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1931

Converter With B Supply

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RADIO WORLD

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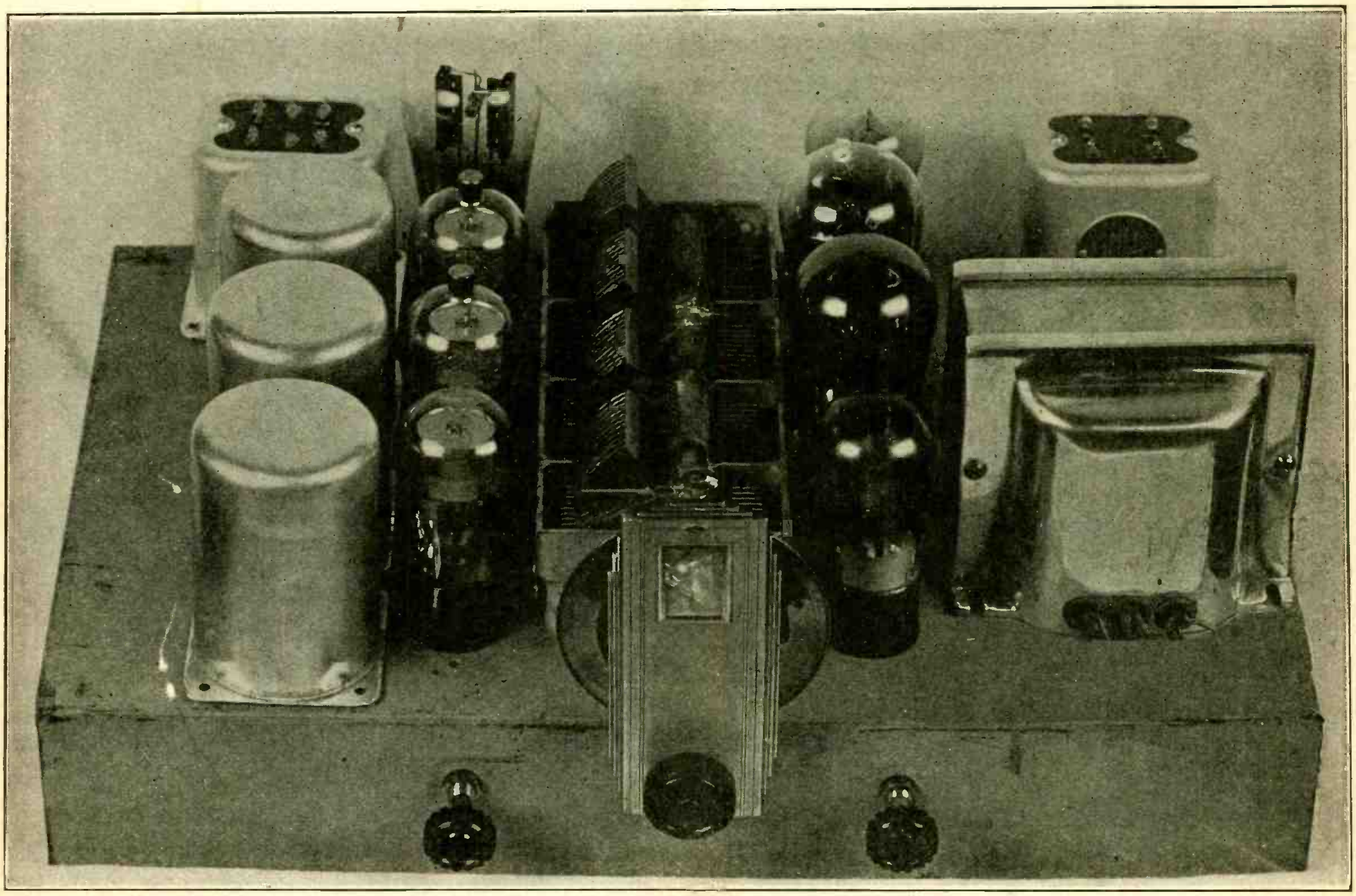
The First and Only National Radio Weekly

462d Consecutive Issue—NINTH YEAR

PICTURE DIAGRAM OF 1-A UNIT SW CONVERTER

A FULLY FILTERED CIRCUIT



See Pages 12 and 13 for Construction of the Fully Filtered Circuit

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.

Why Not "Money Back" on Tubes?

Any Lesser Guarantee Inadequate in Present Market

Standard 201A with UX base.

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.

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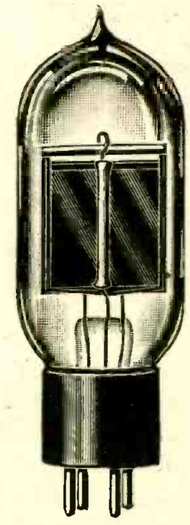

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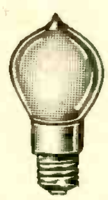
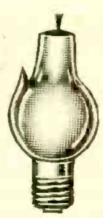
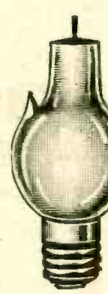


The 2-ampere charger, new type.



The 2-ampere charger, with a connector at top.



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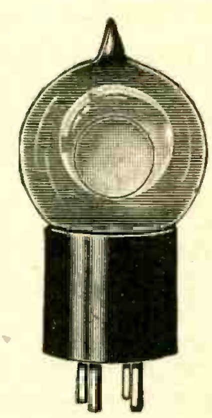
High-mu tube for battery operation, equivalent to the 240, but listed as 201A high mu.



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☐ RX-4 @ 1.00	☐ RX-14 @ 1.00	☐ RX-24 @ 1.00	☐ RX-35 @ 4.95
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Technical Accuracy Second to None
Latest Circuits and News

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The Band Pass Diamond

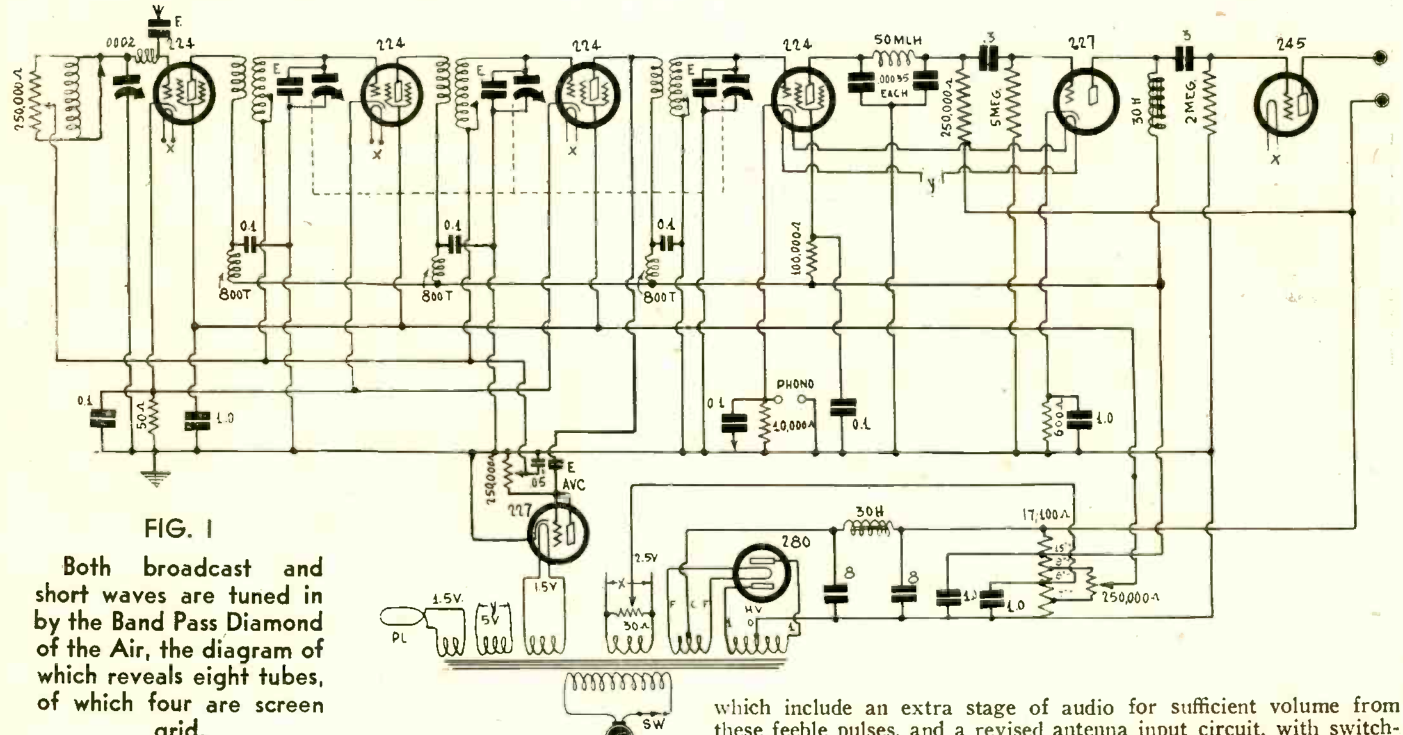


FIG. 1

Both broadcast and short waves are tuned in by the Band Pass Diamond of the Air, the diagram of which reveals eight tubes, of which four are screen grid.

THERE is a surprise in the diagram of the Band Pass Filter Diamond of the Air, shown in Fig. 1, and that is the inclusion of a short-wave feature.

The circuit has been shown for broadcast use, but is presented herewith with such changes as necessary to bring in short waves, which include an extra stage of audio for sufficient volume from these feeble pulses, and a revised antenna input circuit, with switching in four stages.

The simplest way to provide for short waves is to use a switching device. You have your choice of a multiple switch, to throw four poles at one flip, or of separate switches. The choice made in the present instance was by all means for the separate switches,

(*Continued on next page*)

LIST OF PARTS

Coils

One shielded antenna coil for .0002 mfd. tuning, with switch built in.
Three interstage couplers for .0005 mfd. tuning, tapped at 10th turn, with switch built in.
One ¼ millihenry radio frequency choke coil.
One 50 millihenry radio frequency choke coil.
Three 800-turn duolateral choke coils.
One power transformer.
Two 30-henry choke coils (one for B filter, one for first AF).

Condensers

One .0002 mfd. Hammarlund junior midline condenser.
One .0005 mfd. three-gang Scovill condenser, brass plates.
Five Hammarlund equalizing condensers, 20-100 mmfd (three for condenser gang, one for series connection to aerial, one for AVC.
Five blocks of triple 0.1 mfd. condensers, three condensers in each case; two blocks used with red leads interconnected for audio blocking condensers.
Four 1.0 mfd. 200-volt condenser.
Two Aerovox 8 mfd. dry electrolytic condensers.
Two .00035 mfd. fixed condensers.

Resistors

One 50-ohm flexible biasing resistor.
Three 250,000-ohm potentiometers.
One 250-000-ohm metallized pigtail resistor.
One 5 meg. metallized pigtail resistor.
One 30-ohm center-tapped resistor.
One 2 meg. metallized pigtail resistor.
One 100,000-ohm metallized, pigtail resistor.
One 10-000-ohm metallized pigtail resistor.
One 600-ohm wire-wound resistor.
One multitap voltage divider (17,100 ohms)

Other Parts

One Benjamin switch (for phonograph).
Three moulded bakelite twin assemblies. (speaker, phonograph, antenna-ground).
One National modernistic drum dial with 1½-volt bulb.
One 17½ in. x 9 in. metal subpanel, with six five-prong (UY) sockets and two four-prong (UX) sockets.
One AC switch, shaft type.
Hardware, consisting of three milled bushings, three dozen 6/32 machine screws, three dozen nuts to match.
Accessories: Six insulating washers for potentiometers, six soft rubber grommets.

A Short-Wave Conver
Intermediate

By J. E.

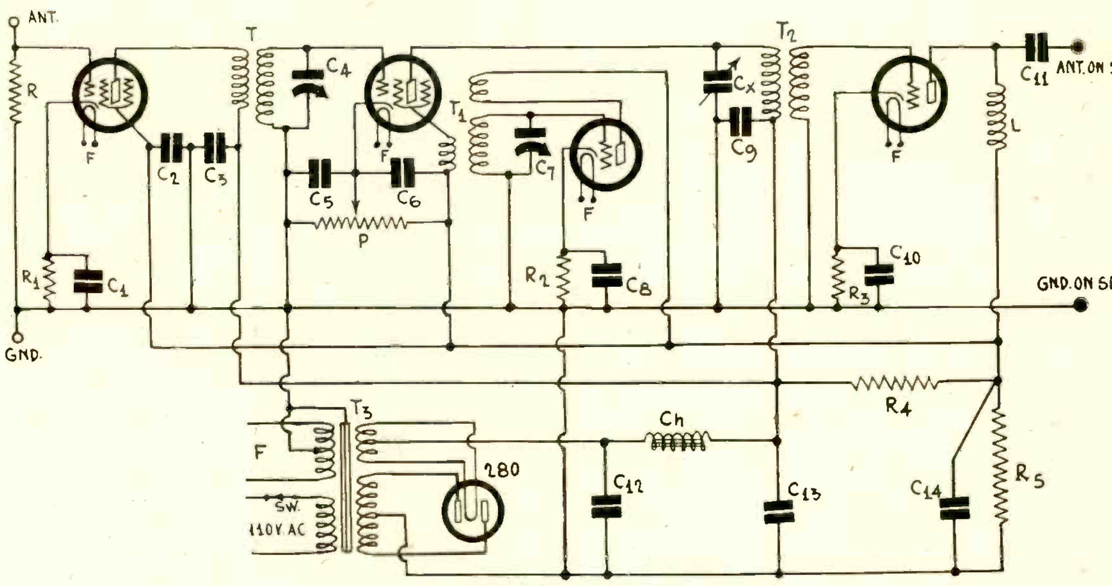


Fig. 1
The circuit of a four tube short-wave converter with the power supply built in. It is especially suitable for use with broadcast receivers which are not very sensitive.

