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RADIO WORLD

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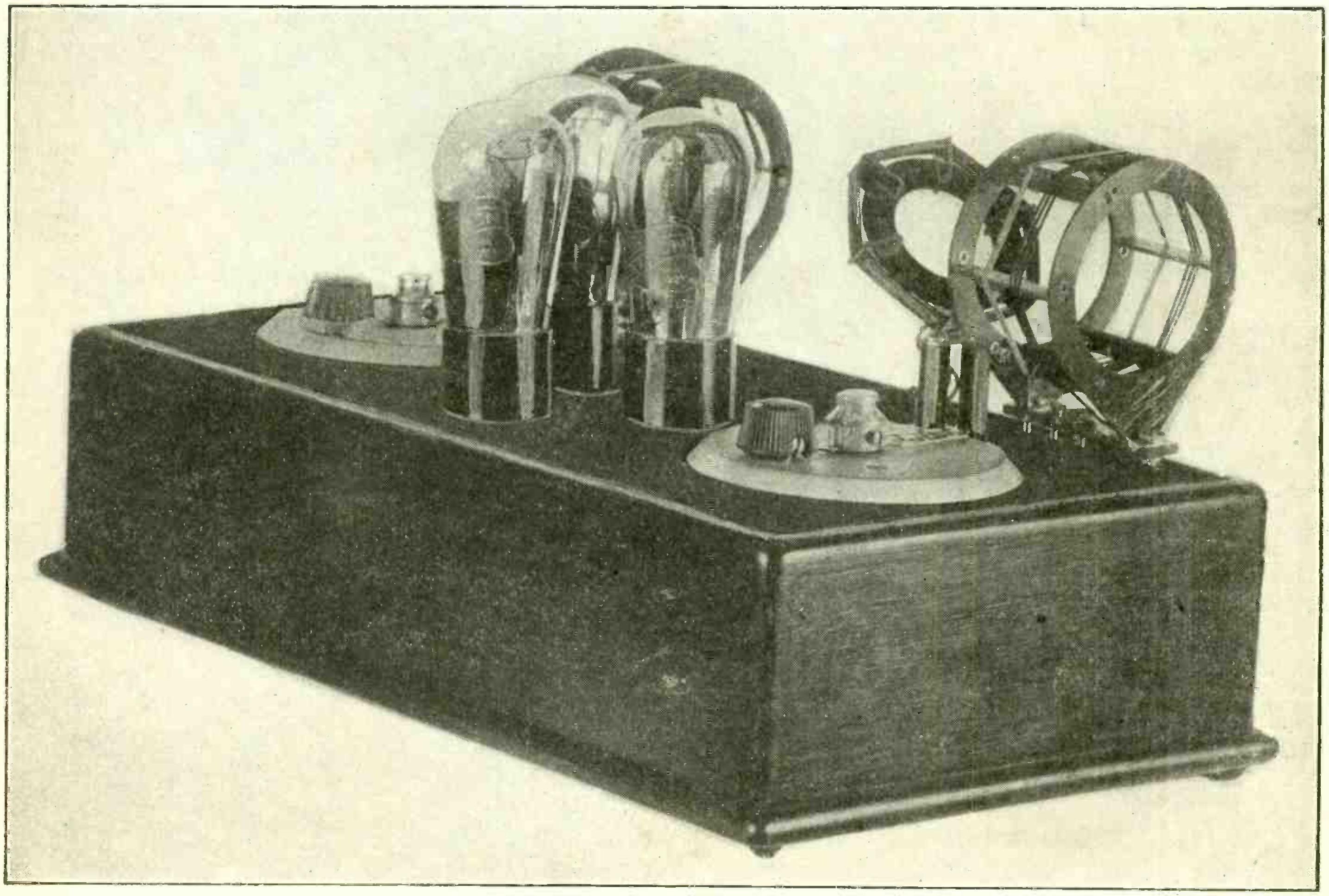
The First and Only National Radio Weekly

464th Consecutive Issue—NINTH YEAR

PICTURE DIAGRAM OF $10 CONVERTER

How to Measure Resistance

MIDGET SHORT-WAVE SET



Chosen for fine sensitivity, the circuit used in the midget short-wave set, for AC or battery operation, is either or adapter. See article on page 5 and 6.

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

The New 2-Volt Tubes at $1.00

THE new 2-volt tubes are the 230 general purpose tube, the 231 power tube and the 232 screen grid tube. They are principally for battery operation. Due to low current drain they are a boon to all who use battery-operated receivers. The Rextron 2-volt tubes are subject to a money-back guarantee as stated below, and are priced at only $1.00 each.

231 Power Tube

The 230 and 232 draw .06 ampere filament current each (60 milliamperes), and each requires about 65 ohms to drop a 6-volt source to 2 volts for filament, or 15 ohms to drop a 3-volt source to 2 volts. The characteristics follows:

230 General Purpose Tube

Filament voltage	2 volts
Filament current	.06 amp.
Plate voltage	90 volts
Plate current (amplifier)	2 m.a.
Amplifier bias	4½ volts
Detector bias	9 volts
Amplification constant	8.8
Output resistance	12,500 ohms

232 SCREEN GRID TUBE

Filament voltage	2 volts
Filament current	.06 ampere
Plate voltage	135 volts
Plate current (amplifier)	1.5 milliamperes
Screen voltage	45 volts
Amplifier bias	3 volts
Detector bias	6 volts
Amplification constant	440
Plate resistance	800.000 ohms

231 POWER TUBE

Filament voltage	2 volts
Filament current	.13 ampere
Plate voltage	135 volts
Plate current	8 ma.
Amplifier bias	22.5 volts
Plate resistance	4.000 ohms
Amplification constant	3.5

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THE economic depression and resultant predicament of some tube manufacturers have resulted in the dumping on the market of tubes of inferior calibre, tubes that failed in the factory test for "firsts," and were sold to distress merchandise operators "as is" at a few cents apiece. These tubes often are in private brand cartons, but do not bear the name of the real manufacturer.

Rextron tubes are made by Rextron.

The estimate a manufacturer places on his tubes in the present chaotic tube market is well measured by the guarantee that backs up the tube. Replacement guarantees are encouraging but not conclusive. Nothing less than "money-back" will do now. Rextron tubes are sold on a 10-DAY MONEY-BACK GUARANTEE. Use them ten days. If not fully satisfied, return the tubes and your money will be refunded at once.

Each tube is packed in an especially rugged and secure carton with "Holed-Tight" safety wrapper inside, as precaution against damage in transit. We — NOT YOU — run the damage risk.

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232	1.00	245	1.00
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171 (for AC)	1.00	226	1.00
112A	1.00	280	1.00
112 (for AC)	1.00	281	2.95
201A	1.00		
240	1.00		
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☐ 240 ☐ UX-199 ☐ UV-199 ☐ 120 ☐ WD-12 ☐ 200A ☐ 224 ☐ 245
☐ 226 ☐ 280 ☐ 222 ☐ 210 ☐ 250 ☐ 281 ☐ Telion ☐ Photo cell

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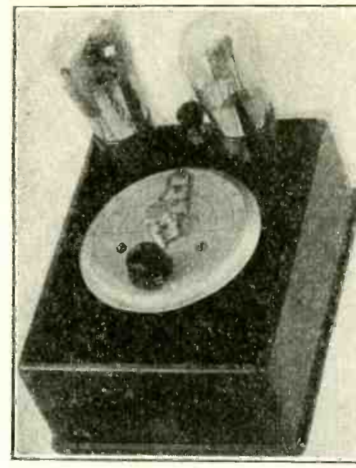
THE RADEX PRESS
1368 E. 6th St. Cleveland, Ohio

RC-27 Converter



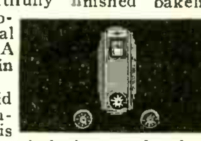
EXTREMELY high sensitivity is achieved in the very latest short-wave converter, Cat. RC-27, using two 227 tubes and one tuned circuit, with the new Hammarlund Junior midline condenser, covering 20-135 meters without plug-in coils. A coil switch changes the wave band. Used with any fairly good receiver, this AC Model converter penetrates uncanny distance, as users report direct reception of European and South American transmitters.

All parts, exactly as specified by Herman Bernard (less tubes), order Cat. RC-27 @ **$10.00**

Wired model (less tubes), order Cat. RC-27-W @ **$12.00**

The 1-A Unit

THE de luxe model all-wave converter tunes from 15 to 600 meters, using two tuned circuits, with a Hammarlund condenser in each. This model, the 1-A Unit, consists of a beautifully finished bakelite front panel and sub-panel, with National modernistic dial. A total of five plug-in coils is used.



Three screen grid tubes are used. Filament transformer is built-in, while AC switch is on the front panel.

The assembly is totally rigid and self-supporting, requiring no cabinet.

This model is of the very finest type, and gives you the advantage of triple screen grid in a deluxe assembly.

All parts, including filament transformer and coils, but not tubes, order Cat. 1-A, @ **$19.87**

Wired model, Cat. 1-AW, @.......... **$22.87**

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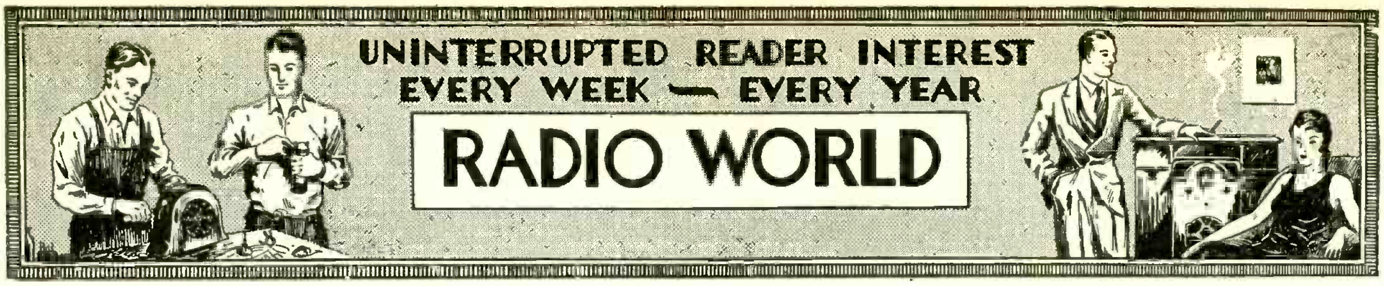

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RADIO WORLD, owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th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

Short-Wave Midgets

By Henry B. Herman

THE three diagrams, showing three-tube circuits for short-wave reception, using precision type de luxe plug-in coils, constitute an assembly that is both a short-wave receiver and a short-wave adapter. When used as an adapter, the device is connected to the plate of the detector or the plate of the first audio tube. But the uncertainties associated without cutting into an "unknown" circuit are removed, since no dependance is placed on the receiver's detector voltage for regeneration.

As those familiar with adapters well know, when they work they work very well indeed, but there is no assurance that they will work with all types of receivers. This is because detectors are circuited differently, and only when conditions are ripe to permit regeneration will you obtain short-wave results. Such conditions do not always prevail, therefore one can not recommend unreservedly adapters that plug into the detector socket and depend for regeneration on the plate voltage thus obtained.

Consider the diagrams as receivers. There are a stage of tuned radio frequency amplification, leak-condenser detector of the power type, and a stage of resistance-coupled audio. Therefore headphone reception will be strong and clear, but it will be impossible to work a speaker, except on loud code.

Thus, when the circuit is used as a receiver the output goes to the phones. When worked as an adapter the plate of the last tube is the output lead and goes to the plate of the detector or first audio tube of a broadcast set. In that instance the lead running from B plus 50 volts to a binding post, shown in the diagram, is not used, as the B voltage is furnished to the plate of the last tube of the adapter through the primary of an audio transformer, or through some other audio plate load in the broadcast set.

The B voltage for the two other tubes is furnished independently, either from the receiver, or from separate B batteries, in which instance 45 volts of B battery may be used, with negative of B connected to A minus.

Bias Considerations

It will be seen there are two battery-operated models. One uses three 227 tubes, with heaters in series, and the other three 230 tubes, with filaments in series. For these series connections the supply voltage is a 6 volt storage battery.

In the case of the 230 tube circuit, the biases are obtained from voltage drops in the filaments. For instance, Fig. 2 shows A minus going to the negative filament of the detector, so when the detector grid is returned to negative filament the bias is zero. The next tube in the series filament chain is the radio frequency amplifier. When the grid is returned to negative A, then the grid is negative in respect to negative filament by the voltage drop in the filament of the preceding tube, which is 2 volts. Likewise, the first audio tube is negatively biased by the voltage drop in the filaments of the two preceding tubes, or 4 volts.

With the Fig. 1 battery model, 227 tubes are used with heaters in series, affording 2 volts to each heater, which is sufficient for good operation. Here, however, the heaters do not affect the bias in any way, so independent biasing resistors are used.

The third model is the one for AC operation, and has the same general circuit as the others, but there is a filament transformer built in. Thus only the B voltage need be obtained from a broadcast receiver, or a 45-volt B battery may be used.

Data on Circuit

There are two independently tuned circuits in all three designs, and each consists of a de luxe precision plug-in coil, wound on 97 per cent. air dielectric, and a Hammarlund .0002 mfd. junior midline condenser, especially compact, for short-wave work, and turning in a 2-inch diameter.

The tuned secondaries of the coils are wound of No. 18 enamel wire, while the primary windings are easily distinguishable because of their different appearance, and the use of silk-covered wire. The tickler winding may be an adjustable coil, as illustrated, or

(*Continued on next page*)

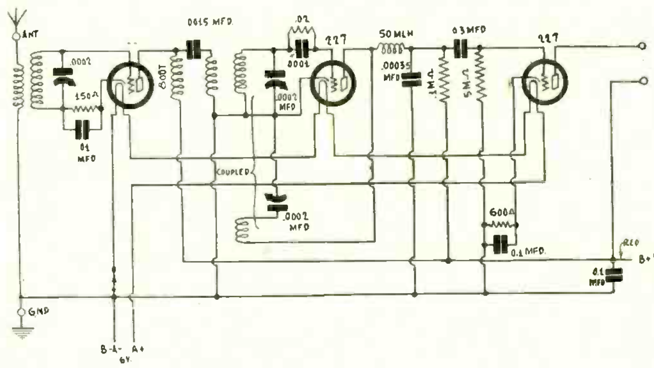


Fig. 1
Three 227 tubes are used with heaters in series in this combination adapter-receiver for short-wave reception, for battery operation.

LIST OF PARTS

For Fig. 1.

One set of precision de luxe coils (six coils and one tickler, total 7 coils; no base receptacle needed, as it is on panel).
One 800-turn duolateral wound radio frequency choke coil.
One 50 mlh. RF choke coil.

Condensers

Three Hammarlund .0002 mfd. short-wave midline junior tuning condensers.
Three fixed condenser blocks, three condensers of 0.1 mfd. in each block.
One Hammarlund equalizer (100 mmfd.).
One .00035 mfd. fixed condenser.

Resistors

One 150 ohm Electrad flexible biasing wire-wound resistor.
One 600 ohm Frost wire-wound resistor.
One Lynch .02 meg. pigtail metallized resistor.
One Lynch 0.1 meg. pigtail metallized resistor.
One Lynch 5.0 meg. pigtail metallized resistor.

Other Parts

One Hart & Hegeman shaft type switch.
Two knobs for switch and feedback condenser.
Two Ultra-Vernier REL dials.
One 7x14-inch bakelite drilled panel.
One walnut-finish midget cabinet to fit.
Three five-prong sockets.
Two wire leads for antenna and ground.
One wire lead for B plus.
One twin assembly for plugging in phones.
One dozen small nickel-plated 6/32 nuts, and one dozen ½-inch nickel plated round-head 6/32 machine screws.

Same Set Is Adapter-Receiver

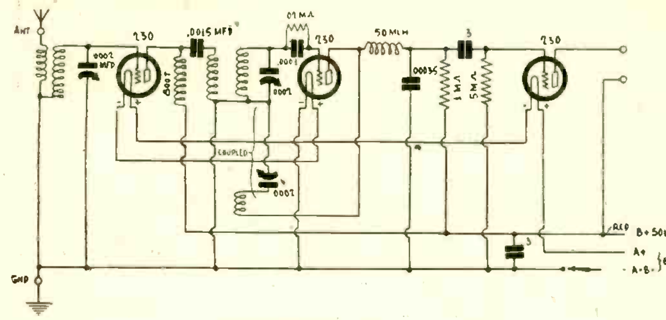


Fig. 2
Filaments are in series in this design, which is the same essential circuit, using the new 2-volt tubes.

