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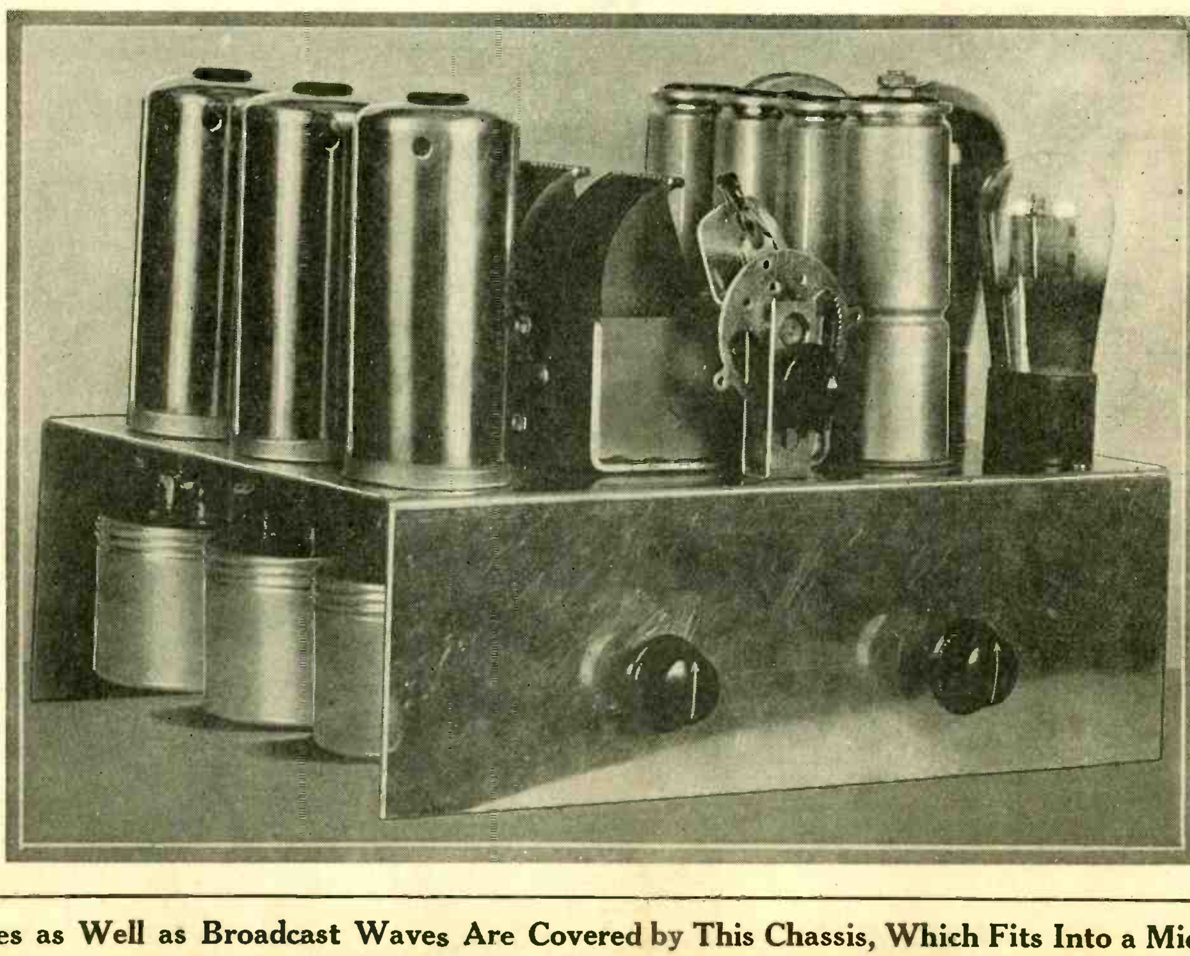

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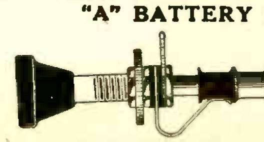

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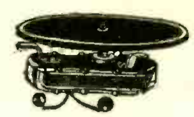

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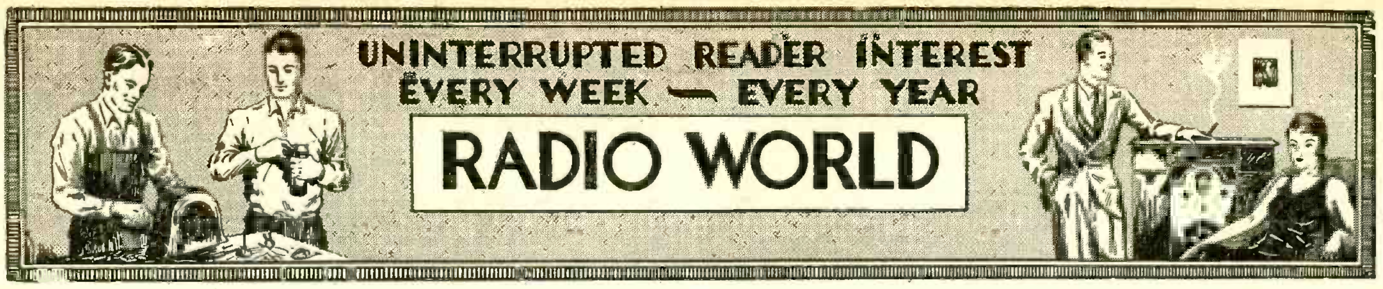

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The Finest Midget

Expert Design for Amazing Six Tube Model; Also Simpler Set with Modest Results

By Herman Bernard

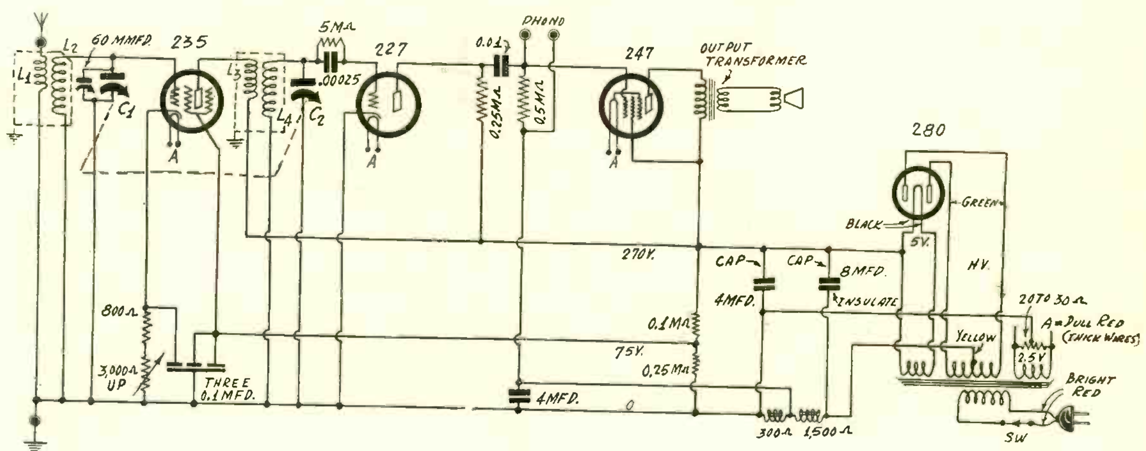

FIG. 1
A four tube set for midget construction that will give excellent tone quality up to the practical limitations of speakers used in such receivers. How the three-element tube as detector is an aid to this end is explained in the text.

*[This is the third of a series of consecutive articles on midget receivers. The theoretical and practical considerations have been discussed step by step, and now two circuits are shown in definitive form. One is a four-tube model, including rectifier, and the other is a six-tube model, including rectifier. Departure from common practice is noted in several particulars, but the author backs this up with a highly logical technical argument, and besides has verified the results empirically. The two circuits herewith are highly recommended.—*EDITOR.]

IN THE construction of midget receivers it is necessary to bear in mind that the baffle area for the speaker is extremely limited, and the speaker diaphragm itself is relatively small. The two statements are tantamount to the same thing, since the baffle serves as extension of the radiating surface of the speaker. Therefore it is necessary to safeguard against low-note suppression, a vice commonly present in midgets, and wrongly attributed by some to shortcomings in the 247 pentode tube.

An article in last week's issue of RADIO WORLD took up this subject of tone quality in regard to the pentode tube, and somewhat anticipated what I intend to say. In brief, my position is that it is not possible to build utterly economically and include a screen grid tube for any audio purpose whatever. That means the detector can not be a 224 or 235, nor can the first audio tube, nor can the output tube be a pentode, which of course is also a screen grid tube. The reason is that these tubes require high capacities for bypassing, and such high capacities can not be obtained cheaply.

Why Speaker is Important Factor

There are two ways of regarding the question of high capacities for bypassing. One is, What is the smallest capacity one can get away with? And the other is, How large should the bypass capacity be for as nearly perfect results as modern radio affords? They are really two distinct questions, since it is not valid to assert that the capacity always should be as large as audio amplification requires. The reason for the distinction is that the low note response is limited by the size of speaker and baffle, and it is of little advantage to pursue the capacity to the enormous values that otherwise would be prescribed, as the audio channel simply would be building up amplification in a region which gains hardly any response from the speaker.

Both the husky capacities and a high current voltage divider are relatively expensive, and if these can be avoided without any adverse effect on tone quality, parts for a four tube set (less tubes but including speaker and cabinet) could be obtained for about $16, and parts for a six tube set for around $20.

Considering the capacity question in regard to Fig. 1, the four tube set, we find the only bypass capacities are 0.1 mfd. across the biasing system for the radio frequency amplifier, 0.2 mfd. across the 0.25 meg. resistor, thus bypassing the screen of that tube, 8 mfd. and 4 mfd. respectively in the rectifier filter, and 4 mfd. across the biasing section of the B choke (300 ohms).

Radio and Audio Bypassing

As for adequateness, 0.1 mfd. is all-sufficient for the r-f biasing, and 0.2 mfd. likewise for the r-f screen, since the only current involved is radio frequency, and these capacities are virtually a short circuit to such.

It makes little difference how high the resistance is. In the biasing section of the first tube the maximum possible to use would be 3,800 ohms, assuming 3,000 ohms for the rheostat, while the screen has 0.25 meg. between that point and the ground. The radio frequencies travel through the condenser virtually exclusively in both instances, and this situation of the condenser impedance representing virtually the total impedance is exactly what is desired in the audio frequency biasing circuits. It can

(*Continued on next page*)

Four Tube Midget Mee

Satisfactory Reception of Lo

(*Continued from preceding page*)
not be attained without high capacities, for audio frequencies, but passable results may be produced with 4 mfd. across the 247 biasing section (300 ohms of the B choke), while 8 mfd. next to the rectifier and 4 mfd. at the end of the rectifier filter will keep down hum adequately.

The only compromise of any magnitude is the 4 mfd. across the 300 ohm section of the B choke. The bypassing requirements lead us to consider the d-c resistance as if the unit were not part of a choke.

A Little Matter of 72 Mfd.

The 4 mfd. capacity probably will come very close to the lower limits of energetic response from a small speaker in a small Gothic cabinet such as used for midget sets. The test can be made readily, by taking 8 mfd. additionally, and cutting it in and out, noting the result when listening to an orchestra. If there is no appreciable difference it does not mean that the 12 mfd. bypass capacity is no more effective across the the biasing choke than the 4 mfd., but that the effect does not register on the speaker. The 4 mfd. gives excellent protection to about 500 cycles, with rapidly declining effect from that down, while 12 mfd. would give excellent protection down to about 100 cycles, with rapidly declining assistance on lower frequencies. If the speaker-baffle combination were such as to afford strong response down to 24 cycles, it is recommended that the bypass capacity across the 300 ohms be 72 mfd. This might consist of an electrolytic condenser, the largest such capacity now commercially obtainable in a single can.

It is the practice in some midget set factories wholly to omit any bypass condenser from this position, but 4 mfd. must be included as the absolute minimum, or the shrilly notes from midgets that seem to crack your ears will be the inevitable result.

Why Three-Element Detector is Used

The detector is not a screen grid tube, and it is not a negative bias or so-called power detector, simply because there is no way of establishing the biasing voltages in the circuit without the use of resistors. The grid biasing resistor might be 20,000 ohms, from cathode to ground (grid leak and condenser shorted out in Fig. 1). and the screen biasing resistor for a 224 or 235 detector might be the same resistor that serves the radio frequency tube, 0.25 meg., 0.1 meg. (with 0.25 meg. between screen and ground to insure some current the moment the set is turned out on). But then we would require a large capacity across the 20,000 ohms, and another large one across the 0.25 meg., because audio frequencies are concerned. The detector handles both audio and radio.

Since the gain is virtually nil for the screen grid detector tube the negative feedback through these two resistors will be much less than was true in the power tube stage, still the capacities should be of the order of 4 mfd. Two 4 mfd. condensers are omitted when the detector tube is a 227 as diagrammed or is any screen grid tube with screen and plate tied together. There is no screen, and cathode goes direct to ground. The mu of the screen grid tube used as a triode is higher than that of the 227, and the substitution is worth while.

Negative feedback is an amplification reducer, so unless the capacities are large, as screen grid detector will de-amplify. Hence it is folly to use a screen grid tube as detector, with the expectation that the audio amplification will be large therefrom, when that amplification is seriously crippled by the absence of large condensers across the screen and cathode resistors. As so many sets present the screen grid tube as a gainful detector, and omit the large capacities necessary to make the promise hold true, the fact is the three-element tube will give larger gain, compared to the screen grid detector tube that has inadequate bypassing, for the 227, if hooked up as grid leak detector, requires no bypass capacity across at any point except across the grid leak, where the usual clipped 0.00025 mfd. condenser serves this purpose. The converted screen grid tube requires 0.00025 mfd., plate to ground.

Not even a plate-to-cathode or plate-to-ground bypass condenser is needed to keep the radio frequencies out of the audio channel, because if a somewhat higher resistor is used in the plate circuit than ordinarily recommended, not only will the amplification be higher in general, but there will be present a plate-to-cathode capacity due to the high resistance, and this capacity automatically serves radio frequency bypassing purposes.

Frequency Effect

The usual recommendation is 0.1 meg. (100,000 ohms) in the plate circuit, but if this is raised to 0.25 meg. (250,000 ohms), the aforesaid conditions will be met. Also, while the amplification is generally increased because of the heightened plate load, the plate current drain is reduced, and the high audio frequencies are subdued a little, which helps atone for the discrimination in favor of the high audio notes by the speaker-baffle.

It can be seen, therefore, that the audio gain from the detector is heightened by using a three-element tube, as compared with a 224 or 235 detector with negative bias detection and a relatively small condenser across cathode and screen biasing resistors. The radio frequency amplification, on the other hand, is less, but the net result is that more volume is obtained.

The screen grid detector, even with low values of bypass capacities, amplifies well at radio frequencies, because the condensers are small only for audio frequencies, but extremely large for radio frequencies. However, there is nothing at all gained from the radio frequency amplification of the screen grid detector, or any other detector, since a tube is only as good as its output, and the detector's output at radio frequencies is never used, except in regenerative receivers. If the circuit were regenerative it follows that the screen grid tube would regenerate more readily, even as a negative bias detector.

Overload Characteristics

However, we are not using regeneration, so when we ascertain that the radio frequency amplification in a tube that has output almost short circuited as to radio frequencies, and especially under conditions where we desire to keep such frequencies out of an intended audio channel that would amplify them well, we come to the conclusion we would be wasting time trying to capitalize what is virtually eliminated by necessity.

There is only one audio stage in the circuit, Fig. 1, and local stations may be received well. The detector will overload before the pentode does, but the volume control is a complete check on detector overload. The sensitivity of the detector is much higher than by the negative bias system, yet it never will be possible to load up the 247, so instead of using the entire 300 ohms effective for biasing this tube, to give about 16.5 volts negative, a resistor of 800 ohms or so may be placed in parallel with the 300 ohm section, if desired, to lower the bias on the last tube, really to lower the impedance of the biasing resistor, which is of the same effect as adding considerable more capacity to the 4 mfd. minimum.

Other Points

Now, to look over the circuit and discuss some points that have not been treated of in this article so far.

There is a manual trimmer across the tuning condenser in the first stage, necessary because there is no sensitivity or selectivity to sacrifice to mistuning. L1 is a radio frequency choke coil of 200 or 300 turns or thereabouts, preferably wound honeycomb style and placed inside the tubing on which L2, the secondary is wound. The choke is ½ to 1 inch away from where the secondary begins. If the diameter is one inch, and C1 is 0.00035 mfd., then 135 turns of No. 38 wire may be used for the secondary. In that case the trimmer must be at least 60 mmfd. Otherwise—for a smaller trimmer—five extra turns may be put on that secondary only.

The reason is that the mutual coupling between choke and secondary tends to reduce the inductance of the secondary, a condition not true of the interstage coupler, because there the primary has only a few turns.

Bias for Pentode

The phonograph jack is accessible at rear of the chassis. To play the phonograph, turn the set dial to some position that does not bring in a station. This may be any position that gives the result, but the tuning permits you to go below and above the brodcast limits, so the dial extremes, 0 and 100, are available to all, no matter where located.

The output transformer for the pentode is built into the small dynamic speakers intended for midget sets, and so is the field coil. Here the field coil has a d-c resistance of 1,800 ohms, divided into two sections, one of 1,500 ohms and the other of 300 ohms. The total 1,800 ohms are useful for field coil excitation, but the 300 ohms and for B supply filtration for the set, also, although the 300 ohm section serves the additional purpose of biasing the pentode.

The diagram correctly shows how to connect to the split field coil, which is really a single tapped winding on one core. The choke is in the negative leg of the rectifier, so one side of the choke goes to the center tap of the high voltage winding of the power transformer. That of course is the most negative point in the set.

It is not, however, the grounded connection in this circuit, although B minus usually is grounded in other circuits.

Watch Condenser Next to Rectifier

The 1,500 ohm part of the choke comes first, looking from negative B, then the tap is connected grid return of the pentode

ts Price Cry of the Day

cals in a Simple A-C Design

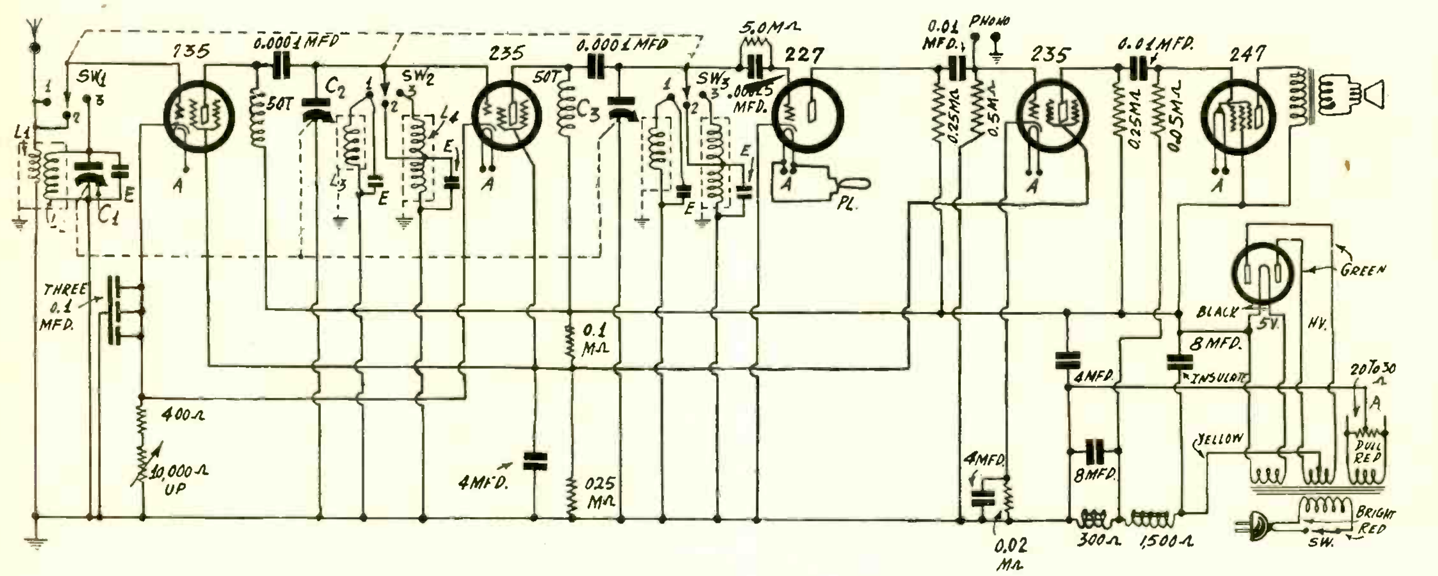

FIG. 2

The detector is shown as a 227, but if a 224 or 235 is used, screen and plate posts united, include a plate bypass condenser

output tube (247). So, if the center tap on the resistor across the 2.5 volt winding (A) is grounded, the pentode grid return (0.5 meg. leak) is negative in respect to the pentode's filament by the voltage drop across the 300 ohm section. Thus the grid bias is negative.

The condenser next to the rectifier (8 mfd.) has its case connected to negative B, center of the high-voltage winding, therefore if a metal chassis is used, the condenser case must be insulated, because the chassis will be grounded, and the case of this condenser does not go to ground. However, the cases of the other electrolytic condensers (two 4 mfd. in one case the same size as that containing the single 8 mfd.), do go to ground, so no insulation is necessary there.

The voltages aren't shown on the diagram. Around 270 volts are recommended for maximum, because if the voltage is 300 volts the pentode tube may get too hot for long life. The screen voltage should be 50 to 75 volts, not readable accurately on ordinary meters.

* * *

THE performance of a circuit like that shown in Fig. 2 can come close to perfection, because the selectivity, while adequate, is not pressed to the sideband-cutting degree present in many receivers, and the audio amplification is resistance coupled, with biasing resistors bypassed by large capacities. The hum is kept below the 5 per cent limit by the B supply choke coil and 16 mfd. of filter capacity, even though the field coil of a dynamic speaker may serve also as the B supply choke.

The fundamental receiver may be used as follows:

1 as an all-wave midget, 24.9 to 545.1 meters, in a mantel type cabinet, where everything is contained in the cabinet, including the speaker.

2 as an all-wave chassis for installation in a console, which requires only omission of the cabinet specified under subdivision (1).

3 as an all-wave chassis for installation in a console, where the user already has a speaker, in which case a B supply choke coil would have to be added, to constitute the choke represented by the one otherwise in the speaker, marked 1,500 ohms, and an output transformer would be necessary. The choke would be mounted under the electrolytic condensers, screws passed through long elevating bushings.

