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RAPID TROUBLE SHOOTING

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Radio Valley, 143 West 45th Street, New York, N. Y.
Rapid Trouble Shooting
Rules for Success and Advice on Remediying Faults

J. E. Anderson

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 quickly, 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 in 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 coupling 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 possibility is that the winding is open. 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 hissing noise in the output of the receiver. Under these circumstances the resistances are different, 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. The noise is referred to as scratching or boiling noises. There is practically no other way of locating these defective contacts than making substitution of parts. For example, if the grid-bias condenser is suspected, it can be replaced by 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 leads 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 tears 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 overloaded 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 become sufficient to break the insulation during surges. Just ordinary voltage may be sufficient to cause sparking between the points, and that sparking gives rise to the hissing 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 satisfactorily for a short time.

Similar troubles occur 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 hissing noise. After the break has occurred the resistance and the form of 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 right. Hence, substitution of a new one is the only way of correcting 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 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 Jan Jacinto, Peru. In a letter recently to WGY's short wave station WZKX, 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
**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 try the transformer and then whether the filament 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 the voltage almost (8) and should be next that 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 near zero if the point is normal.

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 is the basis on the tubes in the push-pull amplifier. Next put the positive terminal of the meter to the points 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 of the tube. A low reading at the screen should not be interpreted as a defect. The effect of the resistance will be greater the sensitivity of the voltmeter used. No reading indicates an amplifier 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), and then to the plus (10), (11), and (12) should be next that is in succession. If the drop across the windings.

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 and find a short in a component. To find a short in a condenser it is necessary to remove the connection on the cathode tube 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 voltage across the grid bias resistor 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 grid bias is opened the grid bias resistor is 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 (16) and ground. Moreover, there is likely to be evidence of the short in the rectifier tube, the plate of which might be red hot. As before, if removing the positive lead of the condenser does not eliminate 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 can also be found by these methods. But, as a rule, a short in a tuning condenser occurs only at certain settings of the condensers. Scrutiny 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 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. The oscillator is an amplifier and should be so tested.

The tube in the oscillator socket must be in good condition for 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 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 and the condenser C is across it in the circuit, and the ground connection 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 should be against for 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 frequency. There is little chance of anything going wrong with the oscillator tuning condenser except the getting out 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 adjust-
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. (30,000 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 have the voltage as the minus 20 volts positive bias to 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 200 milliampere currents 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 to 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 detector and grid 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 does not change. The voltage on the detector screen is altered simply by taking off different values of voltage from the fixed drop.

This unusual method will work perfectly, 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 resistance, voltage measurement attempt, and used the meter as a current indicator in series with the circuit.

The voltage could be measured, however, with a vacuum tube voltmeter, if properly 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, so no extra primary for filament is left. This leaves room to drop the 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 hand shifting may be done from the front panel with a single switch knob, the circuit shows a good way of accomplishing this. The first requirement is to have a dual control 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. These 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 moving arms is insulated. You may even have 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, 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 enamal wire. The antenna winding is 20 turns, the tickler 30 turns. The space between adorning windings is ½ inch.

The ends of the secondaries intended for grid go to the taps on the transformer 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. 18 wire, with primary 13 consisting of 8 turns and tickler L11 consisting of 12 turns, the same kind of wire. The separation between adorning windings is ⅜ inch.

The last coil would consist of 25 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 ⅜ 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 upper, the chassis leaves room to dispose of two of the remaining coils in the same general area, while the other two coils would have to be to the left of the center 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 switches. In the antenna circuit, there is no retard in tuning, even in 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 the transformer terminals, or as the circuit is formed to drop the coil associated with the contact, the grid terminals of the secondaries. Regeneration also will result if the adjoined 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 the polarities are of no account.
Short Wave
Three and Four Tube Models,
By J. E. Anderson

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 is to be obtained externally.

The dimensions are given in Fig. 14. The front panel is laid out to accommodate a vernier dial, two knobbled 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.

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.

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 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 inak-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...
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.