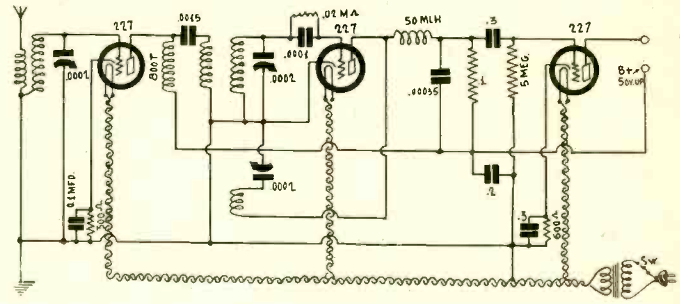


Fig. 3
The AC model has a filament transformer built in.

Directions for Connections

THE designs shown in Figs. 1, 2 and 3 permit the use of the circuit either as a short-wave adapter, for speaker operation, or as a short-wave receiver for headphone use. The only difference is in the output connections.

For earphone use, connect as shown in the diagrams. Place phones from plate of the audio tube to B plus 50 volts or more. For speaker use, an extra audio amplifier is necessary, so the audio channel of a broadcast receiver may be used. To utilize the full audio channel of the broadcast set, connect plate of the short-wave circuit's audio tube to plate of the broadcast set's detector socket from which tube is removed. A tip jack plug will make the connection directly through top of the socket.

it may be wound on the same form as the two other windings of the detector or input coil. The circuit connections are such that five different terminals are required for the detector coil, and three for the antenna coil. However, the coil bases would have the same nmuber of prongs, only in the case of the antenna coil not all the prongs are used.

Regeneration is obtained by capacity feedback. Perhaps you will fail to obtain regeneration. If so, reverse the connections of the tickler coil, putting to plate of detector the terminal that went to the stator of the regeneration condenser, and to the stator of the regeneration condenser the connection that went to plate. The circuit will work, even if there is no regeneration, but to cover great distances, and have the set sensitive enough and selective enough to receive directly many European, South American and Canadian stations, regeneration is necessary.

Covers 15 to 175 Meters

Despite the use of de luxe parts of finest workmanship, the whole outfit in any instance costs relatively little, even though it is housed in a handsome walnut-finish wooden cabinet of midget proportions (7x14-inch panel). Parts for the AC model should not cost more than $20, while those for the battery models not more than $18, not including tubes.

The wavelength coverage will be from about 15 meters to 175 meters, which includes all the worth-while parts of the short-wave spectrum. The coils total five, including the tickler as the seventh, except that two extra coils may be used to permit broadcast band coverage.

The dials track nicely, which is a great aid, especially in short-wave reception. This advantage is possible because identical tuned circuits are used with identical capacities to tune in the same frequently at the same time, as distinguished from converters, where the oscillator has to tune in a different frequency than the one transmitted by the station desired to be received.

The coil diameter is an odd one, but is about 3 inches. The respective secondaries consist of 3 and 19 turns respectively. The primaries may consist of five turns for the same smallest coil, using No. 24 single silk covered wire, and 10 turns for the next. The number of secondary turns alone is important. Variation in the number of primary turns is not of much importance, within reasonable limits. The tickler winding may consist of 10 turns, on an adjustable form.

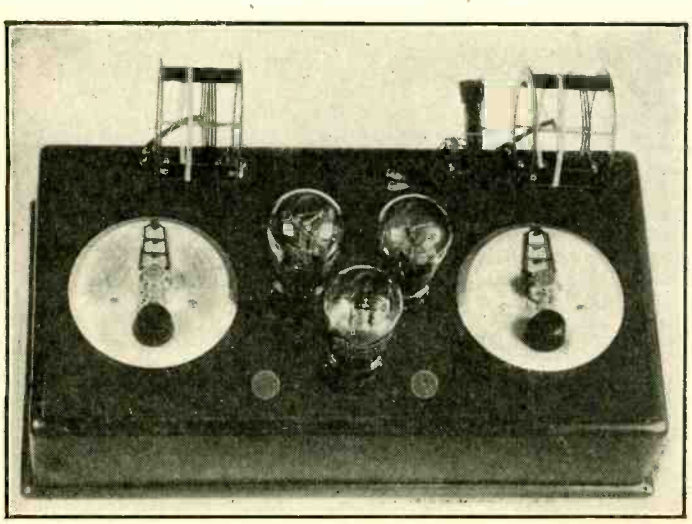


Fig. 4
Top view of the midget short-wave receiver-adapter. The external appearance of all models is the same.

LIST OF PARTS
For Fig. 3

Coils

One set of precision de luxe coils (six coils and one tickler, total 7 coils; no base receptacle needed, as it is on panel).
One 800-turn duolateral wound radio frequency choke coil.
One 50 mlh. RF choke coil.
One Polo 2½ volt filament transformer.

Condensers

Three Hammarlund .0002 mfd. short-wave midline junior tuning condensers.
Three fixed condenser blocks, three condensers of 0.1 mfd. in each block.
One Hammarlund equalizer (100 mmfd.).
One .00035 mfd. fixed condenser.

Resistors

One 300 ohm Electrad flexible biasing wire-wound resistor.
One 600 ohm Frost wire-wound resistor.
One Lynch .02 meg. pigtail metallized resistor.
One Lynch 0.1 meg. pigtail metallized resistor.
One Lynch 5.0 meg. pigtail metallized resistor.

Other Parts

One Hart & Hegeman shaft type switch.
Two knobs for switch and feedback condenser.
Two Ultra-Vernier REL dials.
One 7x14-inch bakelite drilled panel.
One walnut-finish midget cabinet to fit.
Three five-prong sockets.
Two wire leads for antenna and ground.
One wire lead for B plus.
One twin assembly for plugging in phones.
One dozen small nickel-plated 6/32 nuts, and one dozen ½-inch nickel plated round-head 6/32 machine screws.

RC-27 Converter Wiring

How to Mount the Parts, Wind the Coil and Establish Connections

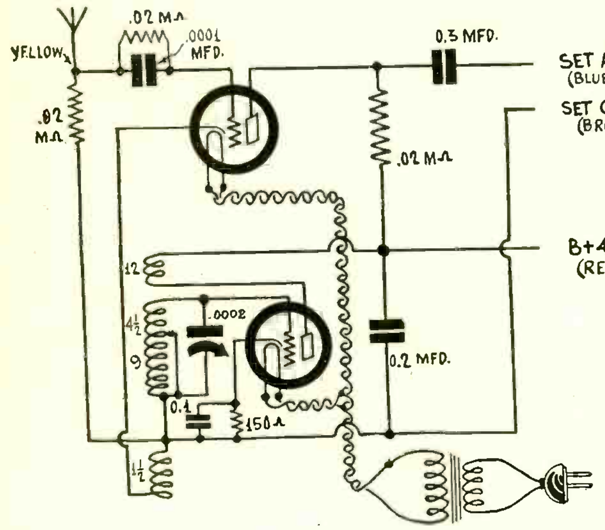


Fig. 1
The Schematic Diagram

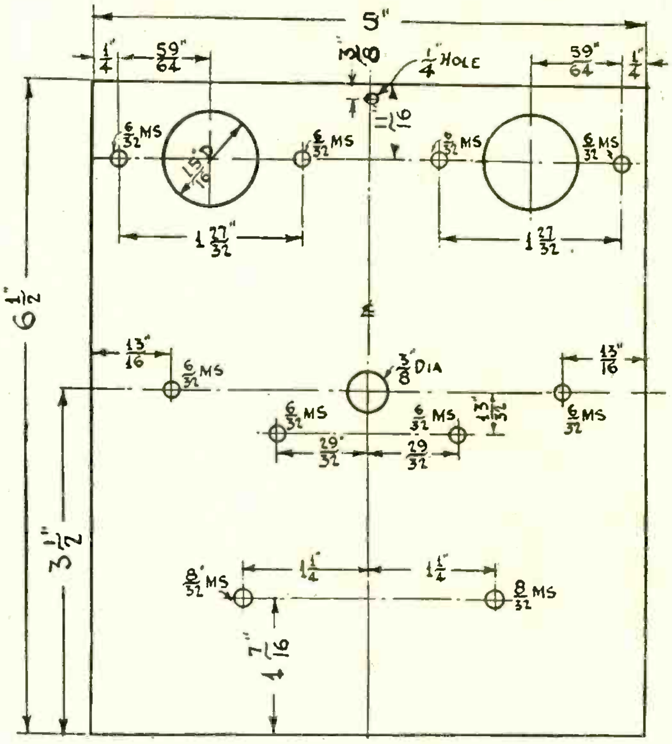


Fig. 2
Dimensions for Panel

USING only two tubes and single tuning control, remarkable sensitivity may be developed with the RC-27 short-wave converter, with a tuning range of from 20 to 135 meters. What the selectivity will be will depend largely on the receiver with which the converter is worked, but any receiver that is even passably selective for broadcast use will be adequate for the converter. Although the converter is AC-operated, it may be used with any type of set, whether AC or battery-operated, tuned radio frequency or superheterodyne.

Having gathered together the parts for the construction of this highly sensitive model, as listed on this page, first mount the two condenser blocks on the panel, using two small holes on the same alignment as the large hole for the tuning condenser. The condenser blocks referred to are in small shield cases, and have a built-in 6/32 screw extruded. This screw is put through the drilled panel holes, and a small nickel-plated 6/32 nut is tightened down against it. Thus the condenser blocks are firmly affixed to the panel.

If small nuts are used, as recommended, then the dial will not strike either the nut or screw.

Mounting the Tuning Condenser

Next mount the Hammarlund junior midline condenser, which has a capacity of .0002 mfd., and swings in a diameter of only 2 inches. Due to the short swing diameter, the condenser rotor plates will clear the shields of the fixed condenser blocks very nicely.

Mount the Hammarlund condenser tight, with bottom of its frame parallel with the bottom line of the panel. This is the end of the panel opposite to the one where the large holes are drilled for the sockets. Turn the condenser in the direction of loosening its mounting firmness, that is, to the left, for an angle of 90 degrees, so that the bottom of the frame of the condenser is parallel with one side of the panel. The reason for this is that one of the holes for mounting the dial is not readily accessible unless the condenser is thus turned out of position.

Now loosen the set-screw of the dial, and place the dial hub onto the shaft of the condenser. The dial hardware includes two 5/32 screws and nuts. Put the screws through the two dial holes intended therefor, and they will be found to penetrate the holes already drilled in the panel for this purpose. Turn down the dial screws against the nuts affixed to the under side, but do not exert much pressure, as if you overdo it, then you will bend the dial frame. The only object of these screws is to keep the scale from turning.

With the dial mounted, turn the condenser back into position. This action of turning the condenser in the tightening direction will result in the same security of mounting as existed prior to the displacement of the condenser.

Bushings Used on Transformer

Next mount the filament transformer. For this purpose two milled bushings are used. These are of brass, ⅝-inch high, and have a bore through them, tapped for 6/32 machine screw. Tighten one such bushing on each of the two protruding screws of the Polo filament transformer. When that is done, the transformer is held against the panel in such a way that the emerging wires from the transformer are close to the tuning condenser. The two thick wire leads are for the heaters, and may seem to be obstructive, but if you will pull them tight to left and right they will sit nicely in the recesses of the transformer's shield case. The two thin leads are for the 110-volt AC input.

First lightly turn down a 6/32 machine screw from the top of the panel to engage one of the milled bushings, then swing the transformer around until the other bushing is exactly over the corresponding mounting hole of the panel. If it is not quite in the right place the trouble is not with the panel holes but with the milled bushing on the transformer, which is on a slight slant. Therefore bend this bushing in the corrective direction, and lightly turn a screw through this also. Now

(Continued on next page)

LIST OF PARTS

Coils

One oscillator coil as described on picture diagram; diameter 1¾ in.; length 1½ in.

One Polo short-wave filament transformer with 6 ft. AC cable and plug separate.

Condensers

One Hammarlund special junior midline short-wave tuning condenser, .0002 mfd.

One Hammarlund 20-100 mmfd. equalizer for use as grid condenser.

Two condenser blocks, three condensers of 0.1 mfd. in each case.

Resistors

Three .02 meg. (20,000 ohm) Lynch metalized pigtail resistors.

One Electrad 150-ohm flexible biasing resistor.

Other Parts

One 5x6½ inch drilled bakelite panel with three UY sockets marked "227."

One cabinet to fit (walnut finish wood).

Three ⅝ inch milled threaded bushings.

One Benjamin switch.

Four wire outleads, 6 ft. long: yellow, blue with yellow tracer, brown and red.

One REL vernier dial, 20-to-1 reduction ratio; dial hardware.

One dozen nickel plated small 6/32 brass nuts, one dozen 6/32 screws ½ inch long.

Picture Diagram of $10

[Data on the RC-27, a two-tube short-wave converter, using 227 tubes, with filament transformer built in, were published last week in the February 7th issue. This week the constructional phase is carried to a conclusion with the publication of textual explanation of mounting and wiring, together with a picture diagram. The performance of this small, inexpensive short-wave converter, using no plug-in coils, but instead of a single coil with a wavelength changing switch, is exceptional indeed.—Editor.]

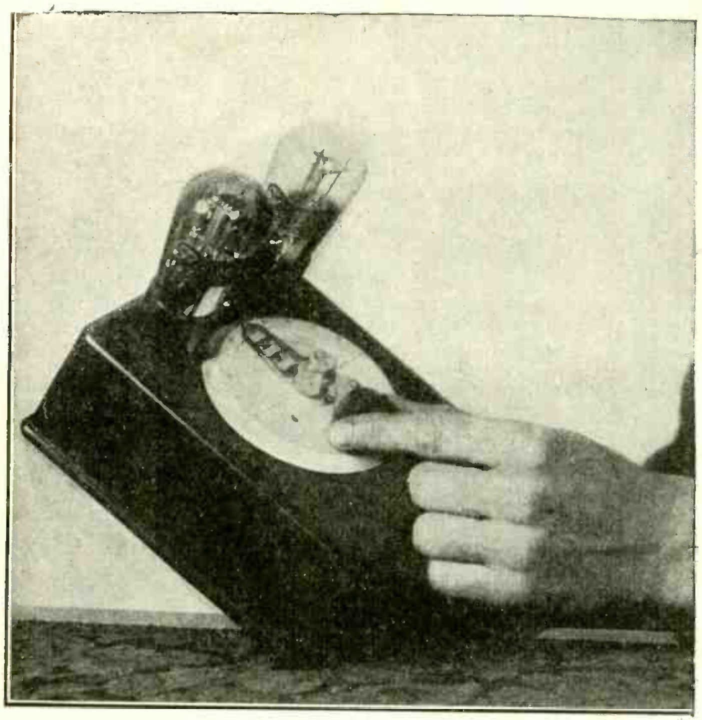


Fig. 3
A pointer moves across the fixed scale. The dial reduction ratio is 20-to-1.

(*Continued from preceding page*)
tighten down the opposite screw, and return to the remaining one, tightening that.

Close Fit

The fit is very close indeed, as all the apparatus is to be encompassed in a 5 x 6½-inch surface on inside, with a cabinet depth of only 1⅝ inches. The parts are not crowded, but close figuring was required to enable the mounting of the parts on the necessary positions, due to the filament transformer, tuning condenser, dial and sockets having to take up no more than 6½ inches.

Inspect the assembly to be sure that the tuning condenser is free and clear of the filament transformer. This clearance will prevail if the condenser is mounted straight and the filament transformer likewise. By the way, the filament transformer mounting holes are purposely made 8/32, although for 6/32 machine screws, so that there will be tolerance, either to take up any accidental jutting of laminations in factory assembly of the transformer, or slight angular dip of the tuning condenser due to other than straight mounting.

This distance between the tuning condenser and the filament transformer is measured from the bottom of the stator plates and the top of the transformer. The transformer case may be grounded, if desired, by soldering to the milled bushing, but even if not grounded, there must be no contact between stator plates and the transformer. If there is contact, with an ungrounded transformer, body capacity will result. If the case is grounded, and there is contact, of course the tuning condenser is shorted.

The distance referred to is not great by any means, nor need it be more than 1/32 of an inch, although actual provision has been made for a clearance of 1/16 inch. If you cannot readily establish perfect clearance, slip a piece of wrapping paper between condenser and transformer.

Cut the Socket Wafer

The way clearance is obtained is by putting the tube sockets as far up as practical, so that when the tubes are inserted the rim of the dial just barely misses touching the base of the tubes. It should be remembered that the dial scale does not turn, but a pointer moves across the scale, so there is no danger of interference between moving scale and tube base.

So close is the provision for avoiding obstruction that the wafer of the tube sockets have to be cut to be kept inside the dimensions of the panel. The sockets are mounted next, so that the grid terminals pointing to each other, that is, are on the inside, adjoining. By a trial placement you will find that one side of one socket and the opposing side of the other socket mark the distance on the wafer. Remove the socket and snip off the excess. No hesitancy need be felt about this, as the socket security is not diminished. In one instance the socket has to be snipped right up to the prong, while in the other instance there is just a trifle more room. The socket material is thin bakelite, and snippers will remove the excess, as will pliers or gardener's shears. In fact, a pair of large household scissors will do it.

