between that frequency and the intermediate frequency.

Learn the Technique

So, realizing that as a starter tuning of the oscillator will be around 75 on the dial when the modulator is at 100 on the dial, to bring in a particular short wave, around 1,500 meters, we will put on 30 turns as the total for the oscillator, tapped from the grid end at the 18th and 24th. As the coil will be wound as beginning from the ground end, these taps, are from ground. the 6th and 12th, the winding being continued to a total of 30 turns.

Notice that the smaller percentage of difference at the higher frequencies shows up on the number of turns. At the lowest frequency the respective secondaries in use are 36 and 30 turns, where only .00025 mfd. of the .00035 mfd. is used for the 30-turn winding. Now when we get into the region of 4,500 kc. and higher, the difference in number of turns is only two, as compared to 6, and at the next tap there is no difference, as a slight displacement of the oscillator condenser from the reading of the modulator condenser will result in reception, due to the difference being so small a percentage, even if 1,500 kc. is the intermediate frequency.

Perhaps all this technique about the theory of operation is not quite clear, and if not it is well worth studying out, for the facts are as presented, and it adds immeasurably to the joy of construction and of operation to gain the greatest possible familiarity with the theory.

Bargains in Chokes!

The choke coil in the modulator output is of the honeycomb type, consisting of 300 turns begun on a ⅜ inch dowel, but if you want to wind a coil as substitute, use ⅜ inch dowel and put on 200 turns of No. 36 or 38 wire, winding one layer on top of the other, if you want a coil smaller in size, the distributed capacity not mattering, as there is a tuning capacity across this

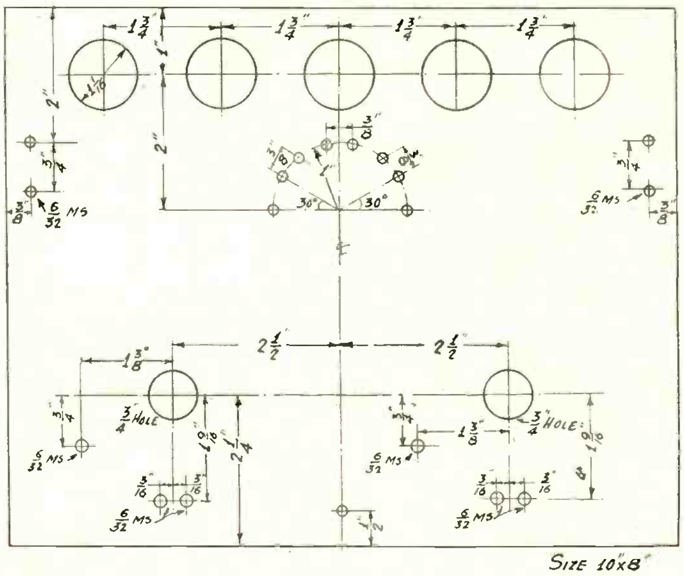


FIG. 2

Dimensions for preparing the top panel of the converter. If a box is to be made it should have, for use as cabinet, an inside height of 3 inches.

winding anyway, an equalizer of 20-100 mmfd. This little condenser is to be in circuit only if the intermediate frequency used is lower than 900 kc., but if it is higher than 900 kc., then you should omit the condenser.

The B supply choke you hardly can build, or, at least, it is not worth while going to the trouble, as a suitable choke can be bought for around $1.00 for 15 henries, or, if a huskier one is desired, $1.50 will purchase 30 henries these days. (But not much longer hereafter, let's hope!)

The a-c switch is located on the top panel, a 20-volt filament transformer is used and the series-connected heaters put across it, the electrolytic condensers are placed in the extreme left and right circular holes of the panel, the antenna and ground posts in the two side holes at left, and output posts at holes at right.

Connections

Now, having completed the panel and the wiring, we place the whole apparatus inside a suitable wooden cabinet, and we are ready to connect. Aerial is removed from the antenna post of the broadcast receiver, ground of converter is connected to the ground post of the broadcast set, where the ground is left connected. The output of the converter goes provisionally to the vacated antenna post of the broadcast set, and the corresponding post goes to a resistor that provides special coupling from the converter. This is something new. And here is the reason for it.

Sometimes the input to the broadcast set is of a special type and will not transfer the energy from the converter in a manner in any way acceptable. If this is true, and if the broadcast set is a screen grid set, then disconnect cap from the first radio frequency amplifier in the set, and connect cap to the output post of the converter, closing the circuit between the two posts on the converter to introduce the 0.02 meg. resistor (20,000 ohms) to provide a grid return for the screen grid tube. If the set hasn't a screen grid tube in this position, a service man's adapter is necessary to provide independent access to the grid (thus disconnecting the secondary coil in the broadcast set), the connection procedure in the converter remaining the same.

Tuning Consequences

For the standard method, connection to receiver's antenna post, only the output post is used, and no connection made to the companion post on the converter.

The new method omits the tuning of the receiver's input, except so far as the 300-turn choke.

Short-Wave Coupling

Sometimes a Quarter Turn Gives Too Much

By Brunsten Brunn

ALL experimenters encounter peculiarities in short-wave reception. The short waves give a little trouble, too. One of the reasons for this is that considerable energy can pass through a very small capacity. Another is that much energy can be transferred from one circuit to another by means of a very small mutual inductance.

There is particularly trouble with short-wave converters and superheterodynes. One of the troubles is the pulling together of the tuned circuits. The oscillator ceases to function or begins to oscillate at the frequency of the signal. When it stops oscillating it does so with a sharp click and the reason for the stoppage is that the tuned radio frequency circuit is coupled too closely to it. A high resistance is introduced into the oscillator circuit by the wave trap effect of the r-f circuit and there is not enough feed back in the oscillator to overcome the resistance. The coupling that causes the trouble may be intentional or stray.

When the two circuits pull together the oscillator may continue to function but at the frequency of the incoming signal, which acts as a trigger controlling the oscillator. The circuit breaks into this condition with a click and breaks away similarly. No signals can be received when the circuit is in this condition because no intermediate frequency is being generated.

Cures for Pulling Together

One aid against pulling together of the oscillator and the r-f tuned circuit is to make the oscillator coil much better than the radio frequency coil. The less the natural resistance in the oscillator circuit the more tenaciously it holds to its own frequency. If the resistance were zero it would not be possible even to alter the frequency by means of coupling to other circuits. But if the r-f tuner is superior to the oscillator tuner in this respect the r-f tuner can easily pull the oscillator over.

Another way of avoiding pulling together is to make the coupling between the two circuits looser. If it is loose enough there can be no pulling together no matter how high the resistance in the oscillator or how low it is in the radio frequency tuner. But we must have some coupling or the oscillator will not serve any purpose in the set. It is therefore a matter of choosing the proper type and degree of coupling between the two circuits. It is possible to arrange the circuits so that the adverse coupling between the two is negligible and yet so the useful coupling is quite close.

It should be stated here that as far as the performance of the superheterodyne is concerned there is no need to distinguish between pulling together and stopping of oscillation by the wave trap effect. The causes and cures of the two are the same.

Effect of Frequency

These troubles depend a great deal on the ratio of the intermediate frequency to the signal frequency. Suppose we have an intermediate frequency of 50 kc. This may be entirely high enough when the signal frequency ranges from 550 to 1,500 kc., but it would be much too low when the frequency is of the order of 6,000 kc. or higher. We may take the ratio between 50 kc. and 1,500, that is, 1/30, as the smallest ratio that should be used. Then when we are to receive signals of 6,000 kc. we should have an intermediate frequency of at least 200 kc. And if we are to receive signals of 30,000 kc. we should use an intermediate frequency of at least 1,000 kc. By loosening the coupling between the oscillator and the radio frequency tuner it may be permissible to use a somewhat lower frequency. In fact, successful superheterodynes on 30,000 kc. have been built with an intermediate frequency of 250 kc., but there was thorough shielding.

In nearly all commercial superheterodynes the intermediate frequency is 175 kc. This is high enough not to cause any trouble in the broadcast band, but it is too low for extremely high frequency signals. If the intermediate frequency is made of the order of 450 kc., it would be practical to build a superheterodyne that would not only tune in broadcast signals but all signals up to about 30,000 kc, provided the shielding were good and the coupling were arranged to fit the frequency. This is a simple matter when plug-in coils are used.

The shielding should be done so that there is no electric or magnetic coupling between the tuned circuits.

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Dynatron Oscillator Uses

Simplicity and Frequency Stability Mark Circuit

By Brunsten Brunn

THE dynatron oscillator is rapidly gaining in popularity over other types of oscillators because of its reliability and simplicity. Such oscillators are now used in laboratories as oscillating frequency meters and sources of high frequency current and they are also used extensively in superheterodynes and short-wave converters for providing the high frequency for the frequency changer.

In Fig. 1 we have a simple circuit of such an oscillator utilizing a 235 variable mu tube, which is rated as one of the best tubes for this purpose. Simplicity is a noteworthy feature of this circuit. The characteristic features of the dynatron are that the voltage applied to the screen is higher than the voltage applied to the plate and that the tuned circuit is connected to the plate of the tube. A circuit of this type oscillates at the resonant frequency of L1C by virtue of the negative resistance characteristic of the plate circuit. No tickler is necessary, but it is absolutely necessary that the screen voltage be higher than the plate voltage, for otherwise the plate circuit will not have a negative resistance.

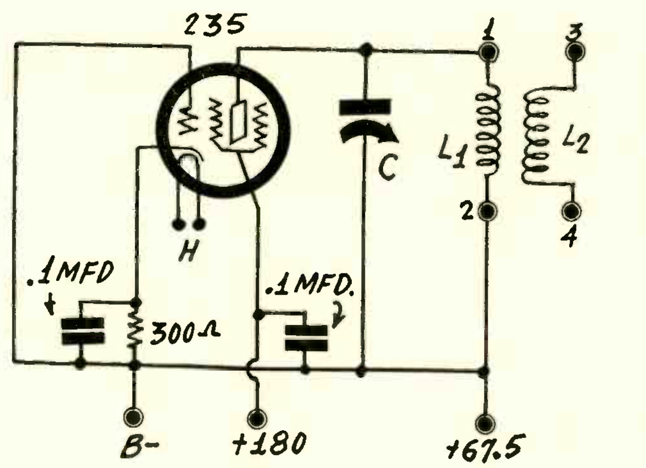


FIG. 1
The circuit of a dynatron oscillator utilizing a 235 variable mu tube. An oscillator of this type finds many applications in the laboratory.

Suitable Values

Suitable values for condensers, resistors, and voltages are indicated on the diagram when the frequency of the oscillation is in the broadcast band or higher. The values of C and L1 depends on the particular frequency or frequency range that is desired.