List of Parts for Fig. 13

<table>
<thead>
<tr>
<th>Coils</th>
<th>Resistors</th>
<th>Other Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four plug-in coils for antenna coupler (L1, L2)</td>
<td>One 5 meg. pigtail resistor (R1)</td>
<td>Two binding posts (Antenna, Ground)</td>
</tr>
<tr>
<td>Four plug-in coils for interstage coupler (L4, L5)</td>
<td>One .005 meg. = 5,000 ohm pigtail resistor (R2)</td>
<td>One output twin jack assembly for phones</td>
</tr>
<tr>
<td>One 50-turn honeycomb coil (L3)</td>
<td>One 25,000 ohm potentiometer with switch (R3, SW1)</td>
<td>One 7½ x 10 inch front panel</td>
</tr>
<tr>
<td>One 300-turn honeycomb coil (L6)</td>
<td>Two 0.25 meg. = 250,000 ohm pigtail resistors (R4, R5)</td>
<td>One subpanel with six UY sockets</td>
</tr>
<tr>
<td>Condensers</td>
<td>One vernier dial (pilot lamp PL optional)</td>
<td>One vernier dial (pilot lamp PL optional)</td>
</tr>
<tr>
<td>One two-gang 0.00035 mfd. tuning condenser (C1, C7)</td>
<td>One follow through switch (SW2)</td>
<td>One 2½2 tubes and one 230 tube</td>
</tr>
<tr>
<td>One small variable condenser, about 60 mfd. (C6)</td>
<td>One 0.25 milliammeter</td>
<td>Batteries: One 6 volt storage A battery, three 45 volt B batteries</td>
</tr>
<tr>
<td>One block of three 0.1 mfd. condensers (C2, C3, C4)</td>
<td>One dozen 6/32 machine screws and one dozen nuts</td>
<td></td>
</tr>
<tr>
<td>Three 0.0001 mfd. condensers (C5, C8, C10)</td>
<td>One dozen lugs</td>
<td></td>
</tr>
<tr>
<td>One .00035 mfd. fixed condenser (C8)</td>
<td>One roll of hookup wire</td>
<td></td>
</tr>
<tr>
<td>Two 0.01 mfd. fixed condensers (12, C13)</td>
<td>Two 222 tubes and one 230 tube</td>
<td></td>
</tr>
<tr>
<td>One 2 meg. pigtail resistor (R6)</td>
<td>Batteries: One 6 volt storage A battery, three 45 volt B batteries</td>
<td></td>
</tr>
<tr>
<td>One 1.0 mfd. bypass condenser (C11)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

List of Parts for Fig. 16

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<tr>
<th>Coils</th>
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<td>One 5 meg. resistor (R4)</td>
<td>Two binding posts (Antenna, Ground)</td>
</tr>
<tr>
<td>Four Plug-in coils for interstage coupler (L4, L5)</td>
<td>One .005 meg. = 5,000 ohm pigtail resistor (R5)</td>
<td>One output twin jack assembly for phones</td>
</tr>
<tr>
<td>One 50-turn honeycomb coil (L3)</td>
<td>One 25,000 ohm potentiometer with switch (R6, SW)</td>
<td>One 7½ x 10 inch front panel</td>
</tr>
<tr>
<td>One 300-turn honeycomb coil (L6)</td>
<td>Two 0.25 meg. = 250,000 ohm pigtail resistors (R7, R8)</td>
<td>One subpanel with six UY sockets</td>
</tr>
<tr>
<td>One 15 heavy B supply choke (L7)</td>
<td>One 0.1 meg. = 100,000 ohm pigtail resistor (R11)</td>
<td>One vernier dial (pilot lamp PL optional)</td>
</tr>
<tr>
<td>One 2.5 volt filament transformer</td>
<td>One resistor 0.01 meg. = 18,000 ohms (R18)</td>
<td>One 235, one 224 and two 227 tubes</td>
</tr>
<tr>
<td>Condensers</td>
<td></td>
<td>One 300 ohm flexible biasing resistor (R1)</td>
</tr>
<tr>
<td>One two-gang 0.00035 mfd. tuning condenser (C1, C7)</td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>Two 0.01 mfd. fixed condensers (12, C13)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One 2 meg. pigtail resistor (R6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One 1.0 mfd. bypass condenser (C12)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two 8 mfd. electrolytic condensers (C4, C15)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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, is 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 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 about 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 withstand 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 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 as 80 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 spectators 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

There are fifteen thousand television receivers operating in American homes today. One year from now there will be another 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 is imaginative, this problem will be overcome as research and development proceed.