The radio frequency circuit is so arranged that the direct plate current for the first and second radio frequency amplifiers passes through 50 turn honeycomb r-f chokes, built into the form that contains the large tapped tuned winding. There is no inductive coupling, as between this tuned winding and the plate choke, because the two inductances are strictly at right angles. Coupling is obtained through two equalizing condensers set at maximum (marked 0.0001 mfd. on diagram).

A single switch, of the three-deck, three point type (triple pole, triple throw), with shaft insulated from everything, permits front panel wave band shifting.

Considering the broadcast band, let us examine the coil system

(*Continued on next page*)

LIST OF PARTS

Coils

One shielded antenna coupler for broadcasts, choke primary.
Two shielded impedance coils for broadcasts, tapped for first short wave band.
Two shielded impedance coils for the second short-wave band.
Two 50 turn honeycomb choke coils.
One power transformer.
One B supply choke coil (field coil of speaker, 1,800 ohms, tapped at 300 ohms).
One output transformer (in speaker).

Condensers

One Scovill three-gang condenser.
Three 0.1 mfd. condensers in one case.
Seven 20-100 mmfd. equalizing condensers.
One 0.00025 mfd. grid condenser with clips (on insulated disc).
Two 0.01 mfd. condensers.
Four 8 mfd. electrolytic condensers and one 4 mfd. (or two 8 mfd. and three 4 mfd.).
One 0.00035 mfd. fixed condenser, (optional, from a-c line to antenna post.).

Resistors

One 400 ohm biasing resistor, flexible.
One potentiometer of 10,000 ohms up, with a-c switch attached.
One 0.1 meg. pigtail resistor.
Three 0.25 meg. pigtail resistors.
One 0.5 pigtail resistor.
One 0.05 meg. pigtail resistor (50,000 ohms).
One 5 meg. grid leak.
One 0.02 meg. pigtail resistor (20,000 ohms).
One 20 to 30 ohm center tapped resistor.

Other Parts

One antenna binding post, one ground binding post.
One phonograph twin jack assembly.
One chassis, drilled for six sockets and three condenser cans.
One three-deck, three-pole switch.
One dynamic speaker, with field coil and output transformer listed above.
One cabinet.
Four sockets marked 235, one marked 247, and one marked 280, (assuming converted 235 as detector).
One knob for volume control, one for dial, one for coil switch.
One vernier dial, 3/8 inch diameter shaft, (or for 1/4 inch dial shaft use reducing bushing).
One roll of hookup wire, four dozen 6-32 machine screws and nuts, 1½ dozen 6-32 milled bushings.
Three tube shields and three bases.

Unexcelled Tone Fidelity in

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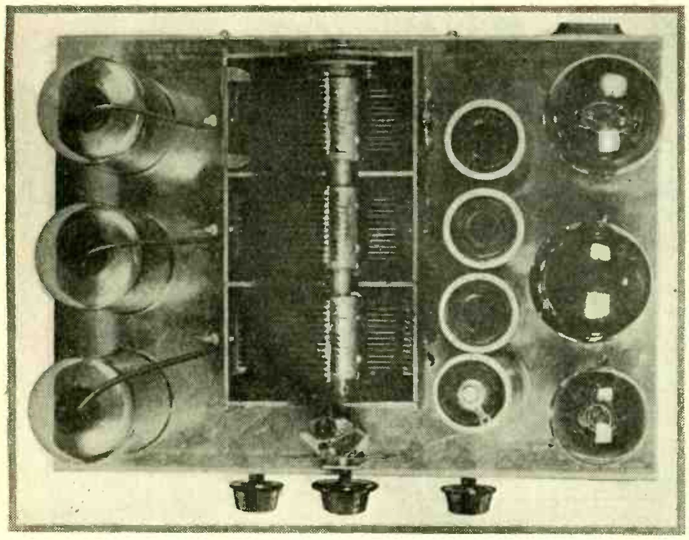

FIG. 3
View of the assembly from the top.

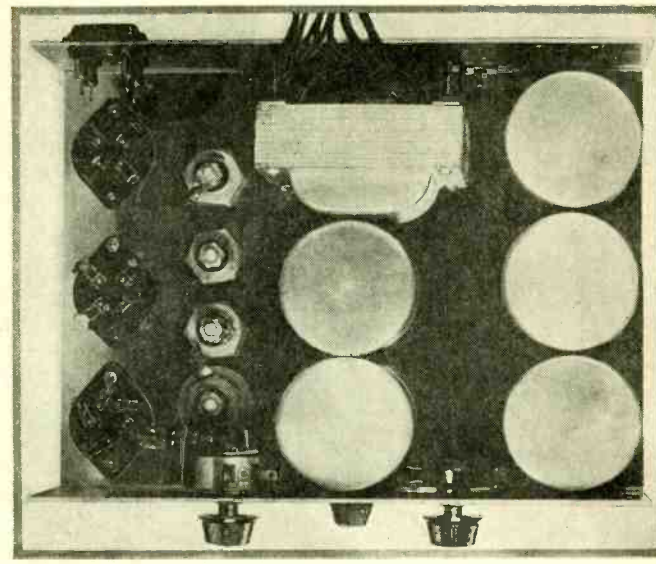

FIG. 4
Bottom view, with shields plainly in view. All coils are underneath.

(*Continued from preceding page*)
and the switch position. The antenna coupler consists of two windings, the primary, which is an r-f choke coil of around 200 to 300 turns, honeycomb style, coupled to the secondary, which is of the usual inductance for broadcast coverage with the tuning condenser section that governs it.

The object of the choke primary is to make the input at the lower radio frequencies (higher wavelengths) much stronger, to compensate for the characteristic of tuned radio frequency amplification whereby the higher radio frequencies are built up more than the lower ones. This characteristic asserts itself in most receivers of the t-r-f type as resultant low volume on low frequency (high wavelength) stations. But if the choke in the primary is of such inductance that with the average antenna-ground capacity present in installations there is a broadly resonant circuit around 500 kc., the overall sensitivity becomes much more nearly uniform, and more enjoyable results are obtained in the spectrum where many of the best broadcasting stations are located.

Value of Even Amplification

In large metropolitan centers, like New York, Chicago, Philadelphia and the like, where powerful stations are geographically near enough to the point of reception to provide large volume despite low sensitivity of the set, the advantage of the even sensitivity may not be appreciated by all, in the first instance, though ultimately the value will become apparent. In smaller communities, which include some really large cities, with considerable distance intervening between such low-frequency stations and the reception point, the merit of the even-sensitivity curve is striking. And even in the largest cities there are mysterious areas where powerful stations do not deliver signals of considerable strength. These areas are regarded as semi-dead spots, and while many listeners will wonder at their plight, they are suffering from the double detriment of being in an unfavorable area for reception of such stations, and also having a receiver that does not do justice to the most desirable wavelengths, anyway. So, with even amplification, they, too, come to the forefront as enjoyers of excellent programs, no matter what the frequency of transmission. Besides, there can be no argument in favor of a receiver that discriminates as to sensitivity, especially as it requires unique technical design to overcome this condition, and the best-trained engineering minds can not be supposed to be devoting their time to useless endeavor. It is indeed an outstanding advantage in a t-r-f set to have it designed for even sensitivity.

So the antenna r-f choke coil is highly recommended, and it conforms to the best and most advanced engineering practice.

Aerial Considerations

For broadcast reception, then, antenna and ground are connected to the two extremes of this primary, as part of the wiring, and these leads are brought out to binding posts for external connection to aerial and ground. However, the receiver is so designed that no outside aerial normally will be necessary, as nearly all locations afford good pickup from the alternating current line. This receiver is for use with alternating current, 50-60 cycles, at a voltage of from 105-120 volts, and a series condenser, connected to one side of the line, the other side of the condenser to the antenna post and to one side of the radio frequency choke coil, give an adequate input in nearly every case. This is the optional 0.00035 or 0.00025 mfd. in the list of parts and is not in the diagram. For detector plate bypassing an additional similar capacity would be required.

However, an indoor aerial may be used in addition, or an outdoor aerial, and connected to the same antenna post, the input from both the line and the external aerial being cumulative. In rural or suburban communities an auxiliary outdoor aerial of 50 to 100 feet is recommended. The stated length includes lead-in.

No hum is introduced from the a-c line by using the series condenser, even though the condenser is connected to one side of the line, because the capacity of the condenser is too small to transfer much of a low frequency as 50-60 cyrles, and because there is only inductive coupling between primary and secondary of the antenna coil, these windings being a short circuit to audio frequencies. The third consideration is that the line voltage is not connected to grid of the first tube.

The inductive relationship results because the antenna-ground current in the primary causes a voltage to exist across the winding, and as the current and voltage are varying at a radio frequency, the resultant magnetic field around the primary varies identically, and the voltage appears across the secondary for much the same reason that the voltage at the antenna of the broadcasting station is communicated, at least in part, to your antenna. It is a case of radiation in both instances, transmission through air, only in the present case of the antenna coupler the two windings are close enough together to permit the voltage from one to be communicated to the other without the use of tubes such as are necessary in a broadcasting station which has to contend with coverage of many miles, as compared to an inch in the coil instance.

Compensating the Antenna Secondary

The coupling of the relatively large choke coil to the secondary results in the reduction of the secondary inductance from what it would be were the choke absent, or only a few turns of wire used as primary. However, since only inductance is concerned, the number of turns of wire on the antenna coupler secondary may be made greater than that on the succeeding two tuned windings for broadcast use, by the amount necessary to compensate.

Let us see how that works on in the present instance. The tuning condenser's three sections each has a maximum capacity

Balanced Six Tube Set

tally to Achieve Notable Results

of 0.00046 mfd. Using 1⅛ inches diameter tubing, about 1½ inches high, the antenna secondary L2 may consist of 105 turns of No. 31 enamel wire. If just that diameter wire is not obtainable, the same number of turns may be used for somewhat different diameter wire, without material alteration of the result. The r-f choke is placed parallel inside the form on which the secondary is wound, and ½ to 1 inch away, considering the turns of the two coils that are closest together. Now, ordinarily, 100 turns of the same kind of wire on the same diameter would be required for 0.00046 mfd., and as the two succeeding coils represent an ordinary condition, both similar circuits, the coils would have 100 turns, tapped at the 68th turn from the grid end. So the difference of 5 turns makes the inductances equal despite the r-f choke primary in the antenna coupler. The 50-turn r-f plate chokes are put in these two coil forms at right angles to the tuned windings.

These coil assemblies are put in aluminum shields of 2.5 inches diameter about 2.25 inches high.

More Than Covers Broadcast Band

Now, for broadcast coverage, the switch is thrown to the right, which results in antenna and ground connection to the r-f choke primary of the antenna coupler, inclusion of the 105-turn secondary for the tuned input of the first r-f tube, and the inclusion of the two succeeding sections of the gang condenser across the total windings (100 turns). The wave band coverage will well exceed the broadcast band, that is, you will tune in frequencies higher than 1,500 kc (waves lower than 199.9 meters) and frequencies lower than 550 kc (waves higher than 545.1 meters). It is characteristic of the best designed sets that they cover the full broadcast band of frequencies or wavelengths, without any missout whatsoever.

Now, the switch has three decks. When the knob is at extreme right, position (1), the condition prevails that has just been described, so that no further switching is necessary on the broadcast band to cover it completely. When short waves are to be tuned in, only two tuned circuits are necessary, or indeed advisable, so we must inquire as to the purpose of the third deck of the switch.

Short-Wave Ranges

That deck is used for antenna switching. For broadcasts we desire to use the choke primary, to have the first stage input tuned, but for short waves we switch the grid from the tuning condenser and from the broadcast coil across it, to the choke, so that the grid load is only the antenna choke, and the tuned circuit is out. Now, the choke coil is a good grid load for short waves, and we have an untuned input, while the same motion that performed the antenna switching causes the grids of the two succeeding tubes, second r-f and detector, to pick up the tap on the tuned windings, positions (2). Thus 32 turns are used from grid to ground, and where we left off at a frequency higher than 1,500 kc (wave lower than 199.9 meters) in the broadcast band, we start now with a little lower frequency, say, 1,450 kc (206.8 meters), as the lowest frequency (highest wave) of the first short-wave band. Thus we have some overlap, which spares us the danger of switching to too small a winding, with an uncovered frequency gap between. The tap will afford tuning from 1,450 to 4,350 kc, or from the metrical equivalent, 206.8 meters to 68.92 meters.

The next range is covered by switching to the third position, extreme left in the mechanical operation of the switch, or point (1), which requires a separate coil, as for these frequencies it is inadvisable to resort to another tap. The coil has 11 turns of No. 18 enamel wire on 1⅛ inch diameter, and a separate shield. The range is from 4,250 kc to 12,000 kc, or 70.5 meters to 24.99 meters.

Capacity Compensation

We have thus covered the wave bands between the extremes, 550 kc and 12,000 kc, or 545.1 meters to 24.99 meters, with only three switch positions, and have done so in a simple and unerring manner, without resort to any tricky or undependable devices.

Were not compensation made at the broadcast band for the resultant difference in inductance between the antenna secondary and the two remaining tuned windings, an individual manually operated trimming condenser would be necessary on the front panel. By proper engineering we avoid this, and yet the tuning tracks satisfactorily over the broadcast band.

On the first short-wave band, position (2) of the switch, it is advisable to trim the circuits with the equalizing condensers E, of 20-100 mmfd. capacity, since the higher the frequencies, the greater the relative effect of the capacity used. So when the smaller section, 32 turns, is trimmed, the balance is as fine as it can be made, and since the relative capacity difference on the broadcast band will be less, we have the two tuned circuits, grids of the second r-f and detector tubes, in excellent adjustment for the two bands. We would tune in a broadcasting station at around 1,000 kc, and adjust the antenna coil's trimming condenser only. Of course for the first adjustment short-wave reception is necessary, and any station may be used, including amateur code in the 80 meter band, and police radio or television at the lower frequency end of the band covered.

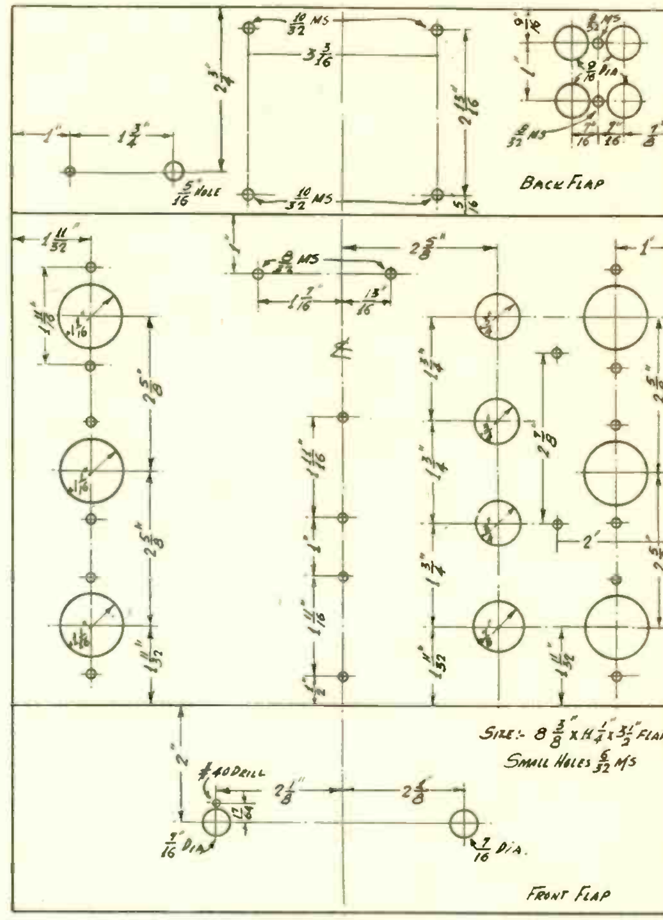

FIG. 5
Plan for the chassis. There are no flaps at side. The coil switch is at left.

Trimmers in Coil Shields

For the smallest coils independent trimming is used, and this has a tremendous advantage, as the balance struck for the broadcast band of the first short-wave band would not apply at all to the very high frequency band of the tiniest coils. Therefore the trimming condensers are not put on the three-gang tuning condenser at all, but are built into the respective coils, being accessible to a screwdriver from the top of the shield.

Radio Frequency Sensitivity

The gain in the radio frequency channel is very high, and the sensitivity at broadcast frequencies will be better than 10 microvolts per meter average, while the selectivity will be sufficient for broadcast purposes, with three tuned circuits, and for short waves will be amply sufficient with two tuned circuits.

Sensitivity and volume are controlled with one operation, that is, the rheostat, 10,000 ohms, will check any tendency toward instability on the short waves. There will be no instability at the broadcast band, as the limiting resistor (marked 400 ohms) will be increased to stop oscillation. This resistor also safeguards against working the r-f tubes at zero bias, since both tubes get their bias through the same resistance network.

The detector is the most sensitive type known, using grid leak and condenser. The value of the condenser is 0.00025 mfd. which is standard, and if the condenser is on an insulating disc, mounting on a metal chassis without accidentally grounding

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Coil Data for Midgets

How to Wind Inductances for Different Capacities

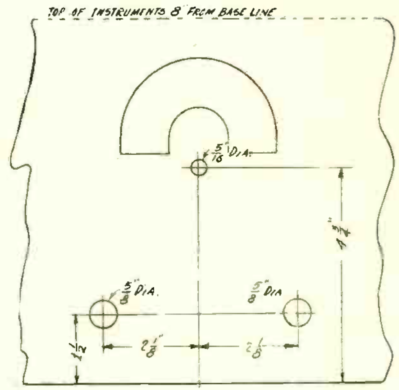

FIG. 6
The front panel may be prepared with this sketch as basis, the width determined by the cabinet, also the height which, however, is 8 inches minimum.

(*Continued from preceding page*)

the condenser is facilitated. The leak value should be high for several reasons. First, the sensitivity is greatly increased. Second, the low-note response is keener, which is due in part to the heightened sensitivity. Third, the hum is much less. In fact, with a grid leak of 5 meg., and with 16 mfd. capacity in a filter having adequate inductance B supply choke (15 henries or more at 75 ma), the hum may be as low as 2 per cent., which means that the ordinary ear could not detect it even with no signal tuned in.

Great Advantage of Vari-Mu R-F

The radio frequency channel therefore may be rated as a good one, far in excess of the performance previously associated with t-r-f sets with three tuned circuits, because of the valuable contribution of the variable mu tube to selectivity. Moreover, there is no cross-modulation, and the hissing background noises due to overamplification of the tube noises and strays, as compared to the signal, by reason of insufficient selectivity, are reduced to a fraction of a percent of what was present in sets of the 1930 season—another contribution by the variable mu tube. Both radio frequency amplifiers are such tubes—type 235.

A three-element detector is used, as that is an all-around better detector for the grid leak type of detection than any other alternating current tube. It stands a greater load, which is important, for that means it does not overload as quickly as does the screen grid tube as grid leak detector, and moreover it permits of a simplified output circuit, without radio frequency choke and plate bypass condensers. This abundant result is achieved simply by using a higher value of plate load resistor than usual, that is, include 0.25 meg. (250,000 ohms) instead of 0.1 meg. (100,000 ohms). The result is a capacity developed in the plate to cathode circuit that serves as a bypass to radio frequencies, keeping them out of the audio channel.

Moreover, this type of detector has its cathode grounded to B minus, so there is no biasing resistor to require a very large capacity to safeguard the low audio frequencies. If a biasing resistor were used here, a bypass condenser of 18 mfd. would not be too large. But we don't need any bypass condenser with this type of detector circuit, unless the grid condenser be considered as such.

A screen grid tube, screen and plate tied together, may well be substituted for the 227, as then a three-element high mu tube results. Put, then, 0.00025 mfd. or so from plate to ground.

Audio Gain 720

The audio amplification is very high indeed. There is no audio gain from a detector, so we find the first amplification at audio frequencies in the 235 first a-f tube. The rest of the audio amplification is provided by the 247 output pentode. The working mu, or practical amplification attained, is 12 for the 235 and 60 for the pentode, or a total of 720, which is high gain for two stages. The only amplification at audio frequencies, using resistance coupling, is that provided by the mu or amplification factor or mu factor of the tubes, with the exception of audio regeneration, and there is some feedback at low audio frequencies, which requires that the pentode's grid leak value be 0.05 meg. (50,000 ohms) for this circuit. In no way can this value resistor be considered as a drag on the low frequency response, in the light of the low frequency regeneration present that the leak counteracts only in part. In fact, if the leak were of the order of megohms the circuit would be distorting, in that the low frequency regeneration would be so strong that the middle and high audio frequencies would be discriminated against, and in fact the circuit would motorboat. But the present circuit does not and will not motorboat, and is offered as one of the finest audio circuits of any kind ever presented. There is no form of coupling superior in tonal fidelity to resistance coupling, and the only problem is to introduce scientific engineering so as to counteract the ills to which resistance coupling at high gain is admittedly heir. Any starting roar can be corrected by decreasing the screen voltage 10.1 meg. to ground, or increasing the first audio biasing resistor.

The coil data for the two circuits, for two slightly different diameters, to permit use of shields 2⅞ inches high, 2¼ inches diameter for the smaller tubing diameter, and shields 2½ inches diameter, 2¼ inches high for the larger tubing diameter, are as follows:

For Fig. 1

Antenna Coupler

For 0.00035 mfd. tuning condenser, wind 132 turns of No. 38 enamel wire for the secondary, and mount a honeycomb type radio frequency coil choke coil of 200 to 300 turns, inside the secondary, parallel to it, so that at nearest points the two coils are not more than 1 inch apart, but do not put closer than ½ inch apart. For 0.0005 mfd. make the secondary turns 127. The tubing diameter is 1 inch. The shield is 2¼ or greater diameter, not more than 2⅞ inches high.

If 1⅛ inch diameter tubing is used, because the shield is only 2¼ inches high, the secondary takes 122 turns of No. 31 enamel wire for 0.00035 mfd., or 95 turns for 0.0005 mfd.

Interstage Coupler

On either diameter stated above, the primary consists of 20 turns of any fine wire wound directly over the secondary, near the end at shield bottom, separated from the secondary with insulating material. Wrapping paper will do in a pinch. The secondary has five fewer turns than the antenna coil's secondary in either instance.

For Fig. 2

Antenna Coupler

For 0.00035 mfd., using 1 inch diameter, wind 132 turns of No. 38 enamel wire for the secondary, and for the primary use a honeycomb radio frequency choke coil of 200 to 300 turns, placed not more than 1 inch away at nearest points, and not closer than ½ inch away. Mount the choke with a long screw, inside the secondary form, parallel to the secondary winding, above the top of the secondary (but inside the form).