It will be noted that a 300-ohm grid bias resistor is used just as if the tube were to be an amplifier, and that a 0.1 mfd. by-pass condenser is connected across it. There is no impedance of any kind in the external grid circuit so that the resistance is used solely to maintain the control grid at a constant negative potential.

The heater voltage, applied at H, is the same as that required when the tube is used for other purposes, and it is 2.5 volts. The heater may be connected to any 2.5 source, either a-c or d-c.

The voltage applied to the screen is 180 volts and the voltage applied to the plate is 67.5 volts. That is, in the dynatron the screen and plate voltages are reversed as to magnitude. A 0.1 mfd. condenser is connected between the screen and the ground to maintain the screen voltage constant relative to the high frequency oscillation.

In this particular case the tuning condenser C is connected between ground and the plate. It is grounded on one side in order to eliminate body capacity effects as much as possible and also to simplify the construction. It is easier in case the subpanel is of metal to mount the condenser when its rotor and frame are at ground potential. To complete the tuned circuit a 0.1 mfd. condenser is connected between the plate return and ground. This condenser is so large that it does not affect appreciably the tuning characteristic of the tuning condenser C.

The tuned coil is L1. Its inductance should be adjusted to fit the particular frequency range that is desired. L2 is a small coil or winding coupled to L1 and its purpose is to provide a means of taking off the oscillation. It may be the pick-up coil in a superheterodyne or short-wave converter or it may be a winding to be connected in the grid circuit of an amplifier in case the dynatron is a master oscillator.

Further Applications

A large number of uses can be found for an oscillator of this type. For example, it may be used to convert certain receivers into receivers of continuous wave code. In such cases L2 should be connected in the grid or plate circuit of the final detector. If the frequency of the dynatron is adjusted to differ by a frequency of from 500 to 1,000 cycles per second from the carrier that is being received, the code signals will be converted into pure tone dots and dashes. When it is used for this purpose it is necessary to adjust the turns of L2, or the coupling between L1 and L2, so that the the detector is not overloaded. It is applicable to tuned radio frequency and superheterodyne receivers alike, but in a radio frequency receiver the frequency of the dynatron should be approximately equal to carrier being received while in a superheterodyne it should be nearly equal to the intermediate frequency.

Another use for the oscillator is to convert a broadcast receiver, especially a sensitive tuned radio frequency receiver, into a short-wave superheterodyne. If L2 is connected into the screen, grid, plate, or cathode leads of the first tube in the circuit and C adjusted until the frequency of CL1 differs from the desired signal by the frequency to which the broadcast receiver is tuned, the desired short-wave signal comes through. L2 may also be connected to the input terminals of the receiver under certain conditions, the antenna and ground leads being left in position. This does not make the very best short-wave converter, but it certainly makes the simplest one.

The dynatron may also be substituted for the oscillator in a superheterodyne. The oscillator already in the circuit is killed and L2 is connected in one of the leads of the first detector. If this is a screen grid tube the simplest connection is to open the screen grid lead and to connect L2 in the break. Another simple way in case the first detector is a screen tube is to connect L2 between the cap of the tube and the clip that ordinarily fits on the cap. But in the case it is essential that L2 be very small or that the coupling between L1 and L2 be very loose, for otherwise there will be overloading.

Still another use of the dynatron is in lining up the intermediate frequency amplifier in a superheterodyne. In this case the frequency should be equal to the intermediate frequency and L2 should be connected to the grid of the first detector in place of the circuit already in the circuit. The tuners in the intermediate frequency amplifier should then be adjusted until the output is maximum.

Suppose the dynatron oscillator is to cover the broadcast band. In that case C should be either a 350 or a 500 mmfd. condenser. If the coil diameter is 1.75 inches and the wire used is No. 28 enameled, L1 should have 75 turns for a 350 mmfd. condenser and 69 turns for a 500 mmfd. condenser. The number of turns on L2 depends entirely on the purpose of the winding and to what kind of device it is to be connected. It may have just a few turns or it may have more turns than the tuned winding.

Many tuned radio frequency transformers for 350 and 500 mmfd. condensers may be used as they are. L1 would then be the large winding and L2 the primary. A primary of five turns, which is often used in the antenna circuit, would be about right for connecting in the screen circuit of a first detector. Even a ten-turn primary could be so used without overloading the detector tube.

If the transformer L1 L2 is to be for short-wave reception where plug-in coils are used, the wire may be wound on a form which fits a UX socket, since there are only four terminals. Suppose the form has a diameter of 1.125 inches, a common size for plug-ins. If the oscillator is to tune to 1,500 kc. and if No. 28 enameled wire is used the tuned winding should have 22 turns, the condenser being a 250 mmfd.

With this condenser it is reasonable to suppose that the minimum capacity in the circuit is 25 mmfd. so that the capacity ratio is 250/25, or 10. Hence, the frequency ratio is 3.16, the square root of 10. Since the large coil is short compared with the length, it is allowable to assume that the turns for coils to cover shorter waves should vary inversely as the frequency, or directly as the wavelength.

The large coil will tune up to 4.74. The next coil in the plug-in set should begin here with 250 mmfd. in the circuit. Therefore the second coil should have 7 turns, and the third coil 3 turns.

If the oscillator is to be used in a superheterodyne the frequency coverage is not the same as when it is used in a radio frequency tuner, allowance must be made for the intermediate frequency. Suppose that this is 1,500 kc. in a short-wave converter. Then the lowest frequency to which the oscillator coil should tune in order to reach 1,500 kc. is 3,000 kc. Since it is permissible to assume that the turns vary inversely as the frequency, the coils being short enough for this assumption, the oscillator coil should have 11 turns instead of 22 turns. This will reach up to 9,500 kc. The second oscillator coil, however, should not start there. It should be based on the second r-f tuner in addition to the oscillator tuner.

Switching Se

All-Wave Coverage Enjo

By Einar

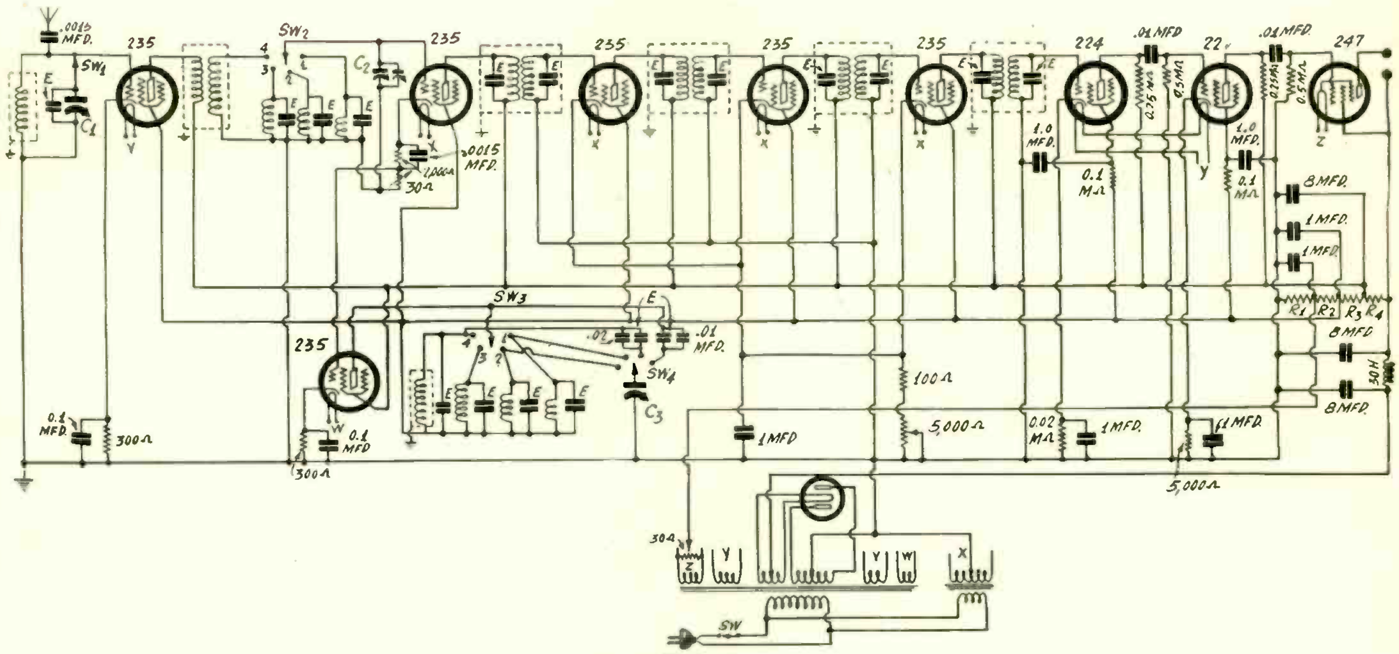


FIG. 1

The circuit of an all-wave super-heterodyne in which the tuning range is changed by picking up different coils by means of switches.

THERE is a certain popular interest now in all-wave receivers, and the poularity is growing. There is one recognized way of getting all-wave reception, and that is by plug-in coils. But some prefer the all-waveness of the receiver be accomplished by means of switches.

There are several ways in which switches can be applied to accomplish all wave-tuning. One is to move the stator of a tuning condenser to different points on a coil, leaving the circuit otherwise undisturbed. Another way is to short circuit some of the turns by means of the switch. Still another way is to move both the stator of the tuning condenser and the lead to the grid by means of the switch, leaving the unused turns open. All of these methods have certain advantages, and all overcome the necessity for using plug-in coils.

Complications

When switches are used they have to be put in all the windings, such as tuned ones, primaries, ticklers, pick-up, in order to maintain the proper ratio of turns. But if switches are placed in every winding and the circuit contains several radio frequency transformers it is clear that complications multiply rapidly. So complex does the circuit become that it is necessary to compromise. Usually, this is done by tapping only the tuned windings. This compromise is allowable provided that the frequency band to be covered by the tuner is not too wide. A band from 550 kc. to 30,000 kc. is entirely too wide for if the auxiliary windings are made right at the middle frequency they are too small at the 550 kc. limit of the tuner and they are too large at the 30,000 kc. limit.

Fortunately, there are certain circuits which require no auxiliary windings. For example, if direct tuned impedance coupling is used there is only one winding to contend with and that can be tapped by one of the methods listed above. Short-circuiting of the unused turns is about as good as any. In the case of the dynatron oscillator there is only one winding, and this also may be tapped without adding complications. Thus a tuned impedance coupled r-f amplifier and a dynatron oscillator are logical in all-wave superheterodyne. When a tuned impedance coupled r-f amplifier is not very selective, this is not serious in a superheterodyne in which the intermediate frequency is high.

