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455th Consecutive Issue—NINTH YEAR

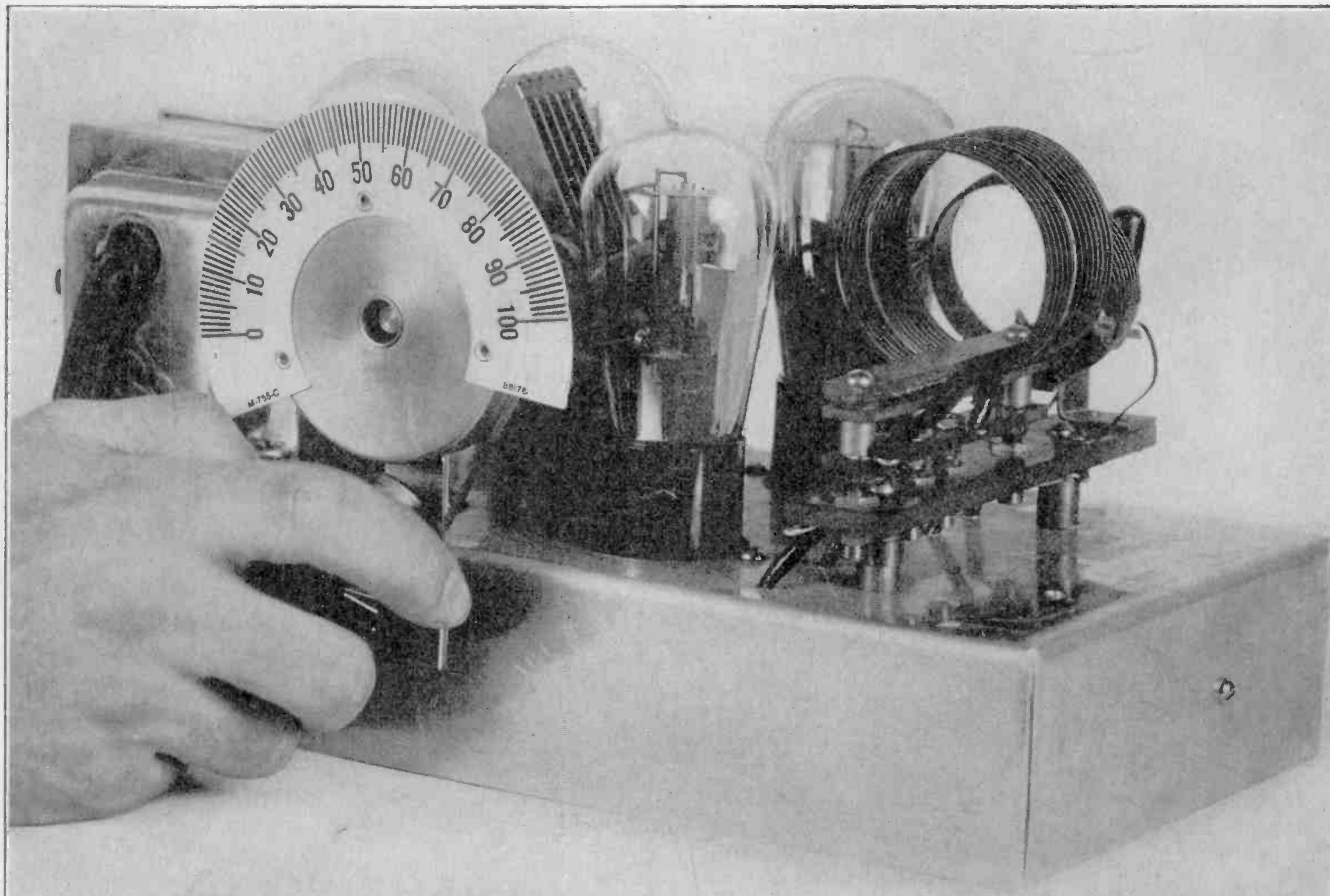
AN ALL-WAVE MIXER

HOW NATIONAL'S SHORT-WAVE SET WAS DESIGNED

STATIONS BY FREQUENCY

DIAGRAMS OF RADIOLA 80 AND 82, ALSO PHILCO 40 AND 41

4-TUBE DE LUXE SW CONVERTER



A fetching layout of a few simple parts in a good circuit constitutes the Hammarlund de luxe converter. See pages 5, 6, and 7.

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A 4-Tube De Luxe Short-Wave Converter

By Lewis James

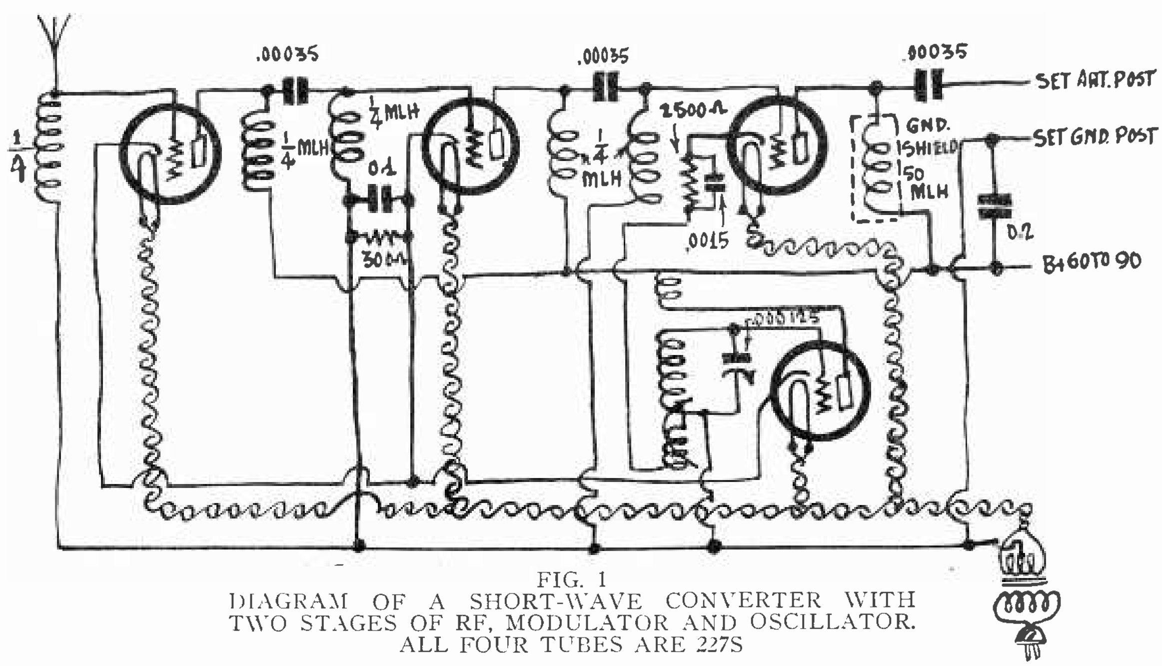


FIG. 1
DIAGRAM OF A SHORT-WAVE CONVERTER WITH TWO STAGES OF RF, MODULATOR AND OSCILLATOR. ALL FOUR TUBES ARE 227S

HERE is a compact, single-control short-wave converter which by means of four plug-in coils covers the entire short-wave band from 15 to 110 meters, that is, down to the shortest waves now generally used for communication.

Single control is made possible by utilizing untuned coupling between the antenna and the first tube and again between the first and the second tubes.

Instead of using resistance coupling or high inductance choke coupling small choke coils of the order of ¼ millihenrys are used both in the antenna circuit and in the inter-tube coupler. While these small chokes do not give as much amplification at certain frequencies as larger ones would give, they give consistently good results over the entire wide band of frequencies covered by the three plug-in coils, and avoid dead spots completely. The big advantage is that there is no frequency at which the coils form resonant absorption circuits which stop oscillation in certain frequency regions.

The radio frequency amplifiers in the circuit are 227 tubes and their bias is provided for by a 300-ohm resistance in the cathode lead, this resistor being shunted by a 0.1 mfd. condenser. This also supplies the bias for the oscillator tube.

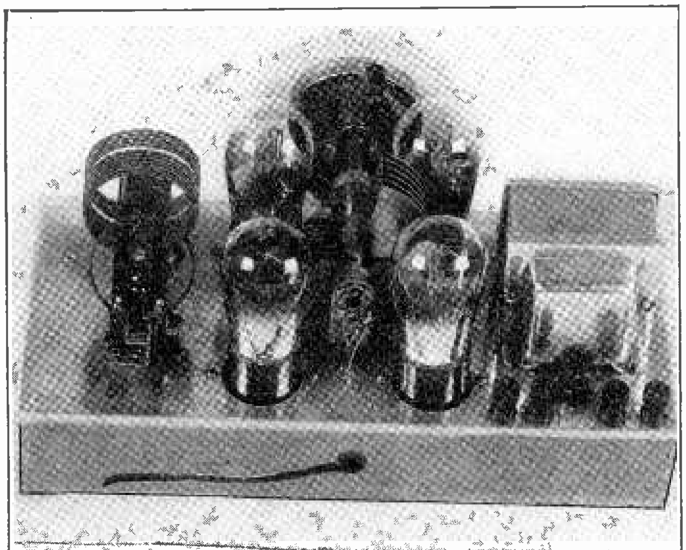
Grid Bias Detection

The detector is also of the 227 type and it operates on the grid bias principle. The bias for this tube is obtained from a resistor of 2,500 ohms, shunted by a condenser of .0015 mfd., in the cathode lead directly over the pick-up coil, which is also connected in a part of the cathode circuit. Grid bias detection is used because it operates with greater uniformity throughout the band and also with less noise. In fact, freedom from noise is (Continued on next page)

LIST OF PARTS

Five ¼ mlh coils (QML).
One 85 mlh Hammarlund choke coil (RFC-85).
Three .00035 mfd. fixed condensers.
Three 0.1 mfd. condensers in one case (parallel two).
One .00015 mfd. Hammarlund tuning condenser (MLW-125).
One set of four Hammarlund plug-in short-wave coils with mounting (LWT-4).
Four UY sockets.
One 2.5 volt Polo step-down filament transformer (SP-FLT).
One vernier dial.
One special metal chassis, 11 x 5½ x 2".
One Electrad 300 ohm grid bias resistor.
One Electrad 2,500 ohm grid bias resistor.
One .0015 mfd. by-pass condenser.
Four binding posts (Ant., Gnd., B+ and blank).

A High-Gain Converter



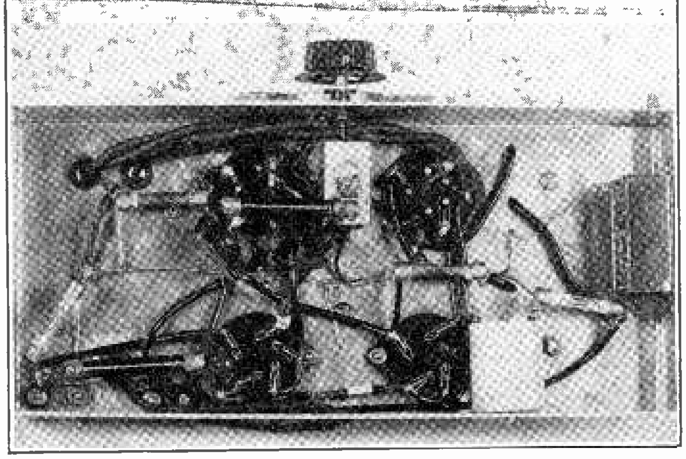


FIG. 2 (TOP)
REAR VIEW OF THE 4-TUBE SHORT-WAVE CONVERTER. A HAMMARLUND 125 MMFD. CONDENSER AND HAMMARLUND PLUG-IN COILS ARE USED, WITH A HUSKY POLO FILAMENT TRANSFORMER

FIG. 3 (LOWER)
VIEW OF THE WIRING AND PARTS UNDER THE SUB-PANEL

(Continued from preceding page)

the principal reason for using the bias on this weak signal detector, for to receive short-wave signals a minimum of noise is required.

The grid bias detector will also stand a greater voltage from the oscillator before overloading, and when it is remembered that the sensitivity of a converter of this type is directly proportional to the voltage picked up from the oscillator, as long as there is no overloading, the advantage of this form of detection is obvious.

The large coupling condenser, .00035 mfd., used between the plate of the first tube and the grid of the modulator insures that the full output of the radio frequency amplifier is impressed on the modulator. The DC resistance of the second choke in the inter-tube coupler is so low that it may be neglected, so that there is no tendency at all for the grid to block. This is true even when the oscillator voltage impressed on the modulator tube in series with the signal is comparatively very high.

Output Circuit

In the output circuit of the modulator is a 50 to 100 milihenry choke coil (designated 60 mlh.). There is a little distributed capacity in this coil and there is more in the circuit to which the converter is connected, so that the modulator works well as a detector. That is, there is enough capacity in the plate circuit to offer very little impedance to the high frequency carrier currents. Still there is little enough to prevent any shunting of the intermediate frequency selected, even if this is as high as 1,500 kc.

The oscillator is of the tuned grid type and the coil contains three windings, a tuned secondary, a fixed tickler and a pick-up coil. The tickler and the tuned windings are on the plug-in coil form and vary in turns according to the frequency band covered. The pick-up winding is permanently mounted on the plug-in socket and is the same for all the coils in the set.

However, it is so arranged that its coupling with the tuned winding may be varied over a wide range so that the pick-up may be adjusted to the particular frequency range that is used. For the largest coil in a set the coupling may be comparatively close, but for the smallest it must be loose if the voltage impressed on the modulator from the oscillator is not to be excessive. Once the proper coupling for any one coil has been found by trial it is a simple matter to set the pick-up coil at the time the coil is inserted in the socket.

Of course, the coupling between the pick-up coil and the tuned winding may be varied for any one coil. If the coupling is close the signals will be strong but the selectivity will not be so good, and if the coupling is loose the signals will be weaker but the selectivity will be considerably better. The only object of getting a high selectivity is to prevent picking up unnecessary noise and interference from other stations which happen to be so related in frequency that they form a frequency which will go through the intermediate frequency selector, that is, the broadcast tuner.

The size of the tuning condenser used in the circuit is .00015 mfd. This is used because the plug-in coils selected for the set are designed so as to cover the bands of frequencies with a minimum of overlapping.

Filament Supply

The filament current for the three 227 type tubes is obtained from a special Polo step-down transformer having a 2.5 volt winding. This transformer is built into the circuit for convenience.

Only a total of five connections need be made in connecting this converter to any broadcast receiver. One is the primary of the filament transformer which is made to the nearest 110-volt AC outlet. Another is the antenna, which is transferred from the broadcast receiver to the antenna post on the converter. A third is the output lead, which is connected to the post on the receiver vacated by the antenna. The other two connections are the ground and the B plus. The B voltage may be taken from the voltage divider in the broadcast receiver or from one of the screens of the amplifier tubes, or it may be supplied by a battery.

Constructional Features

The circuit is built on an aluminum chassis, 11 inches long, 5½ inches front to back, and 2 inches high, which is indeed compact. Regarding the chassis from the front, the filament transformer, a Polo Cat. SP-FLT, is at left, the dial and Hammarlund condenser in center, and the plug-in coil base at right. The tube sockets are so arranged that they are in pairs, each pair consisting of one socket behind another, with the tuning condenser between. There is ample rotor clearance from the tubes. Leads are kept short, as is highly desirable on short waves.

Besides the parts just mentioned, the only ones on the top of the chassis are the four binding posts that go respectively to aerial, antenna post of set, ground and B plus. The positive voltage may from 50 volts up, and the method of biasing the tubes renders them satisfactorily operative whether the plate voltage is high or low.

The dial is equipped with a pilot light, not shown, and if this is used, it is inserted in a Yaxley socket specially made for the purpose, and slipped onto the upright flat bar at rear of the dial. By the way, the dial should read counterclockwise for the position of condenser mounting as illustrated.

Attractive Appearance

The appearance of the chassis is decidedly attractive, as the Polo filament transformer and the chassis have a high polish, one matching the other, while the brass plates of the new Hammarlund short-wave condenser, 125 mmfd., and the green wire of the new Hammarlund plug-in coils constitute a fetching contrast and color scheme.

The new point about the Hammarlund coils is the plug-in fixtures and base, the contacts being beyond doubt of the finest security of contact.

If the pilot light is used, one of the windings of the filament transformer should be connected exclusively to the light, and the red center tap grounded. This is the winding with the small black insulated wire leads. No wiring for this is shown in the diagram. The heater winding for the four 227 tubes (illustrated) has thick black insulated wire, with red center tap, and center goes to ground, also, while the thick wire is led to the nearest tube socket, soldered to the heater prongs thereof, and the connection continued with twisted pair to the three other tubes.

Coil Data

As for the coils, there are four of them to cover the bands from 15 to 110 meters. The adjustable "primary" is built in. The recommended capacity for this coverage is .000125 mfd. These

(Continued on next page)

Stations You Can Tune In

(*Continued from preceding page*)

coils are used so as to provide a more liberal overlap to permit the use of the small tuning capacity, whereby stations are spread out better. The coils, from smallest to largest, may be regarded as No. 1, 20-meter band; No. 2, 30-meter band; No. 3, 40-meter band, and No. 4, 80-meter band.

It can be seen therefore that the outfit is highly suitable not only for reception of broadcast programs relayed on short waves, as by KDKA, WGY, WENR, WABC, WRNY and others, and for television reception, too, but is highly suitable for reception of amateur code and phone, and for trying to get Europe. The bands assigned to the coils represent the general region of reception, but, as all familiar with short-wave reception already know, wavelengths several meters on either side, with the smallest coil, and many meters on either side with the larger coils, are covered. There is no gap in between, but overlapping instead, which is necessary insurance, and besides there is oscillation, hence reception, at all dial positions. There are no skips or dead spots, no growling, squealing or squaking, and no body capacity.

When the circuit was originally set up it was found to work well indeed on all the coils except the smallest, out of which not the faintest sign of a peep was obtained. This trouble was quickly traced to failure of oscillation. The cure was readily at hand. The winding that was intended in the other coils as the secondary in the oscillator grid circuit, for the smallest coil alone is used as the plate winding, while the one used in the other coils for the plate winding is used for the tuned oscillator grid circuit.

Coil Alteration

When the coil is mounted on the base it fits in only one way. The variable primary, so-called, is at the rear end in the assembly on this chassis. Really it is not used as a primary in any direct sense, but is the adjustable pickup coil in the modulator grid circuit. The normal position, with the row of coil lugs at left as you regard the chassis front, is pickup coil connections at left and right rear, grid next, at left, as you move toward the front, ground, B plus and plate. This holds good for the three coils, but not for the smallest one, and to effectuate the desired change you will have to alter the connections made to the coils at the factory, so that the arrangement is: left and right rear lugs to pickup coil, as formerly, the polarity not being important here; lug second from rear on left side to plate of the oscillator, next lug, moving toward the front panel, to B plus; next to ground and next to grid of the oscillator and stator of the tuning condenser. When this change is made the secondary and plate windings are switched for the smallest coil.

The adjustable feature of the pickup coil helps a little, as the coupling may be tighter for the lower frequencies, whereas if it were the same for the higher frequencies, particularly with the smallest coil, oscillation might not endure. So when you put in the smallest coil, be sure to use loose coupling.

It is also a fact that loose coupling is effective even on the lowest radio frequency receivable, but the volume may be less than desired, hereupon the coupling may be tightened advantageously. The position referred to as "loose coupling" obtains when the moving coil is parallel to the other windings, due to the distance between them, and as the moving coil is brought closer to the others it dips into their diameter. It is not necessary to provide a panel depth that will allow the adjustable coil's lever to be at an angle of greater than 45 degrees to the rear of the chassis top.

The AC switch may be of the follow-through type, so that it is a part of the AC cable, rather than occupying a front panel position with nothing to match it esthetically. There is no need for anything on the front panel except the dial and its knob. Really, the dial is mounted on the chassis, and the escutcheon on the front panel.

Selectivity Adequate

Although only one tuned circuit is used, the selectivity is as great as is required, since it consists of the selectivity of the broadcast receiver with which the de luxe short-wave converter is used. While on the broadcast band a 10 kc selectivity often obtains in receivers, there is no need for 10 kc separation on short waves, so the selectivity may be expected to be even greater than absolutely necessary, without quality impairment, however, since some short-wave transmission uses a 100 kc band.

This is no doubt one of the neatest short-wave converters every brought out, and it does work well. It consists of parts of the highest calibre, expertly arranged in a sensibly designed circuit, and all operating at full efficiency. Certainly the eye appeal has not been exceeded by any short-wave converter previously produced, and as to performance, the quality of the parts used should be some guarantee of that, the tuning system consisting of Hammarlund condenser and coils, the filtered output of a Hammarlund choke coil and a fixed condenser, the filament transformer the husky Polo product in polished aluminum case, the short-wave choke coils the ¼-millihenry variety of Supertone Products Corporation, and the biasing resistors of the Electrad wire-wound type. Even so, the cost of the parts should not exceed $23 net.

As for the choke coil, while 50 millihenries is the designation on the diagram, this is merely indicative, and not necessarily persuasive. Any value of inductance may be used from 100 millihenries down to 50 millihenries, and it is well to use the 85 millihenry type manufactured by Hammarlund in the moulded bakelite case, Cat. RFC-85. The reason for a large choke here, as compared with tiny chokes at the short-wave end, is that the output is a broadcast frequency, that is, the intermediate frequency to which the broadcast receiver is tuned, which may be any frequency within the broadcast band where the receiver is most sensitive, without a strong broadcast station being there.

As for the smallest coil, it makes no difference in readable dial settings what the intermediate frequency is. For the next largest coil the difference is slight. For the other coils the difference may be a few degrees on the dial, but it is well to use the same intermediate frequency all the time, for then you can rely on the same converter dial settings bringing in the same stations at the same points time and again.

Right or Wrong?

QUESTIONS

(1)—A 227 tube canot be used as a rectifier in a low power B supply because there is no connection between the heater and the cathode and therefore there can be no rectification.

(2)—A high resistance in series with the screen lead of a screen grid tube used in a resistance coupled amplifier does not serve any purpose and it is always better to omit it and insure that the screen is at ground potential to the signal by means of a large condenser.

(3)—A relatively pure output, that is, free from harmonics, can be insured by putting a very high impedance in the plate circuit of the amplifier tube.

(4)—A 231 and a 232 tube may be connected with their filaments in series because they require the same filament current.

(5)—A neon tube such as used for television reception has a low AC impedance and cannot be used directly in series with a power tube without a current limiting arrangement.

(6)—The output of a detector is not suitable for feeding into a loudspeaker because it is a mixture of carrier current and direct current. It would not be audible.

ANSWERS

(1)—Wrong. The heater has nothing to do with the current conduction except to heat the cathode and the tube would function as a rectifier just as well if the cathode were heated with a gas flame.

(2)—Wrong. It is sometimes desirable to put a high resistance in the screen lead because when the applied screen voltage is high this resistance prevents the screen voltage from assuming a value equal to or greater than the effective voltage on the plate of the tube and thus prevents distortion.

(3)—Wrong. It is usually said that this eliminates distortion because the grid voltage, plate current curve appears to be more nearly straight, but when the two curves are plotted on suitable scales there is very little difference. However, the slight difference is in favor of the higher load impedance.

(4)—Wrong. They cannot be connected in series because the 231 requires a filament current of 130 milliamperes and the 232 only 60 milliamperes.

(5)—Right. The AC impedance of the Kino lamp is about 500 ohms and if the voltage in series with the tube is high a current limiting resistance in series with the tube is necessary. In fact, if the voltage is high enough to cause a glow, which it must be, the protecting resistance is necessary.

(6)—Wrong. In the early days of radio reception the headphones were connected in the plate circuit of the detector tube and the signals were audible. There is no difference between a loudspeaker and a pair of headphones except that the loudspeaker can handle more power. If a real power detector were used the speaker could be connected directly in the plate circuit and the signals would not only be audible but they would be of better quality than they are after they have been amplified.

Three-Tube Short-Wave Con

Tunes from 10 to 200 Meters, Using Total of Two Plug-in

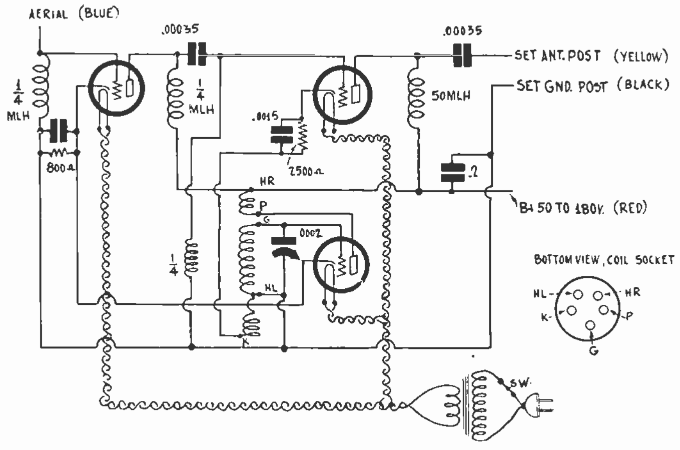


FIG. 5

DIAGRAM OF A SHORT-WAVE CONVERTER WITH FILAMENT SUPPLY BUILT IN, WHICH WILL TUNE FROM 10 TO 200 METERS, USING A TOTAL OF ONLY TWO PLUG-IN COILS.