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 unsought, but those of considerable importance, for 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 already has a television receiving set ready 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 eager to announce in the press 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. A. A. Nahod, 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 simple 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. RCA, which is a member of the Rockefeller group, declared that 'on the air.' Customers will tune in, watch the display of waves and, with telephones 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 the 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 12, definitely subscribe to the 60-line method:

<table>
<thead>
<tr>
<th>Call Letters</th>
<th>Company</th>
<th>Location</th>
<th>Power (watts)</th>
<th>Lines per Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1XAV</td>
<td>Shortwave &amp; Television Lab., Inc., Boston, Mass.</td>
<td>1,000</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>W1XK</td>
<td>Jenkins Laboratories, Wheaton, Ill.</td>
<td>5,000</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>W1XCR</td>
<td>Jenkins Television Corp., New York, N.Y.</td>
<td>5,000</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>W1XAP</td>
<td>Jenkins Television Corp., portable</td>
<td>250</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>W1XCD</td>
<td>DeForest Radio Co., Passaic, N. J.</td>
<td>5,000</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>W1XBU</td>
<td>Harold E. Smith, Newark, N. J.</td>
<td>400</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>W1XAO</td>
<td>Western Television Corp., Chicago, Ill.</td>
<td>500</td>
<td>45</td>
<td></td>
</tr>
</tbody>
</table>

2,100-2,500 k.c. (142.8 to 136.3 m.)

<table>
<thead>
<tr>
<th>Call Letters</th>
<th>Company</th>
<th>Location</th>
<th>Power (watts)</th>
<th>Lines per Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1XAD</td>
<td>RCA Victor Co., Camden, N. J.</td>
<td>500</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>W1XBS</td>
<td>Nat'l Broadcasting Co., New York, N. Y.</td>
<td>5,000</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>W1XGW</td>
<td>Gen. Elec. Co., S. Schenectady, N. Y.</td>
<td>20,000</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>W1XAY</td>
<td>Westinghouse Electric &amp; Mfg. Co., E. Pittsburgh, Pa.</td>
<td>20,000</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>W1XR</td>
<td>Radio Pictures, Inc., L. I. City, N. Y.</td>
<td>500</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>W1XAP</td>
<td>Chicago Daily News, Chicago, Ill.</td>
<td>1,000</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>W1XAK</td>
<td>Nat'l Broadcasting Co., Brook, N. J.</td>
<td>5,000</td>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>
| 2,750-2,850 k.c. (109.9 to 105.2 m.)
| W1XAB | Columbia Broadcasting Sys., N. Y. City | 500 | 60 |
| W1XAA | Chicago Federation of Labor, Chicago, Ill. | 1,000 | 48 |
| W1XG | Purdue Univ., W. Lafayette, Ind. | 1,500 | 60 |
| W1XBO | United States Government, L. I. City, N. Y. | 5,000 | 60 |
| 2,850-2,855 k.c. (105.2 to 101.6 m.)
| W1XAR | Great Lakes Broadcasting Co., Downer's Grove, Ill. | 5,000 | 24 |
| W1XR | Radio Pictures, Inc., L. I. City, N. Y. | 500 | 60 |
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 .00025 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
Short-Wave Converter Line

Output Circuit to Insure Good Coupling

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 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 3/8 inch away from the secondaries with which they are associated. The order of the turns, to be: first, the antenna winding, 10 turns. Leave 3/8 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 30 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 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 only go to lower intermediates than 900 kc. (for 1,450 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, as the turns are used, in that 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 1,000 on the dial when the modulator is at 100 on the dial, 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 begins 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 last 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 as presented, and it adds innumerable 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 3/4 inch dowel, but if you want a coil as a substitute, use a 3/4 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 winding anyway, an equalizer of 20-100 mfnf. 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 hennies, or, if a huskier one is desired, $1.50 will purchase 30 hennies 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 varated 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 has 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 input 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 superhetereodynes. 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, 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. It may be

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 two conditions, so 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 mutual 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 circuit is kept on 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 superhetereodyne is concerned, there is no need to distinguish between pulling together and stopping of oscillations 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 if it 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 superhetereodynes on 30,000 kc have been built with an intermediate frequency of 220 kc, but there was thorough shielding.