An All-Wave Circuit

In Fig. 1 is an all-wave superheterodyne receiver in which separate coils are picked up by means of the switches, which is a good alternative method. There is a switch SW1 in the input circuit of the first tube. This switch is closed when broadcast waves are to be tuned in and then condenser C1 tunes the coil. When shorter waves are to be tuned in the switch is opened so that the coil acts as a choke. The extra selectivity provided by the first tuned circuit is not needed on short waves. This simplifies the circuit greatly.

Between the first and the second tubes is a regular tuned coupler for the broadcast waves. Switch SW2 is set on (4) and the secondary is tuned by means of C2. The small variable condenser across C2 is just a trimmer which is used for all the coils.

There should be a small coupling condenser of the equalizer type (20 to 100 mmfd.) connected between the plate of the first tube and the grid of the second tube. This is not shown in the diagram, as either this method or the series primaries as shown on page 6 may be used, as you prefer.

Using Smaller Coils

When switch SW2 is set on (3) the band of frequencies just above the broadcast band is covered by the tuning condenser C2. When it is set on (2), the next band is covered, and when it is set on (2), the next band is covered, and when it is set

List Prices of Tubes

The following table gives the prevailing price lists of the various tubes

Tube	Price	Tube	Price	Tube	Price
227	@ $1.25	551*	@ $2.20	WD-11	@ $3.00
201A	@ $1.10	171A	@ $1.40	WX-12	@ $3.00
245	@ $1.40	112A	@ $1.50	200A	@ $4.00
280	@ $1.40	232	@ $2.30	222	@ $4.50
230	@ $1.60	199	@ $2.50	BH	@ $4.50
231	@ $1.60	199	@ $2.75	281	@ $5.00
226	@ $1.25	233	@ $2.75	250	@ $6.00
237	@ $1.75	236	@ $2.75	210	@ $7.00
247	@ $1.90	238	@ $2.75	BA	@ $7.50
223	@ $2.00	120	@ $3,00	Kino	
235	@ $2.20	240	@ $3.00	Lamp	@ $7.50

*This table comparable to the 235.

parate Coils

yed in a Superheterodyne

Andrews

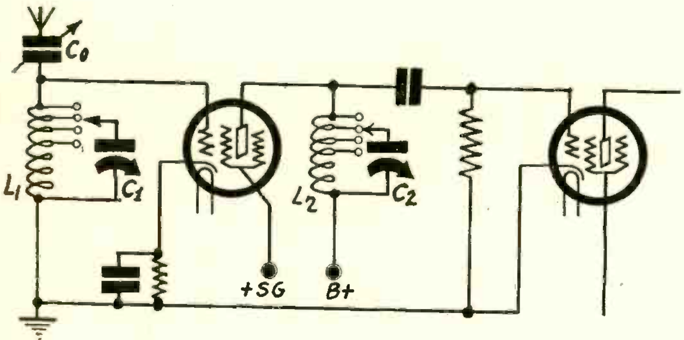


FIG. 2
In this direct coupled circuit the inductance is changed by connecting the tuning condensers to different taps on the coils. The untuned turns remain useful.

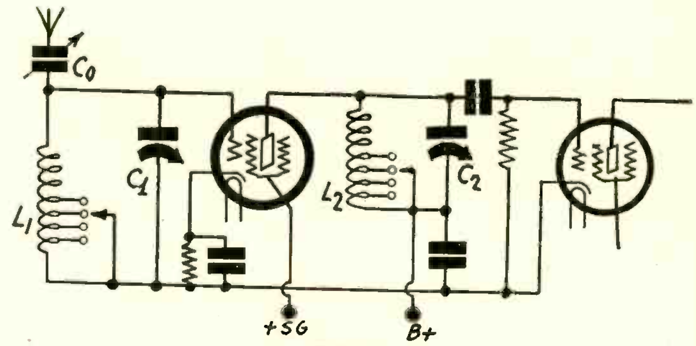


FIG. 3
In this circuit the inductance is changed by shorting turns by means of the switches. The shorted turns remain on the low potential side of the tuned circuits.

on (1) the highest frequency band is covered. Across each of these small coils is a trimmer condenser E which help in lining up the rf tuner with the oscillator tuner.

When the three smaller coils are used the circuit is a type o ftuned impedance, the primary of the r-f transformer used for broadcast frequencies acting as a choke for the high frequencies. This will not work without the coupling condenser specified above or the series primaries.

The oscillator in this circuit is of the dynatron type, which requires only one winding at a time. There are two switches associated with this tube, the two being controlled by the same knob. When SW3 is set on (4) the other switch SW4 is set on the extreme right point. The circuit is then adjusted for broadcast reception. As the other points are picked up the circuit is put in condition for tuning in the shorter wave bands. Across each of these oscillator coils is a trimmer condenser E for the purpose of lining up the oscillator with the r-f tuner.

Series Condensers

It will be observed that there are series condensers in the first two oscillator circuits. That is, when the switch SW4 connects the oscillator tuning condenser C3 for the broadcast wave band it is connected to a 0.01 mfd. fixed condenser. This condenser is shunted with a trimmer E. The object of the series condenser is to equalize the oscillator tuning with that of the radio frequency circuit. On the second point the tuning condenser picks up a 0.02 mfd. condenser shunted by a trimmer. This is larger because on this coil the relative discrepancy between the r-f and oscillator frequencies is not nearly so great as it is on the broadcast band. For the higher frequency bands it is not necessary to have series condensers at all. The oscillaitor and r-f tuners, for equal inductances and tuning condensers, tune very close together because the intermediate frequency is relatively small, although absolutely it may be quite high. A suitable intermediate frequency for a receiver of the type depicted in Fig. 1 is 450 kc. This is low enough for broadcast frequencies and high enough for frequencies up to 30,000 kc. There are such transformers available, with both primaries and secondaries tuned to the 450 kc. frequency and both inclosed in an aluminum shield.

The oscillator condenser C3 is grounded on one side but the coils are connected to a positive d-c potential. The oscillator circuit is therefore completed through a by-pass condenser from the positive potential to ground. In this case the condenser in the oscillating circuit is the one microfarad condenser from the junction of R2 and R3 to ground in the voltage divider.

When screen grid tubes are used in a resistance coupled circuit for audio frequency amplification or detection, motorboating is likely to result, and due to the high gain of screen grid tubes it i svery difficult to stop it by ordinary means. One of the best ways to reduce the tendencv to motorboat, and at the same time to improve the quality of the amplification, is to put in high resistances in the screen leads. In the circuit in Fig. 1 0.1 megohm is used in each screen lead. It is notnecessary to use the by-pass condensers for screen resistors. In the circuit a 1 mfd. condenser is shown for each resistance. These condensers can be utilized to greater advantage across the grid bias resistances. The detector and the first audio amplifier are 224 tubes but a 235 may be used to advantage in the audio amplifier.

List of Parts for Fig. 15, page 8

Coils

Four plug-in coils for antenna coupler (L1, L2)
Four plug-in coils for interstage coupler (L4, L5)
One 50-turn honeycomb coil (L3)
One 300-turn honeycomb coil (L6)
One 2.5 volt filament transformer

Condensers

One two-gang 0.00035 mfd. tuning condenser (C1, C7)
One small variable condenser, about 60 mmfd. (C6)
One block of three 0.1 mfd. condensers (C2, C3, C4)
Three 0.0001 mfd. condensers (C5, C9, C10)
One .00035 mfd. fixed condenser (C8)
Two 0.01 mfd. fixed condensers (12, C13)
One 1.0 mfd. bypass condenser (C11)

Resistors

One 300 ohm flexible biasing resistor (R1)
One .005 meg. = 5,000 ohm pigtail resistor (R5)
One 25,000 ohm potentiometer with switch (R5, SW)
Two 0.25 meg. = 250,000 ohm pigtail resistors (R7, R8)
One 2 meg. pigtail resistor (R6)
One 0.1 meg. = 100,000 ohm pigtail resistor (R11)
Two 0.01 meg. resistors = 10,000 ohms (R2, R3)
Two 5 meg. grid leaks (R4, R9)

Other Parts

Two binding posts (Antenna, Ground)
One output twin jack assembly for phones
One 7¾ x 10 inch front panel
One subpanel with five UY sockets
One vernier dial (pilot lamp PL optional)
One 0-25 milliammeter
One dozen 6/32 machine screws and one dozen nuts
One dozen lugs
One roll of hookup wire

Radio University

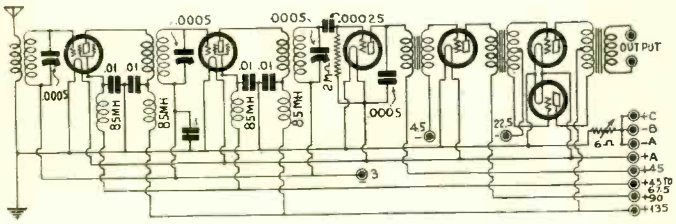


FIG. 942
The diagram of a six-tube receiver that is suitable for use as a portable if the tubes are of the 2-volt type.

Circuit for Portable

WILL you kindly publish a circuit diagram of a six tube receiver suitable for a portable? I should like to have two 232 screen grid tubes for radio frequency amplifiers, two 230 tubes for detector and first audio, and two 231 for output stage. Kindly indicate the voltage values.—B. S.

In Fig. 942 is a diagram of such a circuit. The filament voltage should be supplied by four No. 6 dry cells in series-parallel and the 6-ohm rheostat should be adjusted so that the filament terminal voltage is 2 volts. This set is not sensitive enough to be used in an automobile because a good antenna and a good ground are required, and neither can be provided in an automobile.

* * *

Measuring AC Voltage with Current

I HAVE a sensitive thermo-couple meter with which I can measure the current flowing in the secondary circuit of a coupling transformer. Is there any way that I can use this meter for measuring the effective radio frequency voltage on the grid of the tube following the transformer, the secondary winding being tuned?—E. S.

Connect the thermo-couple meter in series with the tuning condenser and note the current. The voltage across the condenser, or across the input circuit to the tube, is then the product of the condenser reactance and the current in amperes. Since the condenser reactance is 1/Cw, the voltage is I/Cw, in which I is the measured current expressed in amperes, C the capacity of the condenser in farads, and w is the frequency of the current multiplied by 6.2832. The capacity to use is not the maximum capacity of the condenser but the actual capacity in the circuit when the current is measured. It may be necessary to measure both the frequency and the capacity to get the result.