LIST OF PARTS FOR FIG. 5

One Hammarlund special junior midline condenser, 200 mmfd.; single hole panel mount.
Three 1/4-millihenry radio frequency choke coils
One 50-millihenry radio frequency choke coil
Two plug-in coils constructed on tube base forms
Four UY sockets (three for 227 tubes, one for coil)
Two .00035 mfd. mica dielectric fixed condensers
One .0015 mfd. mica dielectric condenser
One three-in-one 0.1 mfd. condenser (three 0.1 mfd. in one case; two reds paralleled to constitute 0.2 mfd.)
One 2,500-ohm flexible biasing resistor, with lugs.
One 800-ohm flexible biasing resistor with lugs
One 5 x 6½-inch panel, drilled for sockets, condenser and switch.
One walnut finished wooden cabinet to fit panel.
Two knobs with pointers moulded at rim
Two engraved scales, one for switch (On-Off) one for tuning (0-100)
One filament transformer, 2½-volt secondary (center tap not needed); 8 ampere capacity.
One AC switch of the shaft type; single hole panel mount.
One AC cable with male plug
One four-lead cable (blue, yellow, black, red).

[*The first of this series of articles by Herman Bernard on short-wave converters of his newest design was published in the November 8th issue of* Radio World *and concerned principally the three-tube AC model with filament supply external and the battery model, both using three 227 tubes. Those interested should obtain the November 8th, 15th and 22nd issues. Last week, in the December 6th issue, an instalment discussing a converter with built-in filament transformer was printed. This week the constructional details are completed, except that shortly a full-sized picture diagram of the Fig. 5 circuit will be printed, just as the full-scale picture diagram of the AC design for external filament transformer was published last week, issue of December 6th. The earlier models can be built of parts costing less than $5, and the coverage is 30 to 110 meters. The AC model with internal filament supply can be built of parts costing less than $10, while the equivalent design for battery operation (less filament transformer) can be built of parts costing less than $7.50.—Editor.*]

THE short-wave converter with filament supply built in uses a total of two plug-in coils to cover the short waves, beginning at 200 meters, so that with the receiver in conjunction with which the converter is to be worked, the coverage would be from 10 to 545 meters.

Fig. 5 Explained

The diagram is published this week as Fig. 5, and is a little different than the one shown last week, although without any difference in results. If the resistor in the modulator's cathode is returned to the cathode of the oscillator, then 20,000 ohms in the modulator cathode would result in the same bias as would be present if 2,500 ohms were used and the return made to grounded B minus. Hence the diagram this week shows 2,500 ohms used, which may be done more conveniently, since a flexible resistor of the familiar grid biasing type, as made by Electrad, is employed.

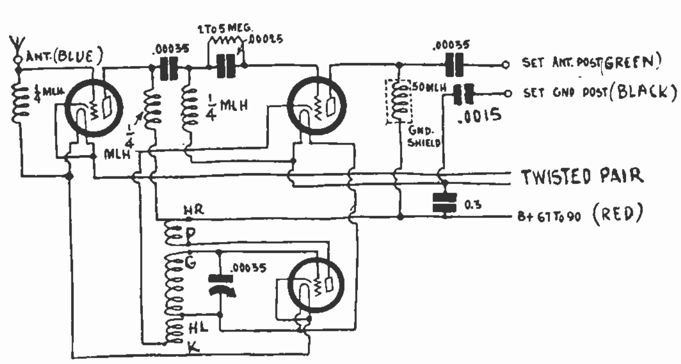


FIG. 6

THE CIRCUIT WITH 227 TUBES USED FOR 6-VOLT STORAGE BATTERY OPERATION. HEATERS ARE IN SERIES.

Coil Prong Connections

The diagram also shows the coil socket connections when the socket is viewed from the bottom with grid connection toward you. This view preserves the same relative left and right positions of heaters, cathode and plate. Hence HL stands for the left-hand heater, HR for right-hand heater, K for cathode, P for plate, and G for grid. These designations do not refer to any tube connections in particular, but only to coil connections, since no tube goes into the coil socket. The coil connections to tubes are shown in the schematic circuit.

The winding comprising the tuned secondary and the pickup coil is really one winding, tapped. Sometimes the pickup coil is shown at the left side of the other, instead of beneath it, and some assume the pickup is a physically independent winding, but it is not. Its independence is electrical, not physical.

The windings should be all in the same direction, no matter if that direction is left-handed or right-handed. Granting unidirectional winding, then one terminal of the larger winding goes to the biasing resistor of the modulator, the tap goes to ground, and takes in two coil connections at once by this method, while the other extreme of the winding goes to oscillator grid. There remains, then, only the plate winding, which is connected so as to produce oscillation, i. e., with the plate winding physically below the other, the lower terminal goes to the plate and the upper terminal to B plus. Fig. 8 gives the relative positions, the connections and the number of turns.

It is possible with the .0002 mfd. tuning condenser to cover the short-wave band from 10 to 200 meters with two coils, which is the reason for using this slightly larger capacity than ordinarily employed in short-wave work.

Transformer Needs No Center Tap

The filament transformer is not shown as being center-tapped, as no hum arises from lack of center-tapping a filament transformer in a short-wave converter, and it is therefore just as well, and somewhat simpler, to omit the usual center tap. Some diagrams of converters with filament supply have shown a center tap to ground, but any of these diagrams may be followed, with center-tap omitted, with just as good results.

There are only four output leads in the cable this time, and the connections are: Blue, to aerial which has been removed from the antenna post of the receiver; yellow, to set antenna post vacated when aerial was removed from set; black to ground post of the receiver, the ground connection being left at the receiver post also; red to a positive B voltage, of from 50 to 180 volts. The biasing arrangement being automatic, the higher the plate voltage, the higher the plate current, the higher the bias, so no alteration need be made no matter what positive B voltage is used. Also, this voltage is not critical. The main objective is to attain oscillation, so if oscillation fails you may increase the B voltage.

The coils as recommended are designed to produce oscillation even at 45 volts, since the same general circuit may be used for battery operation by connecting the heaters in series, providing suitable grid returns and omitting the filament transformer, while retaining the three 227 tubes with a 6-volt storage battery

verter with Filament Supply

Coils—Designs also for Battery Operation—Coil Data Given

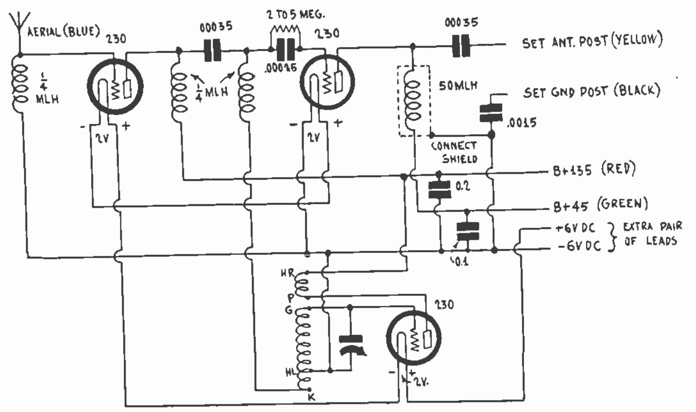


FIG. 7
THE SERIES FILAMENT METHOD USED WITH THE NEW 2-VOLT TUBES, TYPE 230, WITH A 6-VOLT STORAGE BATTERY SOURCE. B MINUS IS AUTOMATICALLY ESTABLISHED AT THE A BATTERY, TO WHICH B MINUS ALREADY IS CONNECTED, WHILE THE .0015 MFD. CONDENSER PREVENTS SHORTING THE A BATTERY.

across them to afford 2 volts to each tube, which are enough for good results.

For battery operation, using 227 tubes, follow the diagram as shown in Fig. 6, remembering that the heaters are in series, and that differences in grid return connections are made intentionally, to effectuate proper biases.

Use of New 2-Volt Tubes

Also, the same general circuit may be used for the new 2-volt tubes, 230, and the diagram for these is shown in Fig. 7. The same layout of parts may be followed.

The parts for Fig. 6 are the same as those for Fig. 5, except that the 800-ohm and 2,500-ohm resistors are omitted, also the .0015 mfd. condenser and the filament transformer, while a 6-lead cable supplants the four-lead one and grid leak and condenser are added.

For Fig. 7, the parts are the same as for Fig. 5, except that three UX and one UY socket are used, the 2,500-ohm and 800-ohm resistors are omitted, also the filament transformer, and the 4-lead cable is replaced by a 6-lead cable, while leak and condenser are newly included.

It must be borne in mind that if you have AC in your home you may use the Fig. 5 diagram, since the converter will work with any type receiver, whether battery-operated or not.—Herman Bernard.

Common Resistance in Grid Return

In most modern receivers there is a high resistance in the lead from the mid-tap of the push-pull input transformer to ground. In view of the fact that no current flows in the grid circuit when the tubes are properly biased what function does this resistance serve? Would it not be just as well to ground the mid-tap directly?—B. M. L.

As far as the grid current is concerned there would be no object of using the resistor for when there is no current there can be no voltage drop and if there is no drop in the resistance it does not serve any purpose. But suppose the signal is so great that grid current does flow. There would then be a current through the resistance during the positive half, or during a part of the positive half of the signal, and this current would set up a voltage drop in the resistance which would tend to make the grid less positive and this in turn tend to reduce the current. It would therefore tend to prevent overloading of the tube, but this would be at the expense of quality for the positive peaks would be reduced. However, since the characteristic curve of the tube is not a straight line but is considerably curved, the lowering of the positive peaks would just about balance the normal reduction of the negative peaks so that the effective characteristic would be nearly symmetrical. To produce symmetry is one of the functions of the push-pull circuit.

The advantage of the common resistance must be looked for in the capacity currents rather than in the grid currents, capacity currents from the primary to the secondary of the transformer. The resistance in the common lead tends to equalize the inputs to the two tubes when there is capacity current. The beneficial effect of this would be on the high audio notes for only on those notes is the capacity current appreciable.

Coil Data for 10-200 Meters With .0002 Mfd. Condenser

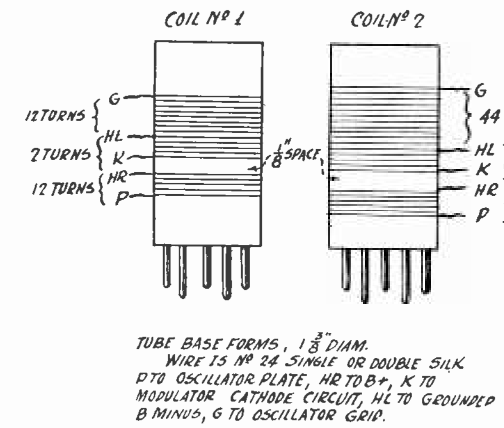


FIG. 8
DIAGRAM OF COIL WINDING.

The form used for winding the two short-wave coils that afford coverage from 10 to 200 meters is of the tube base type, with tube prongs built in. The form is about 2½ inches high. The diameter is assumed to be 1⅜ inches, which is a trifle larger than the diameter of the actual base of a tube, yet it is the actual diameter of most coil forms patterned after tube bases. The wire used is No. 24 single silk covered.

Coil No. 1—Plate winding at bottom. Lower connection is for plate of the oscillator tube and connects to the P prong of the winding form. Put on 12 turns, side by side, close-wound. Terminate this winding so that is goes to the right-hand heater. See Fig. 1. This completes the plate winding. Now leave ⅛ inch and begin winding the other coil. Connect the beginning of this winding to the cathode prong of the tube winding form, put on two turns, tap and connect tap to the left-hand heater. Put on 12 turns more. Terminate the fourteenth turn at the grid prong of the tube winding form. This completes the winding of Coil No. 1.

Coil No. 2—The same polarity and terminal references as given for the other coil apply to this one, but the number of turns differs. The plate winding has 15 turns. The pickup coil consists of three turns (K to HL), while the tuned secondary consists of 44 turns. Hence the single large winding has 47 turns, tapped at the third turn. The wire used is the same as for Coil No. 1.

As for bringing out the tap, it is well to proceed as follows: Having drilled two small holes side by side for threading the wire at terminals of windings, drill instead one larger hole where the tap comes, scrape the insulation off the wire for about ¼-inch, bend the bared wire back on itself to constitute a tight V shape, and pass through the opening drilled therefor. Pass the end of an extra 4-inch long piece of wire through the V, inside. Then tighten with pliers, by light twisting. When time comes to solder this connection, it may be done by cutting the 4-inch wire length after it has been passed through the heater-left prong for soldering.

The directions given for winding the coils apply to all the circuits, whether AC-operated or battery-operated, and without regard to the type of tubes used, since due allowance was made for those tubes that do not oscillate as readily as others, and inductance was made large enough to take care of the relatively sluggish types.

The data were given for tube-base forms, as these are the most convenient to use, but of course coils may be wound on larger diameters. The only trouble is that there would not be room for such coils on the particular assembly, i.e., 5x6½-inch panel. However, any who desire to do their own woodwork, and use a larger cabinet, may wind coils on larger diameters. Roughly, a three-inch diameter would require half the number of turns of the 1⅜-inch diameter.

An All-Wave Mixer

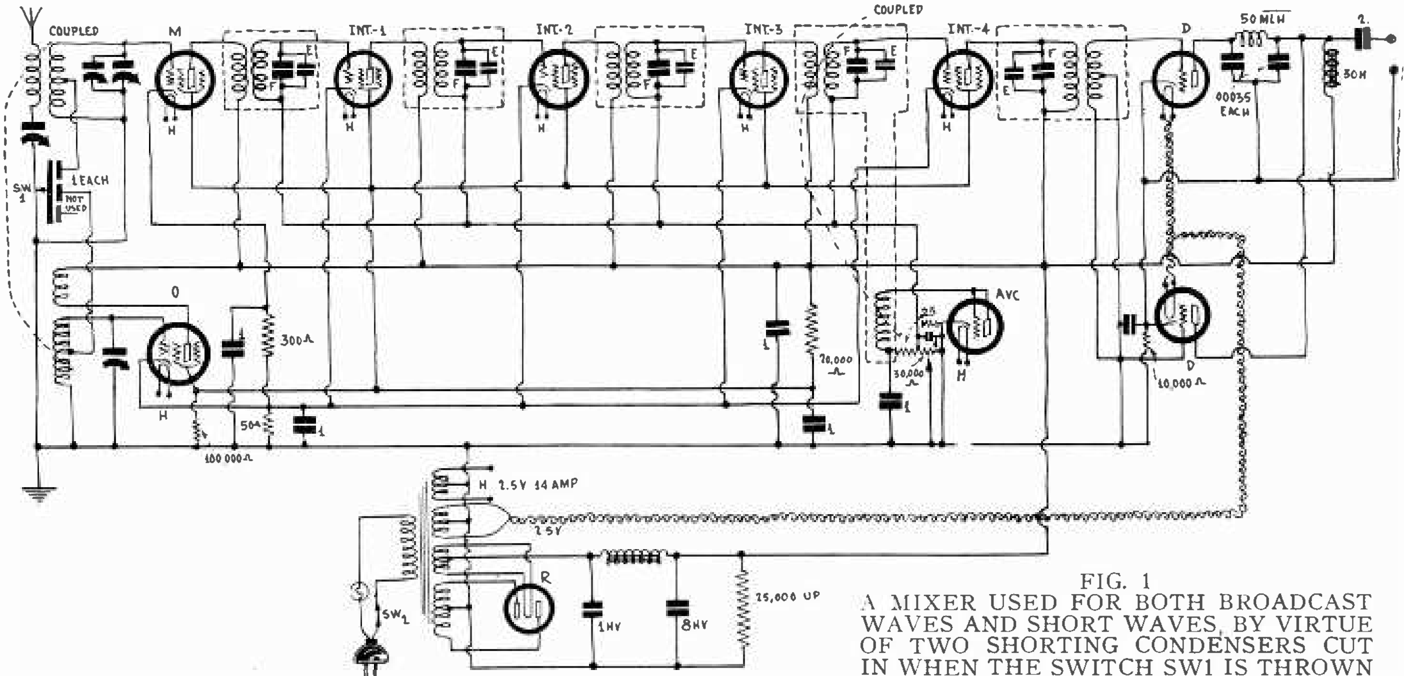


FIG. 1
A MIXER USED FOR BOTH BROADCAST WAVES AND SHORT WAVES, BY VIRTUE OF TWO SHORTING CONDENSERS CUT IN WHEN THE SWITCH SW1 IS THROWN TO "ON" POSITION.

[*In the November 22nd issue the first of a series of articles dealing with all-wave receivers was published. The diagram in that issue showed a screen grid battery-operated tuned radio frequency tuner with three tubes ahead of it, for use for short-wave conversion. A combination switch threw the aerial from the input to the short-wave adjunct to the input to the TRF amplifier, turning off the voltage to the filaments of the three converter tubes when broadcast waves were to be received. The intermediate frequency, instead of being fixed, was ever-changing, as the same dial was used for short-wave or broadcast reception, one section of a gang condenser tuning the short-wave oscillator. In the November 29th issue a complete AC-operated TRF receiver was shown, embodying the same principle. The December 6th article on this topic dealt also with a complete AC receiver. However, for the first time a method was shown for using only a single pole, single throw switch to accomplish the result, and utilizing all the tubes all the time. Now the diagram reveals the single-switch method, but with the same mixer used for short waves and for broadcasts. In a few weeks it is expected constructional data will be presented on an all-wave receiver embodying the method that works out best.—Editor.*]

IN the development of an all-wave receiver a mixer is generally used, especially for the short-wave reception, while the rest of the circuit may be a tuned radio frequency receiver. But it is possible to use the mixer for broadcast work as well, as shown in Fig. 1.

This diagram may be read as a tuner, since no audio amplification is included, but instead of three intermediate frequency stages there are four, and the amplification from the extra stage is about the same as that from a stage of transformer-coupled audio. Since there are circuits with three intermediate stages that work a speaker with a single audio stage, the so-called tuner should be loud enough in this instance to constitute a speaker-operating circuit, and with that in mind the detector stage is considered as the final output. Instead of a single tube, two tubes are used, the input to the stage being push-pull and the output in parallel. Since the output tubes are 227s, the B supply need furnish only 180 volts.

Consider the two tuned circuits shown at left, one above the other. The top one, M, is the modulator, and it uses negative bias modulation instead of the leak-condenser type. The windings for the oscillator are on the same tubing as those for the modulator, hence inductive coupling results. No other coupling is needed.

Therefore the oscillator works suitably into the modulator, and the output of the modulator, representing the difference between the carrier frequency and the oscillator frequency, is amplified in the intermediate channel.

All windings are used in toto for broadcast work, with single tuning control.

Now, how shall short waves be received?

It is well known that if a tuned circuit consisting of inductance and capacity is so altered that a small part of the inductance is shorted out, the effect on the tuning characteristic is bad. A short-circuited turn is a "losser," a resistance-introducer. But if a relatively large number of turns is shorted out, the tuned circuit is virtually unaffected, the only result being that the frequencies are much higher. A large number of short-circuited turns acts like a choke, since no current will flow in the shorted section.

The method of shorting is to introduce a large capacity between the tap and ground, to permit single switching. So, taking the modulator coil, this is tapped near the grid end.

Suppose the windings are as follows: Antenna coil, 15 turns; modulator secondary, 73 turns; oscillator plate winding, 10 turns; oscillator secondary, 20 turns. The diameter is 1¾ inches. These data would apply to an intermediate frequency a little below the lowest broadcast frequency, say, 450 kc., or 666 meters. This requires an inductance for the oscillator secondary of .274, the inductance of the modulator secondary, or, roughly, about one-quarter.

Covers 23 to 110 Meters

Now, by cutting in the bypass condensers up near the grid ends of both tuned circuits, the frequency of response is greatly heightened. With tuning condensers of .0005 mfd. capacity, a single winding will tune from 23 to 110 meters, approximately, and the number of turns for the 1¾ inch diameter tubing is 8. The wire in all instances may be No. 24, single or double silk covered, except that the plate winding of the oscillator may have smaller wire, with the same specified number of turns.

Now the frequency of the carrier to be received will be much higher, and the intermediate frequency will be a small percentage of the modulator or oscillator frequency, so the inductances may be the same for the tuned circuits in the short-wave range. Hence tap the grid coil of modulator and oscillator, each at the eighth turn from the grid end, and connect to one side of a three-in-one fixed condenser that has sections of 0.1 mfd. each. This is one of the three red leads of the condenser. The third red lead is not used. The black lead, representing the common plate, is connected to a switch, so when the switch is closed to ground the condensers are in circuit and when the switch is open they are out of circuit. The coupling between modulator and oscillator is automatically

New Tubes Make

SEVERAL manufacturers specialize in portable radio sets. The portable set is made to operate with batteries, usually has a self-contained loop aerial which opens up in use, and may be carried like a handbag or suitcase.

There are highly efficient dry battery tubes which permit distance reception and good tone qualities at moderate loudness. For the man who travels and spends lonely evenings in hotels, in unknown cities, the portable radio is worth while to the "nth" degree. Easily carried on the train or in the automobile, it is the most convenient form of radio to move from one place to another. For country homes, trips, camping tours, hotel visits, for use in the sick-room, for personal use in one's own room or in the office, the portable fills a unique place in radio receiving. It may be used in the car, too, on a boat or train and offers a great deal of pleasure in circumstances where radio ordinarily

with Single Switch

close on short waves, due to frequency, and there is virtually no modulator tuning then.

The series tuning condenser under the antenna coil is one of the sections of a three-gang condenser, and it keeps reducing the natural period of the antenna as the resonant frequency of the parallel tuned circuits is increased.

The all-wave feature is essentially very simple. The intermediate frequency chain is standard, but the frequency is higher than that generally used. In former years 70 kc. and thereabout were popular. This year set manufacturers are using 175 kc. The choice for the design in Fig. 1 is 450 kc., because it is desired to dispense with any tuned radio frequency amplification ahead of the modulator, so that the all-wave feature may be worked more simply.

It is not necessary for sensitivity reasons to include TRF ahead of the modulator, but only for selectivity. This selectivity is for a single main objective, the elimination of image interference, a form of interference peculiar to Superheterodynes. It arises from the fact that the oscillator at any particular setting may bring in weakly another station than the desired one, because the frequency of the interfering station differs from the other carrier frequency by twice the intermediate frequency.

The lower the intermediate frequency the less capable is the tuning of the modulator circuit able to reject the frequencies that give rise to image interference. At 70 kc. the suppression is required to be high in the modulator filter, killing off interference 140 kc. away, whereas at 175 kc. it is required to be still rather high for 350 kc. effectiveness, and in both instances it is probably desirable to use tuned radio frequency amplification ahead of the modulator.

Image Far Removed

But with an intermediate frequency of 450 kc., the modulator's tuned circuit is called on to suppress carrier frequencies differing from the desired resonant frequency by 900 kc., and even a single tuned circuit affords ample suppression of frequencies 900 kc. apart, in fact, almost as far apart as the highest and the lowest broadcast frequencies, represented by the extremes of a tuning dial.

The choice of a high intermediate frequency makes it possible to constitute the intermediate couplers of coils intended primarily for broadcast use, the only provision being that primaries in the plate circuits of the screen grid intermediate tubes must have a high impedance. The ratio of primary to secondary should not be higher than 1 to 2. A fixed condenser, F, is connected across the secondary, and in addition an equalizing condenser, E. F may be .00035 mfd. and E may be 100 mmfd. E is adjusted until response is loudest. First turn the setscrew of the first intermediate (INT-1) down nearly to the end, by actually reaching the end and coming up half a turn. Then adjust the rest.

Detector Coil

In the detector input circuit, due to the push-pull arrangement, the coil is used in inverted fashion, and the primary is tuned instead of the secondary, although it is the same winding that otherwise would be the secondary. The pick-up coil to the detector may be constructed of an existing coil by adding as many more turns as are on the present primary. The resultant distributed capacity will call for only a small part of E being in this circuit.

In the diagram M is the modulator, O is the oscillator, INT-1, INT-2, etc., are the first, second and subsequent intermediate frequency stages; D is the push-pull-parallel detector; R the rectifier (a 280 tube), and AVC the automatic volume control, which helps to minimize fading common to short-wave reception.

The principle of the automatic volume control is one of simple rectification. This control was developed by J. E. Anderson. The carrier is introduced into the grid circuit by coupling to the fourth intermediate stage. The tying of grid and plate together accomplishes a diode rectifier (half wave). The rectified voltage will be greatly more than what is needed for supplemental and automatic bias variation, so a .25 meg. grid leak is used in series with a 30,000-ohm potentiometer, and the potentiometer itself is used as a manual volume control.

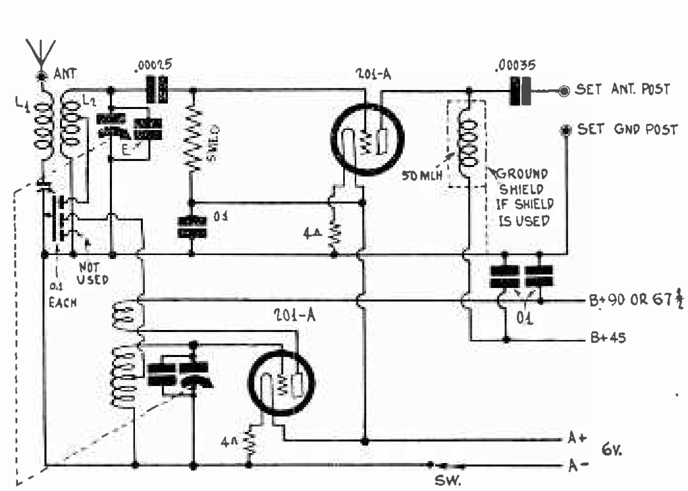


FIG. 2

DIAGRAM OF A MIXER ONLY, FOR BATTERIES, WHEREBY IT IS POSSIBLE TO USE THE HIGHEST DIAL SETTING (LOWEST FREQUENCY RESPONSE) OF A TUNED RADIO FREQUENCY RECEIVER FOR INTERMEDIATE AMPLIFICATION

Any TRF Set a Super

Since the system as outlined uses a high intermediate frequency, it will occur to many that they may try out the plan in conjunction with any broadcast receiver that will tune, say, below 550 kc., or, indeed, even if it will not tune below that, provided no broadcast interference is present on the frequency to be used for intermediate amplification.

