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TENTH YEAR

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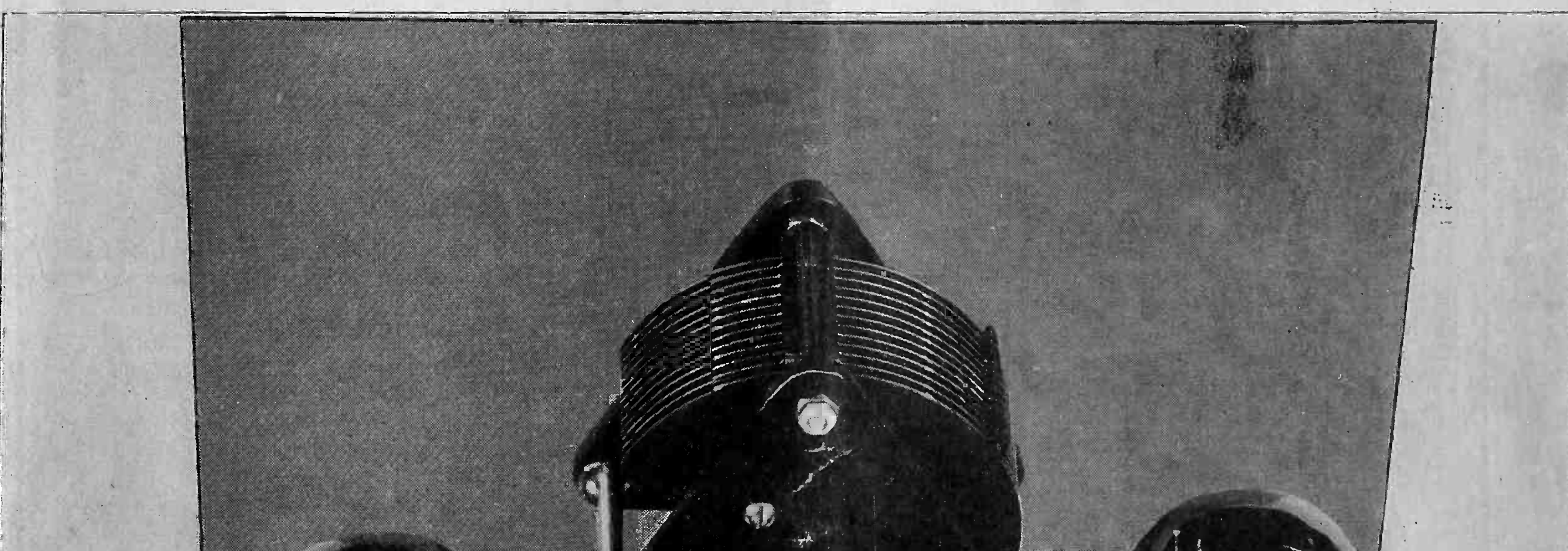

A Modulated-Unmodulated Oscillator, Broadcast and Intermediate Amplifier Frequencies. See page 6.

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A Continuity Tester

A Voltmeter Also Enables Resistance Measurement

By Herbert E. Hayden

A CONTINUITY tester is a convenient device to have around. There are many types, but in all cases there is a source of voltage and an indicating device. An ohmmeter is in effect a continuity tester. Sometimes a neon glow tube of small dimensions is used as the indicator, but in most instances a d-c voltmeter is used. A neon tube will indicate continuity all right if there is continuity and a sufficient voltage in the circuit to start the glow, but it will not indicate about what the resistance in the circuit is. It may, for example, give the same indication on short circuit as on one million ohms. A voltmeter gives an approximate indication of the value of the resistance in the continuity.

Suppose we have a 0—7.5 volt d-c voltmeter. If we connect one terminal of this meter to the proper terminal of a battery of suitable voltage, we have a good continuity tester. A meter of a different range would make just as good a tester, provided that we selected the proper voltage.

In Fig. 1 we have the circuit of such a tester composed of a dual range voltmeter and a battery. The voltmeter has three bindings posts, one common negative, which is connected to the negative terminal of the battery, one low potential positive, and one high potential positive terminal. In use, one of the positive terminals of the meter and the positive terminal of the battery are used for exploring the set or for testing for continuity.

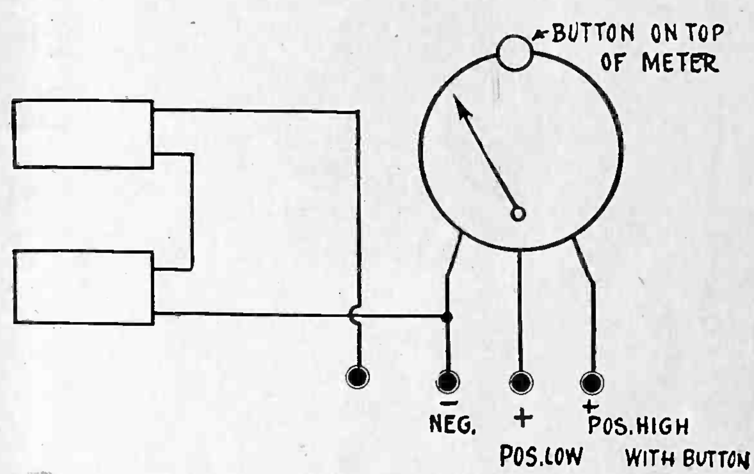

FIG. 1

The circuit of a simple continuity tester consisting of a battery and a double range voltmeter.

Double Range Meter

It is assumed that the battery voltage is so high that it gives full reading on short circuit when the high range of the voltmeter is used. There is a button on the voltmeter which must be pressed to make the meter read when the high range is used. This is a safeguard against blunders. Now it may be that the circuit indicates continuity but that the reading is so small that it is a mere flicker. In that case the low range may be used even if the applied voltage is so high as to cause full deflection on the higher range on short circuit. Using the lower range gives a larger deflection and gives a better indication of what the approximate resistance in the circuit is.

When tests of mere continuity of short circuits are to be made it makes no difference which scale of the meter is used provided that the voltage of the battery is such that it will not cause the deflection to be off the scale when a short is encountered. It is safe practice to use a low voltage and a high range meter when shorts are expected and to increase the voltage and lower the range only when conditions call for such change.

Measuring Resistance

An arrangement like this can be used for measuring resistances provided that the internal resistance of the meter is known. The method is based on the fact that when a resistance is connected in series with the battery and the voltmeter the deflection, or indicated voltage, is lowered by an amount which depends on the relative values of the external and internal resistances. If the internal resistance is not known the same method can also be used in determining it provided that one resistance of known value is available.

When the battery is connected directly across the voltmeter terminals the indicated voltage is the voltage of the battery, assuming that it is not old and nearly exhausted. When an external resistance is connected in series in addition the indicated voltage is lower. The voltage of the battery has not changed. Hence we know the drop in the external resistance, for it is the difference between the two voltage readings. For example, suppose we have a battery of 22.5 volts and connect this across the voltmeter. This reads a voltage of 22.5 volts. To make it general let us call this reading E. Now let us connect a resistance in series. We get another reading on the meter. Let us call it V. Then the drop in the external resistance is E—V. This is equal to the current through the meter multiplied by the resistance external to the meter. The current to use, of course, is that which causes a deflection of V on the meter.

Suppose we know the value of the external resistance. Then the current in question is (E—V)/R, where R is the known external resistance. Let us assume that the reading on the meter with 1,000 ohms externally is 17.5 volts. Then E—V is 5 volts. Hence the current through the meter when the reading is V is 0.005 ampere. The resistance in the meter can now be found because we know that the drop in it is 17.5 volts when the current is 0.005 ampere. Therefore the resistance is 3,500 ohms. We don't know yet what the resistance per volt is but in this case we don't need it. However, if the full scale reading is 30 volts, the ohms per volt is 116.5 ohms. These figures were just assumed and for that reason we got such an odd value.

Finding a Resistance Value

Now that we have found the total resistance in the meter we can find the value of any external resistance. Let the resistance of the voltmeter be r and let the value of the external resistance to be found be R. Let the battery voltage be E and let the reading on the meter with R in series be V. The current through the meter is directly proportional to the deflection, that is, to the indicated voltage. Let the current be I. Then by

(Continued on next page)

Views of Testing Outfits

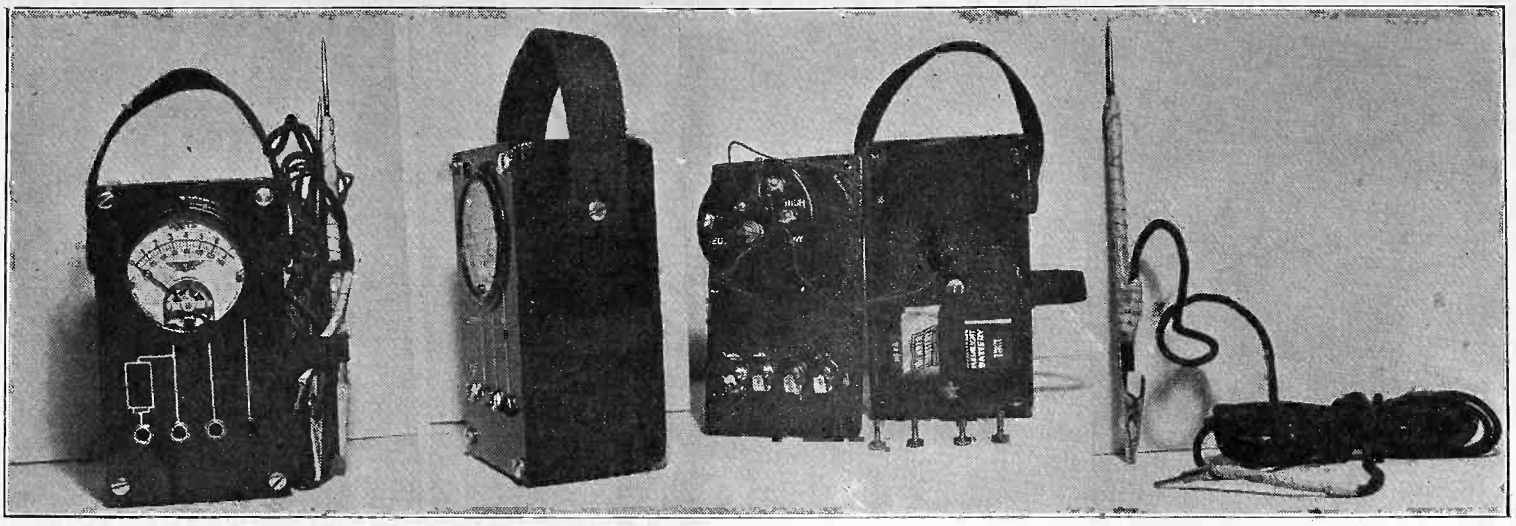

FIG. 2
Several views of the continuity tester and ohmmeter showing the construction and the layout of parts. A carrying handle and a set of special test leads make the device convenient.

(*Continued from preceding page*)
Ohm's law we have $E=(R+r)I$, or $E=RI+rI$. Divide both sides of this equation by rI and we get $E/rI=(R/r)+1$. But rI is the voltage reading on the meter with R in series externally, that is, $rI=V$. Hence $E/V=1+R/r$. If we solve this for R we get $R=r(E-V)/V$. This is a simple expression for determining the value of any resistance in terms of two readings on a voltmeter the total internal resistance of which is known.

Let us apply this to a case. Suppose we have a voltmeter known to have an internal resistance of 100,000 ohms, the value of r in this case. When we connect this meter in series with a battery of 45 volts and an unknown resistance we get a reading of 6 volts. What is the value of the unknown resistance? E is 45, V is 6, and r is 100,000. Putting these values in the formula we just developed gives us $R=100{,}000\ (45-6)/6$, or 650,000 ohms. Again, suppose we have a meter the resistance of which is 10,000 ohms. When we connect this in series with an unknown resistance and a 45 volt battery we get 40 volts. What is the value of the unknown?

Resistance Examples

In this case r is 10,000 ohms, E is 45 volts, and V is 40 volts. Hence $R=10{,}000(45-40)/40$, or 1,250 ohms. The method is quite flexible if we have different voltage available and if, also, we have a dual range meter. It should be remembered that the total resistance of a meter is different for different ranges although the resistance per volt is the same. Thus if the ohms per volt is 1,000 and there are two ranges of the meter, one 0-10 and the other 0-100, the resistance of the meter when the first ranges is used is 10,000 ohms and when the second range is used the resistance is 100,000 ohms. The proper value should be used in computing the value of an external resistance. While this reference was made to a meter of high sensitivity, it is not necessary to use this as good results may be obtained with less expensive meters. For simple continuity almost any meter will do.

In Fig. 2 are shown several views of the continuity tester. At left is a front view showing the meter and the terminal jacks. The rectangular symbol from the extreme left terminal to the meter represents the battery built into the instrument. Since one side of this connects with the second terminal, it is clear that the voltmeter can be used as such without having the battery in the circuit. The other two terminals represent the two ranges of the instrument.

Use of Test Leads

At right center are shown two views of the interior of the tester, one displaying the meter and the terminal jacks and the other the battery. At the extreme right of Fig. 1 are shown the connecting leads. Three of the four terminals of the two leads are provided with phone tips which fit into the jacks. The remaining terminal is provided with a sharp point as well as with alligator jaw clips, these two representing continuity.

The box containing the instrument is provided with a convenient handle for carrying. On the side there is also a loop for holding the terminal leads.

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Short Wave Shielding

How to Effect Stability Without Sacrifice

By Fred Worth

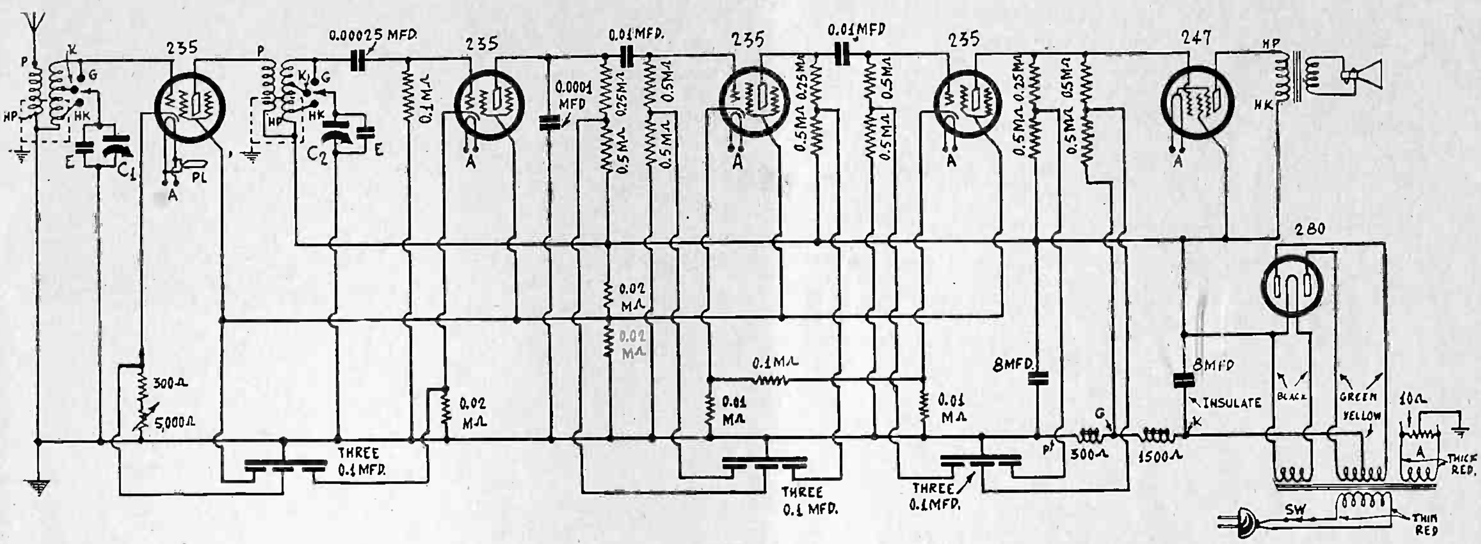

FIG. 1

A simplified short wave set, which can be adapted to use of plug-in coils for wave band shifting, or for use of tapped coils so front panel switch will change the wave bands. Short leads result even with switching, and the coils may be fairly close together. The speaker plug and power transformer connections are identified.

FOR short wave work complete shielding may incur too severe losses, where there are one stage of tuned radio frequency and a detector. In that case the shielding is sufficient if only the lower part of the coil is "covered." The problem has been worked out experimentally in a given instance, aluminum tube shields being cut down until just the right height remained.

The problem usually arises when the coils are relatively close together, as they may have to be for certain chassis layouts, or for switching. But when the circuit is stabilized the results are as good as by any other way.

It is easy to kill the sensitivity, or not to reduce it enough and leave objectionable and almost uncontrollable oscillation. Therefore the shield was cut down ¼ inch in height at a time until the correct height obtained. The solution herewith presented is one applying to the dimensions given, including the number of turns on the primary in the plate circuit of the r-f tube. The larger this number of turns, the more shielding is necessary, whereas the antenna primary works in the opposite direction. However, the limiting factor in the antenna circuit is selectivity. One desires that the selectivity shall be serviceable, hence an extremely large primary very closely coupled to the secondary would not do.

Leave Some Feedback

Some little feedback may remain, and it is desirable. Every one who has experimented with squealing circuits knows that the trouble is you can not find just the right point and hold it, the control being unmanageably critical. But if the feedback is reduced suitably, then the control is easy to work. Hence the volume control in the circuit, Fig. 1, a rheostat in the cathode leg of the r-f tube, controls the feedback in that tube. The height of the shield determines the degree of stability. A 1¼ inch height, open top, proved satisfactory.

In the audio channel there is another question of stability. There are three stages of resistance coupling, using screen grid tubes throughout, for of course the 247 pentode is a screen grid tube, too. It was found that the 235 as audio amplifier afforded far better stability than the 224, and as each plate and grid circuit is filtered to check positive feedback, therefore the circuit is tamed for 224 tubes as well. It is not practical to omit these filters. They consist of the resistors in the lower section of the grid and plate circuits, with a condenser from the juncture to ground.

The audio circuit is stable at high as well as low audio frequencies, and no bypass condenser is necessary across the 0.01 meg. (10,000 ohm) biasing resistors of the first and second audio tubes.

Option of Coil Use

Plug-in coils are used, although not necessary to change the wave band. If it is desired to use different coils for different bands they may be wound on a total of six UY plug bases, affording three sets of coils, 15 to 200 meters. In that case the

(*Continued on next page*)

LIST OF PARTS

Coils

For wave band changing by plugging in, three sets of coils, two coils to a set, total six coils, as described in text.

For switching, one set of coils, (total, two coils), tapped, as described in text.

[*Note: B supply choke coil is field coil of dynamic speaker, which speaker also has output transformer built in. Speaker specified later.*]

One power transformer to work four heater tubes, one pentode 247 and 280 rectifier.

Condensers

One 0.00025 mfd. fixed condenser.
One two gang 0.00035 mfd. condenser, with equalizers.
One 20-100 mmfd. equalizer, used at full capacity as detector plate bypass condenser.
Three 0.01 mfd. mica fixed condensers.
Two 8 mfd. electrolytic condensers, one with two insulating washers and connecting lug.
Three shielded blocks, three 0.1 mfd. condensers in each block. (Black, common, grounded; reds interchangeable).

Resistors

One 10 ohm center tapped resistor.
One 150 ohm pigtail resistor.
One 5,000 ohm potentiometer with a-c switch attached.
Two 0.1 meg. pigtail resistors (100,000 ohms).
Three 0.25 meg. pigtail resistors (250,000 ohms).
Six 0.5 meg. pigtail resistors (500,000 ohms).
Three 0.02 meg. pigtail resistors (20,000 ohms).
Two 0.01 meg. pigtail resistors (10,000 ohms).