For 0.00046 mfd. use 120 turns of the same kind of wire on the same diameter, same choke primary.

For 0.0005 mfd. use 100 turns of the same size wire on the same diameter, same choke primary.

If the diameter is to be 1⅛ inches, then the same directions apply as above, except that the number of secondary turns for 0.00035 mfd. should be 122, for 0.00046 mfd. 105 turns, for 0.0005 mfd. 95 turns, and the wire No. 31 enamel.

Interstage Tuned Windings

For 0.00035 mfd., on 1 inch diameter, using No. 38 enamel wire, the number of turns total is 127, and the tap is at the 82nd turns from the grid end.

For 0.00046 mfd. on 1 inch diameter, 115 turns of the same kind of wire, tapped at the 76th turn.

For 0.0005 mfd., 95 turns of the same kind of wire, tapped at the 65th turn.

If the diameter is to be 1⅛ inches, then the number of turns for 0.00035 mfd. should be 117 turns, of No. 31 enamel wire tapped at the 76th, or for 0.00046 mfd. 100 turns of No. 31, tapped at the 68th, or for 0.005 mfd., 90 turns, tapped at the 62nd turn.

Separate Short-Wave Coils

Wind 11 turns of No. 18 wire on either 1 or 1⅛ inch diameter.

In all cases the size wire may be somewhat different without materially affecting the result.

[*Readers interested in midget sets are welcome to send questions about such circuits to Midget Set Editor*, RADIO WORLD, 145 *West 45th Street, New York, N. Y.*—EDITOR.]

A Compact Auto Set

Combination of Midget Parts with Auto Tubes

By Burton Williams

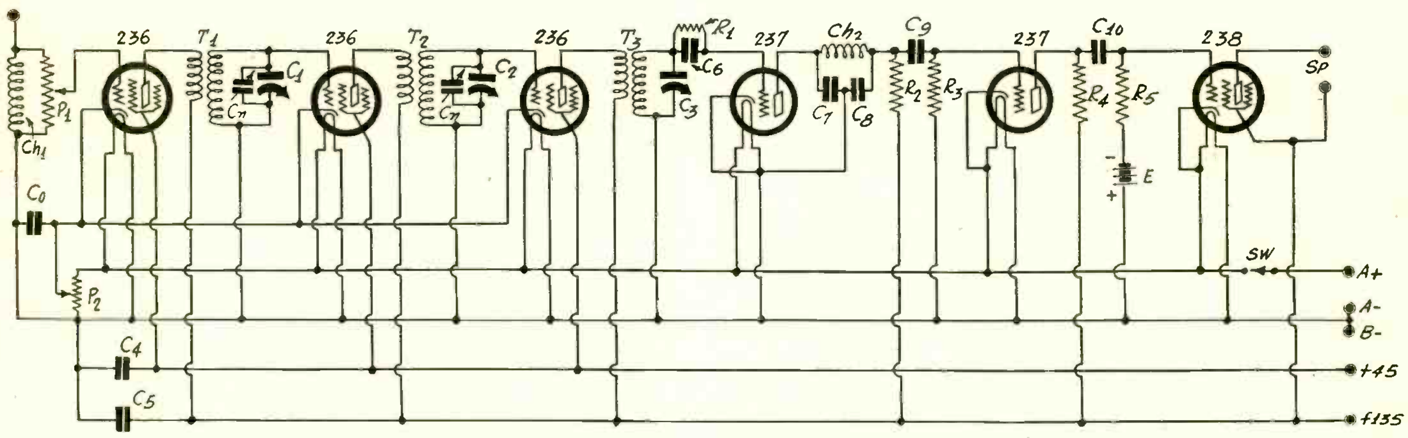

FIG. 1

This six tube circuit has been designed especially for use in an automobile. The 6.3 volt tubes are used throughout.

IT WOULD seem that the season for automobile receivers is over for the year, but this is not so. Indeed, the season is just opening, just as the radio season in general is opening. Radio reception is better in Winter and therefore there is a greater chance of receiving good programs in the car in this season than in the Summer. Automobiling is almost as popular in the Winter as in the Summer and due to the fact that there are fewer outside attractions in Winter there is more attraction for the radio set.

The requirements for a car receiver are quite definite. The set must be very sensitive because the conditions of operation are just about as poor as can be. There is no ground possible, only the counterpoise of the car chassis. Also, there is almost no antenna possible because there are wires connected to the chassis that extend all the way to the top. Sometimes the body as a whole is metal and any antenna inside the car would then be inside a metal cage. There would be no antenna in such cases, and even in the best of cases an antenna entirely inside the car is very poor. This does not apply to open cars. The antenna wire should be strung up on the top or it should project a short distance outside a window. If it is entirely inside the car the set must be much more sensitive to overcome the small pick-up.

Tube Requirements

The tubes to be used in the car set should be those especially designed for the purpose. All others are unsuitable for various reasons. Some tubes would take entirely too much current from the storage battery. Others would not stand up under the vibration to which they are subjected in the car. The automotive tubes are rugged and they do not take a great deal of current from the battery. For example, a six tube set would only take 1.8 amperes, which is only slightly more than the current required by a single tube like the 227 or the 224. A sensitive six tube receiver of good quality and adequate volume could be built with three 236 screen grid tubes, two 237 general purpose tubes, and one 238 pentode. A set of this kind is diagrammed in Fig. 1. It has three tuned circuits, all controlled with the same dial, a leaky condenser detector, one stage of resistance coupled audio frequency amplification, and a power amplifier.

A wide-range volume control is desirable in a receiver of this type, for sometimes the car may be close to a broadcasting station where the signal is strong and at other times the car may be far from any station where signals from all stations are very weak. The control must be adequate to compensate for all these differences.

In the circuit depicted there are two controls, both of which are potentiometers. P1 across the input choke Ch1 is a 500,000 ohm instrument which controls the input voltage and P2 is a 400 ohm instrument which controls the grid bias on the three screen grid tubes. The 400 ohm potentiometer is connected across the storage battery so that there is 6.3 volts across it. The cathodes of the three screen grid tubes are connected to the slider of this instrument so that the bias on these tubes may be varied from zero to 6.3 volts. The bias is not only determined by the current through the potentiometer, and therefore on the setting of the slider, but also on the plate current in the tubes. The larger portion of the bias, however, is due to the current through P2 as a whole because this current is greater than the combined plate current of the three tubes.

Connections for Bias

It is the lower part of P2 that provides the bias for the three screen grid tubes, and this portion may be considered as a common bias resistance. Since this common bias resistance may cause feed back it is shunted by a condenser Co, which should have a value of 0.1 mfd. All the grid returns, it will be noted, are made to the negative side of the bias battery. This is done so that full advantage may be taken of the storage battery voltage for bias purposes.

The power tube normally takes a negative bias of 13.5 volts. This can only be obtained by making use of a grid battery E. In as much as the storage battery supplies 6.3 volts, since the cathode of the tube is connected to positive A, only 7.2 volts are needed in E. There is a standard 7.5 volt grid battery,

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LIST OF PARTS

Coils

Ch1—One 10 millihenry choke
Ch2—One 10 millihenry choke (optional)
T1, T2, T3—Three shielded r-f transformers as described

Condensers

Co, C9, C10—Three 0.1 mfd. condensers
C1, C2, C3—One triple gang, .00046 mfd. condenser
Cn—Two 20-100 mmfd. trimmer condensers
4, C5—Two 2 mfd. by-pass condensers
C6—One 0.00025 mfd. grid condenser
C7, C8—Two 0.00025 mfd. condensers (C8 to be used only if Ch2 is used)

Resistors

P1—One 500,000 ohm potentiometer for volume control
P2—One 400 ohm potentiometer for volume control
R1—One 1 megohm grid leak
R2, R4—Two 100,000 plate resistors
R3, R5—Two 500,000 ohm grid leaks

Other Parts

Sw—One heavy duty filament circuit switch
E—One 7.5 grid battery
Three blocks of 45 volt B batteries
Six UY sockets
One dial for condenser gang
Six grid clips
Antenna wire
A loudspeaker, preferably six volt field dynamic
A battery cable

How to Get Rid of

One Way Preserves Tone Quality, Ot

By Henry B.

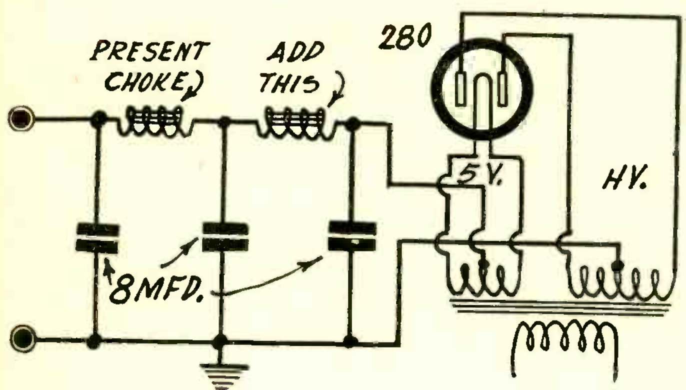

FIG. 1

An adequate filter, representing the addition of a choke and a condenser to a humming receiver. The capacity next to the rectifier should be 8 mfd., the succeeding condensers preferably of the same value or higher.

THE subject of hum in alternating current receivers is one that even yet requires considerable attention, since there is hardly anything so distressing as to listen to a set that hums objectionably.

Usually it is said that the hum is not objectionable, and then it must be taken for granted that there is a considerable ripple voltage present, and the manufacturer or other asserter is frank enough to make the admission, with tactical assurances.

Yet there is no necessity for tolerating a hum. It can be eradicated fully, and this is true even of regenerative short wave sets. The only requirement is that the filtration be adequate. This calls for sufficient inductance and capacity. As auxiliaries, or as antidotes, B supply choke coils may be mounted at critical angles to power transformers and audio transformers, but even so, extra capacity and extra inductance would solve the problem. The critical angle may be resorted to where all else fails, but all else will not fail if high enough inductance and high enough capacity are used. One should be able to say the set is free of audible hum.

Tonal Consideration

The object should not be to keep the expense down, but to provide virtually complete filtration—with less than the 5 per cent. limit of ripple voltage established by manufacturing custom—for then the signal will be free of audible hum. Once the hum gets into the signal it is virtually impossible to eradicate it, except by eradicating all response by the audio amplifier-speaker combinations to the hum frequencies. That means cut-off of low frequency amplification. A set can be built that fully registers the low notes and yet which is free of audible hum. (See the filter in Fig. 1.)

The choke coils used in previous years frequently had a tap, sometimes at center, and three condensers were used in the filter, one next to the rectifier, one at the tap and the other at the end of the choke. However, the capacities normally were small. Around 2 mfd. were common values, while sometimes 4 mfd. would be used, and if so perhaps only one of the condensers would be 4 mfd.

Now the general practice is to use an untapped choke, with larger filter capacities, because electrolytic large capacities may be purchased in compact form at a lower cost than one-eighth the capacity in a paper condenser. For instance, 8 mfd. electrolytic might cost $1, while 1 mfd., for the same working voltage, would cost about the same.

Confusion About Inductance

If the inductance is large enough, the single choke system is very successful in hum elimination with 8 mfd. next to the rectifier and 8 mfd. at the opposite end of the B supply choke.

On the subject of inductance, it is well to avoid expression in henries, as that has come to mean next to nothing in commercially produced chokes. The inductance decreases with current, and the decrease is sharp, therefore if the inductance is expressed in henries, the expression should carry with it a statement of the current. So a choke of 15 henries at 100 ma would mean something. However, chokes marked 30 henries, a popularly selected figure, seldom carry any current rating, so the inductance indeed may be 30 henries at no current, or at 1 ma, milliampere. If the inductance is expressed as 30 henries at 2.5 volts, with the direct current resistance of the choke given, then the disclosure is complete, too, for the current is the voltage (2.5) divided by the resistance (say, 400 ohms d-c), hence 62.5 milliamperes is the current.

But chokes commercially rated at 30 henries, and nothing else, normally have a much lower inductance at that when used at current drains that are normally passed through them.

So a choke designated as 30 henries, while it may not have that at 80 ma, may have that inductance at 10 ma, and the failure to give the current figure is not the fault of the manufacturer, exactly, since he does not know just what current will be passed through the choke, although he could furnish the data on inductance for various currents, by printing the curve.

It can be imagined, therefore, that builders are using much lower inductance than they suppose, or that they haven't the slightest idea about the inductance, since choke coils are so prevalently rated as to their d-c resistance, with no word of the inductance. The use is intended then is known to the manufacturer, so an inductance is provided that is deemed suitable for the purpose.

Hum Elimination at Any Tonal Price

We must now investigate the purpose. If the object is to build a midget set at a price that will startle even Cortlandt Street for its modesty, then we have little choice except to use, say, the field coil of a small dynamic speaker. In many midgets this is sufficient, as the current is around 50 ma, instead of 80 to 100 ma, and that makes a whale of a difference in the inductance, and besides the customer cannot expect to get what he does not pay for.

The set may hum, because the filtration is not complete, and then the scheme is to get rid of all possibility of amplification of or reproduction of the low notes, thus making it a matter of small difference if the filtration is only fair or is even poor. This can be done in a number of ways, one of which is the introduction of a high pass filter in the audio channel, in other words, a low-note suppressor. See resistor-capacity filter in Fig. 2. Another method is to omit the bypass condensers from the biasing resistors, for instance the biasing adjunct of the 247, or from such resistor in a preliminary audio tube, or a negative biased detector tube. Or, if the condenser is not omitted, it is of such a small capacity as to be little more than worthless in

Battery Operated

(*Continued from preceding page*)

which would make the total grid bias on the tube equal to 13.8 volts. In case it is found that the circuit will give more satisfactory results by making the bias less it may be reduced by connecting the grid return to the appropriate tap on the battery. There is a tap at every cell so that the bias may be varied in steps of 1.5 volts.

The receiver contains three tuned circuits, all put in essentially the same settings so that alignment of the condensers for high selectivity is an easy matter. The three tuning condensers are mounted in one gang, the first two sections of which have trimmers Cn across them. If the condenser used has a trimmer across all the sections, that is all right. The Cn, then, would be an integral part of the tuning condenser section.

The three r-f transformers, T1, T2, and T3, are of the midget, shielded type which is now used extensively both for midgets and for larger sets. These coils may be obtained in aluminum shields 2.5 inches in diameter and 2 inches high, the coils inside being 1.125 inches in diameter.

The low pass filter in the plate circuit of the detector consisting of C7, C8, and Ch2 is to prevent the radio frequency currents from entering the audio amplifier, but C7 serves the additional purpose of increasing the detecting efficiency of the detector tube. Ch2 is of no appreciable use alone so that if it is used C8 must also be used. Many prefer to leave out both Ch2 and C8 for space and economy reasons. In a resistance

Hum In Any Set

her Way Spoils It Almost Completely

Herman

the circuit. Values of a fraction of a microfarad are laughable across 300 or 400 ohms, or indeed across any grid biasing resistor, for frequencies below 1,000 cycles.

The Good Way

But the set when turned on will not hum, despite even poor filtration, since possibility of reproduction is prohibited in the low-note region. The cut-off may be around 300 cycles, which takes care of the 60 cycle line frequency and also the predominating hum frequency of full wave rectifiers in such circuits (e. g., using 280 tubes), which is the second harmonic, or 120 cycles.

Also all the musical notes are absent from 300 cycles down, or at least badly bent around 300 cycles and lower, and soon crushed out of the picture, say, at 200 cycles.

The other consideration, or good way, is to enjoy a full tone quality without impairment of any sort whatever, and have no hum. It is to be expected that home builders of radio sets will desire the type of performance that comes as close as possible to perfection, and yet some methods of eliminating hum at the expense of quality are suggested because service men run into the problem and must solve it at all hazards for hum-ridden customers, or starve.

Applying the Rough Remedy

Taking up the sad case of hum eradicated at the expense of the signal, or by impairment of quality, or introduction of more distortion, all meaning the same thing, we invoke first the high pass filter, as diagrammed in Fig. 2, and show where the bypass condenser is to be omitted from biasing resistor or resistors. The amplification will be lower with the bypass condensers omitted, because the feedback is negative through the biasing resistor, and all know that reverse feedback is a damper. However, the service man cannot concern himself too loftily with unctuous tonal considerations where a customer must get that hum out of the house, and doesn't want to pay more than $2 for the feat.

For $2 the high pass filter can be introduced, and it needs no explanation to show that omission of the bypass condenser from the biasing resistor costs nothing. Indeed, that condenser simply may be used as the one in the high pass filter. Besides these two remedies none other need be suggested, as they are very effective. They represent an instance, I believe, of the remedy being worse than the ailment, but the customer gets what he asks for, and wants, and will wonder at the dextrous ingenuity of a service man who so quickly can solve a riddle that has puzzled many.

But take the case of the tone conscious, the man who will spend, say, $5 to get rid of hum, and not limit himself to $2. The $2 customer may be talked into the higher prices class, in some instances, and it is well to try to get him to spend the

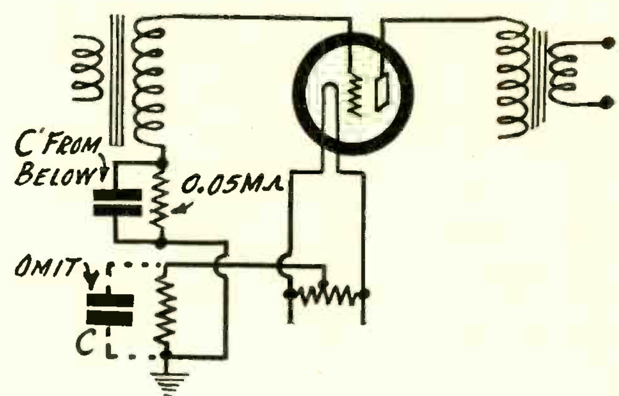

FIG. 2
The high pass filter is a hum killer, because it kills amplification or reproduction of low notes. It is a desperate remedy. If a grid leak is used the filter is the same.

little extra money, as he will enjoy his radio better, especially orchestral, concert and band music.

More inductance being needed, a choke coil is introduced additionally, and this should be placed next to the rectifier. The condition now present is the equivalent of that presented by a tapped choke, so another condenser of 8 mfd. is placed from the tap to grounded B minus. If the set has only a small capacity next to the rectifier, introduce the 8 mfd. there, as no less should be used, and move the capacity that previously was next to the rectifier to the midtap position. Sometimes merely adding 8 mfd. to the capacity already next to the rectifier will get rid of hum sufficiently, and if so it will be without impairment of quality.

The most effective position for hum-eradication by capacity effect is next to the rectifier. You can confirm this yourself by putting 1 mfd. next to the rectifier, and 8 mfd. at the other end, then reversing the positions, and noting the great reduction in hum. This advice has to be followed even though the 8 mfd. puts a heavy starting drain on the rectifier tube, and shortens that tube's life. Instead of 1,000 hours, the tube life is around 500 hours, but the rectifier tube costs little, and the benefit is well worth the price.

Choke Input Is Trying

Sometimes a choke input is recommended. It is a good way to make the choke take up the strain, to relieve the tube, but then you run into hum difficulty, as you have only a choke next to the rectifier, and we have found that we need a high capacity there. The ripple voltage across the choke input represents a definite percentage of unfiltered power, and puts on the succeeding filter so heavy a burden of hum eradication that, unless extra large capacities are used, and much higher inductance than normally, there will be no possibility of keeping the hum within acceptable limits.

Sometimes one has a power transformer with voltage on the secondary too high for the intended purpose. Also the voltage is too high for the rating of the filter condensers used. So the voltage is dropped through a resistor next to the rectifier. But the same trouble from hum will be present, because there is no capacity directly next to the rectifier. It would be better to put the resistor after the condenser, or entirely after the filter, even though the condensers of higher voltage rating would have to be used. This problem of higher voltage rating does not apply to the lowering of voltage for the 247, when using a 245 power transformer, because the electrolytic condensers will stand the 245 voltage, and the drop can take place after filtration.

When a set hums, therefore, the first remedy is to add more capacity next to the rectifier, say, 8 mfd., then, if necessary, a choke coil, using one of medium d-c resistance, say, not more than 400 ohms. The output voltage will be reduced for a given resistance in proportion to the current. At 50 ma the reduction due to the extra 400 ohms would be 20 volts, but this is nothing serious, and especially the virtue of hum-freedom overcomes the theoretical disadvantage of lowered voltage.

Short-Wave Set

coupled circuit either C7 or C8 should not be larger than 0.00025 mfd., and the coil should not be larger than 10 millihenries.

In order to get a fair amplification out of the second 237 and a good output of the detector the plate resistances in R2 and R4 should not be smaller than 100,000 ohms each, and when 237 or similar tubes are used it is not necessary to use higher values. In order to get a good low note response the isolating condensers C9 and C10 should be 0.1 mfd. each, and the grid leaks R3 and R5 should not be smaller than one megohm each.

There is a possibility of motorboating in this circuit, but only when the B battery is old and has a high natural internal resistance. In case there should be motorboating it may be stopped by making the by-pass condensers C4 and C5 large. Ordinarily they may be as low as 2 mfd. each.

The normal plate voltage is 135 volts and the corresponding screen voltage is 45 volts. However, fair results may be obtained with 90 volts on the plates and 22 volts on the screens. If the lower voltages are used the voltage on the control grid of the pentode should be reduced to 9 volts, or even to the 6.3 volts provided by the storage battery. If the lower voltage is used it may be necessary to apply a low positive voltage to the grid of the first audio amplifier since the 6.3 volts provided by the storage battery would be too high for best results. The best arrangement is to use 135 volts on the plates and 45 volts on the screens.