SHORT-WAVE converters are almost invariably successful in bringing in short-wave signals if they are connected to the receiver the proper way. Now and then a complaint is made that a converter does not produce signals when used with certain receivers. Such complaints usually result from one of three causes: first, that the oscillator does not function; second, that the receiver with which the converter is used is not sensitive enough; third, that the B supply is not correct.

Lack of oscillation is usually traced to a defective oscillator tube or to insufficient voltage on the heater or filament. Of these lack of voltage on the heater is perhaps the more common.

Failure to give results due to comparative insensitivity of the receiver with which the converter is used is most common of all, for converters are frequently used with old receivers which do not bring in distant stations when used for broadcast reception and the sets are used in such manner with the converter that they loose a great deal of the sensitivity that they do have. The difficulty is usually in the coupling between the converter and the receiver.

LIST OF PARTS

Coils

T—One set of RF transformers as described.
T1—One set of oscillator coils as described.
T2—One radio frequency transformer, one-to-one ratio, for .0005 mfd.
T3—One Polo 180 volt power transformer.
Ch—One Polo 30 henry choke coil.
L—One 50 millihenry radio frequency choke coil.

Condensers

C1, C2, C3, C5, C6, C8, C9, C10—Eight Supertone 0.1 mfd. by-pass condensers.
C4,C7—Two .0002 mfd. midget variable tuning condensers.
C11—One .00035 mfd. fixed condenser.
C12, C14—Two 2 mfd. by-pass condensers.
C13—One 4 mfd. by-pass condenser.
Cx—One .0005 mfd. tuning condenser.

Resistors

R—One 250,000 ohm coupling resistor.
R1—One 300 ohm grid bias resistor.
R2, R3—Two 1,000 ohm grid bias resistors.
R4—One 10,000 ohm resistor for voltage divider.
R5—One 6,500 ohm resistor for voltage divider.
P—One 30,000 ohm potentiometer.

Other Parts

Four binding posts.
Five UY sockets.
Two UXXX sockets.
Two dials.

Tubes

Two 224, two 227, one 280; total, five tubes.

Incorrect B Supply

Many times a converter has been tested and found to work satisfactorily only to fail completely when connected up by another. In such cases the trouble almost invariably is that the converter does not get any plate voltage. Perhaps the positive lead goes to the proper voltage but the B minus may not be connected at all. In other cases the B minus is taken care of by the common ground but the B lead is not connected properly. Sometimes the lead is connected to a plate of a tube in the set in such manner as to short-circuit the signal. Sometimes the B plus outlet is connected to a screen in such way that there is a high resistance in series which causes high drop in the voltage and the converter tubes do not get enough to function.

To avoid these difficulties the converter is built with a stage of intermediate amplification with an output tube such that it matches the input impedance to the broadcast receiver and also with a B supply of its own. If a radio frequency amplifier also be built into the converter the sensitivity of the converter and the set will be satisfactory.

Noisy Reception

Other complaints with converters are that they are noisy, and these complaints are about those that do bring in signals, that is, those that are sensitive. If the signals are noisy that is not the fault of the converter, because the noise comes in from the outside and it is only an indication that the circuit is adjusted to high sensitivity. There is no more noise in the short-wave signals than in the broadcast signals if the intensities of the signals are the same. Indeed, there may be less noise in the short-wave signals, especially on signals of less than 50 meters. In many localities the broadcast stations come in with so much noise that it is impossible to enjoy the programs, but the short-wave stations come in with practically no noise. This is particularly true in the sub-tropics in Summer.

Some persons who have got short-wave converters complain that they 'do not work" but bring in only code, lots of that. Well, if a short-wave converter brings in lots of code, it works well, for the code is carried on short-waves and it could not come in if the circuit did not work. If the converter does not bring in short-wave broadcast stations it is because no such stations are working within range or, more likely, because the converter has not been tuned properly. Hence if the converter brings in code, all that is necessary is to tune properly and turn up the volume control. If still nothing comes in, except code, there is no voice-modulated station on the air at the time within range of the receiver.

The diagram in Fig. 1 is that of a converter designed especially to overcome the objections mentioned above. It has a built-in B supply so that there can be no error in connecting up the converter

ter with B Supply and Stage Built In

Anderson

to any radio receiver, and also a filament winding so that there will be no question about adequacy of heater voltage.

It has a stage of RF ahead of the modulator so that the signals will be amplified before they are mixed with the local oscillation. It has an intermediate frequency stage after the detector so that the amplification in this level will be high even if the broadcast receiver is not sensitive by itself. Since the last tube is a 227, which has a low impedance, the coupling between the antenna circuit and the converter will be matched and there will be very little transition loss.

The circuit is essentially the same as that of the de luxe four tube converter published in the November 15th issue, which is one of the most sensitive converters operated by the writer. However, it is an improvement over that circuit in that it has a built-in power supply. That circuit had only a filament transformer.

Another change is that a resistance R of 250,000 ohms is used in the antenna circuit in place of a small choke coil. The resistance will give a greater sensitivity but the choke will pick up somewhat less static and similar interference. The resistance makes the sensitivity so much greater that it is well worth while to use it.

Method of Modulation

The method of modulation is the same in the two circuits, that is, the oscillation is introduced into the modulator tube by way of the screen, and grid bias detection is used.

The plate circuit of the modulator tube contains a circuit tuned to the intermediate frequency. This is done for two reasons, first, to insure a high impedance load on the modulator at the intermediate frequency, and second, to provide a by-pass condenser for the high frequencies. Thus CX serves two purposes.

While it is possible to use any intermediate frequency in the broadcast band, it is best to use that at which the broadcast receiver is the most sensitive. If it is equally sensitive throughout the tuning band the intermediate frequency should be either 1,500 kc, or higher, or 550 kc, or lower. If a frequency is decided on it is possible to select a coil, the primary of T2, which will tune in the desired frequency with a midget condenser of the trimmer type. But a small condenser cannot be used to cover the entire broadcast band for the selection of any frequency therein. Hence if it desired to have the choice of any frequency from 550 to 1,500 kc, the condenser should be at least 500 mmfd. It need not be represented by a control on the panel, because after the intermediate frequency once has been selected for a given broadcast receiver there is little need of changing it again so that the tuning of CX may be left fixed. Neither is it desirable to change it for every time it is changed the tuning characteristic of the RF circuit is changed and also that of the oscillator.

One side of the condenser CX is grounded and the tuned circuit is completed by means of condenser C9. If the CX is fixed it is not necessary to ground it, as it may be connected directly across the winding, but if it is a large tuning condenser it is best to connect as in the diagram.

Controlling Volume

It is important to have a volume control on the converter even though the broadcast receiver with its volume control is close at hand, because the signal intensity range will be very large and two controls are desirable. In this circuit the control is the potentiometer P, which is connected between the screen return and ground, with the cathode of the modulator tube connected to the slider. When the slider is moved to the left, that is, toward the ground, the bias on the tube is reduced and at the same time the screen voltage is increased. The circuit will work somewhat below maximum sensitivity when the cathode is grounded and the point of maximum sensitivity will be found when the slider is a short distance to right of the ground end. As the slider is moved still farther to the right, that is, toward the positive end of the resistance, the volume will decrease and a point will be found where the set is entirely dead. Thus there is a wide volume control range.

The filament and plate voltages are supplied by a power transformer L3 and a 280 rectifier. This transformer has one 2.5 volt filament winding which supplies the four tubes in the converter and one 5 volt winding for the rectifier filament. The high voltage winding is such that the output voltage is 180 volts after the filter. This high voltage is applied to the plate of the two screen grid tubes. A voltage of 75 volts is applied to the plates of the two 227 tubes and the screens of the two 224 tubes. It is dropped from 180 to 75 in the resistance R4 of the voltage divider. R5 has a value of 10,000 ohms so that the bleeder current is 7.5 milliamperes.

Resistance R4 should have a value of 6,500 ohms, or as near that as may be obtained by using the taps on a multi-tap voltage divider.

The plug-in coils are exactly of the same design as those in the De Luxe converter cited. The RF coil is wound on a UX form and therefore requires a UX socket. The oscillator is wound on a UY form so this requires a socket of that type. A five-prong is practical because the plate voltage on the oscillator is the same as the screen voltage on the modulator and therefore one of the prongs can be used as terminals for two windings, the tickler and the pick-up.

Terminal Connections

The terminal connections on the RF coil T1 should be as follows: G on the coil socket to P on the RF tube socket; F minus on the coil socket to B plus 180; P on coil socket to G on the modulator, that is, to the control grid; F plus on coil socket to ground. The coil terminals on the form should be made to the prongs in the corresponding manner.

The terminal connections of the oscillator should be made as follows: G on the coil socket to G on the oscillator socket; P on the coil socket to P on the oscillator socket; K on the coil socket to ground; HP on the coil socket to B plus for the screen voltage; HK on the coil socket to G on the modulator socket. The terminals of the oscillator coil should be connected to the prongs on the base in the corresponding manner, two terminals being connected to HP.

To insure oscillation the G and the P terminals of the tuned and tickler windings should be far apart and the K and HP close together, the two windings being in the same direction. No special mode of winding the pick-up coil is necessary just so the terminals are connected to the prongs as explained. It is well, however, to put the pick-up winding on the side of the tuned winding opposite to that of the tickler so as to keep the tickler and the pick-up windings as far apart as practical.

No special mode of connecting the RF coil terminals need be observed. However, it is well to wind the coil so that the grid and the plate terminals are far apart and the ground and B plus close together.

Number of Turns

The number of turns on the various windings depends on the size tuning condensers used. The condensers specified in the circuit cited were .000125 mfd. This is a good size. However, at this time a smaller condenser made especially for short-wave converters is available. This may be obtained in various capacities up to .0002 mfd., and this capacity is suitable. If this size condenser be used, the same coils as for the .000125 mfd. condensers may be used. The circuits will tune just as high in frequency, the different tuning ranges will overlap a little more, and the largest coil will tune a little lower in frequency.

The coils are wound on forms a little smaller in diameter than tube bases, or on forms 1.25 inches in diameter. The tuned windings on T1 and T2 are exactly the same, and the three coils in each set have seven, eleven, and sixteen turns. The corresponding primaries on T1 are three, five, and seven. The corresponding ticklers are six, nine, and ten, and the pick-up windings one, two, and three.

The size of wire on the tuned windings should be No. 22 double cotton covered. The other windings may be of smaller wire. The size is not important. Even the tuned windings can be made of wire as fine as No. 30, although it is better to use the heavier wire.

Wiring the 1-A Converter

By Herman Bernard

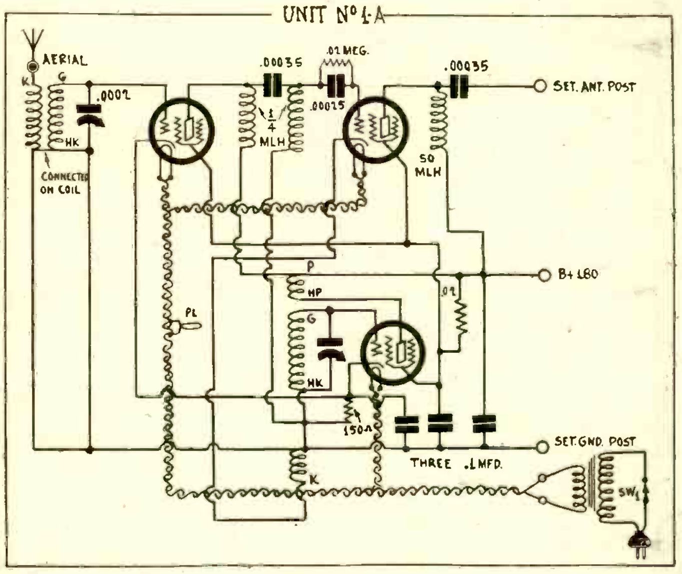


Fig. 1
The schematic diagram of the 1-A all-wave converter unit, corresponding in all particulars to the pictorial diagram printed full-scale on the opposite page.

THE triple-screen grid AC-operated all-wave converter, known as model 1-A, using de luxe parts, including National Company's flat type modernistic dial and two Hammarlund .0002 mfd. junior midline condensers, is diagrammed schematically in Fig. 1 and shown in pictorial or so-called blueprint form full-scale on the opposite page.

The converter uses two tuned circuits. With plug-in coils it covers from 15 to 600 meters, therefore it may be used as a broadcast tuner as well as for short waves.

Use of the extra tuned circuit is necessary for broadcast reception, to get rid of image interference, which is usually code. On short waves the extra tuning helps only a little.

Although there are two individually tuned circuits, only the oscillator circuit has a dial, the other using a knob, since the setting is not critical in the second instance.

Logging Is Practical

You may log the oscillator, and, if the same intermediate frequency is used in the receiver with which the converter is worked, the log holds. The other tuned circuit, affecting only the radio frequency stage, does not influence the setting of the oscillator in any way, as there is no back-coupling between the two circuits.

The pictorial diagram well illustrates the disposition of parts and shows all the connections, except those to oscillation frequency tuning condenser and to the grid control caps of the three tubes. The connections not shown are designated in text on the pictorial diagram, the reason being they are on top of the subpanel, and the pictorial diagram shows only the view underneath.

The oscillator condenser is affixed to the subpanel at the front center, using holes already drilled in this panel, while the AC switch and the radio frequency tuning condenser are affixed to the front panel by means of special brackets. To permit the filament transformer to rest evenly against the bottom of the subpanel the forward mounting hole for the oscillator condenser must be countersunk underneath, and a flathead screw used.