Miscellaneous Other Parts and Accessories

One dynamic speaker, with 1,800 ohm field coil, tapped at 300 ohms, and pentode output transformer built in.
One vernier dial, ghost type, with escutchen, scale, pilot lamp.
One three point, double throw rotary selector switch, shaft insulated from everything (for use with tapped coils for switching wave bands); keyed knob.
One chassis, 13.5 x 7.75 x 3 inches, with seven socket holes; extra socket is for speaker plug.
Three 235 sockets, one 224 socket, one 247 socket, one 280 socket and one speaker socket.
One midget cabinet to fit (not suitable if plug-in coils are used for wave shifting).
One knob to match keyed knob of wave band switch.
One dial knob.
Six tube shields and bases, two shields to be cut down for use as coil shields as directed.
Four grid clips.
One roll of hookup wire.
Two dozen 6/32 machine screws and nuts.
[*Note: If plug-in coils are used, the potentiometer has no switch, a separate shaft type a-c switch is used, and two separate matched knobs are needed.*]

A Two-Tube Modu

Useful in Testing and Serv

By Burton

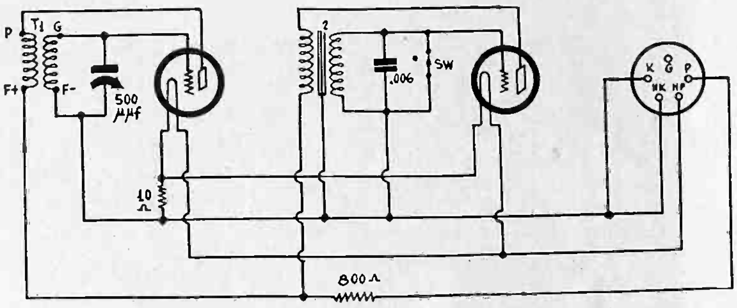

FIG. 1

The circuit diagram of a modulated radio frequency oscillator for use in testing radio receivers and superheterodynes in particular.

WHEN adjusting superheterodyne receivers during production and servicing it is necessary to have a modulated oscillator covering both the broadcast band of frequencies and the intermediate frequency. It is first needed for adjusting the intermediate frequency amplifier for greatest response at 175 kc, or at whatever intermediate frequency is used. For this purpose the output of the oscillator should be modulated with a tone that may be heard easily through many, and perhaps loud, competing noises. After the intermediate frequency amplifier has been tuned to the desired frequency, an oscillator is needed for adjusting the broadcast tuner and the oscillator. For this purpose it is sometimes convenient to have the output of the oscillator modulated and sometimes to have it unmodulated. Therefore the test oscillator should be provided with a switch by means of which the modulation frequency may be cut out, and this should be done so that there is no change in the calibration of the oscillator when the switch is thrown.

Two-Tube Test Oscillator

The modulated oscillator shown diagrammatically in Fig. 1 was built to cover the broadcast band as well as the intermediate band from about 90 kc to 350 kc. Since it was desirable to cover the different frequency bands without switches, plug-in coils were provided. One coil was adjusted to cover the broadcast band. It was wound with 71 turns of No. 32 enameled wire on a 1.25 inch diameter of the tube base type. The tickler for this coil was wound with 50 turns of the same wire. The calibration curve for this coil and a 500 mmfd. General Radio type 247 condenser is given in Fig. 2. As will be noted, the frequency is adjustable between 525 and 1,500 kc. Of course, another 500 mmfd. tuning condenser can be used if desired but the calibration curve will not be the same, for it depends on the cut of the plates. However, the frequency coverage will be about the same for any 500 mmfd. condenser, provided the same coil is used.

Calibrating the Oscillator

The calibration of the oscillator in the broadcast band is very simple. A receiver of good sensitivity is required. Tune in a station of known frequency. Turn the oscillator condenser until a squeal is heard in the loudspeaker. Adjust for zero beat. The reading on the oscillator dial then fixes the position of the known frequency. For example, in the sample calibration curve the dial reading for 600 kc is 21. This was obtained by tuning in a signal known to have a frequency of 600 kc and turning the oscillator condenser for zero beat. Other points were located similarly throughout the band.

This method may fail at the extremes of the curve for lack of stations of known frequency, or any stations at all. In that case the range may be extended by means of harmonics. Suppose we cannot find a station of 1,500 kc but we can find a station of 750 kc. If we first tune in the 750 kc station and turn the oscillator for zero beat we locate the 750 position. If now, without touching the tuning of the receiver, we turn the oscillator dial to where 1,500 kc should come in, we again hear a squeal, though not so loud, and the zero beat position locates the 1,500 kc accurately. Care should be taken not to get the wrong squeal, for there will be many points where a squeal will be heard. As a rule, the second harmonic, which in this case is used, gives the second strongest squeal.

Reversing Procedure

By the same method, reversed, it is also possible to locate positions below the broadcast band. For example, suppose the oscillator will actually go down to 500 kc. The broadcast set may be tuned to a station of 1,000 kc and the oscillator turned until the squeal appears as the condenser is set near maximum. In this case the second harmonic of the oscillator beats with the fundamental of the broadcast frequency tuned in. In the first case the second harmonic of the signal frequency beat with the fundamental of the oscillator.

An attempt should be made to locate points for every five divisions on the oscillator condenser, including zero and 100. When these points have been located on the graph a smooth curve should be drawn through all the points. If the frequencies at zero and 100 cannot be found, too much reliance should not be placed in the apparent trend of the curve near the ends, for there is very little change in the frequency between about 97 and 100 and between zero and 3 on the dial. Just how the curve will run near the ends of the scale will depend on the particular condenser used. It is assumed that the dial has been set so that zero coincides with minimum capacity and 100 with maximum.

The Circuit

The circuit consists of one radio frequency amplifier and one audio frequency amplifier. Both are of the tuned grid type and each tube is a 230, 2-volt type. In the completed oscillator there are four sockets, two for the tubes, one for the radio frequency coil and another for the battery cable. The cable socket was made of the UY type so that no mistake could be made in plugging in. The r-f coil socket was made of the UX type but it was clearly marked so that a tube would not be plugged into it. The wiring of the coil and the cable sockets is shown in Fig. 1.

Transformer T2 used in the audio frequency oscillator was an old one-to-one power transformer. When this was connected with a 0.006 mfd. condenser across the winding in the grid circuit, the frequency genereated was about 2,000 cycles per second. An old audio coupling transformer can also be used, but if this is a good one, the generated frequency is likely to be too low even when no condenser is connected across either winding. An old cheap transformer that will give a shrill whistle when con-

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How to Wind Coils for

(*Continued from preceding page*)

0.00025 mfd. condenser and 0.1 meg. (100,000 ohm) grid leak in the detector stage would be omitted, and the interstage secondary returned to ground. If a switch is to be used, then that secondary is returned to B plus maximum, although this does not affect the grid bias, which is negative by about 7.5 volts. Despite the leak and condenser this is a high negative bias detector, and not a leak-condenser detector. It is the bias that distinguishes the type of detector. The leak simply affords a means of establishing the grid bias independent of the secondary coil return. The tuned circuit for this coil, in Fig. 1, is bypassed by one of the 8 mfd. filter condensers.

If UY plugs are used, since they have five terminals or prongs, P for the antenna coil plate may go to aerial, heater adjoining plate (HP) to ground, one extreme of the secondary also to ground, two taps to heater adjoining cathode (HK) and cathode (K), respectively, while G goes to grid. Therefore the five prongs are in service. For the interstage coil P may go to plate, HP to B plus, which is also the connection for the end of the secondary, while the two taps go to HK and K, and the other extreme to G. Hence the coil socket terminals would be wired in the set in that manner, just as if the coils were in position, for when the coils are inserted, the proper connections result.

Assuming now that plug-in band shifting is to be selected, using 1.25 inch diameter, at the bottom, near the prongs, wind the antenna primary, 12 turns of No. 24 silk covered wire. Connect the beginning of the winding to P prong, end of winding to HP prong. Leave 1/16 inch space and wind 32 turns of No. 28 enamel wire, the beginning of the winding, adjoining the end of the plate winding, going to HP prong, as did the end of the primary winding. The end of the secondary goes to the grid prong.

The primary of the other coil consists of 12 turns of No. 28 enamel wire, beginning to P, end to HP. Leave 1/16 inch space and wind 32 turns of No. 28 enamel wire and connect the end to the G prong.

All windings are in the same direction.

The foregoing accounts for one set of coils. Two more sets, a total of three sets, or six coils are needed.

The next pair consist of 8 turns primaries, 1/16 inch spaces,

ated R-F Oscillator

ing Superheterodynes

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nected up as an oscillator is preferred. If a lower frequency is desired it is only necessary to connect a small condenser across one of the windings. A one-to-one output transformer designed to operate between an ordinary power tube and a magnetic speaker will also work well and will give a suitable frequency with a small condenser across either winding.

Cutting Out Modulation

A switch Sw is provided in the grid circuit of the audio oscillator for cutting out the modulation frequency. The switch in the drawing is set for no oscillation. When it is thrown to the blank point the circuit will oscillate. Since the audio tube is left in the circuit there is practically no change in the voltages when the switch is thrown and for that reason there is no change in the radio frequency generated by the first tube.

A common 10 ohm ballast resistor is used in the filament circuit. This assumes that the two tubes are of the 230 type and that the filament supply voltage is 3 volts. If it is desired to use other tubes it is only necessary to change the value of the ballast resistor and the supply voltage. For example, if the two tubes are 201A the ballast resistance should be 2 ohms and the battery voltage should be 6 volts.

For modulation an 800 ohm resistor is used in the plate circuits. This is not by-passed. This resistance caused satisfactory modulation without overloading the radio frequency tube.

A plate voltage of 45 volts was used and it gave good results. However, the circuit will also work on 22.5 volts just about as well.

Making Use of Oscillation

Apparently there is no means for taking off the oscillation for use in test applications. All that is necessary is to place a wire near the oscillator coil and to connect one end of this wire to the antenna lead of the set, or to a grid clip of an amplifier tube, or to a plate. The intensity of the signal picked up can be varied by varying the distance between the wire and the oscillating coil. In some cases it is not even necessary to use the wire but just place the oscillator near the receiver under test, and in still other cases, and particularly when the circuit is generating an intermediate frequency, it is necessary to wrap the wire around the oscillator coil for several turns. In all cases the coupling should be as loose as possible.

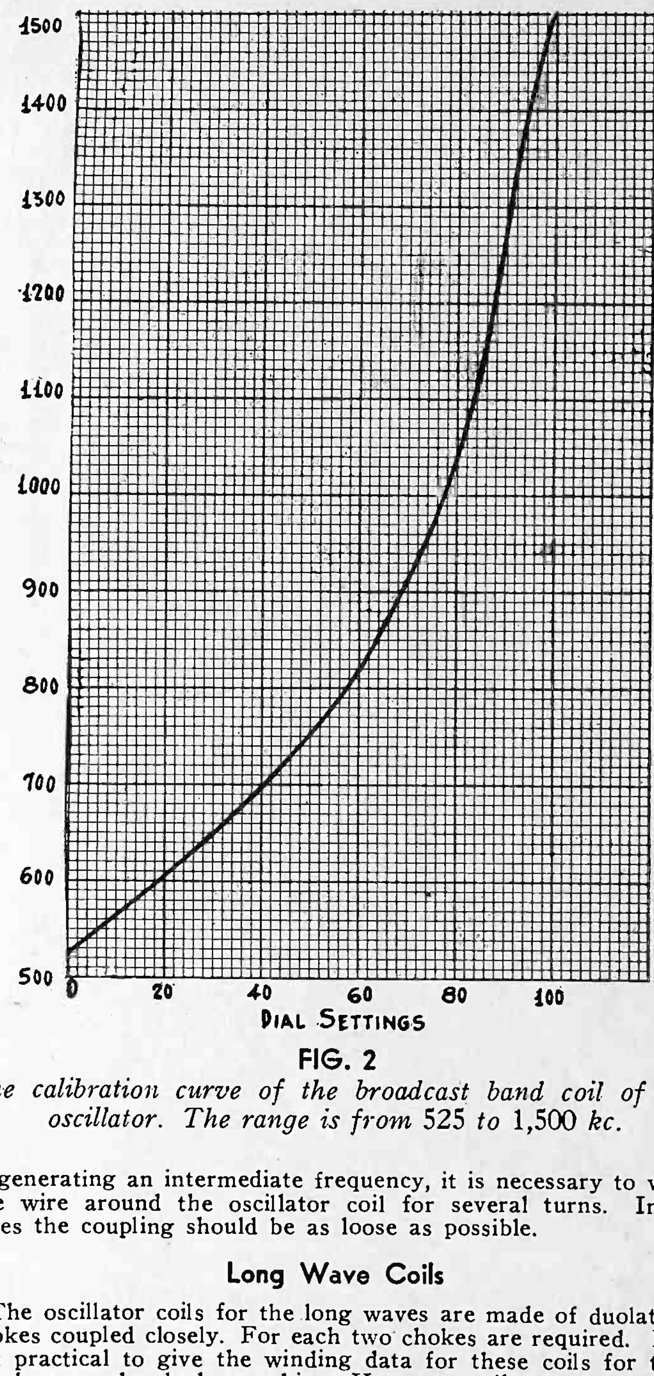

FIG. 2

The calibration curve of the broadcast band coil of the oscillator. The range is from 525 to 1,500 kc.

Long Wave Coils

The oscillator coils for the long waves are made of duolateral chokes coupled closely. For each two chokes are required. It is not practical to give the winding data for these coils for they can be wound only by machine. However, coils already wound can be used and the turns reduced until the inductance is correct. The calibration is not easy unless a calibrated oscillator covering about the same range is available. It can be done, however, using harmonics of broadcast stations. For example, suppose we have a coil covering the 150 to 350 kc band. If we tune in a broadcast station having a frequency of 600 kc we will get a squeal with the oscillator when the dial is set at maximum for the fourth harmonic of 150 is equal to 600 kc. Likewise, if we tune in a station of 700 kc we will get a squeal when the oscillator is set at minimum for the second harmonic of 350 is 700 kc. The difficulty arises from the fact that there are squeals everywhere on the intermediate frequency oscillator and it is hard to tell which harmonic is involved. But this comes with experience.

Long Wave Curves

In Fig. 3 we have two sample calibration curves of long wave coils in this oscillator. One covers the range from 72.5 to 170 kc and the other from 155 to 364 kc. The calibration was actually done against an oscillator which covered the range from 100 to 200 kc but it could have been done just about as well against broadcast station signals. In fact it will be done over

(*Continued on next page*)

mple Short Wave Set

and 11 turn secondaries, No. 28 enamel wire, except for antenna primary, No. 24.

The last pair consist of 4 turn primaries, ⅛ inch space, and 4 turn secondaries, using No. 18 enamel wire same wire as above.

If switching is to be used, instead of plugging in to change the wave bands, then constructionally you will make only two coils, and tap them, returning the secondary of the interstage coupler to the HP connection, that is, both the primaries and secondaries of both coils go to the same points exactly, in respect to each other, although comparing interstage coils for plug-in wave changing with switched wave changing, the secondary returns go to different places, as will be emphasized again.

Therefore for switching wind 12 turns of No. 24 single silk covered wire for the primary of the antenna coupler, beginning to P, end to HP. Leave 1/16 inch space. Connect the begining of the secondary winding to HP, wind four turns, tap and bring the tap to HK, wind 7 more turns (total now is 11), tap, bring the tap to K, and wind 21 more turns, completing the required number of a total of 32 turns, end to grid prong.

The interstage coil is wound exactly the same way, except that the primary is No. 28 enamel wire, the same as all secondaries, or, if desired, the No. 24 wire may be used on the primary here, too, although with no improvement.

The wave band coverage will be approximately as follows: 200 to 67 meters for the largest coils, 67 to 23 meters for the next pair, and 23 to below 15 meters for the next pair, or, if switching is used, consider the word "taps" replacing the word "pair."

The tuning capacity used is working out the above coil data was 0.00035 mfd., and a two gang condenser may be used, if provided with equalizers. Although the volume control will change the frequency a little, this is helpful, as some discrepancies in peaking will creep in from one band to another, and the slight change can be compensated for in the volume control. If the limiting resistor is 150 ohms you will have sufficient leeway, provided the rheostat (which may be a potentiometer used as a rheostat) is not much more than 5,000 ohms.

The cable connections for the Rola series F speaker, are, left to right, at back: plate to HP; B plus maximum to HK, grid return to G, ground to P, B minus to K.

Curves on Oscillator

How to Calibrate Simple, Handy Device

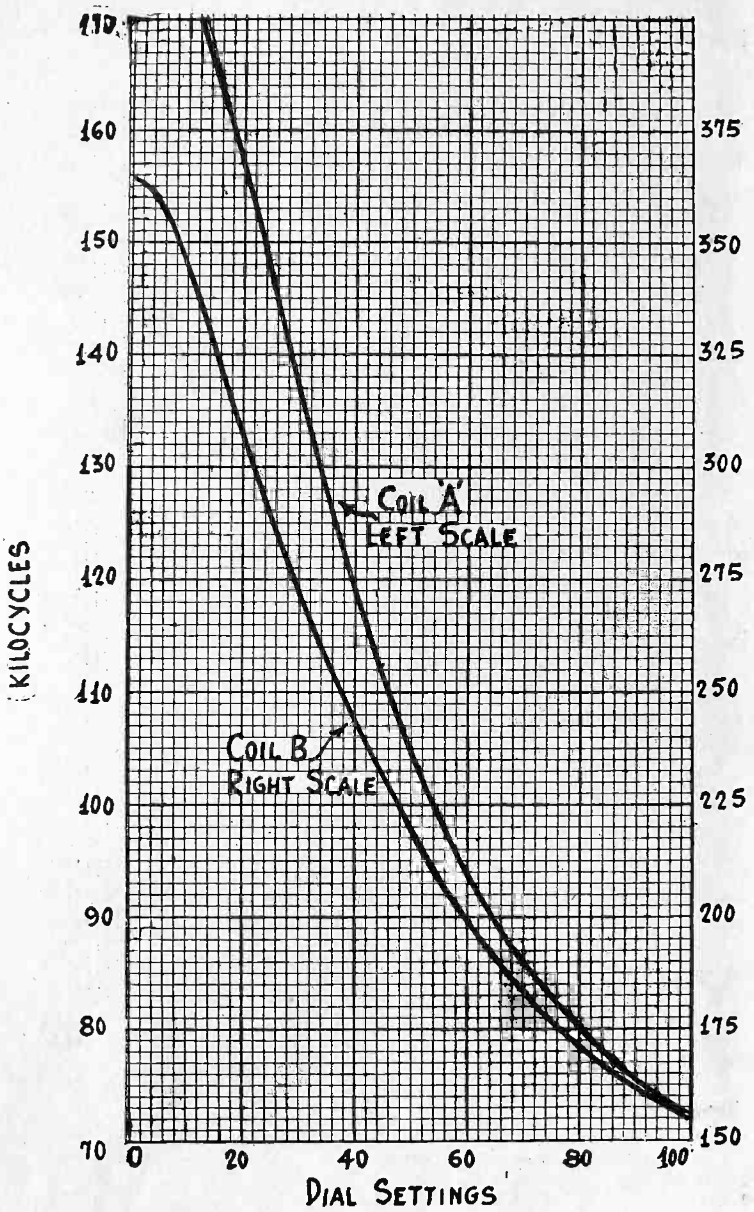

FIG. 3

Two calibration curves of two coils jointly covering the range from 72.5 to 364 kilocycles. "Scale" refers to frequencies at left and right.