For an intermediate frequency lower than 550 kc. it will be possible to cover the entire broadcast spectrum, but if the set does not tune lower than, say, 520 kc., then 520 kc. would be the lowest frequency (highest wave) to which you could tune, because at that point the system would tend to act in tuned radio frequency fashion, with not much possibility of response at frequencies lower than the intermediate frequency.

No B voltage is contained in the Fig. 2 diagram, but this may be supplied from the set itself, and is not critical.—Herman Bernard.

MAKING A MICROPHONE

IS it very difficult to make a carbon button microphone or is it within the skill of a fan who has built countless radio receivers? If you think a successful microphone can be built at home will you kindly describe one?—W. B.

It is quite possible for a fan to build one, and a good one at that. The main ingredient are carbon granules, which you can get from chemical supply houses. Granules come in various sizes, and the larger they are the more sensitive the microphone is likely to be. If you cannot buy the granules take a soft lead pencil and break up the carbon into fine pieces. For the frame of the microphone you might take an old headphone unit, removing everything but the diaphragm. Inside put a piece of wood or other insulator and cut a little cavity in the end that faces the diaphragm. Line the sides of the cavity with metal and connect this metal with an insulated wire through the case for one of the terminals. In the center of the granule mass put another electrode and connect this to the metal frame. To hold the granules in the cavity you might glue a piece of very thin paper over them. The pile of granules should bulge out a little so that the diaphragm when put in position presses against them, but no part of the wood or insulator should touch the diaphragm. The two electrodes in the carbon granule mass should be insulated from each other except for the conductivity of the carbon.

* * *

VOLUME CONTROL OUT OF ORDER

THE knob that controls the volume on our set seems to be out of order. Turning it seldom makes much difference in the loudness, and it continues turning in either direction instead of stopping. As I am unable to buy one like the unit in the set would you advise me what to do?—C. S. M.

Replace the volume control unit, or have a service man do it. An experienced radio man will know what resistance unit to substitute.

Portables Effective

is out of the question, but for these convenient and attractive little receivers of moderate cost.

Portable radio sets are made to operate from B and A eliminators, too, so that when used at home, the batteries are not needed. As a rule the aerial is of the loop form, which is a small rectangular or square coil of wire held in an upright position while the set is used. The aerial is placed in the lid or cover of the set, and the lid is raised when the set is used, thus putting up the aerial and providing access to the control knobs and dials and the loud speaker all at once. The loop, or else the set with the loop, must be moved around into position, for the loop must point toward the station you wish to receive. The portable set should not be expected to deliver a broadside of volume, but it will furnish pleasing entertainment for personal use, or for a small room.

How an AC Short-W

By Dana

Radio Engineer,

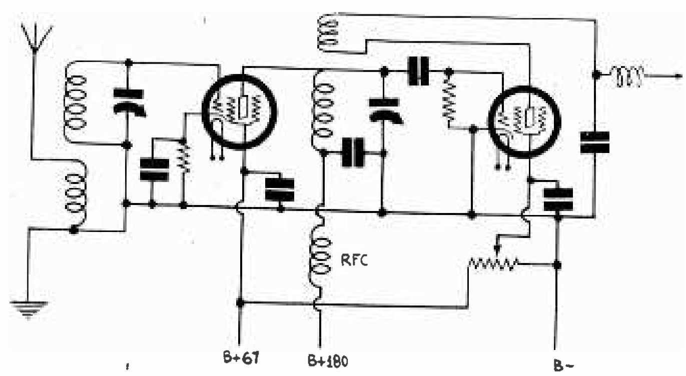


FIG. 1
CIRCUIT USED FOR PRELIMINARY TESTS AND NOT FOUND SATISFACTORY.

AFTER a survey of all the short-wave kits and receivers that were available last Spring, the National Company's engineers decided that the most acceptable short-wave set should incorporate the following things: Full AC operation without hum even on earphones, sensitivity enough to get down to the static level (which is pretty low on short waves), full wavelength coverage from 9 to 550 meters, and loudspeaker operation on all waves.

This proved to be quite a large order, and numerous problems arose which were difficult to solve.

The best practical circuit was found to be a stage of tuned radio frequency using amplification, a screen grid tube, a screen grid detector, a 227 first audio and push-pull output with two 227's. The 227 push-pull output was found essential, as earphones cannot be used with the regular output tubes, such as the 171A or 245, without considerable hum.

67-to-100 Coil Ratio

The next thing was to make each one of these tubes deliver maximum gain. An experimental model was built up, using the RF circuit shown in Fig. 1. This model had low RF gain, a bad hum, and tuning was very broad.

Investigation showed that this method of coupling the RF tube to the detector was inefficient, because the plate impedance of the 224 RF tube puts a heavy load on the tuned circuit, resulting in low gain and broad tuning. The hum was caused by the condenser next to the leak, preventing AC coil pickup from going direct to ground. This fault could not be eliminated even by increasing C to 2 mfd.

All these difficulties were overcome by the use of an RF transformer, as shown in the complete diagram. With a primary winding of approximately two-thirds the number of secondary turns, maximum gain and selectivity were obtained. Hum from pick-up by the detector coil almost vanished.

The most sensitive detector was found to be the 224 using a grid condenser and leak of the values shown with a plate voltage of 180 and a screen grid voltage of 25 to 35 volts. In order to obtain an actual plate voltage of 180 and still match the high plate impedance of the tube, a special audio choke coil was developed, having an inductance of about 1,000 henries. The use of this choke, instead of the more customary resistor, increased signal strength 400 per cent.

One of the most objectionable faults of a large number of short-wave receivers is poor regeneration control, usually accompanied by fringe howl. This trouble was found to be caused by RF coupling between the detector and first audio tubes, occurring largely in the power supply.

Cabinet Acts As Shield

By operating the first audio tube at full 180 volts and thereby taking advantage of the high capacity filter condenser as a by-pass, most of the fringe howl was eliminated. Proper by-passing of the detector and RF screen grid leads also helped greatly. Undesirable coupling was found to exist between the coils and the audio tubes, necessitating shielding in the form of partitions, which divide the chassis into three sections. This killed the last vestige of fringe howl.

The RF and detector tubes were found to be picking up stray fields from 110-volt wiring, power pack, etc., making tube shields absolutely necessary for quiet operation. The metal cabinet serves a double purpose: to insure stable operation of the RF circuits, and to prevent any pick-up of stray fields by coils, condensers or wiring.

Two Types of Hum Experienced

In spite of all these precautions, two types of hum were still found to exist. One was the familiar 120-cycle hum caused by poor filtration in the B supply, and the other a series of tunable hums appearing at various points in the shorter wavelengths and persisting over bands several meters in width. The 120-cycle hum was reduced greatly by careful design of the two filter chokes. This, however, was not enough, since short-wave receivers are famous for bringing out the smallest AC ripple. It was found necessary to place the chokes in a certain very critical position with relation to the power transformer, so that

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Forum

Announcers "Talk Too Much"

AMOS PARRISH, the fashion expert, states that "style is what people are buying." In other words, it doesn't matter if all the experts in any line should decide that a certain kind of hat or dress or suit or fur coat is the style, if the people go into stores, take one look and walk out or else buy something else, then the thing that was promoted would never really become the style.

Of course it is difficult for a radio manufacturer to get this information and particularly to express the preferences of the public in two or three cabinets.

However, I don't believe even a big improvement in radio cabinets would stimulate radio business right now. My own opinion is that radio business won't get any better until broadcasting methods are reformed and until some plan is adopted to give the public a better choice of programs.

My idea would be that stations be asked to set aside certain evenings for music programs or for what might be termed, "Programs for busy people."

I enjoy listening to music over the radio, but during my leisure time in my home, I am usually reading, talking, playing cards or working at my desk or carrying on some form of activity that requires a certain amount of mental concentration, and the sort of programs we get over the radio are quite annoying.

It seems to me that the average radio program is designed for the kind of man who comes home in the evening, eats his dinner in the evening and at about 6:30 or 7:00 o'clock he and his wife are sitting in their living room waiting to be entertained. The announcer evidently figures that unless he talks to them at least once every two or three minutes that they will go to sleep and pass out on him so it is necessary to talk to them to keep them awake.

A GREBE DEALER.

Delighted With MB-30

I HAVE assembled one of the MB-30 kits, and I am working it into a 250 pushpull power amplifier. I get 100 and 500-watt stations 1,000 to 1,500 miles away with three high power locals on, two of 10,000 watts and one of 50,000. The tone quality is excellent and there is no interference.

In case any builders of the MB-30 kit desire a phonograph connection, I have arranged one in mine that is very good. Simply drill a hole in the back of the set chassis and mount a single circuit jack. (Be sure to insulate the jack with fibre washers). Connect one side of this to the output post and the other to the blue 67½-volt screen grid lead. This arrangement keeps an excessive current out of the pick-up and audio transformer. A single pole-single throw switch may be connected in series with the pickup to switch from phono to radio.

One very peculiar thing I noticed about this set is that distance comes in with the same volume as the locals. I am using a 12-inch auditorium type speaker and such a large volume is obtained on all stations that I cannot tell whether I have California or Fort Worth.

If any skeptics desire to write me about this set, I will certainly be glad to set them straight.

JERRY MINTER,
3116 Cockrell Ave.,
Fort Worth, Tex.

We'll Investigate

PLEASE let me know whether you still publish RADIO WORLD. I used to read it eight years ago.—J. E. M.

ave Set Was Designed

Bacon

National Company, Inc.

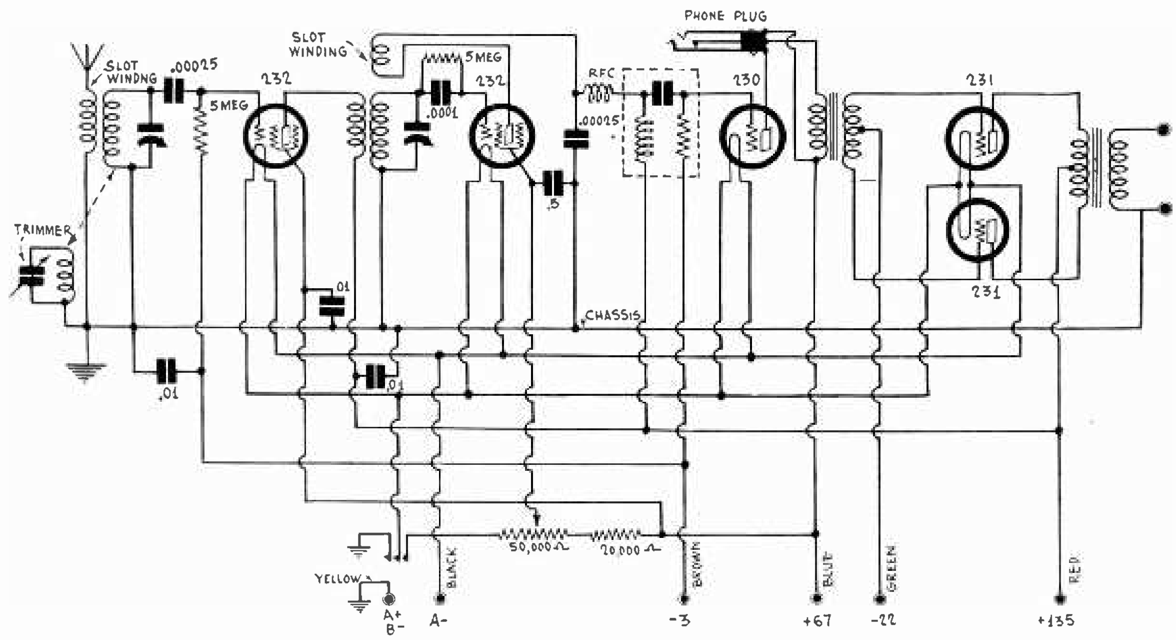

FIG. 2
DIAGRAM OF THE NATIONAL COMPANY'S SHORT-WAVE THRILL BOX, FOR BATTERY OPERATION. THIS IS ONE OF THE MOST EFFECTIVE SHORT-WAVE SETS EITHER IN AC OR BATTERY DESIGN.

the hum picked up by one would buck out the hum picked up by the other.

Now, only the tunable hums remained, but these were particularly difficult to remove, since their source was not fully understood.

Disturbances from AC Line

To find out what was going on the receiver was first connected with B batteries for plate supply, and AC on the heaters. About half of the hums was still present, however, until it was found that the trouble was caused by RF in the heater circuits which was prevented from getting to ground by the impedance of the center-tapped resistor. The resistor was acting as a choke on wavelengths below fifty meters. A by-pass condenser from one side of the heater circuit to ground completely remedied this.

When the B eliminator was used for plate supply, the rest of the tunable hums reappeared and could be removed only by the introduction of an electrostatic shield around the power transformer primary winding, together with an RF by-pass condenser across the output of the rectifier tube. It was evident, therefore, that these disturbances were coming in on the AC line, and that the regular B supply filter circuits were incapable of removing them.

Final tests using an AC supply line, neither side of which was grounded, proved entirely satisfactory, since performance was as quiet as when the regular line was used. Even when using a rotary converter having poor wave form and considerable commutator ripple, results were the same, showing that the design was such as to give perfectly normal operation even under extremely adverse conditions.

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EXPERIENCE FIVE YEARS, custom set builder and designing. 25 years old, single, reliable. Knew radio when Electro Importing Co. was the only supply house available to amateurs. Would like factory or laboratory work—go anywhere. Floyd Hoskins, Jr., care Hotel Atlantic, Bay and Hogan Sts., Jacksonville, Fla.

RADIO SERVICE-MAN wishes position in either store or factory. Have three years outside experience. Am now student of National Radio Institute, Washington, D.C. L. Schudde, 155 Meserole St., B'klyn, N. Y.

RADIO MAN, 3 YEARS EXPERIENCE, desires work. Write Frank Lavallee, 218 Baxter St., Pawtucket, R. I.

YOUNG MAN WANTS WORK IN RADIO LABORATORY or radio repairing. Have had Technical School Training, and experience. Also have an Amateur Ticket. Matthew Ajeman, 75 Park Street, Rockland, Mass.

30 YEARS OF AGE, A COLLEGE GRADUATE. Primarily a sound engineer (R.C.A.) with expert knowledge of installation, service, maintenance and repair of sound motion picture systems as well as all kinds of amplifiers and public address systems. Aso of acoustical problems (treatments of theatres, etc.). This knowledge is backed by eight years' experience in the electrical and radio field, enabling me to install, service and repair expertly any and all radio sets and accessories on the market. I am free to travel, speak several languages and am equipped with all necessary tools, meters and latest type analyzer and checker. Although I made, of course, a good deal more, I am willing to start at $30.00 per week. I am prepared to furnish excellent references.—Address Able. Box X, care of Radio World.

NATIONAL RADIO INSTITUTE GRADUATE, with three years' experience in building and repairing receivers. Would like to obtain position. William B. Floyd, Box 22, Monroe, Virginia.

EXPERIENCED. Good general knowledge of technical radio work, construction and repairing. Am 30 years of age and married. Reference: Radio and Television Institute, Chicago, Ill. Steve Marko, 139 Brighton Drive, Akron, Ohio.

YOUNG MAN 19, TECHNICALLY INCLINED, desires position as assistant in radio laboratory. Formerly connected with Pilot experimental tube laboratory. Write August L. Oechsli, 280 Linwood St., Brooklyn, N. Y., or phone Applegate 8631.

RADIO SITUATION WANTED. Radio Repair and serviceman, 21 years old, High School education, three years experience, would consider radio position of any kind, anywhere in United States. Kenneth P. Henderson, 115 Honeoye St., Shinglehouse, Pa.

EXPERIENCED RADIO SERVICE MAN wants position. Write Thomas E. Martin, Keota, Iowa.

From Batteries to AC

By *John C. Williams*

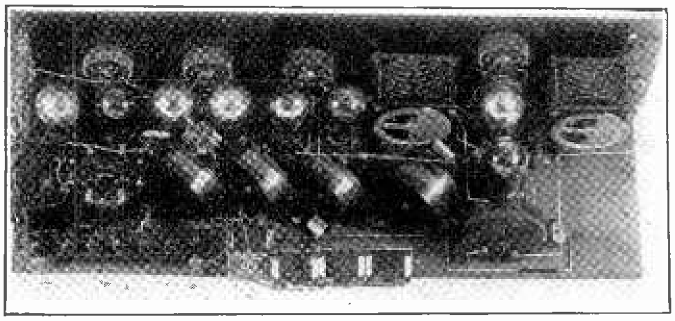

FIG. 1.

THE BATTERY OPERATED SUPERHETERODYNE, SHOWING THE LAYOUT OF PARTS, WHICH WILL BE SUBSTANTIALLY UNCHANGED WHEN IT IS CONVERTED FOR USE WITH AC TUBES.

THERE is much interest among owners of battery-operated Superheterodynes in the conversion to AC operation.

The rectifier system must be given full consideration in the light of the load to be placed on it.

The concept of rectifier operation carries with it the necessity of ascertaining roughly the extent of the probable load. This load may or may not include a DC-operated dynamic speaker field winding, of applied voltage of 70, 110, 220, or 300 volts, depending on either what you have on hand, or and how the field coil or "pot" is to be connected in to the B voltage network.

The methods in use at present are the series connection, where the field winding becomes a part of the filter choke, and the parallel connection across the rectifier output, in shunt with the first fixed condenser ahead of the usual filter choke.

What Rearrangement is Necessary?

The type of winding for the parallel case is the 300-volt variety, and if the field wattage is 12, the current is .040 ampere, and the resistance of the winding should be 7,500 ohms to meet these requirements. These are DC values, of course, and as the voltage applied is pulsating, the effect of the self-induction of the winding will limit the current slightly, the limitation not affecting the flux value of the field winding produced in the air gap in which the voice coil operates.

The magnetic structure of commercial dynamic speaker field "pots" usually operates at a point far enough above the knee of the magnetization curve so that a relatively small change in the value of the exciting current produces no detectible change in the audio output level of the speaker.

It is to be supposed that the contemplated process of changing over the battery-operated set to the AC operation raises the question of the probable extent of rearrangement necessary exclusive of additions and etc.

No Space Alteration

A case where no space alteration is necessary is one, for instance, where the tube sockets (four-prong variety) are sufficiently well center-spaced so that the substitution of the AC type tube sockets can be made without inconvenience.

As there is no sensible difference in size between the AC and DC tubes, all will go well. There is generally enough room between the tube sockets and the coils of the set, throughout the assembly, to permit access with the soldering iron.

My set was a Victoreen Superheterodyne in which the coil assemblies that form the intermediate frequency amplifier were situated at a "sacred" angle, and the changeover to AC operation did not necessitate the alteration of the assembly in this regard in the least.

Placement of Oscillator

The oscillator coupler coil is at right angles to the intermediate frequency coils, and it, too, remains as it is. There is some apparent crowding at the audio frequency end of the assembly, but it is not detrimental to the operation of the set. The audio transformers are placed at right angles to each other, and there is directly behind them the usual terminal board, which is to be removed.

The front panel of most battery-operated sets of some years ago carries the tuning condensers, filament rheostats, and a bias changing potentiometer, not to mention jacks, etc. For the sake of appearance, anyway, it is best to leave these. Later models are arranged differently, but there is no good reason why any of the foregoing should be altered mechanically.

The next part of our story concerns the case where some revisions may be necessary. These apply to all those where the use of a different shape of cabinet is involved.

Modern Cabinet Layout

As is by now realized, the change from the battery-operated type of set involves the scrapping of filament resistors, though not necessarily the intermediate frequency amplifier grid bias potentiometer, where that was used.

So if you change the layout of a 7 x 24 inch front panel to accommodate the space limitations of a panel such as fits the modern style of cabinet, you will have to alter the layout of the tuning condensers principally, and if you purchase a double drum dial to operate them, it's logical to have the left-hand one operate the loop tuning condenser and the other one the oscillator.

The disposition of the other controls will have to be left to the judgment of the constructor, and the style of knobs, etc., to his taste.

In this case it may be necessary to alter the position of the parts but in most cases it will be possible to keep the parts of the intermediate amplifier in the same relative position mutually, this meaning that you will have to arrange the parts of the radio amplifier in one along one center line to the left of a given center, and the parts of the audio amplifier to the right of this line.

Rectifier Tube and Circuit

If the total plate load of an eight-tube battery operated set using the 201A type tubes, with a 171A output tube included is 35 milliamperes, the load under the new conditions will be about the same, for 227 and 171A tubes, provided the plate voltage per stage does not result in excess current. The addition of say a 100-volt DC dynamic speaker to the normal plate load may result in an additional 40 milliamperes being required, so you see the necessity of checking up on these requirements.

Maximum operative load current for the 280 rectifier tube is shown to be 110 milliamperes, but this does not mean that you can obtain this current and at the same time have a variety of voltages up to say, 300 volts for the plates of two 245-power tubes, and seven 227s plus a dynamic field winding in shunt.

The maximum output current for the 280 for continuous operation is not in excess of 90 milliamperes, and in some instances it should be even less, say, 80 milliamperes. If you find that your plate load requirements are going to be in excess of the above it is suggested that you use two 281s in a full-wave rectifier circuit, for then you will be able to obtain at least 150 milliamperes without danger of rectifier tube burnout.

It is always best to have an ample margin between the theoretical output capacity of the rectifier tube and the actual load, because the operative condition of various rectifier tubes is not always the same.

A good preventative against rectifier tube burnout is to provide a fuse in series between each of the plates of the rectifier tube and the transformer secondary lead that normally connects to the plate in question. The fuse may be a piece of No. 40 copper wire, or its equivalent in lead wire, about 1 inch long.

In the modern type of cabinet there is likely to be room enough to mount the rectifier tube on the same level as that of the rest of the tubes, but it is not recommended that you mount the power transformer close to the coils and other parts of the set, in fact, in some commercial sets the power pack parts are mounted in a separate steel box.

Economic Aspect

The reason why the fans want to convert their battery-operated sets to AC operation is that it is a means of modernizing the old set to provide convenience.

Suppose you previously used a five-ampere charger. If the device is 90 per cent efficient it requires in round numbers 660 watts from the power line, and if it operates for 48 hours per month, the total watt-hours are 31,680, and in terms of kilowatt hours the amount is 31.68 and at the rate of 11 cents per kilowatt-hour the monthly bill is $3.49 and that ignores the B eliminator.

Let us now compare the above with the power transformer, which is the source of the plate and heater voltages in the electrified set.

A power transformer of ample secondary output capacity to operate the converted set is the Polo 245 P T with its generous rating of 96 watts on 120 volts. Let us see what the bill will be now.

96 watts for five hours per night per month is total of 14,400 watt-hours, and in terms of kilowatts hours is 14.4 and at the 11 cent rate the monthly bill is $1.58. And in addition this is the

(Continued on next page)

Tips on Buying a Set

By Brainard Foote

SOME folk shop for bargain radio sets. "Big 9-tube model at $59.98" sounds mighty attractive, I suppose. So frequently, however, such "bargains" turn out to be "duds" so far as real radio satisfaction is concerned. There's far more to radio set use than the price ticket on the package, and a few dollars more or less on the original price are hardly worth considering too seriously.

If you're buying a radio set for your own home, or getting one for a gift for someone else, stop and think—first! Why do you buy a radio set, anyway? Surely not just to have a good-looking bit of furniture around the house! Here are some reasons outlined:

(A)—For RESULTS.
1. Tone quality.
2. Sensitivity.
3. Selectivity.
4. Volume.

(B)—For ECONOMY.
1. On initial Cost.
2. On Upkeep.

(C)—For PERMANENCE.
1. Durability of set and tubes.
2. Freedom from repairs.
3. Convenience for repairs, if needed.

Great Variety in Tone

The above will give us a basis for talking over the purchase of any radio outfit. As to results, let's consider the four main points. Tone quality is, of course, essential. Radio sets vary greatly in this respect, and cheapness of cost usually means a poor quality of reproduction, by comparison with other sets.

The better the loudspeaker, and the larger the power tube, within certain limits, the finer tone quality you'll obtain.

Sensitivity makes it possible for you to get distant stations. Selectiveness carried to the extreme is customary with supersensitive radio sets, and selectivity of this degree may impair tone. The volume should be sufficient for the size room you are to use the set in, and the larger the power tube and speaker, the greater the volume that may be expected with good tone.

Sidelights on Economy

As to economy, the first cost of a set is only a part of your radio expense. New tubes are needed from time to time, and parts may wear out or break down in service, requiring replacement or repair. Accordingly the set made a little better, while costing a little more in the beginning, may cost less in the end. A set that is too cheaply made often becomes too hot, because of insufficient "safety factor" in the design of the power parts, and in addition to breakdown of units, the tubes may be lighted too brightly and shortly become useless.

The matter of installation has a great deal to do with economical operation, and an intelligent dealer and serviceman will save you money by the care with which he checks up on the voltage and adjusts the power supply line.

Many a listener has soon had to buy a whole new set of tubes because he "saved" $10.00 or less by purchasing his set at a bargain somewhere and installing it himself.

Failing to test the electric voltage, or to at least know that it is not excessive, may mean short-lived tubes.

Buy for Permanency

Permanent satisfaction, too, is dependent upon the type of set itself, the installation, and in addition, upon the kind of radio service you get. Of course, a good radio set shouldn't require repairs. Nevertheless, a radio set is a complex and somewhat delicate bit of mechanism, and it is humanly impossible to make every one without faults. So, once in a while, something goes wrong. The volume control gets out of order, the set develops noisiness, the tuning dial or shaft breaks, etc.

Accordingly, the most important thing, to my mind, in buying a radio set, is to purchase it from some one, whose reputation is good, so you'll be sure of permanence.

It is not possible to claim nowadays that any particular make of set is the best there is. As in the automobile line, you generally get about what you pay for.