How Switch Is Mounted Flush

On the switch there are two tiny rivets. The switch is placed in the slot of the bracket so that these two rivets are not interfered with by the bracket. Otherwise the switch would not mount flat.

In both instances the bracket is mounted so that it is held to the front panel by the device occupying front panel position, while the right angle of the bracket extends upward. Then the oscillator condenser shaft is slipped into the dial opening. The condenser already has been mounted on the subpanel.

Do not push the subpanel all the way against the back of the front panel, but leave a slight space, about 1/8-inch, otherwise the radio frequency tuning condenser will come too close to the filament transformer.

In mounting the radio frequency condenser, have its frame

LIST OF PARTS FOR UNIT 1-A

Coils

Five plug-in coils
Two Hammarlund .0002 mfd. midline jr. tuning condensers
Two 1/4 mlh RF chokes
One 50 mlh RF choke
One filament transformer, 2.5 volts

Condensers

Two .00035 mfd. fixed condensers
Three 0.1 mfd. in one case
One .00025 mfd. grid condenser with clips

Resistors

Two .02 meg resistors (20,000 ohms)
One 150-ohm flexible biasing resistor

Other Parts

One National modernistic dial, flat type, with pilot lamp and knob, type VGE
One front panel 7x10"
One subpanel with five UY sockets
Two brackets
One binding post for antenna
One three-lead cable
One AC cable and plug
One AC switch, shaft type
Two extra knobs
Three grid clips
Six small right-angle brackets

parallel with the subpanel, so the plates, when they are being disengaged, turn outward toward the bottom. The condenser will clear the prongs of the socket under which it is mounted, especially if pocket springs are bent upward toward the subpanel just a trifle.

Each bracket is affixed to the subpanel by a 6/32 machine screw and nut.

No Cabinet Necessary

When this work is completed, the filament transformer is mounted and the assembly, already rigid, becomes totally self-supporting, as the depth of the filament transformer is exactly the same as the distance from the under side of the subpanel to the bottom of the front panel. Hence no cabinet will be necessary.

The diagrams show the wiring explicitly, as to connections, although it is not necessary to duplicate the exact routes shown on the pictorial diagram, since the wiring is illustrated in the most revealing manner, to avoid leads being on top of one another, which would make for confusion in reading the diagram.

As for sequence, the heaters may be wired first. The filament transformer has two pairs of wires emerging, a thick pair and a thin pair. The thick pair is for the heaters. If there is a red lead also, between the thick wires, this is the center tap and goes to ground. If there is no center tap, ignore this fact. The thin pair is for the 110-volt 50-60 cycle input. Connect the thick wires to the heaters of one of the sockets and put the heaters of the two other tubes in parallel with the heater of the first tube so wired.

Advice on Wiring

The thin pair has one lead going to the AC switch, other side of the switch to one side of the AC line (it makes no difference which side), while the other remaining thin lead from the transformer goes directly to the remaining side of the AC line. There is no AC cable and plug on the filament transformer, so connect the cable to one side of the switch and to one side of one of the thin wire leads from the transformer. Where the joint is soldered, between thin wire and cable, insulate carefully with friction tape.

In wiring the converter remember that the pictorial diagram shows the view underneath, with front panel toward you, so that the left and right positions are reversed. Seen from underneath, as diagrammed, the sockets are: radio frequency tube, extreme right front; radio frequency coil, extreme right rear; modulator tube, center rear; oscillator tube, extreme left front; oscillator coil, extreme left rear.

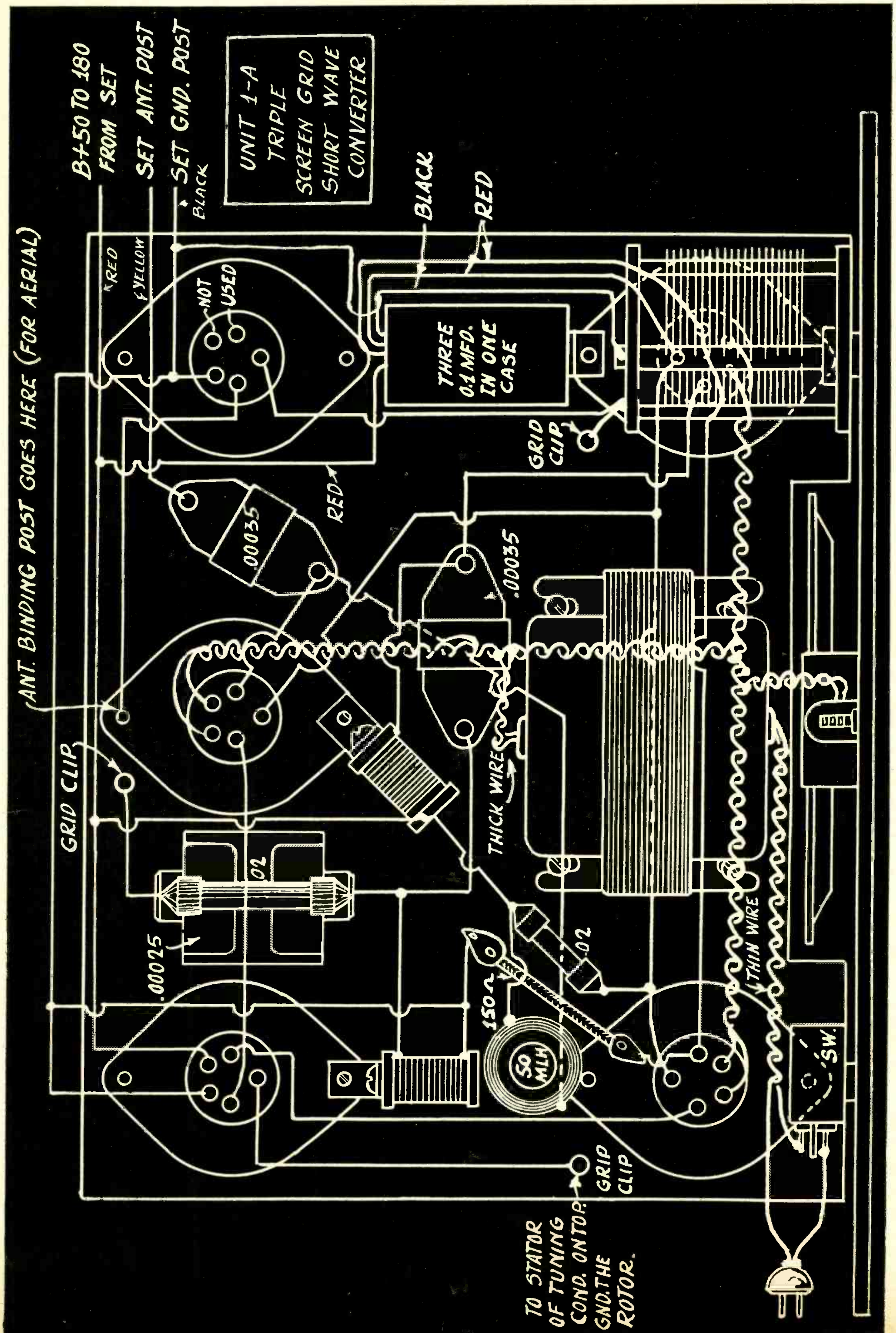
But when the layout is right side up, the RF tube is at left front, the RF coil at left rear, the modulator tube at center rear, the oscillator tube at right front and the oscillator coil at right rear.

How to Connect Up 1-A Unit

As for installation connections, there are four:

1. The black cable lead goes to the ground post of the receiver, while ground connection is left as it was found at the receiver. No matter what the color, this is the lead from

(*Continued on page* 15)


B+50 TO 180 FROM SET
SET ANT. POST
SET GND. POST
BLACK
UNIT 1-A TRIPLE SCREEN GRID SHORT WAVE CONVERTER
BLACK
RED
RED
YELLOW
NOT USED
THREE 0.1 MFD. IN ONE CASE
GRID CLIP
ANT. BINDING POST GOES HERE (FOR AERIAL)
.00035
RED
.00035
GRID CLIP
THICK WIRE
.02
.00025
.02
THIN WIRE
150 Ω
50 MLH
SW.
GRIP CLIP
TO STATOR OF TUNING COND. ON TOP. GND. THE ROTOR.

A Fully-Filtered

By Henry

IN some circuits virtually everything that can be or should be filtered is filtered. In others, filtration is restricted only to the barest necessities. In the present instance filtration is carried out faithfully, some might say to the extreme, but the result is better stability, dependability and quality. Here is a fully filtered receiver of extraordinary quality, the FF-8.

The first example of filtration that greets the eye, as one surveys the circuit beginning at the antenna input, is the band pass filter circuit. This is not only a method of introducing additional tuning prior to the first tube, which makes for better selectivity, but it is also a distinct cure for cross-modulation.

In recent months the subject of cross-modulation has become

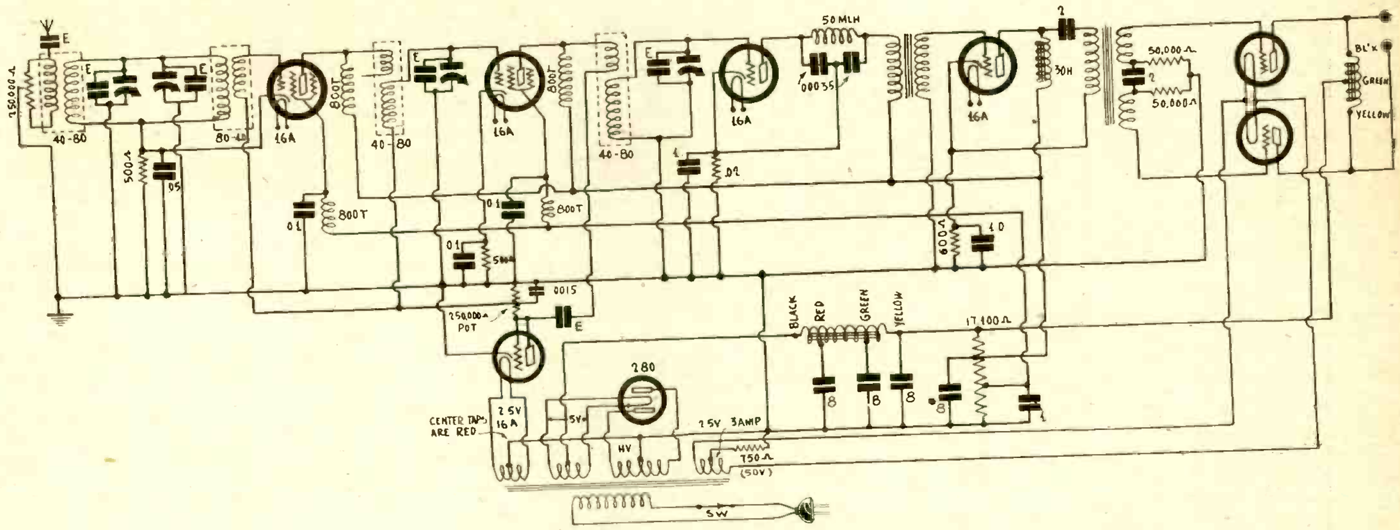


FIG. 1

Highest possible quality, with absence of sideband cutting in the tuner and presence of most faithful audio amplification are afforded by the FF-8.

an important one, because gain in radio frequency channels is so high that interference, if present, is lifted to substantial absolute values. The condition of cross-modulation results in a strong local being heard as interference when the set is tuned to some other frequency, and while this situation is principally one calling for greater selectivity ahead of the first tube, it is also one that calls for high plate voltage on that tube and corresponding negative bias voltage.

Band Pass Filter

The band pass filter, contributing an extra tuned circuit ahead of the first tube, thus constitutes a pre-selector. The two separately tuned circuits are familiar. They are loosely coupled, however, through a series circuit consisting of paralleled .05 mfd. condenser and 500-ohm resistor. The tuned coils, instead of being returned directly to ground, go to one side of this coupling circuit, and thence to ground. The constitution of the coupling circuit is such that the condenser plays the more important part, especially in determining the admittance band. The value of .04 mfd. is commonly used for this purpose, but the value .05 mfd. has substantially the same effect. The larger capacity narrows the admittance band just a little bit, as this was found advisable in the present circuit.

The capacity .05 mfd. is obtained by using a three-section fixed condenser block where each capacity is 0.1 mfd. There are four leads, the black being common and the three reds representing the other sides. By snipping off the black lead and one of the red leads, the two remaining leads constitute the connection of two 0.1 mfd. in series, or an effective capacity .05 mfd.

Since both the value of the resistor and the value of the condenser are suitable for biasing and by-passing, and the circuits are united, anyway, the coupling circuit is put to a double utility, the plate current from the cathode being run through the resistor to ground, with radio frequency removed by the condenser.

Inherent Capacity Coupling

The first radio frequency amplifier, a 224 tube, has a radio frequency choke in its screen lead, with a 0.1 mfd. condenser from screen to ground. The object of the choke is to prevent radio frequencies from going through the B supply and also from being coupled to other tubes through a common lead. The object of the condenser from screen to ground is to maintain the screen at a constant potential, while aiding materially in sidetracking the radio frequencies from undesired courses.

The coupling from first to second radio frequency amplifier is by means of the capacity inherent in the large primary winding of the transformer used. There is a radio frequency choke coil in the plate lead that constitutes the effective load. This choke should be of high inductance, as provided by about 800 turns of No. 40 wire, or thereabouts, and in commercial form is usually very compact, being duolaterally wound (honeycomb style).