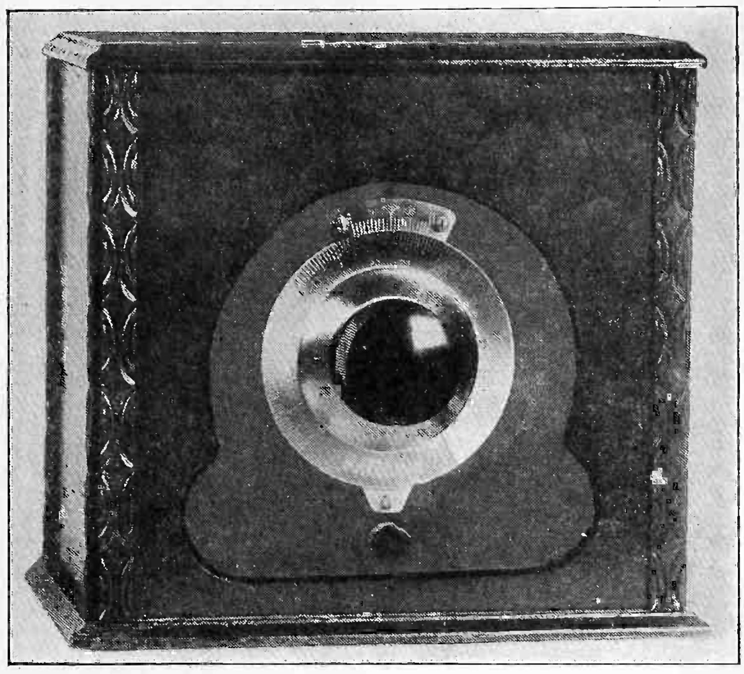

FIG. 4

The panel contains only the condenser dial but may also contain the switch Sw.

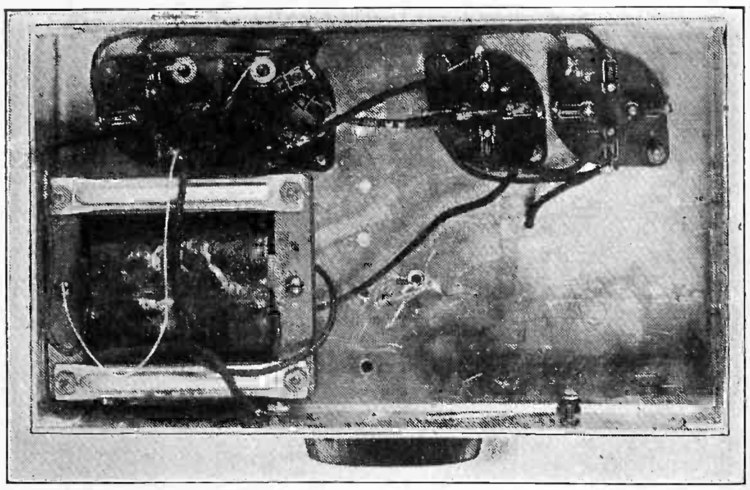

FIG. 5

A view of the bottom side of the subpanel showing the position of the audio oscillating transformer and the wiring.

(*Continued from preceding page*)

against these stations because broadcast station signals are more reliable than laboratory oscillators.

In calibrating one oscillator against another, and the other may be the broadcast station oscillator, it is well to remember that squeals are heard whenever any harmonic of one beats with any harmonic of the other. For example, let F be the frequency of the known signal and let f be the frequency of the unknown. Let m be any harmonic of F and let n be any harmonic of f. Then the condition for zero beat is that $mF = nf$, or $f = mF/n$. The lower the values of m and n the stronger will be the squeal near the zero beat position. For instance, when $m=1$ and $n=1$ we have the strongest squeal and then the two frequencies are equal.

When we calibrate a low frequency oscillator against a broadcast frequency, or broadcast frequencies, m will in most cases be unity and n will have higher values.

When calibrating an oscillator by the beat method it is well not to have the signals modulated because the sound will only cause confusion. The zero beat positions will not be silent. The modulation on the broadcast frequency will not cause as much trouble in this respect as the modulation on the other oscillator. Hence close the switch Sw when calibrating.

Views of Assembled Oscillator

In Fig. 4 is a view of the interior layout of the assembled oscillator. This shows the tuning condenser, the oscillating coil, the two tubes, and the power supply cable. In Fig.5 is a view of the bottom side of the subpanel showing the position of the audio oscillating transformer and the various small parts such as the two resistors and the audio tuning condenser. Fig. 6 shows a drawing of the front panel. The panel, incidentally, is of aluminum so that there is no body capacity in tuning. In addition to the shielding effect the only object of panel is to provide a reference for the dial.

Extending the Range

If it is desired to make coils that will cover short wave frequencies they can easily be made in the same manner as the broadcast coil, using the same size wire and the same size form. The primary and the secondary for these coils may be made equal as to the number of turns. The first coil just above the broadcast band can have half the number of turns, the next half as many as the first short wave coil, and so on. It is better to have more than enough coils and have plenty of overlap between ranges than to be short. This method of halving will give plenty of overlap.

Calibration of the small coils can be done by means of harmonics of broadcast stations without any difficulty. The first band is very easy because the second harmonic of broadcast stations may be used. For the next band third and fourth harmonics will have to be used.

Oscillator Frequency Stability

Methods for Reducing the Fluctuation

By Brunsten Brunn

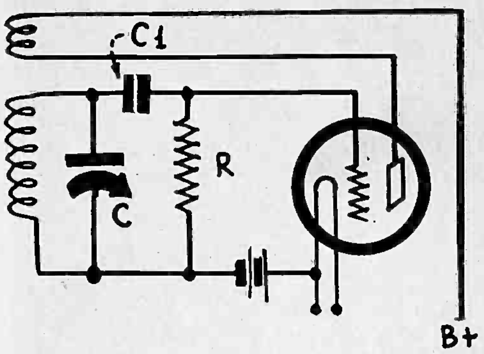

FIG. 1

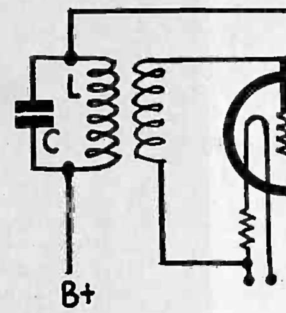

FIG. 2

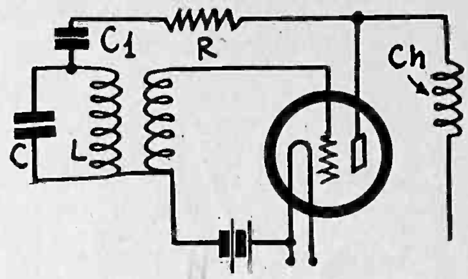

FIG. 3

A simple feed-back oscillator in which a stopping condenser C1 and a grid leak R have been used to stabilize the frequency. (*Fig.* 1.)

A tuned plate oscillator in which no attempt at stabilization has been made. (*Fig.* 2.)

The same oscillator as in Fig. 2 after it has been treated to increase the stability of frequency. R has a high value. (*Fig.* 3.)

MUCH thought is now given to the stabilization of vacuum tube radio frequency oscillators in respect to frequency fluctuation. Greater and greater frequency stability is always demanded. Part of this is imposed by official rulings, part by the crowding of radio channels and part by the fact that at high frequencies if the carrier is not constant the quality of the signals is impaired.

Frequency fluctuation is caused by many different effects. The main ones are temperature variation, vibration, and voltage fluctuations. Vibration is not a serious factor because steps can easily be taken to prevent it. Temperature changes, which affect mainly the inductance and capacity of the frequency determining circuit, can also be controlled within fairly narrow limits by means of thermostats. Hence the principal cause of frequency fluctuations is voltage variation. Changes are not confined to any one voltage but may occur in plate, grid, and filament voltages. When the circuit is battery operated the variation in the voltage is in part due to temperature and this can be eliminated as was stated above. But the voltage also varies with age and this is not so easily compensated for.

A-C Operated Circuits

If the oscillator is completely operated from an alternating line the voltage fluctuations are mainly due to a fluctuation in the load on the line. There are means, more or less effective, for compensating such variations. Frequency variations also occur as a result of varying the load on the oscillator tube, but this may be reduced to a very small value by coupling the oscillator to the grid circuit of another tube from which the load is taken.

If we assume that temperature effects on the inductance and the capacity in the frequency determining circuit are negligible, the stabilization takes the form of preventing fluctuations in the plate and grid resistances of the oscillating tube or of preventing the fluctuations from affecting the oscillatory circuit.

The most important condition for frequency stability is that the loss in the oscillating circuit should be small, that is, that the selectivity should be as high as possible. One reason why quartz piezo oscillators are so stable in respect to frequency is that the selectivity of the quartz oscillator is enormously high. If the selectivity of a frequency determining circuit consisting of inductance and capacity could be made as high as that of quartz, the frequency stability of such a circuit would be of the same order of magnitude.

Reason for High Stability

The reason for high frequency stability of a highly reasonant circuit is not difficult to see. The frequency varies because the reasonant circuit is driven off its natural frequency by a small amount depending on the phase shift of the feed back circuit. In a highly resonant circuit the phase shifts very rapidly with frequency about the reasonant frequency. Hence for a given shift in the feed back, this is compensated for by a much smaller change in the frequency in a highly reasonant circuit than in a broad circuit. If the phase shift is too great the circuit simply stops oscillating, and this occurs much sooner, for a given amount of feed back, in a highly reasonant circuit than in a broad circuit.

Let us compare two circuits, each having an inductance of 200 microhenries and a capacity of 200 mmfd. The natural frequency is then 795 kc. Let the resistance in one be 40 ohms and that in the other 4 ohms. That is, the selectivity of the second circuit is ten times that of the other. Suppose now that the phase shift of the feed back is such as to force the circuit to oscillate one electrical degree off its natural frequency. In that case the low selectivity circuit will oscillate 278 cycles off the natural frequency and the high selectivity circuit will oscillate only 27.8 cycles off the natural frequency. If the phase shift is a retardation the frequency shift will be an increase.

In-Phase Feed Back

If there is no phase shift in the feed back circuit, the circuit as a whole will oscillate at the natural driven frequency of the frequency determining circuit, that is, the frequency will be determined by the LC of the reasonant circuit and the oscillator will be relatively frequency stable.

It is not an easy matter to separate the oscillator components so that it is known whether or not there is a phase shift, so that the above observations are quite theoretical. However, they indicate in many instances what to do when a given change occurs in frequency.

It is apparent that if the phase shift is small only a small change can occur in the frequency when given changes are made in the circuit outside the reasonant circuit.

One of the methods of stabilizing the frequency is to isolate the frequency determining circuit as much as practicable from the tube and power sources. This isolation removes the effect of tube resistances and capacities from the resonant circuit and so tends to hold the frequency constant. Moreover, if this isolation is done by means of high resistances the phase shift is reduced and so allows the resonant circuit to oscillate nearer its natural frequency. It also removes or minimizes the effect of varying grid and plate resistances.

Effect of Grid Leak

The use of a grid condenser and leak in an oscillator has always been found to stabilize the frequency. The reason for this is that this tends to keep the grid resistance of the tube constant as the voltages and the load vary. A similar treatment of the plate circuit has been found to stabilize the frequency, and for a similar reason. Besides, if the resistance added is put in series with the feed back circuit the phase shift of the feed back is reduced. Limiting the amplitude of oscillation also tends to stabilize the frequency because this prevents to some extent the tube from operating on a positive bias during any part of its swing, that is, it tends to keep the grid resistance infinite.

The use of very close coupling between the plate and the grid coils has also been found by experience to stabilize the frequency. This has been pointed out by F. B. Llewellyn of Bell Laboratories, who has given the mathematical theory for it. On the basis of phase shift this effect may be explained on the assumption that close coupling tends to reduce the phase shift although Mr. Llewellyn explains it from another point of view.

Incidentally, in his paper on frequency stabilization in the December issue of the Proc. I. R. E., Mr. Llewellyn considers frequency stabilization of all types of oscillator exhaustively, treating the subject both mathematically and experimentally. He finds that in any oscillator there is a critical capacity or inductance that may be inserted in the grid or plate circuit which will render the generated frequency independent of the battery voltages. For every type of circuit he gives an expression for determining the critical value. He also shows that

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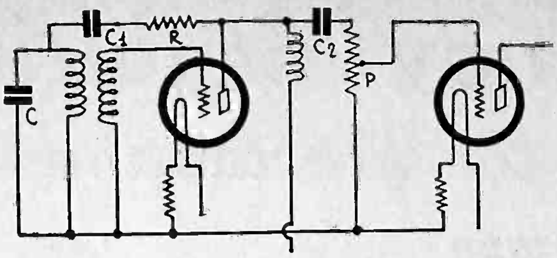

FIG. 5

In this tuned plate oscillator an extra amplifier tube has been added to isolate the more thoroughly the tuned circuit from the tubes.

(*Continued from preceding page*)

impedances may be inserted both in the plate and grid circuits to achieve the same effect, giving expressions from which these impedances may be computed for any type of circuit. Although the author does not say so, these critical impedances are those required to produce the proper phase shift so that the net shift is zero when the resonant circuit oscillates at its natural driven frequency, that is, the frequency determined by LC of the resonant circuit.

Sample Circuits

In fig. 1 is a typical tuned grid oscillator in which LC is the frequency determining circuit. C1 is a stopping condenser which tends to isolate the tuned circuit from the tube, and R is a grid leak which tends to keep the grid resistance constant. The tickler coil should be coupled closely to the oscillating coil L if the circuit is to be relatively frequency stable.

In Fig. 2 is the tuned plate oscillator. No attempt to stabilize the frequency has been made in this circuit and the frequency will depend to a large extent on the load as well as on the battery voltages. In Fig. 3 is the same circuit after it has been treated so as to stabilize the frequency. If the reactance of condenser C1 is small and that of the choke Ch is very large, the phase of the feed back, as well as the intensity of the feed back, depends on the value of resistance R. If this is as large as possible consistent with oscillation, the circuit will be relatively frequency stable. This stability is enhanced by making the coupling between the coil L and the grid coil close. It is possible that by choosing a particular value of C1 that the frequency at some value will be still more stable.

Connecting the Load

In Fig. 4 is the oscillator in Fig. 3 with a tube added for taking off the load. The grid of the second tube is connected to a voltage divider P through a small condenser C2 to the plate of the oscillator tube. If the load is taken off the plate circuit of the second tube, changes in the load can produce very little effect on the frequency, provided that the voltage sources are thoroughly by-passed.

In Fig. 5 is an oscillator in which two tubes are used for generating the oscillation. The first tube is coupled resistively to the second tube and then the plate circuit of the second tube is coupled back to the resonant circuit as in Fig. 3. The object is to permit the use of a higher value for the feed back resistance R. Only a small part of the output voltage of the first tube is impressed on the grid of the second tube. This method, and the use of a large value of R, tends to isolate the tuned circuit LC more completely. The load is taken off as in Fig. 4 from the first tube.

In Fig. 6 is a typical tuned plate oscillator which has been stabilized with an impedance in the feed back circuit. Ch is a choke coil which has a very high reactance at the resonant frequency of L1C3. C5 is the stabilizing capacity, and M is the mutual inductance between the tuned coil and the grid coil. If k is the coefficient of coupling that is, if $M^2=k^2L1L2$, then the value of C5 is determined by $k^2/(1-k^2)$ multiplied by C3. Assume that we couple L1 and L2 so closely that the value of k is 0.8. Then the value of the expression containing k is 1.778. If then the tuning condenser C3 has a value of 200 mmfd., the value of C5 should be 356 mmfd. Of course, the stabilization is effected at only one frequency, that determined by 200 mmfd. and the inductance of the coil L1. If we could use unity coefficient of coupling the value of C5 would be infinite, that is, we would use as large a condenser as possible. If the coupling coefficient is 0.9, the value of C5 would be 842.5 mmfd. when the tuning condenser has the value 200 mmfd.

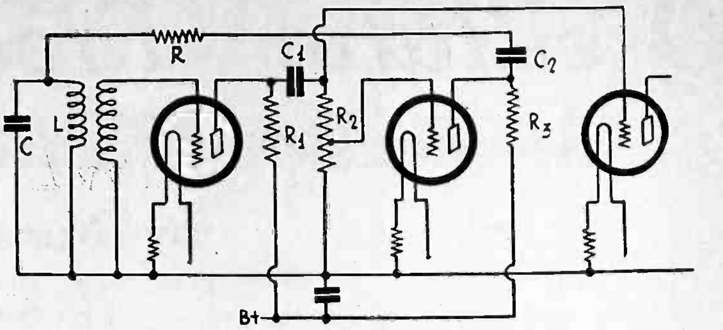

FIG. 4

This oscillator is the same as that in Fig. 2 but an extra load tube added in such a manner as to minimize the effect of varying load.

Single Frequency Stabilization

When a critical impedance is used to effect stabilization as in Fig. 6 the stability obtains at only one frequency. When the stabilization is done by "brute force" it applies more or less over a wide band of frequencies. The critically adjusted circuit is useful in a standard frequency circuit that may be used as a reference frequency in calibrating other circuits. For example, a stable oscillator may be made to generate a frequency of 400 kc. This may be used for calibrating other oscillators both of higher and lower frequencies by the harmonic method.

In case it is desired to have a stabilized oscillator the frequency of which may be varied without upsetting the stability, it can be made by ganging condensers so that the stabilizing capacity varies with the tuning capacity. This is especially applicable to the Colpitts type oscillator. Fig. 7 shows such an oscillator as given by Llewellyn. The stopping and by-pass condensers are supposed to be very large. The other values are indicated in the circuit.

Design Values

If this circuit is to be built to cover the broadcast band C1 and C2 may be 0.0005 mfd. variable condenser put on one shaft. L3 should have an inductance of 335 microhenries. L4 and L5 each should have an inductance of one-half this amount. An inductance of 335 microhenries may be made by winding 95 turns of No. 28 enameled wire on a 1.75 inch form. An inductance of half that value can be obtained by winding 59 turns of the same kind of wire on the same size form.

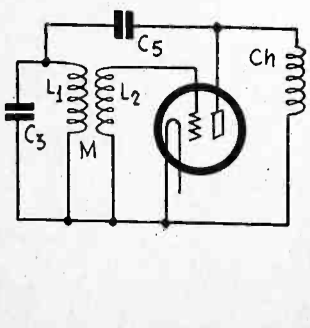

FIG. 6

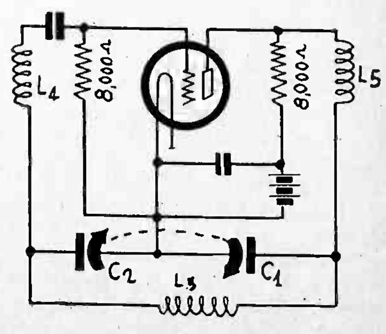

FIG. 7

A plate stabilized oscillator of the tuned plate type. C5 has a critical value. (No. 6)

In this Colpitts type oscillator stabilization has been effected for all frequencies covered by the tuner. C1 and C2 are ganged and are equal. L4 and L5 are also equal and equal to one half the inductance of L3. (Fig. 7.)