* * *

Loss of AF Amplification

MY receiver contains a resistance coupled amplifier that is supposed to have uniform amplification throughout the audible scale. It is fine on the low notes but it does not seem to bring in the high audio notes as well as some transformer coupled amplifiers. Can you give a reason for this?—A. G. B.

There are many reasons why the high notes don't come through well. The first is excessive selectivity. This may be ruled out on the assumption that you have tried the two types of audio amplifiers on the same tuner and that there is still a difference. Assuming also that the same loudspeaker is used in the two cases, we can only assign distributed shunt capacity effects as the cause of the suppression of the high notes. There are two major shunt capacities in each stage, the plate to ground capacity of the tube ahead of the coupler and the grid to ground capacity of the next tube. In some instances the second of these is the greater by a large factor. This is particularly true when a three-element tube is used and when this is followed by a resistance coupler.

* * *

Non-reactive Resistances

I HAVE a quantity of Manganin wire, silk covered, which I want to use in making non-reactive resistances for use as standards. Will you kindly suggest a method of winding so as to keep the inductance as well as the capacity as low as possible?—W. H. J.

Take a strip of bakelite about 3 inches wide, 3/32 thick, and from five to six inches long. Round the long edges with a file and sand paper. Start at one end of the strip and wind the wire in the right handed direction, leaving room between adjacent turns equal to the diameter of the wire. When the strip has been wound to the required length, put on another winding exactly like the first, beginning and ending at the same points but wind in the left handed direction and put the turns in the spaces left between the turns of the first winding. This method of winding will put two equal windings in parallel. Each of these will have a very low inductance and the inductance of one continually neutralizes the inductance of the other. The distributed capacity will also be very small because of the continual cross-over of the turns. This is recognized as the best method of winding. The resistance of the double winding will be one-half that of either. To vary the resistance vary the turns.

* * *

Capacity Short-Circuits Feedback

IN the July 25th issue, on page 9, you have the circuit of a regenerative one-tube set, Fig. 7. Will this oscillate? It seems to me that C3 effectively short-circuits the feedback circuit so that no matter what the value of C4 may be the circuit will not oscillate. Am I right?—W. R.

Unless C3 is tiny in capacity compared to C4 the circuit won't regenerate.

* * *

Scraping Sound in Receiver

MY receiver worked fine for about two years and then a scraping noise gradually appeared which is now so bad that it is impossible to hear anything clearly. This noise does not come from the outside for it continues when the antenna and ground are removed. Neither does it seem to be in the radio frequency part because it continues when all the tubes ahead of the detector are removed. What do you think is the cause of the trouble?—E. R. W.

A broken resistance, a bad by-pass condenser, a defective tube or simply a poor contact may be the cause. It is probable that the trouble is to be found in the B supply.

* * *

Turns Data

I HAVE a piece of bakelite tubing 2.5 inches in diameter and some No. 22 double cotton covered wire. This material I wish to use in a wave meter which will cover the frequency range from 550 kc to 1,650 kc with a tuning condenser of 0.0005 mfd. How many turns do I need?—G. D.

You will need 58 turns if the capacity is just 500 mmfd. Since there will be some distributed capacity it may be necessary to remove a few turns to allow for this. If the circuit is very simple, we may assume that the distributed capacity is 25 mmfd. and that this is also equal to the minimum capacity in the circuit. The maximum capacity in the circuit is then 525 mmfd. Hence the ratio of the maximum to the minimum is 21. The frequency ratio is the square root of this, or 4.58. Therefore if you adjust the turns so that when the condenser is set at maximum the frequency is 550 kc, the frequency when the condenser is set at minimum will be 2,520 kc. If the circuit is not the simplest possible you will not be able to cover so wide a band.

* * *

Tuning the Loudspeaker

WOULD it be possible to construct a satisfactory loudspeaker on the principle of tuned resonators? That is, would it be possible to make a loudspeaker with a tuned resonator of some kind for every note in the musical scale? Since resonance increases the output enormously it would seem that this is a good way to go about it.—W. E. N.

In the first place there would have to be one resonator for every note in the scale from the lowest bass to the highest audio frequency. From 16 to 8,192 cycles per second there are 9 octaves. If we say there are 11 notes in an octave, without duplication, there would therefore be 99 notes. We have to add one to this in order to count both extreme notes, making a total of 100. We would have to have 100 different resonators. That is only the beginning of the complications. All these resonators would be tuned to definite frequencies, that is, they would be based on a certain pitch at middle C, there being several different pitches for this. If music were played in a different pitch the resonators would not be useful. Now the pitch of the resonators changes with temperature, but the instruments at the transmitter could not possibly be tuned to all the different receivers, even if they could be tuned to one. So much for music. How should we tune the resonators so as to respond to speech and other non-musical sounds? There is still another objection, and a serious one. The resonators would be selective by their nature. When one is excited by a note, it would take a considerable time for it to respond, and after it got going it would continue to sound off quite a while after the original sound ceased. Possibly, if we used a smaller number of very broadly tuned resonators we could get something out of them that resembled the original and gain some from the resonance. The only good speaker is one that does not have any resonance at any frequency but responds to all frequencies impartially.

* * *

Capacity and Frequency Changes

IS there a simple relation between capacity and frequency changes in an oscillator? For example, if I knew the amount of change of frequency can I determine the change in the capacity that caused that change? I have reference only to very small changes in both the capacity and the frequency. —B. G. L.

If the frequency of the circuit at the beginning is F and the change in the frequency is f, both measured in the same units, and the total capacity in the circuit at the beginning is C and the change in the capacity is dC, the following relation obtains among these factors: $f = -FdC/2C$. The minus sign simply indicates that F and C change in the opposite directions. If C increases by dC, F decreases by f. If C decreases by dC, F increases by f. Suppose F is 1,000,000 cycles per second and C is then 250 mmfd. Let dC be positive and have a value of 1 mmfd. That is, we make the capacity in the circuit 251 mmfd. The value of f is then—2,000 cycles per second, and the new frequency is 998,000 cycles per second. This simple relation does not hold unless the changes are small in comparison with the original values. In this case 1 is small enough in comparison with 250.

* * *

Simple Converter Circuit

I HAVE a number of ¼ millihenry chokes, an 85 millihenry choke, a 125 mmfd. tuning condenser and some fixed condenser. Will you kindly publish a circuit diagram of a three tube short-wave converter in which I can use these parts?—B. O. H.

In Fig. 943 is a circuit in which these parts can be used. The 85 millihenry choke you can use where it calls for a 50 mh coil. The values of the fixed condensers are given but it is not necessary to use these values. They may be larger or somewhat smaller. The grid condenser you should not make larger but you may make it as small as .0001 mfd. The circuit calls for a .00035 tuning condenser but it is all right to use the 125 mmfd. condenser you have. It is only necessary to make the tuning coil larger. If you are to tune to 200 meters and if the form on which the coil is wound is 1.75 inches you can use 39 turns of No. 24 enameled wire. Five turns will do for the pick-up winding and 25 turns for the tickler. Put taps at 12 and 4 turns.

* * *

Increase in Inductance Due to Wire

HOW much does the thickness of the wire increase the inductance? That is, suppose a coil is wound with No. 20 enameled wire on a 2.5 inch diameter and the inductance is calculated without taking into consideration the thickness of the wire, how great is the error?—B. E. Q.

If the coil contains 50 turns the computed inductances are 137 and 140.3 microhenries. Hence the increased diameter causes an increase of 3.3 microhenries.

* * *

Why Stenode Radiostat Works

THERE have been some articles against the Stenode Radiostat system of tuning. I have heard several of these circuits work well. Is this not proof that the sideband theorists are wrong? I have never seen any other circuit nearly so selective as the Stenode circuits and the quality appears to be just as good.—W. G. H.

Nobody has ever said that the Stenode does not work. Even the most rabid sideband theorist would not maintain that a minute. What he says is that the sideband theory applies just as much to the Stenode as it does to any other resonant system, mechanical or electrical. He takes issue with the theory usually associated with the Stenode. That the Stenode circuits are exceptionally selective he does not deny for he knows and uses the selectivity of the piezo crystal for many radio purposes. The quality of the Stenode receivers is obtained by compensation in the audio frequency amplifier. The same compensation can be used in receivers having highly resonant inductance-capacity circuits. The only difference is that in the Stenode circuits much more compensation is required. The high selectivity reduces the output on the high audio frequencies, a process usually called sideband cutting, and this reduction is practically proportional to the frequency. It also increases with selectivity. If there is anything at all left of a side frequency, say of 10,000 cycles per second, it is possible to build it up in the audio amplifier until it has the value that it would have had had it not been reduced at all in the tuner. One advantage of this compensation is that it can be effected in the frequency range desired with an extremely sharp cut-off above the range. For example, suppose we desire only the side frequencies between zero and 5,000 cycles per second. We can then put in a compensating circuit which builds up the frequency from zero to 5,000 cycles in proportion to the frequency, or rather in proportion to the suppression, and then make the compensator cut off at 5,000 or slightly above. A much sharper cut-off can be obtained at 5,000 cycles than at 175,000 cycles. In fact the possible sharpness of cut-off is about inversely proportional to the frequency.

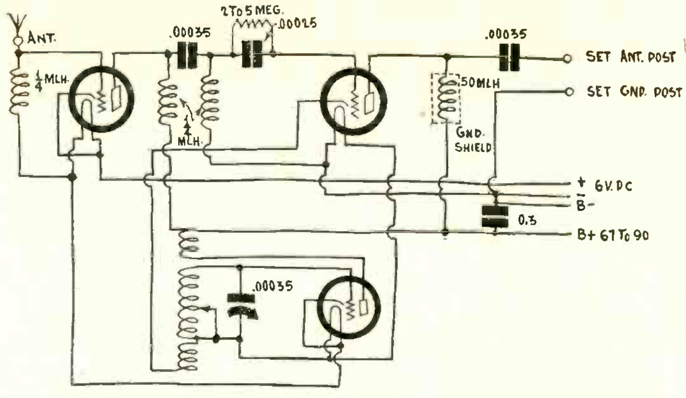


FIG. 943
The circuit of a simple three-tube converter for use with battery operated sets.

* * *

Omitting the By-Pass Condenser

IN some audio frequency amplifiers the by-pass condenser across the grid bias resistor is omitted and in other cases it is insisted that it should be used. When is it necessary to use it and when may it be omitted?—T. N. C.