Next mount the coil, just to be sure you get it in place properly. Looking at the bottom of the panel, with sockets in upper position, the oscillator socket is at left. On the left-hand side of this socket, where the mounting screw protrudes, put the third milled bushing, and fasten the coil to this bushing by passing through the coil through a small right brass right-angle bracket affixed or to be affixed to the coil. Turn the coil so it clears the panel edge. Then remove the coil.

The wiring with which the coil is not at present involved is more readily and handily done with the coil off.

Wire the heaters first. Be sure to get the ground connections as shown there, or if in doubt, refer to the schematic diagram, republished herewith for your convenience. The exact routes shown need not be followed, as wire leads were turned out of their natural or shortest courses in some instances to prevent too many wires being shown on top of one another, as that would have obscured the picture diagram.

Although in some respects the diagram appears to show a crowded condition, this fact is due to a few wires passing a given elevation, where in fact there is adequate separation in height.

When the wiring is completed except for the coil, affix the Hammarlund equalizer to the coil form. This equalizer should be set to full capacity, with set-screw turned all the way down, and the mounting bracket bent to a right angle, close to the frame of the condenser, being mounted with a nut and screw on top of the coil form. The other hole, for the brass

(*Continued on next page*)

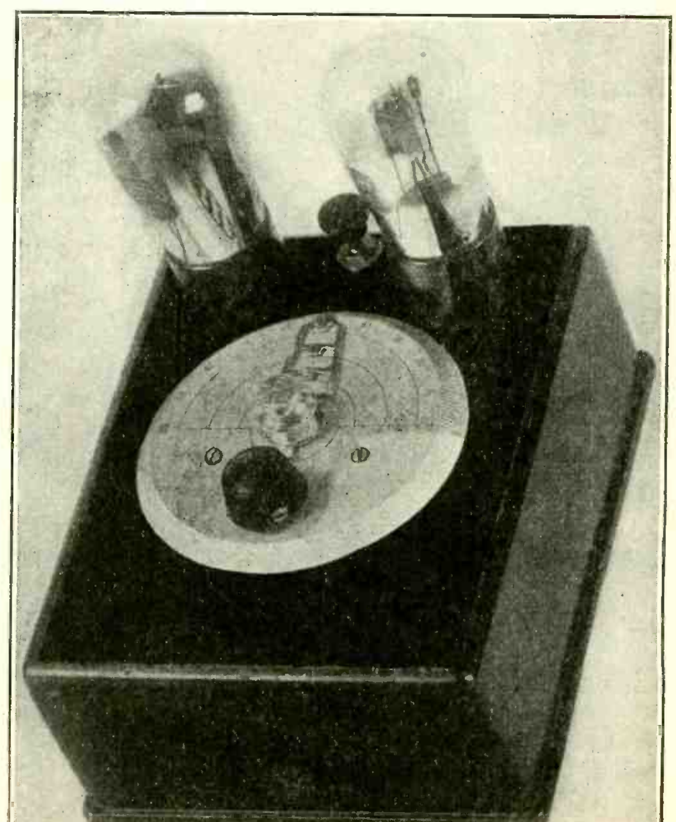
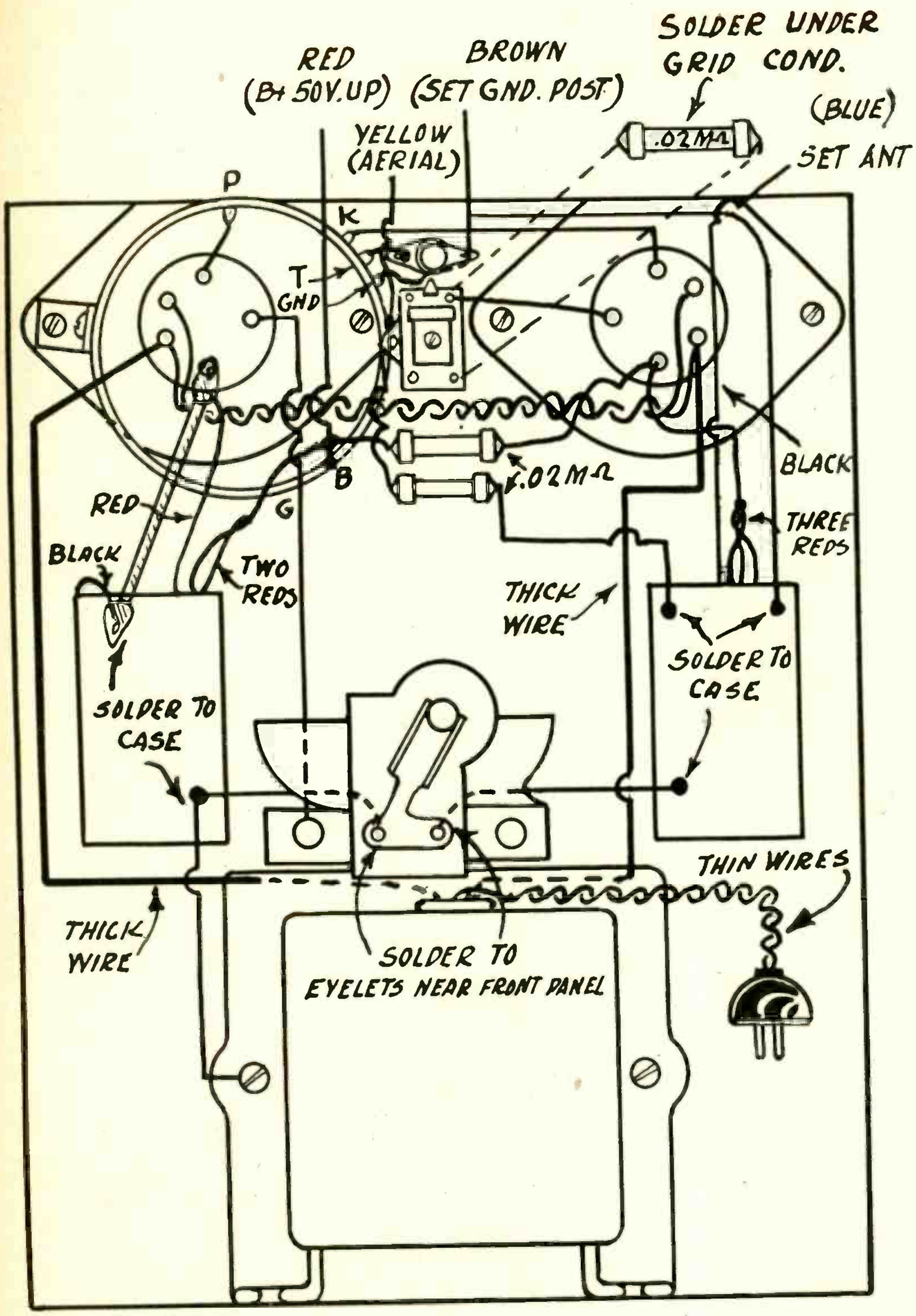
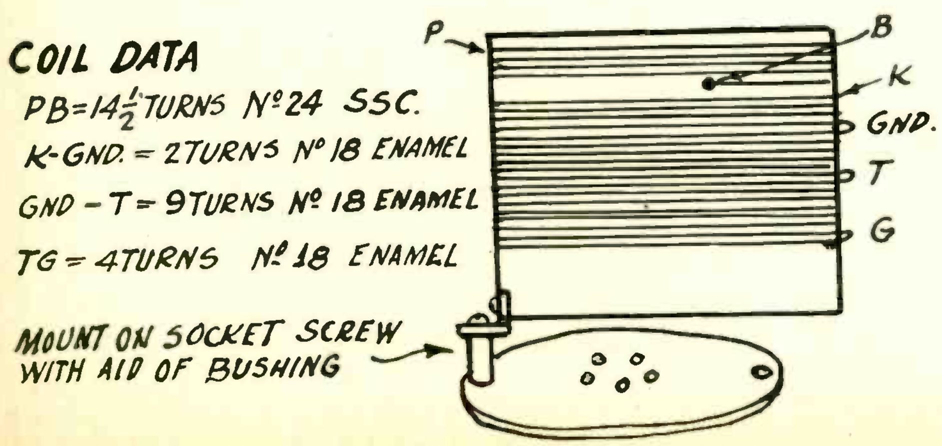


Fig. 4
The wavelength-changing switch is at rear.

Converter, Model RC-27





angle, is diametrically opposite and at the other or lower end of the coil form. Solder the .02 meg. grid leak to the grid condenser (equalizer), by using opposite eyelets, obviously connecting to the two different plates, as revealed by a glance at this condenser.

Now mount the coil and wire its connections. Refer to the coil diagram accompanying the picture diagram. The coil diameter is 1 3/4 inches (natural bakelite), while the axial length is 1 1/2 inches. Once again, there is not much room to spare, and if you wind your coil you may begin the secondary right next to the tickler winding. But be sure to get the coil terminals correctly connected.

If you wind your own coil, be ever so careful to have the windings in the same direction, for if you don't observe this precaution you will not obtain any oscillation (hence no results at all) although following the terminal connection data shown on the coil diagram.

The wavelength-changing switch should be connected with lug between insulators going to the tap T.

The tuning condenser should be counterclockwise to make the higher numerical readings of the dial represent higher wavelengths. Since you may write the frequencies on the ultra-vernier dial, it makes little difference in which direction the condenser turns, as the numerical readings hardly are referred to, once the converter is logged with respect to some single intermediate frequency.

How to Connect Up

Connect as follows:

(1)—Remove the aerial from your receiver and connect it instead to the yellow lead of the converter.

(2)—Connect the brown converter lead to the ground post of your set, but leave the ground attached to the set.

(3)—Connect the blue-with-yellow-stripe converter lead to the vacated antenna post of the receiver.

(4)—Connect the red converter lead to B plus 50 volts or more, even up to 180 volts, whichever is most accessible from your set. The higher the voltage, the greater the pep, but do not exceed 180 volts.

Operation of Converter

To operate the converter, turn up the volume control of your receiver to full-volume position, and see that the wave-length-changing switch is pushed in, for the higher short waves. Slowly turn the dial pointer by knob actuation, until stations are heard. Experiment with various settings of the receiver dial, to determine which setting gives greatest volume. It should be one on which no broadcasting comes through direct. To avoid broadcast reception by the direct method, if necessary use either extreme of the receiver dial, 0 or 100, whichever is more sensitive. This may afford less sensitivity than some intermediate setting, on which direct reception of broadcasts results frequently, because some local or semi-distant station is heard there. Nothing is wrong with the converter if direct reception of broadcasts is heard. In fact, the converter acts as a booster for such reception.

To receive higher short-wave frequencies, push in the switch.

When you have settled on a favored setting of the receiver dial you may log the converter, writing down the frequencies for one coil switch setting in the upper semi-circle and for the other switch setting in the next semi-circle. switch setting in the next semi-circle of the dial. —Herman Bernard.

Making Converters Work

By Einar Andrews

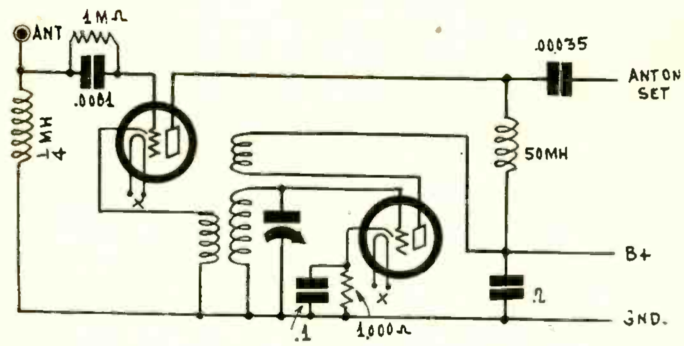


Fig. 1
The circuit of a converter which is sensitive and easy to tune

SHORT-WAVE converters are peculiar in that they have to be connected correctly to work. One mistake in the connection renders the converter null and void. But nobody, it seems, who has trouble getting signals suspects that an error has been committed in the connections. Everybody thinks there is a mistake in the design. "I got one of your converters," said one man, "and I hooked it up exactly as specified. Yet I cannot get a thing out of it. I wonder if you did not use the wrong tuning condensers." This particular model during a test had brought in Marconi's station in Rome and also a British station in London. It seems strange that the tuning condensers should have changed in the process of shipping! If the wrong tuning condensers had been selected the error must have been in choosing a chameleon type of condenser.

Another man who got a tested converter complained that the coils were not the proper type. It is very careless of the builder of a short-wave converter to choose coils which do not work in one place and do work in another. Still another fan complained that the converter did not work because the color of the leads had been changed. Of course, he had a real basis of complaint, for if the directions for connecting a converter refer to the color of the leads and the converter has a different color code, there is a good chance of connecting up the circuit incorrectly. But to complain because the condensers do not have the correct capacity or because the coils are not of the proper type is simply seeking an alibi for not following explicit direction for hooking up three or four leads.

Directions for Connecting

In nearly all the converters that have been described the directions for connecting one up to a broadcast receiver are identical. First, remove the antenna from the broadcast receiver and transfer it to the antenna binding post or the antenna lead on the converter. Second, connect the output binding post or output lead to the antenna post on the broadcast receiver just vacated by the antenna. Third, connect the ground lead on the converter to the ground post on the set, without removing the ground from that post. Fourth, connect the B plus lead on the converter to a point in the set where the voltage has the proper value.

The fourth of these directions alone is subject to uncertainty and may cause trouble, for there is no definite place in the broadcast receiver where the voltage may be picked up. If there are binding posts or available leads for different voltages there is no trouble at all. This is the case of all assembled sets and a few commercial sets. In most commercial sets all the voltages are quite inaccessible from the outside. If the receiver contains screen grid tubes it is possible to obtain the required voltage from one of the screens. A screen grid tube is removed from its socket and a clean wire is wrapped tightly around the screen prong on the tube and then the tube is inserted. This does not work in all cases either because the sets are often designed so that there is a high resistance in series with the screen lead. This resistance causes an excessive voltage drop when the converter tubes are put on it and neither the converter nor the radio frequency amplifier will work. However, it is easy to try and in most cases it works.

Voltage From Field

Sometimes the required voltage may be obtained from the loudspeaker field, but to use this requires a knowledge of the circuit. There is danger of getting excessive voltage on the converter tubes. In some sets the required voltage may be obtained from the bias resistor for the power tubes. If these tubes are 245s the voltage is 50 volts, which is enough for most converters, especially if they do not contain screen grid tubes.

If there is no simple way of getting the voltage for the plates of the converter tubes from the broadcast receiver without opening it up, it is always possible to use batteries. The minus terminal of the battery should then be connected to the ground side of the converter and the positive side of the battery to the B plus lead of the converter. This is the surest way of getting the voltage. If the converter does not work then, there is reason to suspect that somehing has gone wrong with it in shipment. Because of this certainty it is well to try a converter on a battery first to see whether it works or not. If it brings in signals with the battery and not when the plate voltage is taken from the broadcast receiver the fault is in the connection and not in the converter.

Converter Acts as Booster

Some converters act as boosters of broadcast signals and as such they work even if the oscillator does not work. Some of those who have this type of converter have said that they cannot get any short-wave signals clear of broadcast station signals. They claim that, no matter where the broadcast receiver is set as to frequency, broadcast station signals come in on top of the short-wave stations. This is an exaggeration, of course, because the broadcast receiver does not bring in stations everywhere on the dial. Even if the broadcast receiver is so sensitive that every station in the country can be brought in with it, there are still two chances of getting a clear spot, one is at 100 on the dial and the other at zero. And there are many places in between because the broadcast receiver can be set on the wave of a distant station and this will not interfere with the short-wave stations.

If the converter acts as a booster only and does not bring in code or short-wave voice stations, the trouble is with the oscillator in the converter. For some reason it does not work. It may be that the filament or heater voltage is not high enough, or that the tube used in the oscillator is defective, or that the plate voltage applied to the oscillator tube is not high enough. It sometimes happens that the heater voltage is too low on 224 and 227 tubes, and if it is below 2 volts oscillation may not result even if all other conditions are correct.

How to Tune

Whichever type of converter is used, the broadcast receiver should be tuned to a frequency at which no broadcast station comes in and at the same time at a frequency at which the receiver is most sensitive. If there is interference, set the receiver at either zero or 100, depending at which point the receiver is the more sensitive. Then advance the volume control on the receiver until the sensitivity is as great as it can be made. Then tune the converter. If there are two tuners, set the RF tuner on the converter at zero and turn the oscillator dial carefully from one end of the dial to the other. If any station is heard, set the oscillator where it is loudest and then adjust the RF tuner until it is as loud as it can be made with that.

If no station is heard with the first position of the RF tuner, set the dial at a little above zero, say at 5, and repeat the performance with the oscillator.