Tone Control Not a Serious Matter

Many of the new radio models display features which are really little more than "talking points," or sales arguments. Lights which flash on and off as your favorite stations are reached, "trick" dials, etc., serve to make the radio set more interesting, though not adding a great deal so far as reception goes. Electric time clocks are worth while to some buyers. Tone Control is getting popular this year, although I do not feel that it is a serious matter should this item be left out of consideration.

A tone control is more useful on a very low-cost set than it is on the higher grade models, because a tone control will help to compensate for non-uniform amplification of the different frequencies by the set. It will also help in adjusting the tone range to suit the individual listener and to match the acoustics of a bare or heavily furnished room.

Best Time to Buy is Now

This year is proving to be a better year than any in the past to buy a good radio set at a moderate price. Greater quantities in manufacture and wider sales have brought prices to lower levels than heretofore, and radio improvements are of course included in all of them.

This year, more than ever, a radio set promises hour after hour of uninterrupted entertainment and instruction, for use with the regular radio programs or for the reproduction of phonograph records.

Conversion of Battery Set to AC Operation

(Continued from preceding page)

maximum amount of your bill, the actual amount will in all probability be less.

This power transformer furnishes five volts at two amperes, 2.5 volts at 16 amperes (only 12 amperes are used), 2.5 volts at three amperes, and lastly 350 volts at 80 milliamperes.

The given rating is thus seen to be most generous, and proof of this is the fact that the operating temperature of the transformer is not over 50 degrees centigrade.

So it does not take one long to decide which is the cheaper rearrangement to maintain, and it is also apparent that the saving in maintenance cost in a few months will pay the cost of the conversion and in addition you will be enjoying improved reception.

The changes involved in this case may be extended to any other battery-operated set, the scheme here being merely to show the application from the point of view of most importance at this time.

Circuit Revisions

Some of the new Superheterodyne receivers incorporate one or more tuned RF stages, in between the loop or other aerial and the first detector, and there is no reason why the fan who wants to should not copy this simple improvement.

The principal precaution is to see that the oscillator tunes in step with the TRF condenser, which is not hard at the 70 kc intermediate frequency of the Victoreen.

Another question that may come up is shielding for the added RF coils.

Normally these added coils would be shielded, but it sometimes happens that when the fan attempts to do his own shielding the results are not very satisfactory, and then a lot of experimenting begins which is likely to lead anywhere. The primary rule is, shield one, shield all, but this does not apply to the intermediates.

There are some connections of the battery-operated model Superheterodyne that are not exactly duplicated in the AC circuit revision, although the functioning of the completed circuit might not indicate this difference.

Reference is made to the loop tube that in old sets functions as a first detector. In the battery-operated set the grid return of this tube is connected to the positive side of the filament circuit, thus placing a positive bias on the grid of that particular tube. If a somewhat similar procedure is followed when the 227 or the 224 tube is used, the result will be a considerable admixture of hum with the signal at the loudspeaker, so evidently this plan will not do. Make the first and second detectors grid bias types.

Suppressing Hum

Reference was made to hum, and here we have to pay some attention to methods for its suppression. There are two principal sources of hum, the filter circuit and stray pickup. The thermal lag of the heater type cathode element of the AC type tube is sufficient to keep hum at a low level.

*(More data next week on conversion of battery sets to AC operation.—*EDITOR.)

The New Radiola 80 and

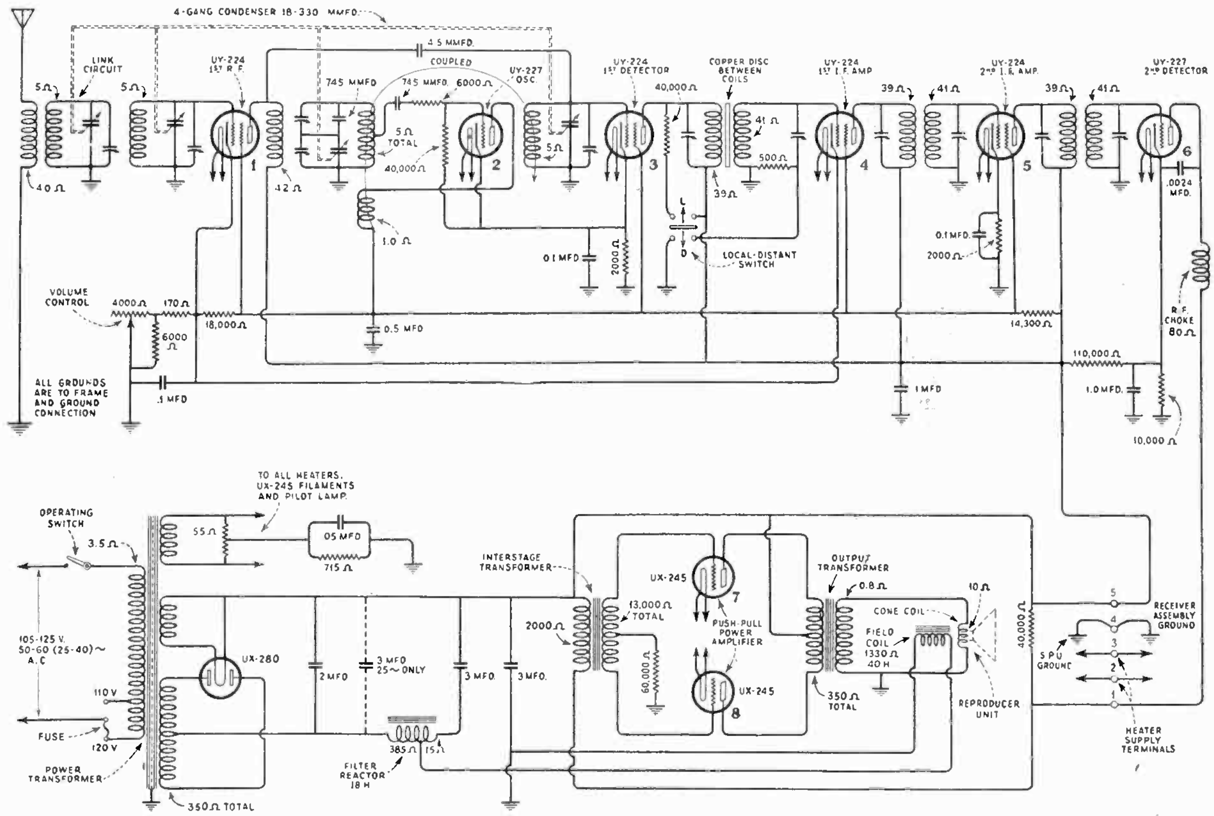

FIG. 1
COMPLETE CIRCUIT DIAGRAM OF THE RADIOLA 80 RECEIVER. THIS IS A 175 KC SUPERHETERODYNE WITH SCREEN GRID AMPLIFICATION AND POWER DETECTION.

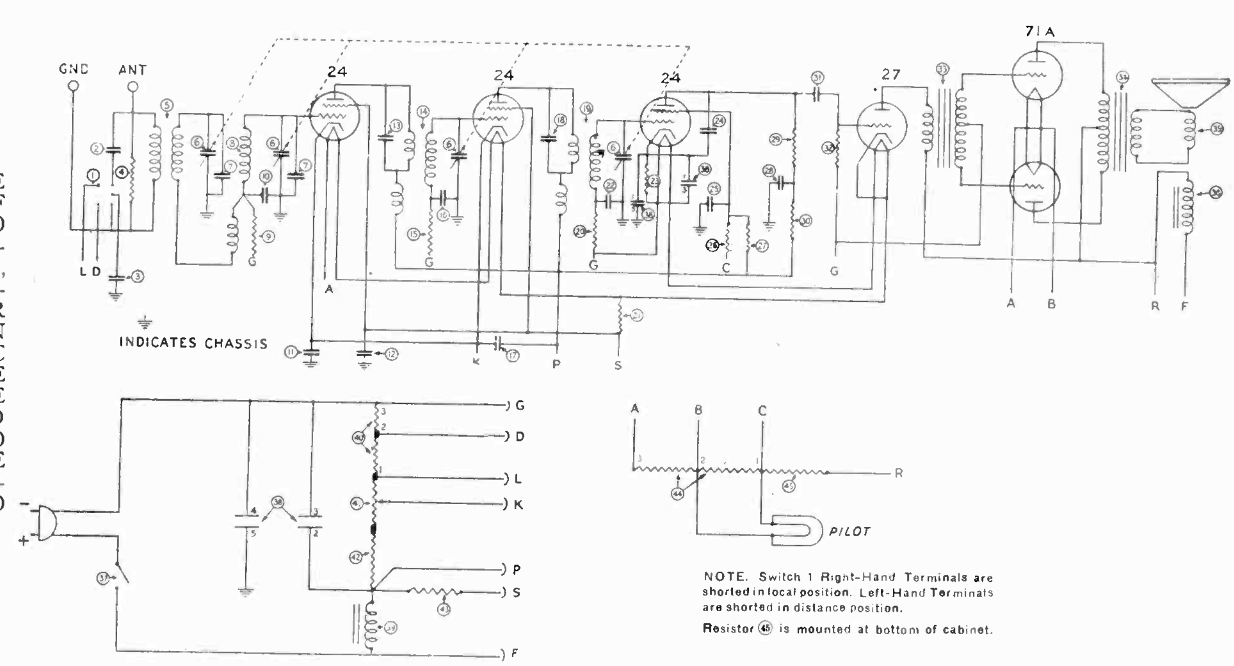

FIG. 4
A COMPLETE DIAGRAM OF THE PHILCO MODEL 40 RECEIVER, WHICH IS DESIGNED FOR OPERATION ON A 110 VOLT DC LINE. THE HEATERS ARE CONNECTED IN SERIES TO LIMIT THE POWER REQUIRED TO OPERATE IT.

THE Radiola 80 is an eight-tube Superheterodyne operating on an intermediate frequency of 175 kilocycles and incorporating four 224 screen grid tubes, two 227 tubes, and two 245 tubes. The first screen grid tube is a radio frequency amplifier, the second is the first detector, and the other two are intermediate frequency amplifiers. The first 227 tube is the oscillator and the second is the second detector and operates on the high bias principle. The two 245 tubes are operated in push-pull and constitute the output stage. In addition to the eight amplifier tubes there is a 280 rectifier tube.

There are three tuned circuits for selecting the desired frequency and for suppressing the frequency which might cause image interference. Since the intermediate frequency is 175 kilocycles, the frequency of any station which might cause interference is 350 kc away from the desired frequency and therefore the three tuners are quite effective in suppressing the interfering carrier.

The 175 kc intermediate frequency has been chosen because in that band there is very little radio communication so that the frequency is relatively clear so that the intermediate frequency channel will not pick up signals directly, and also because it is high enough to permit suppression of image interference.

Gang Tuning

Mechanical coupling among the four tuning condensers, including that of the oscillator, is made practical by trimming the tuned circuits and by a special arrangement of the oscillator tuning condenser. This contains four parts, one fixed and three variable. In series with the tuning condenser connected to the

82 and Philco 40 and 41

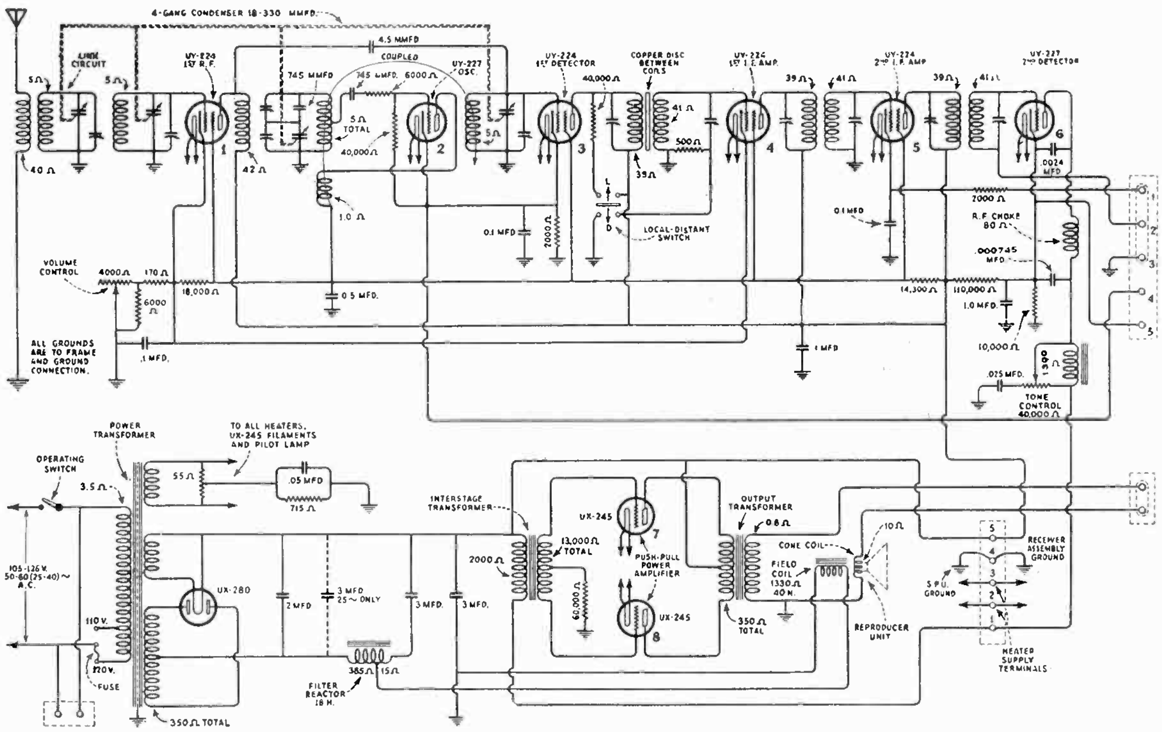

FIG. 2
A COMPLETE CIRCUIT DIAGRAM OF THE RADIOLA 82. THIS RECEIVER IS ESSENTIALLY THE SAME AS THAT OF THE RADIOLA 80, BUT IT HAS A TONE CONTROL IN THE PLATE CIRCUIT OF THE DETECTOR.

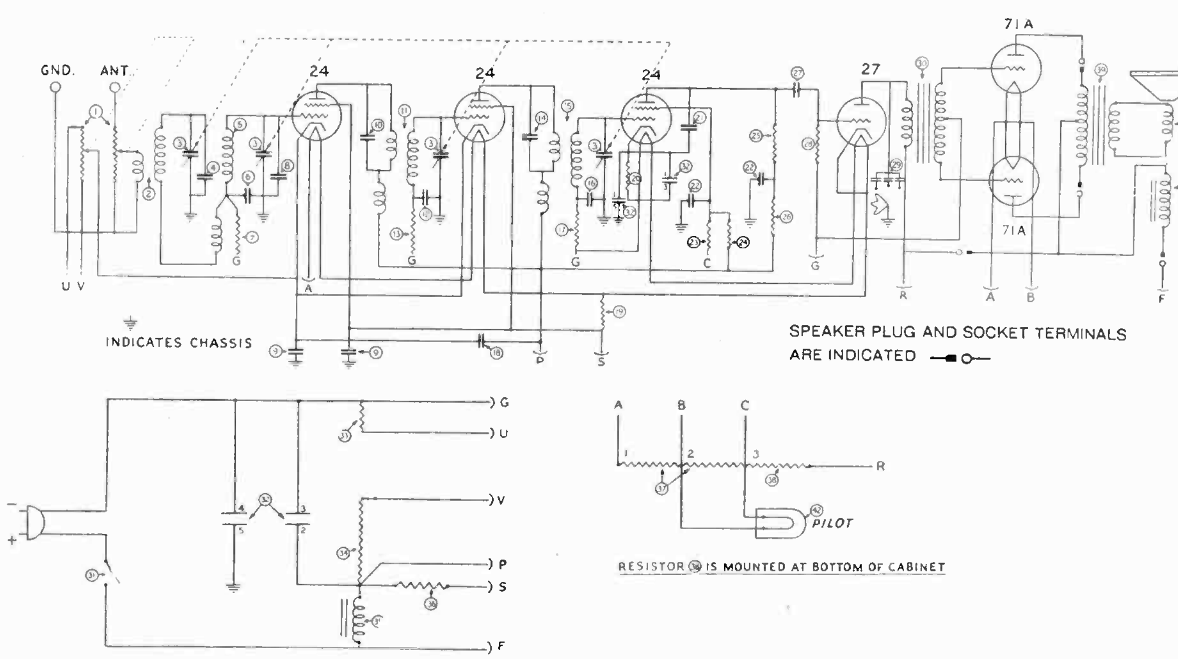

FIG. 5
THIS IS THE DIAGRAM OF THE PHILCO MODEL 41, WHICH IS ESSENTIALLY THE SAME AS MODEL 40 BUT HAS INCORPORATED A TONE CONTROL IN THE PLATE CIRCUIT OF THE FIRST AUDIO TUBE AND A CONTINUOUSLY VARIABLE SENSITIVITY OR VOLUME CONTROL.

gang is a fixed condenser of 745 mmfd. and across each of these is a variable trimmer condenser. By adjusting the trimmer condensers it is practical to make the oscillator track along with the radio frequency condensers notwithstanding the large difference in frequency.

The volume is controlled by varying the bias on the first radio and first intermediate frequency tubes. A fixed bias resistor of 170 ohms is used and in series with this are two parallel-connected resistors, one variable having a resistance of 4,000 ohms and one fixed having a resistance of 6,000 ohms. The bias resistance also carries bleeder current and the 6,000 ohm fixed resistance is used to prevent this from going to zero in case the 4,000 ohm resistance should be opened.

The filter reactors (chokes) are put in the negative side of the rectifier circuit and one of these is the field coil of the loudspeaker. The inductance of one of the chokes is 18 henries with a DC resistance of 400 ohms, and the inductance of the field coil is 40 henries with a DC resistance of 1,330 ohms.

Local-Distance Switch

The "local-distance" switch is arranged so that when it is thrown to the "local" position a 500-ohm resistance is cut into the secondary of the first intermediate frequency transformer and at the same time a 40,000-ohm resistance is connected across the primary. When the switch is thrown to the "distance" position the 500-ohm resistance is short-circuited and the 40,000-ohm resistance is opened.

The grid bias resistor for the power detector is 10,000 ohms,

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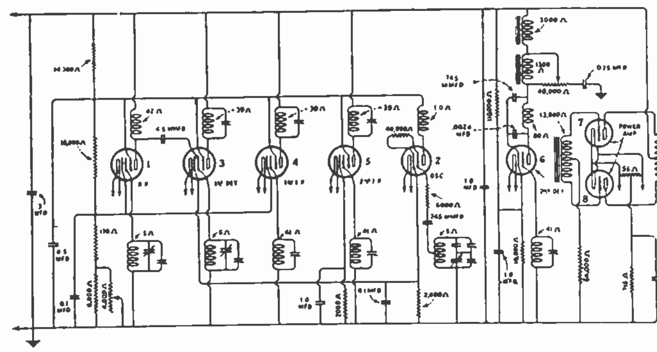


FIG. 3
A SIMPLIFIED DIAGRAM OF THE RADIOLA 82 DRAWN SO AS TO SHOW CLEARLY THE VOLTAGES APPLIED TO THE VARIOUS ELEMENTS. THIS MAY ALSO BE CONSIDERED AS A SIMPLIFIED DIAGRAM OF THE RADIOLA 80 PROVIDED THAT THE TONE CONTROL IS ELIMINATED.

(*Continued from preceding page*)

but the plate current in it is augmented by the current through a 110,000-ohm resistor connected between the highest voltage tap in the rectifier and the cathode of the detector. The current through this high resistance and the normal plate current of the detector establish a voltage drop in the 10,000-ohm bias resistor high enough to permit the operation of the tube as a power detector.

Radiola 82

The Radiola 82 is like the Radiola 80 in every particular except that it has a tone control in the plate circuit of the detector. This consists of a 1,330 ohm choke coil in series with the plate lead, a 40,000 ohm potentiometer, and a 0.025 mfd. condenser. The potentiometer resistance is connected in series with the condenser between the B plus side of the choke coil and ground, and the slider of the potentiometer is connected to the plate side of the choke. Thus the choke coil may be short-circuited when high notes are desired as well as low notes, and the choke may be shunted by the 0.025 mfd. condenser when it is desired to weaken the response of the receiver on the high notes. Fig. 1 gives the diagram of the Radiola 80 and Fig. 2 that of the Radiola 82, while Fig. 3 gives a simplified diagram of the Radiola 82. This may also be considered a simplified diagram of the Radiola 80 by cutting out the tone control feature consisting of the 1,300-ohm choke coil, the 0.025 mfd. condenser and the 40,000-ohm potentiometer between the 80-ohm choke and the 2,000-ohm choke directly over the detector tube. The 80-ohm and the 2,000-ohm chokes would be joined together.

Philco Model 40 Receiver

The Philco Model 40 receiver is a direct current receiver to be operated from a 110-volt DC line. The heaters of the 224 screen grid and the 227 detector tubes are connected in series and the filaments of the two 171A push-pull output tubes are connected in parallel. Resistances of suitable values are connected in series so as to limit the currents to the proper values. **The connections are clearly shown by** means of lettered terminals on the voltage divider and the receiving circuit proper. The diagram comes in three sections, as will be noted on Fig. 4, and when the terminals having the same letter designation are joined together the circuit is properly connected. For example, F on the circuit proper at the extreme right goes to F on the lower left figure. The four G terminals on the diagram go to the G on the lower left figure, or to the negative side of the supply line. Note carefully that this is not ground because in most cases the positive side of the DC line is grounded. If G is grounded also the line will be short-circuited.

Note that the field coils of the speaker are connected so that this acts as the choke for the plate current to the power stage and the first audio amplifier. Another choke, marked (39), is connected so that the plate currents for the remaining tubes flow through this coil.

It is clear from the connections that the filament and heater currents flow through the field winding of the speaker, and therefore that this is a low impedance choke.

Resistor and Condenser Values

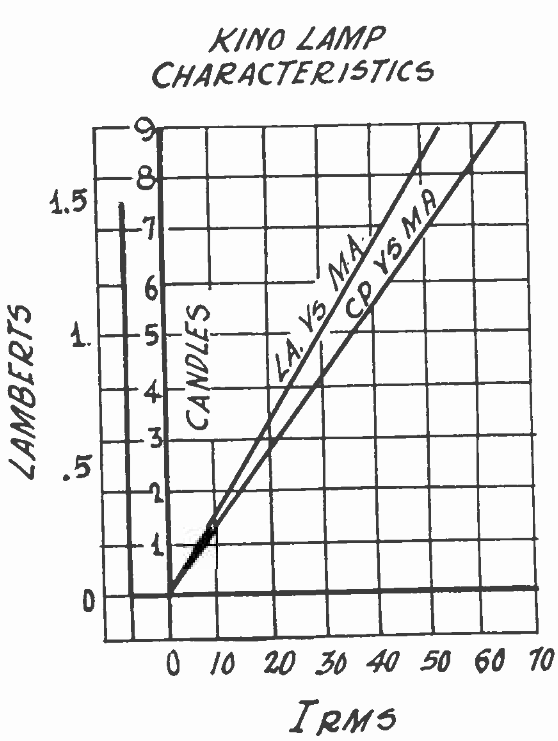
The values of the condensers and resistances in the receiver are not specified but all are numbered for specification purposes. All parts having the same number have the same values, but those having the same values may have different numbers. The values are as follows:

No. on Fig. 4	Capacity or Resistance
(2)	.002 mfd.
(3), (31)	.01 mfd.
(10), (16), (17), (22)	.05 mfd.
(11), (12), (25), (28)	.25 mfd.
(24)	.0005 mfd.
(4), (20), (43)	5,000 ohms
(9), (15)	33,000 ohms
(21), (42)	25,000 ohms
(23), (30)	100,000 ohms
(26)	13,000 ohms
(27)	70,000 ohms
(29), (32)	500,000 ohms
(40), 1-2	800 ohms
(40) 2-3	250 ohms
(44) 1-2	2 ohms
(44) 2-3	4 ohms
(45)	53 ohms

Philco Model 41 Receiver

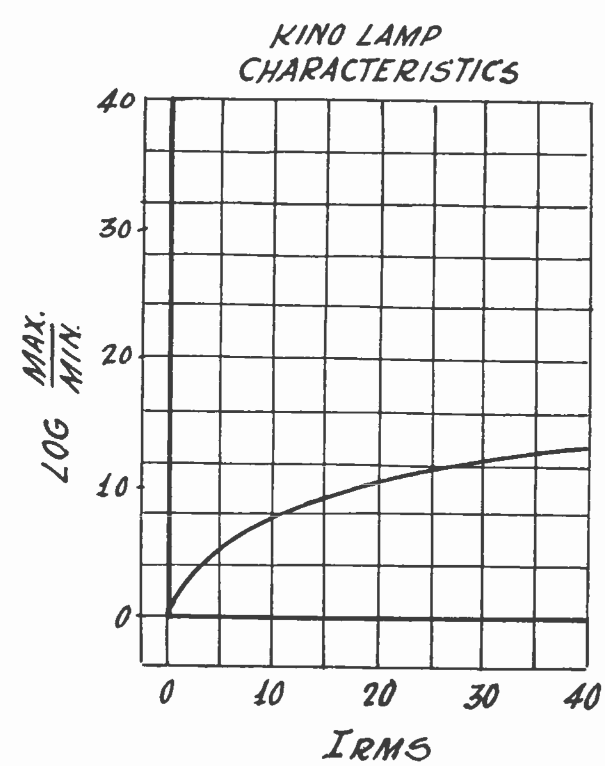
Model 41, shown in Fig. 5, is similar to Model 40 and differs from it only in minor details. The principal difference is that it has a tone control consisting of three shunt condensers connected in the plate circuit of the first audio frequency amplifier. By means of a butterfly switch, one, two or three condensers may be connected from the plate of the tube to ground and thus shunt out different proportions of the high frequencies in the signal.