The radio frequency transformer has an 80-turn secondary for .00035 mfd. or .00037 mfd. tuning capacity, the wire being No. 28 enamel, and the diameter of the bakelite tubing 1¾ inches. Then an insulating wrapper is placed over the secondary, to prevent short circuit between the two windings, and 40 turns are put of the No. 28 enamel wire are put on for the primary. Hence the designation, 40-80. The coupling therefore is extremely tight, and the capacity between the two coils is large enough to provide plentiful coupling, and at the same time the smaller coil acts as a stabilizing agency, due to the open end.

Exceptional Performance

The second radio frequency tube is circuited like the first one, with screen lead choked, and bypassed by a condenser. So the radio frequency is subjected to four stages of tuning, prior to detection, and this gives adequate selectivity. As for sensitivity, it is high enough to provide abundant reception of distant stations, and since the radio frequency gain is very high, due to load on plates, the all-around tuner performance is of exceptional character.

The AF coil connections are: First, shielded wire to aerial condenser E, red to ground, blue to stator, yellow to .05 mfd.; second, blue to stator, yellow to .05 mfd., shielded wire to grid, red to control tube resistor. Third, shielded wire to plate, red to B plus, blue to grid of next tube, yellow to control tube resistor. Fourth, same as third, except yellow goes to ground.

One of the objects of providing liberal filtration is that with fewer tubes more may be accomplished. It is well known that the gain from just a pair of 224 tubes as radio frequency amplifiers easily may be so high as to attain a sensitivity of 5 microvolts per meter. Then the question of selectivity arises. This is always deceptive in practice, since it is an accepted belief, although a false one, that the practical selectivity of a receiver is a constant value, independent of the power of the input, and is expressible numerically or in words.

Shielding of Coils

The apparent selectivity depends on the antenna field strength as well as on the discriminating faculty of the tuner, and so a volume control so placed as to govern the amount of input from the antenna is one that makes for greater practical selectivity and for further avoidance of cross-modulation. About the only

Circuit the FF-8

B. Herman

LIST OF PARTS

Coils

Four shielded radio frequency transformers, Screen Grid Coil Company's Cat. 40-80
Two 800-turn honeycomb radio frequency choke coils for plate circuits of two RF tubes
Three 50-millihenry radio frequency choke coils
One Amertran de luxe first stage audio transformer
One Amertran push-pull input transformer, No. 151
One 30-henry audio choke coil for first AF plate circuit
One Polo 245 B choke, used as center-tapped choke in output (black and yellow for extremes, green for center)
One Polo 245 B choke, used as B choke (black to rectifier, yellow to voltage divider, red and green to 8 mfd. condensers only)
One Polo 245 power transformer, 110 volts, 50-60 cycles; secondaries, 2½ volts, 16 amperes; 2½ volts, 3 amperes for power tubes; 5 volts for rectifier filament; high voltage to afford 300 volts DC; all secondaries center-tapped
Two 800-turn RF choke coils, duolateral wound

Condensers

One Hammarlund four-gang .00037 mfd. tuning condenser with trimmers built in
One Hammarlund equalizer, 20-100 mmfd., for antenna series condenser
Two blocks of triple .1 mfd., three fixed capacities in each block
Two 1 mfd. by-pass condensers, 200-volt DC rating
Two 2 mfd. condensers, or four 1 mfd. condensers, each pair in parallel, 200-volt DC rating, for plate circuit of first AF
Four Aerovox 8 mfd. dry electrolytic condensers, with four brackets
One .0015 mfd. fixed condenser
Two .00035 mfd. fixed condensers
One .00035 mfd. fixed condenser

Resistors

One 250,000-ohm potentiometer, for volume control
Two 500-ohm wire-wound flexible biasing resistors
Two .02 meg. pigtail metallized resistors (20,000 ohms)
Two 50,000-ohm pigtail metallized resistors
One 0.5 meg. pigtail metallized resistor
One 600-ohm wire-wound biasing resistor
One Multi-tap voltage divider, 17,100 ohmls, 8th tap for screens, 15th tap for 180 volts
One 750-ohm resistor, for biasing power tubes (10 watt)
One 250,000 ohm potentiometer for automatic volume control circuit

Other Parts

One Hart and Hegeman AC switch, shaft type
One metal subpanel, with five five-prong (UY) sockets and three four-prong (UX) sockets
Molded bakelite twin assembly for speaker
Molded bakelite twin assembly for phonograph
Molded bakelite twin assembly for antenna and ground
One National flat type modernistic dial, counterclockwise (type G), with pilot light bracket and 2½-volt lamp
One roll of hookup wire
Hardware, consisting of two dozen 6/32 screws and two dozen nuts to fit

Tubes

Two 224, three 227, one 280 and two 245; total, eight tubes

way that selectivity can be pictured or described accurately is by a curve.

The coils used are shielded. The degree of shielding actually used may be varied. If the shields are attached directly to the metal subpanel, then there exists total shielding, so-called. There is still some chance of coupling between stages, but it is very slight coupling, and will not disturb a circuit like this one. In fact, if desired, the top shields, that slide over the coil, may be elevated from the subpanel to any height that installation room permits. A slight elevation has no noticeable effect. The rise should be considerably more than one inch, preferably two inches, if this method is to be introduced at all.

The way to try out this plan is to build the circuit with close shielding, then, using tubular bushings about 2 inches high, with screw inside, or dowel stick with wood screws at top and bottom, to fasten the dowel to top shield and to subpanel, try out the circuit that way. There will be a slight change in the dial settings, in a downward direction (less capacity needed to resonate to any particular frequency) and the circuit may squeal

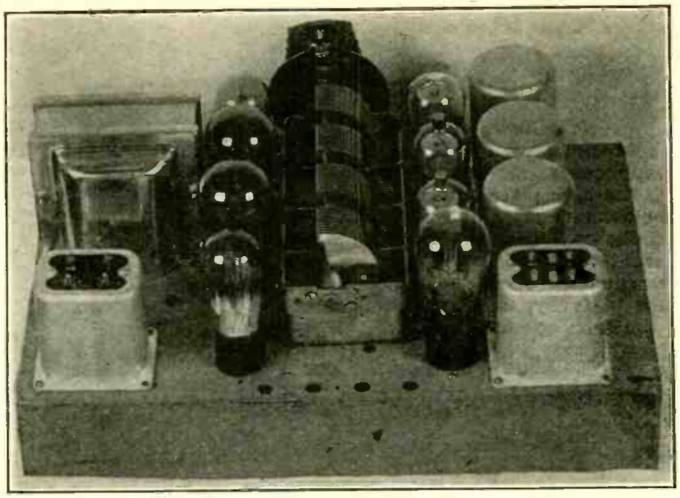


FIG. 2
How the parts are disposed on top of the subpanel is revealed.

at the high frequency end of the dial. If so, reduce the elevation of the shields a little, say ¼ inch, or until there is no squealing at any point.

The reason for this suggestion is that by altering the degree of shielding the sensitivity may be increased somewhat, since most circuits are designed so that they will not squeal at all, and therefore the dampening effect of shields is pressed to the utmost, with no option for raising the effective amplification to just below the oscillation point.

The Automatic Volume Control

It will be noticed that the primary of the radio frequency transformer that couples to the detector, instead of being left free, is returned through a condenser to the united plate and grid elements of a 227 tube, a resistor going from this joint to grounded cathode. This tube is an automatic volume control and operates on the principle of simple single-wave rectification. The direct current flows from negative grid-plate to positive cathode, so by returning the two radio frequency amplifier grids to a potential lower than grounded B minus, extra negative bias is obtained when there is a carrier. The extra bias voltage is like that of a variable C battery.

A steady bias is provided by the separate biasing resistors in the cathode leads of these two amplifier tubes, so that even when there is no carrier there will not be an absence of bias. When a carrier is tuned in, part of the second radio frequency tube's output is delivered to the automatic volume control tube, which rectifies this current. The higher the amplitude of the carrier, the greater the amount of rectified current, the voltage drop in the resistor, and the greater the bias. Thus a loud signal occasions increased bias, or decreased effective amplification (due to rise in the plate resistance), and the desired levelling effect results. Then stations may be tuned in, even strong locals, without roaring blasts. Also, this automatic volume control, or constant output level, is valuable when the set is used in conjunction with a short-wave converter, since then the fading effects that prevail on short waves are minimized, although not completely obliterated.

The detector output is filtered, with a radio frequency choke coil, and fixed condenser at both sides, so that only the audio is delivered to the first audio transformer.

Audio Stages

Since the detector is of the power type, the plate current will be small, of the order of 1 milliampere or less, hence the high primary inductance of the first audio transformer is not shrunk by an overload of direct current. At 1 milliampere the inductance of the primary is 200 henries, which is very substantial. The transformer used was the Amertrand de luxe first stage unit.

Owing to the second audio stage, we find that the plate current must be relatively high, with the proper tube, which is a 227, and there is no way of avoiding it. The current may be as much as 10 milliamperes. This is far in excess of the amount of direct current that should be put through the primary, if the precious asset of high inductance is to be preserved, and easy saturation avoided.

It is advantageous to have a high permeability core on an audio transformer, as Amertrans have, but such cores will saturate much sooner than would an silicon steel core. The special core of the Amertran gives the advantage of higher volt-

(*Continued on next page*)

Returned Quality in Filtered Set

No Honolulu but lots of Domestic DX with Realism

(*Continued from preceding page*)

age in the secondary, so high permeability is somewhat akin to high amplification factor in a tube.

Although the high plate current can not be avoided, its course through the primary may be avoided, and this is done by putting an audio choke coil in the plate lead, and passing only the alternating current to the primary. Notice that the primary itself is then returned to cathode, the same return as was made for the detector plate bypass condensers, since the cathode is the datum of the tube operation.

Push-Pull Connections

The push-pull input transformer under discussion, an Amertran 151, has the secondary in two separate windings. These are to be joined as shown, with a 50,000-ohm resistor from the low potential end of the winding to ground, in each instance, and a 2 mfd. condenser, or two 1 mfd. condensers in parallel, across the coil terminals as diagrammed in Fig. 1. The secondary terminals are numbered on the transformer, 1 and 4 going to the grids and 2 and 3 to the resistors. This special treatment of the secondary circuit is another example of filtration, and helps prevent feedback.

The audio choke in the output is a center-tapped type, which permits connection of any type speaker to the plates, without any direct current flowing in the speaker winding. In most instances a dynamic speaker will be used that has an output transformer built in, and the usual connections may be made (speaker's tipped cords to plates) without removal of the transformer from the speaker.

If a Farrand 12-G speaker is used, no output choke is necessary, as this speaker has its magnet coil center tapped. The tap is either brought out by a yellow lead, or has no wire attached to it, in which instance you must solder a connection from the maximum B plus lead, connecting tipped cords to plate.

B Supply Filtration

The B supply is still another example of excellent filtration. The B choke permits of a so-called "choke input," whereby no condenser is next to the rectifier. Thus when the set is turned on the rectifier tube is not subjected to the high strain due to charging up a capacity, so rectifier tube life is lengthened. The connection is made, on the Polo 245 choke, by joining the black choke lead to red center lead of the 5-volt rectifier filament winding, the red, green and yellow leads of the B supply choke being connected individually to 8 mfd. electrolytic condensers. The yellow lead goes to the voltage divider.

Hence there are four connections to the choke coil, and three of them go 8 mfd. capacities. The 180-volt lead also has an 8 mfd. electrolytic condenser, to prevent feedback, while the voltage that goes to screens, already filtered, needs only 1 mfd., of the 200-volt DC type.

The Polo 245 power transformer furnishes all the necessary voltages with margin to spare, without being overtaxed at all by the circuit.

No Condenser Across This Resistor

The voltage divider is the Multi-Tap, but no biasing voltages are taken from it.

The power tube bias is obtained through the drop in a 750-ohm resistor, across which it would be a mistake to put a bypass condenser, since the current of a push-pull circuit is concerned. A push-pull circuit being symmetrical, there is no need for bypassing, current being equal in value but opposite in phase at any instant. A condenser would remove the stabilizing influence.

It can be seen quite readily from the foregoing discussion that the primary object was not to determine how much can be produced for the least possible cost, but what attainments may be reached, using the best parts, knowing that their cost is bound to be greater than that of indifferent parts. Nevertheless, the parts for the amplifier less tubes, should not cost more than $50.

In the tuner it would not be economical at all to use a condenser that afforded diverse capacities in the four sections, for the tuning must be in step, or indeed it isn't really tuning, besides destroying the sensitivity and selectivity. So a Hammarlund condenser was used that has trimmers built in. The frame is die-cast aluminum and the plates are aluminum, too.

The coils are those of the Screen Grid Coil Company, as these afford the necessary inductance and capacity values for the circuit.

The choice of audio transformers just naturally fell to Amertran, since quality was the foremost consideration, while to provide power equipment that certainly would stand the strain without any sign of overload, the Polo 245 power transformer and 245 choke coil were selected.

The electrolytic condensers are those made by Aerovox and are of the dry type.

So anyone who wants a receiver that obviously is of the highest quality,that won't get Honolulu but will bring into the home the voice and music just as they are delivered to the microphone, with plenty of distance reception from continental United States, may build this receiver with utter safety and assurance. It is a receiver that will provide the highest possible delight of possession and will be a revelation to visitors to your home who perhaps never heard radio at its very best.

FREE AID TO A NEW JOB!

SITUATIONS WANTED AND HELP WANTED ADVERTISEMENTS WITHOUT COST!

Address: Industrial Dept., RADIO WORLD, 145 W. 45th St., N. Y. C.

SITUATIONS WANTED

RADIO MAN WITH 8 YEARS' EXPERIENCE; both technical and practical; 32 years of age, married, willing to go anywhere and very much interested in a foreign position. Would like connection with some reliable concern or factory. E. W. Becker, 24 Wallingford Rd., Brighton, Mass.