Phonograph Amplifiers

Earphone Hookup, Two and Three Stage Circuits

By Warren J. Edwards

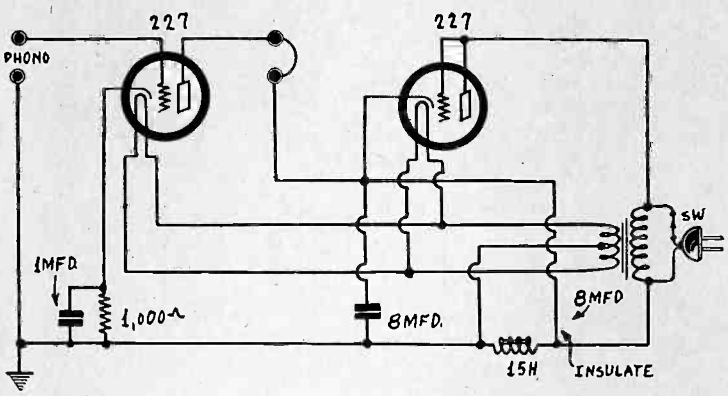

FIG. 1

A simple audio amplifier and power supply, to enable earphone reproduction of phonograph records.

WITH a phonograph pickup it is not possible to obtain reproduction unless the output of the pickup is fed to a tube circuit from which sound may be reproduced by inserting earphones or speaker. Therefore Fig. 1 is presented as a simple a-c operated device for achieving audibility. The next circuit, Fig. 2, has two stages of audio, instead of only one, while Fig. 3 has three stages. The constants are marked on the diagrams. For Figs. 2 and 3 regulation power supply is used, but for Fig. 1 a filament transformer will suffice, if the hookup is followed as shown.

The diagrams, Figs. 2 and 3, may be used as power amplifiers following a radio tuner's detector, provided a load is put on the detector tube either in the set or in the amplifier, and the direct current of the B supply fed to the detector plate that way, and in addition a condenser of 0.01 mfd. or higher connected from plate of detector to grid of the power amplifier. If variable mu tubes are used for r-f in the tuner, and a screen grid or other tube as detector, then only maximum B plus and the screen voltage are necessary from the B supply, and are afforded by Figs. 1 and 2. Fig. 1 affords a d-c voltage of about the same as the root mean square line voltage, the only precautions being that the rectifier tube should not have a cathode leakage, which few tubes have, and that the electrolytic condensers should be first class. If either of these conditions fails, then rectifier tubes will not last long.

Transformer Connections

Of course, one must insulate the designated 8 mfd. condenser if a metal panel is used, because of the voltage difference between the cases of the two 8 mfd. capacities. This voltage difference is the drop in the choke, so if no insulation is provided the choke is shorted out.

The primary of the filament transformer is connected to the line in the usual manner. Besides, either side of the primary goes to the joined grid and plate of the 227 tube used as rectifier, while the other primary terminal is connected to the case of the insulated 8 mfd. condenser and to one side of the choke. The other side of the choke, like the center of the filament transformer, goes to ground, which is not B minus. It will be noted that B minus is really one side of the line.

The biasing resistor for the 227 audio amplifier may be 1,000

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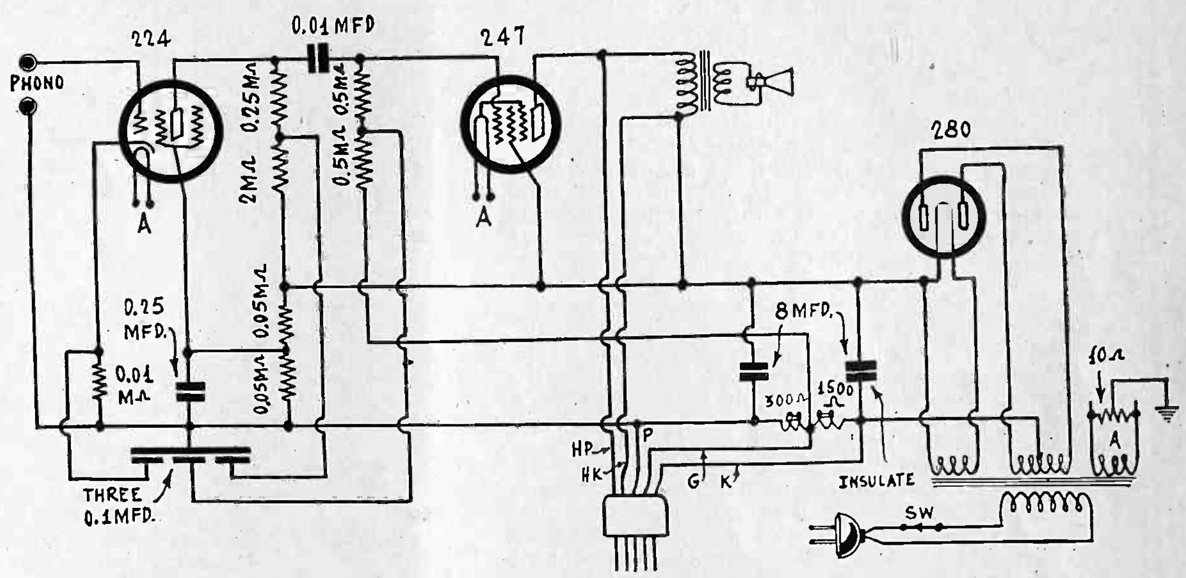

FIG. 2

A two stage audio amplifier, with pentode output and a complete power supply. This produces enough volume for loudspeaker reproduction in any home.

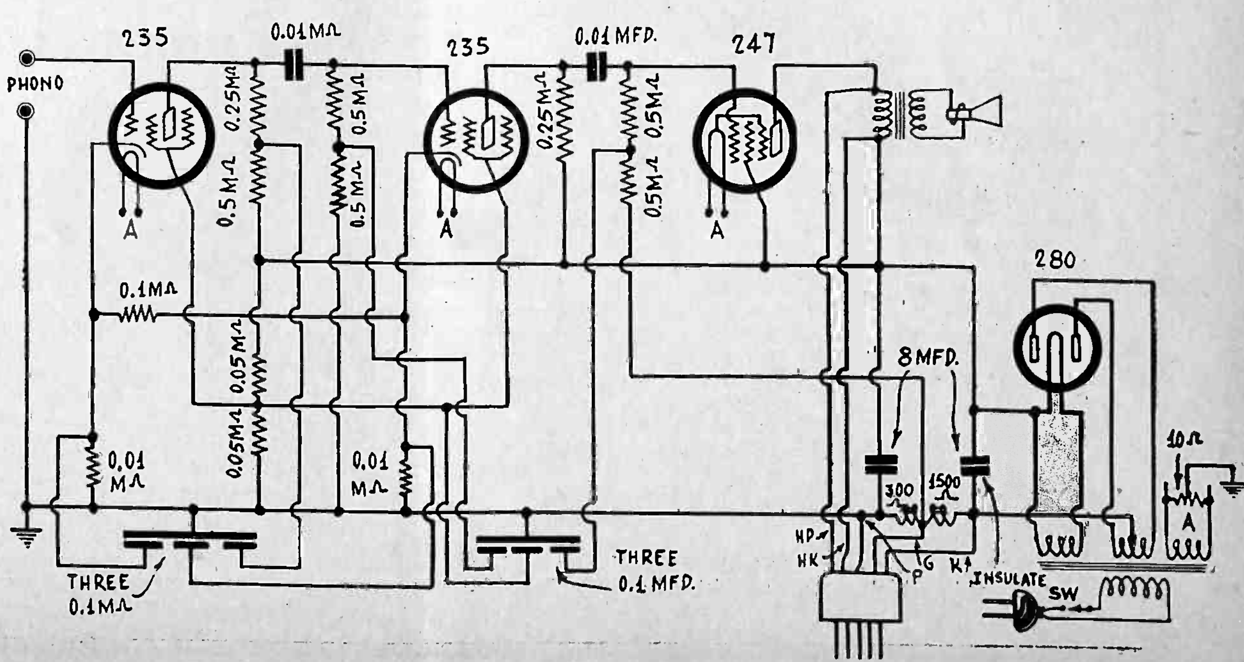

FIG. 3

Where the room is especially large this circuit may be built. Although it consists of three stages of screen grid audio it is stable.

A Universal Six Tube A

Simple Changes Adapt Receiver to

By Willian

PREVIOUSLY we have described automobile receivers in which part of the grid bias was obtained from the storage battery in the car. In these it was assumed that in most automobiles the negative side of the storage battery is connected to the car chassis, and therefore the circuits were wired accordingly. But many cars have the positive side of the battery connected to the chassis. A receiver wired with the idea that the negative side of the battery is connected to the chassis will not work in a car in which the positive is connected to the chassis, unless special arrangements have been used.

It is quite possible to make the receiver universal by keeping the filament circuit distinct from the plate and grid circuits, but in this case it is not possible to add the voltage of the storage battery to the plate battery nor to utilize the voltage in the storage battery for bias. It is desirable to boost the plate voltage by the six volts in the storage battery and it is also desirable to use this voltage for bias. It saves by-passing of bias resistors as well as the resistors themselves, and in general it improves the performance of the receiver. Anyone who has attempted to design a good automobile receiver will appreciate that it is necessary to take advantage of every trick that will improve the sensitivity and the tone of the set.

Remote Control Complications

If the receiver is insulated from the car chassis, except at points where connections are desired, there is little trouble in any case, but when the control unit is strapped to the steering column and when the control forms a part of the circuit, complications arise which impose certain restrictions on the wiring. One faulty connection is likely to short-circuit the car battery if the circuit has been wired for a car in which the negative is grounded and it is used in a car in which the positive is connected to the car chassis. Let us see whether it is not possible to connect the circuit so that it will be applicable to all cars and still utilizing the voltage of the storage battery to boost the plate voltage and also for bias purposes.

A Universal Receiver

In Fig. 1 we have the diagram of a six tube automobile receiver in which the circuit has been arranged so that it may be used for either type of car wiring. But even so, the connection cannot be made blindly.

We have in the battery cable four leads. One of these is devoted to the positive 135 volts on the plate battery, the second is devoted to the positive 67.5 volts for the screens, the third is devoted to the B return, which is made to the positive side of the heater circuit so as to add the storage battery voltage to the plate voltage. We have one left and this we connect to the positive side of the storage battery in cars in which the negative is grounded and we connect it to the negative in cars in which the positive is grounded. That is, in each case we connect it to the live side. The other side will be connected automatically through the juncture of the car and the receiver chasses.

On the receiver chassis is a socket into which the remote control plugs. To P of this socket we connect the antenna and the antenna terminal of the input coil. This connection is the same for both types of car wiring. The volume control built into the remote control device is a potentiometer, and one side of this connects through the cable to the P prong on the plug, thus making connection with the antenna and the input coil. To G on the socket for the remote control we connect the low ends of the antenna and first tuned coil and also the negative side of the heater circuit. Through the remote control cable G connects with the slider on the potentiometer. This connection also is the same for both types of car wiring.

The K on the socket picks up the 300 ohm bias resistance for the first two tubes and through the remote control cable connects with the remaining end of the potentiometer. There is no difference in this connection regardless of the car wiring. It should be noted that there is yet no connection to the negative side of the storage battery.

Connecting the Heater Circuit

Now suppose we have a car in which the negative side of the battery is grounded. We then use the fourth lead in the battery cable and connect it to the positive side of the storage battery and to Hp on the remote control socket. The lead in the remote control cable which connects with Hp first picks up the fuse,

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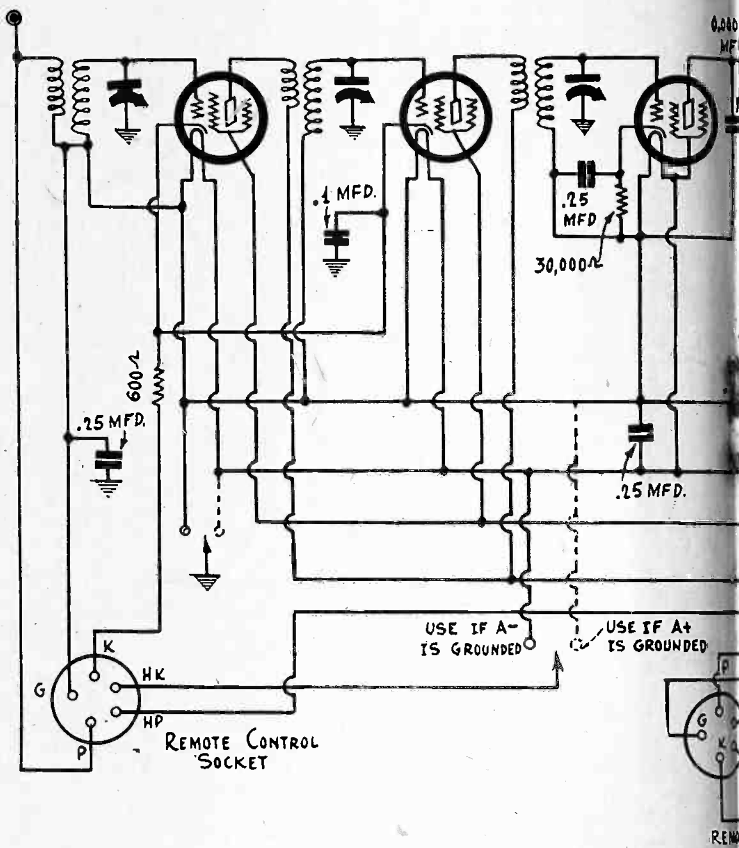


FIG

This is a diagram of a six-tube automobile receiver whic car battery is grounded. Slightl

LIST O

One remote control unit containing dial, pilot light, volume control, and connecting plug and cable.
One chassis for a six tube receiver, with metal container.
One metal box for the plate battery.
Eight UY sockets.
One 600 ohm resistance.
One 300 ohm resistance.
One 0.25 megohm resistance. One 1.0 megohm resistance.

Power Amplifiers for Ph

(*Continued from preceding page*)

ohms, as marked on the diagram, or may be from 800 to 2,000 ohms, not being at all critical in this circuit. The volume will be all-sufficient for earphone use.

Filters Prevent Feedback

Fig. 2 shows a 224 screen grid tube as first audio amplifier. Since resistance coupling is used to the pentode output tube, the 224 is highly suitable, particularly as the two stage circuit is stable, and if there would be any tendency toward instability it is removed by the resistor-capacity filters in the plate and grid circuits. These filters prevent feedback.

The transformer used will be serviceable also for the heaters of a tuner, as two or three heater tubes can be worked as to this power from the general run of transformers.

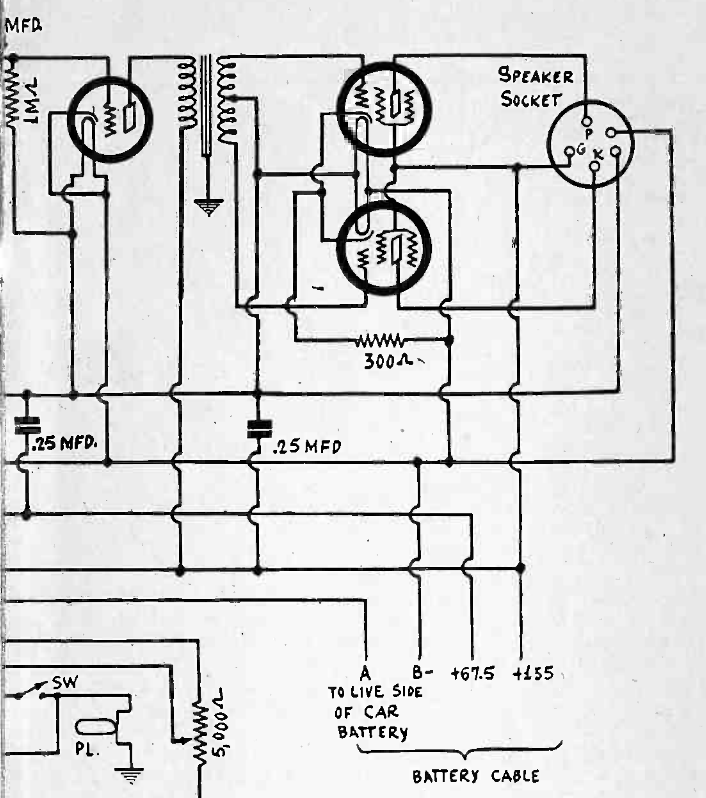
The speaker is of the dynamic type with the now familiar field coil that serves also as B supply choke and affords bias for the pentode. A five lead cable, with UY plug, connects speaker, field coil and output transformer, the connections now almost standard being shown in the diagram.

The three stage amplifier uses 235 tubes, because their stability is of a higher order, although 224's could be used, due to the adequacy of the plate and grid circuit filtration. The gain from

ıtomobile Receiver

ısitive or Negative Car Grounding

A. Jones



TROL AND PLUG

be used either when the positive or the negative of the ent connections are required.

RTS

Two 0.1 mfd. condensers.
Five 0.25 mfd. condensers.
One set of spark suppressors on the spark plugs, and one d. spark killer condenser to 80 across generator brushes.
One triple gang 0.00035 mfd. condenser.
Three automobile t-r-f coils to match condensers.
One push-pull input transformer.
One special dynamic type, 6 volt field type.

ograph and Other Uses

three stage amplifier is easily large enough to overload the ıtode, with phonograph use, so the volume control is brought o play. This control is not shown in any of the digrams ause the pickups have such a control built in.

Audio Regeneration

The stability is great enough even to support some extra feed-k purposely introduced, as through the 0.1 meg. resistor join- the cathodes of the first and second audio tubes. This pro-es a little audio regeneration. Also, the very method of ıtode bias through the drop in the part of the choke coil vides additional audio regeneration. However, the 0.1 mfd. es a small amount only, so that all danger of instability, h as motorboating, high-pitched continuous squeal or other ilar evidences of audio oscillation, are avoided.

The design, Fig. 3, is especially noteworthy, since it represents olution of the mystery of how to build a three stage resistance ıpled audio amplifier, screen grid tubes throughout, and yet run into trouble. The circuit is along lines now familiar readers of these columns, as the solution was perfected in DIO WORLD's laboratories, and is embodied by this time in eral circuits featured in these columns.

then the switch and then the pilot light as well as another lead which goes back through the cable and connects with Hk. This terminal on the remote control connects with the positive side of the heater circuit. One side of the pilot light is connected to ground, that is, to the frame of the remote control unit and hence to the car and set chasses. Thus the pilot light is on as soon as the switch is closed. But the tubes in the set do not get any current because there is no connection to the negative side of the heater circuit. This is made by connecting the negative side of the heater circuit to the receiver chassis.

When the negative side of the car battery is grounded the 0.25 mfd. condenser between ground and the negative side of the heater circuit is short circuited. Hence for this type of car wiring the condenser may be omitted.

Positive Side Grounded

When the positive side of the car battery is connected to the chassis the fourth lead in the battery cable is connected to the negative side of the battery. It still is connected to Hp on the remote control socket. As before, this live side, now negative, connects with the fuse, the switch, and the pilot light. The ground side of the pilot light is now positive so the lamp lights up as soon as the switch is thrown to the closed position. The lead in the remote control cable which connects with Hk should now be connected to the negative side of the heater circuit as shown by the dotted line. To complete the heater circuit so as to give the tubes and the field current when the switch is closed, it is necessary to ground the positive side of the heater circuit, according to the dotted line. The 0.25 mfd. condenser between ground and the negative side of the heater circuit is now necessary. It serves to complete the three tuned circuits. Since this condenser constitutes a common impedance among the three circuits, it will do no harm to make it even larger than 0.25 mfd.

Connection Differences

Assuming that the 0.25 mfd. condenser is kept for both types of car wiring and the circuit is wired as in the diagram, the differences between the two connections are slight and can be effected in a few minutes.

The volume control potentiometer is connected in the same way in both cases. The wiring of the cable to the remote control unit remains the same. The fuse, the switch, and the pilot light are also connected the same in both instances, one side of the pilot light being connected to the frame of the control unit.

When the negative of the car battery is grounded, the unused lead in the battery cable is connected to the positive side of the battery and Hk on the remote control socket is connected to the positive side of the heater circuit in the set. The negative side of the heater circuit is connected to the chassis.