In nearly all commercial superhetereodynes the intermediate frequency is 125 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 kept low. 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.

Here is a list of new members of the Short Wave Club. New names are printed each week:

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Hans Muller Carlisba, Villa Americana, Estado S. Paulo, Brazil.
Walter Jacob, Optr., Amateur Radio Sta. W2CDR, 444 Schiller St., Elizabeth, N. J.
H. T. Jordan, 3911 Healy St., Chicago, Ill.
William Boyd, P. O. Box 602, Wintoning, N. J.
Clytus L. Vincent, P. O. Box 800, Detroit, Mich.
Harry Karol, 3625 Prospect Ave., Kansas City, Mo.
J. Mansfield, 442 Barber Ave., Fairport, N. Y.
Joseph D. Maresco, 22 Olive St., New Haven, Conn.
A. P. Mussal, 1936 5th Ave., New York, N. Y.
Chuye Boring, 219 N. Hellertown Ave., Quakertown, Penna.
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C. W. Valenec, 700 W. 3rd St., Ft. Worth, Texas.
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Danny Reynolds, 309 Garden St., Holochen, N. J.
Elvin F. Laib, Chesterville, Ont., Canada.
I. W. Lusk, 226 Gray Ave., Chicago, Ill.
Walter Anderson, 24 South St., Rockland, Mass.
Glen Brabant, 20 W. Ky., Amherst, Ohio.
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 discriminator.

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 flicker 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.

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 depend on the particular frequency or frequency range that is desired.

It should be noted that the 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 is connected to any 2.5 volt line, 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 in the grid between the 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 where it does not affect appreciably the tuning characteristic of the tuning condenser C.

The tuned circuit L1. Its inductance should be adjusted to fit the particular case. In this particular case desired. L1 is a small inductance 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 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, and output circuits of the first tube of the circuit and adjusted until the frequency of C1 differs from the desired signal by the frequency to which the broadcast receiver is tuned, the desired short-wave frequency can then be obtained. It 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 and C1 are connected in parallel between the transformer and the detector, and the resonant frequency of the newly connected condenser and inductor is adjusted to the desired frequency. The tuning condenser C is then connected between the ground and the plate of the tube. 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 where it does not affect appreciably the tuning characteristic of the tuning condenser C.
There is a certain popular interest now in all-wave receivers, and the popularity is growing. There is one recognized way of getting all-wave reception, and that is by plug-in coils. But some prefer the all-waviness 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 (1), the next band is covered, and when it is set

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**List Prices of Tubes**

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

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<td>$7.50</td>
</tr>
</tbody>
</table>

*This table comparable to the 23S.
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.

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 r-f tuner with the oscillator circuit.

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

The oscillator circuit in this case is 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 SW is set on (A) the other switch (SWA) 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 upper 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 connected one tuning coil 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 oscillator 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 enclosed in an aluminum shield.

The oscillator condenser C3 is grounded on one side but the coil is 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 and tuning or detection, motorboating is likely to result, and due to the high gain of screen grid tubes it is very difficult to stop it by ordinary means. One of the best ways to reduce the tendency 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 the 0.1 megohm is used in each screen lead. It is not necessary 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

Two 0.0035 mfd. fixed tuning condenser (C1, C7)
One variable condenser, about 60 mfd. (C6)
One block of three 0.1 mfd. condensers (C2, C3, C4)
Three 0.0001 mfd. condensers (C5, C9, C10)
One 0.0035 mfd. fixed condenser (C8)
Two 0.01 mfd. fixed condensers (L2, C11)
One 1.0 mfd. bypass condenser (C13)

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 7/8 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

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WILL you kindly publish a circuit diagram of a six tube receiver suitable for portable use? I would like to have two 252 screen grid tubes for radio frequency amplifiers, two 283 first detector and audio amplifiers, two for detecting and ending at the same point as for the previous tubes. Two final output stages. Kindly indicate the voltage range. 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 even 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 V/Cw, in which V 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 6,283. The capacity to use is not the maximum capacity of the condenser but the actual capacity of 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 resonators 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 capacitance as the cause of the suppression of the high notes. There are two major shunt capacitances in each stage, the plate to ground capacitance of the tube ahead of the coupler and the grid to ground capacitance 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 conductance 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 wound to the required length but not on the winding exactly like the first, beginning and ending on the same point as for the first winding but the wire wound 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 capacitance also will 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-Circuit 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. E. 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 and 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, simply a poor contact, or some dirt could have caused the trouble. It is probable that the trouble is to be found in the B supply.