A Short Wave He

Two Tubes of Two Volt Type P

By Brunsten

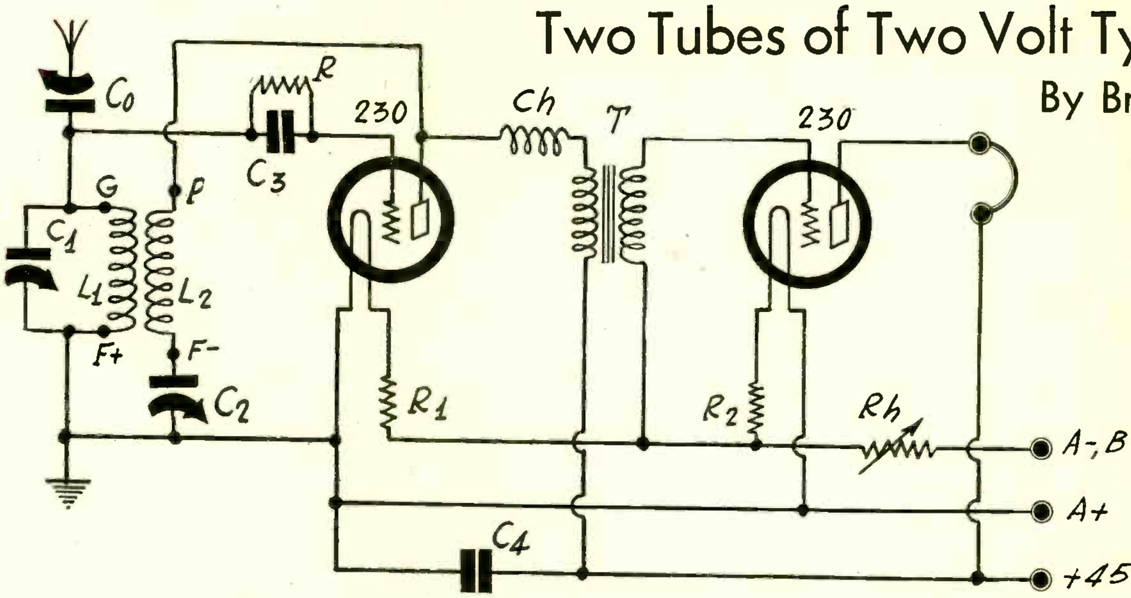

FIG. 1
The circuit of a two-tube regenerative, short-wave receiver for battery and earphone operation.

THOSE who want to play with short-wave reception and do not want to spend a great deal of money for it can build a simple two-tube receiver for earphone listening. It is really remarkable how many stations can be received with a simple set, and the distance which it will cover.

A receiver of this type should be built with the smallest tubes available, or tubes of the low filament current type. We have for this purpose the WD12 tubes, which take a filament current of 0.25 ampere and a filament terminal voltage of 1.1 volts. The battery voltage required is 1.5 volts, so that the power required for the filament of each of these tubes is really 1.5x0.25, or 0.375 watt. The other economical tube is the 230. This requires a filament current of 0.06 ampere and a battery voltage of 3 volts. Hence the power required by each of these tubes is 3x0.06, or 0.18 watt. Therefore this tube is much more economical, and it is just as efficient where only headset reception is in question. Two of these tubes in a receiver would only take a power of 0.36 watt. Two No. 6 dry cells connected in series will supply the power. The rating of a cell of this kind is 0.25 amperes, and the two 2-volt tubes require only 0.120 ampere. These cells are cheap and obtainable practically everywhere so frequent replacement is not a serious matter.

Regenerative Circuit Necessary

In order to get much sensitivity out of a circuit of this type it is essential that it be made regenerative and that the regeneration be closely controllable. The fixed tickler with the variable throttling condenser in series has been found to be satisfactory for short-wave reception and for that reason this type is incorporated in this two-tube circuit.

Another feature that has been found suitable for short-wave receivers is direct coupling between the antenna and the tuned circuit, provided that a small adjustable condenser is put between the antenna and the tuned circuit. This condenser is necessary in order to reduce the antenna effect on the tuning characteristic of the circuit, and to increase the selectivity. Without this series condenser, which is marked Co in Fig. 1, it is usually not possible to make the circuit oscillate, because the resistance in the antenna is added to the resistance in the tuned circuit.

Sometimes the regeneration cannot be controlled satisfactorily with the variable condenser, C2, in series with the tickler because the variation is too rapid. Sometimes this is remedied by putting a variable resistance in series with the tickler circuit, sometimes by varying the applied plate voltage. In this circuit the extra control is effected by varying the filament current by

LIST OF PARTS

Coils
L1L2—One est of four plug-in coils as described.
T—One audio frequency transformer, preferably of 1-to-6 ratio.
Ch—One 10 millihenry choke.

Condensers
Co—One 60 mmfd. midget variable condenser.
C1—One 140 mmfd. variable condenser, preferably straight line frequency.
C2—One 250 mmfd. variable condenser.
C3—One 0.0001 mfd. fixed grid condenser.
C4—One 2 mfd. by-pass condenser.

Resistors
R—One 2 megohm grid leak.
R1, R2—Two 15 ohm ballast resistors.
Rh—One 10 ohm rheostat.

Other parts
Three UX sockets, one for coil and two for tubes.
Seven binding posts.
Two knobs, for Co and C2.
One dial for C1, preferably vernier.
Small wooden subpanel.
A small bakelite panel with metal foil or sheet backing for shielding.

Eternal Vigilance—and Still

By J. R.
Chief Engineer,

IT is doubtful that any department of broadcasting is as important as the transmitter. If that fails the efforts of every other becomes futile. One may liken it to the human heart.

The number of break-downs in the case of major stations is exceedingly small. But it is not so extraordinary when one considers that even royal infants get no better care.

Lay listeners, of course, take this efficiency as a matter of fact, but there is an interesting story behind the precautions taken to insure continuous transmission. Naturally the care centers around the vulnerable parts of the apparatus parts which wear out after a certain number of continuous operations.

Tubes head the list. Then come fuses, resistances and condensers. As the quality of the signals depend upon the tubes they are under constant surveillance. When one is received from the manufacturer, its characteristic chart is carefully studied and tested for discrepancies.

Once a tube goes into the WOR transmitter, a graph of its operation and efficiency is started. This concerns the amount of grid bias and plate current which tells the story of its electronic emission. All tubes are guaranteed for a thousand hours, but nothing is taken for granted. As a matter of fact some of the tubes in WOR's transmitter have been used as many as 10,000 hours. Many of them have "lived" between 6,000 and 9,000 hours.

On WOR's transmitter panel are thirty-one meters, thirteen of which tell the story of the tubes. Readings of all of these meters are taken every fifteen minutes and comparisons with previous checks made. Wide variations put the engineers on their guard and investigation as to the cause immediately instituted.

Excessive heating and corrosion form the two banes of the broadcasting engineer's life. The former causes the condensers to bulge. Sometimes they explode with a report that would do credit to the famous French "75" cannon. All the connections in the transmitter are burnished and re-tightened daily to eliminate the effects of corrosion. This is because WOR is located in the Jersey meadows, which are really salt marshes.

Exploding condensers are rare. When they do happen an

adphone Midget

ermit Construction of Tiny Set

Brunn

means of Rh. By setting this rheostat properly it is always possible to adjust the tube so that the control of the regeneration by means of C2 is gradual and smooth.

Choice of Condensers

Condenser Co should be a midget variable of not more than 100 mmfd. and perhaps not less than 50 mmfd. This condenser should be mounted on the panel and be represented there by a knob. The place on the tuning condenser dial where any particular station comes in depends largely on the setting of Co. When it is set at a low value the tuned circuit C1L1 practically alone determines the tuning, but when Co is set at a large value the antenna capacity is added to the C1 to a large extent. However, the added capacity is always less than the capacity at which Co is adjusted. If the antenna is very long and has a large capacity Co determine the capacity which is added to C1.

If Co is too small the set will not be sensitive because there will be too large voltage drop across it, and too little across the tuned circuit. But if the frequency is high the capacity of Co has to be very small before there is any noticeable drop in the sensitivity. One reason for this is that the regeneration increases as the value if Co is made smaller.

The tuning condenser C1 should be comparatively small, so that the stations will be spread out on the dial well. A popular capacity for this condenser is 140 mmfd., but capacities from 60 to 200 mmfd. are quite suitable. The larger values are all right if the dial is of the slow motion type. If an ordinary knob type of dial is used it is better to use a small tuning condenser.

Condenser C2 in series with the tickler may be larger than the tuning condenser and 250 mmfd. is a popular value. This is recommended. However, if the circuit is to be built on diminutive proportions C2 may be of the midget type, which can be had in capacities up to 200 mmfd. The rotor of this condenser, as well as that of the tuning condenser, should be grounded, as shown in the diagram.

Not only should the rotors of the two condensers be grounded to prevent body capacity, but there should be a metal shield, also grounded, between the dial and the coils and condensers. It will be noticed that the rotor of the antenna series condenser Co is connected to the antenna rather than to the stator of the tuning condenser. This connection is also in the interest of elimination of body capacity.

The grid condenser C3 should have a value of 0.0001 mfd. and the by-pass condenser C4 a value of 2 mfd. C4 may be omitted when the B battery is fresh, for then it is not needed. Of course, since it is needed when the battery is old, it might as well be put in.

The grid leak R should have a value of 2 megohms or more. R1 and R2, the ballast resistors in the filament circuits of the two tubes, each should have such a value that they cause a drop of one volt. The current normally in each filament is 0.06 ampere, and therefore the resistance should be 1/.06, or 16.7. This is not a commercial value, so 15 ohms should be selected. This is perfectly safe even when the filament battery is new and when the rheostat is set at zero.

The rheostat Rh is used as a volume control in addition to C2, as was stated previously. This should have a resistance such that the terminal voltage can be reduced to as low as 1.5 when desired. Let us see what value is necessary. The resistance of each filament and the 15 ohm resistance in series is 48.3 ohms. Hence the resistance of the two parellel branches will be 24 ohms approximately. The voltage in the circuit is 3 volts. Hence the total current with Rh in the circuit is 3/(24+Rh), in which Rh stands for the resistance of the rheostat. If the voltage across the tubes is 1.5 volts, the current in each tube must be 1.5/2 of the normal current, or 1.5/2 of 0.12 ampere. That is, 0.09 ampere. Hence we have 3/(24+Rh)=0.09. Solving this equation for Rh we obtain Rh=9.33 ohms. Therefore we choose a 10-ohm rheostat. This is based on the supposition that that the voltage of the filament battery is 3 volts, two dry cells in series.

Audio Amplifier

A small choke Ch is put between the plate of the detector and the primary of the audio frequency transformer T to force the r-f currents through the tickler circuit. This choke should be one of about 10 millihenries and may be one of the 300 turn duolateral chokes now available.

The audio transformer T should have a rather high ratio, say 1-to-6, to step up the signal voltage and make the set sensitive. Of course, a transformer of lower ratio is all right, too. The output tube is of the same type as the detector, and should be a 230 2-volt tube.

If the capacity of the tuning condenser C1 is 140 mmfd., and allowing 10 mmfd. additional for distribution, the inductance required to tune to 1,500 kc is 75 microhenries. If the minimum capacity of the condenser is 15 mmfd., the total zero setting capacity is 25 mmfd. Hence the capacity ratio is 150/25, or 6. Therefore the frequency ratio is 2.45, which is the square root of 6. Therefore if we want to tune from 1,500 kc to 30,000 kc we need four coils in the set. This will allow considerable overlap. In fact, the frequency ratio of any one coil need only be 2.12.

On this basis the largest coil in the set will be used for the band 1,500 kc to 3,180 kc, the next from 3,180 kc to 6,750 kc, the next from 6,750 kc to 14,300 kc, and the smallest coil from 14,300 to 30,000 kc. We determine the required inductances from 1.500, 3,180, 6,750 and 14,300 kilocycles. We have already found the inductance for the largest coil. For the second coil we need 16.7 microhenries, for the third 3.71 microhenries, and for the smallest 0.825 microhenries.

Plug-in Coils

If we use No. 28 enameled wire and plug-in forms of 1.25-inch diameter we will need the following turns to give these inductances: 48, 18, 8.56 and 4 turns. Due to the arrangement of the terminals on the plug-in sockets there will always be a fractional turn on any coil. The nearest whole number of turns should be used in each case, except for the third coil, in which the fraction should be recognized. The overlap is ample to cover any discrepancies which will necessarily arise in winding the coils under these conditions.

The tickler winding in each case should be approximately 2/3 of the tuned winding. That is, they would be 32, 12, 6 and 3 turns. The tickler winding is not critical at all. It is assumed that the spacing of the turns is that determined by the diameter of the wire. There need be no spacing between the secondary and the primary in any case, although there may be as much as a quarter of an inch.

The Transmitter Stops!

Poppele

WOR, Newark, N. J.

auxiliary transmitter of 500 watts is put in operation and the interruption is short-lived. One of the engineers has a record of shifting between two notes on an organ. A return shift is almost as fast because duplicates of every vital part of the transmitter have their own particular niches on the shelves of the stock room.

Nature sometimes defeats the best efforts of the technical staff, however. Storms take the leading role, while birds and insects play an occasional part. Dust has no chance to accumulate. One could wipe any part of the transmitter with a white glove and find it unsoiled.

Electrical disturbances in the atmosphere sometimes put a part of the public service power circuits out of commission. When this happens a surge takes place. Power-house engineers remedy it within a few seconds but WOR engineers take no chances. They "break" the circuit with anyone of a number of push-buttons conveniently placed about the transmission room.

On the big transmitter is a safety gap that guards against short-circuits. At either side of the quarter-inch space are two brass bells about two inches in diameter. When a fly or other insect flies between the two points there is a flash and ten-thousand volts send the insect to join his ancestors. Meanwhile, of course the station goes off the air for a split second.

These incidents belong to the category of the unexpected and it is such occurrences that give the technicians the most worry. Seth Gamblin, chief of the transmission engineers under Mr. Poppele, and Vincent J. Doyle, one of his assistants, were talking shop one evening at dusk. Suddenly they noticed that the aerial circuit was being detuned. Running outside they discovered hundreds of blackbirds roosting on the antenna. They were dislodged with stones. The next day neither was able to raise his "throwing" arm.

Another break-down was due to the curiosity of a police officer, who had stopped in for a drink of water. After getting it he stopped at the "cage" door and opened it for a "better look." As a precaution against electrocution, the door is so arranged that it automatically shuts off the transmitter when opened. Meanwhile. the station crew dashed hither and yon changing fuses and other apparatus until one of them saw the "cop."

Experiments with Short-

Elimination of Two Tubes Made a Partic

By Eina

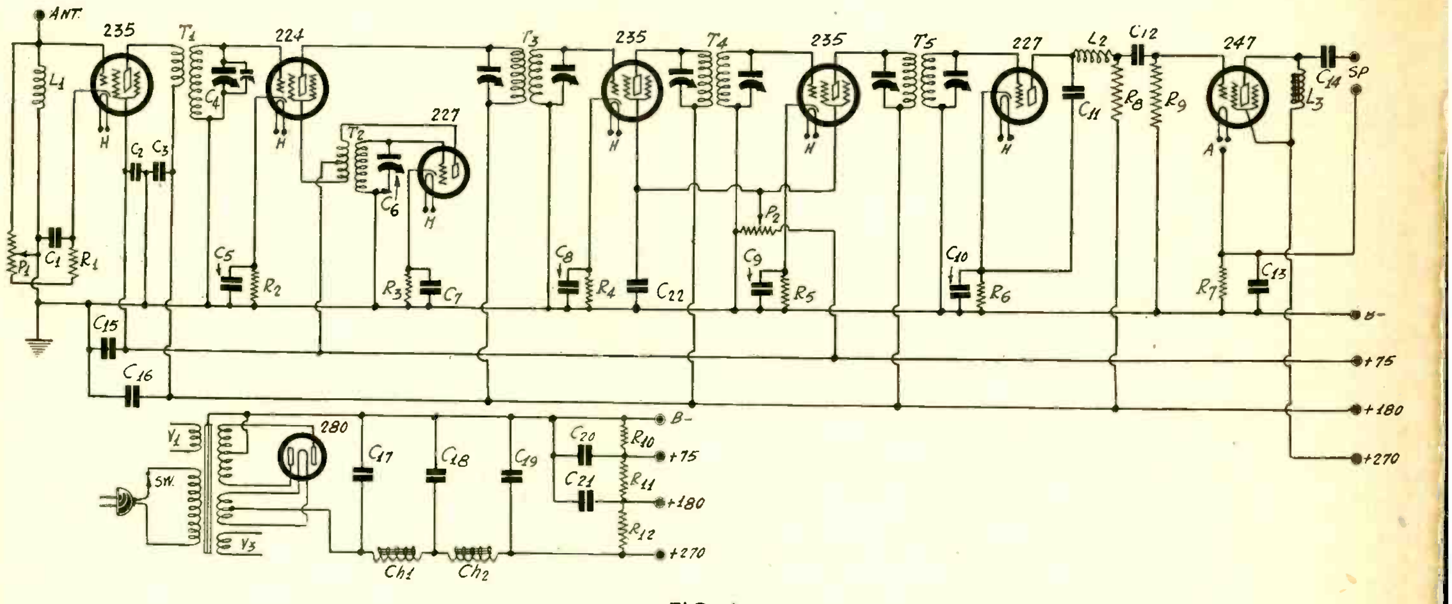

FIG. I
The diagram of a seven tube short wave or all-wave superheterodyne with an intermediate frequency of 450 kc. This was used for experimental purposes rather than for reception.

THE circuit shown in Fig. 1 was built for short-wave reception primarily, but by means of plug-in coils it was made to cover the broadcast waves as well, and better. It was not intended as a final receiver, but rather as a subject of experimentation for finding out the characteristics of the superheterodyne in short-wave reception. The circuit is a typical one, so there is no necessity of explaining the function of the various components.

Instead of starting at the antenna, as is usual, we shall start at the output and recount the experiences as the various parts and values were changed. During the tests the signal was constant and was generated by a modulated laboratory oscillator set up a short distance from the receiver. The modulation frequency was of the order of 120 cycles per second.

The Output Stage

The voltage maintained on the plate and screen of the pentode was 270 volts total, which was divided between the plate and the grid in the usual manner. The bias resistance R7 was 400 ohms. The output at the low modulation frequency depended appreciably on the value of the condenser C_{13} across this resistance. With the condenser off the output was weak and as the capacity was increased the strength increased. A condenser of 8 mfd. was used finally, but this does not represent the best value, for a larger one would bring out the signal more strongly, especially on modulation frequency lower than that used.

There was also a marked difference between the output obtained when the speaker was returned to the positive end of R7 and that obtained when it was returned to ground. The positive return was considerably better as judged by the output at the modulation frequency employed. L3 and C14 were a unit especially designed for filtering the output. The condenser in this unit was only 2 mfd. When an external condenser of 8 mfd. was connected in shunt with C14, the output was appreciably greater. If low notes are desired in full both C13 and C14 should be at least as large as stated and the speaker return should be made to the positive end of the bias resistance. This, however, is not practical when an output transformer is used in place of the output filter.

The values of C12 and R9 also had a considerable effect on the output. Various values were tried for C12 and finally a 0.1 mfd. capacity was retained. This was in conjunction with a value of 500,000 ohms for R9. That is, the time constant of the two is 0.05 second, which is high enough to transmit all essential low notes.

For detection a 227 tube with high grid bias was used. The voltage applied in series with the 100,000 ohm resistance R8 is 180 volts. This gave good results when the bias resistance

LIST OF PARTS
For Fig. 2

Coils:
L1—One set of plug-in coils.
T—One set of oscillator plug-in coils.
T1, T2—Two 450 kc shielded and tuned intermediate frequency transformers.
Ch1, Ch2—Two 30 henry choke coils.
PT—One power transformer.
Condensers:
Co—One 100 mfd. variable condenser.
C1, C2—Two 200 mfd. midget tuning condensers.
C3, C4, C5—Three 0.1 mfd. by-pass condensers.
C6—One 2 mfd. by-pass condenser.
C7—One 0.00025 mfd. condenser.
C8—One 0.1 mfd. condenser,
C9—One 4 mfd. condenser or larger.
C10—One 8 mfd. condenser or larger.
C11, C12—Two 4 mfd. electrolytic condensers, or larger.
C13, C14—Two mfd. by-pass condensers or larger.
Resistors:
R1, R3—Two 300 ohm bias resistance.
R2—One 2,000 ohm resistance.
R4—One 16,000 ohm resistance.
R5—One 100,000 ohm resistance.
R6—One 0.25 megohm resistance.
R7—One 0.5 megohm grid leak.
R3—One 400 ohm bias resistance.
R9—One 5,000 ohm resistance.
R10—One 4,000 ohm resistance.
R11—One 5,000 ohm resistance.
Rh—One 10,000 variable resistance.
Other Parts:
Five UY sockets.
One UX socket.
Sw—One line switch attached to Rh.
One vernier dial for C2.
One knob for C1 to match knob on Rh.

wave Superheterodynes

lar Circuit More Sensitive and Selective

Andrews

R6 was adjusted to a suitable value. Its final value was 16,000 ohms. The results were not satisfactory until condensers C10 and C11 were connected and until C10 was made 2 mfd. C11 had a value of 0.00025 mfd. There was no appreciable difference between the results obtained when C11 was connected to ground and the point shown. There is a good theoretical reason, however, for connecting it as in the diagram, and the reason is the same as the reason for connecting the speaker return to the top of R7. The choke L2 makes little difference and it might just as well be left out. The condenser C11 alone has an impedance of about 1,000 ohms at the lowest broadcast frequency and this amounts to a practical short circuit across the 100,000 ohm resistance R8. Hence no radio frequency signal will be transmitted to the power, or at least not enough to interfere with the power tube.

The intermediate amplifier consists of three doubly tuned transformers, T3, T4 and T5, all of the six tuned windings being tuned to exactly the same frequency, approximately 450 kc, and two 235 exponential tubes. In this part of the circuit the first real trouble was encountered. Although each transformer was in an aluminum shield and all leads were shielded, with the exception of the leads to the caps of the tubes, there was oscillation in the circuit. It was impossible to approach close tuning without oscillation occurring. When the screen voltage was reduced oscillation persisted even when the amplification was so low that the circuit had lost most of its sensitivity. The use of higher grid bias resistors for R4 and R5 than 300 ohms did not help much. To stop the oscillation it was necessary to detune the i-f stages, to reduce the screen voltage excessively, or to increase the bias to a high value.

The first 235 in the i-f amplifier and the middle tuned transformer were then eliminated from the circuit by connecting the grid clip from T3 to the cap of the second 235 tube, first removing the grid clip from that tube, that is, the clip connected to T4. The two tuned circuits in T4 were then detuned as far as possible. Then it was possible to tune the four remaining circuits to exact resonance. Even then there was oscillation when the screen voltage was raised to 75 volts by means of the potentiometer P2. This, however, was not regarded a defect, since the oscillation could be controlled with P2. Of course the circuit was more selective when four accurately tuned circuits were used than when six detuned circuits were used. And there was more useful amplification.

Too Many Tubes

This is just one example of using too much amplification and getting less out of the circuit. Many superheterodynes as well as tuned r-f sets have had this defect. Obviously, it is sound economy to eliminate one tube and one tuned transformer and get more reception for less expenditure.