In most cases practically all the short-wave stations covered by a given coil can be tuned in with the RF tuner set at zero and tuning the oscillator only, but usually it can be made much louder by tuning with the RF condenser also. However, it depends on what the frequency of the signal is. It may be necessary to change the RF coil in order to get any increase by means of the RF tuner.

Single Tuner Converter

Many converters have only one control, that of the oscillator condenser. These are very easy to tune, for all that is necessary is to turn the oscillator dial slowly until stations are heard. And they come in almost as well as if there were a radio frequency tuner. There is only slightly more interference. For example, two stations, one code and one voice, may be heard simultaneously. When this is the case the interference can often be eliminated entirely by resetting the broadcast receiver just a little bit.

By far the largest number of short-wave stations heard will be code stations. They will come in from everywhere, some loud, some weak and others of medium strength. One of these code stations may be in Europe, another in Mexico, and still another in South Africa, or one may be within a few miles of the receiver. There is no way of telling where it may be without identifying the call letters. The strength of the signals does not have much significance. One of the distant stations may be stronger than a station much nearer. Those who cannot identify the stations by means of the call letters cannot know whether they have received foreign stations or not.

There will be voice and music stations, too, and they will be mingled with the code stations without any apparent order. Many of the more important of these stations are in the 50 meter, or 6.000 kc. band, but there will be important stations all the way from 16 to 50 meters.

What Short Waves Afford

By Brainard Foote

THE technique of operating a short-wave receiving set is vastly different from that of running the regular broadcasting receiving outfit.

There are many critical factors which affect the operation of the short-wave receiver which are not noticed on broadcast frequencies, and success on short waves depends to a tremendous extent upon how you are able to control these factors.

To help us clarify this subject, suppose we attempt to group the main points about the short-wave set which we'll need to consider:

(1)—Antenna system,
(2)—The set itself,
(3)—Operation of the set,
(4)—Information and Data.

With this general grouping in view, let's start with the radio waves and examine our antenna. The short-wave aerial should be much smaller than that required for broadcast wave lengths. Now—it IS possible to use a regular broadcast aerial for short-wave work, but it will not prove as satisfactory as a special aerial for the purpose. Many a good short aerial is located indoors. A simple method is to stretch about 40 feet of wire from the window to a pole or building. Try for height, if possible. The reason for the shorter aerial is to keep the natural wavelength of the aerial as low as possible.

Use Good Insulators

Strive for as few insulators as possible—two should be enough—and good insulators, too. Use heavy wire, such as No. 14 stranded or heavier, or solid enamelled wire about No. 12. A good direct ground connection is essential, or in country locations, the counterpoise method will work well. This is a wire about the same length as the aerial, stretched on insulators on sticks so as to be about two feet above the ground. In this system no actual contact with the ground is employed.

For a good ground connection where you use the city water pipes, it's a good plan to make a direct and short wire connection to the water main where it enters your cellar. Then, in addition, run several other wires from the ground post of your short-wave set to nearby grounds such as a radiator, water pipe, steam pipe, etc. This practice greatly reduces the ground resistance, because a larger effective contact area is secured.

It is a simple matter to set up a small "single-blade, double-throw" knife switch so as to make a change from the broadcast aerial to the short-wave set. As a rule, however, the listener will have two distinct outfits, so that one aerial is connected to the broadcast set and the other one to the short-wave set.

The Set

The adjustments of the short-wave set are much more "ticklish" than those of broadcast sets. Two prime requisites for success are:

(1)—Dials for controlling the tuning and the regeneration which provide a very fine vernier or geared control.

(2)—Proper connections in the set so that the "capacity" of the hands does not upset the tuning.

The dials used should have a very high ratio, 20 to 1 or so. With this, a very considerable movement of the knob is required to produce a small change in the tuning condenser itself, giving you good control.

It is very important to have the condensers, or other adjustment devices, connected so that any metal parts which pass through the panel or come close to it are connected to the ground portion of the circuit. When this is done, the capacity of the hands does not upset the delicate adjustments.

The Circuit

If you make up your own set, be sure to adopt a standard and recommended scheme. The safest way to make your own short-wave set is to buy a "kit" of parts, with complete assembly directions. Completely built sets can be purchased, as well as short-wave converters which are used in conjunction with a regular broadcast set.

It is difficult to use the all-electric system on short waves, so if you wish to avoid batteries, be sure to get a completely built set or and extremely detailed and well-built outfit of parts.

Simplicity

The short-wave set is a very simple affair. It uses no more than one radio frequency amplifier tube, and even that is not an absolute necessity for fine results. The coils have less wire on them, the parts are smaller and less costly, and the connections are easier. Hence it really is a very inexpensive hobby to satisfy your interest in short-wave receiving.

The successful short-wave listener generally subscribes to one or two magazines giving short-wave information. He keeps fully informed on short-wave developments. He studies his set, so that he knows which coil to plug in, and where to set the dials, for the various wave-lengths. He learns where the stations "are" and when to tune for them.

What You Hear

What do you hear now on a short-wave set? Of course, every day springs surprises, but an hour or two might reveal the following:

Just about 200 meters—the shorter wave broadcasting stations, heard with clarity and volume, much more successfully than with the broadcasting set, which is designed for effective work on a higher wavelength.

Then, about 150 meters, experimental stations transmitting test programs with voice and music.

Still lower, you may stumble on police alarm stations of various cities—New York, Birmingham, Mass., Washington, D. C., State Police systems etc., giving quick information to police automobiles and other police stations with radio equipment. You'll perhaps hear one "side" of a conversation from an incoming liner the latest in person-to-person telephone facilities.

You'll go lower, and tune in three or four stations where you hear little but a whirring and buzzing sound—television broadcasting. If you listen to some of them a few moments, they will switch over to voice and announce, for the benefit of those not having television sets.

Amateurs

About 75 to 85 meters, you'll come across the busiest "radio wave band" you ever encountered, with private amateur radiophone stations talking to each other from all over the country. Columbia, S. C. carries on a friendly confab with Maywood, Illinois. The main station of the amateurs' Radiophone League at Providence is heard clear and strong, talking over radio set problems with amateur stations throughout the East.

Then, as you tune lower, you'll find American short-wave broadcasting stations at Chicago, New York, Schenectady, Pittsburgh carrying on with the regular chain programs, and once in a while, if you're lucky, you'll catch some broadcasts from Europe. All through you'll find plenty of "dots and dashes"—code communications which are full of absorbing interest once you are able to decipher them and "copy" them. Short wave is not only fascinating from the standpoint of the set, but also from what you hear, as well. Try it!

The most important factors to keep in view for short-wave success are these: 1. A properly designed set. 2. A suitable aerial. 3. Experience and care in adjusting the set. 4. Adequate information, call books, etc.

Does Sensitivity Depend on Number of Tubes?

A LETTER received the other day from a listener requested the diagram of the most sensitive radio set he could make, with as many tubes as possible! He clearly stated that he wanted a large number of tubes because he knew that would get more distance.

This notion is quite common, too. The results obtained with a radio set depend so much upon location, manner of operation, condition of tubes and accessories, form of aerial, that it's not merely a question of "tubes." In fact, there is a definite limit to the number of tubes that can be employed, even in very scientifically constructed laboratory radio sets, because of the increasing complications that occur with multi-tube sets, such as noise and oscillation.

In ordinary usage, about three radio frequency tubes is a maximum and too many for home construction, one detector tube, and two tubes complete the outfit. An additional power tube, so that two are used in "push-pull," does really count as nothing added, because the same results are obtainable with one power tube of larger size. If the rectifier tube is counted (which it shouldn't be) 7 to 8 tubes are a maximum. The main point is the number and connections of the radio frequency tubes, since they determine the sensitivity of the set.

Excellence in Tuner

By Herman

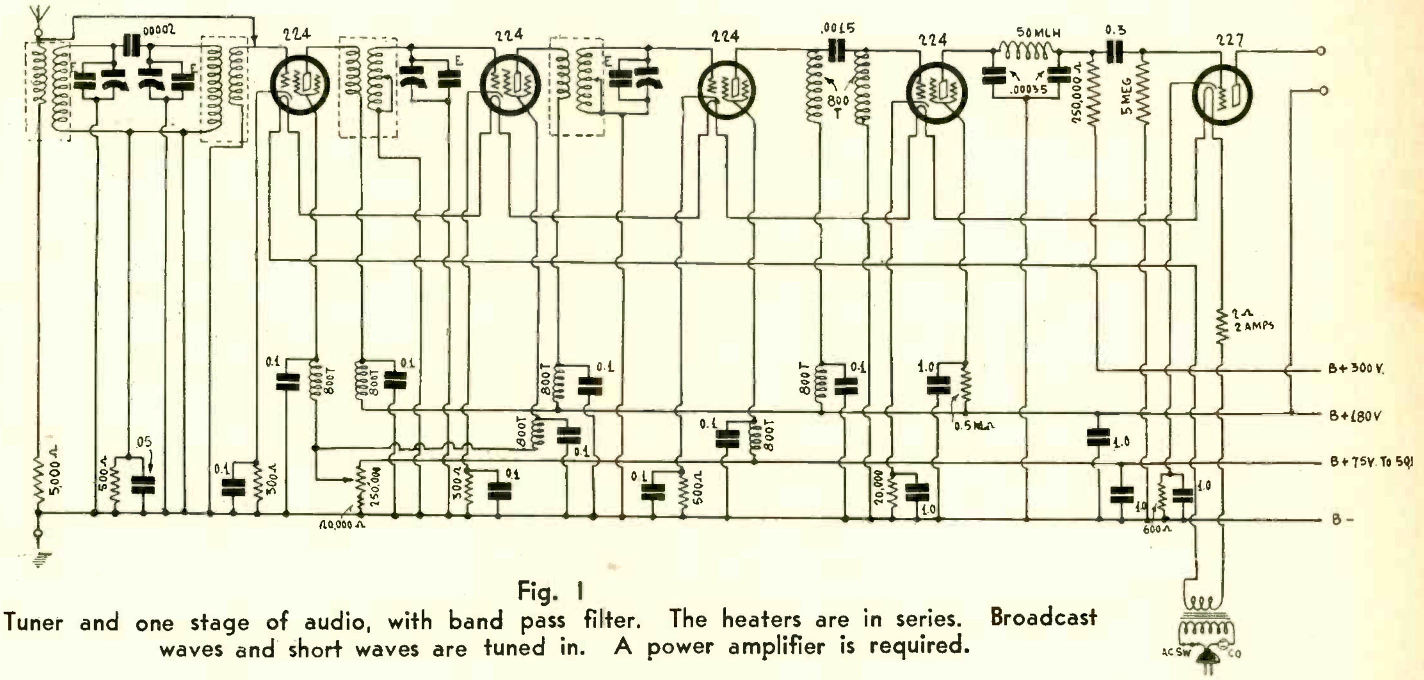


Fig. 1
Tuner and one stage of audio, with band pass filter. The heaters are in series. Broadcast waves and short waves are tuned in. A power amplifier is required.

ONE of the important considerations in the design and construction of a tuner is the avoidance of cross-modulation. If the input to the first stage is so strong, due to a powerful local, and that this local is heard as a background to reception of other stations, then you have a palpable example of cross-modulation.

This nuisance evidently is caused by detection in the first radio frequency amplifier, due to shock excitation. Hence the tube acts as a detector, and the condition is ripe for modulation, since the same working conditions serve for both modulation and detection, and indeed the two functions often are referred to as one, since in both instances the circuit is the same and frequency-changing is concerned.

Use of Pre-Selector

The most common method used at present for avoiding cross-modulation is to build up the selectivity prior to input to the first tube, by use of a band pass filter. It may be called a bi-resonator, or a duotuner, or a doubly tuned circuit, or by any other name, but it is the same circuit, essentially, and the purpose is always the same.

The method of uniting the circuits is to use a condenser of .04 or .05 mfd. or closely thereabouts, across a resistor of around 500 ohms, making the common return to ground for the two tuned circuits through this parallel combination of impedances, connected as a unit in series with the return of the tuned windings.

The selectivity is improved in that way, although the selectivity is a little less than if the band pass filter feature were omitted, and the two condensers united simply through the capacity. The object of the filter is to provide an admittance band equal to or a little less than the channel width of 10 kc.

By pre-selection of a higher order than one tuned circuit alone would afford, a stronger input may be tolerated without cross-modulation, although it is well to maintain the negative bias on the first tube a little higher than commonly recommended, and to use the recommended plate voltage of 180 volts. The high plate voltage and high bias help get rid of cross-modulation, because they improve the selectivity, due to increased input impedence.

Heaters in Series

The method used is diagrammed in Fig. 1, where four tuned circuits constitute the tuning arrangement for three stages of screen grid radio frequency amplification and screen grid detector. The tuning arrangement would be the same if a 227 detector were used.

There is also one stage of resistance-coupled audio frequency amplification in the circuit, so that the output may be connected to an audio power amplifier that has in it either one or two stages of audio, with output either single or push-pull.

Heaters of all five tubes are connected in series, and are fed by a filament transformer that affords 2½ volts when six tubes are used, hence a 2-ohm resistor is included to provide almost 2½ volts when only five tubes are included. It is an economical way of supplying the heaters, especially when you have a power transformer that will not "pull" 8¾ amperes extra, as required by the five tubes if across a regular 2½-volt winding to feed parallel heaters.

The circuit has a short-wave feature as well. A switch is built into three of the coils. When the switch is closed for the first tube, the antenna input is made to the grid of that tube. A limiting resistor is included in series with the antenna winding of the first coil, so that that winding will not take away too much of the current when one intends to deliver a strong aerial input to the first grid for short-wave reception.

How to Wind the Coils

The two other switches simply short-circuit all except ten turns of the tuned winding, to afford short-wave reception, the same dial being used, of course, as when broadcast frequencies are tuned in.

As for the coil data, the large winding in each instance, for .00035 or .000375 mfd. tuning, may consist of 80 turns of No. 28 enamel wire. The antenna winding may consist of 15 turns, the winding in the grid circuit of the first tube, 20 turns, and the two primaries in the plate circuits of the 224 tubes of 25 turns. The separation between primary and secondary may be ⅛ inch.

If possible, use space winding, as only in this way will the inductances of the large windings be assuredly identical. A suggested degree of separation is a distance equal to the thickness of the wire used. In this instance the 80 turns, so spaced, will wind on a two-inch axial length. The bakelite tubing diameter is 1¾ inches, and for space winding must be threaded. The size of wire used for the small windings is not important. For the antenna winding it may be No. 28 wire, as formerly, and for the input to the first tube, the same size, while for the other small windings Nos. 28, 30, 32 or 36 wire.

It will be seen that one of the coils is used in "inverted" fashion, the small winding being the secondary. This produces a step-down ratio, which may be avoided, if desired, by putting the tuned winding into the grid of the first tube and ignoring the small winding. However, reduction in the input to the first tube is in line with the precautions taken against cross-modulation.

Series Condenser as a Remedy

In support of the theory that cross-modulation is due to detection by shock excitation is the fact that the vice may be cured without increasing the selectivity by pre-selection, or resorting to increased bias supported by high-plate voltage. All that is necessary is to shorten the aerial or decrease the number

and Audio Channel

Bernard

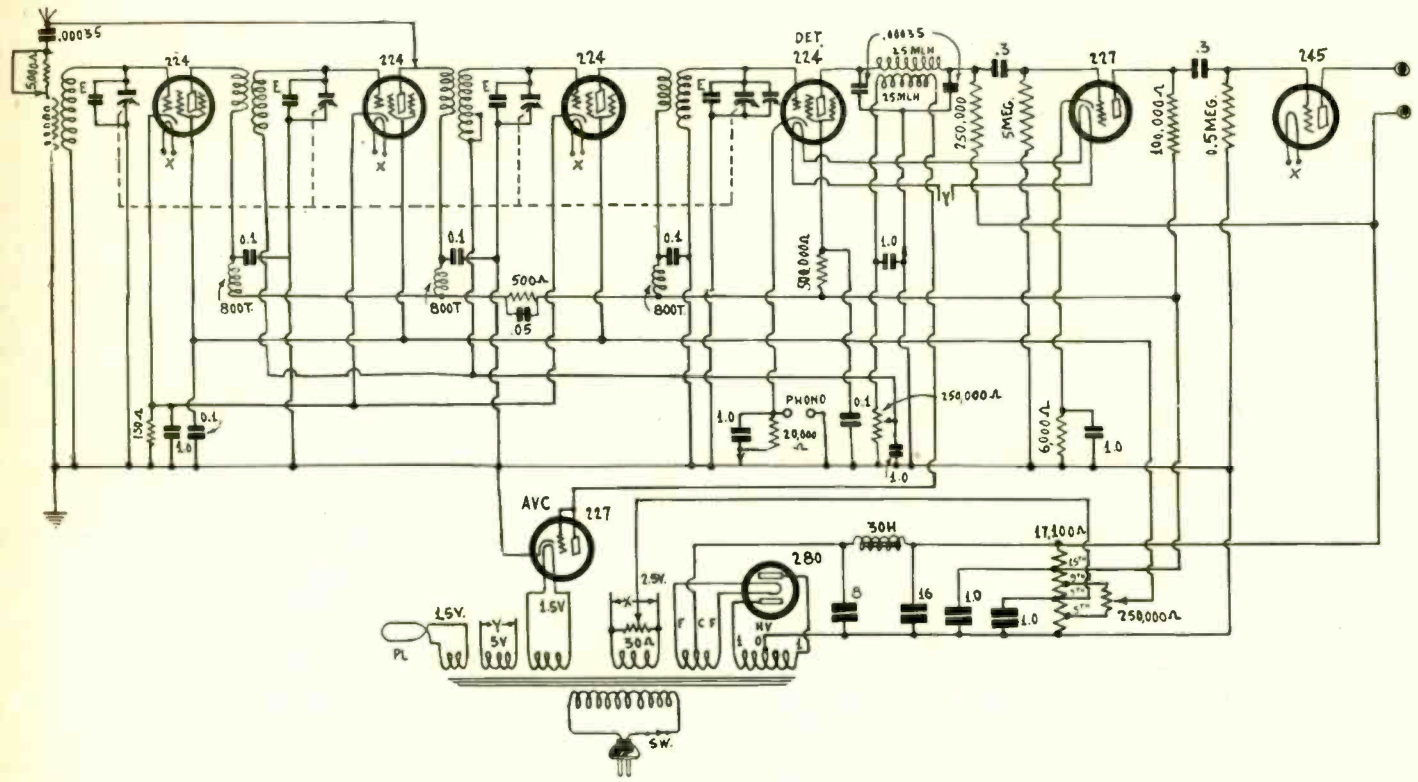


Fig. 2

A complete AC receiver, the Band Pass Filter Diamond of the Air, for broadcast and short waves, with automatic control.

of turns on the antenna winding or leave the number of turns as you find it, and use a series condenser.