It is used whenever its omission would cause a reduction in the amplification. In every push-pull stage when a bias resistor is used for the two tubes, there is no reason for using the condenser because if the circuit is balanced there is no signal current flowing in the resistor. Hence there can be neither a reduction nor a gain in the amplification due to the resistor. Obviously, it is economy to leave it out. Sometimes there is actually an advantage in leaving it out. Suppose the push-pull amplifier is not quite balanced. A small signal current will then flow through the common bias resistor. This current will set up a voltage drop in the resistor and this drop is such that it will tend to balance the circuit. In cases of single-sided amplification the condenser is omitted because it is not practical to make it large enough to do any good on the low frequencies. This is the case when the resistance is very small, comparatively. Suppose it is only 300 ohms. Then a 2 mfd. condenser reduces the impedance of the resistance by less than half of one per cent at 25 cycles per second. At this frequency it would require 36.7 microfarads to cut the impedance to 150 ohms. It might as well be 300 ohms. But when the resistance is very high, or when the frequency is high, it is advantageous to use the by-pass condenser, and in all cases the larger the condenser the better.

Forum

CHEER UP AND WEEP!

I NOTICE my subscription to your valuable paper has expired, and I had almost decided to discontinue the magazine, since it has been turned into a baby midget, short-wave adapter and converter kidding periodical. I have tried just one short-wave mess. That was plenty. Betcha. The boys I have talked with say they chose one or another of the many adapter or converter freak circuits, built it up, then rebuilt about twice, meeting with poor results, money out, time and interest lost, all in two weeks, and finally branding the layout as a 95 per cent. bunk!

But cheer up, boys, as I imagine the kidding is about over, as on front page of July 18th issue we have to stomach a short-wave, *earphone* tuner.

That must be some efficient circuit if one can hold down a pair of earphones, back of four of our present-day tubes!

I am in accord with some of the boys, as quoted in Forum, in finding descriptions and diagrams incomplete; in fact, so much so that I have stopped hooking them up until that new broom gets going good.

We can also stand more data on coil winding, wire tables, constants, on condensers, resistors, etc., not found in repair books.

Now please do not take the ravings of us knockers to heart, for we are all for the success of RADIO WORLD, and will try to help you as best we can.

But there are a lot of readers who are still interested in broadcast receivers: up-to-date go-getters. We had an inkling of the Ultradyne, and were promised more, but never got it.

Mr. Anderson's super tuner also got side-tracked. It's about time to turn Mr. Anderson loose on a good super. He has the makings, we know.

Although your super-heterodyne circuits will be about a year and a half late in the publishing we will greatly appreciate them.

Please find my enclosed check for subscription renewal.

CHAS. W. YEAGER,
1316 S. Date Ave.,
Alhambra, Calif.

Sparkles

By Alice Remsen

BASIL RUYSDAEL'S BEAUTIFUL speaking voice was never heard to such great advantage as when he read Longfellow's "Hiawatha" with a background of Emil Velazco's lovely organ music, over WOR on a Thursday evening at 10 o'clock. Resonant, soulful, natural and sincere, the voice of Mr. Ruysdael is ideal for the reading of poetry. "Weaver of Dreams" is the program title.

* * *

DO YOU LISTEN to the Three Mustachios on WEAF every Saturday at 7:30 p. m.? These boys sound as if they enjoy their work. Peter De Rose, Jimmie Haupt and Paul Simmons comprise the trio—and—oh, yes, each has a tender patch of down which is his alibi for the name of the program. A network feature.

* * *

IT DOESN'T SEEM POSSIBLE, but Dennis King, famous star of musical comedy and pictures, now of radio, assures us that when he first came to this country times were so hard for him he was forced to sleep on park benches. How times have changed—now his salary runs into the thousands per week!

* * *

TWO GIRLS who have been with NBC for a long time deserve a word or two of commendation—Muriel Pollock and Vee Lawnhurt. Both are composers of merit, pianists of note and singers of no mean ability. They are now featured, together with Harold Van Emburgh, a promising young tenor, on the Flyosan program over WJZ each Wednesday at 7:15 p. m. Well worth a listen!

* * *

BIOGRAPHICAL BREVITIES

Arthur Q. Bryan Not Married

This popular WOR announcer was born in Brooklyn, New York, in 1899, which makes him 32. His face is very young even for his years and possesses a fortunate sense of humor. When asked to provide your reporter with a few particulars, Lil' Arthur became facetious and responded as follows:

"Born of very humble parents and all that sort of thing. Very young at birth. NOT MARRIED."

Expected to be a singer but soon had that knocked out of him. First entered broadcasting, however, as a member of the original Seiberling Singers, a sixteen-manpower male chorus under Marshall Bartholemew; also sang as a Jeddo Highlander, which ought to show that a nom-de-plume more or less is next to nothing in his young life.

Followed various occupations before radio blighted things. Insurance clerk—dry goods clerk—yes, was even a second-class laborer in a coal mine around Scranton, but that job wasn't relished. Chief objection was that he couldn't stand up to work and had to lie down for lunch so as to straighten out. Lent his corpulence to the show "Follow Thru" as member of an octet of over-healthy country club members.

Heard that Lewis Reid was going to leave WOR. Knowing him quite well, Arthur went up to his office to kid him a bit. Said Arthur, "Guess I'll have to come down and take your job, Lew!" Said Lew, "We have auditions tomorrow!"

Arthur thought he'd have some fun next day, but it wasn't fun. He got the job and was scared to death about it. Managed to survive. Really enjoys broadcasting, but is the despair of the publicity department because he never has a picture for publication. Thinks Uncle Don one of the greatest personalities in radio. Enjoys chatting with everybody. Simply crazy about the country and kids; he's like a kid himself—the Peter Pan of WOR.

* * *

[*Inquiries about radio artists should be addressed to Miss Alice Remsen, c/o* RADIO WORLD, 145 *West 45th Street, New York, N. Y. Answers of general interest will be published.*—EDITOR.]

Ohio School of Air Preserved After Fight

Columbus, O.

The Ohio Legislature has appropriated $26,000 with which to carry on the Ohio School of the Air for the next two years. This amount is just enough to provide for a small staff of workers who expect to continue the work through the aid of many organizations and individuals. Chief of these are WLW and W8XAL, which carry the broadcasts without charge.

The Ohio Education Association, the Parent-Teacher Association, the Ohio Federation of Women's Clubs, Ohio State University and the University of Cincinnati are some of the organizations aiding in the work. Besides these there are many schools and individuals who assist in carrying on the work.

The Ohio Legislature was faced with the task of cutting the state budget 25 per cent and every position in the state departments was challenged. The Ohio School of the Air was challenged not less than fourteen times. But teachers by the hundreds and listeners by the thousands came to the aid of those fighting for the existence of the school. Legislators' wives extended the lists and pleaded the cause.

Literature Wanted

Andrew Miller, 1034 44th St., Brooklyn, N. Y.
Wilson Radio Service, Herbert Ferger, 95 Austin St., Buffalo, N. Y.
Charles B. Galloway, 304 N. Congress St., Jackson, Miss.
Stanley J. Fredrickson, 816 Macon St., Brooklyn, N. Y.
Arthur Friedlund, 1036 Fernhill, Detroit, Mich.
Elmer Ogle, First Natl. Bank Bldg., Crowley, La.
S. J. Nessa, Story City, Iowa.
Murl Ed de Beauchamp, Beau-Ideal Radio Services, 228½ North 13th Street, Muskogee, Okla.
Rev. Frank T. Hallett, 2 Bingley Terrace, Thornton, R. I.
Chas. F. Larseon, La Moille, Iowa.
Jacob Wheeler, 319 Second Street, Johnsonburg, Pa.
R. C. Hammel, 2619 N. Mason Ave., Chicago, Ill.
K. C. Humphrey, Franklin, Ohio.
R. H. Bates, The Pas, Man., Canada.
Chester W. Kirby, 102 Beacon Ave., Holyoke, Mass.
Everett F. Mackay, 75 Clarendon St., Saint John, N. B., Canada.
George Ewing, Box 157, Grafton, Ohio.
Edw. S. Worthington, Jr., 6811A Nashville Ave., St. Louis, Mo.
Merland L. Maxim, South Paris, Maine.
Alfred Galvin, 1122 Meadow Lane, Chester, Pa.
R. Younger, 7431 Greenville, Houston Tex.
Frederick F. Tone, N. Riverside Ave., St. Clair, Mich.
C. R. Sinclair, Casilla No. 2191, Lima, Peru, S. A.
Roy Rust, Waring, Tex.
Geo. C. Holmes, Ashland, Nebr.
James F. Drew, Box 135, Fishkill Village, N. Y.

Blues Singer Seeks Her Kidnapped Sister

Mitizi Rich, who sings blues songs over WOR, Newark, N. J., can do a few other things besides sing. She's a composer, a pianist, an actress and a writer. She's been on the stage since she was three years ald and she's now in her early twenties.

Mitzi is combing the world in search of a sister who was kidnapped before Mitzi was born. Just at present she thinks she's on the trail. A woman stopped her in a store and accused her of snubbing her. Mitzi had never seen her before and the woman apologized, saying that she looked enough like a friend she had not seen in many years to be her younger sister. Mitzi was all excited and the woman has promised to help her locate her friend. Mitzi is confident that she'll find her some day soon.

PARK CENTRAL SELECTED

The Park Central Hotel has been selected as official headquarters for the Eighth Annual Radio-Electrical World's Fair, Madison Square Garden, September 21st to 26th, inclusive. The hotel is at 55th Street and Seventh Avenue, and is near Madison Square Garden.

MORE STATIONS CONFINE SHIFT IN 50 CYCLES

Washington.

A steady increase in the number of broadcasting stations maintaining their transmissions on their assigned frequencies is indicated in the May records of the Radio Division, Department of Commerce.

During May 5,455 measurements made of 326 broadcasting stations showed that 78 at no time deviated as much as 50 cycles, 89 at some time or other deviated more than 50 cycles but not as much as 100 cycles, and 68 deviated over 100 cycles but under 200 cycles. The remaining 91 stations deviated over 200 cycles which shows remarkable improvement in this category in comparison with the figures for December, 1930, January and February, 1931, when 238, 207, and 213 stations, respectively, went over this mark.