The volume control is also different. In Model 40 there is a Local-Distance switch in the antenna circuit, and a means for varying the bias on the radio frequency tubes by moving the cathode return lead over a portion of the voltage divider. In Model 41 there is a dual potentiometer in the antenna circuit, one of these being in the voltage divider and so connected as to vary the bias on the radio frequency tubes.



Curves of Kino Lamp

CHARACTERISTIC CURVES OF THE KINO LAMP ARE REPRODUCED HERE. AT LEFT IS A VISUAL CONTRAST CURVE GIVING THE LOGARITHM OF THE RATIO OF THE MAXIMUM TO MINIMUM BRIGHTNESS TO THE AC CURRENT. AT RIGHT IS GIVEN THE RELATION BETWEEN THE BRIGHTNESS AND THE EFFECTIVE VALUE OF THE CURRENT.



The Raytheon Photo Cells

By J. E. Anderson

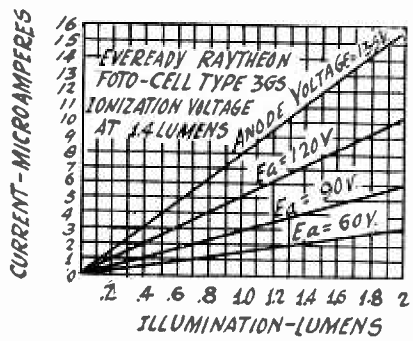


FIG. 1

A FAMILY OF ILLUMINATION VERSUS PHOTO-ELECTRIC CURRENT CURVES FOR A TYPICAL GASEOUS PHOTO-ELECTRIC CELL.

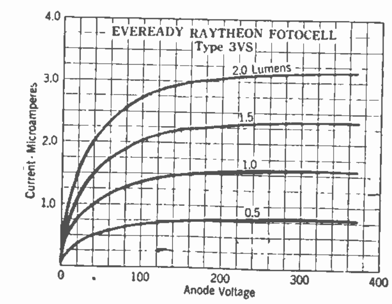


FIG. 2

A FAMILY OF ILLUMINATION VERSUS PHOTO- ELECTRIC CURRENT CURVES FOR A TYPICAL HIGH VACUUM PHOTO-ELECTRIC CELL.

THE photo-electric cell is a vacuum tube device in which the electrons are released from the cathode by means of light instead of heat. The ordinary cell has two electrodes, an anode, or positive member, and a cathode, the light-sensitive, electron-emitting member. The number of electrons released from the cathode is proportional to the amount of light flux that falls on the cathode surface.

The response of the photo-electric cell to changes in the amount of light flux entering it is instantaneous. That is, there is no time difference between a certain light flux value and the corresponding current through the cell. This is true of the cell alone and does not hold for the cell and its associated circuit when this circuit contains either inductance or capacity.

The photo-electric cell is used in television transmitters for converting the light values of the object into equivalent electrical values. It is also used for still picture transmission, for reproducing sound recorded on films, and for operating relays by means of changes in light values. As an example of relay application, the cell has been used for counting the number of people passing a certain point in a certain period of time by recording the interruptions of a beam of light by the individuals counted.

Two Types of Cells

There are two general types of photo-electric cells, the vacuum, or hard, and the gas cell. The vacuum cell has been exhausted to as high a degree of vacuum as possible, while the gas cell has been filled with a monatomic gas at low pressure. The vacuum cell works on pure electron conduction and in this respect is like high vacuum thermionic amplifier tubes. The gas cell depends in addition to electron conduction on the ionization by collision of electrons with gas molecules.

In both types of cell the photo-electric current is directly proportional to the light flux entering the cell, provided the anode voltage remains constant. The behavior of the two with changes in anode voltage, however, is different. In the vacuum tube the current increases at first rapidly and then more slowly as the voltage increases, the light flux entering the tube remaining constant. For high voltages there is little change in the current. In the gaseous tube the current increases slowly at first and then rapidly as the voltage increases, the light remaining constant.

In the gaseous cell, for a given amount of light entering the cell, there is a certain critical voltage at which the cell begins to glow. This is called the ionization or glow voltage. For voltages higher than the ionization voltage the tube will not function properly as a light sensitive device. That is, the current will not respond proportionately to the amount of light. It must always be operated below the ionization voltage.

Characteristic Curves

In Fig. 1 is given a family of illumination versus current curves for a typical gaseous tube, the Eveready-Raytheon Fotocell 3GS. The photo-electric current in microamperes is given by the ordinates and the illumination in lumens by the abscissas. Each of the four curves is a straight line, showing that for any given anode voltage the current is directly proportional to the illumination. As indicated on the graph, the ionization voltage of this particular cell is 150 volts when the illumination is 1.4 lumens. For greater illumination the ionization voltage is lower and for less illumination it is lower.

Fig. 2 gives the illumination versus current curves for a typical vacuum tube, the Eveready-Raytheon Fotocell 3VS, which is the same tube as the 3GS, except that it has a high vacuum. As will be noted, the curves for this tube are also straight, so that the direct proportionality between the current and the illumination holds. It will also be noted that the current in the vacuum cell is much less than that in the gaseous cell, even when the anode voltages are considerably higher.

Anode Voltage, Photo-Current Curves

In Fig. 3 is a family of curves giving the relation between the anode voltage, photo-current curves for the 3GS for different illuminations, and Fig. 4 gives the corresponding curves for the 3VS tube. These curves show clearly the difference between a gaseous and a vacuum cell. In Fig. 3 the current rises rapidly as the voltage increases, while in Fig. 4 the current rises rapidly at first and then approaches a constant value. There is no ionization voltage for the gaseous type cell.

The curves in Fig. 4 are similar to the plate voltage, plate

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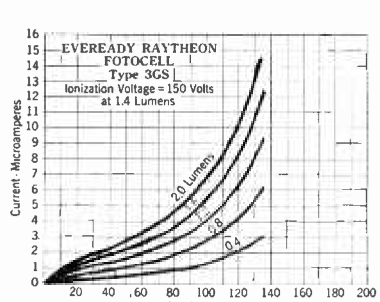

FIG. 3

A FAMILY OF CURVES GIVING THE RELATION BETWEEN THE ANODE VOLTAGE AND THE PHOTO-ELECTRIC CURRENT FOR A TYPICAL GASEOUS PHOTO-ELECTRIC CELL.

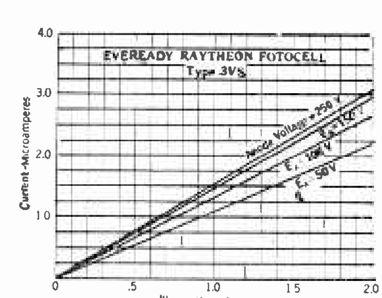

FIG. 4

A FAMILY OF CURVES GIVING THE RELATION BETWEEN THE ANODE VOLTAGE AND THE PHOTO-ELECTRIC CURRENT FOR A TYPICAL HIGH VACUUM PHOTO-ELECTRIC CELL.

(*Continued from preceding page*)

current curves for a thermionic tube, the illumination in Fig. 4 corresponding to the heating current in the thermionic tube. The constant value of the current for a given excitation, either illumination or heating, being determined by the total number of electrons emitted from the cathode by the excitation.

The photo-electric current curves given above for these cells assumes that the illumination remains constant in quality, that is, that the color composition of the light entering the cell remains constant, because the sensitivity of a photo-electric cell depends on the color of the light exciting the cathode. Ordinary cells are most sensitive to violet and blue light, while for ultra-violet and red light they are quite insensitive. The color sensitivity of a cell is very nearly the same as that of a photographic plate. The lack of photo-sensitivity in the ultra-violet end of the spectrum is due rather to absorption in the glass envelope than to lack of photo-sensitivity of the cathode itself, while the lack of sensitivity in the red region of the spectrum is due to lack of sensitivity in the cathode. If the cell envelope were made of quartz, which passes ultra-violet light without much absorption, the sensitivity of the cell would be quite different, just as the sensitivity of a photographic plate is quite different when exposed by means of a quartz lens.

Spectral Sensitivity Curve

In Fig. 5 is reproduced the spectral sensitivity curve of a typical photo-electric cell in a glass envelope, that of the 3GS previously discussed. The sensitivity is given by the ordinates of the graph and the wavelength of the light in millimicrons by the abscissas. The various color regions are given along the abscissas to give a better idea of the change in sensitivity with color of the light.

As will be noted, the sensitivity is very low in the region of the red and orange. In the region of the yellow and the green the sensitivity increases rapidly, attaining a high maximum in the blue and violet. In the ultra-violet the sensitivity falls rapidly again, which is largely due to the absorption in the glass envelope.

The spectral sensitivity of a photo-electric cell also depends on the nature of the cathode surface. Cells can be made so that the maximum sensitivity falls in different portions of the spectrum, for example, in the yellow and red. The point of maximum sensitivity depends largely on the kind of metal used for the cathode and the chemical treatment of its surface.

Industrial Applications

The peculiar properties of the photo-electric cells are made use of in many industrial applications. The fact that its response is proportional to the amount of light of a given color composition is made use of in grading commercial products as to shades of color. For example, cigars of different shades are graded by a system of photo-electric cells and relays. The fact that the sensitivity of a photo-electric cell depends on color is made use of in matching colors of textiles and dyes. By means of cells it is possible to match colors exactly, whereas by other methods it is extremely difficult to obtain accurate matching.

Fig. 6 is the spectral sensitivity curve of the Eveready-Raytheon Fotocell Type 4GP, which is a red-sensitive gaseous cell. Comparing this curve with that in Fig. 5 shows the greatly increased sensitivity in the red and infra-red portion of the spectrum. At 500 milli-microns, in the blue-green portion of the spectrum, the sensitivity of the two cells is about the same, being a minimum for the red-sensitivity cell. At 650 milli-microns, in the red-orange regions, the sensitivity of the red-sensitive cell is 180, while at the same wavelength the other cell

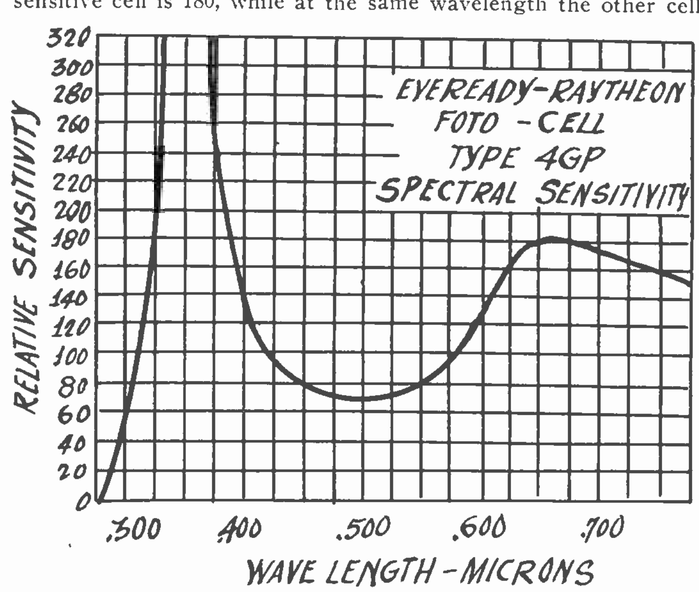

FIG. 6

THE SPECTRAL SENSITIVITY CURVE OF A PHOTO-ELECTRIC CELL THAT IS HIGHLY SENSITIVE TO RED LIGHT.

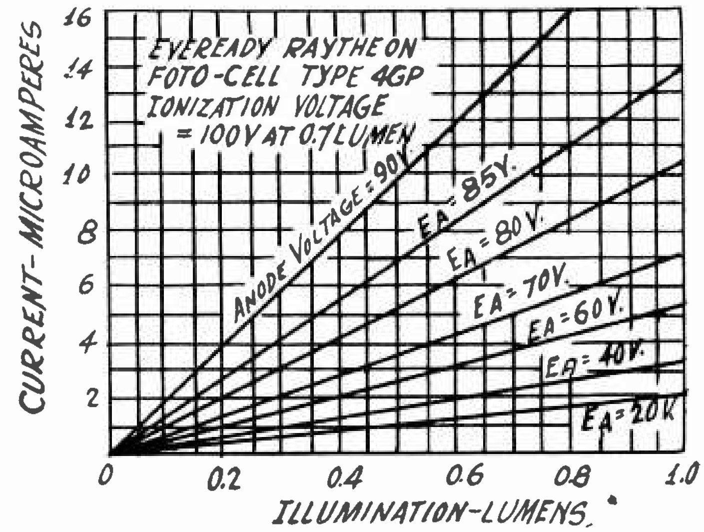

FIG. 7

THE RELATION BETWEEN THE ILLUMINATION AND THE PHOTO-ELECTRIC CURRENT FOR A RED-SENSITIVE, GASEOUS PHOTO-ELECTRIC CELL.

shows a sensitivity of only about 4. At 350 milli-microns the red-sensitive cell shows an enormously high sensitivity. This wavelength comes in the near ultra-violet portion of the spectrum.

The relation between the illumination and the photo-electric current for the 4GP cells is given in Fig. 7, and that for the corresponding high vacuum tube, the 4VP, in Fig. 8. In both these graphs the curves are straight lines, just as in the case of the 3GS and the 3VS tubes. It will be noted that the ionization voltage for the 4GP is comparatively low, being only 100 volts when the illumination is 0.7 lumen.

Anode Voltage, Current Curves

The relation between the anode voltage and the photo-electric current for the 4GP tube is given in Fig. 9. The curves in this figure show that as the anode voltage is increased from zero, the current first rises rapidly, then more slowly, and finally at an ever increasing rate until the ionization voltage is reached.

Fig. 10 gives the relation between the anode voltage and the photo-electric current for the corresponding high vacuum tube, the 4VP. In this case the current rises rapidly at first as the voltage increases and then assumes a constant value, which is the saturation current for the particular illumination.

The gaseous type of photo-electric type of cell is used when a high light-sensitivity is essential and when distortion is not important. The high vacuum type of cell is used when freedom from distortion and stability are important. The gaseous cell should always be operated below the ionization voltage and as near it as practical to attain a high light-sensitivity, and a current limiting resistance should always be used in series with it to protect the cell in case the ionization voltage should accidentally be exceeded.

The vacuum cell should always be operated at a sufficiently high voltage to insure that the operating point is on the satu-

(*Continued on next page*)

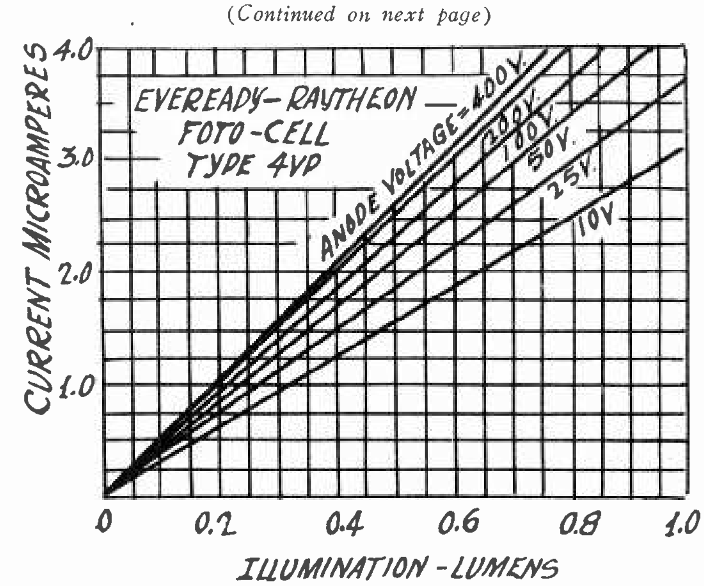

FIG. 8

THE RELATION BETWEEN THE ILLUMINATION AND THE PHOTO-ELECTRIC CURRENT FOR A RED-SENSITIVE, HIGH VACUUM PHOTO-ELECTRIC TUBE.

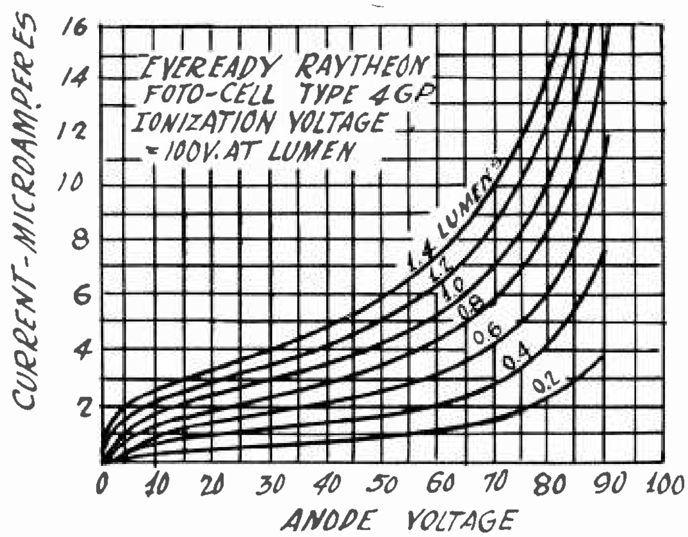

FIG. 9
THE RELATION BETWEEN THE ANODE VOLTAGE AND THE PHOTO-ELECTRIC CURRENT FOR A GASEOUS, RED-SENSITIVE PHOTO-ELECTRIC CELL.

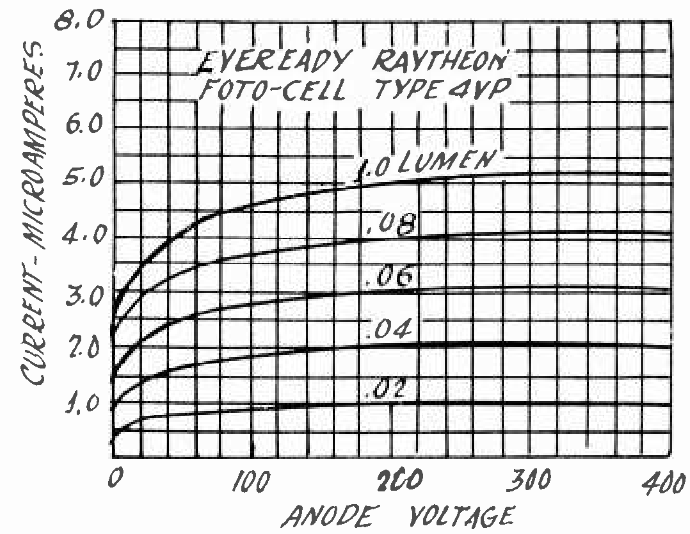

FIG. 10
THE RELATION BETWEEN THE ANODE VOLTAGE AND THE PHOTO-ELECTRIC CURRENT FOR A RED-SENSITIVE, HIGH VACUUM PHOTO-ELECTRIC CELL.

(*Continued from preceding page*)

ration portion of the characteristics, that is, so that a change in the anode voltage produces no appreciable change in the current. For example, the 3VS should be operated with an anode voltage of 250 volts or more, while the 4VP should be operated with the anode voltage of about 400 volts. The normal operating voltage of the 3GS is about 135 volts and that of the 4GP is 90 volts. In any case a gaseous tube should always be operated so that the glow does not appear, regardless of what the illumination may be.

Photo-Electric Cell Circuits

Many different circuits have been devised for use with photo-electric cells for different applications. In most of them thermionic amplifier tubes are used to amplify the photo-electric effect.

The simplest circuit containing a photo-electric cell is shown in Fig. 11. It consists of the cell, a sensitive microammeter or galvanometer, G, a current limiting resistance R1, and a battery. A circuit of this type can be used for taking characteristic curves on the photo-electric tube and for photometric work. The resistance is only needed when a gaseous cell is used and when the battery voltage is near the ionization voltage of the tube.

A simple relay circuit is given in Fig. 12. This circuit contains one amplifier tube and the relay is connected in its plate circuit, the photo-electric cell being in the grid circuit. The anode voltage for the cell is partly supplied by the plate battery serving the tube and partly by a boosting battery in series with the plate battery. The cell feeds into a high resistance R1, and the voltage developed across this resistance is impressed on the grid of the amplifier tube.

There will be a steady voltage drop across this resistance, the value of which is determined by the anode voltage and the "dark current" or the mean illumination current through the cell, and this voltage makes the grid positive with respect to the filament or cathode of the amplifier tube. To offset this, a grid bias battery with a voltage divider across it is provided so that the bias may be adjusted to the proper value for amplification.

Fig. 13 is essentially the same circuit arranged especially for photometric work. The meter A is a sensitive microammeter or a galvanometer for detecting the change in the plate current due to changes in the illumination on the cell. An auxiliary circuit is associated with the current meter by which the steady plate current is balanced out of the meter. This greatly increases the sensitivity of the arrangement and permits the use of a galvanometer or microammeter. R1 is a resistance which may have any value from 0.2 to 20 megohms, R2 should have a value of from 100 to 2,000 ohms, and R3 is a shunt resistance used for protecting the meter during adjustments of the circuit.

Fig. 14 is a relay circuit arranged for operation from a 110 volt DC line. In this circuit R1 should have a value from 5 to 50 megohms, R2 about 100 ohms, and R3 400 ohms. The tube should be one that requires a filament current of 0.25 ampere. R2 should be a rheostat variable between zero and 100 ohms so that the filament current may be adjusted to the proper value in case the line voltage varies. The proper setting of this rheostat when the line voltage is 110 volts is 20 ohms.

Fig. 15 is a circuit suitable for use when the light varies rapidly, as in sound reproduction from film records, picture transmission and similar uses. The amplifier is essentially an audio amplifier and will not work on sub-audible frequencies. The values of the resistances are as follows: R1, 0.5 to 10 megohms; R2, 0.5 to 10 megohms; R3, 0.1 to 0.25 megohm; R4, 2 megohms. The voltages must be adjusted for the type of photo-electric cell and the amplifier tubes used.

Fig. 16 is a circuit which will respond to very slowly changing light intensities as well as to frequencies in the audible range and super-audible frequencies. It is strictly a non-reactive amplifier. It is suitable for photometric work, relay operation, audio amplification and television work. This circuit requires careful adjustment of the voltages, especially the bias on the output tube. The battery B1 is connected so that it makes the grid of the power tube positive and this arrangement is used because the voltage drop in R2 would make the grid excessively negative. The values of the resistances in Fig. 16 may be as follows: R1, 0.2 to 20 megohms; R2, 0.25 megohm; R3, 0.25 megohm; R4, 2 megohms.

AC Tube Circuits

The circuits in Figs. 12, 13, 14, 15 and 16 are for direct current tubes, but they can be changed for use with alternating current tubes very easily. In fact, the circuit in Fig. 14 can be changed for AC by only connecting a condenser of from 2 to 10 mfd. across the relay winding. The 110 volt terminals may then be connected to a 110-volt AC outlet and the circuit will function as a light-sensitive relay.

Fig. 17 is the same circuit as Fig. 12 but arranged for use with a 227 amplifier tube, and Fig. 18 is the same as Fig. 13 arranged for a 227 tube. While a 30,000-ohm potentiometer is suggested across the bias battery a lower or higher resistance may be needed, depending on the voltage of the battery across which it is connected. This voltage, as has been stated, depends on the photo-electric cell and on the anode voltage applied to it. A 3,000-ohm potentiometer is suggested across the 1.5 to 15 volt compensating battery in the output circuit, but the proper value depends on the sensitivity of the meter A.

Fig. 19 is a circuit essentially the same as that in Fig. 15 but arranged for use with one 224 screen grid tube and one 227 tube. The resistances not specified are the same as the corresponding resistances in Fig. 15. Since the coupling resistance R3 has a high value it is essential that the screen voltage be not too high. If the plate voltage is 180 volts, the voltage on the screen should not be greater than 15 or 22.5 volts, or else the bias on the screen grid tube should be increased. A 1,000-ohm bias resistor is suggested, but this may have to be made several times larger. The by-pass condensers, the capacities of which are not specified, may be 2 mfd. or larger.

The non-reactive circuit in Fig. 16 might take the form of Fig. 20 when the first tube is a 224 screen grid tube and the output tube is a 227. As in Fig. 19, the screen voltage must not be too high, and from 15 to 22.5 volts should be about right, assuming that the plate voltage is not less than 180 volts. The anode voltage on the photo-electric cell must first be adjusted to suit the particular cell used, and then the grid bias on the screen grid tube must be adjusted by means of the first 30,000-ohm potentiometer. The net voltage should be about 1.5 volts negative. When the bias has been adjusted the screen voltage should be fixed by returning the screen lead to the proper point on the battery.

The most critical adjustment is the bias on the second tube, because this depends on the current through the photo-cell, the grid bias on the screen grid tube, the screen voltage on that tube, the plate voltage, and on the value of the coupling resistance R2. The voltage drop in the coupling resistance due to the steady plate current from the first tube is greater than the required bias on the second tube. Hence it is necessary to return the cathode of the second tube to a point which is lower in potential than the low end of the resistance R2. A 30,000-ohm poteniometer is connected across a part of the plate battery and the cathode of the output is connected to the slider. By moving the slider the voltage on the grid of the second tube can be adjusted to any required value. The simplest way to bring about the proper adjustment of the circuit in case the signal is audible is to try various values until the sound is greatest and purest.