Such a condenser was used with a somewhat similar circuit, that shown in Fig. 2. When no series condenser was in the aerial circuit cross-modulation by WOR's signal as background interference to WJZ's wave was bad in the New York City area, but when a capacity of .00035 mfd. was used in series this trouble disappeared entirely. In fact, WLW, Cincinnati, was tuned in from New York then without any interference from WOR, the strongest local at the point of reception, although the two stations are only 10 kc. apart. This was very surprising, as so simple a remedy as a series condenser seemed unlikely to get rid of cross-modulation and even permit 10 kc. separation between the most powerful local and a semi-distant station that affords a weak field strength in the antenna at the reception location.

This is only another way of saying that the practical selectivity of a receiver depends greatly on the field strength in the antenna circuit. Without a statement of the power at the input 10 kc. separation becomes a mere phrase. The field strength of WOR was 240 microvolts per meter.

Unusual Location of Filter

In considering either model, Fig. 1 or Fig. 2, remember that the volume control should govern the first two tubes, at least; if any sign of oscillation appears when tuning in short waves, this may be removed by volume control adjustment.

Fig. 2 omits the band pass filter unit from the usual place but includes it in the plate circuits. Here the two amplitudes united in the filter section are divergent, the difference being due to the amplification of the second tube, but this resembles band pass filtration by detuning of respective stages, when the amplitudes of several circuits differ greatly.

The audio channel, Fig. 2, is of interest also. It consists of two stages of resistance coupling, with values so chosen as to assure stability. As most readers know, resistance coupling reproduces with a tone quality second to none, if stability is achieved and proper loads introduced. One of the methods used in achieving stability is avoidance of over-amplification, that is, too much gain. Another aid is the choice of a suitable tube in the first audio socket, to this same end. Therefore a 227 was selected.

Motorboating, the commonest example of instability, may result from improper values anywhere in the audio channel, including the detector, which is to be regarded as an audio tube, of course. Excellent detection with the screen grid tube will result when the applied plate voltage is the full 300 volts from the power supply, fed through a 250,000 ohm plate resistor, while the screen grid voltage is supplied from the 180-volt tap of the voltage divider in the power supply, through a by-passed 0.5 meg. resistor. The bypass capacity here can never be too large. The biasing resistor is 20,000 ohms and must be bypassed.

Biasing Resistor Values

The radio frequency choke should be included in the detector plate circuit, of any value from 20 mlh to 65 mlh, and the bypassing of radio frequencies completed by the pair of fixed condensers, which also aid detection.

The biasing resistor for the first audio tube in Fig. 1, a 227, is shown as 600 ohms, assuming transformer or impedance coupling. If the second audio stage is resistance coupled, the resistor in the plate circuit of the final tube in Fig. 1 (not shown) would be 100,000 ohms, and the biasing resistor 6,000 ohms, instead of 600 ohms. That is, the different values of biasing resistors for this stage, Fig. 1 contrasted with Fig. 2, are correct.

The detector plate-screen current is .75 milliampere (.00075 ampere), so the bias afforded by the 20,000 ohm resistor is 15 volts negative.

The applied plate voltage is therefore 300 less 15, or 285 volts. The screen current is .2 milliampere (.0002 ampere) and the effective screen voltage is 80 volts, since 100 volts are dropped in the limiting resistor.

Fig. 2 is the diagram of a complete AC receiver, including automatic volume control tube. This type of volume control was designed by J. E. Anderson as one that does not tend to reduce the sensitivity much, although some energy is taken from the detector output and fed into the control tube. That is, whatever bias is used, determined by the setting of the potentiometer, there is little drain on the circuit and no possibility of shorting.

For this type of automatic volume control a double radio frequency choke coil is used having two windings of 25 millihenries closely coupled to each other.

Theory of the Control Circuit

The theory of the automatic volume control was set forth by Mr. Anderson as follows:

"A signal current of the carrier frequency flows in the primary.

(*Continued on next page*)

Automatic Volume Control

Its Theory of Operation Is Analyzed

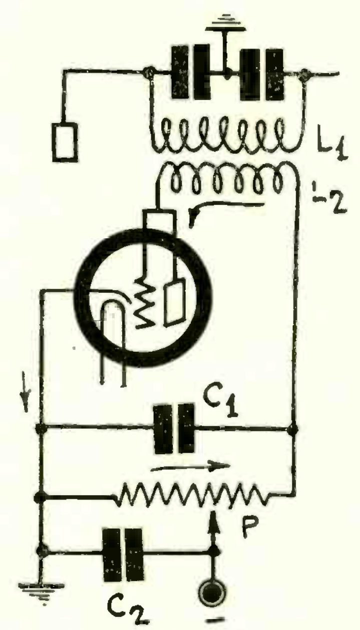


FIG. 3
The control tube's current flow.

(*Continued from preceding page*)

which is shunted by condenser. This current induces a voltage in the secondary because of the close coupling. Since the secondary is connected in a rectifier circuit a rectified current will flow in the output circuit of this tube, and this rectified current will set up a voltage across the high resistance.

"One end of this resistance, or potentiometer, is connected to the cathode of the rectifier tube and also to ground, if the grid returns of the radio frequency amplifier tubes are connected to any point on the potentiometer the grids will be made more negative by the amount of drop in the resistance included between ground and the tap used.

"As the signal intensity increases, the current through this resistor will increase and therefore the grid bias on the controlled tubes will increase. This in turn will decrease the amplification of the tubes. The signal will rise and fall, it is true, even though this check is put on the amplification, but it will not vary nearly as much as if the automatic feature were not used.

"It is necessary to filter the rectified current so that there is no ripple at the carrier frequency. This filtering is done by the condensers across the resistance and across the portion of the resistance actually used for automatic biasing."

The operation of the automatic volume control is illustrated by the simplified circuit diagram of the control tube. L1 is the choke coil in the plate circuit of the detector and L2 is a winding in close inductive relation to this choke winding. The ratio of turns may well be one to one.

Storing the Charge

When the signal current in L1 is in such direction that the voltage in L2 is in the direction of the arrow, the plate-grid of the rectifier is positive with respect to the cathode of the tube and current circulates in the direction of the arrows. As will be noted, the current flows through the potentiometer P from the cathode toward L2 and the plate. Thus the cathode is positive with respect to any portion of the potentiometer resistance, or every portion of the potentiometer is negative with respect to the cathode.

When the signal current in L1 is in the opposite direction the plate is negative with respect to the cathode and therefore no current flows. The rectifier is inactive during this half cycle.

Condenser C1 stores some of the electricity that flows during the active half cycle and discharges during the inactive half cycle. This discharge current through P is in the same direction as the direct current when the circuit is active. Hence current flows through P in the same direction all the time, and in such direction as to make the cathode positive with respect to every point on the potentiometer.

If the cathode of the rectifier tube be connected to ground as indicated, and the point marked (—) is connected to the grid returns of the amplifier tubes in the receiver, the grid bias on those tubes will be augmented by the drop in the portion of the potentiometer which is between ground and the slider. As the signal rises and falls, the drop in this portion also rises and falls, and the amplification is approximately inversely proportional to the signal. Thus the check on the amplification is automatic and the output of the receiver will be nearly constant regardless of the strength of the signal at the antenna.

Voltage and Current Check-Up

There is, of course, a difference between the applied voltage and the effective voltage, as to screen and plate circuits, because of the load resistors. In the plate circuit is a 250,000-ohm resistor, and as .55 milliampere (.00055 ampere) of plate current flows, the voltage drop in the resistor is 110 volts, the effective voltage is the difference between 300 volts applied and 110 volts dropped, or 190 volts.

It is not possible to measure the effective plate voltage or the effective screen voltage with meters ordinarily used, since the meters draw more current than do the circuits desired to be measured. When a set analyzer or tester is plugged in, say, at the detector plate, the reading may show "5 volts," which does not mean anything, except to disclose the meter error. Even if the meter has a resistance of 1,000 ohms per volt, and, say, has a 500-volt scale, the full-scale deflection current is 1 milliampere, (for 500 volts), while the current flowing at a "5-volt" reading, is 1 per cent. of the total current, or .01 milliampere, nearly twice the amount of current flowing through the "measured" circuit.

The same obstacle arises in trying to measure the effective screen voltage, where the situation is even worse.

However, both these voltages may be read with a vacuum tube voltmeter, which does not draw any current from the measured circuit. In lieu of that, the respective currents may be measured, on a 0-1 milliammeter, and the resistance values and the applied voltage measured, whereupon by computation based on Ohm's law, these two effective voltages may be obtained, as was done by the author.

With resistance coupled audio, using a 227 tube, 100,000-ohm plate load, and a 6,000-ohm biasing resistor, the plate current is only a little more than that in the detector circuit, still less than 1 milliampere.

The DC resistance values are easily obtained for the tube itself. At a voltage drop of 300 volts the detector tube draws .00075, so the total resistance is 300 (the voltage in volts) divided by .00055 (the current in ampere), or 545,454 ohms. There are 250,000 ohms in the plate circuit and 20,000 in the grid circuit, so the plate DC resistance is 275,454 ohms. The impedance to alternating current is about half that. Since the detector plate resistor and the following grid leak are in parallel, the load impedance is a little more than 129,000 ohms. This is in line with the requirement of a good load impedance on the detector.

An Excellent Circuit

Fig. 2 has three stages of tuned radio frequency amplification, instead of two stages shown in the other diagram, and may be built up of parts costing less than $50. It represents an excellent circuit for all-around results, including selectivity of the degree mentioned, and faithful audio amplification, if the stated values are duplicated, especially the plate and grid load values. Due to excellent help from the detector tube, which therefore may be considered as one in the audio channel, the gain is well above the amplification value of 400, usually set as a suitable working value.

It is a refined and well-filtered version of the Band Pass Filter Diamond of the Air.

Germany Plans Nine New, Powerful Stations

Berlin, Germany.

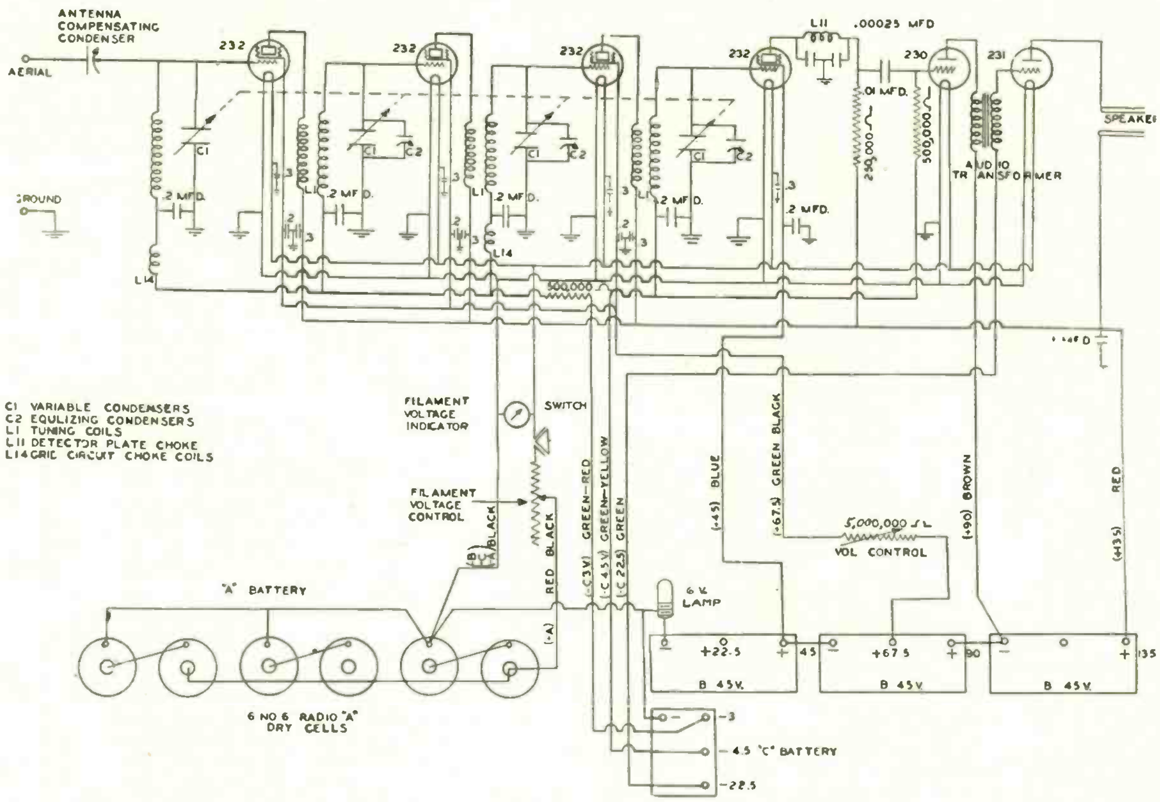
The Department of Commerce has received from its German representative, Commissioner James E. Wallis, Jr., the information that the Ministry of Posts has planned the construction of at least four new high-powered stations within the Republic.

The stations are to be located at Heilsberg, East Prussia, Langenberg, and Rhineland. One of the four is in experimental operation now at Müehlacker, Stuttgart. The plan of the new construction program is gradually to replace the present broadcasting stations, and the frequency assignments of the old stations will be assumed by the new plants, with the addition of higher power.

The present plans provide for the early erection of four stations, but the year's programme will include nine stations. The expansion of the country's broadcasting facilities has been declared necessary because of the erection of modern equipment by bordering nations, and it is said that these produce interference with the present relatively low-powered German

The Sparton Model 31

New 2-Volt Tubes Used in Battery-Operated Receiver



The circuit diagram of the Sparton Model 31, a six tube receiver utilizing the 2 volt tubes. It is suitable for use either as a midget or as a portable receiver

THE Sparton Model 31 is a six-tube receiver utilizing four 232 screen grid tubes, one 230 audio amplifier and one 231 power amplifier. It is a battery-operated set. All the tubes are of the 2-volt, low current type. The filament current is supplied by six No. 6 dry cells connected in series parallel to give a terminal voltage of three volts.

The grid bias is supplied by a single block of small dry cells furnishing a maximum voltage of 22.5 volts, the bias required by the 231 power tube. Since there are taps on the battery the bias for the other tubes is also taken from this battery. The other two bias values are 3 and 4.5 volts.

Three 45 volt blocks are required for the B voltage, giving a a maximum voltage of 135 volts, which is the voltage required by the plates of the 231 and the 232 tubes. Ninety volts is used for the 230 audio amplifier, and a maximum of 67.5 volts is used for the screens of the radio frequency amplifiers and the 45 volts for the screen of the detector.

Volume Control

The volume is controlled by means of a 5,000,000 ohm variable resistance in series with the common lead to the screens of the radio frequency amplifiers. This resistance also serves as a stabilizer in that it helps to prevent feedback from the plate circuits in case there is any appreciable resistance in the plate battery, as there will be when the batteries have been used a while. To prevent coupling among the screen circuits a by-pass condenser is connected from each screen to ground, each one having a value of 0.2 mfd.