When the positive of the car battery is grounded, the unused lead in the battery cable is connected to the negative side of the car battery and Hk on the remote control socket is connected to the negative side of the heater circuit in the set. The positive side of the heater circuit is connected to the chassis.

Voltages Unchanged

These connections leave all the voltages unchanged when the circuit is altered from one type of car wiring to the other. The only difference lies in moving the ground connection from the negative to the positive of the heater circuit. In some cases the slider on the potentiometer in the remote control unit is connected to the frame. This connection should be removed, particularly when the positive of the car battery is grounded.

If it is not known which side of the car battery is grounded it can be determined very quickly and easily. With a voltmeter one side of the meter is connected to the chassis of the car and the other is connected first to one terminal and then the other of the battery. The one which gives no reading is grounded. In the absence of a voltmeter the test can be made with a small 6 volt light. Connect one side to the chassis of the car and the other alternately to the two terminals of the battery. In one position of the free lead the lamp will light up. That is the live terminal and the other is grounded. In the absence of any test instrument use a wire. Connect one side to the chassis of the car and brush the other end momentarily over the terminals of the battery. In one case there will be a spark. That is the live terminal. In the other there will be

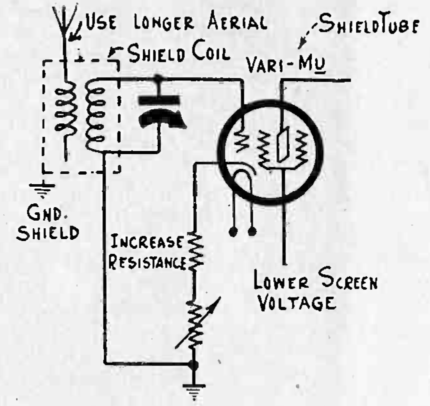
(*Continued on page* 18)

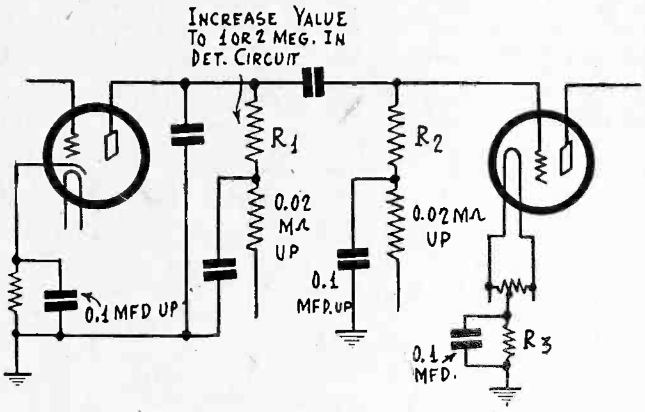
Stopping Oscillation

Remedies Applied to Radio and Audio

By Jack Tully

The location of the limiting or "hop-off" resistor is shown at left, with some r-f squealing remedies. At right R1 is the detector load, R2 the grid leak, R3 the output (power) tube biasing resistor.





[The December 19th issue contained an article on the solution of radio frequency coil winding problems, telling how to arrive at the correct solution even if you do not actually know the capacity of the tuning condenser used, and giving data for short waves as well as for broadcast waves. Last week's article, December 26th, dealt with solution of voltage division problems in a-c receivers. Next week's article will deal with short wave converter coupling. The series is intended as a help to beginners.—EDITOR.]

STABILITY at both radio and audio frequencies is necessary in a receiver. Instead of neutralizing methods previously popular, now that screen grid tubes are the rule, careful shielding is used for r-f stability, with adjustment of the biasing resistor value so that any tendency toward incipient oscillation is removed. The varable mu tubes make such bias adjustment practical, since there is little drop in sensitivity, although the bias is increased considerably. The recommended value of resistance, hence bias voltage, may be exceeded greatly, even by 100 per cent., for stability reasons. Also, the selectivity is increased at the same time. Another option is to reduce the screen voltage, but this is not usually so handy.

R-f choke coils in screen and plate leads may be used, with fixed condensers from the "high" side of the choke to ground, but as the other methods suffice, the chokes are not as popular as formerly. Instead of chokes, resistors may be used, of the order of thousands of ohms in screen leads and a few thousand ohms in plate leads.

Equalized Sensitivity

If it is desired to make a t-r-f set amplify all the broadcast frequencies virtually evenly, it is practical to put 1,000 ohm resistors in each of the r-f plate leads, without a condenser across them. This of course reduces the selectivity, a fact to be considered in circuit design, but the higher wavelengths get about as much amplification as the lower ones, an otherwise unusual situation. Of course this is a corrective for instability at radio frequencies, because the instability would be at the high frequencies, whereas the amplification is cut down for these frequencies by the series plate resistors, and we borrow from Peter High to pay Paul Low.

The shielding should be used in all cases where there are more than one stage of t-r-f. The shields should be copper or aluminum, not tin or iron, as the latter two cause heavy eddy current losses, and drop the inductance more considerably, so that coil data given for shielding conditions will not apply accurately, as tin or iron shields are not intended by those who give the coil winding directions. Some sets having numerous tubes are so poorly designed that brute force methods must be adopted to make them workable, and in such instances tin or iron shields may be used, but broadness may result, and indeed the general performance will be poorer than with fewer tubes in a circuit more sensibly designed and built.

Parallel Resistor as Antenna Compensator

The shield must be grounded, otherwise it is not a shield. It is also advisable to put a shield over the r-f and detector tubes, or, in a superheterodyne, over the intermediate and second detector tubes as well. These tube shields increase the capacity slightly, and the tuning condensers have to be peaked with the shields on, or, if the shields are newly put on, the tuning condensers repeaked.

Thus r-f stability is reduced to a simpler practice than formerly. There remains, however, the consideration of primary turns. In the antenna circuit, the more primary turns, and the longer the aerial, the more stability. Both these factors introduce greater resistance. Some set manufacturers put a parallel fixed resistor across the antenna primary, so that the set will not oscillate no matter how short an aerial is used.

Any one having a set that oscillates on a short but not on a long aerial, and who wants to use a short aerial, may resort to the same practice. With no aerial connected, adjust a variable resistor until oscillation stops. Then measure the resistance in circuit and replace with a fixed resistor of the same or approximately the same value.

Reduction of primary turns of interstage couplers reduces the tendency toward squealing, and of course increases the selectivity while reducing also the sensitivity. The fewer turns mean looser coupling, and looser coupling spells increased selectivity. A short aerial is a form of loose coupling, in effect, since a smaller input is delivered to the primary, hence the secondary.

Sometimes when you build a set you hear two stations at one setting, and this will happen at different dial positions. Also, a peanut whistle is frequently heard. These are due to too low selectivity. If the tuner rejected the interfering carrier the beat whistle would not be heard.

Stability at Audio Frequencies

In audio circuits stability is just as important, indeed perhaps more important, for at r-f we may use a manual control, but at a-f we have no control. Therefore to get rid of instability, such as motorboating, high-pitched continuous whistle, blasting or other forms of oscillation (for that is what they are), the positive feedback should be removed.

If an audio channel is unstable it is heaping on added cause of the same kind of trouble to use large bypass condensers across individual biasing resistors, so reduce these values to r-f proportions, say, not more than 0.1 mfd. That applies to the condenser across the detector biasing resistor as well, as the detector handles audio frequencies, hence must be rated as an audio tube. In circuits other than detector the condenser may be omitted entirely.

Also, filter circuits should be included. One for each stage is advisable, and may be in the grid circuit, but if the audio is high gain, then two in each stage, one in the grid, the other in the plate circuit, should be used. An exception exists in the case of single stage audio, where one filter, in the power tube grid circuit, suffices.

Leaving the resistors in the amplifier as you find them, values for filtering may be from 0.02 meg. up, and the condenser from 0.1 mfd. up. The condenser is connected from the joint of the two resistors to ground.

Substitutes for Very High Capacity

These filters are anti-feedback devices and should be used in unstable audio circuits. If not needed of course do not include them. Sometimes the filters will improve a bad condition, but not cure it entirely. Resort to omission of condensers from biasing resistors is next tried, and if even that fails, the grid leak values are decreased. Try decreasing the value of any one grid leak in the audio circuit. Since the amplifier may be considered as a unit impedance, it is not necessary to make reduction in more than one grid circuit. However, if you haven't low enough values to stop the trouble, then lesser reduction effected in each of the audio grid ciruit should be tried.

It is assumed that the filter condenser across the end of the rectifier, the set's maximum B plus, has a 8 mfd. or higher capacity from that point to ground, and a large capacity helps get rid of instability in the high or medium-pitched frequency region. Such a condenser for elimination of low frequency oscillation is of no use. The capacity to be effective on the very low frequencies would have to be of the order of a 100 mfd., and the alternative recommendations are more practical.

(*Continued on page* 18)

The Economical Converter

Coil Data, Other Constants, and Connections

By Henry B. Herman

LIST OF PARTS

Coils

Two coils, one for modulator, one for oscillator; two windings on each; secondaries tapped.
One 300 turn honeycomb coil.
One 20 volt transformer.
One 15 henry B supply choke coil.

Condensers

Two 0.00035 mfd. tuning condensers.
Three 0.00025 mfd. fixed condensers (one with grid clips).
Two 8 mfd. condensers, with mounting nut and lug for each.
One equalizer, 20-100 mmfd.
One 0.0015 mfd. fixed condenser.

Resistors

One 5 meg. grid leak.
One 1,200 ohm fixed resistor.

Miscellaneous Parts and Accessories

One a-c cable and male plug.
Three leads for external connection (ant., gnd., output).
One 10x8x3 inch cabinet.
One a-c toggle switch.
Hardware: two dozen 6/32 machine screws, two dozen nuts, two dozen screws; one machine screw 2 inches long; two threaded bushings for mounting coils on socket screw; two right angle brackets for coils.
Two flexible leads, tipped at both extremes.
Two dials.

EXCELLENT results have been obtained by users of the short wave converter described in the August 29th and December 12th issues, there being a little constructional difference between the two, but no performance difference.

Besides, there was an error in the previously printed pictorial, having to do with the grid leak-condenser position, and the accidental grounding of the modulator grid lead. The diagram was correct schematically in both instances, but wrong pictorially in both instances, as Joseph Moynihan, of Mohawk, N. Y., kindly pointed out.

The coil data have been revised to apply strictly to the short waves, instead of some broadcast inclusion, and this application is good no matter what intermediate frequency is used. The frequency may be selected on the basis of sensitivity of your receiver. The data are: modulator coil, 15 turn primary, 1/16 inch space, 3 turns and tap, six turns more and tap, 16 turns more and stop; oscillator coil, 20 turn tickler, 1/8 inch separation, 8 turns and tap, 3 turns more and tap, six turns more and tap, 12 turns more and stop. The totals of secondaries are 25 turns (modulator) and 21 turns (oscillator). The wire is No. 28 enamel. The 8 turns on the oscillator are not part of the secondary, as the eighth-turn tap is grounded, but constitute the pickup coil, associating the modulator through its cathode with the oscillator through its grid. The diameter is 1.75 inches.

Only three connections need be made externally, these with wire outleads: one the connection to converter of aerial removed from set, another the connection to ground post of the set where ground is left intact, and the third, output of converter to vacated antenna post of set.

The operation of the converter is to select some intermediate frequency that is clear of direct broadcast pickup, after converter and set are turned on, and to leave the modulator dial (at left in top view) at minimum capacity, plates unmeshed. Then use the oscillator to pick up a strong station. Then turn the modulator dial until the station comes in loudest. Then use different intermediate frequencies of the set, leaving the modulator dial untouched, but always changing the oscillator setting to keep up with the change in the setting of the receiver dial. Use the same loud signal, compare results, and your ear will disclose what the best intermediate frequency is for your set, or at least whether nearer one or the other end or middle of the set dial. Often there is no difference in intensity over a quarter of the set dial, but nearly always a distinct difference between the two extreme settings, usually the higher frequency setting of the receiver giving much keener response. Then always use the same intermediate frequency and calibrate the converter dial settings for the three inductive values.

(*Continued on page* 18)

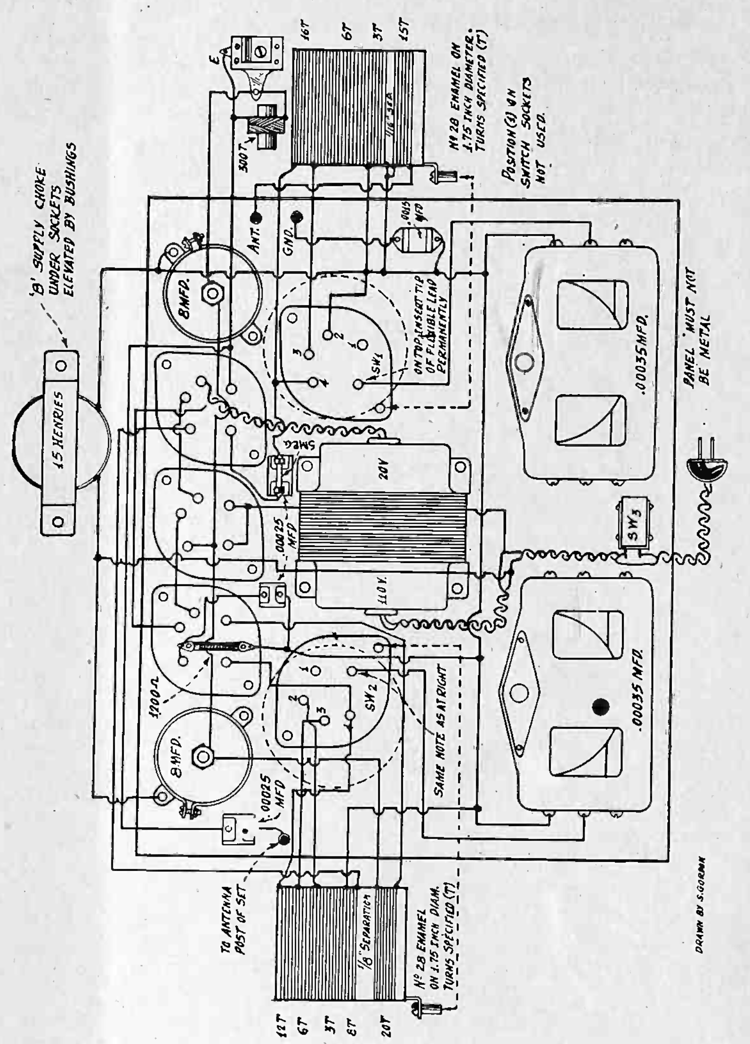


FIG. 1

Pictorial diagram of an extremely economical short wave converter that is an excellent performer. The schematic diagram is printed below.

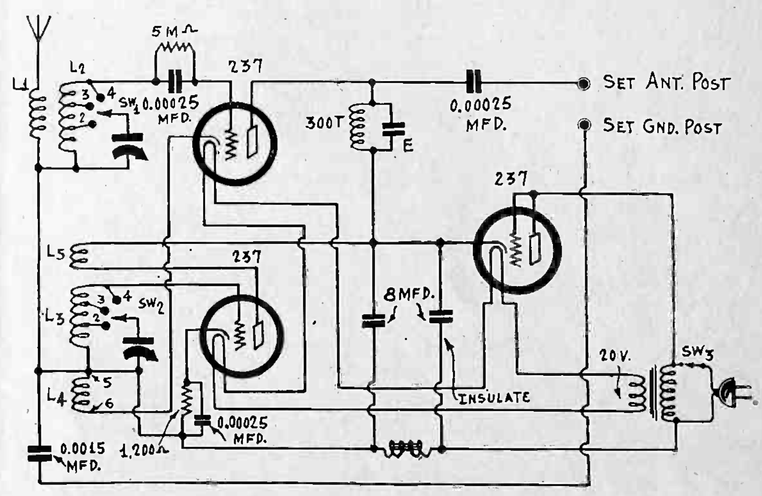


FIG. 2

The schematic diagram shows the connections at a glance, while the pictorial diagram (Fig. 1.) gives the physical layout and wiring, too. The output equalizing condenser is set at minimum for a high intermediate frequency and turned down with a screwdriver for tuning to a lower frequency. Once set it is left thus.

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Universal Converter

WILL you please supply a hookup for a short wave converter that can be attached to a Kolster K-21 set?—D. J. MacD., Chicago, Ill.

The converter diagrammed on page 15 of this issue will serve your purpose. This converter works with any receiver.

* * *

B Power From Radiola Unit

KINDLY give details for connecting the converter described in the December 12th (1931) issue to a Radiola 28, with 104 loudspeaker and UP-972 a-c package. Can the voltages supplied in the 104 unit be used on a short wave set or a converter of any type?—J. R. McL., Sheraden, Pittsburgh, Pa.

The converter described in the December 12th issue, and concerning which further data will be found in the present issue, page 15, does not require any external B voltage, for it supplies all its own power. However, if you desire to revamp the converter circuit yourself, as your question seems to suggest, to obtain only the B voltage externally, connect ground of converter to ground of your set, and connect the B plus lead of the converter to the 90 volt post on the terminal strip of the power unit (attached to the 104 speaker). This lead is the third one from the right, next to the two posts marked "field."

* * *

Improvement of T-R-F

I AM still using a 1926 Diamond of the Air, with some changes. The first tuned radio frequency stage has a 235 tube, the second stage of r-f is resistance coupled, also 235, while there is a tuned input to the 227 detector. The first audio is resistance coupled 224, second audio 227, with 245 a-c output. I have never seen anything in print using such an r-f channel. I incorporated this combination so that I could work a converter, and have had good success. The last converter was taken from Blueprint 628-B. This one works the best of the several converters I have made. Have I the right combination on the two stages of r-f? Can you suggest a better combination? Should I change over to three tuned circuits for more sensitivity and selectivity? Or could I get more out of a set similar to that of Blueprint 627? I have been a reader of RADIO WORLD for almost 10 years and experiment quite a lot, especially with resistance coupling.—C. C. W., Loomis, Calif.

The sensitivity and selectivity can be improved considerably if you will substitute a tuned stage for the resistance coupled r-f stage. As a rule, resistance coupled r-f amplification is of little use, because there is amplification without selection, and besides the amplification does not begin to compare with that obtainable from a tuned stage. Since you have a set in working condition, and need make only a small change to improve it considerably, we suggest you economize by replacing the resistance coupled stage, as recommended, rather than build an entirely new set. The 627 that you inquire about is a most remarkable set, considering that it has a total of only five tubes, including rectifier. You showed ingenuity in using the 628-B Blueprint, which is for a six-tube all-wave set, for a converter. You will find that with the recommended tuned stage you will get much better results from all converters. To get high class results it is advisable to have a set that has a sensitivity of at least 25 microvolts per meter, which your set probably will have when the recommended improvement is made. Of course, the coils must be shielded and the shields grounded if you want to avoid oscillation trouble.

* * *

Building a Converter

PLEASE recommend me a suitable hookup for a short wave converter. I have five Pilot coils, three windings each, one seven plate condenser, one 27 plate midget condenser, and a 5 plate midget. Also I have a number of fixed condensers and grid leaks.—G. D., Somerset, Mass.

You can build a converter with two tuned circuits. Evidently the 27 plate midget is a Hammarlund midline junior, and its capacity then would be 0.0002 mfd., which is suitable. You could use the large condenser in the modulator circuit, putting in series with it a 0.00025 mfd. fixed condenser, to make the actual capacity only a little more than that of the 0.0002 mfd., assuming the large one is 0.005 mfd. As for the coils, since no information is given about them, with separate tuning of each condenser, one pair of coils could have 30 turn secondaries, the next pair 12 turn secondaries, enough tickler winding on the oscillator coil to afford oscillation all over at all settings, usually requiring about half as many tickler as secondary turns. The general hookup of the converter descrbed in this issue may be followed, as that circuit is fundamentally very sound, affords fine results for the number of tubes used, is economical and has proven a good means of getting distance.