SITUATION WANTED: ELECTRICAL ENGINEER, graduate Washington University, knows radio, wishes position in radio laboratory or engineering department. Small salary to start. Louis R. Conrath, 3623 Fillmore St., St. Louis, Mo.

RADIO TECHNICIAN, 26 YEARS OLD — 7 years' active experience in radio service, graduate of two radio schools, with active photophone, sound and amplifier experience, desires position with firm either to act as field service man or laboratory worker. Is married but will go anywhere. Prefer south-west or Pacific coast. References on request. Has complete laboratory equipment. Address, Dougherty's Radio Laboratories, New Market, Iowa.

EXPERT RADIOTRICIAN, trained and graduated by National Radio Institute, high school education, four years' experience in sales and service. Desires position with manufacturing firm. Karl C. Fischer, Gen. Delivery, Knoxville, Tenn.

CUSTOM SET BUILDER WITH INVENTIVE ABILITY wants work in repair shop or laboratory. E. Widell, 915 N. 19th St., Saint Louis, Mo.

CERTIFIED RADIOTRICIAN. Also high school graduate and at present C. R. E. I. student. Can furnish satisfactory references as to character and ability. Address: H. F. Goodrich, 2020 Seminary St., Dubuque, Iowa.

INVENTIVELY INCLINED, and have diploma from Radio Training Association of America; would like to get in touch with radio factory with high-class laboratory. Former student in Electrical & Mechanical College of University of Kentucky. P. B. Kehoe, 2100 Lee Street, Fort Myers, Florida.

NATIONAL RADIO INSTITUTE STUDENT wishes position in service and installation work. Jewell test equipment. Experienced in servicing. Willing to do any kind of work. Chas. C. Stutzenberger, 228 Turner Street, Allentown, Pa.

YOUNG, ENERGETIC MAN; several years' experience building and servicing sets. Has worked in Westinghouse & Electric Manufacturing Co. research laboratories. Excellent references. Free to travel. Not afraid of work. Desires location that will permit of carrying on schooling in pursuit of a degree. Russell J. Ramsey, Alpine Blvd., Wilkinsburg, Pa.

A REGISTERED RADIO TECHNICIAN wishes position either store or factory. Anywhere in United States. Have three years' experience. Fred Kelly, 1909 4th Ave., North, Minneapolis, Minn.

YOUNG MAN, 10 YEARS' EXPERIENCE in designing and building of radio production test equipment, production, designing home and automobile receivers, and elimination of ignition interference in motor radios, desires position with reliable company. Best of references. F. S. Palm, 5815 W. Roosevelt Road, Cicero, Ill.

YOUNG MAN 19, TECHNICALLY INCLINED, desires a position as assistant in laboratory. High School education, several years experimenting with radio and chemistry; formerly radio operator; interested in research work. Melvin Kocher, Pershing, Ind.

YOUNG ELECTRICAL ENGINEER, 25 years of age, South American. Would like connection with radio manufacturing company to open branch in South America. Have references. D. C. Mendez, 236 Washington Ave., Brooklyn, N. Y.

YOUNG MAN, 33 YEARS OLD, mechanical, electrical and radio knowledge and experience, technical education, seeks position at anything. Paul Weber, 1822 Bleeker St., Brooklyn, N. Y.

SERVICE MAN, five years' experience, with two of Chicago's largest servicing companies. 27 years old, A1 man, good references. Have finest test equipment. Will go any place. Robert Murray, 1520 Howard St., Chicago, Ill.

A Portable AC Phonograph

Motor and pickup in Handy Case Solves Home Problem, Too


View of the portable AC phonograph.

IF YOU have no room in your console or radio cabinet for a phonograph attachment, an arrangement like the one illustrated herewith is a good solution. A synchronous motor with the accompanying turntable is mounted on a panel that has been cut to fit a suitcase and mounted thereon. A pickup unit with a "tone arm" is also mounted on the panel, in one corner. In another corner of the panel is mounted a volume control, at a place where it is easily accessible to the operator.

When the radio programs are not satisfactory it is easy to take this portable phonograph attachment from the closet where it is normally stored and place it near the receiver, make a few connections and play what "you want when you want it."

The synchronous motor is so thin that there will be plenty of room under the panel if an ordinary suitcase is used, and there will be ample room in the lid for the pickup unit, the turntable, the volume control knob and the cord and plug. Indeed, there will even be room for a few records. The motor is designed for 60 cycles and will only run at the proper speed when connected to a line of this frequency. That makes it nearly universal in its application, for this frequency is used nearly everywhere, and in those places where other frequencies are used they are rapidly changing over to 60 cycles.

There is another application of the portable motor. Suppose a group of young folks desires to attend a dancing party at a house where there is a radio receiver not equipped with a phonograph attachment. The portable motor can be brought along in the car and set up at the home where the party is being held. This seems quite far-fetched but it is a suggestion taken from experience. Motors of this kind actually are used considerably for this purpose.

Still another use of the portable motor is for demonstration of audio frequency amplifiers and other acoustic devices. The salesmen take the motor along, together with the records wherever they wish to demonstrate.

One particular case is that of a tone control being demonstrated to prospective licensees and others interested. These carry along their own dynamotor for converting DC to AC in case their business takes them to locations where only DC is available.

How to Connect and Work Converter

(*Continued from page* 10)

the heater prong next to cathode on the RF coil socket (right rear in pictorial diagram). "Heater" and "cathode" here do not refer to any tube connection, since this is a coil socket.

2. The red cable lead goes to B plus 180 volts, obtained from the receiver. However, less than 180 volts may be used. One expedient with screen grid receivers is to bare the end of this wire, turn it into a loop that will just fit over a tube prong, remove an RF screen grid tube from the receiver, slip the wire noose over the screen grid prong, and restore the tube to the receiver. This makes the screen voltage the B plus voltage. Whatever the color of the lead, it is the one coming from the heater prong next to plate in the oscillator coil socket (left rear in pictorial diagram).

3. Remove the aerial from the receiver and instead connect to the vacated antenna post of the set the yellow lead cable. No matter what the color, this is the lead emerging from one side of the .00035 mfd. condenser the other side of which goes to the 50 millihenry choke coil.

4. The aerial, removed from the receiver post, is connected instead to the solitary binding post on the converter. This post is at rear center and is used also for socket anchorage.

As for operation, it is necessary to turn on the set and also the converter, and wait until the tubes heat up. Then an intermediate frequency is chosen, which is done simply by selecting some setting of the receiver. As sensitivity differs at different receiver settings, select the most sensitive position, consistent with the absence of broadcasting interference, that is, direct station pickup by the receiver to interfere with the short-wave reception. Broadcast reception will come right through, although the converter is working properly.

For broadcasts, use the very large-winding coil in the radio frequency socket, and the next largest coil in the oscillator socket. At an intermediate frequency around 1,500 kc, the lowest broadcast frequency will come in at about 90 on the converter dial, and the highest broadcast frequency at around 40 on the dial. The radio frequency tuning condenser should be rotated in searching for a station, but strong stations will be audible, in most instances, no matter what the setting of the knob-actuated condenser. After logging is established, simple rotation of the knob will bring about greatest sensitivity setting without trouble.

The same oscillator coil may be left in the socket when the highest broadcast frequency is passed, but then a coil like the one in the oscillator coil socket should be placed in the radio frequency coil socket. For the extremely high frequencies the two identical smallest coils are used. All coils are so wound as to be interchangeable on radio frequency and oscillator circuits, except the very large-winding radio frequency coil, which can be used only for broadcasts and only in the RF coil socket.

Commercial Television Called Feasible Now

WITH a number of stations now transmitting radio television programs on schedule, together with a decided indication of real showmanship about to replace haywire experimentation, the average household may be ready to consider radiovision as something more than a passing news item. What equipment is necessary? How much skill is required to snatch pictures out of the air? Such questions are becoming commonplace.

There are two answers to the first question regarding equipment, depending on who is interested, states D. E. Replogle, of the Jenkins Television Corporation. For the experimenter, there are components that may, with skill and good fortune, be assembled into a workable layout, or again a kit of matched components for ready assembly and positive results.

For the layman interested in immediate results in living room terms, there are various combinations of special television receivers and radiovisors, covering a wide range. The equipment necessary comprises a suitable receiver with which the television signals may be tuned in and amplified with an absolute minimum of distortion, in combination with a radiovisor or device to translate signals into pictures.

The engineers have succeeded in reducing television reception to the simplest terms, so that the average layman may readily operate a properly designed outfit and receive satisfactory signals from television transmitters within service range.

Special television receivers cover the television broadcast band. A single tuning knob serves to tune in on the different wave lengths carrying television signals. The radiovisor is readily brought into proper step with the transmitted pictures and properly framed by simple adjustments. In the latest equipment, the pictures are self-synchronized so that little trouble is experienced in this respect.

The sound accompaniment, available with many television broadcasts, is being taken care of by regular broadcasting stations, so that the usual broadcast receiver may be employed for this purpose without change or additional investment.

Principles Actuating Su

By J. E.

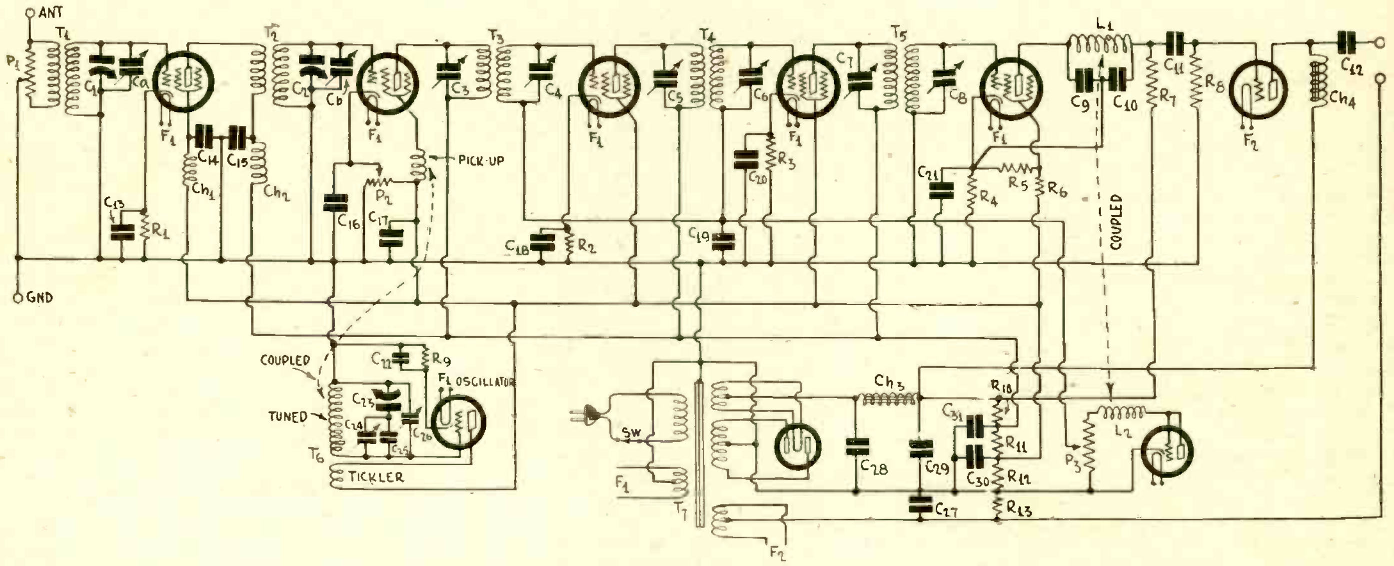


Fig. 1.

This is the circuit of a nine tube superheterodyne that is in the process of development. Not all the design features have been decided on and it will not be described for construction until the design is complete.

PUBLIC interest has swung to the superheterodyne again, due to the fact that the patent restrictions on this form of circuit have been lifted by the owners to the extent that licensed manufacturers are allowed to build them.

There never did exist any particular reason why the radio fans who build their own receivers should ever have lost interest in this fascinating circuit, but they did when all the manufacturers turned to tune radio frequency receivers. And now that manufacturers are free to turn out circuits of this type, the fans are going back to their first love.

Now that so many are designing superheterodynes we have a right to expect many innovations and improvements, but so far nothing outstanding has turned up. Perhaps engineers have not had time yet to develop the new ideas, but competition will bring them out without fail. So we may expect something new in the next crop of commercial receivers.

Standardized Intermediate

In the first crop of commercial superheterodynes the intermediate frequency was 175 kilocycles, a value much higher than those used a few years ago, yet considerably lower than frequencies that have been used in many successful circuits. Why did the manufacturers uniformly choose 175 kilocycles as the intermediate frequency? Apparently because the Radio Corporation had selected this frequency and turned over the design data in full to the licensees. But why did the RCA choose 175 kc in preference to other frequencies that could have been used? The only answer that has been given is that the 175 kc channel is singularly free from commercial cummunication traffic. If a channel can be selected which is free from all traffic no interference need be expected from direct pickup by the intermediate frequency amplifier even if that amplifier is not shielded.

However, to look for a clear channel for use as intermediate channel in a superheterodyne is effort not well spent, for with the intense demand for channels throughout the world there is practically no channel which is not crowded with traffic. But not all channels are crowded as closely as others and not all are crowded with the same type of traffic. The 175 kc channel is said to be less productive of interference than most other channels, at least in this section of the world. Even if this be true there is no particular reason for selecting this frequency, for any interference that may result from direct pickup can be eliminated by judicious shielding. There are many other factors which must be given due consideration in selecting the intermediate frequency, and these factors are closely tied up with the purpose of the receiver.