Considerable attention has been given to the prevention of feed back in this circuit, much more so than is common even in AC operated receiver when the grid bias and the plate voltage is obtained from a B battery eliminator. There is a radio frequency choke L14 in each of the first and the third control grid returns, and for each there is a 0.2 mfd. condenser to complete the tuned circuit. There is also a condenser of this value in each of the other grid circuits for the purpose of by-passing the leads to the common portion of the grid battery. In the common return lead of the three radio frequency amplifiers there is also a 500,000 ohm resistor which serves to check feedback.

In the filament circuit is a rheostat for controlling the current delivered from the battery. Since the total filament current normally is 0.43 ampere and one volt has to be dropped in the rheostat, the resistance should be adjusted to 2.34 ohms, or until the voltage indicator reads just 2 volts. This is normal reading. The set will work with less but it should not be operated with more voltage, because the life of the tubes will be shortened without gaining any advantage while they do last.

It will be noted that each plate lead in the radio frequency amplifier has a by-pass condenser of 0.3 mfd., connected from the low side of the primary to ground. These are large condensers for this purpose and they should be very effective. There is also an 0.3 mfd. condenser connected from each positive filament lead to ground. Thus the common impedance in the A battery is reduced to a negligible value. The negative side of the filament is grounded, and there is one connection for each tube.

There is still another by-pass condenser, one of 1 mfd. connected from the 135 volt tap on the B battery to ground.

The detector is of the high signal voltage type and the bias on the 232 detector is 4.5 volts. This voltage in conjunction with the plate voltage of 135 volts, a plate load resistance of 250,000 ohms, and a screen voltage of 45 volts, makes the tube efficient as a detector.

The combination of 0.01 mfd. stopping condenser and the 500,000 ohm grid leak assures a high gain at the lowest audio frequencies. Between the audio frequency amplifier and the power tube is an audio transformer, used to get a greater step-up than a resistance coupler would afford.

A low pass filter consisting of two .00025 mfd. condensers across the line and a choke L11 in series is used for filtering out the radio frequency component from the output of the detector. The coil L11 in the filter is a regular radio frequency choke and the coils L14 are similar.

Use of Receiver

The circuit is eminently suited for either a midget receiver in the home or for a portable to take along in a suitcase. In either form it could be assembled in very compact form, and it would not be excessively heavy for portability. The heaviest parts are the batteries.

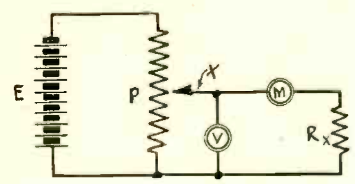
As will be noted from the circuit diagram, the four tuning condensers are ganged, thus making the receiver a one-control set. Trimmer condensers are put across three of the sections and a compensating condenser is put in series with the antenna lead to make the first tuned circuit equal to the other three.

The use of a filament voltage indicator is always recommended for the 2 volt tubes because the filaments are critical. However, in a portable set where weight and compactness are of importance it may be omitted provided that a fixed ballast resistance is connected in series with the A battery to limit the current to normal value. The rheostat is then used only to control the volume or to operate the circuit at subnormal filament current. For a 3 volt battery the fixed resistance should be 2.34 ohms. Since this is not obtainable a good way of arranging the circuit is to put a stop on the rheostat at the proper point so that its resistance cannot be decreased below this value. Adjust the setting with the aid of a voltmeter connected temporarily across the filaments.

The six volt lamp connected in the common B minus lead is there for protection of the tubes against short-circuit of the plate battery. Should a short-circuit occur this lamp will either limit the current to a safe value or the lamp filament will burn out, thus acting as a fuse.

How to Measure Resistance

By Brunsten Brunn



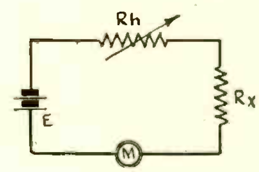


FIG. 1 (Right)
A simple circuit for the measurement of resistance by Ohm's law. The voltage of the battery E is supposed to be known and M indicates the current.

FIG. 2 (Left)
The circuit of a type of direct reading ohmmeter in which the voltage across the unknown resistance is varied until a desired current is obtained.

FANS often have occasion to measure resistances, but they are not willing to apply Ohm's law. Just why they have an aversion to applying this simple law is difficult to see, for it involves nothing more than measuring a current and then dividing one number with another. It is one of the simplest things to do, much simpler than to solder a joint. Anybody who can read a voltmeter and an ammeter and can use long division can do the work required just as well as anybody.

Nearly everybody has a dry cell or a storage battery, and everybody should know that the voltage of each storage cell is 2 volts and that of a dry cell is 1.5 volts. While these voltages may not be exact as determined by precision standards they are close enough for practical work, for the purpose of measuring the value of a resistance.

The Measurement

Everybody also knows that when cells are conected in series the voltages add up. Thus the three storage cells in an ordinary A battery add up to 6 volts and therefore we have the almost universal 6 volt battery. We also have 3, 4.5, and 6 volt dry cell batteries as well as many other of higher voltages. For example, we have 45 volt blocks consisting of 15 individual dry cells connected in series. All these voltages remain reasonably constant so that they can be assumed to be correct even without measurement. Hence if we have a battery we can apply Ohm's law without having a voltmeter, for we know the voltage already. It remains to measure the current, and as soon as we know that all we have to do is to divide the voltage by the current by long division, a sliderule,or logarithms, whichever methods seems to be the best in any case. The long division method is always available, assuming that everybody has a pencil or the equivalent.

It is necessary to choose the voltage to be used to fit the current meter and the resistance to be measured. It will not do to choose a voltage so high that when it is connected in series with the meter and the resistance the meter runs off the scale or burns out. We must have some idea of what the resistance is and use a bit of common sense. If we have no idea of what the resistance may be we have to use still more common sense for the safety of the meter depends on it.

Increasing the Voltage

Common sense in this case requires that we use the lowest voltage that we have to start with until we find out that we may use a higher one with safety. Suppose, for example, we wish to measure the resistance value of a certain device and that we do not know whether the resistance is zero or one megohm. Let us further assume that the current meter is a O-1 milliammeter. The lowest voltage that we are likely to have is 1.5 volts, that of a single dry cell. If the resistance is less than 1,500 it is not safe to connect the device in series with the 1.5 cell, for the needle of the meter will run off the scale. The thing to do is to connect a variable resistance in series with the circuit and set this at a value higher than 1,500 ohms. The resistance of this may then be reduced gradually to see whether it is safe to short-circuit it and leave the unknown in the circuit alone.

If the resistance is so high that there is practically no deflection, the voltage may be increased by a cell at the time until a readable deflection is obtained. It is always well to choose a voltage such that the deflection is between full and half scale, for if the deflection is less than half scale the reading is not accurate.

In Fig. 1 is shown a simple circuit for measuring the value of resistance Rx. Rh is used only as a protection as was explained above, and it should not be in the circuit when the final reading is taken, for if it is the resistance obtained is the sum of Rh and Rx.

This suggests a way of measuring the value of Rx even when it is less than the minimum that may be measured with a given meter and the minimum available voltage. For example, the sum of the two resistances may be measured first and then that of Rh alone. The difference between these two values is then the resistance of Rx. It is true that any measurement involving a difference is not very accurate but it will be accurate enough for most purposes in radio, except when Rx is very small compared with Rh. It is clear that if the difference method is used the rheostat Rh must not be altered between the two measurements.

Illustration of Difference Measurement

Let us assume that the value of E, the voltage, is 1.5 volts and that M reads 0.9 milliampere when Rx is short-circuited and 0.5 milliampere when it is not. What is the value of Rh and that of Rx? Ohm's law tells us that the sum of Rh and Rx is 1.5/.0005, or 3,000 ohms and that Rh alone is 1.5/.0009, or 1,667 ohms. Therefore Rx is 1,333 ohms. Rx is less than 1,500 ohms and therefore it could not have been measured with 1.5 volts and the 0.1 milliammeter without the aid of Rh. In this case the accuracy of the measurement is good because Rh and Rx were nearly the same and they were such that the deflections were large.

If we know that Rx is greater than 1,500 ohms we may leave out Rh or short-circuit it. Suppose we use a voltage of 1.5 volts and find that the deflection of the meter is 0.2 milliampere. What is the value of Rx? It is 1.5/.0002, or 7,500 ohms. But this value may be in error because the deflection was small, only one-fifth of the scale. Hence let us increase the voltage to 6 volts,, four dry cells in series. Now let us suppose that the deflection is .00081. Then the resistance is 6/.00081, or 7,410 ohms. This value should be more accurate because the deflection was greater. The first deflection should have been .0002025 but the fraction was so small that it could not be read.

If very small resistances are to be measured it is best to use a meter that is not so sensitive. For example, if the meter is a 0-100 milliampere instrument the smallest resistance that can be measured directly with a 1.5 volt cell and without resorting to the difference method is 15 ohms, and with a 0-1 ammeter the smallest resistance that can be measured directly is 1.5 ohms.

Reading Resistance on Voltmeter

There is a simple method of using a voltmeter and a milliammeter for measuring resistance, the circuit of which is illustrated in Fig. 2. Rx is the unknown resistance, M a current meter of suitable range, V a voltmeter, P a potentiometer or voltage divider, and E is a battery of suitable voltage.

By means of the potentiometer it is possible to get any desired voltage between zero and the voltage of the battery E. Let the reading of the voltmeter be V volts and the reading of the current meter be I amperes. Then the value of the resistance is V/I ohms by Ohm's law. This really includes the resistance of the meter M but it may be assumed that this is negligible in comparison with the unknown. If it is not the resistance of the meter may be measured and subtracted from the reading obtained.

This method may be made direct reading, or almost so. Suppose that the voltage is adjusted so that the current reads some multiple or submultiple of 10. It is then only necessary to read the voltage and point off the proper decimal or to add the proper number of zeros after the voltage reading. Let us illustrate. Suppose we adjust the voltage until the meter reads 0.001 ampere and that the voltmeter reads 1.25 volts. Then we have Rx equals 1.20/.001, or 1,250 ohms. That is, we multiply the voltage reading by 1,000 to get the resistance.

Reading Higher Resistances

Again, suppose that we have to adjust the voltage so that the meter reading is 44 volts when the current is just 0.001 ampere. The resistance of Rx is then 44,000 ohms. If the unknown resistance is still higher in value we do not necessarily have to use 0.001 ampere as the current reading. We can make it one-tenth as high, or 0.0001 ampere. In that case we have to multiply the voltage reading by 10,000.

There is an error in using the method illustrated in Fig. 2 as was indicated above, because the resistance of the current meter is included in the measurement. If the resistance of the current meter is not known, or if it cannot be measured

(*Continued on next page*)

Right or Wrong?

Questions

(1)—The effective resistance of a condenser and a resistor in parallel is lower the higher the resistance across the condenser and also the lower the higher the capacity of the condenser.

(2)—An automatic volume control operates on the principle of a diode rectifier.

(3)—In an automatic volume control of the diode type the tube is active only half the time, and therefore the bias varies in corresponding pulses.

(4)—Electric power lines near a receiver often increase the apparent sensitivity of a radio receiver.

(5)—Two tubes in push-pull give twice as much output for the same input voltage as a single tube of the same type.

(6)—Two tubes in parallel give the same output as a single tube of the same type for the same signal voltage input.

(7)—The sensitivity of a superheterodyne receiver is greater the closer the coupling between the oscillator and the first detector.

(8)—It is impossible to estimate the intermediate frequency of a superheterodyne by tuning in the same signal at the two different points on the oscillator at which it comes in.

(9)—The quality of a crystal receiver is superior to that of a set in which the detector is a grid bias detector.

(10)—The best way to locate the taps on the voltage divider of a power pack to get the desired voltages is to divide the desired voltage between two taps by the bleeder current. The quotient is the required resistance between these two taps.

Answers

(1)—This statement is true provided that the product of the condenser capacity in farads, the resistance in ohms and the frequency in radians is greater than unity. In most cases where a condenser is used for by-passing across a resistance this condition is satisfied, and it must be satisfied if the condenser is to have any appreciable effect. If the resistance is very large it is possible by means of a relatively small condenser to make the effective resistance negligibly small. For example, if the resistance is one megohm, the capacity of the condenser 0.1 microfarad, and the frequency 550,000 cycles, the effective value of the resistance and the condenser in parallel is only 8.375 millionths of an ohm. If the resistance is one ohm the effective resistance of the parallel circuit is .894 ohm.

(2)—Right. It works in the same manner as the rectifier in a power supply, but the voltage supply is obtained from the carrier of the signal instead of from the power line.

(3)—Wrong. It is true that the tube is active only half of the time, but this bias does not vary in half-wave pulses. The filter, which in most cases is only a by-pass condenser, smooths out the current so that the bias is steady as far as the variations at carrier frequency are concerned.

(4)—Right. The wires seem to guide the waves so that a receiver located near such lines often pick up signals it could not pick up without the wires. This is not due to the fact that the wires are electric but to the fact that they are conductors. A long bridge or a water course does the same thing.

(5)—Wrong. Two tubes in push-pull give no more output for the same input than a single tube, but they give the same amount with less distortion.

(6)—Wrong. Two tubes in parallel give more output than a single tube, because the output impedance of the two is only one-half as great as that of a single tube.

(7)—Right. The output of the first detector is proportional to the product of the voltage induced in it by the oscillator and that induced by the signal. Hence the closer the coupling the greater the sensitivity.

(8)—Wrong. There are several ways in which the intermediate frequency may be estimated quite closely by tuning in the same signal at two points. But the signal frequency tuned in must be known. The simplest way is to calibrate the oscillator dial and note where the same signal comes in at two points. Dividing the frequency differences on the dial by two gives the intermediate frequency. By this method it is not necessary to know the signal frequency, but it is necessary to calibrate the oscillator first. If the condenser on the oscillator is of the straight line capacity type the intermediate frequency may be obtained by the following formula: Fc/4C, in which F is the frequency of the signal tuned in at two places, c the difference in capacity of the condenser at the two settings, and C is the mean of the two capacities obtained by multiplying the two capacities and taking the square root of the product.

(9)—Wrong. This was an error which became accepted as fact when amplifiers were first used immediately after the crystal era, and it was the result of much distortion in the audio frequency amplifier.

(10)—Wrong. This method gives the correct voltages only when no current flows except the bleeder current. It will give entirely wrong voltages if tubes are connected to the B supply. The reason is that current distribution in the voltage divider is different when the tubes take current.

Simplified Measurement of Resistance

(*Continued from preceding page*)

accurately, the method illustrated in Fig. 2 can still be used provided that the voltmeter is connected across the unknown resistance only, that is, so that the current meter is in the lead marked "X."

But even this is subject to inaccuracy, for when the instruments are connected in this manner the current required to operate the voltmeter flows through the current meter. What is then obtained is the resistance of Rx and V in parallel, which is slightly less than the resistance of Rx alone. The other method gives a resistance that is too high. Using both methods and taking the average results in a more accurate value. The second method, that is, connecting the current meter at "X," is more accurate the higher the resistance of V is in comparison with the resistance to be measured.

When To Use Methods

When the resistance to be measured is large so that the resistance of the current meter may be neglected in comparison with it, the method illustrated in Fig. 2 should be used, but when the resistance Rx is small the current meter should be connected in the "X" position.

Since the accuracy of the measurement depends on the relative values of the resistance of the meter and the unknown it is best to use a sensitive current meter when measuring high resistances and less sensitive when measuring low values, because the resistance of a current meter is higher the more sensitive the instrument.

The method illustrated in Fig. 1 is also subject to the same errors and others in addition, for the result is not Rx alone but the entire resistance in the circuit, including the resistance of the battery and that of the current meter. When the differential method is used the undesired resistances are eliminated and only the unknown is obtained. However, as we pointed out previously, the differential method is subject to error due to the difficulty of reading the scale accurately.

In order to reduce the errors of measurement the battery used should have the lowest possible internal resistance. If dry cells are used they should be fresh, for then the resistance of each cell is very small, of the order of 0.05 ohm. If a storage battery is used it should be fully charged, for then the resistance of the battery is extremely small and entirely negligible for all practical measurements of resistance occurring in radio sets. The meter used for measuring the current should have a low internal resistance compared with the resistance to be measured. If the proper current meter is used this will take care of itself.

Elimination of Arithmetic

The use of the method in Fig. 2 eliminates one of the chief objections to the measurement of resistances by an application of Ohm's law, the use of long division. Nobody could possibly object to moving a decimal point. If somebody can't move the decimal point to the correct number of places he would have no use for resistance measurement.