* * *

Coil Connections for 627 Blueprint

IN building the 627 circuit, five tubes, a-c operated, t-r-f, I have not been able to get results. I checked the wiring and it is as diagrammed. The coils I got from Roland Radio Co. have a lug soldered to the shield base. The bottom of the base is marked: ground symbol, G, P and B. I get a continuity click through all windings. What is the voltage from plate to maximum B plus? I also got 15 plate condensers and are these O.K.? Is it all right to displace a coil with a socket to provide more room? Please define B minus connections.—A. L., Philadelphia, Pa.

The coils have the secondary return grounded to the shield, so no connection is to be made to any lug for ground, save end of antenna primary, since the chassis and shields are grounded. P goes to plate and B to B plus, except of course for the coil used in the antenna circuit, when P goes to aerial and B to ground. Connect G of coils to tuning condenser stators, and do not make any connection to the lug represented by the ground symbol, unless you want to tune higher than the highest broadcast frequency, when a switch would slide the stator connection from G to ground symbol. However, make the coil connections as previously directed, at first, disregarding switching, and then you will get results. Your present connections (shown in diagram with letter) short out nearly all the secondary. It is all right to move the coil to a position the diagram shows occupied by a socket. The maximum B plus to plate return of tubes should show a potential difference of about 50 volts. B minus to K of speaker socket goes to the can side of the electrolytic condenser. Both condenser caps are joined to B plus maximum. The 15 plate condensers are all right as supplied by this company.

* * *

Coils and Audio

LOOKING over a list I was interested in coils. I would like to get a set of five shielded coils, to use with gang tuning, trimmers manually operated from the front panel. This is a Silver Marshall Sargent-Raymont, remodelled for a-c tubes. I desire to try other coils and shields. Please let me know what to use. Also, the tone has changed in my set to a marked degree. The sounds are muffled or forced, and are of higher pitch. It sounds as if something is holding the sound back. Previously I could have heard a pin drop. I suspect the audio amplifier, as I tried grid leak detection, thinking poor detection was the cause. Also, the hum I used to get, due to high gain audio, is absent. I am using a Wright-De Coster dynamic speaker, Model 107, which is sensititve and realistic, so, again, I suspect the audio amplifier—J. W. W., Mt. Vernon, N. Y.

You may use standard 0.00035 mfd. coils, except that the primaries will be too large for several t-r-f stages, and will have to be cut down, which can be done easily, by removing turns. Use the coils as you get them. Of course there will be oscillation. Then remove primary turns, say, five turns on each coil at first, then two turns at a time, until this disappears. Normally the primaries have 25 turns, or thereabouts. Such a set as you have will get along better on 15 turns or thereabouts. You should use variable mu tubes. We are sending you data on coils, or you may follow the instructions in the December 12th (1931) issue for winding them. The sound trouble in your set seems to be, as you suggest, in the audio channel. An open grid return or winding is a likely guess. Test the plate and grid impedances for continuity, and biasing resistors for opens and shorts. The higher pitch is due to the suppression of the low notes, which would take place if the grid impedances were open. Also, as a precaution, test your speaker. Try coupling detector to the output audio stage, for if the trouble is in preliminary audio you will define it that way. Check up all voltages and performance of tubes.

* * *

Push-Pull Amplifier

COMPLETE parts are on hand for a double push-pull power amplifier and would like to build as follows: first stage resistance coupled, using a 224; second stage, 224 push-pull; output 247 push-pull. Please give me a criticism of this proposal.—W. D., Herrin, Ill.

The second audio stage should be transformer coupled, as there is no satisfactory resistance coupled push-pull method generally avail-

able, and 224 tubes can not well be used with a transformer, so also put in two 227 tubes as the second stage. The rest can be as you suggest.

* * *

Horn Speaker for 627

HAVING followed the Blueprint 627, five tube a-c t-r-f set, I have the set complete, except that have no dynamic speaker with field coil etc. and would like to use a horn type speaker of 700 ohms d-c resistance or thereabouts. Please tell me what connections to make.—A. Z., New York, N. Y.

You should use a dynamic speaker with the field coil tapped as prescribed, for best results. However, if you must press your horn speaker into service, connect a B supply choke coil from either filament of the 280 rectifier to the B plus prong of the speaker socket, and connect the two 8 mfd., one from rectifier filament to ground, the other from the opposite terminal of the B choke to ground, and put a 400 ohm resistor from center of the 2.5 volt filament to ground, connecting the grid return of the pentode to ground also. The B choke connections may be made to the speaker socket by using the two H terminals for connecting the B choke, one terminal of choke to one prong, other terminal to other prong. Then the positive B after choke prong and cathode prong may be joined, and cathode and grid prongs used for the horn speaker connections.

* * *

Resistor a Filter Choke Substitute

HAVING started to build a midget set, one of three published in the September 5th (1931) issue, I would like to know whether I can substitute a resistor for the filter chokes in the B supply, and if so of what wattage rating? I also would like to know the ratio of the pentode output transformer.—A. B., Oakland, Calif.

The proposed substitution can not be made, because a resistor does not provide any filtration in this position. The ratio of the transformer depends on the impedance of the voice coil of the dynamic speaker. Some pentode output transformrs, to work into 15 ohm voice coils, have a ratio of 45-to-1.

* * *

Coil Data in Converter

WILL you please express a preference as between the converters described in the October 10th and 17th (1931) issues? I have nearly all the parts for either one. Please give coil data. I have 32 double silk and 18 enamel wire.—G. S. G., Monroe, N. Y.

The converter shown in this week's issue is superior to those. If two dials are used for independent tuning of the two circuits, as suggested. a wider scope is permissible, because any intermediate frequency then may be used. For 0.00035 mfd. condensers, 1.25 inch diameter tubing, the largest secondary may consist of 32 turns of No. 30 double silk covered wire, for the modulator, and 25 turns for oscillator. The modulator primary may consist of 12 turns, the oscillator pick up coil of 8 turns, the plate winding of 15 to 20 turns. The ratio of frequency is about 3-to-1 for 0.00035 mfd. condensers, so the secondaries for succeeding coils would have one-third the number of turns of the preceding coil, all secondaries equal for these, while primary maintains 1-to-4 ratio and tickler has one-half the number of turns on the secondaries. You may use the No. 18 enamel wire for the smallest coil, antenna primary and two secondaries, with the smaller wire for the plate and pickup windings.

* * *

Patient About Monitor Set

MY sincerest wishes that the laboratory type monitor set you are working on will prove a success, as I would like something for wide frequency coverage that really would perform extraordinarily well. The 15-2,000 meter possibility is alluring, and I don't mind the four separate dials of this t-r-f set a bit. The circuit will appeal to DX fans who really want results. I am saving all copies of RADIO WORLD containing articles concerning this circuit, and desire to know if you have any literature you can send now that contains information not already published. I am patient about waiting, as I agree that the thing to do is to take time and get the circuit just right. I am going to start building this circuit just as soon as you say the word go. Will you spread the amateur bands on your machine? You should provide for television, too.—C.R.G., Wellington, Kan.

Work is going along steadily on the monitor receiver, which consists of three stages of t-r-f, tuned detector input, two stages of resistance coupled audio, with 247 output, and a B supply with 280 rectifier, total, seven tubes. At first 0.000325 mfd. condensers were used, and it was intended to let them cover almost all the broadcast band, for the first coils, and from 250 meters to about 85 meters for the next band. The broadcast coverage was all right, but the first short wave band found the stations too crowded, and tuning too difficult, as there is a separate dial for each tuned stage. Series capacities were to be cut in for the lower waves. But since then it has been decided to split up the broadcast band, using smaller capacity, and have the same capacity obtain for all waves, probably 0.00015 mfd. The set was tried with 0.000325 mfd. on television, but it was too difficult to "find" the stations, except those that came in strongly. The smaller capacities will cure this, and also afford adequate amateur band coverage without crowding. Band spanning for amateur use is not intended, but individually it may be achieved by using band spanning coils with parallel condensers in them, a topic that probably will be treated when the constructional articles finally are printed. The advisability of making the set a little wider, so that larger diameter shields may be used, has become apparent, also. Vernier dials are a requisite. There is no literature available, and about all the information to be imparted has been prnted in articles in RADIO WORLD, or in the University Department. It was expressly stated the circuit is not ready for general construction, but, as said previously, when these data are ready they will be publishd. So watch RADIO WORLD from week to week. The articles were published in the October 24th, October 31st, November 7th and December 5th (1931) issues. The circuit was inspired by the similar monitor receiver used at the Grand Island frequency monitoring station of the Radio Division of the Department of Commerce, which, however, is battery operated, and really includes two receivers, one with four stages of t-r-f, the other with three stages, but we are confining ourselves to a single receiver to cover the same band, and also are utilizing a-c operation.

* * *

Dynatron Converter

THE October 24th (1931) issue contains a short wave converter for which I wish you would give me the coil data.—D.N., Los Angeles, Calif.

This convrter had two separately tuned circuits, one the modulator, the other the oscillator, and was intended for 0.00035 mfd. tuning. The oscillator was padded for the first or longest wave band. The dynatron oscillator was included. L3, modulator, may consist of 32 turns of No. 28 enamel wire on 1.25 inch diameter, L5, the companion largest coil, oscillator, 20 turns of No. 28 enamel wire, L2 and L5 have 11 turns of No. 18 enamel or other covered wire, and L1 and L4 have 4 turns of No. 18 wire.

* * *

Midgets Inconsistent

SOME midgets sets I have with choke primaries do not perform the same. Some are sensitive, others not. I have a five converter but the 227 rectifiers burn out.—R.W.E., Cleveland, O.

Suggest you use an interstage coil for antenna coupler in the midgets. Use this as the antenna coupler instead of the choke primary coil in the weak sets. Improvement should be considerable, as choke primaries detune at one end if peaked at other, or detune at both ends if peaked at middle frequency. Put a 500 or 600 ohm resistor in parallel with the limiting resistor in the r-f cathode leg or substitute 300 ohms for resistor now there. Defectve 8 mfd. would cause the converter trouble. Measure the current through the 8 mfd. If plus 2 ma steady, after starting, that's your trouble. Otherwise too low bias on other tubes, or a defect in those tubes, would cause the same trouble.

* * *

Picture "Shimmies"

AT present I am operating a television receiver, disc and motor that cause the pictures to "shimmy." Previously there was no such trouble. I inspected everything and I can find no cause for the trouble. Please suggest a remedy.—W.R., New York, N. Y.

Inspect the neon lamp socket support. You may find that is a screw that fits into a threaded hole below. The screw permits adjusting the height of the lamp so that the illumination is in the plane of the scanned area. This screw needs a locknut. As soon as you tighten down the support the lamp will not wobble and the shimmying effect will disappear.

* * *

Projected Pictures

IN establishing projected television, is it necessary to have a lens disc, and also a projecting lens, and may I use my present neon lamp, which has 1 inch plates?—H.U.D., Chicago, Ill.

Projected television requires a high powered neon lamp, e.g., a crater lamp, also a lens disc, and a viewing screen a few feet from the disc. The lenses on the disc, one len at each hole, suffice for home use. No extra lens for projection is necessary. Your lamp will not do.

* * *

Not Enough Picture Strength

MY neon lamp does not give what I consider sufficient brilliance. Also, the pentode output tube of the short wave receiver gets red hot when I switch to television, although there is no such trouble when I tune in the television signals by sound. Please rush remedy, as I am afraid I will burn out the 247.—N.I.P., Fargo, N. D.

To give better picture strength, put a limiting resistor in series with the neon lamp, 10,000 ohms, 2 watts. This reduces the d-c flowing in the lamp, the no-signal brillance of the lamp is less, while the signal brilliance is comparatively greater. The situation obtains because the lamp is a current operated device, and a given amount of variation produced by the signal becomes a larger percentage of the total illumination when the no-signal illumination is kept low.

(Continued on next page)

Radio University

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

Annual subscriptions are accepted at $6 for 52 numbers, with the privilege of obtaining answers to radio questions for the period of the subscription, but not if any other premium is obtained with the subscription.

(*Continued from preceding page*)

Hence the remedy provdes what might be termed better picture strngth. The pentode gets red hot because the screen voltage is 250 volts when the effective plate voltage (due to the resistance of the lamp dropping some 200 volts) is only 50 volts. Put a 10,000 to 25,000 ohm 2 watt rsistor in series with the pentode screen and leave it there for aural or visual reception. Please state what television stations you tune in at Fargo. as we are at a loss to tell how you get television results over long distances.

* * *

Too Selective for Television

MY set consists of two stages of t-r-f, with skinny primaries, and a tuned detector input, regeneration being used in the detector. My dials are separate. Regeneration does not seem to do any harm except at spillover. When I try to tune for television it must always be by sound, for I can not tune sharply enough otherwise. Then, too, when I switch from sound to vision I have to retune.—H.E., Brooklyn, N.Y.

Increase the number of primary turns. The set then will tune more broadly, as it should, for television is better served by a lower order of selectivity than you have. Regeneration does not do any harm, unless overdone, that is, unless the tube breaks into oscillation. When the set is oscillating regular patterns are readable on the screen, as you know, and may appear as wavy lines, and will change form and intensity as the degree of oscillation or frequency is varied slightly. The ruinous effect of regeneration on detail seems to be mostly theoretical at the present state of picture definition at the receiving end. Tuning by sound is almost imperative, at least until you have the television stations calibrated, and even then you have to produce lght somewhere, to read the dials, as you are looking in amid darkness. The necessity for retuning arises from the change in voltages introduced when the power tube load is changed. Remember that the d-c in the B supply drops about 25 ma when the neon lamp is switched to replace the speaker. The retuning is not a hardship. Some volume controls, as in cathode leads of r-f tubes, also detune slightly.

* * *

Tin Shields

I READ something by Herman Bernard in the December 12th (1931) issue on coils that I would like to ask about. In fact, I have seen the same admonition by scores of writers and engineers on the same thing. And that is the practice of using tin or any other material containing iron for shielding against radio frequency currents. Although I have never quite understood just the reason for this caution, I want to speak of a case right here in my own city that is beginning to make me lose faith in this theory. I have a friend here who built a ten-tube super-heterodyne, and for shields on his r-f coils and i-f transformers, he went to the local canning factory and obtained some new unused tomato cans, and after polishing them up nicely put them over all the coils. They absolutely killed all oscillations that were present beforehand, and stabilized the whole set as well as I have ever seen copper shields do. And with no more loss in volume than any other shield. Now, mind you, these cans are pure tin, and this is an actual case, no theory, so what is the reason for cautioning builders not to use tin or iron metals for r-f shielding, as I cannot see any difference, unless it might be a loss which is greater than copper, which in this case the ten tube gain took care of?—H. J. R., Mason City, Iowa.

Theoretically, the best shielding material is the best conducting material. Thus silver comes first, copper second, and perhaps aluminum third. The lower the loss in the material the better does the metal reflect the waves without loss. There will be a decrease in the inductance when a shield of such material is put over a coil, but there should not be a great loss in effectiveness if the coil is retuned. There will be some loss because there will be some current in the shielding. But conductivity alone is not the determining factor in the shielding property of the material. The permeability also enters. The greater the permeability the greater the shielding effect, and aa tin can is made mostly of iron which has a high permeability. At low frequencies the permeability of iron such as used in tin cans may be a 1,000 or more times greater than the permeability of silver or copper, for which it is unity. Even at radio frequencies the permeability is considerably higher for iron than for the best conductors. We should expect to find tin cans highly efficient as shields at radio frequencies as well as at audio frequencies. The losses would undoubtedly be somewhat greater in the tin can than in cans made of better conducting metals, but in a ten tube superheterodyne there is so much amplification that much can be thrown away in the interest of stability.

Stabilizing Audio by Filters and Leak Values

(*Continued from page* 14)

No fear need be felt about frequency discrimination when leak values are lowered, biasing resistor condensers omitted or reduced in capacity, or resistor-capacity filters inserted, as the instability is itself proof positive of discrimination of a high order, and the remedies are really for the elimination of discrimination. Theoretical considerations of stopping condenser values as compared to grid leak values, also bypass capacities requisite for avoiding negative feedback in biasing resistors, and other such ideas, while mathematically sound, are computations made without regard to the presence of audio regeneration, much less the excessive amount that causes the trouble. Regeneration is there aplenty, and enough of it should be removed to insure stability. If it were not for regeneration, resistance coupled amplifiers would not produce the gain they do, which is approximately the mu-factor of the tubes used.

In the detector circuit sometimes the enlargement of the plate resistor is necessary even until the value of 1 meg. or more is reached, so that stability will be certain. The reason is, the higher this resistance, the less feedback through the detector. The increased value of the plate load sometimes will require increasing the value of the biasing resistor, for the current has been lowered, and the bias, too, unless the value of the biasing resistor is increased. If the 224 tube is used as detector, the applied plate voltage, the maximum of the B supply (say, not more than 275 voltes), the screen voltage 45 volts, then the negative bias should be around 5 volts, but if the screen voltage is lifted to 90 volts (whereby the r-f screen voltage is applied also to the detector), then the negative bias may be lifted to 7.5 volts, or even more, good detection having been enjoyed on as high as 9 volts negative bias under these conditions. Since the biasing voltage can not be measured with ordinary instruments, it is well to measure the current when the resistor is about 50,000 ohms in the biasing circuit. The current will be about 0.2 milliampere and will chahge very slightly as the bias is proportioned correctly, so the resistor may be selected on the basis of the previously ascertained current.

Universal Auto Set; How to Test for Ground

(*Continued from page* 13)

no spark. That is the grounded one. The polarity of the battery is marked, sometimes with "POS" for the positive and sometimes this terminal is simply painted red. If there is no distinguishing mark, a voltmeter will tell which is plus and which is minus.

Incidentally, the circuit in Fig. 1 is a complete receiver and the diagram may be used for building a set. All the necessary values of condensers and resistances are given, except those of the tuning condenser and coils. It is customary to use a gang of three 0.00035 mfd. condensers for tuning and coils to match. These are standard values.

As the pick-up in a car is minute, it is absolutely necessary to have a high gain in the receiver. Selectivity is not as important a factor as it is in a receiver intended for home use. Hence it is permissible, in fact almost necessary, to design the circuit so as to achieve sensitivity even if selectivity must be sacrificed. This simply means that the coils used should have high impedance primaries. In the circuit shown, as many as 100 turns, closely coupled to the secondary, have been used successfully when the secondary had about 140 turns. t is admitted that the selectivity is not of the best with this combination but it is ample to separate all local stations from each other. And when the car is used out in the country remote from all stations, even better separation is possible.

Blank Post Useful if Condenser is Small

(*Continued from page* 15)

The converter not only is a good one but it is extremely easy to build and costs only a little. You can wind the coils yourself or obtain them commercially. The converter will work on any type of receiver, including superheterodynes. The wave band shifting is done by moving the stator connections of the tuning condensers from extreme to one tap or another, only two intermediate taps being needed for 0.00035 mfd. condensers to cover from 200 to 15 meters. The coil data locate these taps accurately. The condenser grids are brought to a socket post. On top the panel a flexible lead is inserted permanently to this post, then moved to any of the three coil positions—one of the two taps or one extreme. One switch socket post is blank, not being needed. It may be used if smaller capacity condensers are in service, such as 0.0002, 0.00015 or 0.00015 mfd., for then three intermediate taps are necessary, smaller condensers having a smaller frequency range for a given inductance.

REVISED CODE PROPOSED BY RADIO BOARD

Washington.