The Best Frequency

Scarcely a day passes on which somebody does not ask what the best intermediate frequency is to use in a superheterodyne. It must not only be simply the best, but it must be the best from all points of view. And along with this question go the questions as to which is the best intermediate frequency transformer, the best tuning condenser, the best oscillator, the optimum number of stages in, ahead of, and following the intermediate frequency amplifier, and many other questions relating to the ne plus ultra of receivers.

If there were a best intermediate frequency it would have been found years ago and there would never have been any deviation from it. All superheterodynes subsequent to the day of discovery of that mythical frequency would have used it. It is fortunate, perhaps, that there is no best intermediate frequency, for if there were we would have no hope for making any improvements by selecting a diffrent frequency. Likewise there is no optimum in respect to the other phases of the questions. And that, too, is fortunate, for if we had found the ultimate there would no longer be any hope of improvement, and the whole subject would become stagnate. That would mean death to interest in the superheterodyne, and even radio itself, perhaps. It would be the radio counterpart to "heat death" toward which the universe is inexorably drifting according to the pessimists of physical science.

Phases of Superheterodyne Design

In Fig. 1 we have a circuit incorporating nine tubes, and it is of the superheterodyne type. What follows is not to be taken as a description of a superheterodyne but merely as a discussion of the various phases of a circuit of this type. The receiver is in the process of building but the final design has not yet been decided on. Much may have to be weeded out and other parts may have to be added but it will emerge as a practical superheterodyne, and just as soon as it does the constructional details will be presented.

The very first thing in the circuit is a volume control P1. Why is this placed first? Because if the volume control is put in the antenna circuit the signal intensity level will be the lowest in every part of the circuit and distortion and cross modulation will be the least possible for a given output of sound. The antenna circuit is the only logical place for a manual volume control. In most commercial receivers the manual volume control is placed in this position, but usually this is not enough so that another control has to be placed elsewhere, usually in such a manner that the grid bias on the radio frequency tubes is varied. When there are two they are placed on the same knob so that on the panel there appeals to be only one.

RF Amplifier

The first tube is a radio frequency amplifier the input circuit of which is tuned. Why is a radio frequency amplifier used ahead of the modulator tube? The same or greater gain could be obtained by making this tube an intermediate frequency amplifier placed after the modulator tube. But if it were made an intermediate frequency amplifier the circuit would be less stable since there would be three intermediate tubes and four intermediate tuners. If there is any pickup at all directly by the intermediate amplifier this would cause greater interference than if only two intermediates were used.

Moreover, using a radio frequency amplifier does not increase the difficulty of tuning because the same number of tuners would have to be used anyway in order to suppress image interference. But why not choose an intermediate frequency so that the receiver is "one-spot" and thus eliminate image interference? Because there is no such frequency and a "one-spot" super is only a fantastic

perheterodyne Design

Anderson

dream entertained only by those who are unfamiliar with the subject. Tying the condensers together so that a given signal can only be tuned in at one spot on the dial does not make the receiver "one-spot" any more shutting the eyes hides a person from those who keep their eyes open.

The thing to do about multiple response is to accept it as inevitable and then do what is possible to minimize the trouble. If the RF tuner is reasonably sharp and if the intermediate frequency is not too low, no appreciable trouble will be experienced from multiple response. Practically there will be only one; actually there will be an infinite number of responses. Let's be practical.

Being Practical

Since we desire to be practical on the subject of image interference, we use two radio frequency tuners ahead of the modulator tube and make these tuners as selective as we can with practical coils and condensers. Being practical requires that we gang the two variable condensers and that we put the two on the same control as the oscillator condenser. Thus condensers C1, C2, and C23 are on the same control on the panel.

Ganging the condensers cannot be done successfully by simply placing the condensers on one control. We have to make adjustments of both the fixed inductances and the minimum capacities. We have to make sure that the inductances are equal, assuming that the condensers are equal, and then adjust the trimming condensers Ca and Cb. Even that is not sufficient if the oscillator condenser is also to be on the same gang, because the oscillator will not cover the same tuning range as the radio frequency tuners.

Let us turn to the oscillator. Before we can do much about ganging the oscillator condenser to the other tuning condensers we should have a good idea of what the intermediate frequency is to be, because the frequency band covered by the oscillator depends not only on the band to be covered by the radio frequency tuners but also on the value of the intermediate frequency. As most commercial superheterodynes now use 175 kc in the intermediate channel let us use that as an illustration, and not as an admission that that is the best frequency.

Well, the radio frequency tuners are to cover the band from 550 to 1,500 kc if the receiver is for broadcast reception. It has been found that, as a rule, the higher oscillator frequency response is stronger than the lower and that it has other advantages as well. Hence the oscillator is to cover the band from 725 to 1,675 kc, which is obtained by adding 175 to the limits for the broadcast band.

Condenser Ratios

Whatever the absolute values of the tuning condensers used, the ratio of the maximum capacity to the minimum in the radio frequency circuits must be 7.44. In the oscillator the corresponding ratio for the case under discussion must be 5.34. It is clear that if the three condensers on the same shaft are alike that both the oscillator and the RF circuits cannot be tuned without doing something to the oscillator condenser so that the capacity in that circuit does not change so fast as the capacity in either of the other circuits. We must treat the condenser so that its capacity changes in the ratio of 5.34 to one while the capacity in each of the other circuits changes in the ratio of 7.44 to one.

The first step in the treatment is to put a condenser C25 in series with the tuning condenser C23. This reduces the capacity by an amount depending on the capacity of the fixed condenser in respect to the capacity of the variable. And what is more important, it changes the rate of change of the combined capacity as the value of the variable C23 is changed. It requires a very particular value of the fixed condenser in order to get the right value of the series combination. Hence we put a midget condenser C24 across the fixed and adjust the midget until the combination of C24 and C25 has the desired value.

But this alone is not sufficient. We must establish a certain minimum capacity, and this may be entirely different from the minimum capacity of the combination C23, C4, and C25. Hence we put a midget condenser C26 across the other combination and adjust this midget until the minimum capacity of the entire combination is correct. By proper choice of the series capacity C24, C25 and the shunt capacity C26 it is possible to change the rate of change of the combined capacity as C23 varies until it has the value 5.34, the required value in our special case.

Tied at Two Points

The rate of change of the oscillator capacity will not be just right throughout the range of C23, but the two auxiliary capacities, the series C24 and C25 and the shunt C26, will tie the circuits together exactly at two points. If these two points be chosen at suitable places, say at 600 and 1,400 kc in the broadcast band, there will be very little deviation at points in between or outside the points tied.

By tying the points is meant that the two radio frequency tuners are set at exactly 600 and 1,400 kc and the oscillator at 750 and 1,575 kc. As soon as the gang condenser is tuned a little the tuning will not be exact, but may be five or 10 kc off. For all off points the oscillator will mainly determine the maximum sound, the others being off tune when a maximum occurs at any off station. The reason for this is that the intermediate frequency tuner is many times more selective than the radio frequency tuner, and the intermediate tuner selectivity appears as sharpness on the oscillator. Of course, when the tuning is off considerably, and when the RF is very sharp, even the RF tuner will contibute to the determination of the maximum, but in this case there will be a lowering of the sensitivity of the receiver.

To avoid a great diminution in the sensitivity because of detuning the radio frequency tuner must not be too selective. And it does not have to be if the intermediate frequency is 175 kc or higher because the main object of the radio frequency tuner is to suppress image response, and that means that broadcast frequencies differing by twice the intermediate frequency must be suppressed. For example, if we want to tune in a broadcast frequency of 900 kc the radio frequency tuner must be sharp enough to suppress thoroughly stations operating on 550 and 1,250 kc. It does not require a great selectivity to do that. Hence we need not worry very much about the selectivity of the two RF tuned circuits.

Type of Oscillator

The type of oscillator to use in a superheterodyne does not make a great deal of difference. The main thing is to have an oscillator that oscillates over the entire tuning range. There is half a dozen oscillator circuits, any one of which can be used. The tuned grid-plate has been very popular with superheterodyne designers but it suffers from the fact that neither side of the tuning condenser can be grounded. For this reason it is not suitable for a circuit in which the condensers are ganged with a common grounded rotor. The tune grid oscillator is suitable in a case of this kind and for that reason it is shown in the diagram.

The most common tuned grid oscillator in superheterodynes is one in which the bias is zero and a grid leak and condenser combination is used to maintain the grid negative. Apparently the only reason for using this is that it oscillates on a lower plate voltage. In the circuit in the figure the oscillator tube is biased just as an amplifier, which is entirely satisfactory.

One important thing about the oscillator is that it should generate a wave as pure as possible so that the harmonics will be weak. If the harmonics are strong responses will occur on them as well as on the fundamental. The effect of these will be practically eliminated by the ganging of the condensers because the RF amplifier will not be in tune to any harmonic of the oscillator. But if there are harmonics in both the oscillator output and that of the radio frequency amplifier they may give rise to growling and whistling noises.

Eliminating Harmonics

Harmonics are usually prevented in the oscillator by forcing the circuit to oscillate feebly. One way of doing this is to use the smallest tickler that will sustain oscillation at any point of the tuning range. Another is to connect only a portion of the tuned circuit in the grid, usually half. A tap is placed at the middle turn of the tuned winding and connected to the grid, or a centertapped high resistance is connected across the tuned circuit with the center connected to the grid.

Still another way is to couple the oscillator and the modulator resonantly. The only practical way of doing this is a broadcast superheterodyne is to place the pickup coil nearer the tuned circuit than the tickler and making the coupling between the tuned and pickup windings fairly loose. If either the oscillator output or the output of the RF amplifier is free from harmonics the output of the modulator will be free from troublesome harmonics.

Type of Modulator

When a screen grid tube is used as modulator, as in the present instance, there are three main methods of coupling the pickup coil to the modulator, first, in the screen lead, second, in the control grid lead, and third, in the cathode lead. The first method is illustrated in this instance. The control grid connection is rejected because the pick-up coil is then on the live side of the second tuned circuit and there are adverse capacity effects. The cathode connection is rejected because it would require either an oscillator coil of six terminals or else a different modulator. That is, the grid bias method could not be used.

Just as it makes little difference what oscillator is used, so it makes little difference what method of coupling the oscillator to the modulator. The writer is partial to the method illustrated, mainly for practical reasons.

The pickup coil and the tuned winding of the oscillator are placed far apart in the drawing. Actually they are wound on the same form. The pickup is one side of the tuned winding and the tickler on the opposite.

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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A Five-Tube Receiver

I HAVE a Polo 245 power transformer and a Polo choke and desire to use them in a receiver comprising three 224 tubes, one of which is the detector, a 245 output tube and a 280 rectifier. Will you kindly publish a diagram of such a circuit? Is a circuit of this type practical? I desire only local stations but I want first class quality, and it is for this reason that I wish to omit all but the last stage of audio.—J. B.

You will find such a diagram in Fig. 876. All the design values are given on the drawing to enable you to build it. For local reception this receiver is quite satisfactory, and the quality is excellent.

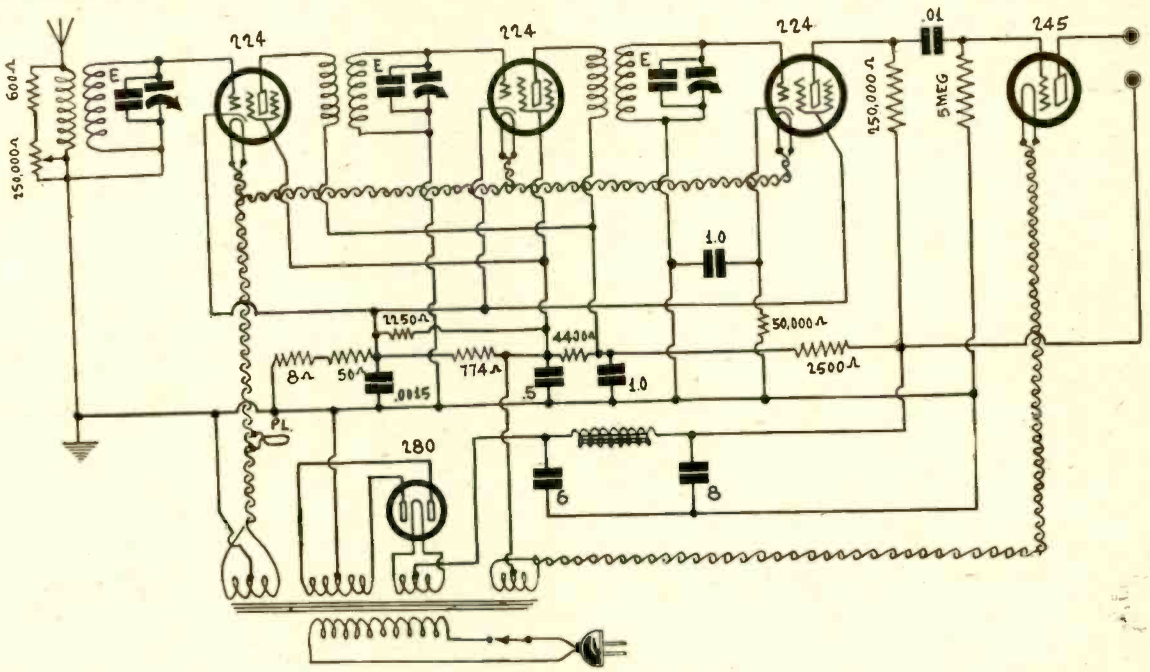

FIG. 876
A circuit for Polo parts.

this frequency and the known frequency of the station is the intermediate frequency. Repeat this process on several stations and average the results. If your oscillator condenser cannot be turned independently of the others, you can open up the live side of the condenser and substitute an external condenser provided with a good dial.