Tuning 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 wire which will cover the frequency range from 550 kc to 1,600 kc with a tuning condenser of 0.0005 mfd. How many turns do I need?—G. D.

You will need 88 turns to cover the frequency range. Since there will be some distributed capacitance 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 capacitance is 25 mmfd, and thus 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, and hence 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 this 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 following lines: a tuned resonator of some kind for every note in the musical scale? Since resonances are needed, the output enormously it would seem that this is a good way to go about it.—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 15 to 8,102 cycles per second there are a total of about 20 octaves. We would have to have 100 different resonators. That is only the beginning of the complications. All these resonators would be tuned to definite musical notes. Thus they would have to be based on a certain pitch at middle C, there being several different pitches for this. If music were played in a single 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 return to rest, and after it got going it would continue to sound off for a while after the original sound ceased. Possibly, if we used a larger 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 in the capacity that I had to produce for a certain desired change in frequency, could I then calculate the change in the capacity that caused that change? I have reference only to very small changes in both the capacity and the frequency.

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, then the change in capacity that will bring about the change in frequency is given by $dC = \frac{f}{F}$. The minus sign simply indicates that $F$ and $C$ change in opposite directions. $F$ increases by $dC$, $F$ decreases by $dC$. 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 $C$ be positive and have a value of $0.001$ mmfd. We make the change in capacity $-251$ mmfd. The value of $F$ is then $2,000$ cycles per second, and the new frequency is $98,000$ cycles per second. This simple relation does not hold unless the values are small in comparison with the original values. In this case $I$ is small enough in comparison with $250$.

**Simple Converter Circuit**

I HAVE a number of 14 millihenry chokes, an 85 millihenry choke, a 125 mmfd. tuning condenser and some fixed condensers, and I am planning to make a 3-tube short-wave converter in which I can use these parts—B. O. H.

FIG. 943 is a circuit in which these parts can be used. The 85 millihenry choke you can use where it calls for a 33 ohm choke. The value of the fixed condensers are given but it is not necessary to use these values. They may be larger or somewhat smaller. The tuning condenser should not be larger but your circuit will work as it is as small as .001 mfd. The circuit calls for a .00035 tuning condenser but it is all right to use the 125 mfd. condenser you have. If you have one, you can 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 of a coil? 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. O. H.

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 the circuits work well. Is this not proof that the sideband theorists are wrong? I have never seen any other circuit nearly so simple 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 traditional theorists do not maintain that it is a failure. 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 sideband circuits are exceptionally selective he does not deny for he knows and uses the selectivity of the piezo crystal for many radio purposes. The selectivity 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 deviation of 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 find 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 add the compensation or off if 5,000 or a little 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. 

**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. F. 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 by-pass circuit because when properly 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. Occasionally 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-ended 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 mfd. condenser reduces the bias current to less than half of one per cent at 25 cycles per second. At this frequency it would require 36.7 microrads 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.

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ASIL RUVYDAEL'S BEAUTIFUL speaking voice was never heard to such great advantage as when he read Longfellow's "Hiawatha" with a background of Emil Velasco's lovely organ music over WOR on Thursday evening at 10 o'clock. Resonant, soulful, natural and sincere, the voice of Mr. Ruvydael 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 10 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 on his face. Despite his height of six feet, he is the alma for the name of the program. A network feature.

IT DOESN'T SEEM POSSIBLE, but Dennis King, famous star of musical comedy and pictures, is a WOR denizen. Mr. King assures us that when he first came to this country these times were so hard for him he was forced to sleep out on the park benches. How times have changed—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 Lawhurst. Both are composers of merit, pianists of note and singers of no mean ability. They are now featured, together with Van Em- burgh, a promising young tenor, on the Friday program over WJZ each Wednesday at 7:15 p.m. Well worth a listen!

BIORAPHERICAL BREVITIES

Arthur Q. Bryan Not Married

This popular WOR announcer was born in Brooklyn, New York in 1899, which makes him an older lady and a very young gentleman even for his years and possesses a fortunate sense of humor. When asked to provide your reporter with a few particulars, Mr. Bryan became facetious and responded as follows:

"Born of very humble parents and all that sort of thing. Very young at birth. Not now!"