Direct reading ohmmeters, which are favored by many fans, are no more accurate than the instruments discussed above and they are scarcely more convenient. The scale is not linear and therefore it is very difficult to read it correctly unless it happens that the needle points to one of the division lines, which rarely occurs. Moreover, when the resistance is high only a rough approximation to the resistance can be obtained because the lines are so close together and also because the lines are not accurately placed on the scale. The only accurate readings that can be obtained are those of low resistance where the scale divisions are far apart. And even then the accuracy depends on the accuracy of the voltage applied to the meter.

However, a direct reading ohmmeter can be made somewhat more accurate even for the higher resistances by using a higher voltage than is supposed to be used. For example, if the voltage supposed to be used is 1.5 volts and the unknown resistance is such as to put the deflection on the crowded end of the scale, the applied voltage may be increased to 3, when the correct resistance is obtained by doubling the indicated value.

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

Radio University

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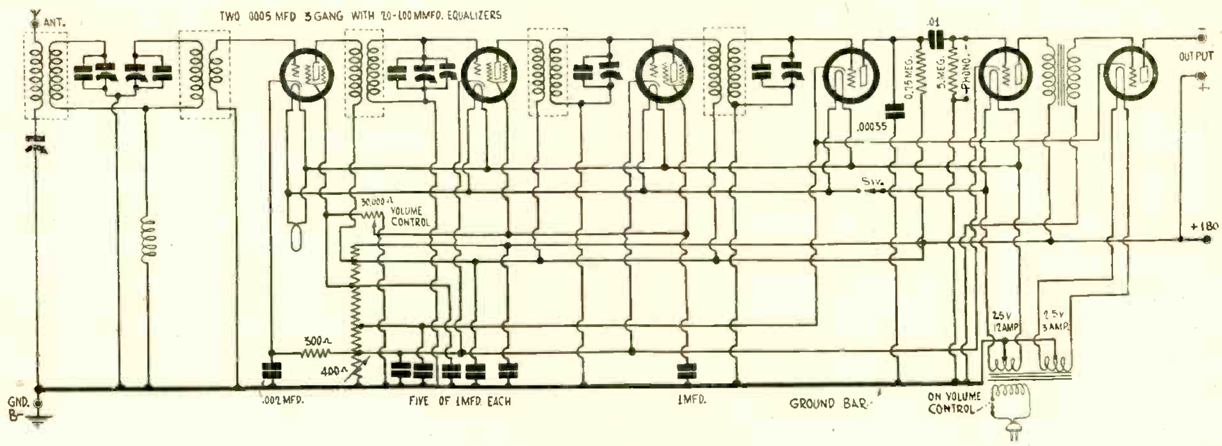

Fig. 890
Five tuned circuit assure selectivity of this receiver and three screen grid tubes high gain

A Six Tube Receiver

PLEASE publish a circuit diagram of a six-tube receiver in which three 224-screen grid tubes are used as radio frequency amplifiers with a band pass filter ahead of the first tube to prevent cross-modulation. Is such a receiver practical? I realize that there will be five-tuned circuits including the two in the band pass filter.—A. W. S.

Such a receiver is reproduced in Fig. 890. It will be practical if you do not make the tuned circuits too selective and if you take precautions against oscillations in the radio frequency amplifier and also if you trim the circuits very carefully by adjusting the inductances as well as the capacities. Perhaps you could select a better receiver, one not having quite so many tuned circuits. For example, you might do better by making one of the couplers in the RF amplifier untuned.

* * *

Receiver Develops Hum

ABOUT a year ago I got a receiver which worked very well without the slightest trace of hum. Then the hum began, and increased in intensity until now it is impossible to listen to the receiver. What could account for this behavior?—W. G. F.

Undoubtedly, the filter in the B supply contains electrolytic condensers. After a certain time they cease to function properly and the hum comes through.

* * *

Automatic B Supply

WOULD it be possible to put a second winding on the radio frequency choke coil in the plate circuit and use this winding for input to the automatic volume control tube? Would it work?—V. M. C.

It is possible, to be sure, but whether or not it would work depends on whether or not there is any appreciable current flowing in the choke coil. If the coil is in a wave trap circuit, that is, if there is a capacity across it, there ought to be enough current to make the arrangement operative. The scheme probably would not work in a tuned radio frequency receiver where the trap cannot be tuned, but it should be practical in a superheterodyne where the trap may be tuned to the intermediate frequency. The arrangement might help to eliminate the intermediate carrier from the input to the audio frequency amplifier.

* * *

Output Transformers and Tubes

I HAVE a push-pull output transformer which is designed for 210 tubes. Could this transformer be used with 231 power tubes to advantage or are the impedances of the two types of tubes too much different to make it feasible?—S. G.

The output impedance of the 210 is of the order of 5,000 ohms and that of the 231 is 4,000 ohms. These are near enough alike to make it practical to use the transformer for either type.

* * *

AC Portable

IN the Feb. 7th issue you published the circuit diagram of a portable receiver utilizing the new 2-volt tubes. Could this receiver also be built with AC heater tubes? If so, will you kindly publish the diagram?—S. P.

The receiver is not practical in the AC form. You would have to carry an AC power plant along with you to operate it.

* * *

More on Motorboating

I HAVE a peculiar noise in my receiver which I have traced to the audio amplifier. This consists of only one stage coupled to the power detector by means of a high resistance, a 0.1 mfd. stopping condenser and a 2-megohm grid leak. Could it be a type of motorboating?—W. H. J.

It is not likely that the trouble is motorboating, for an amplifier of two plate circuits, counting that of the detector as one, is inherently stable. Possibly there is an intermittent contact somewhere.

* * *

Distributed Capacity of Coils

HOW is it that the distributed capacity of duolateral coils decreases with the number of turns? Also, why does the distributed capacity of solenoids remain practically constant for all lengths while it increases with the diameter?—L. W. C.

The distributed capacity between two layers of a duolateral coil has a certain value, but the capacities between successive layers are in series. The more condensers of a given value that are connected in series the smaller the combined capacity. In solenoids the distributed capacity of two turns is proportional to the length of the wire in one turn, or to the diameter of the turn. The reason the distributed capacity of the entire coil is practically constant in respect to length of the winding is rather complex and no simple mathematical explanation has been given.

* * *

Input Capacity of Tubes

DOES the input capacity of a tube, that is, the capacity between the control grid and the cathode, in any way depend on what is connected in the plate circuit of the tube? If so, in what manner does it vary?—G. B.

It does, and it increases with the resistance in the plate circuit. It also increases somewhat with the capacity connected from the plate to the cathode, but after the capacity in the plate circuit becomes large there is practically no further change in the input capacity. In a resistance coupled amplifier the input capacity of a tube followed by a high resistance and having a high amplification constant, the input capacity may be very large, in some cases as high as 350 mmfd.. This capacity results in a decrease in the amplification at the high audio frequencies.

* * *

Foucault Currents

DO Foucault currents work on the same principle as the Foucault pendulum? If not, will you kindly explain how each works?—G. W. C.

No, there is no connection between the two whatsoever. The Foucault pendulum seems to swing around in different planes because the earth turns under it. Actually, the pendulum swings in the same plane all the time, the plane in which it was started to swing. Foucault currents are currents induced in metals because they happen to be exposed to a varying magnetic field, or because they are in a magnetic field. This varying field may be caused by a moving permanent or electro magnet, by an electro magnet carrying alternating or varying current, or by a coil carrying alternating or varying current.

* * *

Converter with Superheterodyne

I HAVE a superheterodyne in which there are two radio frequency stages, a first detector, an oscillator, three intermediate frequency stages, a second detector and two stages of audio frequency. Do you think that this will work with one of the short-wave converters which you have described? If so, which one do you suggest?—L. M.

There is no apparent reason why this superheterodyne should not work with any of the converters which we have described. It has the desirable radio frequency amplification ahead of the first detector. It will do no harm to choose a converter in which an intermediate stage is built in so as to boost the amplification at the broadcast frequency selected for the intermediate.

* * *

Designing Band Pass Filters

WHAT determines the size of the coupling coil or the coupling condenser in band pass filters as used in many broadcast receivers, that is, the type in which two tuned circuits are coupled together with either a small inductance or a large condenser? Please do not explain it in terms of mathematics. I have seen explanations of filter action of this kind and that is the reason I am asking this question?—W. C. F.

In the first place the inductance of the coupling coil or the capacity of the coupling condenser depend on the band width. In the second place coupler constants depend on the frequency at which this band is to occur. The coupling inductance can be computed on the following formula: The inductance equals the inductance of each tuning coil in henries, times the band width in cycles, divided by the frequency in cycles at the lower limit of the band. For example, let the band be 10,000 cycles, the inductance of the tuning coil 160 microhenries, and the frequency at the lower limit of the band 750,000 cycles. The inductance of the coupling coil should then be 2.14 microhenries. When the circuits are coupled by a condenser the values of this condenser in farads is equal to the frequency in cycles at the upper limit of the band multiplied by the capacity of either tuning condenser at that frequency divided by the width of the band in cycles. For example, suppose the tuning condenser is set at 281 mmfd. when the higher limit of the band is 750,000 cycles, and suppose further that the band width is 10,000 cycles. We get .0211 mfd. as the value of the coupling condenser.

* * *

Super with Five IF Stages

WOULD it be practical to build a superheterodyne with five intermediate stages and no radio frequency amplification ahead of the first detector? If such a circuit is not practical, will you kindly give the reason?—J.B.

There are two main reasons why such a circuit is not practical. First, it would be very difficult, if not impossible, to stabilize the intermediate frequency amplifier if all the stages are to contribute their full quota of amplification. Second, since there is no radio frequency amplification ahead of the first detector there is not likely to be any selectivity in the radio frequency level. If there is not, image interference will practically spoil the receiver.

* * *

Type of Band Pass Filter

WOULD it be possible to make a band pass filter by linking a series of tuned circuits and tuning them to the same frequency? What I have in mind is a number of radio frequency transformers with equal primaries and secondaries, the secondary of one being connected with a condenser to the primary of the next, the two windings being tuned by the condenser.—B. W. F.

Such a filter can be constructed and it will be a band pass filter provided that the coupling between each primary and its secondary is loose. If it is close the band will be so wide as to spoil the band pass characteristic.

* * *

About the Ground Wave

DOES the so-called ground wave in radio travel through the ground between the transmitter and the receiver? Is sky wave that part of the signal which travels through the air?—C. B. W.

The so-called ground wave does not travel through the ground but along the surface of the ground in the air. That is, the ground wave is that part of the total wave which is "earth-bound." The sky wave is that part which shoots up to high altitudes, from 200 to 400 miles up, and then is returned to ground by reflection by the Heaviside layer. While part of the so-called ground wave may travel through the ground, it is not essential that it do so. That the ground wave travels through the ground is a misconception.

* * *

Constancy of Inductance

DOES the inductance of a coil that is wound in a threaded groove remain absolutely constant so that it could be used for a constant frequency, calibrated oscillator? If not, what kind of coil should be used?—B. L. W.

Such a coil does not remain constant because the size of the form and the length of the wire change with temperature. Of

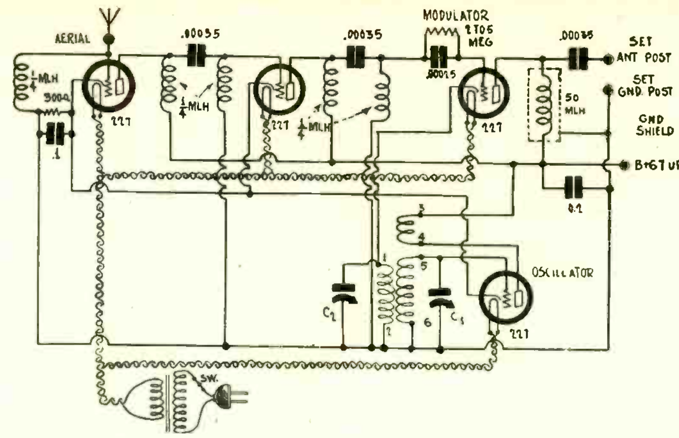

FIG. 891

The circuit of a short-wave converter utilizing two RF stages.

course, this is true of all inductances. The threaded-wound oscillator would remain more nearly constant than many other coils because there could be no relative movement of the turns in the axial direction. The frequency will change with temperature both because the inductance of the coil and the capacity of the tuning condenser change with temperature. This change will be small, however, and will be negligible for most practical purposes.

* * *

Four-tube Converter

I SHOULD like to have a circuit diagram of a four-tube converter in which there is only one tuner, that of the oscillator, I prefer to have two radio frequency stages ahead of the modulator tubes, and these should be coupled by means of small inductances such as you have been recommending for short-wave converters.—V. A. W.

Fig. 891 is such a converter. Omit condenser C2 across the pickup coil and make this coil small, say about one-third as many as on the oscillator tuned winding.

* * *

Converters and Foreign Stations

WHAT is the chance of receiving foreign short-wave stations with the converters which you have published? I have an up-to-date radio receiver with which I can get almost every station in the United States and Canada. I understand that the sensitivity of a short-wave converter depends directly on the sensitivity of the broadcast receiver with which it is used.—R. B. Y.

The chance is very good since you have a sensitive receiver. There is no assurance, however, of picking up signals from the other side of the Atlantic. All that can be said is that many have received foreign short-wave stations with these converters. It is largely a matter of skill in tuning for the weak stations and selecting the proper time for doing the tuning. At some time of the day there is no chance whatsoever of picking up stations across the Atlantic, but at those times the chance of picking up short-wave stations from South America is good.

* * *

Coupling Choke Design

HOW large should a coupling choke be to be effective as a 20,000 ohm resistance at a frequency of 1,500 kc, the lower frequency limit of the short-wave band? Which is preferable, a choke or a resistance for coupling the antenna to the first tube in a short-wave converter.—W. A. J.

The inductance of the choke should be 2.12 millihenries. A choke will eliminate to some extent the low frequencies, which is somewhat of an advantage, whereas a resistance is equally effective at all frequencies.

* * *

Heaviside Layer Height

BY what means do they determine the height of the Heaviside layer when that layer is much higher up than any airplane or balloon has ascended, and when they do not even know for sure that is exists? Is the whole matter guesswork?—S. J.

Nobody pretends to measure the height of the layer very accurately. Neither does anybody claim that the layer is well defined within narrow boundaries. However, experimenters have discovered phenomena which tend to show that there is a layer and that this layer is at an "effective" distance above the ground. It is this effective distance which is measured approximately. The measurement is based on the supposition that the layer acts as a mirror reflecting the waves back to ground. A transmitter and a receiver are located on the ground at a known distance apart. A signal pulse is sent from the transmitter. This pulse is received twice at the receiver, once directly from the transmitter and again by reflection from the layer, the time elapsed between the reception of these pulses is accurately measured. From this time, the known rate of speed of the radio wave and the known distance between the transmitter and the receiver it is possible to compute the height of the reflecting surface above the ground half way between the two stations.

PUPILS LEARN BETTER BY AIR, TESTS REVEAL

Madison, Wisc.

Radio as a means of instructing school children has scored a victory over its human rival in the school room in tests conducted in 25 public schools of Wisconsin by Prof. H. L. Ewbank, of the University of Wisconsin.

Taught by radio, pupils in the sixth, seventh, and eighth grades of the twenty-five schools passed with higher marks on written tests in current events than those in another twenty-five schools on identical material taught by teachers in persons.

Radio also scored in music instruction, as evidenced by pupils' progress tests. The children were successfully taught rhythm, singing, music appreciation, and facts about composers and instruments by means of radio.

"The radio program," according to an observer quoted by Prof. Ewbank, "expanded immensely the pupils' interest in people and things and events. It brought about the fuller reading of newspapers and magazines, of investigation into books and encyclopedias.

"It brought about discussions with other members of the family and even induced them to 'listen in' in their own homes during the radio hour. Particularly in the schools a little distant from the city, children repeatedly expressed their appreciation of these radio programs as a means of equalizing educational opportunity."

X-Ray Is Used As Tool To Drive Home a Screw

Palo Alto, Cal.

Professor Perley Anson Ross, of the Physics Department of Leland Stanford, Jr., University, has shown in a remarkable demonstration conducted here recently, that it is possible to utilize the phenomenon of bombardment with X-rays for the purpose of driving wood screws.

The demonstration conclusively proved that X-rays have properties rather more similar to bullets than the popular wave theory encouraged. The screw to be driven first is started in the wood with an ordinary screwdriver, then the X-ray beam is aimed at the head of the screw.

NEW MUSICAL INSTRUMENT

Germany.

Two inventors, one a physicist, and the other an electrical engineer, claim to have perfected a new type of electrical reproducing instrument to augment the ranks of orchestral musical instruments. The name of the new device is the Hellertion, and it is inspired by an idea due to Dr. Lee DeForest relative to a method whereby electrical tones may be altered at will by a touch of the finger. The frequency range is from 16 to 3,000 clcles.

LICENSE DATES CHANGES

Washington.