As not all of the 613 broadcasting stations of the United States were measured it must be borne in mind that many of those not measured undoubtedly are as efficient in maintaining their frequency as those measured and mentioned in the following:

UNDER 50 CYCLES

Call signal — *Transmitter location, studio location in parentheses*

KFAB—Lincoln, Nebr.
KFDM—Beaumont, Tex.
KFEQ—St. Joseph, Mo.
KFLV—Rockford, Ill.
KFQU—Alma-Holy City, Calif.
KFRC—San Francisco, Calif.
KFRU—Columbia, Mo.
KFSD—San Diego, Calif.
KFVD—Culver City, Calif.
KFXF—Denver, Colo.
KGBX—St. Joseph, Mo.
KGER—Long Beach, Calif.
KGW—Portland, Oreg.
KHQ—Spokane, Wash.
KJR—Seattle, Wash.
KLZ—Denver, Colo.
KMBC—Independence, Mo. (Kansas City, Mo.).
KMJ—Fresno, Calif.
KMO—Tacoma, Wash.
KMPC—Beverly Hills, Calif.
KPO—San Francisco, Calif.
KRSC—Seattle, Wash.
KSD—St. Louis, Mo.
KTAR—Phoenix, Ariz.
KTW—Seattle, Wash.
KVI—Des Moines, Wash. (Tacoma).
KWJJ—Portland, Oreg.
KYW, KFKX—Bloomingdale, Ill. (Chicago).
WABC—New York, N. Y.
WBBR—Rossville, N.Y. (Brooklyn).
WBSO—Needham, Mass.
WCAO—Baltimore, Md.
WCBA—Allentown, Pa.
WCCO—Anoka, Minn. (Minneapolis).
WCFL—Chicago, Ill.
WCRW—Chicago, Ill.
WCSH—Scarboro, Me. (Portland).
WDAF—Kansas City, Mo.
WEAF—Bellmore, N.Y. (New York, N. Y.).
WEEI—Weymouth, Mass. (Boston)
WENR—Downers Grove, Ill. (Chicago).

Call signal — *Transmitter location, studio location in parentheses*

WFAA—Grapevine, Tex. (Dallas).
WFI—Philadelphia, Pa.
WGES—Chicago, Ill.
WGH—Newport News, Va.
KGN—Elgin, Ill. (Chicago).
WGST—Atlanta, Ga.
WHAP—New York, N. Y.
WHBL—Sheboygan, Wis.
WHO—Des Moines, Ia.
WIBW—Topeka, Kans.
WILL—Urbana, Ill.
WIP. WFAN—Philadelphia, Pa.
WJAZ—Mount Prospect. Ill. (Chicago).
WJDX—Jackson, Miss.
WJTL—Oglethorpe University, Georgia.
WJZ—Bound Brook, N. J. (New York, N. Y.).
WKBI—Chicago, Ill.
WKBN—Youngstown, Ohio.
WLS—Downers Grove, Ill. (Chicago)
WKBC—Detroit, Mich.
WMBI—Addison, Ill. (Chicago).
WMCA—Hoboken, N.J. (New York, N. Y.)
WMT—Waterloo, Iowa.
WNYC—New York, N. Y.
WOC—Davenport, Iowa
WOI—Ames, Iowa.
WOL—Washington, D.
WOR—Kearney, N. J. (Newark).
WOW—Omaha. Neb.
WPTF—Raleigh, N. C.
WREC—Whitehaven, Tenn. (Memphis).
WRUF—Gainesville, Fla.
WSB—Atlanta, Ga.
WSBC—Chicago, Ill.
WTBO—Cumberland, Md.
WWRL—Woodside, N. Y.
WWVA—Wheeling, W. Va.

The stations deviating less than 100 and less than 200 cycles were listed also.

The under-50-cycle list may be used for calibrating frequency meters on the broadcast band. Station lists give the frequencies.

Lowell-Dunmore Patent Affirmed

Washington.

The Board of Appeals of the United States Patent Office affirmed the decision of the Examiner of Interferences in upholding the Lowell and Dunmore patent on the alternating current operation of radio receiving apparatus.

The Lowell and Dunmore patent has been in litigation for the past eight years and has heretofore been held valid and infringed in a decision rendered by the U. S. District Court for the District of Delaware in a suit brought under the patent against Radio orporation of America by the Dubilier Condenser Corporation. During the pendency of the infringement suit, interfering claims were filed against the Lowell and Dunmore patent by Westinghouse Electric and Manufacturing Company and others. After the taking of extensive testimony and hearing agreements, the Examiner of Interferences awarded priority of invention to Lowell and Dunmore. Lowell and Dunmore's opponents, including Westinghouse Electric and Manufacturing Company, appealed to the Board of Appeals. The arguments were heard last May. The decision now by the Board of Appeals upholds the Lowell and Dunmore patent and adjudges Lowell and Dunmore the original inventors of the alternating current operated radio broadcast receiving set.

DUBILIER SUES TUBE MAKERS

The Dubilier Condenser Corporation announces it has filed suit against the Radio Corporation of America, the Perryman Electric Co., and the National Union Radio Corporation in the United States District Court at Wilmington, Delaware. The Dubilier Condenser Corporation charges infringement of their patent No. 1,797,205 covering radio and amplifying tubes as invented by their engineer, Harry W. Houck. The announcement continues:

"This patent covers practically every radio amplifier tube used in connection with alternating current sets, and was conceived by Mr. Houck many years ago when the company placed on the market the first power pack for the purpose of eliminating batteries, and permitting the operation of radio sets from electric light lines.

"The Dubilier Condenser Corporation charges that tubes manufactured by the above companies and others are a direct infringement of the type originated and patented by them, their development making possible the operation of a-c radio sets and talking moving picture equipments. Other patents covering the same subject matter have already been issued and are pending, and include developments which were decided in favor of the Dubilier Condenser Corporation and against the Radio Corporaiton of America by the United States District Court in Delaware several years ago, and confirmed several days ago by the Patent Board of Appeals."

New Corporations

Pitt Radio Corp., Wilmington, Del., broadcasting stations—Corp. Trust Co.
Brown & Hart, radio, television advertising—Atty. W. M. Garden, 25 Broad St., New York, N. Y.
Court Radio Co.—Atty. A. E. Baker, 19 West 44th St., New York, N. Y.

STOCKHOLDERS OF RCA NEARING 100,000 MARK

Stockholders of the Radio Corporation of America are now reaching in number toward the 100,000 mark, having increased from a total of 25,000 since 1928.

The number of RCA stockholders is now approximately 93,000. On June 10, 1931, there were 74,824 holders of the new common stock, an increase from 50,160 in April, 1930. In April, 1928, there were 11,976 common stockholders. In addition to the holders of the new common stock there still remain outstanding some shares of the original common and of the A common which has never been exchanged, giving a total of approximately 77,000 common stockholders.

On June 30th, 1931, there were approximately 10,000 owners of A preferred stock and approximately 6,000 owners of B preferred stock. This makes the total number of RCA shareholders approximately 93,000. RCA has stockholders in every State and territory of the nation.

New Schedule for Television from Boston

Shortwave & Television Corporation section, WIXAV, Boston, operating on 1,000 watts power and a frequency of 2,070 kilocycles, is now functioning on a daily schedule as follows:

2 to 4 p.m.: Half-tone program.

7:30 to 10:30 p.m.: Half-tone program, with direct pick up and silent films.

On Monday, Wednesday and Friday, from 10 to 10:30 p.m., sound is synchronized on 1,604 kilocycles through W1XAU, using 500 watts power.

Gerald Slattery has been appointed program manager for these stations. Regular reception of the transmissions of these stations is reported in the Middle-West as well as the Eastern Seabord. WIXAV will increase its power to 1,500 watts within a few weeks. It has been authorized to use as high as 2,500 watts.

ALL-WAVE SPECIALISTS

All-Wave Radio Company has started business in suite 1304 at 50 East Forty-second street, New York City, specializing on all-wave receivers and converters.

The company is a partnership consisting of G. A. Moeller, former controller of the Pilot Radio & Tube Corporation; A. L. Rudick, former advertising manager of the Kohler-Brambach Piano Co., Inc., and formerly of the Pilot Corp. Mr. Rudick was in charge of Speed, Inc., which sold Pilot products by mail.

A THOUGHT FOR THE WEEK

WHY is it that so many folk seem to feel a sense of elation when some court rules against the Radio Corporation of America? It reminds us of the old days when the name of Rockefeller was anathema to the man in the street—but what a change has come over the mind of the public in the past few years! Incidentally, the R. C. A. may lose a suit once in a while, but it still holds a tight rein when it comes to the matter of basic patents. If you don't believe it, try to make and sell a commercial set without talking business with the royalty department of the R. C. A.

BOOKS

A New Volume by
Prof. Morecroft
An Event in Radio Literature

PROF. JOHN H. MORECROFT, of the department of electrical engineering, Columbia University, is the outstanding writer of radio text books in the United States. Two of his volumes, "Principles of Radio Communication," a large volume for advanced students, and "Elements of Radio Communication," a smaller volume, for those not yet in the advanced stages of radio studies, have won him the reputation of being foremost in this line.

Now Prof. Morecroft has just brought out a new book, "Experimental Radio Engineering," just the volume for the radio experimenter, a valuable adjunct to the actual work performed by radio enthusiasts in their laboratories, whether at home or in shops or factories.

Also, the new volume marks the Professor's recognition of the great amount of experimental work and receiver and amplifier construction going on throughout the world. He has handled the experimental subject with the same deft skill and authority that marked his two previous volumes.

It behooves every radioist to possess all three books by Prof. Morecroft, but if he can choose only one at a time the experimenter of course wants to start with "Experimental Radio Engineering."

Prof. Morecroft's style is clear and definite and besides he writes with the authority of a scientist. Problems that have vexed you will be found solved and explained in as simple a manner as is consistent with accuracy.

The volume contains fifty-one experiments on the more important phenomena of radio. It is intended to be companion book to the author's "Principles of Radio Communication" but is in itself a text on practical radio measurements. Contains a vast fund of useful information for the beginner as well as for the advanced student of the principles of radio.

Measurements of resistance, self-inductance, mutual inductance, capacity, radio frequency voltages and currents, frequency, amplification; characteristics of antennas, tubes, loud-speakers, vacuum tube voltmeters, rectifiers, detectors; study of selectivity, sensitivity, fidelity, filters, modulation, and many other phases of radio are fully discussed.

The book has 345 pages, 250 illustrations, and is cloth- bound.

Order Cat. M-EXRE @............ $3.50

"ELEMENTS OF RADIO COMMUNICATION"

"ELEMENTS OF RADIO COMMUNICATION," written in plain language, requiring little foundation knowledge of radio, is a complete course on the elements of radio, and gives one an insight into radio phenomena in such a way as to clear them up. For instance, take tuning. A variable condenser commonly is connected across the secondary of a tuning coil. Just what processes take place to accomplish tuning? Obtaining full knowledge of the causes of resonance, and learning how to compute the resonant frequency of a circuit, contribute toward the enjoyment of radio construction. Resistance, impedance, reactance, inductance and capacity are explained with fitting analogies, and the whole theoretical story of radio laid bare in such a fascinating and compelling manner as to make the volume of inestimable value.

The book contains much material never before published, is up-to-date and contains 226 pages, 170 illustrations and a complete index. Cloth bound.