* * *

Hiss In Receivers

WHAT is the cause of the hissing in a radio receiver? I have noticed that it ceases in most instances when the broadcast station to which the receiver is tuned is shut down—B. C.

There are many causes of hiss in a receiver, or in the output of a receiver. Some of the hiss originates in space and is a form of static. Then it may come from the tubes, both receiving and transmitting. Electrons are not emitted from the cathode uniformly but in a very irregular manner, and the irregularity gives rise to a hiss. Irregular conductivity of wires and grid leaks is also a source of hiss.

* * *

Wattless Power Component

WHAT is the meaning of the wattless power component? It seems to me that it is a contradiction of terms, for if the watt is the unit of electrical power how can a power component be wattless?—W. G. L.

Sure it is a contradiction of terms and every time one sees "wattless" one inevitably thinks of "witless." But the term is well established and has a very definite meaning. When an alternating voltage is applied in a circuit containing inductance and resistance, or capacity and resistance, the current that flows either lags behind the voltage or it leads it, lagging when there is inductance and leading when there is capacity. The total power involved is the product of the voltage and the current. But since the voltage and current are out of phase by a certain amount, or by a certain time, the total power involved is not dissipated. Only that component for which the current and the voltage are in phase results in dissipation or useful work, as the case may be. For the remaining power involved the current and the voltage are 90 degrees out of phase, or a quarter period out of phase. This power is not dissipated and it does no work. Although it is measured in watts it is called wattless.

* * *

Determining the Intermediate Frequency

WILL you kindly suggest a simple method of determining the intermediate frequency of a Superheterodyne? I have built such a circuit and it works all right but I have no idea of what the intermediate frequency is.—G. D. F.

If your oscillator condenser can be turned independently of the RF condensers, calibrate the oscillator dial against broadcast stations and plot a curve with frequency against dial settings. Then tune in a station the frequency of which you know and note the dial setting. Look on the calibration curve what frequency is represented by this setting. The difference between

Distributed Capacity of Coils

IS there any relationship between the distributed capacity of a solenoid and the dimensions of the coil? If so, what is it and how can it be used for determining the distributed capacity?—C. T. C.

There is no definite relationship, that is one that can be used for determining accurately the distributed capacity. However, of the coil is far from other conductors the distributed capacity is approximately proportional to the diameter and it is equal numerically in micromicrofarads to the diameter in centimeters. Let us illustrate. The diameter of the coil is 3 inches. Every inch contains 2.54 centimeters. Hence the diameter of the coil in centimeters is 7.62. Therefore distributed capacity of the coil, when not close to shields and other conductors, is approximately 7.62 mmfd. This rule is only good for making estimates. It should be remembered that the capacity is higher when the coil is close to shielding and also that the distributed capacity of the coil is not the only distributed capacity in a tuned circuit connected to a tube.

* * *

Poor Quality, Circuit Checks OK

I HAVE a receiver which gave good results for nearly a year. Then gradually it began to fall, the sensitivity and the quality going down. Now it is so bad that it is impossible to get any enjoyment out of listening in. Tubes are all OK and the circuit tests all right. What do you think is the matter?—L. N.

If the tubes are all OK and the circuit tests all right there is nothing at all wrong with the set. The poor quality must be pure imagination. But let us suppose that there is something wrong with the circuit, something that has not been tested. Since the trouble developed gradually it is due to something that deteriorated with use. Although you do not say so, I suspect that you have electrolytic condensers in your B supply and that these have dried out. Remove them and put in new condensers.

* * *

Inspect the Antenna

FOR about a year my set gave me excellent results, but now I cannot get any distant stations. Even the locals don't come in unless I turn up the volume control to the limit, and then there is much noise. I have had two service men to look it over. One changed the dector tube and the other did something else for which he charged me five bucks. They both agreed that there was nothing wrong with the set when they got through with it, but as far as I can tell it is just as bad as it was before either worked on it. What do you think is the matter with the set?—B. W.

If there had been something the matter with the set one of the two service men undoubtedly would have discovered it so the trouble must be where neither looked for it. What about the antenna? Did they look it over for poor connections, defective insulation, and the like? Follow the antenna wire from the set to the most remote point and see that it does not touch anything it should not touch, that here are no unsoldered joins, that the insulators are clean. After you have overhauled the antenna, including the ground wire, your set will probably be as good as it ever was.

* * *

Estimating Bias Resistor for Tubes

WHEN a screen grid tube of the 224 type is used in a radio frequency amplifier stage with transformer coupling it is customary to make the bias resister 300 ohms. But what should be the bias resister when the coupling is by resistance, as when the screen grid tube is used for audio frequency amplification? It is clear that if 300 ohms are used the bias will not be nearly enough since it will only be a fraction of a volt. Can you suggest any way of determining what the resistance should be?—L. M. M.

The best way to determine what the resistance should be is to try different values until the circuit amplies satisfactorily. It may, however, be determined approximately in the following manner: First find the DC resistance of the tube under normal operating conditions, that is, with 180 volts on the plate, 75 volts on the screen and 1.5 volts on the grid. Divide the applied plate voltage with the sum of the screen and plate current. This gives a number which might be called a resistance. If the plate, screen, and grid voltages are as given above the plate and screen current will add up to .005 ampere, and 180 divided by this number gives 36,000 ohms. Add this to the load resistance, say 250,000 ohms, obtaining 286,000 ohms. Divide the applied voltage, say 300 volts, by this and get 1.05 milliampere. Now if we divide the desired grid bias by this we get the required grid bias resistance. Since the bias is to be 1.5 volts we get 1.5/1.05 thousands of ohms, or 1,430 ohms. We would specify 1,500 ohms. It is not to be supposed that this method is as good as the experimental.

* * *

Measuring Plate Voltage

PLEASE outline a method of measuring the correct voltage on the plate of a resistance coupled amplifier. I have a high resistance voltmeter, 1,000 ohms per volt, but when I attempt to measure the plate voltaeg I get so low values that they are obviously in error. I understand that this is due to the high voltage drop in the coupling resistance.—B. W. K.

The effective voltage on the plate of a tube in a resistance coupled circuit is not of great importance. Measure the voltage between the B plus end of the coupling resistance and ground, or the cathode of the tube. If the tube in question is a screen grid tube, this should be at least twice as high as if the same tube were used in a transformer coupled circuit. In a three-element tube is may be high but it is not necessary. To obtain the correct effective voltage on the plate measure the value of the coupling resistance and the current through it. Multiply the two together, using ohms and amperes, and then subtract this product from the applied voltage. For example, if the plate coupling resistance is 250,000 ohms, the current 0.5 milliampere, and the applied voltage is 300 ohms, the effective voltage on the plate is 300 less 250,000X.0005, 175 volts. A more direct way is to measure it with a vacuum tube voltmeter, connecting its terminals to the plate and the cathode.

* * *

Purpose of Phone By-Pass Condenser

IN what manner does the by-pass condenser across headphones operate? Is there any relation between the operation of such a condenser and the condensers in the B supply?—W. N.

It is said that the by-pass condenser across the phones serves to by-pass the radio frequency currents, and of course that statement is correct. Also, the condensers in the B supply serve to by-pass the hum frequency current. The by-pass condenser capacity and the inductance of the headphones constitute the elements of a low pass filter. A B supply filter is also a low pass filter. The only difference between the two cases is the frequency of the cut-off. In the B supply this is very low; in the headset it is at a frequency above audibility. The rectified pulses at radio frequency charge the condenser and the charge leaks off through the phones. The rate of leakage varies at an audio frequency according to the modulation, and therefore the headphones respond.

* * *

Shielding Improves Selectivity

IF shielding introduces losses into the coils shielded, how is it possible that a shielded receiver may be more selective than one not shielded when the number and type of tuned circuits are the same?—P. A. S.

It is not at all certain that the selectivity will be better in a shielded circuit than in an unshielded. If there is any advantage it must be that the signals are forced to go through the entire tuner rather than to get in the circuit near the detector. Again, in some instances reverse feedback causes a decrease in the selectivity when the coils are unshielded. In most instances shielding reduces the selectivity of the individual circuits, as well as the gain per stage, and it is for this reason that well shielded receivers usually contain a large number of stages.

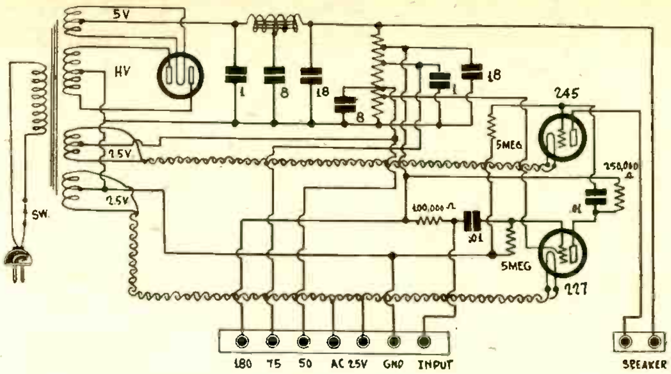

Fig. 877
Two-stage resistance-coupled audio power amplifier

* * *

Amplifier and Power Supply

PLEASE publish a circuit diagram of a two stage amplifier, resistance coupled, and a power supply suitable for use with five-tube tuner and radio frequency amplifier. I wish to use the Polo 245 power transformer.—W. G. F.

In Fig. 877 you will find the circuit you ask for. All the values of resistors and condensers are given. The choke in the B supply filter is a Polo center tapped 30 henry choke.

* * *

Balancing Out 60-Cycle Hum

IF THERE is a 60-cycle hum present, in a receiver in what manner does it get into the signal when the rectifier is full wave? It seems to me that the hum should be 120 cycles.—M. C. A.

It probably gets into the signal because the rectifier circuit is not balanced with respect to its filament. That is, the positive lead from the filter is connected to one side of the rectifier filament rather than to a center tap on the filament winding. The hum may also get into the signal by induction between the power transformer and audio transformer.

* * *

Use of An RF Choke

WHAT is a radio frequency choke coil and how would one be used?—T.M.C.

A radio frequency choke is a coil without an iron core, wound with the turns spaced apart or else in "scramble fashion so as to allow air spaces between. The coil is wound with different numbers of turns of wire according to the inductive requirements, and its purpose is to prevent the passage of radio frequency currents, while permitting steady, direct current to flow. No choke is needed in your set. The choke is used in series with the circuit to be choked, unless used for coupling, when it is in parallel with the circuit to be coupled.

* * *

Microphonic Howl Remedy

MY SET has developed a strong microphonic howl. I have tried many methods of stopping it without luck. Please suggest something that may be done to remedy the condition.—H. V.

Probably the detector tube is defective. If you have more than one of these tubes try them all. Even if some of them are used as radio or audio frequency amplifiers you can shift the tubes around in the sockets until you get one into the detector socket that behaves. If this fails you might mount the detector on rubber or spring cushions. Another help, in case the speaker is not an integral part of the assembly, is to mount the cabinet on sponge rubber.

* * *

Attenuation of Sound

IF IT is true that the intensity of sound varies inversely as the square of the distance from the source, how is it that the intensity seems to be just as great when listening in a room upstairs fifty feet or so from the loudspeaker as when listening within a foot or two of the speaker?—F. W. R.

There are many reasons why the sound seems to be just as intense fifty feet from the speaker as close to it. In the first place, the sound intensity varies inversely as the square of the distance only when the sound can spread out freely in space. In a house this is not the case because the sound is constrained to follow the contours of the building. If sound travels in a pipe there is practically no decrease in the intensity if the pipe is only 50 feet long. The interior of a house is somewhat of a cross between a pipe and free space, but as far as the propagation of the sound is concerned it is more like a pipe, with the listener inside the pipe. Another reason is that the ear adjusts itself to sound intensities. It is more sensitive to weak sounds than to strong.

The January "Proceedings"

Studio Design, Frequency Measurement and Output Tubes Discussed

THE Design and Construction of Broadcast Studios" is discussed by O. B. Hanson and R. M. Morris, of the National Broadcasting Company, New York, in the January issue of "Proceedings of the Institute of Radio Engineers." The subject is treated from the points of view of location, type of building, sound insulation, air conditioning and ventilation, acoostic treatment, lighting, decoration of studios, and technical operatng requirements.

Much emphasis is placed on the acoustic treatment of the studios, to be suitable for broadcasting purposes. This treatment must be such that no sound can penetrate into the studio from outside the building nor from another studio or room. Moreover, it must be such that the period of reverberation within the studio does not exceed a certain time which has been found experimentally to give satisfactorily results. Walls, floor, ceiling, fixtures and furniture must be treated with sound absorbing material which stops echoes of all frequencies in the entire musical range. The studio should be built like a box within a box with the inner box mechanically insulated from the outer to prevent vibrations from being transmitted from the steel structure of the building to the studio.

Size and Shape of Studio

It has been found experimentally that the dimensions of the studio to be most satisfactory both from esthetic and acoustic considerations should be approximately in the ratio 2:3:5 for the height, width, and length, respectively. Therefore the width should be 1.5h and the length, 2.5h, where h is the height of the room. The capacity of a room, in terms of number of artists, is approximately proportional to the volume. From this proportion the authors derive a formula for determining the height of a studio when the number of artists is known. This formula is height equals 5.87 times the cube root of N + 2.5, where N is the number of artists. The 2.5 is derived from the condition that the height of the studio is not to be less than 8 feet. From this formula and the previously given relations between height, width, and length all the dimensions of the studio can be determined. Illustrations of the principles of design are drawn from the New York and Chicago studios of the National Broadcasting Co.

Accurate Measurement of Frequency

E. L. Hall, Radio Section, Bureau of Standards, describes a method of measuring transmitted wave frequencies at 5,000 and 20,000 kilocycles per second to a high order of accuracy. The method depends on the use of harmonics of standard, frequencies which are known to a high order of precision. It is estimated that frequencies of the order of 20,000 cycles per second can be measured to an accuracy of 2 parts in a million, which in this case means 40 cycles.