The Federal Radio Commission has recently announced that the expiration dates of broadcasting stations are changed and will expire on April 30th and October 30th. The license periods were changed to conform to the Commission's recess periods.

Stations Clash Over Position

Washington.

WWL, New Orleans, has requested the Federal Radio Commission for permission to operate full time on the channel on which it is now permitted half time, sharing with KWKH, Shreveport, La. WWL, operated by Loyola University, also requested authority to increase its power from 5,000 to 10,000 watts and to change the location of its transmitter.

Recently W. K. Henderson, owner of the Shreveport station, was heard on his application for full-time operation on the 850 kc. channel, seeking to displace WWL from its half-time assignment. Examiner Elmer W. Pratt recommended that the application of KWKH be denied both as to full-time operation and the increase of power from 10,000 to 30,000 watts.

WESTINGHOUSE BUYS CONCERN

The electrical supply distributing business of Stanley & Patterson, Inc., whose sales amount to more than $5,000,000 annually in the New York metropolitan district, has been purchased by the Westinghouse Electric Supply Company, distributing subsidiary of the Westinghouse Electric and Manufacturing Company. The company's assets were acquired for cash. The purchase will be confined to the distributing organization of Stanley & Patterson. The signal and radio manufacturing branches of the business are not included in the sale. George Patterson, president and principal stockholder of Stanley & Patterson, will retain control of the company, while a new company, the Stanley & Patterson Electric Supply Company, will be formed by Westinghouse to carry on the wholesale business in the metropolitan area.

JENKINS MOVES TO PASSAIC

The offices, laboratories and production facilities of the Jenkins Television Corporation, formerly in Jersey City, have been moved to Passaic, N. J. Meanwhile, a new location is being sought for the Jenkins radiovision transmitter, W2XCR.

A THOUGHT FOR THE WEEK

VELVA DARLING, graduate of Stanford University and one of the Pacific Coast's best known feminine newspaper reporters, recently gave a talk over the air for the United Broadcasting Co. in Los Angeles. The network included Stations KVOS, KORE, KTAB, KBG, KFWB, KXA and KMED. Her subject was titled, "Does It Pay a Girl to be Good?" The idea of the United crowd is "to parallel the activities of the metropolitan dailies"—meaning, presumably, the tabloids. Now let's see how far the Federal Radio Commission will permit Miss Darling to go in her candid discussion of the things which the tabloids handle so freely and often in such atrocious taste. If a man's home is his castle and the air belongs to us all and nearly everybody has a radio, let us suggest to Velva Darling that she watch her step.

Wiring of Homes to Increase Market

Washington.

A potential market for the sale of electrically operated sets is revealed in a recent statement of the Electrical division of the Department of Commerce to the effect that less than one-third of the nation's total homes is wired.

In addition to this, new construction has added to this total. At the beginning of the New Year there were 8,600,000 new homes, and of this number the records show to date that about 43.6 per cent of these are to be wired. The estimates are compiled on the basis of sales of electrical appliances, and construction contracts. The former is supposed to be a reliable indicator of the trend of electrification, which was begun in the first instances in the more crowded sections in the immediate service area of the power stations.

Since 1927 the rate of wiring homes in the small communities, and towns, etc. has been on the increase, has the wiring programme in the resident industrial sections. The total number of wired homes in the United States is estimated at 19,721,486, so the potential market for the sale of radio receiving equipment, and replacements judged by the above, and keeping in mind the fact that new construction is keeping well ahead of the number of completely wired homes, means that the saturation point in this regard is still happily far away.

Work on Radio City To Be Begun in Spring

Construction work on the group of buildings to be known collectively as Radio City is to be begun in New York in the Spring, announced Hugh S. Robinson, of Robinson & Todd, construction engineers supervising the work for John D. Rockefeller, Jr.

The building, as tentatively planned, is to be a 65-story skyscraper. The property on which it is to be built is bounded by Forty-eighth and Fifty-first streets, and by Fifth and Sixth avenues. The lower portions of the building as planned at present are to consist of two thirty-story groups. The plans as originally made called for the commencing of the constructional program this month, but the inclusion of the new Metropolitan Opera House within the plans has necessitated some delay.

There was some opposition to this move by some of the older subscribers, who only recently acquiesced to the proposed new location of the opera house, and the space had been allotted to other prospective tenants. The result was that the Opera House will be accommodated, while the other prospective tenants will be taken care of by revised plans.

Court Opposes Station Change Without Hearing

Washington.

The Court of Appeals of the District of Columbia has ruled that the frequency and time assignments of the broadcasting stations may not be altered unless the parties involved are given a hearing before a judicial body. This pronouncement is contained in an opinion in which the recent Federal Radio Commission order, proposing the shifting of at least a score of cleared channel stations, was voided.

Among the stations involved in the proposed transfer were WHAS, of Louisville, Ky., and WHAM, of Rochester, N. Y.

NAVY'S PART IN RADIO IS TOLD BY AN OFFICIAL

Washington.

In a recent address broadcast over the National Broadcasting Company's network the part played by the United States Navy in the development of the art of broadcasting was reviewed by the Assistant Secretary, Ernest Lee Jahncke.

The Assistant Secretary reminded his audience that the early broadcasts from the Naval radio station, at Anacostia, antedated the first broadcast from KDKA, of the Westinghouse Company, an instance being the broadcasting of music when President Roosevelt sent the fleet around the world in 1907.

Built First in 1900

In addition to this the Naval station communicated with the amateurs, sending data relative to general developments in the art, and other matter, and in the intervening years became one of the outstanding stations of the world.

The Navy Department made the first broadcast station installation in 1900, and the component parts had to be imported, but the interest thus created stimulated the development of Apparatus by our native manufacturers, the Secretary added.

The success of the early experiments of Marconi attracted the attention of the Naval Officers, and it was soon shown that radio waves would be the ideal means of communication with ships at sea. Reverting to the present commercial aspect of the art, Mr. Jahncke drew attention to the statistics of last year, which show that at least $50,000,000 was expended by the various sponsors to bring the broadcast programs to their present level. The public over the same period spent a grand total of $400,000,000 for the purchase of receiving equipment.

America Radiominded

The American public has become increasingly radio-minded, he said, and the development will have to keep step with the increasing demands made upon it. The present scope is even beyond the imagination of those who founded this great institution, he declared.

Board Seeks to Quash Writ Obtained by KOMO

Washington.

The Federal Radio Commission has filed a motion with the Court of Appeals of the District of Columbia to dismiss the appeal of KOMO, of Seattle, Washington, from an order of the Commission that denied an application for a construction permit. The application was for permission to operate on the 970 k.c. channel, using 5,000 watts power. This assignment was granted to KJR, also of Seattle, operated by the North Western Broadcasting System.

The motion to dismiss asserts the Court of Appeals, under the Radio Act of 1927, as amended on July 1, 1930, does not have jurisdiction to entertain a proposed appeal from an order of the Commission which denies an application for a construction permit. The right of appeal from decisions of the Radio Commission, it is also contended, is statutory and not a matter of right.

Literature Wanted

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

Wm. A. J. Frenzel, 34 Wren St., Rochester, N. Y.
Wm. A. Lewis, 19 Willard St., Hartford, Conn.
John Dean, 196 Claremont Ave., Jersey City, N. J.
Rev. George E. Poirier, 5 Water St., Springvale, Maine.
L. C. Berg, 112 S. Cass Ave., Westmont, Ill.
Harold A. Neiswanger, 402 "A" St., Keokuk, Iowa.
N. L. Clark, 2759 Sharon Ave., Dallas, Tex.
M. Alfaya, Asbury Park Lodge No. 128, Order of Elks, Asbury Park, N. J.
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Clinton C. Whittier, 1½ W. Canal St., Penacook, N. H.
Carl H. Waltry, Jr., 1355 Albany Ave., Brooklyn, N. Y.
Gordon H. Ankeney, 3810 7th St., Des Moines, Ia.
C. A. McBeth, Bucyrus, Ohio.
James L. Brown, 2230 Proctor St., Flint, Mich.
Russell Wooley, 132x N. Main St., Manasquan, N. J.
Franklin Porter, 526 Blackhawk Blvd., Beloit, Wis.
T. T. Adams, 529 EZ St., Berwick, Pa.
Carl Jablonsky, Box 54, Cecil P. O., Pa.
Clarence Chedell, 920 Kansas City St., Rapid City, S. D.
Tellner Radio Service, 359 Flatbush Ave., Brooklyn, N. Y.
H. B. Kennedy, Spindale, N. C.
Home Radio Service, 1001 W. Stuart St., Owosso, Mich.
W. A. Copeland, Biltmore Apt., 310, St. Paul, Minn.
Sudney M. Burk, 4917 Greene St., Philadelphia, Pa.
F. H. Wilson, Box 23, Kaleva, Mich.
Geo. G. Kirkland, 515 W. Main St., Decatur, Ill.
William Prestley, 5636 Wabash Ave., Chicago, Ill.
Alex McLaren, 5160 Linwood Dr., Loughlin Park, Hollywood, Calif.
Vernon Steckel, 3149 Maple Leaf Ave., Pleasant Ridge, Cincinnati, Ohio.
John M. Kaar, 1312 Parkinson Ave., Palo Alto, Calif.
Arthur C. Wright, Collins, Ont., Can.
E. C. Kirk, 3028 W. Walton, Spokane, Wash.
Guy Manning, Box 304, R. 9, Sta. K, Cincinnati, Ohio.
Closson's Radio Service, 4034 Shelmire St., Mayfair, Philadelphia, Pa.
Geo. G. Moyer, 2002 Noble St., Swissvale, Pa.
Hugh Brown, 8387 American, Detroit, Mich.
C. J. Smith, P. O. Box 38, Bozeman, Mont.
Lewis Allon, 63 W. Main St., Amsterdam, N. Y.
Dr. M. Carlton Vaughan, 506 W. Utica St., Buffalo, N. Y.

WHITEMAN ON AIR WEEKLY

The famed "King of Jazz," Paul Whiteman, and his orchestra will be heard, 8.30 to 9 p.m., Eastern Standard Time, over the National Broadcasting System network. The program will originate from Chicago (7.30 to 8 p.m., C.S.T.) and will be a weekly feature during the same half hour. The Allied Quality Paint Group is sponsor.

WORTH THINKING OVER

THREE years ago technical radio books were a drug on the market. Some wholesale book concerns threw them out of stock. Folks who were smart but not smart enough said that the market for radio books had sunk, never to rise again. Then something happened. As the science and art of radio became of fixed value and men learned how to write for those who seek technical knowledge in the printed page, the demand for radio books began to grow. In 1929 and 1930 more radio books were sold than in all the preceding years. And the demand keeps up. So Bernard Shaw was right when he said that you never can tell.

Art Advances Fast, Saltzman Declares

Washington.

Charles McK. Saltzman, Chairman of the Federal Radio Commission, said the progress of radio has been continuous despite business conditions.

The general trend of administrative policy in the radio field has lent a distinctively improved tone to the quality of programs both from the technical as well as the practical utilitarian viewpoint, he remarked.

The improved service in the broadcasting field has attracted a larger audience of listeners, and the effect is beginning to be reflected in the upswing of sales of new receivers, he remarked, and the installation of new equipment by the broadcasting stations.

Radio was an intangible thing only ten years ago, when KDKA broadcast the election returns of the Harding-Cox Presidential campaign. In the interval the radio art has established itself as part and parcel of the nation's fabric, he added. With the estimated number of receivers in use totaling 14,000,000 and the turnover in business being of the order of $1,000,000,000 the radio activities are truly a factor of the world's commerce.

16 Applicants Lose New Station Pleas

Washington.

The Federal Radio Commission has recently denied petitions for sixteen new stations, due principally to failure of petitioners to appear or to request re-hearing. Eight other applicants were denied license modifications. There were four broadcast applications granted, as follows:

WRBI—Tifton, Ga. Permission to install new equipment and increase power from 20 to 100 watts.

WSOC—Gastonia, N. C. Ownership transferred to WSOC, Inc.

KDKA—East Pittsburgh, Pa. Granted permission to add two more tubes to the last radio stage, so that full output of 50 kw may be had.

KFPW—Fort Smith, Ark. Granted permission to broadcast a test program for the purpose of checking frequency with the radio inspector.

In addition there were twenty commercial applications granted, these being shared by Press Wireless, Inc. and Western Radio Telegraph Co.

Seth Parker Preferred to Heifetz By "Horde"

The National Broadcasting Company sent out for publication the following:

"Music critics have hailed Jascha Heifetz as a superb violinist but he is just a 'pesky fiddler' to a horde of radio listeners, according to letters recently received by NBC. The letters—even petitions from isolated communities—poured in after Heifetz made his radio debut over an NBC network.

"It was not that the listeners disliked the 'pesky fiddler,' but that he usurped some of the time customarily given to the broadcast, Sunday at Seth Parker's.

"'You did a great thing in bringing Heifetz to us but not on Seth Parker's time,' a Texan wrote. He (Seth) is preaching an old-fashioned gospel and America is listening.'

"'We get violin music all week, but there is only one Seth Parker program,' complained a Sacramento, Calif., listener."

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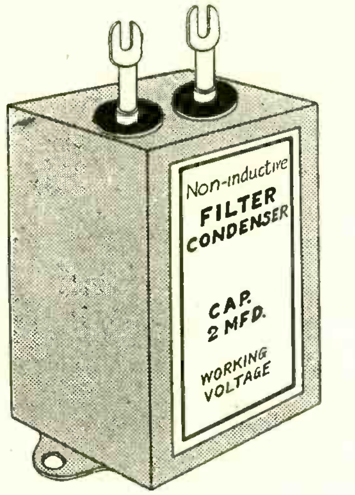
FILTER CONDENSERS



Flechtheim filter condensers for circuits using 245 output tubes, singly or in push-pull, or other circuits using lesser B voltage. Illustration is actual size. Capacities are 1 mfd. and 2 mfd. Continuous working voltage, 800 volts DC, 400 volts AC root mean square. Tested at 1,000 volts DC. Breakdown voltage 1,500 volts DC. Equipped with mounting feet.

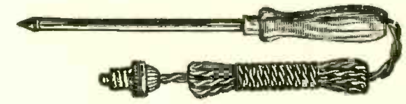
Two condensers of 1 mfd. sent free with each 6 months' subscription at $3.00. Order PR-HVD-1.

One condenser of 2 mfd. free with 6 months' subscription at $3.00. (26 issues). Order PR-HVS-2.

Your Choice of NINE Meters!

To do your radio work properly you need meters. Here is your opportunity to get them at no extra cost. See the list of nine meters below. Heretofore we have offered the choice of any one of these meters free with an 8-weeks subscription for RADIO WORLD, at $1, the regular price for such subscription. Now we extend this offer. For the first time you are permitted to obtain any one or more or all of these meters free, by sending in $1 for 8-weeks' subscription, entitling you to one meter; $2 for 16 weeks, entitling you to two meters; $3 for 26 weeks, $6 for 52 weeks, entitling you to six meters. Return coupon with remittance, and check off desired meters in squares below.

SOLDERING IRON



Works on 110-120 volts, AC or DC; power, 50 watts. A serviceable iron, with copper tip, 5 ft. cable and male plug. Send $1.50 for 13 weeks' subscription for Radio World and get these free! Please state if you are renewing existing subscription. Order PR-SO.

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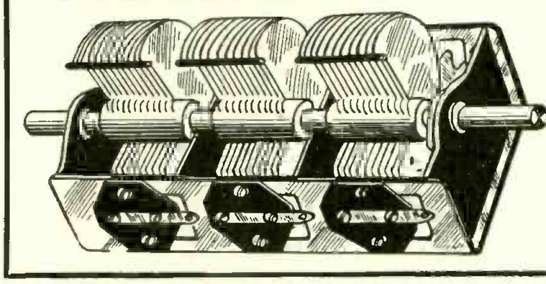
First stage, de luxe (illustrated), primary, in detector circuit, has 200 henrys inductance at 1 milliampere; turns rotio, 1-to-3. Order PR-AMDL, free with 1½ years' subscription at regular rate **$9.00**

Push-pull input transformer, turns ratio, 1-to-2½; single primary; two separate windings for secondary. Order PR-AMPP, free with 2½ years' subscription @ **$15.00.**

These audio transformers are recognized as being predominant. They afford tone realism unexcelled and deliver fully adequate volume. You can never go wrong with Amertrans. And remember that RADIO WORLD circuits show how best to use these transformers. Read RADIO WORLD weekly.

THREE-GANG SCOVILL .0005 MFD. WITH BRASS PLATES



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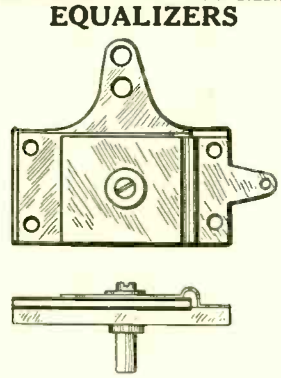

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