Secrecy regarding a proposed new code for the Federal Radio Commission was dispelled when the details were made public by the Commission simultaneous with transmission to Congress of proposed legislation.

The Board proposes:

Station license limitation to one year, instead of three years.

A strong anti-lottery law.

Right to suspend station licenses for 30 days as a milder preventive measure than cancellation.

1600-1700 kc band for television instead of 2850-2950 kc band, sound track on 1550 kc.

Station License Time Limit

Concerning the license time limitation the Board asks the following be enacted:

"No license granted for the operation of a radio station shall be for a longer term than one year, and any license granted may be revoked as hereinafter provided. Upon the expiration of any license, upon application therefor, a renewal of such license may be granted from time to time for a term not to exceed one year, but action of the Commission with reference to the granting of such application shall be limited to and governed by the same considerations and practice which affect the granting of original applications."

Anti-Lottery Provision

In the provision against lotteries the following is the language:

"No person shall broadcast by means of any radio broadcast station for which a license is required by law of the United States, any information concerning any lottery, gift enterprise, or similar scheme, offering prizes dependent in whole or in part upon lot or chance, or any information concerning any ticket, certificate or instrument representing any chance, share or interest in or dependent upon the event of any lottery, gift enterprise or similar scheme offering prizes dependent in whole or in part upon lot or chance. or any list of prizes or information concerning any list of prizes awarded by means of any such scheme, and any person so doing, upon conviction thereof, shall be fined not more than $1,000 or imprisoned not more than one year, or both."

New Rule for Records

Phonograph records, call letter announcements, and quota distribution also are covered.

Regulations relating to announcements of transcription and phonograph broadcasts, now General Order 78, will specify only that language describing such production be "clear:"

"A mechanical reproduction shall be announced as such just before it is broadcast, except when its use is merely incidental, as for an identification or background. The exact form of announcement is not prescribed, but the language shall be clear and in terms commonly used and understood. The following are examples of statements sufficient for the purpose:

"(a) 'This is a mechanical reproduction.'

"(b) 'This is a player-piano record.'"

Call Letter Announcements

Call letter announcements, now required every 15 minutes under General Order 8, may be announced at least every 30 minutes:

"Each license of a broadcast station shall announce the call letters and location as frequently as practicable during the hours of operation, and in any event before or after each program being broadcast. In no event shall more than 30 minutes elapse between such announcements, and in so far as practicable these announcements shall be made on the hour and half hour. These requirements are waived when such announcements would interrupt a single consecutive speech; and in such cases the announcement of the call letters and location shall be made as soon as possible."

Quota Under Radio Law

General Order 102, concerning quota distribution, was revised so where no interference might result, slight deviation from the rigid mathematical formula determining quota will be permitted.

The second part of the new regulations concerns practices and procedure before the Commission. Parties to proceedings before the Commission may appear personally or through attorneys, so long as the persons who appear conform to ethical standards of legal conduct.

When such action is considered by the Commission to be in public interest, properly filed applications may be granted without hearing, on a conditional 20-day basis. If any party is aggrieved, a hearing may be called for upon application filed with the Commission within 20 days after the decision. Such applications must contain a statement of the applicant's interest in the decision, and a sworn objection to facts presented in the Commission's decision.

Hoover Spoke 29 Times, Record

Washington.

Five hundred and fifteen broadcasting hours were utilized by the United States Government over the networks of the National Broadcasting Company during 1931, M. H. Aylesworth, President of the Company, reported.

The report disclosed that 329 government officials spoke over the radio, making a total of 720 addresses. Virtually every day during 1931 some activity of the Federal Government was discussed over the network.

President Hoover, the report showed, spoke 29 times, which is the greatest number of times any President has been heard over the radio in one year; Vice-President Curtis made three radio speeches; the Chief Justice, Charles Evans Hughes, spoke five times.

Every member of the cabinet faced the microphone at least once during the year.

2 TELEVISION BAND CHANGES IN NEW RULES

The "broadcast day," now specified as 12 hours, under General Order 105, for unlimited time stations, is amended to include half-time stations, and other classes of stations, pointing out that every station must operate at least two-thirds of the total time allotted to it for a broadcast day, with the exception of Sunday. Violation of this rule will lead to time reduction of the violating station.

The frequency of 1,550 kilocycles, just above the broadcast limit, is designated as the visual broadcast sound-track. This will enable ordinary sound-receivers to pick up sound accompaniments to television broadcasts, without addition of any shortwave unit. The sound-track was formerly designated as 1,604 kilocycles.

Television Revision

Replacing the 2,850-2,950 kilocycle experimental television band, the Commission specifies the band between 1,600 and 1,700 kilocycles, formerly assigned to aviation. This affects only one of four bands, the others (intact) being 2,000-2,100, 2,100-2,200, and 2,750 to 2,850. W9XR, Chicago; W1XAV, Boston; W2XCP are on 2,850-2,950. The ultra frequencies are not affected.

The Commission deleted General Order 56, regarding visual broadcasting regulations, and substituted the following provisions in the regulations:

"The licensee of an experimental visual broadcast station shall not permit the transmission of programs involving advertising features. This regulation, however, shall not be construed to prevent the transmission of a visual broadcast program simultaneously with a regular broadcast station program having commercial aspects, provided that commercial announcements, either oral or visual, shall not be made on the visual broadcast frequency. In all such simultaneous transmissions from a broadcast station in the band 550 to 1,500 kilocycles and from a visual broadcast station in the band assigned to visual broadcasting, the regular broadcast station shall make the regular commercial announcement only on the broadcast frequency.

Language Specified

"Both stations shall make the announcements of call letters for both the broadcast station and the visual broadcast station on their respectively frequencies; provided that when commercial announcements are made on the broadcast frequency, and the use of the visual broadcast frequency is referred to, the following form of announcement only shall be used:

"This program is being broadcast by television over station ——— on the frequency of .... kilocycles. These visual broadcast transmissions are experimental."

A THOUGHT FOR THE WEEK

THE field of journalism is now furnishing a good proportion of our important and edifying air programs. One of the latest recruits from reportorial and literary ranks is Ada Patterson, whose signature as a "by line" has been attached many hundreds of times to her various contributions to newspapers and magazines. During her brilliant years of service in journalism Miss Patterson has interviewed many of the leaders of the stage, music, politics and science; and it is natural that her program each Wednesday at 4:15 P. M. over WMCA should be entitled "Interesting People I Have Met." Miss Patterson, besides knowing her work well and loving it, has the human touch that makes everything she does stand out while sounding the note of authority. Her training has been long, her observations intelligent and her results gratifying to those who know, admire and esteem her as a clever woman and a conscientious artiste.

RADIO WORLD
Trade Mark Reg. U. S. Pat. Off.
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Tenth Year

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Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager; J. E. Anderson, technical editor; J. Murray Barron, advertising manager.

Hawaii-U. S. Phone Service

Direct radiophone connection between the American continent and the Territory of Hawaii was opened formally recently by Secretary Wilbur when he talked by radio from Washington with Governor Lawrence M. Judd of the Territory, in Honolulu, the connection having been made possible by the completion of a communication channel by the American Telephone and Telegraph Company.

Wires carry the voices from points on the American continent to San Francisco. Then short waves serve to connect San Francisco with Honolulu. From Washington to Honolulu the total distance is about 5,500 miles. The distance from Washington to San Francisco being about 3,000 miles and that from San Francisco to Honolulu being 2,500 miles.

Naval Radio Stations Shut

Washington.

The Federal Government closed down its naval radio stations at the Great Lakes Naval Training School, near Chicago, as a measure of economy, according to an announcement from the Navy Department. The equipment, however, will be kept in operating condition so that it may be used for communication with training vessels of the Naval Reserve Units during their Great Lakes cruises next summer. The Navy department also closed the radio stations at Savannah, Ga., and at St. Augustine, Fla., permanently.

WMAK Ordered to Quit

WMAK, Buffalo, N. Y., has been ordered off the air by the Federal Radio Commission. The station was operating on a frequency of 1,040 kc. with a power of 1,000 watts and was operated by the Buffalo Broadcasting Corporation.

The Buffalo area would receive adequate service without WMAK, the Commission stated in its decision. The Commission's action sustained Examiner Ralph Walker.

Station Sparks

By Alice Remsen

It Might Be Worse

(For Tony Wons, WABC, 9:30 A.M. every day except Sunday)

WHEN everything just seems all wrong,
And you're as blue as blue can be,
Because you own an empty purse,
Just grin and say "It might be worse."
You might have fallen down the stairs,
Or tripped on a banana peel,
Instead of just an empty purse,
It might have been a whole lot worse.
Just think that if you owned a yacht,
You might be drowned far out at sea;
Compared with that an empty purse
Assuredly is "Not so worse!"

A. R.

* * *

And Don't Forget—If you're feeling blue or sore at the world because hard luck pursues you, tune in on Tony Wons and his scrapbook some morning. He'll probably give you a little touch of philosophy that will make you feel better.

* * *

Nat Shilkret, with his thirty-six piece orchestra, and Alex Gray, musical comedy baritone, as soloist, comprise the show for the new Chesterfield account on WABC. Baritones are becoming more fashionable than tenors. They sound softer over the "mike" and seldom go off key. The new program is scheduled to open on Monday, January 4, at 10:00 p.m. and will be heard every night except Sunday at that period.

* * *

At Last Jack Foster, the most popular of New York's daily radio columnists, has succumbed to the lure of radio's beckoning hand. He will assist in the inauguration of a series of literary programs to be broadcast over an N. B. C.-WJZ network at 3:15 p.m., E. S. T., beginning Thursday, January 7th. Mr. Foster will introduce Thomas L. Stix, president of the Book League of America, who will outline and explain the purpose of the program. In subsequent broadcasts contemporary American literary figures will be interviewed.

* * *

May Singhi Breen has taken up the cause of the much maligned ukulele. The Musicians' Union refuses to recognize it as a genuine musical instrument. May will prove that it is, by playing several very difficult classical and jazz compositions upon her silver-fretted favorite ukulele before a group of Musicians' Union officials. Let's hope that May melts their adamantine hearts and wins her Union card.

* * *

Voice of Firestone has at last signed Lawrence Tibbett, for its Monday night broadcasts on the N.B.C.—WEAF network. It is the first time an active member of the Metropolitan Opera staff has been allowed to contract for a radio series. Tibbett will make his initial appearance in the series on January 4. By the way, I wonder what has happened to the original "Firestone Voice," Franklin Bauer. Heard its contralto, Vaughn de Leath, a few Sundays back on WOR, as guest artist on the Ludwig Baumann program. As usual, Vaughn did a very good job.

* * *

Paul Whiteman Will Present a symphonic jazz concert for a very worthy cause—a benefit for unemployed musicians at the Metropolitan Opera House, on Sunday night, February 28. Rudy Vallee will appear as guest conductor. Mark this date on your new calendar and try your best to be there.

* * *

Don Carney takes his talents over to an N.B.C.-WJC coast-to-coast network on Friday, January 1, when he opens on a new program series to be sponsored by the Chesebrough Manufacturing Company. The new series will be called "Friendship Town," portraying modern small-town life. Associated with Mr. Carney in the cast will be that fine actor, Edwin Whitney; Pick Malone and Pat Paget, well-known radio blackface comedians; Virginia Gardner, Edith Spencer and Harry Salter's orchestra.

* * *

New Year Greetings Will Be Heard from Germany and England over WABC on New Year's Eve. Between 6:00 and 6:20 p.m. chimes will be heard from the ancient German cathedral and university city of Heidelberg; a students' chorus will also sing a program of New Year music; then at 7:00 p.m. Big Ben, the famous clock atop the Houses of Parliament in London, will be heard striking the English midnight and ushering in the New Year.

* * *

Sidelights

CAROL DEIS, soprano on the N.B.C. Black and Gold program, is a native of Dayton, Ohio . . . RALPH KIRBERRY, N.B.C.'s Dream Singer, served in a tank corps during the World War . . . BOB CHILDE, of the Fireside Singers, holds the ping-pong championship of Detroit, Mich . . . WILLIAM S. RAINEY was once a tenor in the Metropolitan Opera Co. . . . ART JARRETT carries a lucky guitar pick . . . SINGIN' SAM is still playing vaudeville between broadcasts. . . . So is BING CROSBY . . . TED WEEMS once had John Coolidge as guest conductor, while he danced with the fiance of the Ex-President's son . . . The legal profession is well represented on radio—f'rinstance: CASEY JONES studied law; ART JARRETT and BING CROSBY both took legal courses; MILTON RETTENBERG was admitted to the bar of the State of New York; SCRAPPY LAMBERT is another graduate lawyer . . . NAT BRUSILOFF hails from Washington, D. C. . . . So does KATE SMITH . . . CARL FENTON'S first broadcast was in September, 1924, when his band was invited to furnish music at the welcome-home of the first round-the-world flight . . . MORTON DOWNEY is back at the Central Park Casino . . . BING CROSBY'S full name is Harry Lillis Crosby.

* * *

COMIC CUTS

The meek little man was telling Ted Weems about his trip to Europe: "And when you were in Rome," Ted inquired, "did you do as the Romans did?" "No," was the reply. "My wife was along. I did as she did."

* * *

Judging by the following, contributed by Little Jack Little, England radio listeners suffer as much as we do: A woman entered a butcher's shop with her small daughter. Some tripe was displayed on the counter and the little girl asked what it was. "Tripe, dear," replied her mother. "That's funny," said the child, "Daddy says that's what we get over the wireless."

SPLIT SECONDS MARK TIMING OF BIG CHAIN

Time is literally money in the broadcasting business, and its value is so great that it is checked to the split second several times daily.

There are ninety-seven clocks in the National Broadcasting studios and offices at 711 Fifth Avenue, New York, and each one gives exactly the same time as every other. They are set from the Naval Observatory clock in Arlington, Virginia, at noon and at 10 p. m.

And three times daily time signals are sent out by the N.B.C. to its associated stations across the country, so that synchronization of programs may be perfect not a second wasted.

In the broadcasting studios and control rooms clock-watching is a very important part of the day's work. Without it, network programs would be an impossibility.

How To Read Arlington Time

Arlington gets its time from the Naval experts who "shoot the sun" at frequent intervals. It is exact to a small fraction of a second. And Arlington sends out its signals by short-wave radio for five minutes twice daily, broadcasting the ticks of the clock.

The second-by-second time broadcast starts five minutes before the hour. The twenty-ninth second of each minute is eliminated so that the listening engineer is warned that thirty is next. From fifty-six to fifty-nine inclusive, the ticks again are eliminated to give warning that number sixty is next. The ten seconds immediately preceding the hour also are silent, and then the hour is sounded with a gong.

The same system of second-by-second clicks is used to send the signals to the N.B.C. associate stations, except that in this case, instead of short-wave radio, the Morse wires which link the stations are utilized.

Synchronization Essential

The ninety-seven clocks in the N.B.C. Building are checked from the master chronometer immediately after the Arlington signals are received, to guard against any possibility of variation.

The absolute synchronization of network units is essential, so that one program may not overlap another. For instance, a station in Chicago may be scheduled to pick up a network program starting at 9 p. m. in the N.B.C. studios in New York. Therefore the previous program must be off the air at exactly nine. The same accuracy is required in all the other eighty-four stations on N. B. C. networks.

In addition, time must be allowed for the local station announcements at stated intervals. The N.B.C. chimes are the cue for these. As the chimes end, each station switches off the network and the announcer gives the call letters. The stations remain off exactly fifteen seconds, and then switch back on to the national chain again.

Clocks Highly Accurate

Because of this operation by the second, each of the N.B.C. clocks is equipped with a large red second hand which circles the dial every minute. Variation, according to N.B.C. engineers, does not total more than five seconds in six months.

KALEIDOSCOPE

A searchlight radio loudspeaker can encompass an audience within a radius of three miles. Concentration to this unusual degree gives rise to a problem if its going to earn a living. The flock of listeners must be increased.

* * *

A receiver is a necessity, insists the National Association of Broadcasting, and might cite the charitable feature of orphan sets being adopted by so many families. A. B.

ODDITIES BARED IN STATION TEST

A survey has been made by N. W. Ayer & Son, Inc., a leading advertising agency, of the value of various stations as advertising media. Hyland L. Hodgson, in charge of the broadcasting division said:

"Primarily we wanted to know exactly where each station was heard and to what degree; that is, which was first preference, second, third and fourth. But we have also found out some of the vagaries of radio.

"There is a general belief that all radio is more effective at night than in the daytime. Yet we find some localities where Station A gives perfect broadcasts during the day but cannot be heard at night. Such is the report from a section in the West.

"In North Carolina we find that one section consistently listens in on a Florida station at certain times although there is a good station only 35 miles distant. Atmospheric conditions are said to be responsible.

"From a good territory in Oregon we hear that the best reception is from the South and that a Los Angeles station 1,200 miles away is more effective than another station only 200 miles away.

"In Montana there is a town which finds daylight reception impossible while still another reports that 'a local station is giving marvelous daytime reception' especially to rural listeners. Other sections of the West and Middle West report certain stations which have widespread rural acceptance, due to the types of programs, weather information, market reports and such. This is particularly true of a number of stations in Wisconsin, Nebraska and the Dakotas.

"We find also that some stations actually 'hop over' one or two counties and then go merrily on with perfect broadcasts; that some are useless in the daytime and others to all intents and purposes dead at night; there are others which are far more effective in summer than in winter and some that are popular or unpopular because of their programs and others because of their 'attitude'. For instance we have this information from a town in Nebraska: 'Station X is one of the least popular, as they have a snooty attitude which doesn't take; people don't have to listen, you know; and they sure won't if they do not like the station's manner'.

"From central Wisconsin we get the information that there is one completely 'dead' spot for a powerful and otherwise effective station; from another section we learn that Station Y is popular because of its children's programs."

TUBE PRICE REDUCED

The Arcturus Radio Tube Company, Newark, N. J. has reduced the list price of the 122 D-C screen grid tube to $3.

N.B.C. PROGRAM LIST FOR YEAR TOTALS 33,000

Thirty-three thousand broadcasts involving more than one quarter million participants in a score of nations comprised the 1931 program year of the National Broadcasting Company.

The N.B.C. year revealed the world in review with stirring events and dynamic personalities on the air for the first time. First international addresses by Premier Mussolini and Pope Pius XI inaugurated the radio cycle. World flights, political and sport spectacles followed. A globe-girdling tribute to Marconi, the Oxford-Harvard debate and the radio premiere of Metropolitan Opera climaxed broadcasting of 1931.

Analysis of a typical broadcasting month showed program percentages to be: music, 62.9 per cent; literature, 11.8 per cent; educational (all types), 21.3 per cent; religion, 2.5 per cent, and novelties, 1.5 per cent.

Broadcasting developments by N.B.C. brought the addition of $1,000,000 in talent to daytime programs, establishment of television studios and laboratories atop the Empire State Building, addition of a second Pacific Coast network, and the signing of a lease for twenty-seven studios and other space in Radio City. Included also was the linking of KGU, Honolulu, with domestic networks, and the exclusive broadcasting and entertainment alliance with the Waldorf-Astoria Hotel.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers concerning standard parts and accessories, new products and new circuits, should send a request for publication of their name and address. Send request to Literature Editor, RADIO WORLD, *145 West 45th Street, New York, N. Y.*

Robin Matthew, 5 St. Michaels Pl., Charleston, So. Carolina.
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Wesley Williams, Radio-Trician, 23 Pearl St., San Francisco, Calif.
Lloyd U. Wolff, Wolff Repair Shop, 129 No. Willow St., East Aurora, N. Y.
Graydon Constantine, R.F.D. No. 2, Oshkosh, Wis.
Elwood Brooks, Receiver & Short Wave set parts, 1636 E. 36th St., Cleveland, Ohio.
Floyd L. Nycum, Receiver & Short Wave set parts, 6118 Lorain Ave., Cleveland, Ohio.
Howard Merrill, R.F.D. 1, Box 48, Lake Leelanan, Mich.
H. W. Davis, R. No. 2, Leonard, Texas.
Porter Simpkins, Rt. 2, Vernon, Tex.
Ivan A. Burroughs, 1765 Douglas Ave., Clearwater, Fla.
H. T. Siefers, 1101 N. 6th St., Lafayette, Ind.
Mike Banas, R.F.D. 3, Smithfield, Pa.
B. C. Montgomery, Box 18, Rock Falls, Ill.
Lucien Lesaffre, 178 Water St., Lawrence, Mass.
Jacob D. Shear, 80 N. Pine St., Gloversville, N. Y.
Lee Russ, 4354 W. Thomas St., Chicago, Ill.
Harold Scott, "Utility Shop," Marmarth, No. Dak.