Expected to be a singer but soon had that knocked out of him. First entered broadcasting, however, as a member of the original Seiberling Players, a stentorian teen-age manpower male chorus under Marshall Bartholemeus; also sang as a Jeedo High-school schoolboy that he soon left. He didn't do much after that. Chief complaint was that he couldn't stand up to work and had to lie down for lunch and so to straighten out. Lent his corpulence to the "Toast of the Town," runner-up of the second annual Duke of York race.

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 didn't work. He got the job and was scared to death about it. Managed to survive. Really enjoys broadcasting because he's the busiest, loudest, funniest, and dirtiest job in the department because he never has a picture for publication. Thinks Uncle Don is 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, e/o Radio World, 145 West St., 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 $100,000 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 staff of 30 teachers who expect to continue the work through the aid of many organizations and individuals. Title of these are WVL and WAKX, 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. The school is a model organization and there are many schools and individuals who assist in carrying on the work.

There was faced with the task of cutting the state budget $25 per cent and every position in the state department. The school of the Air was challenged not less than fourteen times. But teachers by the hundred interest lost. By in two weeks came to the aid of those fighting for the existence of the school. Legislators' wives extended the lists and pleaded the cause.

OHIO SCHOOL OF AIR PRESERVED AFTER FIGHT


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

Mitzi is combing the world in search of her older 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 Conference, held in Madison Square Garden, September 21st to 26th, inclusive. The hotel is at 30th Street and Seventh Avenue, and is near Madison Square Garden.
MORE STATIONS CONFLINE SHIFT IN 50 CYCLES

Washington.

A steady increase in the number of broadcasting stations maintaining their transmission frequencies at levels assigned for them has been reported in the May record of the Radio Division, Department of Commerce.

During May 5,455 measurements of 326 broadcasting stations showed that 78 at no time deviated as much as 50 cycles, 89 at some time 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.

At a meeting of all broadcasting stations of the United States were reported and it was then determined that many of the stations named undoubtedly are as efficient in maintaining their frequency as those measured and mentioned in the following:

UNDER 50 CYCLES

Transmitter location, state. Call location in parentheses.

FAXF—Lincoln, Neb. 
KFDH—Beaumont, Tex. 
KFLY—Rockford, Ill. 
KFWX-Arlington, Va. 
KFXV-Culver City, Calif. 
KFXC-San Francisco, Calif. 
KFXD—Columbia, Mo. 
KFD—San Diego, Calif. 
KFDY—Culver City, Calif. 
KFDV—Denver, Colo. 
KGB—St. Joseph, Mo. 
KGX—Long Beach, Calif. 
KGZ—South Bend, Ind. 
KHL—Spokane, Wash. 
KHY—Seattle, Wash. 
KMB—Independence, Mo. 
KMD—Kensico, Calif. 
KRA—Beaver, Calif. 
KRD—Tacoma, Wash. 
KRO—San Francisco, Calif. 
KRXK—Seattle, Wash. 
KHF—St. Louis, Mo. 
KTT—Seattle, Wash. 
KTV—Des Moines, Ia. 
KXW—Dallas, Texas. 
KXWQ—Des Moines, Ia. 
KXWZ—Kansas City, Mo. 
KZK—San Francisco, Calif. 

Call location in parentheses.

WFAA—Dallas, Texas.
WECA—Parkersburg, W. Va.
WGAS—Chicago, III.
WGIR—Wilmington, Del.
WGJ—Eugene, III.
WGST—Atlanta, Ga.
WHAP—New York, N. Y.
WIBL—Shibuyan, III.
WHO—Des Moines, Ia. 
WIBH—Topeka, Kans. 
WIP—GFDM—Phila.-Texa.
WJAZ—Mount Prospect, Ill. (Chicago.
WJJD—Jackson, Miss. 
WJH—Dartmouth Univer.
WJL—Brooklyn, N. Y.
WJLR—Chicago, Ill.
WJY—Youngstown, Ohio 
WJS—Dyersburg Grove, III. (Chicago.
WJCT—Detroit, Mich. 
WJMH—Addison, Ill. 
WJMC—Baltimore, Md. 
WJMC—Hoboken, N. J. 
WJMD—Waterloo, Iowa. 
WJMW—New York, N. Y. 
WJMP—Davenport, Iowa 
WJFN—Winona, Minn. 
WJOL—Washington, D. C. 
WJWS—Camden, O. C. 
WJQN—Whitehaven, Miss. 
WJQG—Gainesville, Fl.
WJQJ—Atlanta, Ga. 
WJQG—Chicago, III. 
WJQF—Cumberland, N. Y. 
WJQJ—Booneville, N. Y. 