Potentiometer P2, used for controlling the screen voltage, had a value of 25,000 ohms, and it was wire wound. This instrument is connected so that the screen voltage can be varied from zero to 75 volts.

The oscillator is an essential feature in every superheterodyne. If the circuit gives anything at all when the oscillator is dead, the circuit is defective to the extent of the signal or noise output. If a signal gets through it does so through distributed capacity and stray inductance fields. But as soon as the oscillator tube starts functioning the receiver should come to life.

The oscillator shown in this circuit is typical. It contains a 227 tube which is biased by means of a 2,000 ohm resistance R3, which in turn is shunt with a 0.1 mfd. condenser. The bias resistance could be reduced to 1,000 ohms, or even less, without affecting the functioning of the circuit. This is the least troublesome part of any superheterodyne.

The only thing that might cause trouble is the coupling between the oscillator and the modulator tube. If this is too close there will be overloading of the circuit from the first detector, or modulator, on. This will result in multiple response. Of course, if the tickler winding is not connected correctly, or if it is not large enough, the tube will not oscillate. This cannot be called a trouble with the oscillator, for the circuit is not an oscillator until this part has been done right.

While the output of the oscillator may be impressed on the modulator in many different ways, one about as good as any other, the method here shown is not only good, but very convenient. The tickler winding is tapped at a point near one end. The large-turn terminal is connected to the plate of the oscillabor tube and the small turn terminal is connected to the screen of the modulator tube, while the tap is connected to the voltage suitable for the plate of the oscillator and the screen of the modulator. In this case the voltage is 75 volts.

To insure correct phasing of the two windings on the oscillator form, start winding the grid winding at one end of the form and connect the first terminal to the grid of the oscillator and the second to ground. Continue winding, with the same other wire, in the same direction and connect the first terminal of this continued winding to screen of the modulator. The final terminal should go to the plate of the oscillator tube. Thus the grid and the plate terminals are farthest apart. The tap on the tickler winding goes to the plate supply as was stated. This arrangement will give the correct phasing and if the circuit does not oscillate there is no reason for reversing any windings, for if a pair is reversed the circuit cannot oscillate.

The placement of the tap should be from one to 10 turns from the end that is connected to the screen. The actual number used depends on the frequency involved and on the number of turns on the grid winding.

The above is simple and insures correct phasing. But an even better arrangement is to put the pick-up turns on the grid end of the coil away from the plate winding. It does not matter how the pick-up winding is phased.

If a five-prong form is used for the oscillator coil connect the coil terminals to the corresponding prongs. For example, G goes to G, P to P and K to ground. To be consistent we should connect the tap to Hp and that leaves Hk for the screen. Of course it does not really matter how the connections are made just so the socket is wired to correspond. There are five terminals on the coil, five prongs on the form and five receptacles in the socket, and the five may be arranged in any consistent manner.

Bias for Modulator

If the 224 tube is used as modulator and the screen voltage is 75 volts and the plate voltage 180 volts, a bias resistance R2 of 3,000 ohms will give best detecting efficiency. This is an experimental fact and not a theoretical deduction. It holds for a typical tube, but not necessarily for every 224 tube. However, the value is not critical, so even 2,000 or 4,000 ohms will work too.

The first tube in the circuit was a 235 exponential screen grid tube. This was used chiefly to isolate the r-f tuned circuit from the antenna, and this is about all that it does. In fact, under certain conditions the sensitivity is greater without the tube than with it. One reason for putting in the tube was to experiment with volume controls. A high variable resistance in the cathode lead, where R1 is shown, did not prove satisfactory. Neither did a simple shunt resistance across the input choke give good results. The best arrangement is that shown in the diagram. R1 is the normal bias resistance of 300 ohms for the pentode or the 224. P1 is a 10,000 ohm, wire-wound potentiometer. When the slider of this is moved the bias increases, because the bias resistance increases and the shunt resistance decreases. Thus the control is double acting.

By-pass condensers C1, C2, C3, C5, C7, C8 and C9 should have a capacity of 0.1 mfd. each, or more. C22 may also be one of this size.

C15 and C16 in the circuit diagram are really the same as C20 and C21 in the B supply circuit below the receiver circuit. Two microfarads each is a good value, but larger values are always better.

The B supply circuit is typical. It has two 30 henry choke coils and condensers, C17, C18 and C19. These may have values of 4, 8 and 8, respectively. The voltage divider resistances R10, R11 and R12 should have values of 5,000, 4,000 and 2,000 ohms, respectively.

The power transformer should have a 5-volt center tapped winding for the 280 rectifier, a 600-volt center tapped winding for the plates of the 280 tube and two other windings, each of 2.5 volts. Both of these should be center tapped also. One should have a heavy current rating, about 12 amperes, and its center should be connected to ground. The other should have a rating of about 3 amperes and its center should be connected to the positive end of R7. A represents the two terminals and the center tap of this winding. The filaments marked H should be connected to the heavy current winding.

(To be concluded next week)

A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions sent in by University Club Members are answered. Answers printed herewith have been mailed to University Members.

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By-pass for Pentode Bias

IT has been emphasized lately that the bias resistor for a 247 pentode should be by-passed with a very large condenser. About what should the capacity be if the amplifier is to be effective as low as 50 cycles per second? Is it also necessary to use a large condenser across the by-pass resistor for a 238 pentode?—L. W. J.

At 50 cycles per second the impedance of the 400 ohm bias resistance is reduced to 62.5 ohms with a capacity of 50 microfarads. This capacity is not too large if full volume is to be secured at the 50 cycle frequency. The same applies to the 238 pentode. In addition to putting a large condenser across the grid bias resistance, the circuit should be arranged so that as little signal current as possible flows through the combination. This may be done by using a high inductance choke in the plate circuit of the pentode for feeding the plate and connecting the loudspeaker, in series with a large condenser, from the plate to the cathode, that is, to the positive end of the grid bias resistance. The greater part of the signal current is then kept out of the bias resistance.

* * *

Interference in Superheterodyne

I HAVE built a short-wave superheterodyne with an intermediate frequency of 2,000 kc. The set is not selective, especially when I am receiving signals in the neighborhood of 2,000 kc. In fact many stations come in just as loud without the oscillator and with it going. What can I do to make the circuit more selective and to eliminate the interference of the 2,000 kc. stations?—T. Y.

Lower the intermediate frequency much below the lowest frequency which you want to receive. It would be better to select a frequency in the upper part of the broadcast band than to go up in the short-wave region. You may also need more selectivity both in the r-f and i-f tuners.

* * *

Lamp Socket Antennas

I HAVE used lamp socket antennas both in the city and in the relatively open country. I have noticed that in apartment houses the lamp socket antenna is not nearly so good as in districts where the houses are smaller or when they are far apart. Can you give an explanation for this?—B. S. L.

If that is generally true it must be because of the differences in the lines. In apartment houses the wiring is well covered and usually inclosed in metal shields. In most places where there are apartment houses, the wiring is entirely under ground until it gets to the building, where it continues in metal inclosures. In the open the wiring is mostly overhead and strung on poles. The wires to the set don't have to go through much, if any, grounded shielding. Therefore in the country one would expect the lamp socket antenna to be very good while in the crowded city one should not expect any signals, or at most, very weak signals.

* * *

Output of a Diode Rectifier

IF the grid and the plate of a 227 tube are tied together and the tube is used as a diode rectifier, how much voltage can be obtained from it without overloading, assuming that we have plenty of signal voltage?—W. T. Y.

The limit is about the same as the limit of plate voltage that may be applied without breaking down the insulation of the elements. A tube ought to stand as much as 180 volts. Of course, it depends on the resistance in the circuit. If this is low the limitation is the saturation current and the corresponding voltage. If the resistance is very high the output voltage is very nearly equal to the peak of the signal voltage and this can be made at least 100 volts. This means that there is a peak voltage of 50 volts per tube in a push-pull amplifier. To load up a pair of 247 pentodes we need only 33 volts, and we can easily get this out of the rectifier. When the 227 is used as a B supply rectifier voltages as high as 150 have been obtained with a nominal input of 110 volts. Peak value of this voltage is about 156 volts. Nearly as well can be done if the a-c voltage put on the tube is radio frequency.

* * *

Induced Voltage

I HAVE read that induced voltage is equal to time rate of change of magnetic flux. Will you kindly explain why this is so?—B. L. S.

This is an experimental fact established by Faraday and it does not admit an explanation. We just have to take it as it comes and let it go at that. If you mean to explain the statement rather than the fact an explanation is easy. Or at least an illustration is easy. Let i be the current flowing in a coil the self-inductance of which is L henries. Then the flux is Li. Then the voltage induced, or the back voltage, is equal to L times the time rate of change of the current. For example, if at the instant the current has the value i amperes it is changing at the rate of one ampere per second, then the back voltage is L volts. A better illustration is obtained by using mutual inductance. Suppose we have a transformer in the primary of which a current i amperes is flowing and the mutual inductance between the two windings is M henries, then at the instance the current has the stated value if the current is changing at the rate of one ampere per second, the voltage induced in the secondary winding is M volts. In case the change is other than one ampere per second the induced voltage is equal to the product of M and the rate of change of the current. In a transformer with an alternating current in the primary both the current and the rate of change of that current are always changing, but at any instant the law holds. Therefore, when the current is minimum or maximum, at which time it does not change, the voltage induced is zero. When the current is zero the current changes most rapidly. Hence the voltage induced then is maximum.

* * *

Bias Voltage Supply

IN view of the fact that it is difficult to get a high enough by-pass capacity across the bias resistor for the 247 pentode to bring out the amplification of the lowest audio notes, would it not be practical to use a small grid battery eliminator which is entirely free of feed back troubles?—A. B. M.

This is quite feasible and it would probably be more economical to do it than to provide a by-pass condenser across the bias resistance, especially if it is essential that audio notes as low as 25 cycles per second are to be amplified. Such a device has been described many times in RADIO WORLD, especially in connection with battery operated tubes, It will soon be described again especially for use with up-to-date circuits. A device of this sort could also be used as a volume control in connection with exponential tubes.

* * *

Motorboating Remedy

I HAVE built a resistance coupled amplifier which motorboats violently on a low frequency. I can stop this by reducing the isolating condenser between the last two tubes and also by reducing the grid leak. But I have noticed that this reduces the response on the low notes more than it does on the high, and therefore it defeats the purpose of the resistance coupling. It occurred to me that I could effect the same change in the motorboating by using a high resistance potentiometer instead of a simple leak and connecting the grid of the power tube to a point below the top. This, as I see it, would reduce the amplification the same amount on all frequencies and it would only be necessary to reduce it until the motorboating stops. What do you think of the idea?—E. W.

The idea is good provided that there is so much amplification that you can spare a large part of it. In some cases of motorboating it requires so much reduction in the amplification that there is practically nothing left. If the same reduction is effected on all frequencies you have no amplifier. There are other methods of reducing motorboating and they should be tried first. For example, much depends on how the return of the loudspeaker is made with respect to the cathode of the power tube. If the plate of the power tube is fed through a very high inductance choke and then the speaker is connected between the plate and the cathode, in series with a very large condenser, there is little feed back from the power tube, and this may be sufficient to stop the motorboating, or at least reduce it so that the rest could be controlled by the method you suggest.

* * *

Displacement Current

WHAT is a displacement current? I have seen this expression in books but I don't have any clear notion just what it is and how it differs from ordinary current.—E. S.

A displacement current might be defined as a condenser current. We speak of current through a condenser but actually there is no current through it. Take any dielectric which is a very poor conductor of electricity. If this is placed in the field of a condenser it alters the capacity. Electrons move in the dielectric to and fro but they do not become dislodged. Imagine any plane in the dielectric. Across this plane there is a displacement of electrons back and forth. This is displacement current.

Sparkles

By Alice Remsen

THE LONE ROAD

(*The Street Singer—WABC,* 2:00 *P.M.*)

Mondays, Wednesdays and Saturdays

IT'S a long road, a lone road, a weary road I travel,
But as long as it is, as lone as it is, I never make moan, or cavil;
I go my way through the silent night, while the stars my cares unravel,
And I'll go alone, and I'll travel light, until Time pounds with his gavel.

For my ears are deaf to the noisy din that flies through the air around me,
And I wend my way through the love and sin of the creatures that surround me.
Though their mouths may speak, I cannot hear; their touch I cannot feel;
Their gall-tipped pens I do not fear; on my soul I keep a seal.

For I've found it's best to travel alone, with mind and soul quite free,
To range afar unseen, unknown, from friendship's curse to flee.
For solitude is my best friend, and I have time to squander;
I take whatever the gods may send as along the road I wander.

Once a companion walked with me—we were equal, side by side,
A kindred soul who talked with me . . . The name of this friend was Pride.
I opened my heart and took him in; I prayed that he might stay,
But Life came along with a cynical grin and took my companion away.

It's a long road, a lone road, a weary road I travel,
But as long as it is, as lone as it is, I never make moan or cavil;
I go my way through the silent night, while the stars my cares unravel,
And I'll go alone, and I'll travel light, until Time pounds with his gavel.

—A. R.

And if you have not yet heard the Street Singer, tune him in at your next opportunity. He is worth a listen. This boy sings well, in several different languages, and by his delivery I should say he has traveled the long lone road of experience, the road that leads to ultimate success.

* * *

Word comes from NBC that four nationally known male singing groups have been reorganized. The membership of each group is now as follows:

The Revelers: James Melton, Lewis James, Philip Dewey, Wilfred Glenn.

The Cavaliers: Henry Shope, Leo O'Rourke, John Seagle, Elliott Shaw.

The Ramblers: Henry Shope, Frank Parker, Walter Preston, William Wirges.

Men About Town: Frank Luther, Jack Parker, Darrell Woodyard, Will Donaldson.

* * *

William Merrigan Daly is having many honors thrust upon him. He was recently chosen by George Gershwin to conduct the "Rhapsody in Blue" when it was played by the New York Philharmonic Orchestra at the Lewissohn Stadium, and a jolly good job he made of it. He was also chosen by the Herald Tribune as its 69th Typical Reader. Swell picture in the paper n'everything. Now he conducts the "Voice of Firestone" symphony orchestra over WEAF every Monday night at 8:30 to 9:00 p. m. Deserves it, does Bill, he's a fine conductor and a regular fellow.

* * *

The time on several WOR features has been changed: "Footlight Echoes" will now be heard on Sunday evenings, at 10:30, for a full hour, with Maria Cardinale, soprano; Alice Remsen, contralto; and Jack Arthur, baritone. George Shackley conducts the orchestra. The Little Symphony orchestra will be heard Saturday evenings at 9:00 p. m.; and Alice Remsen will be heard Saturday evenings at 8:30 instead of 10:00, that spot being taken by Cliff Hammons and his "One Man Show."

* * *

When the market and Halsey Street Playhouse program was taken off the air by WOR, I breathed a sigh of regret, for there was a genuinely outstanding novelty that never lost its exuberant vitality, although it had been on the air for three consecutive years. One of the reasons for its continued success was the personality of its creator, the inimitable Roger Bower, who developed the fine art of creating an illusion for his radio audience, with his graphic descriptions of "dumb acts," "news and comedy reels" and his never-to-be-forgotten cry of "popcorn and peanuts."

* * *

SIDELIGHTS

Daniel Frohman avers that the sketch hastily scratched off by Jeff Sparks, NBC announcer, while Mr. Frohman was broadcasting recently, is the best drawing ever made of him. . . . Ann Leaf has just learned to swim; she took lessons in a pool at Westchester. . . . Andre Baruch owns an alligator named Agamemnon. . . . Dennis King is left-handed. . . . Morton Downey doesn't like black cats. . . . William Lundell, NBC announcer, used to be a Unitarian minister. . . . William Wirges I is a trombonist and bandmaster of Buffalo, N. Y.; William Wirges II is an NBC pianist and conductor, and William III insists that he's only going to conduct. . . . Clem McCarthy learned about horses in his father's livery stable at Detroit. . . . Artells Dickson has bought a house in Flushing, L. I. . . . It will soon be time for the NBC announcers to discard their white flannel trousers and dark coats for the formal evening attire demanded for Winter evenings. . . . Ben Alley wrote a song while on his vacation, entitled "The Old Mill Wheel Keeps Turning Just the Same."

BIOGRAPHICAL BREVITIES

Welcome Lewis

Not only in the days of Shakespeare, but before and after, people have been trying to find out what's in a name, and now the sleuths have been at work on the strange case of Welcome Lewis. Not that we would suggest that she isn't welcome, but simply because such a praenomen (yes, it's in the dictionary) as hers is not often bestowed, the explanation, attested by numerous affidavits, is that her mother had eight children already, and when the subject of this B.B. was born mother was so glad to have another girl that she called her "Welcome." Now the family calls Welcome "Babe." And her friends call her "Half-Pint," for her diminutive size.

Yes, Welcome is miniature, in spite of the power behind her deep contralto voice. Wearing the highest of high heels, she is just five feet. When she steps on a scale, the hand barely points to ninety pounds.

There must be some truth in the saying, "Good things come in small packages," because Welcome is one of radio's most popular radio artists. When she first considered singing over the radio she wished for a beautiful high soprano voice, (all contraltos do, myself included.) It worried her. She did not then realize the radio value of her beautiful contralto tones.

Her chance to sing over the radio came unexpectedly. An NBC musical director heard one of her recordings at a party. He wrote to her, she was given an audition and immediately proceeded to make the name of Welcome something more than lettering on the family doormats throughout the country.

Since her radio debut she has sung, crooned and spoken into a microphone, and neither vaudeville, in which she formerly played, nor the theatre, could lure her away from the halls of broadcasting.

If, as the psychologists say, a child naturally selects its future work when quite young, she proved that her vocation would be a musical one when she was twelve. At that age she had an orchestra of her own, composed entirely of her schoolmates. She was the first violinist, conductor and vocal soloist, and she earned many pennies for trinkets. This was in California. Whenever the mothers of the neighborhood wanted to find their offspring they had only to go to the Lewis backyard. There the kids would be found, either listening to or playing in the Welcome Lewis Orchestra.

Now Welcome lives in Yonkers, and she always drives her own car into town for her broadcasts. She has no chauffeur and vows she'll never have one, for driving is her hobby, her relaxation. Given a new song, she gets into the car, goes off alone into the country and thinks it out. She considers phrasing a lyric as important as tonal quality. She believes that even popular songs require understanding, and she analyzes them in much the same manner as an actress studies a part.

Welcome is loads of fun. A feminine hail-fellow-well-met type, and popular with her fellow artists. She has close-cut dark hair, brown eyes, a swell smile, and flashing white teeth. Underneath her veneer of sophistication is a naivete that often asserts itself.

The National Broadcasting Company introduced her to radio, but lost her when she went commercial for Coty, and now she is heard every Thursday at 9:15 p.m. over WABC, as the Coty Melody Girl. She has a style all her own, a pleasing microphone personality and a sweet voice. Don't miss her.

[*If you like to know something of your favorite radio artists and announcers, address Miss Alice Remsen, c/o* RADIO WORLD, 145 *West 45th Street, New York.*]

A THOUGHT FOR THE WEEK

CHILDREN now of the runaround age take radio as second nature, and get to know the "radio uncles" better than blood uncles. The fathers and mothers to those children, if rarely blessed, may have heard early phonographs that cost four times as much as the present radio set, and which didn't give one-tenth the enjoyment.

RADIO WORLD

The First and Only National Radio Weekly
Tenth Year

Owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.

Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager; J. E. Anderson technical editor; L. C. Tobin, advertising manager.

The Big Show

THE Radio-Electrical World's Fair that will open on Monday, and run for a week, at Madison Square Garden, New York City, comes as a most welcome stimulus to the radio business at a time when it needs that assistance more than at any previous time. That show week is taken by almost everybody as the elongated opening of the radio season, and no doubt what the visitors will see at the show will stimulate them to purchase radio sets and accessories, for there is much from which to choose, and prices are most reasonable.

Even aside from the commercial phase of the show, there is much of interest, including an insight into the latest trends in radio sets, television improvements and exhibitions, and the view of noted performers broadcasting from the crystal room.

Interest in radio may be said to be highly specialized nowadays. This seems to be part of the trend of the times toward specialization. Formerly a person to whom radio was strange would roam through the show and fill a handbag with circulars and an assailed head with miscellaneous information and image retentions. Now a prospect has a fairly good idea of what he wants, but will look over the wares, preparatory to hearing actual tests in dealers' stores later, before purchasing.

So the visitor-specialist will find it easier to "do" the show, and interest will be focused on exhibits that count in the prospect's estimation. The fair not only has gone over virtually completely to manufactured sets, so far as radio is concerned, with the important accessories of tubes as companion, but has taken in other things electrical, including washing machines, refrigerators and fans. That is not going too far afield, but it is an admission that radio has not been able to continue the exclusive support of so large an undertaking as an annual fair in the great arena in New York City, no more than it was able to monopolize the trade show in Chicago.

The entry of radio manufacturers into additional electrical fields in part accounts for the augmentation, but this taking on of a side line is an expression of the same situation, that the fairs were too enormous for the industry.

Forum

That Coil Article

LIKE your publication very much. Find percentage of errors very low for publications of this kind. But will say find some of the articles not quite definite enough in specification of values used. Of course a person can figure out and try it himself, but it would be nicer to have the author's or experimenter's values, at the start.

Thank you very much for the coil data in recent issues. Would appreciate an article on biasing and on by-passing.

PAUL HOELLER,
851 E. 32nd St.,
Los Angeles, Cal.

* * *

Splendid! and Ugh!

I DESIRE to congratulate you on J. E. Anderson's splendid article on the "Design of R-F Coils" in the issue of the August 23rd. This article fills a long need and will be of great assistance to the fellow who has not the necessary technical knowledge to make his own calculations. A fitting supplement for this article would be a table of inductances at various frequencies.

There is, I am sorry to note, a very sour note in Mr. Bernard's article on page 12 of the same issue. The calculation for the turns of the oscillator coil is incorrect. Mr. Bernard evidently set his "slip stick" for an intermediate frequency of 275 kc, as the result is correct for this frequency. 1000/1175 equals 40/47 x 70 equals 59.55 turns. This is an error of approximately ten per cent.

C. A. COOLIDGE.
Kentfield, Calif.

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.