(*See illustrations on next page*)

[*These illustrations refer to the tube article on the three preceding pages*]

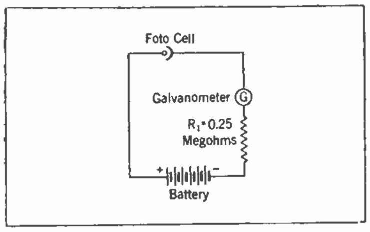

FIG. 11

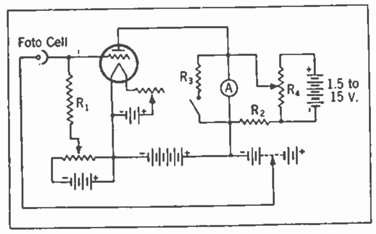

FIG. 13

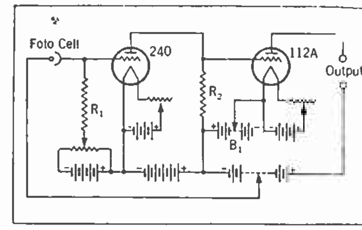

FIG. 16

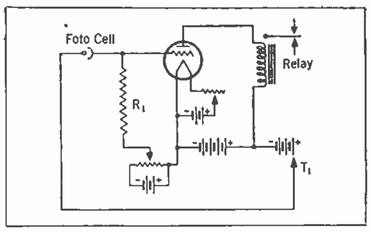

FIG. 12

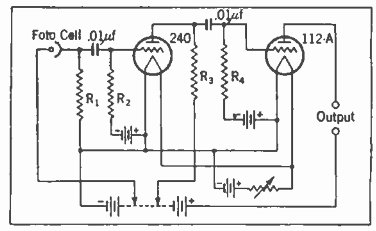

FIG. 15

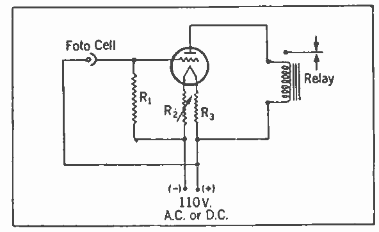

FIG. 14

FIG. 11

A SIMPLE CIRCUIT OF A PHOTO-ELECTRIC CELL FOR TAKING CHARACTERISTIC CURVES AND FOR PHOTOMETRIC WORK.

FIG. 12

A SIMPLE RELAY CIRCUIT CONTAINING A PHOTO-ELECTRIC CELL.

FIG. 13

THIS CIRCUIT IS ESSENTIALLY THE SAME AS THAT IN FIG. 12 BUT ARRANGED FOR USE IN PHOTOMETRIC WORK.

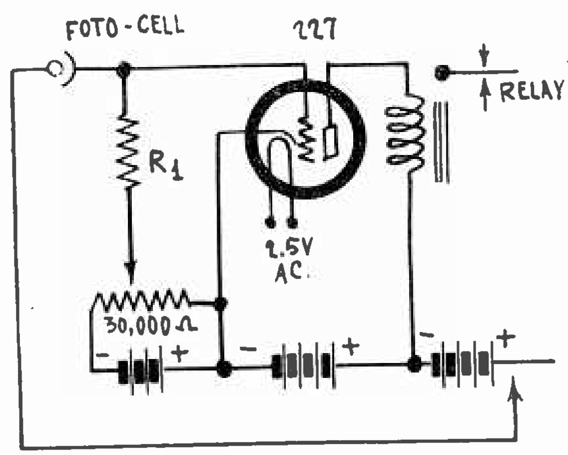

FIG. 17

THIS IS THE SAME CIRCUIT AS THAT IN FIG. 12 BUT IS ARRANGED FOR USE WITH A 227 AMPLIFIER TUBE.

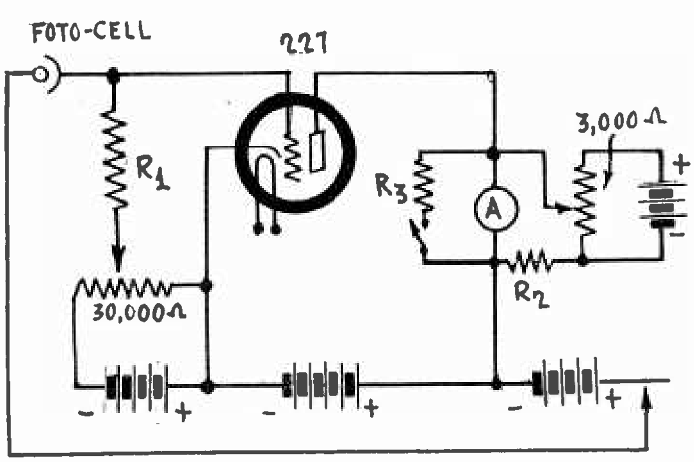

FIG. 18

THE SAME CIRCUIT AS IN FIG. 13 BUT ARRANGED FOR USE WITH A 227 TUBE.

FIG. 14

A RELAY CIRCUIT CONTAINING A PHOTO-ELECTRIC CELL THAT MAY BE CONNECTED TO A 110-VOLT DC LINE. THIS MAY BE CHANGED FOR OPERATION ON A 110 VOLT AC LINE BY SIMPLY CONNECTING A 2 TO 10 MFD. CONDENSER ACROSS THE RELAY WINDING.

FIG. 15

A CIRCUIT SUITABLE FOR USE WITH A PHOTO-ELECTRIC CELL WHEN THE LIGHT INTENSITY VARIES RAPIDLY AS IN TELEVISION, PICTURE TRANSMISSION AND REPRODUCING FROM SOUND FILMS.

FIG. 16

THIS CIRCUIT RESPONDS TO VERY SLOW VARIATIONS IN THE LIGHT INTENSITY AS WELL AS TO VARIATIONS OF AUDIO AND SUPER-AUDIBLE FREQUENCY.

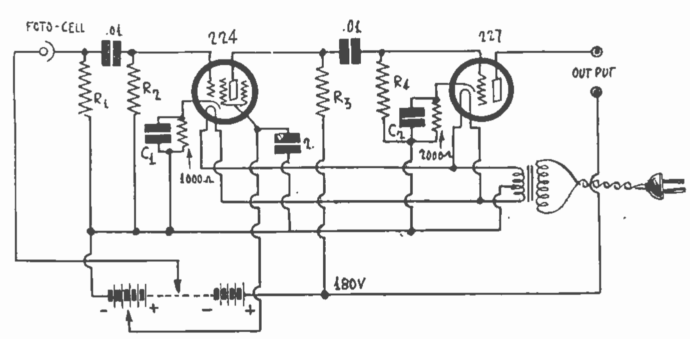

FIG. 19

THIS CIRCUIT IS ESSENTIALLY THE SAME AS THAT IN FIG. 15 BUT IS ARRANGED FOR USE WITH ONE 224 SCREEN GRID TUBE AND ONE 227 TUBE.

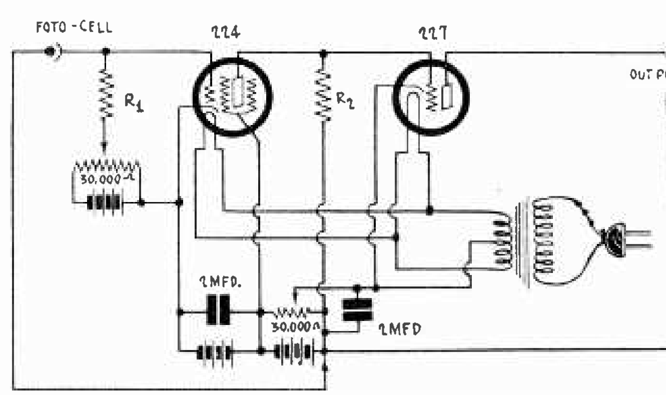

FIG. 20

THE CIRCUIT IN FIG. 16 MIGHT TAKE THIS FORM WHEN ARRANGED FOR USE WITH A 224 SCREEN GRID TUBE AND A 227 OUTPUT TUBE.

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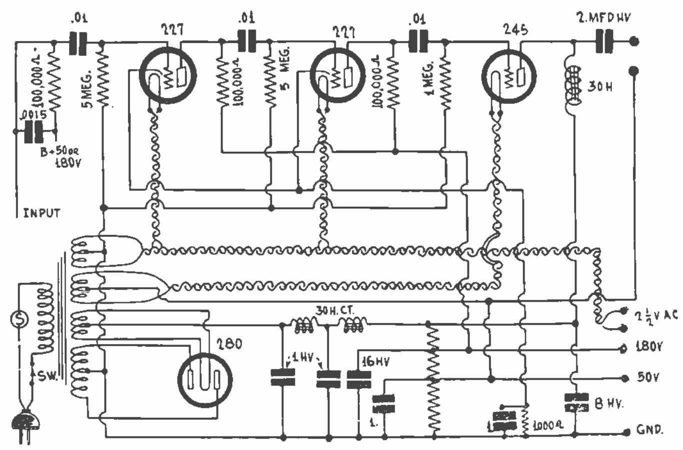

FIG. 869

A RESISTANCE-COUPLED AUDIO POWER AMPLIFIER.

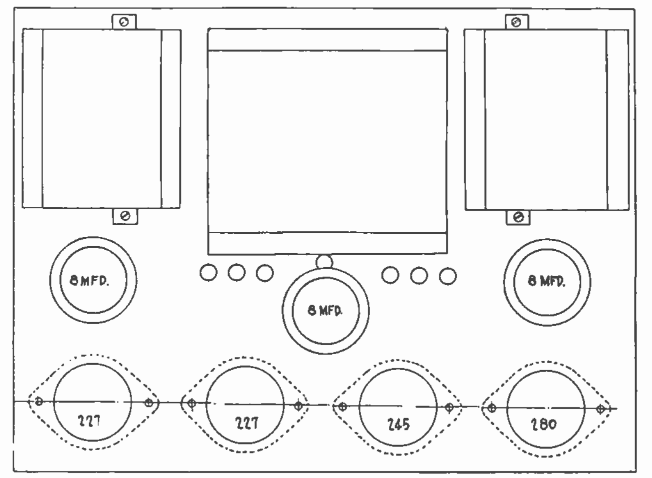

FIG. 870

LAYOUT OF PARTS THAT GO ON THE TOP OF THE CHASSIS. THE OTHER PARTS GO UNDERNEATH.

Resistance-Coupled Audio

REGARDING the $25 audio power amplifier described in the November 29th issue, I note this is resistance-coupled and wonder whether it will motorboat? Do not all resistance-coupled audio amplifiers motorboat? If not, please show constructional plan for the amplifier.—E. C. C.

The circuit was built up in our laboratories and did not motorboat. All good audio amplifiers, of substantial gain, can motorboat, but the filter design, properly chosen, will safeguard against that. Note the large filter capacities in the diagram, republished as Fig. 869. It is not true that all resistance-coupled audio amplifiers motorboat. Use a low resistance choke (200 ohms maximum) and high filter capacities and return the speaker to the filament center. The constructional plan is shown in Fig. 870.

* * *

B Supply with 227 Tube

WOULD it be possible to build a B supply using the 227 tube as rectifier? I want only about 20 milliamperes and a voltage not exceeding 180 volts. If it is possible please outline the necessary connections?—P. S. W.

Sure it is possible. Any three-element tube can be used as rectifier. Connect the grid and the plate together to form the anode and use the cathode of the tube as the positive of the line. Connect the heater to a 2.5 volt source. You may connect the center of the heater winding to the cathode if you wish, or you may leave it unconnected. Of course, the rectifier will be a half wave rectifier so that you will not need a center-tapped high voltage winding. If you draw as much as 20 milliamperes from the tube it will not last long. It may be more economical to use a 226 or a 171A for rectifier. There is one point in favor of using a 227 as rectifier if the tubes in the circuit served are of the heater type, and that is that the rectifier does not begin to function any sooner than the other tubes.

* * *

Low Setting Superheterodyne

WOULD it be practical to build a superheterodyne receiver with an intermediate frequency of 550 kc and using the lower oscillator setting exclusively, the set to tune in the broadcast stations?—W. H. J.

It would not be practical at all. If the intermediate frequency is to be 550 kc and the lower setting of the oscillator is to be used, the oscillator would have to be tuned to zero frequency to bring in the 550 kc broadcast frequency. Obviously, this is not possible. Also, to bring in the 1,500 kc broadcast frequency the oscillator would have to be set at 950 kc. Thus the tuning range of the oscillator would be from zero to 950 kc. How much better it would be to use the upper frequency setting and cover the broadcast range by tuning the oscillator from 1,100 kc to 2,050 kc!

* * *

Resistance in Screen Lead

WILL you kind explain why it is possible to use a high screen voltage in a resistance coupled amplifier using screen grid tubes provided that a high resistance is connected in the screen lead? You have stated many times that there should be no resistance in the screen lead and that the screen voltage should be low.—M. C. A.

There are two methods of operating a screen grid tube in a resistance coupled amplifier. One is to use a low screen voltage without any resistance screen lead and the other is to use a high screen voltage in series with a high resistance. The principle of the second method is as follows: The screen current through the high resistance causes a drop so that the actual screen voltage is considerably less than the applied voltage. As the signal forces the plate current to increase the plate voltage decreases, but at the same time the screen current increases and thus causes a decrease in the screen voltage. The decreases in the plate and the screen voltages are nearly proportional so that the screen voltage cannot become equal to or greater than the plate voltage, a condition that must not be met. The two methods give about the same result and both lower the amplification of the tube, but both yield a fairly high amplification without distortion.

U. S. and Canadian Stations by Frequency

Wavelength, Call, Location, Power and Time Sharers Given

LEGEND

Please observe the following code:

** Channel shared by United States and Canada. The Canadian stations will be found following the United States stations of the same frequency. Expression "Kw" not used for Canada.*

*** Channel exclusively assigned to Canada.*

CP—Construction permit authorized.

T—Transmitter location, specially given where it differs from main studio location.

Where two powers are given, larger is for daytime use. Time-sharers are shown in parentheses for U. S. stations.

THE list of stations by frequency published herewith was corrected up to the moment of going to press. The list includes all broadcasting stations in the United States and Canada. The reason for consolidating them is that so many Canadian stations are tuned in that a United States list would require resort to a Canadian list to make the service complete, and that Canadian list might not be at hand.

540 KILOCYCLES, 555.6 METERS

**CKX—Brandon, Man. 500

550 KILOCYCLES, 555.6 METERS

WGR—Buffalo, N. Y. ....1 Kw.
T—Amherst, N. Y.
WKRC—Cincinnati, Ohio....................1 Kw.
KFUO—St. Louis, Mo. (KSD)..........500, 1 Kw.
KSD—St. Louis, Mo. (KFUO).......... 500
KFDY—Brookings, S. D. (KFYR)....500, 1 Kw.
KFYR—Bismarck, N. D. (KFDY) 500
KOAC—Corvallis, Ore. ....1 Kw.

560 KILOCYCLES, 535.4 METERS

WLIT—Philadelphia, Pa. (WFI)..............500
WFI—Philadelphia 500
WQAM—Miami, Fla .... 1 Kw.
KFDM—Beaumont, Texas ....500, 1 Kw.
WNOX—Knoxville, Tenn. ....1 Kw., 2 Kw.
WIBO—Chicago, Ill. (WPCC, WEBW) .. 1 Kw.
T—Desplaines, Ill. ....1½ Kw.
WPCC—Chicago, Ill. (WIBO, WEBW) 500
KLZ—Denver, Colo. .... 1 Kw.
KTAB—Oakland, Calif. .... 1 Kw.

570 KILOCYCLES, 526.0 METERS

WNYC—New York, N. Y. (WMCA) 500
WMCA—New York City (WNYC)............500
T—Hoboken, N. J.
WSYR—Syracuse, N. Y. (WMAC) 250
WMAC—Cazenovia, N. Y. (WSYR)..........250
WKBN—Youngstown, O. (WEAO)..........500
WEAO—Columbus, O. (WKBN)............750
WWNC—Asheville, N. C. .... 1 Kw.
KGKO—Wichita Falls, Tex. 250, 500
WNAX—Yankton, S. D. .... 1 Kw.
KXA—Seattle, Wash. 500
KMTR—Hollywood, Calif. 500

***580 KILOCYCLES, 516.9 METERS**

WTAG—Worcester, Mass. 250
WOBU—Charleston, W. Va. (WSAZ) 250
WSAZ—Huntington, W. Va. (WOBU)......250
WIBW—Topeka, Kans. (KSAC) ....500, 1 Kw.
KSAC—Manhattan, Kans. (WIBW)..500, 1 Kw.
KGFX—Pierre, S. D. 200
CHMA—Edmonton, Alberta 250
CKUA—Edmonton, Alberta 500
CKCL—Toronto, Ontario 500
CKNC—Toronto, Ontario 500

590 KILOCYCLES, 508.2 METERS

WEEI—Boston, Mass. .... 1 Kw.
T—Weymouth, Mass.
WKZO—Berrien Springs, Mich..............1 Kw.
WCAJ—Lincoln, Nebr. (WOW) 500
WOW—Omaha, Nebr. (WCAJ) ....1 Kw.
KHQ—Spokane, Wash..............1 Kw., 2 Kw.

***600 KILOCYCLES, 499.7 METERS**

WCAC—Storrs, Conn. (WGBS) 250
WCAO—Baltimore, Md. 250
WGBS—New York City (WCAC)............250
T—Astoria, L. I., N. Y......500, LS (Exp.)
WREC—Memphis, Tenn. (WOAN)..........500
T—Whitehaven, Tenn. ....1 Kw.
WOAN—Lawrenceburg, Tenn. (WREC)......500
WMT—Waterloo, Iowa 500
KFSD—San Diego, Cal..............1 Kw., 500
CNRO—Ottawa, Ont. 500
CFCH—Iroquois Falls, Ontario 250
CJRW—Fleming, Saskatchewan 500
CJRM—Moose Jaw, Saskatchewan 500

610 KILOCYCLES, 491.7 METERS

WJAY—Cleveland Ohio 500
WFAN—Philadelphia, Pa. (WIP) 500
WIP—Philadelphia, Pa. WFAN) 500
WDAF—Kansas City, Mo. ....1 Kw.
KFRC—San Francisco, Calif. ....1 Kw.

620 KILOCYCLES, 483.6 METERS

WLBZ—Bangor, Maine 500
WFLA—WSUN—Clearwater, Fla..2½ Kw.,1 Kw.
WTMJ—Milwaukee, Wis. ....1 Kw., 2½ Kw.
T—Brookfield, Wis. ....2½ Kw.
KGW—Portland, Ore. ....1 Kw.
KTAR—Phoenix, Ariz. ....1 Kw., 500

***630 KILOCYCLES, 475.9 METERS**

WMAL—Washington, D. C...............500, 250
WOS—Jefferson City, Mo. (WGBF, KFRU)
1 Kw., 500
KFRU—Columbia, Mo. (WOS, WGBS).....500
WGBF—Evansville, Ind. (WOS, KFRU)......500
CFCT—Victoria, British Columbia............500
CNRA—Moncton, New Brunswick 500
CJGX—Yorkton, Saskatchewan 500

640 KILOCYCLES, 468.5 METERS

WAIU—Columbus, Ohio 500
WOI—Ames, Iowa .. ..5 K.
KFI—Los Angeles, Calif. ....5 Kw

650 KILOCYCLES, 461.3 METERS

WSM—Nashville, Tenn. ....5 Kw.
KPCB—Seattle, Wash. 100

660 KILOCYCLES, 454.3 METERS

WEAF—New York City ....50 Kw.
T—Bellmore, N. Y.
WAAW—Omaha, Neb. ....500—W

670 KILOCYCLES, 447.5 METERS

WMAQ—Chicago, Ill. ....5 Kw.
T—Addison, Ill.

680 KILOCYCLES, 440.9 METERS

WPTF—Raleigh, N. C. ....1 Kw.
KFEQ—St. Joseph, Mo. ....2½ Kw.
KPO—San Francisco, Cal. ....5 Kw.

690 KILOCYCLES, 434.5 METERS

CJBC—Toronto, Ont. 5000
CJSC—Toronto, Ont. 500
CFAC, CFCN—Calgary, Alberta 500
CPRY—CKGW—Bowmanville, Ont...........5 Kw.
CHCA, CJCJ, CNRC—Calgary, Alberta.......500

700 KILOCYCLES, 428.3 METERS

WLW—Cincinnati, Ohio ....50 Kw.
T—Mason, Ohio

710 KILOCYCLES, 422.3 METERS

KMPC—Beverly Hills, Cal. 500
WOR—Newark, N. J. ....5 Kw.
T—Kearny, N. J.

720 KILOCYCLES, 416.4 METERS

WGN, WLIB—Chicago, Ill. ....25 Kw.
T—Elgin, Ill.

****730 KILOCYCLES, 410.7 METERS**

CHLS, CKCD—Vancouver, British Columbia.....50
CKFC, CKMO—Vancouver, British Columbia..50
CKWX—Vancouver, British Columbia.......1000
CHYC—Montreal, Quebec......................5 Kw.
CKAC—Montreal, Quebec......................5 Kw.
CNRM—Montreal, Quebec ....5 Kw.

740 KILOCYCLES, 405.2 METERS

WSB—Atlanta, Ga. ....5 Kw.
KMMJ—Clay Center, Neb. ....1 Kw.

750 KILOCYCLES, 399.8 METERS

WJR—Detroit, Mich. ....5 Kw.
T—Sylvan Lake Village, Mich.

760 KILOCYCLES, 394.5 METERS

WJZ—New York, N. Y.....................30 Kw.
T—Boundbrook, N. J.
WEW—St. Louis, Mo. ....1 Kw.
KVI—Tacoma, Wash. ....1 Kw.
T—Des Moines, Wash.

770 KILOCYCLES, 389.4 METERS

KFAB—Lincoln, Nebr. (WBBM, WJBT)..5 Kw.
WBBM, WJBT—Chicago, Ill. (KFAB)...25 Kw.
T—Glenview, Ill.

***780 KILOCYCLES, 384.4 METERS**

WEAN—Providence, R. I. 500, 250
WTAR, WPOR—Norfolk, Va..................500
WMC—Memphis, Tenn. ....1 Kw., 500
(C. P. issued to move to Bartlett, Tenn.)
WISJ—South Madison, Wis. 250, 500
(C. P. only, Experimental Basis)
KELW—Burbank, Calif. (KTM)..............500
KTM—Los Angeles, Calif. (KELW)..........500
T—Santa Monica, Calif...............1 Kw.
CKY, CNRW—Winnipeg, Manitoba..........5 Kw.

790 KILOCYCLES, 379.5 METERS

WGY—Schenectady, N. Y...................50 Kw.
T—So. Schenectady, N. Y.
KGO—Oakland, Calif. ....7½ Kw.

800 KILOCYCLES, 374.8 METERS

WBAP—Fort Worth, Texas (WFAA).......... 50
T—Grapevine Texas. (Licensed for 10 k.w. at present.)
WFAA—Dallas, Tex. (WBAP)..............50 Kw.
T—Grapevine, Texas

810 KILOCYCLES, 370.2 METERS

WPCH—New York, N. Y..........................500
T—Hoboken, N. J.
WCCO—Minneapolis, Minn. ....7½ Kw.
T—Anoka, Minn.

*****820 KILOCYCLES, 365.6 METERS**

WHAS—Louisville, Kentucky..............10 Kw.
T—Jeffersontown, Kentucky

****840 KILOCYCLES, 361.2 METERS**

WHDH—So. Boston, Mass. ....1 Kw.
T—Gloucester, Mass.
WRUF—Gainesville, Fla. ....5 Kw.
KOA—Denver, Colo. ....12½ Kw.

820 KILOCYCLES, 365.6 METERS

CHCT—Red Deer, Alberta 1000
CKLC—Red Deer, Alberta 1000
CKOW—Toronto, Ontario 500
CFCA—Toronto, Ont. 500
CNRD—Red Deer, Alberta......................1 Kw.
CNRT—Toronto, Ontario 500

850 KILOCYCLES, 352.7 METERS

KWKH—Shreveport, La. (WWL)............10 Kw.
T—Kennonwood, La.
WWL—New Orleans, La. (KWKH) ....5 Kw.

860 KILOCYCLES, 348.5 METERS

WABC, WBOQ—New York City............5 Kw.
T—West of Cross Bay Blvd., Queens Co.
C.P. issued to move & incr. pr. to 50 Kw.—LP
WHB—Kansas City, Mo. 500
KMO—Tacoma, Wash. ....1 Kw., 500

870 KILOCYCLES, 344.6 METERS

WLS—Chicago, Ill. (WENR, WBCN) 5Kw., 50 Kw.
T—Crete, Ill.
WENR, WBCN—Chicago, Ill. (WLS).......50 Kw.
T—Downers Grove, Ill.