New Corporations

Pitt Radio Corp., Wilmington, Del., broadcasting stations—Corp. Trust Co.
Brown & Hart, telecasting advertising—Art.
W. M. Garden, 2 Broad St., New York, N. Y. 
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NEW! NEW! NEW!

Several months ago we sent out a questionnaire to 2,000 radio services men and received a mail order of over 100 orders for a radio service kit. 858 readers have used that kit and have sent us a letter telling us how well it worked. This kit is now being molded in the finest plastic. Order now and get your Service Kit which we believe will save you money in the future.

This kit is a marvel in connection! A marvel in price, a marvel in time-saving! It is a comprehensive kit that contains every thing that the service man requires in his repair calls.

ARE YOU A 50 PER CENT SERVICE MAN?

Too often qualified service men go on a job with an analyzer and a pair of pliers. Then time and labor have to be spent looking for the right tool to get the job done, and time which should be spent on your job is lost. This is the result of a lack of proper service tools. You can get professional prices today with the proper service tools.

When you send in a prospect and you serve him in style—looking all that a professional should look—no one will cut in on your business. If you serve your customers in the manner that a professional does, you will get professional prices today. That is the result of proper service tools.

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

Because the prospect will look upon you as a professional, and not as a repair man. When you visit a home, you must look as you do. Show your customer that you are a professional service man. The prospect will feel that he is looking upon a professional. He wants his appliance serviced by a man who knows what he is doing. You cannot look the part or sound the part if you do not have the tools.

NEW! NEW! IMPORTANT!

There is sufficient room at the bottom of the kit to place the Official Radio Service Manual, as well as a need for the sheets (not at the price quoted Manual is not included). Such tools, when an inside man is used, are lined with blue felt, giving it a beautiful appearance.

Nothing similar has ever been offered. Only the top men acquire various materials that are required to sell this kit at such an attractive low price. The well-crafted tool is sold at a price that is far below market. Separately, in the open market, you would have to pay between 3.00 and 5.95 for these items.

Due to the present depression, we are unable to buy quantities of these materials at exceptionally low prices. For that reason, we are not in a position to sell this kit for 1.00 and 1.95. This item is made entirely of light weight hard plastic, covered with a beautiful plastic covering. Two sets are shipped in each case. One set of tools is made of plastic, covered with a beautiful plastic covering.

CARRYING CASE

We are furnished to you with the complete kit of service tools, without contents, as described above, just the case. The Radio Service kit is carried in the carrying case. The case is a beautiful carrying case.

This case is made entirely of light plastic, covered with a beautiful plastic covering. Two sets are shipped in each case. Each set contains all tools listed above.

Radio service kit...$15.75

NEW!! NEW!! NEW!!

Superheterodyne S-W Converter

At a short-wave converter that can convert any receiving set into a superhet.

This S-W converter consists of a quartz oscillator, an audio amplifier, and a set of tuning rods. It is made of hard plastic and is easy to use. It will save you money in the future.

New 36 page Summer Edition No. 23

The new Summer Edition of our greatly enlarged RADIOTRADING service already has over 300,000 subscribers. It has been expanded to over 2,000 pages, with full color illustrations.

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We cannot match our disc, order, deduct 25% discount, send money order—certified check—U. S. stamps.

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We guarantee these condenser units, mentioned in this ad, to be of importance for your experiment, and we will back any unit with which you are not satisfied, 100% satisfaction guaranteed.

Other units: Modifying Old Radio Sets; How to Obtain FREE Power Transformers; Remote Control; Long Range; and a complete line of radio equipment.

Included in this catalog are the many original ideas which have been evolved by RADIOTRADING FIELD TECHNICIANS, who have long been working in this line of business.