Larry Ciervo, 235 Hull St., Brooklyn, N. Y.
Herbert Ficker, 240 Kingston Ave., Brooklyn, N. Y.
E. B. Roberson, 3625—3rd St., Apt. 1, Detroit, Mich.
Paul Grass, Radio-Trician, 1085 Annette Ave., Montreal, Canada.
Edw. W. Packard, P. O. Box 623, Seattle, Wash.
Isadore Schwartz, 449 New Lots Ave., Brooklyn, N. Y.
Jack H. Hancock, 633 Orange St., Darlington, S. C.
C. R. Adams, 137 E. Rosemary St., Chapel Hill, N. C.
R. G. Jacobson, 811 Cook Ave., Billings, Mont.
J. D. Mecker, 211 E. 4th St., Cincinnati, Ohio.
Randolph C. Green, 22 N. Yewdell St., Philadelphia, Pa.
Thos. H. Brogan, Radio Service Shop, 149 State St., Auburn, N. Y.
C. Rynning, R. No. 3, Pontiac, Ill.
Arnold E. Rudahl, 408 North 10th St., Fairview, N. J.
H. A. Perdue, 1433 N. Berendo, Los Angeles, Calif.
Wm. H. Walker, 100 N. Salinas St., Santa Barbara, Calif.
A. W. Aberle, 45 White St., Eureka Springs, Ark.
Edward A. Halbach, 533 N. 18th St., Milwaukee, Wis.
R. B. McKithan, 817 So. 9th St., Temple, Texas.
G. T. Magill, Box 135, Ocala, Fla.
Pedro L. Damondt, 40 Union St., Guayama, P. R.
J. H. Hancock, 633 Orange St., Darlington, S. C.
H. M. Gifford, Star Route, Van, Penna.
Martin J. Russell, 161 Thompson St., Poughkeepsie, N. Y.

Flechtheim Announces New Condenser Types

A. M. Flechtheim & Co., Inc., of 136 Liberty Street, New York City, well-known makers of Flechtheim Superior Condensers, have announced several new types of small compact, low and high voltage by-pass and filter condensers for all types of repair work such as encountered by service men everywhere.

The new Catalog No. 24 lists these types which are available in all ranges of capacity from 0.1 to 4. mfd., 200 volts; 400 volts; 600 volts and 1,000 volts, d-c.

Especially outstanding amongst the new types of condensers offered by the Flechtheim Co. is the type NU rated at 600 volts, d-c, uncased, of exceedingly pleasing design, readily fitting into the smallest space for replacing burnt-out condensers.

The A. M. Flechtheim Co. will send their latest literature upon request.

Spearman Resigns as Commission's Lawyer

Washington.

The resignation of Paul D. P. Spearman, Assistant General Counsel of the Federal Radio Commission, has been announced at the Commission.

Mr. Spearman, who leaves to engage private practice of law, is the Senior Assistant General Counsel in point of service, having been with the Commission since 1929. His duties, for the most part, have been as counsel for the Commission at formal hearings involving applications of every kind, and he also has represented the Commission in cases before the courts involving appeals from decisions of that body and in cases having to do with violations of the radio law.

Parley on Education

An international conference dealing with adult education by radio has just been concluded in Vienna, Austria, being a part of the program of the World Association for Adult Education, according to information given by the United States Office of Education.

Levering Tyson, director of the National Advisory Council of Radio in Adult Education in the United States, was chairman of the international conference. During the sessions such subjects as the use of broadcasting directly and indirectly in education were discussed. Consideration was given to the technique in the broadcasting of the spoken word, the principles underlying educational broadcasting, and the relationship between the broadcasters and listeners.

SUNDRY SUGGESTIONS FOR WEEK BEGINNING SEPTEMBER 20TH

Sunday, Sept. 20—ANN LEAF	WABC	2:00 p.m.
Sunday, Sept. 20—FOOTLIGHT ECHOES	WOR	10:30 p.m.
Monday, Sept. 21—PAT Barnes	WJZ	12:15 p.m.
Monday, Sept. 21—Frank and Flo	WOR	9:45 p.m.
Tuesday, Sept. 22—Dennis King	WABC	7:15 p.m.
Tuesday, Sept. 22—Eddy Brown and Symphony	WOR	9:30 p.m.
Wednesday, Sept. 23—Nick Lucas	WEAF	7:00 p.m.
Wednesday, Sept. 23—Singing Sam	WABC	8:15 p.m.
Thursday, Sept. 24—John Charles Thomas	WJZ	9:30 p.m.
Thursday, Sept. 24—Weaver of Dreams	WOR	10:00 p.m.
Friday, Sept. 25—March of Time	WABC	8:30 p.m.
Friday, Sept. 25—Moonbeams	WOR	11:30 p.m.
Saturday, Sept. 26—The Goldbergs	WEAF	7:45 p.m.
Saturday, Sept. 26—Alice Remsen	WOR	8:30 p.m.

U. S. Broadcast Stations by Frequencies

(Corrected up to and including September 9th, 1931)

550 KILOCYCLES—*545.1 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WGR	Buffalo, N. Y. T—Amherst, N.Y.	Buffalo Broadcasting Corporation	1KW	Unlimited.
WKRC	Cincinnati, Ohio	WKRC (Inc.)	1KW	Do.
KFUO	St. Louis, Mo.	Evangelical Lutheran Synod of Missouri, Ohio, and other States, Rev. R. Kretzschmar, chairman of Control of Concordia Seminary	500W 1KW—LS.	Shares With KSD.
KSD	St. Louis, Mo	Pulitzer Publishing Co.	500W	Shares with KFUO.
KFDY	Brookings, S. Dak	South Dakota State College	500 W. 1KW—LS.	Shares with KFYR.
KFYR	Bismarck, N. Dak	Meyer Broadcasting Co.	1KW 2½KW—LS[1]	Shares with KFDY.
KOAC	Corvallis, Oreg.	Oregon State Agricultural College	1KW	Unlimited.

560 KILOCYCLES—*534.4 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WLIT	Philadelphia, Pa.	Lit Bros.	500W	Shares with WFI.
WFI	Do.	Strawbridge & Clothier	500W	Shares with WLIT.
WQAM	Miami, Fla.	Miami Broadcasting Co.	1KW	Unlimited.
KFDM	Beaumont, Tex.	Magnolia Petroleum Co.	500W 1KW—LS	Do.
WNOX	Knoxville, Tenn.	Sterchi Bros.	1KW. 2KW—LS	Do.
WIBO	Chicago, Ill. T—Des Plaines, Ill.	Nelson Bros. Bond & Mortgage Co.	1KW 1½KW—LS	Shares with WPCC and WISJ.[2]
WPCC	Chicago, Ill.	North Shore Church	500W	Shares with WIBO and WISJ.[2]
KLZ	Denver, Colo.	Reynolds Radio Co. (Inc.)	1KW	Unlimited.
KTAB	San Francisco, Calif. T—Oakland, Calif.	The Associated Broadcasters (Inc.)	1KW	Do.

570 KILOCYCLES—*526.0 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WNYC	New York, N. Y.	City of New York, Department of Plant and Structures	500W	Shares with WMCA.
WMCA	New York, N. Y. T—Hoboken, N. J.	Knickerbocker Broadcasting Co. (Inc.)	500W	Shares with WNYC.
WSYR-WMAC	Syracuse, N. Y.	Clive B. Meredith	250W	Unlimited.
WKBN	Youngstown, Ohio.	W. P. Williamson, Jr.	500W	Shares with WEAO.
WEAO	Columbus, Ohio	Ohio State University	750W	Shares with WKBN.
WWNC	Asheville, N. C.	Citizen Broadcasting Co.	1KW	Unlimited.
KGKO	Wichita Falls, Tex.	Wichita Falls Broadcasting Co, Inc.	250W 500W—LS	Do.
WNAX	Yankton, S. Dak.	The House of Gurney (Inc.)	1KW	Do.
KXA	Seattle, Wash.	American Radio Telephone Co.	500W	Do.
KMTR	Los Angeles, Calif.	KMTR Radio Corporation	500W	Do.

580 KILOCYCLES (Canadian Shared)—*516.9 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WTAG	Worcester, Mass.	Worcester Telegram Publishing Co. (Inc.)	250W	Unlimited.
WOBU	Charleston, W. Va.	WOBU (Inc.)	250W	Shares with WSAZ.
WSAZ	Huntington, W. Va.	WSAZ (Inc.)	250W	Shares with WOBU.
KGFX	Pierre, S. Dak.	Dana McNeil	200W	Daytime.
WIBW	Topeka, Kans.	Topeka Broadcasting Association (Inc.)	1KW[3]	Shares with KSAC.
KSAC	Manhattan, Kans.	Kansas State Agricultural College	500W 1KW—LS	Shares with WIBW.

590 KILOCYCLES—*508.2 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WEEI	Boston, Mass. T—Weymouth, Mass.	Edison Electric Illuminating Co. of Boston	1KW	Unlimited.
WKZO	Berrien Springs, Mich.	WKZO (Inc.)	1KW	Daytime.
WCAJ	Lincoln, Nebr.	Nebraska Wesleyan University	500W[4]	Shares with WOW.
WOW	Omaha, Nebr.	Woodman of the World Life Insurance Association	1KW	Shares with WCAJ.
KHQ	Spokane, Wash.	Louis Wasmer (Inc.)	1KW 2KW—LS	Unlimited.

600 KILOCYCLES (Canadian Shared)—*499.7 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WICC	Bridgeport, Conn. T—Easton, Conn.	Bridgeport Broadcasting Station (Inc.)	250W	Shares with WCAC
WCAC	Storrs, Conn.	Connecticut Agricultural Colleges	250W	Shares with WGBS.
WCAO	Baltimore, Md.	Monumental Radio (Inc.)	250W	Unlimited.
WREC	Memphis, Tenn. T—Whitehaven, Tenn	WREC (Inc.)	500W 1KW—LS	Unlimited.
WMT	Waterloo, Iowa	Waterloo Broadcasting Co.	500W	Do.
KFSD	San Diego, Calif.	Airfan Radio Corporation (Ltd.)	500W 1KW—LS	Do.

610 KILOCYCLES—*491.5 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WJAY	Cleveland, Ohio	Cleveland Radio Broadcasting Corporation	500W	Daytime.
WIP	Philadelphia, Pa.	Gimbel Brothers (Inc.)	500W	Shares with WFAN.
WDAF	Kansas City, Mo.	Kansas City Star Co.	1KW	Unlimited.
KFRC	San Francisco, Calif.	Don Lee (Inc.)	1KW	Do.
WFAN	Philadelphia, Pa.	Keystone Broadcasting Co.	500W	

620 KILOCYCLES—*483.6 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WLBZ	Bangor, Me.	Maine Broadcasting Co. (Inc.)	500W	Unlimited.
WFLA-WSUN	Clearwater, Fla.	Clearwater Chamber of Commerce and St. Petersburg Chamber of Commerce	1KW 2½KW—LS	Do.
WTMJ	Milwaukee, Wis. T—Brookfield, Wis.	The Journal Co. (Milwaukee Journal)	1KW 2½KW—LS	Do.
KGW	Portland, Oreg.	Oregonian Publishing Co.	1KW	Do.
KTAR	Phoenix, Ariz.	KTAR Broadcasting Co.	500W 1KW—LS	Do.

630 KILOCYCLES (Canadian Shared)—*475.9 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WMAL	Washington, D. C.	M. A. Leese	250W 500W-LS	Unlimited.
WOS	Jefferson City, Mo.	Missouri State Marketing Bureau	500W	Shares with WGBF and KFRU.
KFRU	Columbia, Mo.	Stephens College	500W	Shares with WOS and WGBF.
WGBF	Evansville, Ind.	Evansville on the Air (Inc.)	500W	Shares with WOS and KFRU.

640 KILOCYCLES—*468.5 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WAIU	Columbus, Ohio	American Insurance Union	500W	Limited.
WOI	Ames, Iowa	Iowa State College of Agriculture and Mechanic Arts	5KW	Daytime.
KFI	Los Angeles, Calif.[6]	Earle C. Anthony (Inc.)	50KW	Unlimited.

650 KILOCYCLES—*461.3 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WSM	Nashville, Tenn.	National Life & Accident Insurance Co.	5KW	Unlimited.
KPCB	Seattle, Wash.	Queen City Broadcasting Co.	100W	Limited.

660 KILOCYCLES (Canadian Shared)—*454.3 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WEAF	New York, N. Y. T—Bellmore, N. Y.	National Broadcasting Co. (Inc.)	50KW-LP	Unlimited.
WAAW	Omaha, Nebr.	Omaha Grain Exchange	500W	Daytime.

670 KILOCYCLES—*447.5 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WMAQ	Chicago, Ill. T—Addison, Ill.	WMAQ (Inc.)	5KW	Unlimited.

[1] Experimentally.
[2] WISJ temporarily operating on 780 kilocycles.
[3] Experimentally.
[4] C. P. to decrease power to 250 watts.
[6] C. P. to move transmitter to Buena Park and increase power to 50 KW-LP.

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

680 KILOCYCLES—*440.9 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WPTF	Raleigh, N. C.	Durham Life Insurance Co.	1KW	Limited.
KFEQ	St. Joseph, Mo.	Scroggin & Co. Bank	2½KW	Daytime.
KPO	San Francisco, Calif.	Hale Bros. Stores (Inc.), and the Chronicle Publishing Co.	5KW	Unlimited.

690 KILOCYCLES (Canadian Exclusive)—*434.5 Meters*

700 KILOCYCLES—*428.3 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WLW	Cincinnati, O. T—Mason, Ohio.	Crosley Radio Corporation	50KW-LP	Unlimited.

710 KILOCYCLES—*422.3 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WOR	Newark, N. J. T—Kearny, N. J.	Bamberger Broadcasting Service (Inc.)	5KW	Unlimited.
KMPC	Los Angeles, Calif.	R. S. MacMillan	500W	Limited.

720 KILOCYCLES—*416.4 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WGN—WLIB	Chicago, Ill. T—Elgin, Ill.	The Tribune Co.	25KW	Unlimited.

730 KILOCYCLES (Canadian Exclusive)—*410.7 Meters*

740 KILOCYCLES—*405.2 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WSB	Atlanta, Ga.	Atlanta Journal Co.	5KW	Unlimited.
KMMJ	Clay Center, Nebr.	The M. M. Johnson Co.	1KW	Limited.

750 KILOCYCLES—*399.8 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WJR	Detroit, Mich. T—Sylvan Lake Village, Mich.	WJR, The Goodwill Station (Inc.)	5KW	Unlimited.

760 KILOCYCLES—*394.5 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WJZ	New York, N. Y. T—Boundbrook, N. J.	National Broadcasting Co. (Inc.)	30KW-LP	Unlimited.
WEW	St. Louis, Mo.	St. Louis University	1KW	Daytime.
KVI	Tacoma, Wash. T—Des Moines, Wash.	Puget Sound Broadcasting Co. (Inc.)	1KW	Limited.

770 KILOCYCLES—*389.4 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
KFAB	Lincoln, Nebr.	KFAB Broadcasting Co.	5KW	Shares with WBBM-WJBT.
WBBM-WJBT	Chicago, Ill. T. Glenview, Ill.	WBBM Broadcasting Corp. (Inc.)	25KW	Shares with KFAB.

780 KILOCYCLES (Canadian Shared)—*384.4 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WEAN	Providence, R. I.	Shepard Broadcasting Service (Inc.)	250W 500W-LS	Unlimited.
WTAR-WPOR	Norfolk, Va.	WTAR Radio Corporation	500W	Do.
WMC	Memphis, Tenn. T—Bartlett, Tenn.	Paul Dillard and Enoch Brown, jr., receivers.	500W 1KW-LS	Do.
KELW	Burbank, Calif.	Magnolia Park Ltd.	500W	Shares with KELW.
KTM	Los Angeles, Calif. T—Santa Monica, Calif.	Pickwick Broadcasting Corporation	500W 1KW-LS	Shares with KTM.

790 KILOCYCLES—*379.5 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WGY	Schenectady, N. Y. T—South Schenectady, N. Y.	General Electric Co.	50KW	Unlimited.
KGO	San Francisco, Calif. T—Oakland, Calif.	National Broadcasting Co. (Inc.)	7½KW	Do.

800 KILOCYCLES—*374.8 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WBAP	Fort Worth, Tex.	Carter Publications (Inc)	10KW-LP[8]	Shares with WFAA.
WFAA	Dallas, Tex. T—Grapevine, Texas.	Dallas News and Dallas Journal A. H. Belo Corporation	50KW-LP	Shares with WBAP.

810 KILOCYCLES—*370.2 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WPCH	New York, N. Y. T—Hoboken, N. J.	Eastern Broadcasters (Inc.)	500W	Daytime.
WCCO	Minneapolis, Minn. T—Anoka, Minn.	Northwestern Broadcasting (Inc.)	7½KW	Unlimited.

820 KILOCYCLES—*365.6 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WHAS	Louisville, Ky. T—Jeffersontown, Ky.	The Courier Journal Co. and The Louisville Times Co.	10KW	Unlimited.

830 KILOCYCLES—*361.2 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WHDH	Boston, Mass. T—Gloucester, Mass.	Matheson Radio Co. (Inc.)	1KW	Daytime until sunset at Denver, Colo.
WRUF	Gainesville, Fla.	University of Florida	5KW	Limited.
KOA	Denver, Colo.	National Broadcasting Co. (Inc.)	12½KW	Unlimited.
WEEU	Reading, Pa.	Berks Broadcasting Co.	1KW	

840 KILOCYCLES (Canadian Exclusive)—*356.9 Meters*

850 KILOCYCLES—*352.7 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
KWKH	Shreveport, La. T—Kennonwood, La.	Hello World Broadcasting Corporation	10KW	Shares with WWL.
WWL	New Orleans, La.	Loyola University	5KW	Shares with KWKH.

860 KILOCYCLES—*348.6 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WABC-WBOQ	New York, N. Y. T—West of Cross Bay Blvd. Queens Co., N. Y.[9]	Atlantic Broadcasting Corporation	5KW	Unlimited.
WHB	Kansas City, Mo. T—North Kansas City, Mo.	WHB Broadcasting Co.	500W	Daytime.
KMO	Tacoma, Wash.	KMO (Inc.)	500W	Limited.

870 KILOCYCLES—*344.6 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WLS	Chicago, Ill. T—Crete, Ill.	Agricultural Broadcasting Co.	50KW[10]	Shares with WENR-WBCN.
WENR	Chicago, Ill. T—Downers Grove, Ill.	National Broadcasting Co.	50KW	Shares with WLS.

880 KILOCYCLES (Canadian Shared)—*340.7 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WGBI	Scranton, Pa.	Scranton Broadcasters (Inc.)	250W	Shares with WQAN.
WQAN	Scranton, Pa.	E. J. Lynett, prop. the Scranton Times	250W	Shares with WGBI.
WCOC	Meridian, Miss.	Mississippi Broadcasting Co. (Inc.)	500W 1KW-LS	Unlimited.
WSUI	Iowa City, Iowa	State University of Iowa	500W	Three-sevenths time.
KLX	Oakland, Calif.	The Tribune Publishing Co.	500W	Unlimited.
KPOF	Denver, Colo.	Pillar of Fire	500W	Shares with KFKA.
KFKA	Greeley, Colo.	The Mid-Western Radio Corporation	500W 1KW-LS	Shares with KPOF.

890 KILOCYCLES (Canadian Shared)—*336.9 Meters*

Call letters	Main studio location	Licensee	Power	Time of operation
WJAR	Providence, R. I.	The Outlet Co.	250W 400W-LS	Unlimited.
WKAQ	San Juan, P. R.	Radio Corporation of Porto Rico	250KW	Do.
WMMN	Fairmount, W. Va.	Holt-Rowe Novelty Co.	250W 500W-LS	Do.

(890 *kilocycles continued on next page*)

[8]Licensed at present for 10 KW only.

[9]C. P. to move transmitter to Wayne, N. J., and increase power to 50 KW-LP.
[10]C. P. to increase power to 50 KW-LP.

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

890 KILOCYCLES—*336.9 Meters—Continued*

Call letters	Main studo location	Licensee	Power	Time of operation
WGST	Atlanta, Ga.	Georgia School of Technology	250W / 500W-LS	Shares with WMAZ.
KGJF	Little Rock, Ark.	First Church of the Nazarene	250W	Unlimited.
WILL	Urbana, Ill.	University of Illinois	250W / 500W-$3	Shares with KUSD and KFNF.
KUSD	Vermillion, S. Dak.	University of South Dakota	500W-LS / 750W-LS	Shares with WILL and KFNF.
KFNF	Shenandoah, Iowa	Henry Field Co.	500W / 1KW-LS	Shares with WILL and KUSD.

900 KILOCYCLES—*333.1 Meters*

WBEN	Buffalo, N. Y. T—Martinsville, N. Y.	Edward H. Butler, trustee for Ada Butler, Mitchell and Edward H. Butler, trading as Buffalo Evening News.	1KW	Unlimited.
WKY	Oklahoma City, Okla.	WKY Radiophone Co.	1KW	Do.
WJAX	Jacksonville, Fla.	City of Jacksonville	1KW	Do.
WLBL	Stevens Point, Wis.	State of Wisconsin, Department of Agriculture and Markets.	2KW	Daytime.
KHJ	Los Angeles, Calif.	Don Lee (Inc.)	1KW	Unlimited.
KSEI	Pocaello, Idaho	KSEI Broadcasting Association (Inc.)	250W	Do.
KGBU	Ketchikan, Alaska	Alaska Radio and Service Co. (Inc.)	500W	Do.

910 KILOCYCLES (Canadian Exclusive)—*329.6 Meters*

920 KILOCYCLES—*325.9 Meters*

WBSO	Needham, Mass.	Babson's Statistical Organization (Inc.)	500W	Daytime.
WWJ	Detroit, Mich.	The Evening News Association (Inc.)	1KW	Unlimited.
KPRC	Houston, Tex. T—Sugarland, Texas.	Houston Printing Co.	1KW / 2½KW-LS	Do.
WAAF	Chicago, Ill.	Drovers Journal Publishing Co.	500W	Daytime.
KOMO	Seattle, Wash.	Fisher's Blend Station (Inc.)	1KW	Unlimited.
KFEL	Denver, Colo.[11]	Eugene P. O'Fallon (Inc.)	500W	Shares with KFXF.
KFXF	Denver, Colo.	Colorado Radio Corporation	500W	Shares with KFEL.