***880 KILOCYCLES, 340.7 METERS**

WGBI—Scranton, Pa. (WQAN)..................250
WCOC—Meriden, Miss..............................500
WQAN—Scranton, Pa. (WGBI) 250
WSUI—Iowa City, Iowa 500
KLX—Oakland, Calif 500
KPOF—Denver, Colo. (KFKA) 500
KFKA—Greeley, Colo. (KPOF) ....1 Kw., 500
CNRQ—Quebec, Que. 50
CJCB—Sydney, N. S. 50
CHCS—Hamilton, Ontario 10
CHML—Hamilton, Ontario 50
CKOC—Hamilton, Ontario 50
CHRC—Quebec, Quebec........................100 W
CKCI—Quebec, Quebec ....22½ W
CKCV—Quebec, Quebec 50

***890 KILOCYCLES, 336.9 METERS**

WJAR—Providence, R. I. 400, 250
WKAQ—San Juan, P. R. 500
WMMN—Fairmont, W. Va. 500, 250
WMAZ—Macon, Ga. (WGST) 500, 250
WGST—Atlanta, Ga. (WMAZ) 500, 250
KGJF—Little Rock, Ark. 250
WILL—Urbana, Ill. (KUSD, KFNF) 500, 250
KUSD—Vermillion, S. D. (WILL, KFNF) 750, 500
KFNF—Shenandoah, Iowa (WILL, KUSD)
1 Kw., 500
CFBO—St. John, New Brunswick 50
CKCO—Ottawa, Ont. 100

900 KILOCYCLES, 333.2 METERS

WBEN—Buffalo, N. Y. ....1 Kw.
T—Martinsville, N. Y.
WKY—Oklahoma City, Okla. ....1 Kw.
WJAX—Jacksonville, Fla. ....1 Kw.
WLBL—Stevens Point, Wis. ....2 Kw.
KHJ—Los Angeles, Calif. ....1 Kw.
KSEI—Pocatello, Idaho 250
KGBU—Ketchikan, Alaska 500

****910 KILOCYCLES, 329.5 METERS**

CJGC—London, Ontario 500
CNRL—London, Ontario 500
CFQC—Saskatoon, Saskatchewan 500
CNRS—Saskatoon, Saskatchewan 500

920 KILOCYCLES, 325.9 METERS

WBSO—Needham, Mass. 500, 250
WWJ—Detroit, Mich. ....1 Kw.
KPRC—Houston, Texas ....2½ Kw., 1 Kw.
T—Sugarland, Texas
WAAF—Chicago, Ill. 500
KOMO—Seattle, Wash. ....1 Kw.
KFEL—Denver, Colo. (KFXF)......................500
KFXF—Denver, Colo. (KFEL) 500

***930 KILOCYCLES, 322.4 METERS**

WJBG—Elkins Park, Pa. 50
WDBJ—Roanoke, Va. 500, 250
WBRC—Birmingham, Ala. ....1 Kw., 500
KGBZ—York, Nebr. (KMA)..............1 Kw., 500
KMA—Shenandoah, Ia. (KGBZ) ....1 Kw., 500
KFWI—San Francisco, Cal. (KFWM)..........500
KROW—Oakland, Cal. ....500, 1 Kw.
T—Richmond, Cal.
CJCA—Edmonton, Alta. 500
CKIC—Wolfville, Nova Scotia 50
CKPC—Preston, Ont. 50
CNRH—Halifax, N. S..................................500
CNRE—Edmonton, Alta. 500
CKPR—Midland, Ont. 50

940 KILOCYCLES, 319.0 METERS

WAAT—Jersey City, N. J. 300
WCSH—Portland, Maine........................1 Kw.
WFIW—Hopkinsville, Ky. ....1 Kw.
WHA—Madison, Wis. 750
WDAY—W. Fargo, N. D. ....1 Kw.
KOIN—Portland, Ore. ....1 Kw.
T—Sylvan, Ore.
KGU—Honolulu, T. H.;..........................1 Kw.

950 KILOCYCLES, 315.6 METERS

WRC—Washington, D. C. 500
KMBC—Kansas City, Mo. ....1 Kw.
T. Independence, Mo.
KFWB—Hollywood, Calif. ....1 Kw.
KGHL—Billings, Mont. 500

960 KILOCYCLES, 312.3 METERS
CFRB—Toronto, Ontario 4000
CNRX—Toronto, Ont. .... 4 Kw.
CFCY—Charlottetown, Prince Edward Island...250
CHCK—Charlottetown, Prince Edward Island ...30
CHWC—Pilot Butte, Saskatchewan 500
CJBR—Regina, Saskatchewan 500
CKCK—Regina Saskatchewan 500
CNRR—Regina, Saskatchewan 500

970 KILOCYCLES, 309.1 METERS
WCFL—Chicago, Ill. ....1½ Kw.
KJR—Seattle, Wash. ....5 Kw.

980 KILOCYCLES, 303.9 METERS
KDKA—Pittsburgh, Pa. ....50 Kw.
T—Saxonburg, Pa.

990 KILOCYCLES, 302.8 METERS
WBZ—Springfield, Mass (WBZA) ....15 Kw.
T—E. Springfield, Mass. C. P. to move to Millis Twp. and consolidate with WBZA.
WBZA—Boston, Mass. (WBZ) 500
C. P. to move tr. to E. Springfield and increase power to 1 Kw.

1000 KILOCYCLES, 299.8 METERS
WHO—Des Moines, Ia. (WOC)....5 Kw.
(Synchronized with WOC experimentally.)
WOC—Davenport, Ia. (WHO) ....5 Kw.
KFVD—Culver City, Calif. 250

***1010 KILOCYCLES, 296.9 METERS**
WQAO, WPAP—New York, N. Y. (WHN, WRNY) 250
T—Cliffside, N. J.
WHN—New York, N. Y. (WQAO, WPAP, WRNY) 250
WRNY—New York, N. Y. (WQAO, WPAP, WHN) 250
T—Coytesville, N. J.
KGGF—Picher, Okla. (WNAD) 500
WNAD—Norman, Okla. (KGGF) 500
WIS—Columbia, S. C. ....1 Kw., 500
(C. P. only)
KQW—San Jose, Calif. 500
CKCR—Waterloo, Ont. 50
CFLC—Prescott, Ont. 50

1020 KILOCYCLES, 293.9 METERS
WRAX—Philadelphia, Pa. 250
KYW, KFKX—Chicago, Ill. ....10 Kw.
T—Bloomingdale, Ill.

****1030 KILOCYCLES, 291.1 METERS**
CNRV—Vancouver, B. C. 500
CFCF—Montreal, Que 1650

1040 KILOCYCLES, 288.3 METERS
WMAK—Buffalo, N. Y.....1 Kw.
T—Grand Island, N. Y.
WKAR—East Lansing, Mich. ....1 Kw.
KTHS—Hot Springs National Park, Ark. (KRLD) ....10 Kw.
KRLD—Dallas, Tex. (KTHS) ....10 Kw.

1050 KILOCYCLES, 285.5 METERS
KFKB—Milford, Kansas ....5 Kw.
KNX—Hollywood, Calif. ....50 Kw., 5 Kw.
T—Los Angeles, Calif.

1060 KILOCYCLES, 282.8 METERS
WBAL—Baltimore, Md. (WTIC) ....10 Kw.
T—Glen Morris, Md.
WTIC—Hartford, Conn. (WBAL) ....50 Kw.
T—Avon, Conn.
WJAG—Norfolk, Neb. ....1 Kw.
KWJJ—Portland, Ore. 500

1070 KILOCYCLES, 280.2 METERS
WTAM—Cleveland, Ohio ....50 Kw.
T—Brocksville Village, O.
WCAZ—Carthage, Ill. 50
WDZ—Tuscola, Ill. 100
KJBS—San Francisco, Calif 100

1080 KILOCYCLES, 277.6 METERS
WBT—Charlotte, N. C. ....5 Kw.
WCBD—Zion, Ill. (WMBI) ....5 Kw.
WMBI—Chicago, Ill. (WCBD) ....5 Kw.
T—Addison, Ill.

1090 KILOCYCLES, 275.1 METERS
KMOX—St. Louis, Mo.....50 Kw., 5 Kw.
T—Kirkwood, Mo.
Cp issued to incr powr to 50 KWLP

1100 KILOCYCLES, 272.6 METERS
WPG—Atlantic City, N. J. (WLWL) ....5 Kw.
WLWL—New York City (WPG) ....5 Kw.
T—Kearny, N. J.
(6 P.M. to 8 P.M.)
KGDM—Stockton, Calif. 250, 50
(C. P. to incr. pwr. to 250 W—D)

1110 KILOCYCLES, 270.1 METERS
WRVA—Richmond, Va. ....5 Kw.
T—Mechanicsville, Va.
KSOO—Sioux Falls, S. D. ....2 Kw.

***1120 KILOCYCLES, 267.7 METERS**
WDEL—Wilmington, Del.....350, 250
(C. P. to increase pwr. to 500 w.
WDBO—Orlando, Fla. 500
WTAW—College Station, Tex. (KTRH) 500
KHRH—Houston, Texas....500
WISN—Milwaukee, Wis. (WHAD) 250
WHAD—Milwaukee, Wis. (WISN) 250
KFSG—Los Angeles, Calif. (KMIC)....500
KMCS—Seattle, Wash. 50
KRSC—Seattle, Wash. 50
KFIO—Spokane, Wash. 100
CHGS—Sunnyside, Prince Edward Island....100 W
CJOC—Lethbridge, Alberta 50
CJRX—Middlechurch, Manitoba....2000
CFJC—Kamloops, British Columbia....15

1130 KILOCYCLES, 265 METERS
WOV—New York City ....1 Kw.
T—Secaucus, N. J.
Daytime to 6 P.M.
WJJD—Mooseheart, Ill. ....20 Kw.
KSL—Salt Lake City, Utah ....5 Kw.

1140 KILOCYCLES, 263.0 METERS
WAPI—Birmingham, Ala. (KVOO) ....5 Kw.
KVOO—Tulsa, Okla. (WAPI) ....5 Kw.

1150 KILOCYCLES, 260.7 METERS
WHAM—Rochester, N. Y. ....5 Kw.
T—Victor Township

1160 KILOCYCLES, 258.5 METERS
WWVA—Wheeling, W. Va. (WOWO)....5Kw.
WOWO—Ft. Wayne, Ind. (WWVA)....10 Kw.

1170 KILOCYCLES, 256.3 METERS
WCAU—Philadelphia, Pa. ....10 Kw.
T—Byberry, Pa.
KTNT—Muscatine. Iowa ....5 Kw.

*****1180 KILOCYCLES, 254.1 METERS**
WDGY—Minneapolis, Minn. (WHDI)....1 Kw.
WHDI—Minneapolis, Minn. (WDGY)....500
KEX—Portland, Ore. (KOB) ....5 Kw.
KOB—State College, N. M. (KEX) ....20 Kw.

1190 KILOCYCLES, 252.0 METERS
WICC—Bridgeport, Conn. 500
T—Easton, Conn.
WOAI—San Antonio, Tex. ....50 Kw.

***1200 KILOCYCLES, 249.9 METERS**
WABI—Bangor, Maine 100
WNBX—Springfield, Vt. (WCAX) 10
WCAX—Burlington, Vt. (WNBX) 100
WORC—Worcester, Mass. 100
T—Auburn, Mass.
WIBX—Utica, N. Y. 300, 100
WFBE—Cincinnati, Ohio 100
WHBC—Canton, Ohio (WNBO Sundays)....10
WLAP—Louisville, Ky. 30
WLBG—Petersburg, Va. 250, 100
T—Ettrick, Va.
WNBO—Silver Haven, Pa. 100
Sundays only.
WEHC—Emory, Va....250,100
WCOD—Harrisburg, Pa. (WKJC) 100
WKJC—Lancaster, Pa. (WCOD) 100
WNBW—Carbondale, Pa. 10
KMLB—Monroe, La. Cp. only....50
WABZ—New Orleans, La. (WJBW)....100
WJBW—New Orleans, La. (WBAZ)....30
(C. P. to incr. power to 100 watts.)
WBBZ—Ponca City, Okla. 100
WFBC—Knoxville, Tenn. 50
WRBL—Columbus, Ga. 50
(C. P. only)
KBTM—Paragould, Ark. 100
KGHI—Little Rock, Ark.....100
WJBC—LaSalle, Ill. (WJBL) 100
WJBL—Decatur, Ill. (WJBC) 100
WWAE—Hammond, Ind. (WRAF) 100
WRAF—Laporte, Ind. (WWAE) 100
KFJB—Marshalltown, Ia. 250, 100
KGCU—Mandan, N. D. 100
WCAT—Rapid City, S. D. 100
KGDY—Oldham, S. D. 15
KFWF—St. Louis, Mo. (WMAY, WIL)....100
KGDE—Fergus Falls, Minn....250, 100
KGFK—Hallock, Minn. 50
WCLO—Kenosha, Wis. 100
Studio—Janesville, Wis.
WHBY—Green Bay, Wis. 100
T—West De Pere, Wis.
WIL—St. Louis, Mo. (KFWF, WMAY)....250, 100
WMAY—St. Louis, Mo. (KFWF, WIL)...250, 100
KGFJ—Los Angeles, Calif. 100
KXO—El Centro, Calif. 100
KSMR—Santa Maria, Calif. 100
KWG—Stockton, Calif. 100
KGEK—Yuma, Colo. (KGEW) 50
KGEW—Ft. Morgan, Colo. (KGEK) 100
KVOS—Bellingham, Wash. 100
KGY—Lacey, Wash. 50, 10

***1210 KILOCYCLES, 247.8 METERS**
WMRJ—Jamaica, N. Y. (WCOH, WGBB, WJBI) 100
WJBI—Redbank, N. J. (WCOH, WGBB)....100
WGBB—Freeport, N. Y. (WCOH, WJBI)....100
WCOH—Yonkers, N. Y. (WJBI, WGBB)....100
T—Greenville, N. Y.
WOCL—Jamestown, N. Y. 25
WLCI—Ithaca, N. Y. 50
WPAW—Pawtucket, R. I. (WDWF, WLSI)....100
WDWF, WLSI—Providence, R. I. (WPAW).100
T—Cranston, R. I.
WSEN—Columbus, Ohio 100
WMAN—Columbus, Ohio 50
WJW—Mansfield, Ohio 100
WALR—Cambridge, Ohio 100
WALR—Zanesville, Ohio....100
WBAX—Wilkes-Barre, Pa. (WJBU)....100
T—Plains Twp., Pa.
WJBU—Lewisburg, Pa. (WBAX) 100
WBBL—Richmond, Va. 100
(Sundays only.)
WMBG—Richmond, Va. 100
WSIX—Springfield, Tenn. 100
WRBU—Gastonia, N. C. 100
WJBY—Gadsden, Ala. 50
KGMP—Elk City, Okla. 100
WRBQ—Greenville, Miss. 250, 100
WQDX—Thomasville, Ga....50
WGCM—Gulfport, Miss. 100
T—Mississippi City, Miss.
KWEA—Shreveport, La. 100
KDLR—Devils Lake, N. D. 100
KGCR—Watertown, S. D. 100
KFOR—Lincoln, Nebr. 250, 100
WHBU—Anderson, Ind. 100
KFVS—Cape Girardeau, Mo. (WEBQ) 100
WEBQ—Harrisburg, Ill. (KFVS)....100
KGNO—Dodge City, Kansas....100
WSBC—Chicago, Ill. (WEDC, WCRW)....100
WCRW—Chicago, Ill. (WEDC, WSBC)....100
WEDC—Chicago, Ill. (WSBC, WCRW)....100
WCBS—Springfield, Ill. (WTAX) 100
WTAX—Streator, Ill. (WCBS) 50
WHBF—Rock Island, Ill. 100
WOMT—Manitowoc, Wis. 100
WIBU—Poynette, Wis. 100
KMJ—Fresno, Calif. 100
KFXM—San Bernardino, Calif. (KPPC)....100
KDFN—Casper, Wyo. 100
KPPC—Pasadena, Calif. (KFXM) 50
CHWK—Challiwick, British Columbia 5
CJOR—Sea Island, B. C....1210
CFNB—Frederickton, New Brunswick 50
CFCO—Chatham, Ontario ....100 W
CKMC—Cobalt, Ontario 15
CKPC—Preston, Ontario....25 W

1220 KILOCYCLES, 245.8 METERS
WDAE—Tampa, Fla. ....1 Kw.
WCAD—Canton, N. Y. 500
WCAE—Pittsburgh, Pa. ....1 Kw.
WREN—Lawrence, Kans. (KFKU) ....1 Kw.
KFKU—Lawrence, Kans. (WREN)....1 Kw.
KWSC—Pullman. Wash. ....2 Kw., 500

1230 KILOCYCLES, 243.8 METERS
WNAC, WBIS—Boston, Mass. (T. Quincy, Mass.) ....1 Kw.
WPSC—State College, Pa. 500
WSBT—South Bend, Ind. (WFBM) 500
WFBM—Indianapolis, Ind. (WSBT) ....1 Kw.
KGGM—Albuquerque, N. M. 500, 250
KYA—San Francisco, Calif. ....1 Kw.
KFQD—Anchorage. Alaska 100

1240 KILOCYCLES, 241.8 METERS
WXYZ—Detroit, Mich....1 Kw.
KTAT—Fort Worth, Texas (WACO)....1 Kw.
T—Birdsville, Texas
WACO—Waco, Texas (KSAT) ....1 Kw

1250 KILOCYCLES, 239.9 METERS
WGCP—Newark, N. J. (WODA, WAAM) 250
KFMX—Northfield. Minn. ....1 Kw
WODA—Paterson, N. J. (WGCP, WAAM) 1 Kw
WAAM—Newark, N. J. (WODA, WGCP) 1 Kw., 2 Kw.
WDSU—New Orleans. La. ....1Kw.
WLB, WGMS—Minneapolis, Minn. (WRHM, KFMX, WCAL)....1 Kw.
(C. P. to move locally and increase power to 1 Kw.)
WRHM—Minneapolis, Minn. (WLB, KFMX, WCAL) ....1 Kw.
T—Fridly, Minn.
KFMX—Northfield, Minn. (WLB, WRHM, WCAL) ....1 Kw.
WCAL—Northfield, Minn. (WLB, WRHM, KFMX) ....1 Kw.
KFOX—Long Beach, Calif. ....1 Kw.
KIDO—Boise, Idaho ....1 Kw.

1260 KILOCYCLES, 238.0 METERS
WLBW—Oil City, Pa. ....1 Kw., 500
KWWG—Brownsville, Texas (KRGV)....500
WTOC—Savannah, Ga. 500
KRGV—Harlingen, Texas (KWWG)....500
KOIL—Council Bluffs, Ia. ....1 Kw.
KVOA—Tucson, Arizona 500

1270 KILOCYCLES, 236.1 METERS
WEAI—Ithaca, N. Y. 500
WFBR—Baltimore, Md. 250
WASH—Grand Rapids, Mich. (WOOD)....500
WOOD—Grand Rapids, Mich. (WASH) 500
T—Furnwood.
WJDX—Jackson, Miss. ....1 Kw., 500
KWLC—Decorah, Iowa (KGCA)....100
KGCA—Decorah, Iowa (KWLC)....50
KTW—Seattle, Wash. (KOL) ....1 Kw.
KOL—Seattle, Wash. (KTW) ....1 Kw.
KFUM—Colorado Springs, Colo....1 Kw.

1280 KILOCYCLES, 234.2 METERS
WCAM—Camden, N. J. (WOAX, WCAP)....500
WCAP—Asbury Park, N. J. (WCAM, WOAX) 500
WOAX—Trenton, N. J. (WCAM, WCAP)....500
WDOD—Chattanooga, Tenn. ....2½ Kw., 1 Kw.
WRR—Dallas, Tex. 500
WIBA—Madison, Wis. 500
KFBB—Great Falls. Montana (KGIR)....1 Kw.

1290 KILOCYCLES, 232.4 METERS
WNBZ—Saranac Lake, N. Y....50
WJAS—Pittsburgh, Pa. ....1 Kw.
T—North Fayette Twp., Pa.
KTSA—San Antonio, Texas (KFUL) 2 Kw., 1 Kw.
KFUL—Galveston, Texas (KTSA) 500
KLCN—Blytheville, Ark. 50
WEBC—Superior, Wis. ....2½ Kw., 1 Kw.
(C. P. to incr. pr. to 2½ Kw., L. S.)
KDYL—Salt Lake City, Utah ....1 Kw.

1300 KILOCYCLES, 230.6 METERS
WBBR—Rossville, N. Y. (WHAP, WEVD, WHAZ) ....1 Kw.
T—Staten Island.
WHAP—New York, N. Y. (WBBR, WEVD, WHAZ) ....1 Kw.
T—Carlstadt, N. J.
WEVD—New York, N. Y. (WBBR, WHAP, WHAZ) 500
T—Forest Hills, N. Y.
WHAZ—Troy, N. Y. (WBBR, WHAP, WEVD) 500
WIOD, WMBF—Miami Beach, Fla....1 Kw.
KFH—Wichita, Kansas (WOQ) ....1 Kw.
WOQ—Kansas City, Mo. (KFH) ....1 Kw.
KGEF—Los Angeles. Calif. (KTBI) ....1 Kw.
KTBI—Los Angeles. Calif....1 Kw.
KFJR—Portland, Oregon (KTBR) 500
KTBR—Portland, Oregon (KFJR) 500

1310 KILOCYCLES, 228.9 METERS
WKAV—Laconia, N. H. 100
WEBR—Buffalo, N. Y. 200, 100
WMBO—Auburn, N. Y. 100
WNBH—New Bedford, Mass. 100
WOL—Washington, D. C. 100
WGH—Newport News, Va. 100
WEXL—Royal Oak, Mich. 50
WFDF—Flint, Michigan 100
WHAT—Phiadelphia, Pa. (WFKD)....100
WFKD—Philadelphia, Pa. (WHAT)....50
WJAC—Johnstown, Pa. (WFBG) 100
WFBG—Altoona, Pa. (WJAC) 100
WRAW—Reading, Pa. (WCAL) 100
WGAL—Lancaster, Pa. (WRAW) 100, 15
WSAJ—Grove City, Pa. 100
WBRE—Wilkes-Barre, Pa. 100
WKBC—Birmingham, Ala. 100
WRBI—Tifton, Ga. 20
WOBT—Union City, Tenn. 250, 100
WORL—Knoxville, Tenn. 50
(C. P. to incr. Power to 100 Watts)
KRMD—Shreveport, La. (KTSL) 50
KTSL—Shreveport, La. (KRMD)....100
T—Cedar Grove, La.
WSJS—Winston-Salem, N. C. 100
(C. P. only)
KTLC—Houston, Texas 100

1310 KILOCYCLES (Continued)

KFPM—Greenville, Texas 15
KTSM—El Paso, Texas (WDAH) 100
WDAH—El Paso, Texas (KTSM) 100
KFPL—Dublin, Texas 100
KFXR—Oklahoma City, Oklahoma 100
WKBS—Galesburg, Ill. 100
WCLS—Joliet, Ill. (WKBB) 100
WKBB—Joliet, Ill. (WCLS) 100
KWCR—Cedar Rapids, Iowa (KFGQ, KFJY)..100
KFJY—Fort Dodge, Iowa (KFGQ, KWCR)..100
KFGQ—Boone, Iowa (KWCR, KFJY) 100
KGFW—Ravenna, Nebr. 100
WBOW—Terre Haute, Ind. 100
WJAK—Marion, Ind. (WLBC) 50
WLBC—Muncie, Ind. (WJAK) 50
KGBX—St. Joseph, Missouri 100
KFIU—Juneau, Alaska 10
KFBK—Sacramento, Calif. 100
KGRJ—Jerome, Ariz. 100
(C. P. only)
KGCX—Wolf Point, Mont. 250, 100
KGEZ—Kalispell, Mont. 100
KFUP—Denver, Colo. (KFXJ) 100
KFXJ—Edgewater, Colo. (KFUP) 50
KMED—Medford, Ore. 50
KXRO—Aberdeen, Wash. 75
KIT—Yakima, Wash. 50

1320 KILOCYCLES, 277.1 METERS

WADC—Tallmadge, Ohio ....1 Kw.
WSMB—New Orleans, La. 500
KGIQ—Twin Falls, Idaho (KID) 250
KGHF—Pueblo, Colo. 500, 250
KGMB—Honolulu, Hawaii 500
KID—Idaho Falls, Idaho (KGIQ)....500, 250

1330 KILOCYCLES, 225.4 METERS

WDRC—New Haven, Conn. 500
WSAI—Cincinnati, Ohio 500
T—Mason, Ohio
WTAQ—Eau Claire, Wis. (KSCJ) ....1 Kw.
T—Township of Washington, Wis.
KSCJ—Sioux City, Iowa (WTAQ) ..2½ Kw., 1 Kw.
KGB—San Diego, Calif. 250

1340 KILOCYCLES, 223.7 METERS

WCOA—Pensacola, Florida 500
WSPD—Toledo, Ohio ....1 Kw., 500
KFPY—Spokane, Wash. ....1 Kw., 500
KFPW—Fort Smith, Arkansas 50

1350 KILOCYCLES, 222.1 METERS

WBNY—New York, N. Y. (WMSG, WCDA, WKBQ) 250
WMSG—New York, N. Y. (WBNY, WCDA, WKBQ) 250
WCDA—New York City (WBNY, WMSG, WKBQ) 250
T—Cliffside Park, N. J.
WKBQ—New York City (WBNY, WMSG, WCDA) 250
KWK—St. Louis, Mo. ....1 Kw.

1360 KILOCYCLES, 220.4 METERS

WFBL—Syracuse, N. Y. ....1 Kw.
WQBC—Vicksburg, Miss. 300
(Station burned down. C. P. to erect new transmitter)
WCSC—Charleston, S. C. 500
WJKS—Gary, Ind. (WGES) 500, 1250
WGES—Chicago, Ill. (WJKS) ....500, 1 Kw.
KGIR—Butte, Mont. (KFBB) 500
KGER—Long Beach, Calif. (KPSN) ....1 Kw.
KPSN—Pasadena, Calif. (KGER) ....1 Kw.