Order Cat. M-ELEM @............ $3.00

(Remit with order and we pay transportation. Five-day money-back guarantee attaches to the purchase of all books.)

"PRINCIPLES OF RADIO COMMUNICATION"

"PRINCIPLES OF RADIO COMMUNICATION," the larger and deeper volume by this outstanding authority and former president of the Institute of Radio Engineers, covers essentially the same ground as "Elements of Radio Communication," but does so more extensively and with a mathematical treatment that commends this book to radio engineers and college and university students in radio engineering.

"Principles of Radio Communication," which is in its second edition, contains 1,001 pages, 831 illustrations and is cloth-bound.

Order Cat. M-PRN @............ $7.50

[Remit with order and we pay transportation. Five-day money-back guarantee attaches to the purchase of all books.]

BOOKS BY MOYER AND WOSTREL

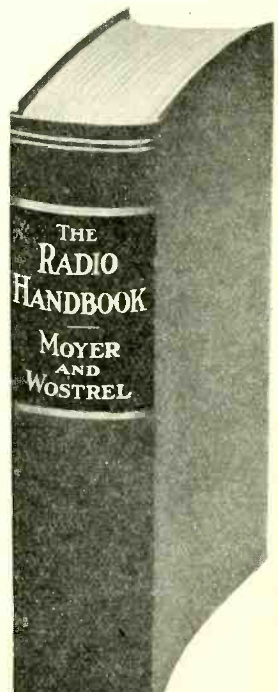
ANOTHER new volume is "The Radio Handbook," by James A. Moyer and John F. Wostrel, both of the Massachusetts Department of Education. This handbook meets the need for a complete digest of authoritative radio data, both theoretical and practical.

From the fundamentals of electricity, magnetism and the electron theory, right down to the latest commercial and industrial applications of radio, this book covers the field, with descriptions, definitions, design data, practical methods, tables and illustrations in profusion. It is a complete modern manual of practical and technical radio information.

Some of the subjects covered are: modern transmitters, piezo crystal control, percentage modulation, commercial and amateur short-wave receivers and transmitters, Kennelly-Heaviside layer effects and measurements, marine radio equipment, auto alarm, automobile receivers, latest tubes including photo-electric cells, television, sound motion pictures, etc.

If you want a book that quickly refers you to the correct information contained within its covers on any subject pertaining to radio, this is the volume. It has 886 pages, 650 illustrations. Flexible binding.

Order Cat. MW-RH @............ $5.00



The need for an up-to-date book on radio tubes that answers all the important questions has been filled by Moyer and Wostrel. This book is a complete discussion of tube principles, functions and uses. The essential principles underlying the operation of vacuum tubes are explained in as non-technical a manner as is consistent with accuracy. The book covers the construction, action, reactivation testing and use of vacuum tubes as well as specifications for vacuum tubes and applications for distant control of industrial processes and precision measurements. 297 pages, cloth bound. Order Cat. MWT............ @ $2.50

"Practical Radio," including the testing of radio receiving sets. 378 pages, 223 illustrations. Cloth bound. Order Cat. MWP............ @ $2.50

"Practical Radio Construction and Repairing," 319 pages, a companion volume to the above. New edition, new price. Order Cat. MWC............ @ $2.50

(Remit with order and we pay transportation. Five-day money-back guarantee attaches to the purchase of all books.)

THREE BOOKS BY ANDERSON AND BERNARD

AUDIO POWER AMPLIFIERS

The book begins with an elementary exposition of the historical development and circuit constitution of audio amplifiers and sources of powering them. From this simple start it quickly proceeds to a well-considered exposition of circuit laws, including Ohm's laws and Kirchhoff's laws. The determination of resistance values to produce required voltages is carefully expounded. All types of power amplifiers are used as examples: AC, DC, battery operated and composite. But the book treats of AC power amplifiers most generously, due to the superior importance of such power amplifiers commercially. Tube characteristic tables and curves profusely included. Cloth cover, 193 pages. Order Cat. APA @............ $1.50

THE SUPERHETERODYNE

This volume by Anderson and Bernard deals with the principles and practice of the Superheterodyne method of receiving and is particularly important now, because this is a superheterodyne year. It explains the function of the oscillator, the modulator, the pre-modulator selector, and the intermediate frequency amplifier. It explains the cause of repeat points and gives methods for avoiding them or minimizing their effect. It illustrates various forms of oscillators and tells of the advantages of each. Different types of modulators and pick-up systems are explained and their advantages stated. Different methods of coupling in the intermediate frequency amplifier are shown. Order Cat. SH @............ 95c

FOOTHOLD ON RADIO

In simple English that any one can understand, the technical side of radio is presented by Anderson and Bernard in their book, "Foothold on Radio" Any one who can read English can understand this book. It is intended for the sheer novice. The treatment is non-mathematical. Order Cat. FOR @............ 60c

(Remit with order and we pay transportation. Five-day money-back guarantee attaches to the purchase of all books.)

RADIO WORLD, 145 West 45th St., New York, N. Y.
Enclosed please find $........, for which mail postpaid the following books in a 5-day money-back absolute guarantee:

- ☐ Cat. M-EXRE @ $3.50
- ☐ Cat. M-PRN @ $7.50
- ☐ Cat. MWT @ $2.50
- ☐ Cat. MWC @ $2.50
- ☐ Cat. SH @ 95c
- ☐ Cat. M-ELEM @ $3.00
- ☐ Cat. MW-RH @ $5.00
- ☐ Cat. MWP @ $2.50
- ☐ Cat. APA @ $1.50
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7 cents a word—$1.00 minimum—Cash with Order

AGENTS WANTED—Sell my Foot Remedy. Draws pain from sore, burning feet, and corns. Used by millions. Make $15 a day. Sample 25c. Perrone, 174 Butler St., New Haven, Conn.

TRANSMITTERS: T. P. T. G. Using 245's push pull. $12.98. Power Supply for same, $12.98. Less tubes. Guaranteed. Wm. Johansen, 33 Orange Ave., Port Richmond, N. Y.

BALKITE A-5 RECEIVER, eight-tube, three stages of Neutrodyne RF and two stages audio with push-pull output. Good distance-getter and very sensitive. Has post for external B voltage for short-wave converters. Brand new in factory case. Berkey-Gay walnut table model cabinet. Price $35 (less tubes). Direct Radio Co., 143 West 45th St., New York.

EXPERT RADIO SERVICEMEN, send for tube prices. Great Kills Electric Shop, 15 Nelson Ave., Great Kills, S. I., N. Y.

SHORT-WAVE NUMBERS OF RADIO WORLD. Copies of Radio World from Nov. 8, 1930 to Jan. 3, 1931, covering the various short-wave angles sent on receipt of $1.00. Radio World, 145 W. 45th St., N. Y. City

LET YOUR RADIO TROUBLES BE OUR TROUBLES. Tuners, Amplifiers, Power Packs built to order. Special phonograph amplifiers $20.00. Precision Radio Laboratory, 3941 Amboy Road, Great Kills, N. Y.

"RADIO TROUBLE SHOOTING," E. R. Haan. 328 pages, 300 illustrations, $3. Guaranty Radio Goods Co., 143 W. 45th St., New York.

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

WANTED—Addresses of Manufacturers of Radio sets to be sold through mail orders. G. E. Ralstin, 1049 Hosbrook St., Indianapolis, Indiana.

"HANDBOOK OF REFRIGERATING ENGINEERING," by Woolrich—Of great use to everybody dealing in refrigerators. $4. Book Dept., Radio World, 145 W. 45th St., N. Y. City.

HAMMARLUND SFL — Hammarlund's precision .0005 mfd. condenser, with removable shaft; single hole panel mount. Lowest loss construction; rigidity; Hammarlund's perfection throughout. Order Cat. HAM-SFL @ $3.00 net price. Guaranty Radio Goods Co., 143 W. 45th St., New York.

SOUND PICTURES TROUBLE SHOOTER'S MANUAL, by Cameron and Rider, an authority on this new science and art. Price $7.50. Book Dept., Radio World, 145 W. 45th St., N. Y. City

SUMMER BARGAIN IN .00035 MFD. Here is your opportunity to get a 4-gang .00035 condenser, with trimmers built-in, at only 92 cents, on basis of remittance with order. Shipping weight, 3 lbs. Include postage or condenser will be sent express collect. Direct Radio Co., 143 West 45th Street, New York, N. Y.

SITUATIONS WANTED

GRADUATE OF PURDUE UNIVERSITY IN ELECTRICAL ENGINEERING, majoring in radio engineering, age 22, single, desires position in any radio research laboratory. Have seven years' experience in all phases of the radio industry. Can write and speak Polish, and understand a little Spanish. Joe Malysiak, 401 Darrow Ave., LaPorte, Ind.

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HERE'S a NEW plan, which saves you money. *Stop shopping—the lowest prices are right on this page.* Yes, lower than in our own catalog. Why? Because no house can get out a new catalog every month, but by advertising in this magazine we can bring you the latest and lowest prices *up to the time this ad is printed.* We watch our competitors and *do not allow anyone to undersell* us. We meet ANY price on NEW merchandise. *Order direct from this page and save money. 100% satisfaction on every transaction.*

NEW! NEW! Official Radio Service Kit NEW! NEW!

Several months ago we sent out a questionnaire to 2,000 radio service men and asked them what their ideas were on a radio service kit. 865 answered us, and their ideas are now embodied in the **Official Radio Service Kit** which we herewith present to you.

This kit is a marvel in compactness, a marvel in price, a marvel in time saving. For the first time you are offered a comprehensive kit that contains **EVERYTHING** that the service man requires in making calls.

ARE YOU A 50 PER CENT SERVICE MAN?

Too often so-called service men go on a job with an analyzer and a pair of pliers. Nine times out of ten they have to run back to the shop to get tools, and thus their usefulness is cut down, as a rule, 50% and over. Why not take along, on every job, a business-looking like service kit that looks just as business-like as your analyzer?

When you call upon a prospect and you arrive with this fine-looking kit, **your prospect knows that you mean business. It gives** you a professional appearance that every service man requires more than anything else today.

AND YOU CAN COMMAND MORE MONEY ON YOUR SERVICE CALLS WITH THIS KIT

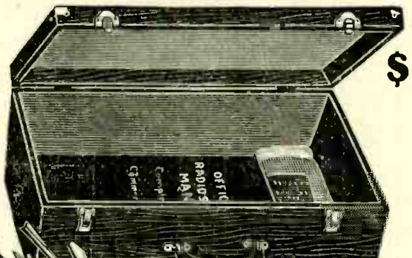
because the prospect will look upon you as a professional, and not as a tinkerer.