930 KILOCYCLES (Canadian Shared)—*322.4 Meters*

WIBG	Elkins Park, Pa.	St. Paul's P. E. Church	25W	Daytime.
WDBJ	Roanoke, Va.	Times-Royal Corp.	250W / 500W—LS	Unlimited.
WBRC	Birmingham, Ala.	Birmingham Broadcasting Co. (Inc.)	500W / 1KW—LS	Do.
KGBZ	York, Nebr.	Dr. George R. Miller	500W / 1KW—LS	Shares with KMA.
KMA	Shanandoah, Iowa	May Seed & Nursery Co.	500W / 1KW—LS	Shares with KGBZ.
KFWI	San Francisco, Calif.	Radio Entertainments (Inc.)	500W	Shares with KROW.
KROW	Oakland, Calif. T—Richmond, Calif.	Educational Broadcasting Corporation	500W / 1KW—LS	Shares with KFWI.

940 KILOCYCLES—*319.0 Meters*

WAAT	Jersey City, N. J.	Bremer Broadcasting Corporation	300W	Daytime until 6 p. m. eastern standard time.
WCSH	Portland, Me. T—Scarboro, Me.	Congress Square Hotel Co.	1KW	Unlimited.
WFIW	Hopkinsville, Ky.	WFIW (Inc.)	1KW	Do.
WHA	Madison, Wis.	University of Wisconsin	750W	Daytime.
WDAY	Fargo, N. Dak. T—West Fargo, N. Dak.	WDAY (Inc.)	1KW	Unlimited.
KOIN	Portland, Oreg. T—Sylvan, Oreg.	KOIN (Inc.)	1KW	Do.
KGU	Honolulu, Hawaii	Marion A. Mulrony and Advertiser Publishing Co. (Ltd.).	1KW	Do.

950 KILOCYCLES—*315.6 Meters*

WRC	Washington, D. C.	National Broadcasting Co. (Inc.)	500W	Unlimited.
KMBC	Kansas City, Mo. T—Independence, Mo.	Midland Broadcasting Co.	1KW	Do.
KFWB	Hollywood, Calif.	Warner Bros. Broadcasting Corporation	1KW	Do.
KGHL	Billings, Mont.	Northwestern Auto Supply Co. (Inc.)	1KW	Do.

960 KILOCYCLES (Canadian Exclusive)—*312.3 Meters*

970 KILOCYCLES—*309.1 Meters*

WCFL	Chicago, Ill.	Chicago Federation of Labor	1½KW	Limited.
KJR	Seattle, Wash.	Northwest Broadcasting System (Inc.)	5KW	Unlimited.

980 KILOCYCLES—*305.9 Meters*

KDKA	Pittsburgh, Pa. T—Caxonburg, Pa.	Westinghouse Electric & Manufacturing Co.	50KW—LP	Unlimited.

990 KILOCYCLES—*302.8 Meters*

WBZ	Springfield, Mass. T—East Springfield, Mass.[12]	Westinghouse Electric & Manufacturing Co.	15KW	Shares with WBZA.
WBZA	Boston, Mass.[13]	Westinghouse Electric & Manufacturing Co.	15KW	Shares with WBZ.

1000 KILOCYCLES—*299.8 Meters*

WHO	Des Moines, Iowa	Central Broadcasting Co.	5KW	Synchronizes with WOC experimentally.
WOC	Davenport, Iowa	do	5KW	Synchronizes with WHO experimentally.
KFVD	Culver City, Calif.	Los Angeles Broadcasting Co.	250W	Limited.

1010 KILOCYCLES (Canadian Shared)—*296.8 Meters*

WQAO	New York, N. Y. T—Cliffside, N. J.	Calvary Baptist Church	250W	Shares with WHN and WRNY.
WHN	New York, N. Y.	Marcus Loew Booking Agency	250W	Shares with WQAO-WPAP and WRNY.
WRNY	New York, N. Y. T—Coytesville, N. J.	Aviation Radio Station (Inc.)	250W	Shares with WQAO-WPAP and WHN.
KGGF	South Coffeyville, Okla.	Hugh J. Powell and Stanley Platz, doing business as Powell & Platz.	500W	Shares with WNAD.
WNAD	Norman, Okla.	University of Oklahoma	500W	Shares with KGGF.
WIS	Columbia, S. C.	South Carolina Broadcasting Co. (Inc.)	500W / 1KW—LS	Unlimited.
KQW	San Jose, Calif.	Pacific Agricultural Foundation Ltd.	500W	Do.

1020 KILOCYCLES—*293.9 Meters*

WPAP	New York City	Palisades Amusement Park	250W	
WLAP	Louisville, Ky.	American Broadcasting Corp. of Kentucky	250W	
WRAX	Philadelphia, Pa.	WRAX Broatcasting Co.	250W	Daytime.
KYW—KFKX	Chicago, Ill. T—Bloomingdale Township, Ill.	Westinghouse Electric & Manufacturing Co.	10KW	Unlimitet.

1030 KILOCYCLES (Canadian Exclusive)—*291.1 Meters*

1040 KILOCYCLES—*288.3 Meters*

WMAK	Buffalo, N. Y. T—Grand Island, N. Y.[14]	Buffalo Broadcasting Corporation	1KW	Limited.
WKAR	East Lansing, Mich.	Michigan State College	1KW	Daytime.
KTHS	Hot Springs National Park, Ark.	Hot Springs Chamber of Commerce	10KW	Shares with KRLD.
KRLD	Dallas, Tex.	KRLD Radio Corporation	10KW	Shares with KTHS.

[11] C. P. to move transmitter to Edgewater, Colo.
[12] Licensed to move transmitter to Millis Township, Mass., and studio to Boston, Mass., and consolidate with WBZA.
[13] C. P. to move transmitter to East Springfield and increase power to 1KW.
[14] C. P. to move transmitter to Amherst, N. Y.

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

1050 KILOCYCLES—*285.5 Meters*

Call letters	Main studo location	Licensee	Power	Time of operation
KFBI	Milford, Kans.	Farmers & Bankers Life Insurance Co.	5KW	Limited.
KNX	Hollywood, Calif. T—Los Angeles, Calif.	Western Broadcast Co.	5KW[15]	Unlimited.

1060 KILOCYCLES—*282.8 Meters*

Call letters	Main studo location	Licensee	Power	Time of operation
WBAL	Baltimore, Md. T—Glen Morris, Md.	Consolidated Gas, Electric Light & Power Company of Baltimore.	10KW	Shares with WTIC.[15a]
WTIC	Hartford, Conn. T—Avon, Conn.	Travelers Broadcasting Service Corporation	50KW—LP	Shares with WBAL.[15b]
WJAG	Norfolk, Nebr.	Norfolk Daily News	1KW	Limited.
KWJJ	Portland, Oreg.	KWJJ Broadcast Co. (Inc.)	500W	Do.

1070 KILOCYCLES—*280.2 Meters*

Call letters	Main studo location	Licensee	Power	Time of operation
WTAM	Cleveland, Ohio. T—Brecksville Village, Ohio.	National Broadcasting Co. (Inc.)	50KW—LP	Unlimited.
WCAZ	Carthage, Ill.	Superior Broadcasting Service (Inc.)	50W	Daytime.
WDZ	Tuscola, Ill.	James L. Bush	100W	Do.
KJBS	San Francisco, Calif.	Julius Brunton & Sons Co.	100W	12.01 a. m. to local sunset.

1080 KILOCYCLES—*277.6 Meters*

Call letters	Main studo location	Licensee	Power	Time of operation
WBT	Charlotte, N. C.	Station WBT (Inc.)	5KW	Unlimited.
WCBD	Zion, Ill.	Wilbur Glenn Voliva	5KW	Limited. Shares with WMBI
WMBI	Chicago, Ill. T—Addison, Ill.	The Moody Bible Institute Radio Station	5KW	Limited. Shares with WCBD

1090 KILOCYCLES—*275.1 Meters*

Call letters	Main studo location	Licensee	Power	Time of operation
KMOX	St. Louis, Mo.	Voice of St. Louis (Inc.)	50KW—LP	Unlimited.

1100 KILOCYCLES—*272.6 Meters*

Call letters	Main studo location	Licensee	Power	Time of operation
WPG	Atlantic City, N. J.	WPG Broadcasting Corporation	5KW	Shares with WLWL.
WLWL	New York, N. Y. T—Kearny, N. J.	Missionary Society of St. Paul the Apostle	5KW	Shares with WPG.
KGDM	Stockton, Calif.	E. F. Peffer	250W	Daytime.

1110 KILOCYCLES—270.1 Meters

Call letters	Main studo location	Licensee	Power	Time of operation
WRVA	Richmond, Va. T—Mechanicsville, Va.	Larus & Brother Co. (Inc.)	5KW	Unlimited.
KSOO	Sioux Falls, S. Dak.	Sioux Falls Broadcast Association (Inc.)	2½KW	Limited.

1120 KILOCYCLES (Canadian Shared)—*267.7 Meters*

Call letters	Main studo location	Licensee	Power	Time of operation
WDEL	Wilmington, Del.	WDEL (Inc.)	250W 350W-LS[16]	Unlimited
WDBO	Orlando, Fla.	Orlando Broadcasting Co. (Inc.)	500W 1KW-LS	One-half time.
WTAW	College Station, Tex.	Agricultural and Mechanics College of Texas	500W	Shares with KTRH.
KTRH	Houston, Tex.	Rice Hotel	500W	Shares with WTAW.
WISN	Milwaukee, Wis.	Evening Wisconsin Co.	250W	Shares with WHAD.
WHAD	do	Marquette University	250W	Shares with WISN.
KFSG	Los Angeles, Calif.	Echo Park Evangelistic Association	500W	Shares with KMCS.
KMCS	Inglewood, Calif.	Dalton's (Inc.)	500W	Shares with KFSG.
KRSC	Seattle, Wash.	Radio Sales Corporation	50W	Daytime
KFIO	Spokane, Wash.	Spokane Broadcasting Corporation	100W	Do.

1130 KILOCYCLES—*265.3 Meters*

Call letters	Main studo location	Licensee	Power	Time of operation
WOV	New York City. T—Secaucus, N. J.	International Broadcasting Corporation	1KW	Daytime until 6 p. m.
WJJD	Mooseheart, Ill.	Supreme Lodge of the World, Loyal Order of Moose.	20KW	Limited.
KSL	Salt Lake City, Utah	Radio Service Corporation of Utah	5KW	Unlimited.

1140 KILOCYCLES—*263.0 Meters*

Call letters	Main studo location	Licensee	Power	Time of operation
WAPI	Birmingham, Ala.	Alabama Polytechnic Institute, University of Alabama and Alabama College	5KW	Shares with KVOO.
KVOO	Tulsa, Okla.	Southwestern Sales Corporation	5KW	Shares with WAPI.

1150 KILOCYCLES—*260.7 Meters*

Call letters	Main studo location	Licensee	Power	Time of operation
WHAM	Rochester, N. Y. T—Victor Township, N. Y.	Stromberg-Carlson Telephone Manufacturing Co.	5KW	Unlimited.

1160 KILOCYCLES—*258.5 Meters*

Call letters	Main studo location	Licensee	Power	Time of operation
WWVA	Wheeling, W. Va.	West Virginia Broadcasting Corporation	5KW	Shares with WOWO.
WOWO	Fort Wayne, Ind.	Main Auto Supply Co.	10KW	Shares with WWVA.

1170 KILOCYCLES—*256.3 Meters*

Call letters	Main studo location	Licensee	Power	Time of operation
WCAU	Philadelphia, Pa. T—Byberry, Pa.	Universal Broadcasting Co.	10KW	Unlimited.

1180 KILOCYCLES—*254.1 Meters*

Call letters	Main studo location	Licensee	Power	Time of operation
WGBS	New York, N. Y. T—Astoria, L. I., N. Y.	General Broadcasting System (Inc.)	500W-LS	Shares with WCAC.
WDGY	Minneapolis, Minn.	Dr. George W. Young	1KW	Limited. Shares with WHDI
WHDI	do	do	500W	Limited. Shares with WDGY
KEX	Portland, Oreg.	Western Broadcasting Co.	5KW	Shares with KOB.
KOB	State College, N. Mex.	New Mexico College of Agriculture and Mechanic Arts.	20KW	Shares with KEX.
WMAZ	Macon, Ga.	Junior Chamber of Commerce	500W	

1190 KILOCYCLES—*252.0 Meters*

Call letters	Main studo location	Licensee	Power	Time of operation
WOAI	San Antonio, Tex. T—Selma, Tex.	Southern Equipment Co.	50KW—LP	Unlimited.

1200 KILOCYCLES (Canadian Shared)—*249.9 Meters*

Call letters	Main studo location	Licensee	Power	Time of operation
WABI	Bangor, Me.	Pine Tree Broadcasting Corporation	100W	Unlimited.
WNBX	Springfield, Vt.	First Congregational Church Corporation	10W	Shares with WCAX.
WCAX	Burlington, Vt.	Burlington Daily News	100W	Shares with WNBX.
WORC—WEPS	Worcester, Mass. T—Auburn, Mass.	Albert Frank Kleindienst	100W	Unlimited.
WIBX	Utica, N. Y.	WIBX (Inc.)	100W 300W—LS	Do.
WFBE	Cincinnati, Ohio	Post Publishing Co.	100W 250W—LS	Do.
WHBC	Canton, Ohio.	St. John's Catholic Church	10W	Shares with WNBO Sundays.
WLBG	Petersburg, Va. T—Ettrick, Va.	WLBG Inc.	100W 250W—LS	Do.

(1200 *kilocycles continued on next page*)

[15] C. P. to increase power to 50 KW—LP
[15a] Synchronizes with WJZ on 760 kc. Also uses 760 kc.
[15b] Synchronizes with WEAF on 660 kc.
[16] C. P. to increase power to 500 Watts-LS. Also uses 660 kc

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

1200 KILOCYCLES (Canadian Shared)—*249.9 Meters—Continued*

Call letters	Main Studio location	Licenses	Power	Tome of operation
WNBO	Washington, Pa.	John Brownlee Spriggs	100W	Shares with WHBC Sundays.
WCOD	Harrisburg, Pa.	Keystone Broadcasting Corporation	100W	Shares with WKJC.
WKJC	Lancaster, Pa.	Kirk Johnson & Co.	100W	Shares with WCOD.
WNBW	Carbondale, Pa.	C. F. Schiessler and M. E. Stephens, doing business as Home Cut Glass & China Co.	10W	Unlimited.
KMLB	Monroe, La.	J. C. Liner	100W	Daytime.
WABZ	New Orleans, La.	Samuel D. Reeks	100W	Shares with WJBW.
WJBW	do	C. Carlson	100W [17]	Shares with WABZ.
WBBZ	Ponca City, Okla.	C. L. Carrell	100W	Unlimited.
WFBC	Knoxville, Tenn.	First Baptist Church	50W	Do.
WRBL	Columbus, Ga.	WRBL, Inc.	50W	Do.
KGHI	Little Rock, Ark.	Berean Bible Class, First Baptist Church	100W	Do.
KBTM	Paragould, Ark.	W. J. Beard, Beard's Temple of Music	100W	Daytime.
WJBC	La Salle, Ill.	Wayne Hummer & H. J. Dee, doing business as Kaskaskia Broadcasting Co.	100W	Shares with WJBL.
WJBL	Decatur, Ill.	Commodore Broadcasting Corporation	100W	Shares with WJBC.
WWAE	Hammond, Ill.	Hammond-Calumet Broadcasting Corporation	100W	Shares with WRAF.
KFJB	Marshalltown, Iowa	Marshall Electric Co. (Inc.)	100W / 250W—LS	One-half time.
WCAT	Rapid City, S. Dak.	South Dakota State School of Mines	100W	Unlimited.
KGDY	Huron, S. Dak.	Voice of South Dakota	100W	Do.
KFWF	St. Louis, Mo.	St. Louis Truth Center (Inc.)	100W	Shares Shares with WIL.
KGDE	Fergus Falls, Minn.	C. L. Jaren	100W / 250W—LS	Unlimited.
WCLO	Janesville, Wis.	WCLO Radio Corporation	100W	Do.
WHBY	Green Bay, Wis. T—West De Pere, Wis.	St. Norbert College	100W	Do.
WIL	St. Louis, Mo.	Missouri Broadcasting Corporation	100W / 250W—LS	Shares with KFWF.
KGFJ	Los Angeles, Calif.	Ben S. McGlashan	100W	Unlimited.
KSMR	Santa Maria, Calif.	Santa Maria Radio	100W	Do.
KWG	Stockton, Calif.	Portable Wireless Telephone Co. (Inc.)	100W	Do.
KGEK	Yuma, Colo.	Elmer C. Beehler, trading as Beehler Electrical Equipment Co.	100W	Sbares with KGEW.
KGEW	Fort Morgan, Colo.	City of Fort Morgan	100W	Shares with KGEK.
KVOS	Bellingham, Wash.	KVOS (Inc.)	100W	Unlimited.
KGY	Lacey, Wash.	St. Martin's College	10W	Do.
WFAM	South Bend, Ind.	South Bend Tribune	100W	
WBHS	Huntsville, Ala.	The Hutchens Co.	50W	

1210 KILOCYCLES (Canadian Shared)—*247.8 Meters*

Call letters	Main Studio location	Licenses	Power	Tome of operation
WMRJ	Jamaica, N. Y.	Peter J. Prinz	100W	Shares with WCOH, WGBB, and WJBI.
WJBI	Redbank, N. J.	Monmouth Broadcasting Co.	100W	Shares with WCOH, WGBB, and WMRJ.
WGBB	Freeport, N. Y.	Harry H. Carman	100W	Shares with WCOH, WJBI, and WMRJ.
WCOH	Yonkers, N. Y. T—Greenville, N. Y.	Westchester Broadcasting Corporation	100W	Shares with WJBI, WGBB, and WMRJ.
WOCL	Jamestown, N. Y.	A. E. Newton	25W	Unlimited.
WLCI	Ithaca, N. Y.	Lutheran Association of Ithaca, N. Y.	50W	Do.
WPAW	Pawtucket, R. I.	Shartenberg & Robinson Co.	100W	Shares with WDWF-WLSI.
WDWF-WLSI	Providence, R. I. T—Cranston, R. I.	Dutee Wilcox Flint & Lincoln Studios (Inc.)	100W	Shares with WPAW.
WSEN	Columbus, Ohio	Columbus Broadcasting Corporation	100W	Unlimited.
WJW	Mansfield, Ohio	John F. Weimer (owner Mansfield Broadcasting Association).	100W	Do.
WALR	Zanesville, Ohio	Roy W. Waller	100W	Do.
WBAX	Wilkes-Barre, Pa. T—Plains Township, Pa.	John H. Stenger, Jr.	100W	Shares with WJBU.
WJBU	Lewisburg, Pa.	Bucknell University	100W	Shares with WBAX.
WBBL	Richmond, Va.	Grace Covenant Presbyterian Church	100W	Certain hours Sunday only.
WMBG	Richmond, Va.	Havens & Martin (Inc.)	100W	Unlimited, except Sundays shares with WBBL.
WSIX	Springfield, Tenn.	Jack M. and Louis R. Draughon, doing business as 638 Tire and Vulcanizing Co.	100W	Unlimited.
WSOC	Gastonia, N. C.	WSOC (Inc.)	100W	Do.
WJBY	Gadsden, Ala.	Gadsden Broadcasting Co. (Inc.)	50W	Do.
WQDX	Thomasville, Ga.	Stevens Luke	50W	Do.
WRBQ	Greenville, Miss.	J. Pat Scully	100W / 250W-LS	Do.
WGCM	Gulfport, Miss. T—Mississippi City, Miss.	Great Southern Land Co.	100W	Do.
KWEA	Shreveport, La.	Hello World Broadcasting Corporation	100W	Do.
KDLR	Devils Lake, N. Dak.	KDLR (Inc.)	100W	Do.
KGCR	Watertown, S. Dak.	Greater Kampeska Radio Corp.	100W	Do.
KFOR	Lincoln, Nebr.	Howard A. Shuman	100W / 250-LS	Do.
WHBU	Anderson, Ind.	Citizens Bank	100W	Do.
KFVS	Cape Girardeau, Mo.	Oscar C. Hirsch, trading as Hirsch Battery & Radio Co.	100W	Shares with WEBQ.
WEBQ	Harrisburg, Ill.	First Trust & Savings Bank of Harrisburg, Ill.	100W	Shares with KFVS.
KGNO	Dodge City, Kans.	Dodge City Broadcasting Co. (Inc.)	100W	Unlimited.
WSBC	Chicago, Ill.	World Battery Co. (Inc)	100W	Shares with WEDC and WCRW.
WCRW	Chicago, Ill.	Clinton R. White	100W	Shares with WEDC and WSBC.
WEDC	Chicago, Ill.	Emil Denemark (Inc.)	100W	Shares with WSBC and WCRW.
WCBS	Springfield, Ill.	Chas. H. Messter and Harold L. Dewing	100W	Shares with WTAX.
WTAX	Springfield, Ill.	WTAX (Inc.)	100W	Shares with WCBS.
WHBF	Rock Island, Ill.	Beardsley Specialty Co.	100W	Unlimited.
WOMT	Manitowoc, Wis.	Francis M. Kadow	100W	Do.
WIBU	Poynette, Wis.	William C. Forrest	100W	Do.
KMJ	Fresno, Calif.	James McClatchy Co.	100W	Do.
KFXM	San Bernardino, Calif.	J. C. & E. W. Lee (Lee Bros. Broadcasting Co.)	100W	Shares with KPPC.
KPPC	Pasadena, Calif.	Pasadena Presbyterian Church	50W	Shares with KFXM.
KDFN	Casper, Wyo.	Donald Lewis Hathaway	100W	Unlimited.
KGMP	Elk City, Okla.	Bryant Radio & Electric Co.	100W	

1220 KILOCYCLES—*245.8 Meters*

Call letters	Main Studio location	Licenses	Power	Tome of operation
WCAD	Canton, N. Y.	St. Lawrence University	500W	Daytime.
WCAE	Pittsburgh, Pa.	WCAE, Inc.	1KW	Unlimited.
WDAE	Tampa, Fla.	Tampa Publishing Co.	1KW	Do.
WREN	Lawrence, Kans.	Jenny Wren Co.	1KW	Shares with KFKU.
KFKU	Lawrence, Kans.	University of Kansas	500W	Shares with WREN.
KWSC	Pullman, Wash.	State College of Washington	1KW / 2KW-LS	Unlimited.
KTW	Seattle, Wash.	First Presbyterian Church	1KW	

1230 KILOCYCLES—*243.8 Meters*

Call letters	Main Studio location	Licenses	Power	Tome of operation
WNAC-WBIS	Boston, Mass. T—Quincy, Mass.	Shepard Broadcasting Service (Inc.)	1KW	Unlimited.
WPSC	State College, Pa.	The Pennsylvania State College	500W	Daytime.
WSBT	South Bend, Ind.	South Bend Tribune	500W	Shares with WFBM.
WFBM	Indianapolis, Ind.	Indianapolis Power & Light Co.	1KW	Shares with WSBT.
KGGM	Albuquerque, N. Mex.	New Mexico Broadcasting Co.	250W / 500W-LS	Unlimited.
KYA	San Francisco, Calif.	Pacific Broadcasting Corporation	1KW	Do.
KFQD	Anchorage, Alaska	Anchorage Radio Club	100W	Do.