NEW INCORPORATIONS

Radio Weekly Publishing Co., New York, N. Y. —Atty., M. G. Lowenstein, 25 Broad St., New York, N. Y.
Todd Transformer Corp., electrical machinery and mechanical engineering—Atty., J. Glenn Anderson, Newark, N. J.
Autogiro Specialties Co., Wilmington, Del., aircraft—Atty., Corporation Trust Co., Wilmington, Del.
George R. Thayer Co., Binghamton, N. Y., musical instruments—Attys., Merchant, Waite & Waite, Binghamton, N. Y.
Gallant School of Music, Inc., Hoboken, N. J., deal in musical instruments—Attys., Levenson, Comen & Levenson, Hoboken, N. J.

[The list of United States broadcasting stations is being published serially. The December 19th issue gave the data on stations from 550 kc (545.1 meters) to 1040 kc (288.3 meters), while last week's issue, December 26th, covered 1050 kc (285.5 meters) to 1230 kc (243.8 meters). The data are complete as to information about stations, and are corrected up to press time. Note the fullest possible particulars are given. Next week the final instalment will be printed.—Editor.]

BROADCASTING STATIONS BY FREQUENCIES—*Continued from last week*

1240 KILOCYCLES—*241.8 Meters*

WXYZ	Detroit, Mich.	Kunsky-Trendle Broadcasting Corporation	1KW	Unlimited.
KTAT	Fort Worth, Tex. T—Birdville, Tex.	S. A. T. Broadcast Co.	1KW	Shares with WACO.
WACO	Waco, Tex.	Central Texas Broadcasting Co. (Inc.)	1KW	Shares with KTAT.
KGCU	Mandan, N. Dak.	Mandan Radio Assn.	250W	
KLPM	Minot, N. Dak.	John B. Cooley	250W	

1250 KILOCYCLES—*239.9 Meters*

WGCP	Newark, N. J.	May Radio Broadcast Corporation	250W	Shares with WODA and WAAM.
WODA	Paterson, N. J.	Richard E. O'Dea	1KW	Shares with WGCP and WAAM.
WAAM	Newark, N. J.	WAAM (Inc.)	1KW / 2KW-LS[18]	Shares with WODA and WGCP.
WDSU	New Orleans, La. T—Gretna, La.	Joseph H. Uhalt	1KW	Unlimited.
WLB	Minneapolis, Minn. T—St. Paul, Minn.	University of Minnesota	1KW	Shares with WRHM, KFMX, and WCAL.
WRHM	Minneapolis, Minn. T—Fridley, Minn.	Minnesota Broadcasting Corporation	1KW	Shares with WLB, KFMX, and WCAL.
KFMX	Northfield, Minn.	Carlton College	1KW	Shares with WLB, WRHM, and WCAL.
WCAL	Northfield, Minn.	St. Olaf College	1KW	Shares with WLB, WRHM, and KFMX.
KFOX	Long Beach, Calif.	Nichols and Warriner (Inc.)	1KW	Unlimited.

1260 KILOCYCLES—*238.0 Meters*

WLBW	Oil City, Pa.	Radio-Wire Program Corporation of America	500W / 1K-LS	Unlimited.
KWWG	Brownsville, Tex.	The Brownsville Herald Publishing Co.	500W	Shares with KRGV.
WTOC	Savannah, Ga.	Savannah Bradcasting Co. (Inc.)	500W	Unlimited.
KRGV	Harlingen, Tex.	KRGV (Inc.)	500W	Shares with KWWG.
KOIL	Council Bluffs, Iowa	Mona Motor Oil Co.	1KW	Unlimited.
KVOA	Tuscon, Ariz.	Robert M. Riculfi	500W	Daytime.

1270 KILOCYCLES—*236.1 Meters*

WEAI	Ithaca, N. Y.	Cornell University	1KW	Daytime.
WFBR	Baltimore, Md.	Baltimore Radio Show (Inc)	500W	Unlimited.
WASH	Grand Rapids, Mich.	WASH Bradcasting Corporation	500W	Shares with WOOD.
WOOD	Grand Rapids, Mich. T—Furnwood, Mich.	Kunsky-Trendle Broadcasting Corp.	500W	Shares with WASH.
WJDX	Jackson, Miss.	Lamar Life Insurance Co.	1KW	Unlimited.
KWLC	Decorah, Iowa.	Luther College	100W	Daytime. Shares with KGCA.
KGCA	Decorah, Iowa.	Charles W. Greenley	50W	Daytime. Shares with KWLC.
KOL	Seattle, Wash.	Seattle Broadcasting Co. (Inc.)	1KW	Shares with KTW.
KUOR	Colorado Springs, Colo.	Reynolds Radio Co., Inc.	1KW	

1280 KILOCYCLES—*234.2 Meters*

WCAM	Camden, N. J.	City of Camden	500W	Shares with WOAX and WCAP.
WCAP	Asbury Park, N. J.	Radio Industries Broadcast Co.	500W	Shares with WCAM and WOAX.
WOAX	Trenton, N. J.	WOAX (Inc.)	500W	Shares with WCAM and WCAP.
WDOD	Chattanooga, Tenn. T—Brainerd, Tenn.	WDOD Broadcasting Corporation	1KW / 2½KW-LS	Unlimited.
WRR	Dallas, Tex.	City of Dallas, Tex.	500W	Do.
WIBA	Madison, Wis.	Badger Broadcasting Co.	500W	Do.
KFBB	Great Falls, Mont.	Buttrey Broadcast (Inc.)	1KW / 2½KW-LS	Do.

1290 KILOCYCLES—*232.4 Meters*

WNBZ	Saranac Lake, N. Y.	Earl J. Smith and William Mace, doing business as Smith & Mace.	50W	Daytime.
WJAS	Pittsburgh, Pa. T—North Fayette Township, Pa.	Pittsburgh Radio Supply House	1KW / 2½KW-LS	Unlimited.
KTSA	San Antonio, Tex.	Lone Star Broadcasting Co. (Inc.)	1KW / 2KW-LS	Shares with KFUL.
KFUL	Galveston, Tex.	News Publishing Co.	500W	Shares with KTSA.
KLCN	Blytheville, Ark.	Charles Leo Lintzenich	50W	Daytime.
WEBC	Superior, Wis.	Head of the Lakes Broadcasting Co.	1KW / 2½KW-LS	Unlimited.
KDYL	Salt Lake City, Utah	Intermountain Broadcasting Corporation	1KW	Do.

1300 KILOCYCLES—*230.6 Meters*

WBBR	Brooklyn, N. Y. T—Rossville, N. Y. (Staten Island).	Peoples Pulpit Association	1KW	Shares with WEVD, WHAZ, and WHAP.
WHAP	New York, N. Y. T—Carlstadt, N. J.	Defenders of Truth Society (Inc.)	1KW	Shares with WEVD, WHAZ, and WBRR.
WEVD	New York, N. Y. T—Forest Hills, N. Y.	Debs Memorial Radio Fund (Inc.)	500W	Shares with WHAP, WHAZ, and WBBR.
WHAZ	Troy, N. Y.	Rensselaer Polytechnic Institute	500W	Shares with WEVD, WHAP, and WBBR.
WIOD	Miami, Fla. T—Miami Beach, Fla.	Isle of Dreams Broadcasting Corporation	1KW	Unlimited.
KFH	Wichita, Kans.	Radio Station KFH Co.	1KW	Shares with WOQ.
WOQ	Kansas City, Mo.	Unity School of Christianity	1KW	Shares with KFH.
KGEF	Los Angeles, Calif.	Trinity Methodist Church, South	1KW	Shares with KTBI.
KFJR	Portland, Oreg.	Ashley C. Dixon, trading as Ashley C. Dixon & Son.	500W	Shares with KTBR'
KTBR	Portland, Oreg.	M. E. Brown	500W	Shares with KFPR.
KFAC	Los Angeles, Calif.	Los Angeles Broadcasting Co.	1KW	

1310 KILOCYCLES—*228.9 Meters*

WKAV	Laconia, N. H.	Laconia Radio Club	100W	Unlimited.
WEBR	Buffalo, N. Y.	Howell Broadcasting Co. (Inc.)	100W / 200W-LS	Do
WMBO	Auburn, N. Y.	WMBO, Inc.	100W	Do.
WNBH	New Bedford, Mass. T—Fairhaven, Mass.	Irving Vermilya, trading as New Bedford Broadcasting Co.	100W	Do.
WOL	Washington, D. C.	American Broadcasting Co.	100W	Do.
WGH	Newport News, Va.	Hampton Roads Broadcasting Corporation	100W	Do.
WEXL	Royal Oak, Mich.	Royal Oak Broadcasting Co.	50W	Do.
WFDF	Flint, Mich.	Frank D. Fallain	100W	Do.
WBEO	Marquette, Mich.	Lake Superior Broadcasting Co.	100W	Unlimited. (C. P. only.)
WHAT	Philadelphia, Pa.	Independence Broadcasting Co.	100W	Shares with WTEL.
WTEL	Philadelphia, Pa.	Foulkrod Radio Engineering Co.	100W[19]	Shares with WHAT, WCAM.
WJAC	Johnstown, Pa.	Johnstown Automobile Co.	100W	Shares with WFBG.
WFBG	Altoona, Pa.	William F. Gable Co.	100W[20]	Shares with WJAC.
WRAW	Reading, Pa.	Reading Broadcasting Co.	100W	Shares with WGAL.
WGAL	Lancaster, Pa.	WGAL, Incorporated	100W	Shares with WRAW.
WSAJ	Grove City, Pa.	Grove City College	100W	Unlimited.
WBRE	Wilkes-Barre, Pa.	Louis G. Baltimore	100W	Do.
WKBC	Birmingham, Ala.	R. B. Broyles, trading as R. B. Broyles Furniture Co.	100W	Unlimited.

(1310 *kilocycles continued on next page*)

[18] C. P. to increase power to 2½ KW-LS.
[19] License granted to increase power to 100 w.
[20] C. P. to increase power to 250 watts-LS.
[21] C. P. to increase power to 100 watts.
[22] C. P. to increase power to 100 watts.

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

1310 KILOCYCLES (Cont.)

WTJS	Jackson, Tenn.	Sun Pub. Co.	100W	
WTSL	Laurel, Miss.	G. H. Hanseman	100W	
WROL	Knoxville, Tenn.	Stuart Broadcasting Corporation	100W	Do.
KRMD	Shreveport, La.	Robert M. Dean	50W	Shares with KTSL.
WSJS	Winston-Salem, N. C.	Winston-Salem Journal Co.	100W	Unlimited.
KTLC	Houston, Tex.	Houston Broadcasting Co.	100W	Do.
KFPM	Greenville, Tex.	Dave Ablowich, trading as The New Furniture Co.	15W	Do.
KTSM	El Paso, Tex.	W. S. Bledsoe and W. T. Blackwell	100W	Shares with WDAH.
WDAH	El Paso, Tex.	W. S. Bledsoe and W. T. Blackwell	100W	Shares with KTSM.
KFPL	Dublin Tex.	C. C. Baxter	100W	Unlimited.
KFXR	Oklahoma City, Okla	Exchange Avenue Baptist Church	100W 250W-LS	Do.
WKBS	Galesburg, Ill.	Permil N. Nelson	100W	Do.
WCLS	Joliet, Ill.	WCLS (Inc.)	100W	Shares with WKBB.
WKBB	Joliet, Ill.	Sanders Brothers Radio Station	100W	Shares with WCLS.
KWCR	Cedar Rapids, Iowa	Cedar Rapids Broadcast Co.	100W	Shares with KFGQ and KFJY.
KFJY	Fort Dodge, Iowa	Cedar Rapids Broadcast Co.	100W	Shares with KFGQ and KWCR.
KFGQ	Boone, Iowa	Boone Biblical College	100W	Shares with KWCR and KFJY.
KGFW	Ravenna, Nebr.	Central Nebraska Broadcasting Corporation	100W	Unlimited.
WBOW	Terre Haute, Ind.	Banks of Wabash (Inc.)	100W	Do.
WJAK	Marion, Ind.	Marion Broadcast Co.	50W	Shares with WLBC.
WLBC	Muncie, Ind.	Donald H. Burton	50W	Shares with WJAK.
KGBX	St. Joseph, Mo.	KGBX (Inc.)	100W	Unlimited.
KFBK	Sacramento, Calif.	James McClatchy Co.	100W	Do.
KCRJ	Jerome, Ariz.	Charles C. Robinson	100W	Do.
KGCX	Wolf Point, Mont.	First State Bank of Vida	100W 250W-LS	One-half time.
KGEZ	Kalispell, Mont.	Donald C. Treloar and Stanley R. Church, doing business as Treloar-Church Broadcasting Co.	100W	Unlimited.
KFUP	Denver, Colo.	Fitzsimmons General Hospital, U. S. Army	100W	Shares with KFXJ.
KFXJ	Grand Junction, Colo.	R. G. Howell and Charles Howell, doing business as Western Slope Broadcasting Co.	100W	Shares with KFUP.
KMED	Medford, Oreg.	Mrs. W. J. Virgin	100W	Unlimited.
KXRO	Aberdeen, Wash.	KXRO (Inc.)	100W	Do.
KIT	Yakima, Wash.	Carl E. Haymond	50W	Do.
WFDV	Rome, Ga.	Rome Broadcasting Corp.	100W	

1320 KILOCYCLES—*227.1 Meters*

WADC	Akron, Ga.	Allen T. Simmons	1KW	Unlimited.
WSMB	New Orleans, La.	Saenger Theatres (Inc.) and Maison Blanche Co.	500W	Do.
KTFI	Twin Falls, Idaho	Radio Broadcasting Corporation	250W[25]	Shares with KID at night
KID	Idaho Falls, Idaho	KID Broadcasting Co.	250W 500W-LS	Shares with KTFI at night.
KGHF	Pueblo, Colo.	Curtis P. Ritchie and Joe E. Finch	250W 500W-LS	Unlimited.
KGMB	Honolulu, Hawaii	Honolulu Broadcasting Co. (Ltd.)	250W	Do.

1330 KILOCYCLES—*225.4 Meters*

WDRC	Hartford, Conn. T. Bloomfield, Conn.	WDRC (Inc.)	500W	Unlimited.
WSAI	Cincinnati, O. T. Mason, Ohio.	Crosley Radio Corporation (lessee)	1KW	Do.
WTAQ	Eau Claire, Wis. T—Township of Washington, Wis.	Gillette Rubber Co.	1KW	Shares with KSCJ.
KSCJ	Sioux City, Iowa	Perkins Brothers Co.	1KW 2½KW-LS.	Shares with WTAQ.
KGB	San Diego, Calif.	Don Lee, Inc.	500W	Unlimited.

1340 KILOCYCLES—*223.7 Meters*

WSPD	Toledo, Ohio	Toledo Broadcasting Co.	1KW.	Unlimited.
KFPW	Fort Smith, Ark.	Southwestern Hotel Co.	50W	Daytime.
WCOA	Pensacola, Fla.	City of Pensacola, Fla.	500W	Unlimited.
KFPY	Spokane, Wash.	Symons Broadcasting Co.	1KW	Do.

1350 KILOCYCLES—*222.1 Meters*

WAWZ	Zarephath, N. J.	Pillar of Fire	250W	Shares with WMSG, WCDA, and WBNX. (C. P. only.)
WMSG	New York, N. Y.	Madison Square Garden Broadcast Corporation	250W	Shares with WAWZ, WCDA, and WBNX.
WCDA	New York, N. Y. T—Cliffside Park, N. J.	Italian Educational Broadcasting Co. (Inc.)	250W	Shares with WAWZ, WMSG, and WBNX.
WBNX	New York, N. Y.	Standard Cahill Co. (Inc.)	250W	Shares with WAWZ, WMSG, and WCDA.
KWK	St. Louis, Mo. T—Kirkwood, Mo.	Greater St. Louis Broadcasting Corporation	1KW	Unlimited.
WEHC	Emory, Va.	Emory & Henry College	500W	
KIDO	Boise, Idaho	Boise Broadcasting Station	1KW	Unlimited.

1360 KILOCYCLES—*220.4 Meters*

WFBL	Syracuse, N. Y.[27]	Onondaga Radio Broadcastting Corporation	1KW	Unlimited.
WQBC	Vicksburg, Miss.	Delta Broadcasting Co. (Inc.)	500W	Daytime. (C. P. only.)
WCSC	Charleston, S. C.	Lewis Burk	500W	Unlimited.
WJKS	Gary, Ill.	Johnson-Kennedy Radio Corporation	1KW 1¼KW-LS	Shares with WGES.
WGES	Chicago, Ill.	Oak Leaves Broadcasting Station (Inc.)	500W 1KW-LS[28]	Shares with WJKS.
KGIR	Butte, Mont.	KGIR (Inc.)	500W	One-half time.
KGER	Long Beach, Calif.	Consolidated Corp. Broadcasting	1KW	Shares with KPSN.

1370 KILOCYCLES—*218.7 Meters*

WRDO	Augusta, Me.	WRDO, Inc.	100W	Unlimited (C. P. only).
WQDM	St. Albans, Vt.	A. J. St. Antoine	100W	Daytime.
WLEY	Lexington, Mass.	Carl S. Wheeler, trading as Lexington Air Stations.	100W 250W-LS	One-half time.
WSVS	Buffalo, N. Y.	Elmer S. Pierce, principal, Seneca Vocational High School.	50W	Unlimited.
WBGF	Glens Falls, N. Y.	W. Neal Parker and Herbert H. Metcalfe	50W	Do.
WPOE	Patchogue, N. Y.	Nassau Broadcasting Corporation	100W	Do.
WCBM	Baltimore, Md.	Baltimore Broadcasting Corporation	100W 250W-LS	Do.
WBTM	Danville, Va.	L. H., R. G., and A. S. Clarke, doing business as Clarke Electric Co.	100W	Shares with WLVA.
WLVA	Lynchburg, Va.	Lynchburg Broadcasting Corporation	100W	Shares with WBTM.
WHBD	Mount Orab, Ohio	F. P. Moler	100W	Unlimited.
WHDF	Calumet, Mich.	Upper Michigan Broadcasting Co.	100W 250W-LS	Do.
WJBK	Highland Park, Mich.	James F. Hopkins (Inc.)	50W	Shares with WIBM.
WIBM	Jackson, Mich.	WIBM (Inc.)	100W	Shares with WJBK.
WRAK	Williamspport, Pa.	Clarence R. Cummins	100W	Unlimited.
WELK	Philadelphia, Pa.	WELK Broadcasting Station (Inc.)	100W 250W-LS	Do.

(1370 *kilocycles continued next week*)

[25] C. P. to increase power to 500 watts—LS.
[28] On Sundays.
[26] C. P. to increase power to 500 watts.
[27] C. P. to move transmitter to Collamer, N. Y., and increase power to 2½ KW—LS.