When you visit a medical specialist today, you are impressed by his instruments, **for which you pay.** An ordinary doctor commands no such fees. It should be clear to you that if you are a professional, you can get professional prices today too. That is why this marvelous kit will pay for itself inside of three months or less.

Herewith, are the Official Radio Service Kit specifications: Size, small and compact, not larger than a good analyzer; 17 in. long, 6¼ in. wide and 10 in. high.

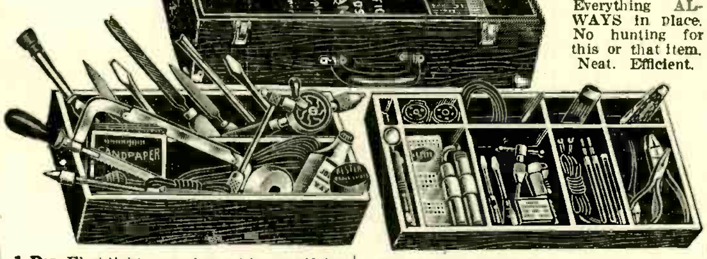
Construction, wood veneer throughout, entirely covered with black leatherette, all nickel trimmings, giving outfit a beautiful professional appearance.

There are two trays which lift out. Top tray contains the following:



$15.75

Both felt lined trays are built to fit the tools and contents of kit. Everything ALWAYS in place. No hunting for this or that item. Neat. Efficient.



- 1 Pen Flashlight, complete with magnifying dentist's mirror (to look underneath chassis, etc.).
- 1 Automatic alcohol blow torch.
- 1 Box containing 300 assorted screws, nuts, washers, lugs, etc.
- 1 Nickel Bicycle wrench.
- 1 Tap holder with one 6/32 tap and one 8/32 tap.
- 1 Set of Test prods, with 6 ft. cord.
- 1 Telephone type pliers.
- 1 Diagonal pliers.
- 1 Insulated (5,000 volt insulated handle) heavy pliers.
- 1 Electrician's knife.
- 1 Set of 8 drill points.
- 10 Ft. of Phosphor bronze drum dial cable.
- 1 Neutralizing socket.
- 1 Pack extra size pipe cleaners (to clean condensers).
- 3 Small screw drivers.

Lower tray contains:

- 1 Complete Neutralizing kit with insulated screw driver and five socket wrenches.
- 1 Electric soldering iron, with 1 extra tip.
- 1 Large and
- 1 Medium imported screw drivers.
- 2 Small files with handles.
- 1 Large file with handle.
- 1 ¼ in. Star drill, 11½ in. long.
- 1 Hand drill, ¼ in. chuck, 10 in. long.
- 1 Electrician's metal hammer.
- 1 Hack saw and blade.
- 1 Package Sand papers and emery papers.
- 1 Roll 50 ft. solid push back wire.
- 1 Can genuine Kester radio solder.
- ¼ lb. of ¾ in. electrician's tape.
- 1 Bottle Furniture polish.
- 1 Package Furniture cheese-cloth.
- 1 Bottle Nujol (for lubricating purposes).
- 1 Tube special cement (to mend cones, etc.)
- 1 Socket tool to straighten socket prongs.

IMPORTANT!

There is sufficient room in the bottom of the kit to place the **Official Radio Service Manual,** as well as other data sheets (but at the price quoted Manual is not included).

Both trays, as well as inside cover, are lined with blue felt, giving kit a beautiful appearance.

Nothing similar has ever been offered before. Only by buying the various materials in tremendous quantities are we enabled to sell this kit at such an extremely low price.

If you were to buy all of the articles separately, in the open market, you would have to pay between $30.00 and $35.00 for them.

Due to the present depression, we are enabled to buy quantities of these materials at exceedingly low prices. For that reason, our production cost is exceedingly low, but there is no question that this price will have to be increased later.

Size, 17 in. long, 6¼ in. wide and 10 in. high; net weight, 16 lbs.; shipping weight, 18 lbs.

No. 1000—Official Radio Service Kit—Your price...... $15.75

CARRYING CASE

We are prepared to furnish you with the Official Radio Service Case only, without contents, as described above, just the case and the two empty trays, size 17 in. long, 6¼ in. wide and 10 in. high.

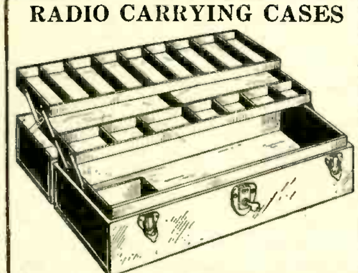
This case is made entirely of light veneered wood, nickel trimmings, covered entirely with leatherette, inside of case covered in blue felt.

Net weight, 4 lbs. Shipping weight, 5 lbs.

No. 1001—Official Radio Service Carrying Case only, your price $4.85

View of kit, closed.

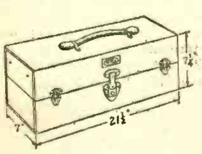
RADIO CARRYING CASES



The cases here shown are a new development. They are made in metal throughout with baked olive green enamel finish. These cases are beautifully and strongly made, and will give you a professional appearance. Lock and side locks are of burnished brass.

The smaller illustration shows dimensions and closed view of the cases. As you open the cover, **two trays automatically fold out in position,** as shown. As you tilt the cover back, the trays fold automatically into the case. The trays are provided with a number of compartments for tools and all other radio appliances that you may wish to carry. The large box accommodates about eight radio tubes in the bottom compartment. The smaller case accommodates about four tubes.

Cases are strong and rugged, **and when closed, nothing can spill.** They are marvels of ingenuity, and will pay for themselves many times over.



Large size measures 21½ in. long, 7¼ in. high and 7 in. wide. Net weight 8 lbs. Shipping weight 10 lbs. List price $8.50.

No. 1002—Carry-Case, your price $4.75

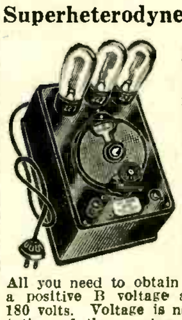
SMALL CARRYING CASE

This case is in all respects the same as the one described above, except that the dimensions are less, otherwise the same in all respects.

Size 12½ in. long, 7¼ in. high and 7 in. wide. Net weight, 5 lbs.; shipping weight, 6 lbs. List price, $6.50.

No. 1003—Carrying Case—Your Price $3.45

NEW! NEW!! Superheterodyne S-W Converter



At last a short-wave converter that converts any broadcast set into a superheterodyne short-wave receiver. Employs three 227 tubes and covers from 20 to 115 meters. No plug-in coils! Coil switch is used to cover all wavelengths. Single dial control, no body capacity, no squeals. This converter has built-in filament transformer to heat the three 227's. All you need to obtain from your receiver is a positive B voltage anywhere from 45 to 180 volts. Voltage is not critical; no molestation of the receiver. So simple a child can operate it. Size 7 x 10 x 5 inches. Shipping weight, 8 lbs. **List Price $25.00.**

No. 1614—Super Converter (less tubes). YOUR PRICE......... $14.69

World-Wide Short-Wave Set
NOT A CONVERTER

NEW

A perfect radio short-wave receiver for use between 17 and 84 meters. To put into operation, connect antenna, ground, 45-volt "B," and 6-volt "A" batteries, and headphones to the posts provided, plug in a type '01A tube, and tune in! An ingenious circuit makes possible a 4-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 5½x7x4 in. high, over all. Ship. weight, 3 lbs. List price, $12.50.

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

New 36 page Summer Edition No. 23

75 New Hook-Ups, etc. 350 Illustrations.

The new Summer Edition of our greatly enlarged RADIO SERVICE TREATISE has just come off the press. If you liked the Winter Issue, you will like this one a hundred-fold. It contains some 75 new hook-ups, circuit diagrams; and some 350 illustrations. **POSITIVELY THE GREATEST BOOK EVER PUT OUT BY ANYONE.** Among the new matters listed are;

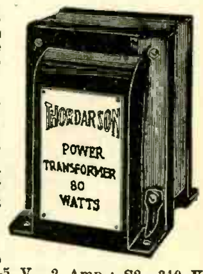
VACUUM TUBE TREATISE. with many illustrations; full page Vacuum Tube Average Characteristic Chart; How to Take Care of Your Tubes; How to Connect Phonograph Pick-ups; Improving the Tone Quality of Old Sets; Connecting Additional Loud Speakers; all fully illustrated with diagrams.

Other articles: Modernizing Old Radio Sets; How to Convert Battery to Power Sets; Selection of Tubes; Push-Pull Amplifiers; Replacing Audio Transformers; Phono Attachments; How to Choose Power Transformers; Voltage Dividers; Wattage of Power Transformers; Selecting and Installing Replacement Parts in Radio Sets; Filter Condensers; Repairing Eliminators.

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

THORDARSON
"245" Power Transformer

A Miniature Power Plant — Supplies All ABC Voltages — 80 Watts



In addition to supplying a full 250 volts to the plates and 50 volts to the grids of two type '45 tubes in push-pull, this transformer may be used to light the filaments of seven or eight 2.5-volt filament tubes; and by connecting in series two of the three 2.5-volt filament secondaries it is possible to light 5-volt filaments too. Five secondaries: S1—5 V., 2 Amp.; S2—340 V. Cent. T.; S3—2½ V., 3 Amp. Cent. T.; S4—2½ V., 10½ Amp.; S5—2½ V., 3 Amp. Cent. T. **Just the power transformer for building up a high-grade public address amplifier to use a screen-grid A.F. amplifier to boost the output of a microphone or phonograph pick-up;** following this with two stages of push-pull amplification consisting of two '27's in the first stage and two '45's in the second. Bottom of transformer has bakelite panel on which are mounted all taps. **It outperforms ANY similar transformer.** Many Service Men keep this model transformer on hand for emergency replacements in hundreds of makes of radio sets. For 110-120 volts, 50-60 cycles. Size: 5 in. high x 4 x 3½ in. Shipping weight, 8 lbs. **List Price, $15.00.**

No. 1450—Thordarson Power Transformer. YOUR PRICE....... $3.84

High-Voltage Condenser Units

We guarantee these condensers unconditionally. They are ideal for general replacement purposes and can be installed in any new power-pack. All condensers are furnished with 8-inch lengths of tinned "push-back" wire.

600 VOLTS			800 VOLTS		
Cat. No.	Mfd. Capac.	Your Price	Cat. No.	Mfd. Capac.	Your Price
1702	½	$0.25	1706	1	$0.40
1703	1	.30	1707	2	.70
1704	2	.40	1708	4	1.05
1705	4	.60			

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