1370 KILOCYCLES, 218.8 METERS

WRDO—Augusta, Maine, CP. only 100
WQDM—St. Albans, Vermont 5
WLEY—Lexington, Mass. (½ time) 100
WSVS—Buffalo, N. Y. 50
WPOE—Patchogue, N. Y. 100
WCBM—Baltimore, Md. 250, 100
WHBD—Mt. Orab, Ohio 100
WHDF—Calumet, Mich. 250, 100
(C. P. to increase power to 250)
WBCM—Baltimore, Md. 1370
(Case pending in court)
WBGF—Glens Falls, N. Y. CP. only 50
WLEY—Lexington, Mass. 100
WJBK—Ypsilanti, Mich. (WIBM) 50
Studio—Highland Park, Mich.
WIBM—Jackson, Mich. (WJBK) 100
WRAK—Williamsport, Pa. 50
WELK—Philadelphia, Pa. 250, 100
WFDV—Rome, Ga. 100
WRBJ—Hattiesburg, Miss. 10
WHBQ—Memphis, Tenn. 100
WRBT—Wilmington, N. C. 100
KGFG—Oklahoma City, Okla. (KCRC) 100
KFJZ—Fort Worth, Texas 100
KCRC—Enid, Oklahoma (KGFG) 250, 100
WMBR—Tampa, Florida 100
KONO—San Antonio, Texas (KGCI) 100
KGKL—San Angelo, Texas 100
KFLX—Galveston, Texas 100
WGL—Ft. Wayne, Indiana 100
WBTM—Danville, Virginia (WLVA) 100
(C. P. only)
WLVA—Lynchburg, Virginia (WBTM) 100
(C. P. only)

KGDA—Dell Rapids, S. D. 50
C. P. to move to Mitchell, S. D.
KFJM—Grand Forks, N. D. 100
KWKC—Kansas City, Missouri 100
WRJN—Racine, Wisconsin 100
KGAR—Tucson, Arizona 250, 100
(C. P. to incr. pr. to 250)
KOH—Reno, Nevada 100
(Note—C. P. issued to KOH to increase power to 500 watts, an increase frequency to 1380 k.c.
KRE—Berkeley, California 100
KZM—Hayward, Calif. 100
KLO—Ogden, Utah 200, 100
KOOS—Marshfield, Ore. 100
KFBL—Everett, Wash. (KVL) 50
KVL—Seattle, Wash. (KFBL) 100
KFJI—Astoria, Ore. 100
KGFL—Raton, N. M. 50

1380 KILOCYCLES, 217.3 METERS

WSMK—Dayton, Ohio. (KQV) 200
KQV—Pittsburgh, Pa. (WSMK) 500
KSO—Clarinda, Ia. (WKBH) 500
WKBH—LaCrosse, Wis. (KSO) ....1 Kw.

1390 KILOCYCLES, 215.7 METERS

WHK—Cleveland, Ohio. T—Village of Seven Hills ....1 Kw.
KLRA—Little Rock, Ark. (KUOA) ....1 Kw.
KUOA—Fayetteville, Ark. (KLRA) ....1 Kw.
KOY—Phoenix, Ariz. 500

1400 KILOCYCLES, 214.2 METERS

WCGU—Brooklyn, N. Y. (WSGH-WSDA, WLTH, WBBC) 500
WSGH-WSDA—Brooklyn, N. Y. (WCGU, WLTH, WBBC) 500
WLTH—Brooklyn, N. Y. (WCGU, WSGH, WSDA, WBBC) 500
WCMA—Culver, Ind. 50
WBBC—Brooklyn, N. Y. (WCGU, WSGH-WSDA, WLTH) 500
KOCW—Chickasha, Okla. 250, 500
WCMA—Culver, Ind. (WBAA, WKBF) 500
WKBF—Indianapolis, Ind. (WBAA, WCMA)..500
WBAA—W. Lafayette, Ind. (WCMA, WKBF) 500
KLO—Ogden, Utah 500

1410 KILOCYCLES, 212.6 METERS

WBCM—Bay City, Mich. Hampton Twp., Mich. 500
WLEX—Lexington, Mass. 100
KGRS—Amarillo, Texas (WDAG) ....1 Kw.
WMAF—South Dartmouth, Mass. (WELX, WSSH) 500
WODX—Mobile, Ala. (WSFA) 500
T—Springhill, Ala.
WSFA—Montgomery, Ala. (WODX) 500
(C. P. only)
WRBX—Roanoke, Va. 250
WSSH—Boston, Mass. (WLEX, WMAF) 500
WDAG—Amarillo, Texas (KGRS) 250
KFLV—Rockford, Ill. (WHBL) ....500, 1 Kw.
WHBL—Sheboygan, Wis. (KFLV) 500

1420 KILOCYCLES, 211.1 METERS

WELL—Battle Creek, Mich. 50
WHDL—Tupper Lake, N. Y. 10
WTBO—Cumberland, Md. 100
WILM—Wilmington, Del. 100
T—Edge Moor, Del.
WEDH—Erie, Pa. 30
WMBC—Detroit, Mich. 250, 100
WKBP—Battle Creek, Mich. 50
WHIS—Bluefield, W. Va. 100
WIBR—Steubenville, Ohio 50
WFDW—Talladega, Ala. 100
WPAD—Paducah, Ky. (C.P. only) 100
WJBO—New Orleans, La. 100
KTAP—San Antonio, Tex. 100
KXYZ—Houston, Texas 100
KFYO—Abilene, Texas 250, 100
WSPA—Spartansburg, N. C. 250, 100
KICK—Red Oak, Iowa 100
WIAS—Ottumwa, Iowa 100
WLBF—Kansas City, Kans. 100
WMBH—Joplin, Mo. 250, 100
KLPM—Minot, N. D. 100
WEHS—Evanston, Ill. (WKBI, WHFC) 100
WHFC—Cicero, Ill. (WKBI, WEHS) 100
WKBI—Chicago, Ill. (WHFC, WEHS) 50
KFIZ—Fon du Lac, Wis. 100
KFXY—Flagstaff, Ariz. 100
KGIX—Las Vegas, Nev. 100
KFQU—Holy City, Calif. (KGGC) 100
KFXD—Jerome, Idaho 50
KGIW—Trinidad, Colo. 100
KGKX—Sandpoint, Idaho 100
KGGC—San Francisco, Calif. (KFQU) 50
KBPS—Portland, Ore. 100
KXL—Portland, Oregon (KFIF) 100
KORE—Eugene, Ore. 100
KFQW—Seattle, Wash. 100

1430 KILOCYCLES, 209.7 METERS

WHP—Harrisburg, Pa. (WBAK, WCAH) 500
T—Lemoyne, Pa.
WBAK—Harrisburg, Pa. (WHP, WCAH) ....1 Kw., 500
WCAH—Columbus, Ohio (WHP, WBAK) 500
C. P. to incr. pr. to 1 Kw.
WGBC—Memphis, Tenn. (WNBR) 500
KGNF—North Platte, Nebraska 500
(C. P. only)
WNBR—Memphis, Tenn. (WGBC) 500
KECA—Los Angeles, Calif. ....1 Kw.

1440 KILOCYCLES, 208.2 METERS

WHEC-WABO—Rochester, N .Y. (WOKO) 500
WOKO—Poughkeepsie, N. Y. (WHEC-WABO).500
T—Mt. Beacon, N. Y.
WCBA—Allentown, Pa. (WSAN) 250
WSAN—Allentown, Pa. (WCBA) 250
WBIG—Greensboro, N. C. 500
WTAD—Quincy, Ill. (WMBD) 500
WMBD—Peoria Hgts., Ill. (WTAD) ....1 Kw., 500
KLS—Oakland, Calif. 250

1450 KILOCYCLES, 206.8 METERS

WBMS—Hackensack, N. J. (See Note) 250
WHOM—Jersey City, N. J. (WBMS, WNJ, WKBO) 250
WNJ—Newark, N. J. 250
WKBO—Jersey City, N. J. 250
WSAR—Fall River, Mass. 250
(Note: WBMS, WNJ, WIBS and WKBO divide time with each other)
WCSO—Springfield, Ohio (WFJC) 500
WFJC—Akron, Ohio (WCSO) 500
*WGAR—Cleveland, Ohio (C. P. only) 500
(*This station when completed will replace Station WFJC and former Station WCSO.)
WTFI—Toccoa, Ga. 500
KTBS—Shreveport, La. ....1 Kw.

1460 KILOCYCLES, 205.4 METERS

WJSV—Mt. Vernon Hills, Va. ....10 Kw.
KSTP—St. Paul, Minn. ....10 Kw.

1470 KILOCYCLES, 204.0 METERS

WTNT—Nashville, Tenn (WLAC) ....5 Kw.
WLAC—Nashville, Tenn. (WTNT) ....5 Kw.
KGA—Spokane, Wash. ....5 Kw.

1480 KILOCYCLES, 202.6 METERS

WKBW—Buffalo, N. Y. ....5 Kw.
T—Amherst, N. Y.
KFJF—Oklahoma City, Okla. ....5 Kw.

1490 KILOCYCLES, 201.2 METERS

WCHI—Chicago, Ill. (WJAZ, WCKY) ....5 Kw.
T—Batavia, Ill.
WCKY—Covington, Ky. ....5 Kw.
WJAZ—Mt. Prospect, Ill. (WORD, WCKY, WCHI) ....5 Kw.

1500 KILOCYCLES, 199.9 METERS

WMBA—Newport, R. I. 100
WLOE—Boston, Mass (WMES) 250, 100
T—Chelsea, Mass.
WNBF—Binghamton, N. Y. 100, 50
(C. P. to incr. pr. to 100 w.)
WMBQ—Brooklyn, N. Y. (WLBX, WCLB, WWRL) 100
WCLB—Long Beach, N. Y. (WLBX, WMBQ, WWRL) 100
WLBX—Long Island City, N. Y. (WMBQ) WCLB, WWRL) 100
WWRL—Woodside, N. Y. (WMBQ, WLBX, WCLB) 100
WSYB—Rutland, Va. 100
(C. P. only)
WKBZ—Ludington, Mich. 50
WMPC—Lapeer, Mich. 100
WPEN—Philadelphia, Pa. 250, 100
WMBJ—Penntownship, Pa. 100
WDIX—Tupelo, Miss. 100
WOPI—Bristol, Tenn. 100
WRDW—Augusta, Ga., (C. P. only) 100
KGKY—Scottsbluff, Nebr. 100
WKBV—Connorsville, Ind. 150, 100
KGFI—Corpus Christi, Tex. 100
KUT—Austin, Texas 100
KGKB—Brownwood, Texas 100
KPJM—Prescott, Ariz. 100
KXO—El Centro, Cal. 100
KVEP—Portland, Ore. 15
KDB—Santa Barbara, Calif. 100
KREG—Santa Ana, Calif. 100
KUJ—Long View, Wash. 100
(½ time)
KGMD—Roswell, N. M. 100
KGFK—Moorhead, Minn 50
(C. P. only)
KGIZ—Grant City, Mo. 50
KPQ—Wenatchee, Wash. 100

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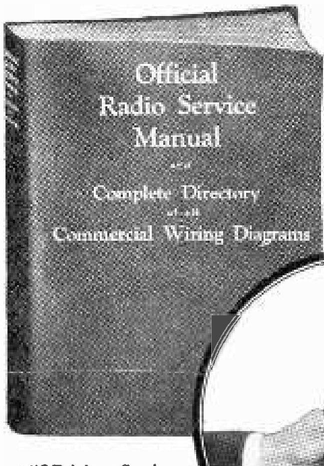

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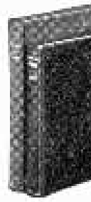

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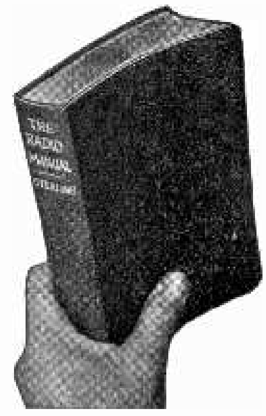

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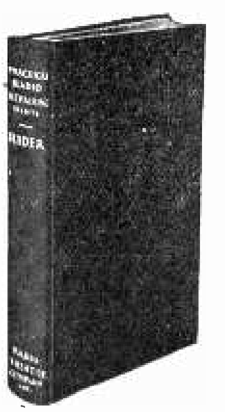

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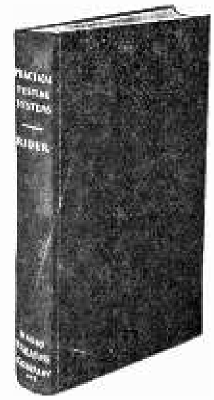

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Image inerference is discussed in detail and methods given by which it may be reduced.

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(Cat. 2-R3)—Same as 2-R5, except that it is for .00035 mfd. tuning .... .60
(Cat. 5-TP)—Radio frequency transformer for use where primary is tuned and placed in plate circuit of screen grid tube, while secondary is not tuned. For .0005 mfd. .... .55
(Cat. 3-TP)—Same as Cat. 5-TP, except that it is for .00035 mfd. tuning .... .55
(Cat. RF-5)—Radio frequency transformer for .0005 mfd. tuning, where untuned primary is in plate circuit of any type tube except screen grid. Useful also as antenna coupler .... .55
(Cat. RF-3)—Same as Cat. RF-5, except that it is for .00035 mfd. tuning .... .55

RADIO FREQUENCY CHOKES

(Cat. 50-MLH)—A radio frequency choke coil for filtration in broadcast use, as in screen or plate leads, particularly detector plate, or in the output (plate circuit) of a short-wave converter. Mounting bracket supplied. Not shielded .... .47
(Cat. QML)—A radio frequency choke for short-wave work only. Inductance, ¼ millihenry. Wound on ⅝" diameter bakelite rod, with connecting lugs at end, and mounting bracket .... .47

FILTER AND BY-PASS CONDENSERS

(Cat. HV-1)—Compact 1 mfd. filter condenser, for use in filter section of any B supply intended to work 245 tubes, single or push-pull, and rest of tubes in receiver $1.50
(Cat. HV-2)—Compact 2 mfd. condenser for 245 B supply 2.50
(Cat. AVX-8)—Compact 8 mfd. Aerovox dry electrolytic condenser with mounting bracket, for 245 B supply 1.50
(Cat. LV-1)—1 mfd. low-voltage condenser for by-passing. 200 v. DC rating .... .50
(Cat. LV-2)—2 mfd. low-voltage condenser for by-passing. 200 v. DC rating 1.00
(Cat. LV-4)—4 mfd. low-voltage condenser for by-passing. 200 v. DC rating 2.00
(Cat. SUP-31)—Three 0.1 mfd. bypass condensers in one compact case. 200 v. DC rating .... .57

KNOBS AND DIALS

(Cat. KNB-2)—2-inch diameter moulded bakelite black knob, no pointer; ¼" shaft .... .18
(Cat. KNB-15)—1½" diameter moulded bakelite black knob, no pointer; ¼" shaft .... .16
(Cat. KNW-15)—1½" diameter moulded bakelite walnut knob, with pointer; ¼" shaft .... .18
(Cat. MCD)—Marco vernier dial; moulded bakelite; black; pilot light window .... .60
(Cat. NAT-H)—National velvet vernier drum dial, type H, with modernistic escutcheon, color wheel (rainbow feature) 3.13
(Cat. NAT-G)—National velvet vernier flat type dial, for use when tuning condenser shaft is at right angles to the front panel; modernistic dial; single color projection 2.05
(Cat. NAT-VBD)—National velvet vernier black moulded bakelite circular dial, variable ratio lever, 6-1 to 20-1; reads 0-100-0; with dial light and bracket 1.70

BLUEPRINTS

(Cat. BP-3A)—Blueprint of three-tube Supertone short-wave converter, using 227 tubes; filament transformer external; coil winding data, list of parts, schematic diagram included .... .25
(Cat. BP-3B)—Blueprint of the battery model of above, with 227 heaters in series .... .25
(Cat. BP-DLC)—Blueprint of DeLuxe short wave converter, using two National VBD dials, two Hammarlund SFL .0005, precision plug-in coils .... .25
(Cat. BP-33)—Blueprint of the HB-33, seven-tube screen-grid battery set, using 222s for RF, push-pull 171A output .... .25
(Cat. BP-44)—Blueprint of the HB-44, eight-tube AC screen-grid set, 245 push-pull output; screen-grid power detector .... .25
(Cat. BP-SGD-4)—Blueprint of 4-tube battery Diamond of the Air, one stage RF 222, regenerative detector, two transformer audio .... .25
(Cat. BP-PPBD)—Blueprint of 5-tube battery Diamond. Extra tube due to push-pull output, either 112A or 171A .... .25
(Cat. BP-DBX)—Blueprint of 4-tube Diamond, for AC operation, screen-grid RF; no B supply, as 180-volt B eliminator is to be used .... .25
(Cat. BP-UNB)—Blueprint of 4-tube Universal, with 222 RF; battery operation .... .25
(Cat. BP-LIB)—Blueprint library of AC hookups .... .25

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GUARANTY RADIO GOODS CO.
143 West 45th Street, New York, N. Y.
Enclosed please find $.............. for which please ship at once the following:

☐	SGT-5	@	90c	☐	SUP-31	@	57c
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☐	5-HT	@	95c	☐	KNB-15	@	16c
☐	3-HT	@	95c	☐	KNW-15	@	18c
☐	T-5	@	80c	☐	MCD	@	60c
☐	T-3	@	80c	☐	NAT-H	@	3.13
☐	2-R5	@	60c	☐	NAT-G	@	2.05
☐	2-R3	@	60c	☐	NAT-VBD	@	1.70
☐	5-TP	@	55c	☐	BP-3A	@	25c
☐	3-TP	@	55c	☐	BP-3B	@	25c
☐	RF-5	@	55c	☐	BP-DLC	@	25c
☐	RF-3	@	55c	☐	BP-33	@	25c
☐	50-MLH	@	47c	☐	BP-14	@	25c
☐	QML	@	47c	☐	BP-SDG4	@	25c
☐	HV-1	@	1.50	☐	BP-PPBD	@	25c
☐	HV-2	@	2.50	☐	BP-DBX	@	25c
☐	AVX-8	@	1.50	☐	BP-UNB	@	25c
☐	LV-1	@	50c	☐	BP-LIB	@	25c
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☐	LV-4	@	2.00				

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BARGAINS

in High-Grade Standard Parts

"A" ELIMINATOR PARTS

Choke coil, to filter out the hum. Wound with No. 16 wire on secondary. Husky choke. Only one needed. Will pass 3 amperes. In shielded case. Cat. AECH @ $5.50
Westinghouse Rectox metal disc rectifier, to pass 2 amperes, or connect rectifiers in parallel to pass 4 amperes; mounting brackets. Cat. WRX @ $1.95
Jefferson transformer, 110 v. 50-60 cycle primary; 12 volts, no load; 9 volts when used full load on Rectox rectifier; DC voltage at full load, 7 volts. Cat. J-12V @ $1.65
Dry electrolytic condenser, 1,500 mfd. (two required). Cat. DRL @ $3.25
Steel cabinet, 12" long x 9" front to back x 9" high; cutout for bakelite binding post strip. Cat. SCAB @ $1.25

TESTOLIGHT

Neon lamp in bakelite housing with two test prods. Tells whether voltage is AC or DC, and if DC which side is negative. Finds shorts and opens. Full directions. Cat. TSTL @ 99c

CABLE AND PLUG

Five-lead cable with 5-prong plug attached that fits into UY socket. Useful as a connector of set voltages or for short-wave adapters. Cat. CPG @ 62c

HOOKUP WIRE

10-strand genuine copper wire (not steel or alloys), with rubber insulation above which is ornamental fabric insulation. Best hookup wire for sets. Insolation good for 1,000 volts or more. Available in five different types: blue, brown, red with black marker, blue with white marker, green. Cat. HW (specify color). 12 ft. lengths @ .. 41c

RESISTORS

Grid leaks 5 meg., 2 meg., ¼ meg., 1 meg., 5,000 ohms (specify which). Cat. CGL % 11c
Filament ballasts: 4 ohm for one 201A, 112A, 200A, 240A, 171A; 2 ohm for two 201A, 112A, 200A, 240 or 171A, or for one 171 or 112 Mounting supplied. (Specify which.) Cat. FB @ 11c
Wire-wound resistors: 1 ohm, 1-3/10 ohm, 6-5/10 ohms; 30 ohms; 50 ohms. (Specify which.) No mounting supplied or needed. Cat. WWR @ 16c
30-ohm rheostat with battery switch attached. Cat. 30RH @ 65c
75-ohm rheostat with battery switch attached. Cat. 75RH @ 65c
25,000 ohm potentiometer, wire-wound; Electrad Tonatrol. Will pass 30 ma. Excellent volume control or for tone control in series with .3 mfd. condenser. Cat. ELTT @ 99c
30,000 ohm wire-wound clarostat potentiometer with AC switch attached. Cat. CLSA @ $1.25
Variable voltage divider; 10,000 ohms; will pass 100 ma; eight sliders and fixed terminal connections; mounting bracket. Cat. VVD @ $1.49

CONDUCTORS

2 ampere fuse, cartridge type, for fusing AC line entering receiver; with fuse holder. Cat. 2AFH @ 25c

GRID CLIPS

Grid clip for connection to control grid of screen grid tube. Cat. GC @ .... $.04

GUARANTY RADIO GOODS CO.
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Enclosed find $.............. for which ship at once:

☐	Cat.	AECH	@	$5.50	☐	Cat.	FB *	@	11c
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☐	Cat.	DRL	@	3.25	☐	Cat.	75RH	@	65c
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☐	Cat.	TSTL	@	99c	☐	Cat.	CLSA	@	1.25
☐	Cat.	CPG	@	62c	☐	Cat.	VVD	@	1.49
☐	Cat.	HW	@	41c	☐	Cat.	2AFH	@	25c
☐	Cat.	CGL	@	11c	☐	Cat.	GC	@	4c

*Specify which ....

Name ....

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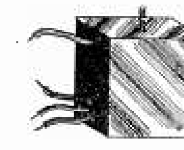
Three 0.1 mfd. in One Case


Cat. SUP-31

Three Supertone non-inductive fixed condensers of 0.1 mfd. each, (250 v.) in steel case, provided with a 6/32 mounting screw, built in. The black lead is common to the three condensers, the three red leads are the other sides of the respective capacities. Size, 1¼" square by ⅞" wide. Order Cat. SUP-31, list price, $1.00; net price, 57c.

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SURPLUS SPECIALS

ALLEN PHONOGRAPH MOTOR

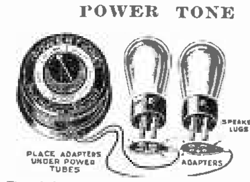
The Allen Synchronous Induction Motor, is a sturdy compact motor only 1¼" thick with dependability and stamina that makes it a marvel of engineering. It starts and stops at the mere touch of a finger. It revolves at exactly 80 revolutions per minute regardless of voltage fluctuations. It is impossible for the Allen to set up disturbances of any sort in the receiver. The Allen motor is so favorably priced that now you can easily afford to make a combination of your radio. **Price of the Allen Motor complete with turntable and mounting parts $4.25**

WEBSTER PHONOGRAPH PICK-UP

With Volume Control

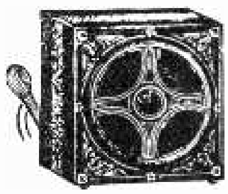
The Webster Electric Pick-up will faithfully reproduce all frequencies now recorded on the best electrically cut records. Remarkable clearness and volume and freedom from any objectionable noises when playing any type record, are features that prove scientifically correct design of this Webster Pick-up. A volume control is built into the base of the pickup allowing a full range of volume control. The Webster Electric pick-up illustrated consists of the volume control base, cantilever supporting arm, pick-up head and mounting hardware. Finished in antique bronze.
List, $17.50 **Price, $5.95**

POWER TONE REGULATOR



The Powertone Tone Regulator is not just another tone control but embodies features of design that make it a real control. Control is actuated on the grids of the power tubes instead of on the plates. Control on the grids is more satisfactory as it gives a larger degree of tone regulation. Provision is made to allow the connection of extra speakers. This is a real convenience and a distinct Powertone feature. Available in table and panel mounting styles, and for push-pull output and single power stage. Power Tone Regulator in panel or table model, adopters only 75c per pair.
For push-pull stage .... Price, $1.95
For Single power stage .... Price, $1.25
(Panel mount type.)

DUO-ART SPEAKER

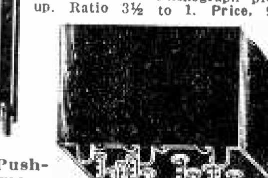


This magnetic speaker uses the famed Duo-Magnetic Speaker unit. This double oversize unit will handle an output of more than 10 watts without blasting or distortion. The diameter of the cone is 9" assuring splendid reproduction of the low notes. The cabinet is acoustically designed for use with the Duo-Magnetic unit. It is finished in a polychrome art finish and is a distinct asset to any receiver. The speaker also makes a wonderful reproducer for use with automobile receivers. **Price, $4.95**

R. C. A. REPLACEMENT PARTS

R. C. A. Victor Audio Transformers

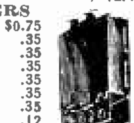
This is a first stage audio transformer for replacement in all Victor sets. It will, however, give fine results in any receiver. Electrostatically shielded, and has a winding for a Phonograph pick-up. Ratio 3½ to 1. **Price, 93c**



R. C. A. Victor Push-Pull Transformer

This is a push-pull unit for Victor replacements, but makes a fine push-pull transformer unit in any receiver. Has output transformer built in for connection to the voice coil of any dynamic speaker. Can be used with 171A, 245, 210, or 250 type tubes. Electrostatically shielded. **Price, $2.45**

MULTI CONDENSERS

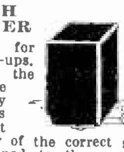


20	1, ½, 1/10, 1/10, 1/10	$0.75
21	.05, .05, .05	.35
22	1/10, 1/10, 1/10	.35
23	1/10, 1/10	.35
24	¼, C, ¼	.35
25	1 Mfd. 600 V.	.35
26	.1, .5, 600 V.	.35
27	.002, 600 V.	.12

R. C. A. CHASSIS

This Chassis is identical with that used in the RCA model 100A - 100B - 103 Speakers. This speaker has built-in output filter and will stand 450 volts without "blast" or distortion. The metal frame is lined with a special self baffling material and the cone surface is corrugated enhancing the tonal reproduction. This Chassis is also ideal for automobile installation ...... **Price, $3.75**

PHONOGRAPH SCRATCH FILTER



This is a necessity for all phonograph pick-ups. The noise made by the needle as it rides in the record groove is amplified and appears as a scratchy sound. The B. B. L. scratch filter has been designed to suppress this noise. It consists of an impedance and condenser of the correct size connected together to form a trap tuned to the scratch frequency. This attenuates the scratch, and gives cleaner and more perfect reproduction. The filter is mounted in a metal case ¾" square by 1¼" high. A tap is provided to match it to different type pick-ups .... **Price, 35c**

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