Output of Tubes

C. E. Kilgour, Chief Research Engineer, Crosley Radio Corporation, contributes a paper on "Graphical Analysis of Output Tubes Performance." This paper first outlines the graphical analysis of power tube output as applied to the case of a simple resistive load and then extends the method to the case when the resistance load is different for direct and alternating current. It is shown that in this case the various load lines cannot be drawn through a common operating point because the effective plate voltage shifts when rectification occurs. The important point in this paper is the attention it calls to the error committed in deducing the output characteristics of power tubes with pure resistance loads when in fact a power tube never is operated that way in radio reception. It is either operated with a speaker in the plate circuit or with some other inductive device between the speaker and the tube. The paper outlines the correct analysis when the load is partly resistive and partly inductive and when there is a difference between the DC and the AC load. The paper deserves careful study.

J. D. Miner, Westinghouse Electric and Manufacturing Co., Springfield, Mass., contributes an interesting paper on "Power Equipment for Aircraft Radio Transmitters." This paper covers all of the systems of power equipment now used or contemplated for supplying power to aircraft radio transmitters. The various types of power equipment are described and the advantages and disadvantages of each type pointed out. The types of power equipment discussed are (1) the wind driven generator, (2) the dynamotor, (3) the main engine driven generator, (4) the auxiliary engine generator seet, (5) the combination wind driven and dynamotor, and (6) the constant speed main engine driven alternator. The discussion brings out the fact that no available type of power equipment can be regarded as entirely satisfactory, as no type of power equipment is sufficiently superior to other available types that its use can be expected to become universal. There is a pronounced tendency towards the use of main engine driven generators, and the chief obstacle to this type is that it does not provide for emergency operation.

Polyphase Rectification

In the ordinary B supply unit for broadcast receivers the rectification is single phase, because the supply is single phase. In broadcast stations, or in many of them, polyphase supply is used. There has been very little information available on polyphase rectifiers in radio literature. There is more now that R. W. Armstrong, Westinghouse Electric and Manufacturing Co., has published a paper on "Polyphase Rectification Special Connections." Characteristics of various rectifier circuits and factors governing their selection are given in this paper. It is pointed out that, in general, the double 3-phase circuit is most desirable from the standpoint of transformer and tube capacity requirements for mercury pool type tubes and the 6-phase single Y for hot cathode mercury vapor tubes or high vacuum tubes, but that other factors may make other circuits more desirable for particular cases Data are given 3-, 4-, 6-, and 12-phase rectifiers using T-connected transformers, so that fewer transformers are required. Since it is cheaper to build two large transformers than three smaller ones of approximately the same total capacity, the connection may permit a saving in transformer cost. The voltage doubling circuit is discussed, its relation to other single phase circuits shown, and its characteristics given as a function of the product, CR, of condenser capacity and resistance load.

Heaviside Layer Study

P. A. de Mars, T. R. Gilliland, and G. V. Kenrick report on "Kennelly-Heaviside Layer Studies" carried out cooperatively by Tufts College, Mass., Bureau of Standards, Washington, D. C., Naval Research Laboratory, and Department of Terrestrial Magnetism. Studies were made at 1,400 kc and higher frequencies. Evidence is found in support of the existence of several ionized strata, such as postulated by Appleton and Eckersley. Numerous oscillograph records of the results obtained are given.

T. R. Gailliland reports on "Kennelly-Heaviside Layer Height Observations for 4045 kc and 8650 kc." The height is variable and falls in the range of 225 to 337 kilometers. During daylight the height is fairly constant increasing slightly from noon to sunet. After sunset the height is very irregular but increases rapidly toward midnight.

Detection of Modulated Waves

Charles B. Aiken, Bell Telephone Laboratories, New York, contributes a mathmematical paper on "The Detection of Two Modulated Waves Which Differ Slightly in Carrier Frequency." It deals with the detection of two waves, modulated with the same or with different audio frequencies, and differing in carrier frequency by several cycles or more. Both parabolic and straight line detectors are discussed and expressions are derived for all the important audio frequencies present in the output of these detectors when such waves are impressed. Interference areas that can be expected under different conditions are treated and graphs shown to illustrate the interference patterns. The inevitable appendix, characteristic of contributions from the Bell Laboratories, is there, too.

Floor Vibration a Difficulty

Your new radio set of 1930 or 1931 model reproduces low tones as they have not been heard in former years. One problem that arises is the excessive vibration that occurs in flooring and walls. Have you ever lived in apartment house and listened to the weird effects you get from these vibrations brought to you from your neighbor's radio?

The simplest way to eliminate this is to "insulate" the radio cabinet from the floor or wall. Thick sponge rubber feet, or "shock absorbers" will be satisfactory, or thick felt strips. Vibrations may still be present to a slight extent, but those transmitted through the legs of the cabinet or the table on which the radio is placed are the principle starting point for these low-vibration effects.

If the receiver cabinet is too close to a "vibrating" wall merely move the cabinet away to check vibration.

STATE TAX ON SETS IS VOIDED BY U. S. COURT

Columbia, S. C.

A decision prohibiting State taxation of radio receiving set owners, as provided by a South Carolina law, has been handed down in the Federal District Court, in the first test case.

An interlocutory injunction against enforcement of the South Carolina law was granted by the Federal Court and restrains collection of the proposed taxes on radio receiving sets. The decision was made by three Federal Judges, Circuit Judge Parker of North Carolina, and District Judges Cochran and Glenn of South Carolina.

The Court's decision was made in the test case of a North Carolina broadcast station, WBT of Charlotte, brought at the instance of the Radio Manufacturers' Association. WBT contended that radio is interstate commerce and not subject to taxation by a State. The court's decision sustained the contention that the South Carolina law is unconstitutional as an interference with interstate commerce and cannot be enforced.

Held to Be Interstate Commerce

"There can be no doubt," said the opinion, "that communications by radio constitute interstate commerce. It has been so held by numerous courts, and the decisions of the Supreme Court of the United States defining interstate commerce necessarily lead to that conclusion.

"Certainly under the facts of the present case, the plaintiff (WBT), through its broadcasting plant, is engaged in interstate commerce. The receiving sets in South Carolina are essential to the reception of the communications by the South Carolina audience. In other words, the receiving sets are absolutely essential instrumentalities of the interstate commerce in which plaintiff is engaged."

Continuing, the Federal Court said:

"Here the tax is not a general property tax, but a license tax for the privilege of using an instrument of interstate commerce."

The South Carolina law, passed last year, levied on owners of radio receiving sets a graduated tax ranging up to a maximum of $2.50 per set. It was the first State law against owners of receiving sets. The WBT case was one of three attacks made upon the South Carolina law at the direction of the Radio Manufacturers' Association in the interests of the radio-owning and buying public, as well as the radio industry.

Saving Estimated

John W. Van Allen of Buffalo, general counsel for the Radio Manufacturers' Association, had charge of the contest litigation, and the local proceedings were in charge of Buist & Buist, of Charleston, South Carolina.

Explaining the decision, Mr. Van Allen said:

"With forty-eight States interested in the outcome, the decision, if sustained, will save the radio set owner from possible taxation in a similar manner in forty-eight States a sum ranging somewhere from $25,000,000 to $50,000,000 yearly and gives the American family radio, free and unhampered by petty license tax on the privilege to tune in for information, entertainment and education."

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.*

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PASTOR'S WMBJ OWED $115,000

Washington.

Attorney Nathan B. Williams, representing WMBJ, of Pittsburgh, that was operated by the Rev. John W. Sproul, has protested to the Federal Radio Commission against the report of Examiner Elmer W. Pratt denying renewal of the station's license. The station operated on the 1,500 kc channel, using 100 watts, and had an unlimited time schedule. The creditors of the Rev. John Sproul, including Pittsburgh Broadcasters, Inc. and William S. Walker, have sought to obtain the assignment of WMBJ at a general hearing before the Commission.

Examiner Pratt has recommended that the requested assignment be granted, and Attorney Williams objects. Exception is taken to the recommendation of the examiner with regard to the financial status of the Rev. Mr. Sproul. The past record of the station is cited as a reason why the Commission should consider the public support accorded the station, which, it is pointed out, also is the only purely local broadcaster.

The applicant admits that there were liabilities to the extent of approximately $115,000 but submits that this was reduced by $89,000 and that at no time was the operation of the station hampered due to debts, until the creditors seized the property, and then afterward appeared before the Commission seeking to erect it in their own name.

KFYR POWER INCREASED

KFYR, Bismark, N. D., is now operating on 2,500 watts daytime and 1,000 watts at night. It formerly used 500 watts.

TRADE OUTLOOK IS FAVORABLE

Chicago.

President Morris Metcalf, of the Radio Manufacturers Association, declared that prospects for 1931 in radio are more favorable. The radio industry leaders are meeting here to canvass conditions affecting prospective business and make plans for measures by the Association to promote all radio interests.

"Radio manufacturers entered the new year with practically no problem of overproduction," said President Metcalf of the manufacturers national organization. "There is very little distress merchandise in radio left in the market, because 1930 manufacturing schedules were held very closely to coincide with public demand. This is in marked contrast to the conditions prevailing a year ago and most manufacturers who have survived that period now are in a healthy condition so far as inventory is concerned.

"There are many new and broad markets open to the radio industry. Radio is nowhere near the saturation point. In addition to the large normal replacement market for modern radio sets and the discarding of obsolete receivers, there is a great rural market now opening for radio sales, especially if the Federal Radio Commission grants higher power to broadcasting stations operating on clear channels.

"In addition, there is a tremendous market for the equipment of offices, factories, schools, auditoriums and other places in which radio has been comparatively little used. Special broadcasting programs for these interests already have been planned for 1931 by broadcasting interests.

"The outlook for the radio industry is not at all discouraging and with an undoubted return of better general conditions, our industry faces the future with confidence."

Gold Seal Loses Point In RCA Tube Suit

The motion made on behalf of Gold Seal Electrical Company, Inc., manufacturer of radio vacuum tubes, for a preliminary injunction restraining the Radio Corporation of America from proceeding against the Gold Seal Company in two suits for alleged infringement of patents has been denied by Judge Nields in the United States District Court for the District of Delaware.

The Gold Seal Company charged that the patents upon which the Radio Corporation was bringing suit were held in violation of the Sherman Anti-Trust Act.

New Corporations

Theatre Magazine Radio Bureau, advertising agencies—Atty. E. R. Kayes, 36 West 44th St., New York, N. Y.
Radio Auctioneers Corp., radios—Atty. W. Weisman, 276 Broadway, New York, N. Y.
Blue Seal Sound Devices, recording apparatus—Atty. H. J. Robinson, 43 Cedar St., New York, N. Y.
Otto Grasso Co., radios—Atty. M. Burt, 679 East 220th St., New York, N. Y.
Parne's Radio Shop—Atty. J. Frank, Woolworth Building, New York, N. Y.
Webster Radio Systems, broadcasting—Attys. Banzshag & Richter, 130 West 42nd St., New York, N. Y.
Broadcast Service Corp., radio broadcasting—Attys. Byrne & Byrne, 26 Court St., Brooklyn, N. Y.
Barty Radio Service—Atty. L. Stansky, 251 Broadway, New York, N. Y.
Public Service Broadcasting Co., Inc., Wilmington, Del., radio broadcasting stations—Corporation Trust Co.

Short-Wave Converter Series

In the November 8th issue of RADIO WORLD there began a remarkable series of articles dealing with the construction of short-wave converters that really do work, and that work well. Besides, the cost of parts is low. One model, 30 to 110 meters, no plug-in coils, may be built of parts costing less than $5, for battery operation, or for AC with extra filament transformer external, while another model, 10-200 meters, two plug-in coils, using somewhat superior parts, filament transformer built-in, can be made up by you for less than $10. Surely these are prices within the reach of all.

Low price and high achievement go hand in hand in these designs by Herman Bernard.

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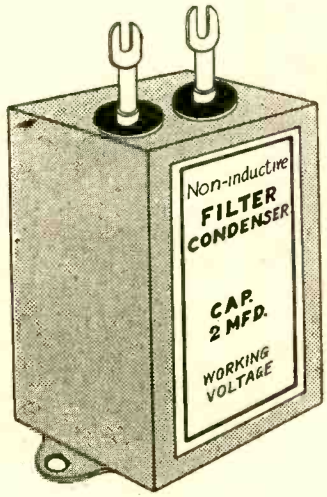

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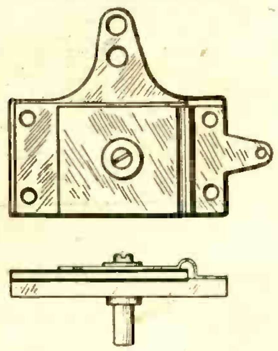

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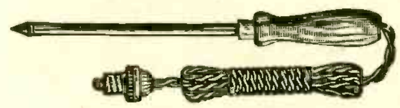

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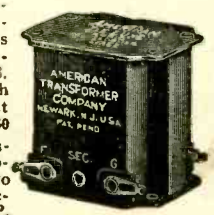

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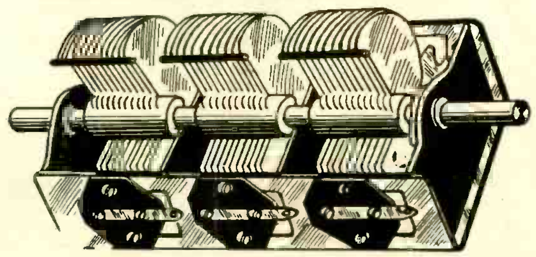

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