17 license granted to increase power to this amount.

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

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.
KIDO	Boise, Idaho	Frank L. Hill and C. G. Phillips, doing business as Boise Broadcast Station.	1KW	Do.

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.

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.	George I. Stevens, trading as Radio Service Laboratories.	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.)

WOBT	Jackson, Tenn.	Sun Publishing Co.	100W; 250W-LS	Unlimited.
WROL	Knoxville, Tenn.	Stuart Broadcasting Corporation	100W	Do.
KRMD	Shreveport, La.	Robert M. Dean	50W	Shares with KTSL.
KTSL	Shreveport, La.	G. A. Houseman	100W	Shares with KRMD.
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	Harry F. Paar	100W	Shares with KFGQ and KFJY.
KFJY	Fort Dodge, Iowa	C. S. Tunwall	100W	Shares with KFGQ and KWCR.
KFGQ	Boone, Iowa	Boon 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 C. Treloar and Stanley R. Church, doing	50W	Shares with WJAK.
KGBX	St. Joseph, Mo.	KGBX (Inc.)	100W	Unlimited.
KFIU	Juneau, Alaska	Alaska Electric Light & Power Co.	10W	Do.
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	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.	Dolies-Goings	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)	500W	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.	50W50W	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	

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.	Fred Jordan and 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	Williamsport, Pa.	Clarence R. Cummins	100W	Unlimited.
WELK	Philadelphia, Pa.	WELK Broadcasting Station (Inc.)	100W; 250W-LS	Do.

(1370 *kilocycles continued on next page*)

[25] C. P. to increase power to 500 watts—LS.
[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.
[28] On Sundays.

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

1370 KILOCYCLES—*218.7 Meters*—(Cont.)

WRBJ	Hattiesburg, Miss	Hattiesburg Broadcasting Co.	10W	Do.
WHBQ	Memphis, Tenn	Broadcasting Station WHBQ (Inc.)	100W	Do.
KGFG	Oklahoma City, Okla	Oklahoma Broadcasting Co. (Inc.)	100W	Shares with KCRC.
KCRC	Enid, Okla	Enid Radiphone Co.	100W 250W-LS	Shares with KGFG.
WMBR	Tampa, Fla	F. J. Reynolds	100W	Unlimited.
KMAC	San Antonio, Tex	W. W. McAllister	100W	Shares with KONO.
KFJZ	Fort Worth, Tex	Margaret Meacham Hightower, Minnie Meacham Smith, and Mary Meacham, executrices of estate of H. C. Meacham, deceased.	100W	Unlimited.
KONO	San Antonio, Tex	Mission Broadcasting Co.	100W	Shares with KMAC.
KGKL	San Angelo, Tex	KGKL (Inc.)	100W	Unlimited.
KFLX	Galveston, Tex	George Roy Clough	100W	Do.
WGL	Fort Wayne, Ind	Fred C. Zeig (Allen-Wayne Co.)	100W	Do.
KGDA	Mitchell, S. Dak	Mitchell Broadcasting Corporation	100W	Do.
KFJM	Great Forks, N. Dak	University of North Dakota	100W	Do.
KWKC	Kansas City, Mo	Wilson Duncan, trading as Wilson Duncan Broadcasting Co.	100W	One-half time.
WRJN	Racine, Wis	Racine Broadcasting Corporation	100W	Unlimited.
KGAR	Tucson, Ariz	Tucson Motor Service	100W 250W-LS	Do.
KRE	Berkeley, Calif	First Congregational Church of Berkeley	100W	Shares with KZM.
KOOS	Marshfield, Oreg	H. H. Hansets (Inc.)	100W	Unlimited.
KFBL	Everett, Wash	Otto Leese and Robert Leese, doing business as Leese Bros.	50W	Shares with KVL.
KVL	Seattle, Wash	KVL, Incorporated	100W	Shares with KFBL.
KFJI	Astoria, Oreg	KFJI Broadcasters, Inc.	100W	Unlimited.
KGFL	Raton, N. Mex	W. E. Whitmore	50W	Do.
KUJ	Walla Walla, Wash	KUJ, Inc.	100W	One-half time (C. P. only).
WRAM	Wilmington, N. C.	Wilmington Radio Asso.	100W	
WJTL	Tifton, Ga.	Ogelethorpe University	100W	

1380 KILOCYCLES—*217.3 Meters*

WSMK	Dayton, Ohio	Stanley M. Krohn, Jr.	200W	Shares with KQV at night.
KQV	Pittsburgh, Pa	KGV, Inc.	500W	Shares with WSMK at night
KSO	Clarinda, Iowa	Iowa Broadcasting Co.	500W	Shares with WKBH.
WKBH	LaCrosse, Wis	WKBH (Inc.)	1KW	Shares with KSO.
KOH	Reno, Nev	The Bee, Inc.	500W	Unlimited.

1390 KILOCYCLES—*215.7 Meters*

WHK	Cleveland, Ohio T—Seven Hills, Ohio.	Radio Air Service Corporation	1KW	Unlimited.
KLRA	Little Rock, Ark	Arkansas Broadcasting Co.	1KW	Shares with KUOA.
KUOA	Fayetteville, Ark.	University of Arkansas	1KW	Shares with KLRA.
KOY	Phoenix, Ariz	Nielsen Radio & Sporting Goods Co.	500W	Unlimited.

1400 KILOCYCLES—*214.7 Meters*

WCGU	Brooklyn, N. Y.	United States Broadcasting Corporation	500W	Shares with WFOX, WLTH and WBBC.
WFOX	Brooklyn, N. Y.	Paramount Broadcasting Corporation	500W	Shares with WCGU, WLTH, and WBBC.
WLTH	Brooklyn, N. Y.	Voice of Brooklyn (Inc.)	500W	Shares with WSCH-WSDA, WCGU, and WBBC.
WBBC	Brooklyn, N. Y.	Brooklyn Broadcasting Corporation	500W	Shares with WFOX, WLTH, and WCGU.
KOCW	Chickasha, Okla	Oklahoma College for Women	250W 500W-LS	Unlimited.
WCMA	Culver, Inc	General Broadcasting Corporation	500W	Shares with WBAA and WKBF.
WKBF	Indianapolis, Ind. T—Clermont, Ind.	Indianapolis Broadcasting (Inc.)	500W	Shares with WBAA and WCMA.
WBAA	West Lafayette, Ind.	Purdue University	500W 1KW-LS	Shares with WCMA and WKBF.
KLO	Ogden, Utah	Peery Building Co.	500W	Unlimited.

1410 KILOCYCLES—*212.6 Meters*

WRBX	Roanoke, Va	Richmond Development Corporation	250W	One-half time.
WBCM	Bay City, Mich. T—Hampton township, Mich.	James E. Davidson	500W	Unlimited.
KGRS	Amarillo, Tex	E. B. Gish (Gish Radio Service)	1KW	Shares with WDAG.
WDAG	Amarillo, Tex	National Radio Broadcasting Corporation	1KW	Shares with KGRS.
WODX	Mobile, Ala. T—Springhill, Ala.	Mobile Broadcasting Corporation	500W	Shares with WSFA.
WSFA	Montgomery, Ala	Montgomery Broadcasting Co. (Inc.)	500W	Shares with WODX.
KFLV	Rockford, Ill	Rockford Broadcasters (Inc.)	500W	Shares with WHBL.
WHBL	Sheboygan, Wis	Press Publishing Co.	500W	Shares with KFLV.
WAAB	Boston, Mass.	Bay State Broadcasting Corp.	500W	
WHIS	Bluefield, W. Va.	Daily Telegraph	250W	

1420 KILOCYCLES—*211.1 Meters*

KGVO	Missoula, Mich.	Mosby's (Inc.)	100w	Daytime.
WHDL	Tupper Lake, N. Y	Tupper Lake Broadcasting Co. (Inc.)	100W	Daytime.
WTBO	Cumberland, Md	Associated Broadcasting Corporation	100W 210W-LS	Unlimited.
WILM	Wilmington, Del. T—Edge Moor, Del.	Delaware Broadcasting Co. (Inc.)	100W	Do.
WPAD	Paducah, Ky	Pierce E. Lackey and S. Houston McNutt, doing business as Paducah Broadcasting Co.	100W	Do.
WEDH	Erie, Pa	Erie Dispatch-Herald Broadcasting Corporation	100W	Do.
WMBC	Detroit, Mich	Michigan Broadcasting Co.	100W 210W-LS	Do.
WELL	Battle Creek, Mich	Enquirer-News Co.	50W	Unlimited.
WIBR	Steubenville, Ohio	George W. Robinson	50W	One-half time.
WFDW	Talladega, Ala	Raymond C. Hammett	100W	Unlimited.
WJBO	New Orleans, La	Valdemar Jensen	100W	Do.
KGFF	Shawnee, Okla.	D. R. Wallace (owner KGFF Broadcasting Co.)	100W	Do.
KABC	San Antonio, Tex	Alamo Broadcasting Co. (Inc.)	100W	Do.
KXYZ	Houston, Tex	Harris County Broadcast Co.	100W	Do.
KFYO	Abilene, Tex	T. E. Kirksey, trading as Kirksey Brothers	100W 250W-LS	Do.
WSPA	Spartanburg, S. C.	Virgil V. Evans, trading as The Voice of South Carolina.	100W 250W-LS	Do.
KICK	Red Oak, Iowa	Red Oak Radio Corporation	100W	Do.
WIAS	Ottumwa, Iowa	Iowa Broadcasting Co.	100W	Do.
WLBF	Kansas City, Kans	The WLBF Broadcasting Co.	100W	Do.
WMBH	Joplin, Mo	Edwin Dudley Aber	100W 250W-LS	Do.
WEHS	Evanston, Ill	WEHS (Inc.)	100W	Shares with WKBI and WHFC.
WHFC	Cicero, Ill	WHFC, Inc.	100W	Shares with WKBI and WEHS.
WKBI	Chicago, Ill	WRGI, Inc.	100W	Shares with WHFC and WEHS.
KFIZ	Fond du Lac, Wis	The Reporter Printing Co.	100W	Unlimited.
KFXY	Flagstaff, Ariz	Mary M. Costigan	100W	Do.
KGIX	Los Vegas, Nev	Los Vegas Radio Corp.	100W	Do.

(1420 *kilocycles continued on next page*)

BROADCASTING STATIONS BY FREQUENCIES—*Continued*

1420 KILOCYCLES—*211.1 Meters*—(Cont.)

KFXD	Nampa, Idaho	Frank E. Hurt, trading as Service Radio Co.	500W	Unlimited.
KGIW	Trinidad, Colo	Leonard E. Wilson	100W	Do.
KGKX	Sandpoint, Idaho	C. E. Twiss and F. H. McCann	100W	Do.
KGGC	San Francisco, Calif	The Golden Gate Broadcasting Co.	100W	Shares with KFQU.
KXL	Portland, Oreg	KXL Broadcasters	100W	Shares with KBPS.
KBPS	Portland, Oreg	Benson Polytechnic School	100W	Shares with KXL.
KORE	Eugene, Oreg	Frank L. Hill and C. G. Phillips, doing business as Eugene Broadcast Station.	100W	Unlimited.
WJMS	Ironwood, Mich.	Morris Johnson	100W	
WDEV	Waterbury, Va.	Harry C. Whitehall	50W	
WAGM	Presque Isle, Me.	Aroostock Broadcasting Corp.	100W	

1430 KILOCYCLES—*209.7 Meters*

WHP	Harrisburg, Pa. T—Lemoyne, Pa.	WHP (Inc.)	500W 1KW-LS	ares with WBAK and WCAH.[85a]
WBAK	Harrisburg, Pa	Pennsylvania State Police, Commonwealth of Pennsylvania.	500W 1KW-LS	ares with WHP.
WCAH	Columbus, Ohio	Commercial Radio Service Co.	500W	Shares with WHP and WBAK.[85a]
WGBC	Memphis, Tenn	Memphis Broadcasting Co.	500W	Shares with WNBR.
WNBR	Memphis, Tenn	Memphis Broadcasting Co.	500W	Shares with WGBC.
KGNF	North Platte, Nebr	Great Plains Broadcasting Co.	500W	Daytime.
KECA	Los Angeles, Calif	Carle C. Anthony, Inc.	1KW	Unlimited.

1440 KILOCYCLES—*208.2 Meters*

WFEA	Manchester, N. H.	Rines Hotel, Inc.	500W	
WHEC-WABO	Rochester, N. Y.	Hickson Electric & Radio Corporation	500W	Shares with WOKO.[85a]
WOKO	Albany, N. Y. T—Mount Beacon, N. Y.	WOKO (Inc.)	500W	Shares with WHEC-WABQ.[85a]
WCBA	Allentown, Pa	B. Bryan Musselman	250W	Shares with WSAN.
WSAN	Allentown, Pa	Allentown Call Publishing Co. (Inc.)	250W	Shares with WCBA.
WBIG	Greensboro, N. C	North Carolina Broadcasting Co. (Inc.)	500W	Unlimited.
WTAD	Quincy Ill,	Illinois Stock Medicine Broadcasting Corporation.	500W	Shares with WMBD.
WMBD	Peoria Heights, Ill	E. M. Kahler (owner Peoria Heights Radio Laboratory.	500W 1KW-LS	Shares with WTAD.
KLS	Oakland, Calif	E. N. and S. W. Warner, doing business as Warner Bros.	250W	Daytime.

1450 KILOCYCLES—*206.8 Meters*

WBMS	Hackensack, N. J.	WBMS Broadcasting Corporation	250W	Shares with WNJ, WHOM, and WKBO.
WNJ	Newark, N. J	Radio Investment Co. (Inc.)	250W	Shares with WBMS, WHOM, anud WKBO.
WHOM	Jersey City, N. J	New Jersey Broadcasting Corporation	250W	Shares with WNJ, WBMS, and WKBO.
WKBO	Jersey City, N. J	Camith Corporation	250W	Shares with WNJ, WHOM, and WBMS.
WSAR	Fall River, Mass	Doughty & Welch Electric Co. (Inc.)	250W	Unlimited.
WGAR	Cleveland, Ohio	WGAR Broadcasting Co	500W.	Do.
WTFI	Toccoa, Ga	Toccoa Falls Institute	500W.	Do.
KTBS	Shreveport, La	Tri State Broadcasting System (Inc.)	1KW	Do.

1460 KILOCYCLES—*205.4 Meters*

WJSV	Alexandria, Va. T—Mt. Vernon Hills, Va.	Independent Publishing Co.	10KW	Do.
KSTP	St. Paul, Minn. T—Westcott, Minn.	National Battery Broadcasting Co.	10KW	Do.

1470 KILOCYCLES—*204.0 Meters*

WLAC	Nashville, Tenn	Life and Casualty Insurance Co.	5KW	Unlimited.
KGA	Spokane, Wash	Northwest Broadcasting System (Inc.)	5KW	Do.

1480 KILOCYCLES—*202.6 Meters*

WKBW	Buffalo, N. Y. T—Amherst, N.Y.	WKBW (Inc.)	5KW	Unlimited.
KFJF	Oklahoma City, Okla	National Radio Manufacturing Co.	5KW	Do.

1490 KILOCYCLES—*201.2 Meters*

WCKY	Covington, Ky. T—Crescent Springs, Ky.	L. B. Wilson (Inc.)	5KW	Shares with WJAZ and WCHI.
WJAZ	Chicago, Ill.	Zenith Radio Corporation	5KW	Shares with WCKY and WCHI.
WCHI	Chicago, Ill. T—Batavia, Ill.	Peoples Pulpit Association	5KW	Shares with WJAZ and WCKY.

1500 KILOCYCLES—*199.9 Meters*

WMBA	Newport, R. I.	LeRoy Joseph Beebe	100W	Unlimited.
WLOE	Boston, Mass. T—Chelsea, Mass.	Boston Broadcasting Co.	100W 250W-LS	One-half time.
WNBF	Binghamton, N. Y	Howitt-Wood Radio Co. (Inc.)	100W	Unlimited.
WMBQ	Brooklyn, N. Y.	Paul J. Gollhofer	100W	Shares with WLBX, WCLB, and WWRL.
WLBX	Long Island City, N. Y	John N. Brahy	100W	Shares with WMBQ, WCLB, and WWRL.
WWRL	Woodside, N. Y.	Long Island Broadcasting Corporation	100W	Shares with WMBQ, WLBX, and WCLB.
WSYB	Rutland, Vt	H. E. Seward, jr., and Philip Weiss, doing business as Seward & Weiss Music Co.	100W	Unlimited.
WKBZ	Ludington, Mich.	Karl L. Ashbacker	50W	Do.
WMPC	Lapeer, Mich	First Methodist Protestena Church of Lapeer	100W	Do.
WPEN	Philadelphia, Pa	Wm. Penn Broadcasting Co.	100W 250W-LS	Do
WWSW	Pittsburgh, Pa	William S. Walker	100W	Unlimited (C. P. only).
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WDIX	Tupelo, Miss	North Mississippi Broadcasting Corporation	100W	Do.
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KGIZ	Grant City, Mo	Grant City Park Corporation	100W	Do.
KGKY	Scottsbluff, Nebr	Hilliard Co. (Inc.)	100W	Do.
WKBV	Connersville, Ind	William O. Knox, trading as Knox Battery & Electric Co.	100W 150W-LS.	Do.
KGFK	Moorehead, Minn	Red River Broadcasting Co. (Inc.)	50W	Do.
KPJM	Prescott, Ariz	A. P. Miller and George R. Klahn, doing business as Miller & Klahn.	100W	Do.
KXO	El Centro, Calif	E. R. Irey and F. M. Bowles	100W	Do.
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RESOLVED, THAT THE PENTODE IS DESIRABLE. Affirmative, By Adam J. Broder. Negative, By Quinlas Ross. March 15.
NEW TUBES IN A CONVERTER. By William J. Woods—August 2.
NEW TUBES IN BATTERY OPERATED AF CIRCUITS. By J. E. A., August 2.
MODERN RADIO TUBES. By J. E. Anderson—August 9.
THE THYRATRON TUBE. By William T. Meenam, August 9.
120, 201A and 240 TUES. By J. E. A.—August 16.
TWO OF THE LATEST TUBES: The 230 and 231. By J. E. A.—Sept. 6.
HOW TO MEASURE THE MU OF A TUBE. By Brunsten Brunn, Sept. 13.
THE LATEST SCREEN GRID TUBE, the 232. By J. E. A.—Sept. 13.
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THE MOST SENSITIVE TUBE. By E. L. Manning—Oct. 11.
ADAPTATION TO NEW TUES. By Neal Fitzalan—Oct. 25.
THE 245 and the 250. By J. E. A.—Oct. 25
THE EARLY HISTORY OF THE VACUUM TUBE. By John C. Williams—Nov. 8.
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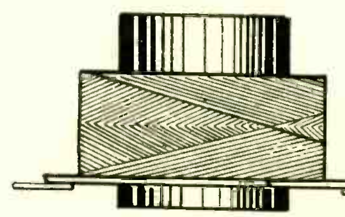
RF CHOKES

HONEY COMB TYPE

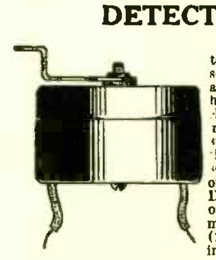


800-turn duolateral wound radio frequency choke, inductance 60 millihenrys, DC resistance 75 ohms. The distributed capacity is so low as to be negligible. The choke, therefore, may be used as plate circuit or grid circuit load, even in short-wave sets and converters, and will provide extremely high sensitivity with a low order of noise level, due to filtration by the choke. Suitable for antenna input (grid of first tube to ground) or for filtration of plate and screen grid circuits with condenser of 0.1 mfd. to ground (extra).

The choke is wound of green silk covered No. 38 wire on a pierced dowel, with bakelite base accommodating two riveted lugs. Contact is perfect. The dowel diameter is ½ inch, the hole through it (which may be used for mounting device) passes 10/32 screw. The extreme coil diameter is only ¾ inch. The distance between lug tips is 1¾ inches. The dowel protrudes ⅛ inch beyond the bottom to prevent shorting where mounting is done on a metal sub-panel. No particular polarity of connections need be observed.

Two of these chokes may be used with an isolating condenser of .00025 mfd. or higher capacity for radio frequency coupling in broadcast sets for amplification peaked broadly around 600 meters to make the total RF amplification more uniform and obviate the "rising characteristic" of tuned radio frequency amplification. 12 ma maximum current rating. Order Cat. CH-800 @.. 50¢

DETECTOR TYPE



For detector circuit filtration, to choke the radio frequency, so it will not go through the audio channel, use a 50 millihenry copper-shielded RF choke. This is supplied with mounting bracket and two insulated wire leads. No particular polarity need be observed. This choke is wound of extra heavy wire, and its DC resistance will not show up on the usual type ohmmeters. Order Cat. SH-RFC (25 ma maximum current rating) @ .... 57¢

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Where a receiver is to be built to incorporate automatic volume control, the shielded choke, consisting of two closely coupled separate windings, may be used. Connect one winding (yellow leads) from detector plate, to the audio input. Connect the two other leads (red and black) as follows: Black to the slider of a potentiometer (400 ohms up, without limit), red to the joined grid and plate leads of a 227 tube used as automatic volume control. Connect cathode of that tube to ground (B minus), and the grid returns of coils in controlled tube or tubes to arm of the potentiometer. Put 1 mfd. from arm to ground. Order Cat. DW-SHCH (maximum current rating, 25 ma) @ .... 67¢

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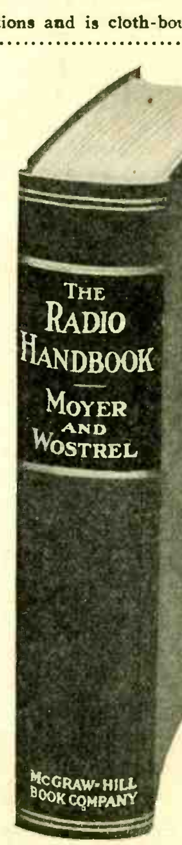

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