

Receiver Construction

¶ A One-Tube Regenerative Receiver

THE SIMPLEST receiver capable of giving at all satisfactory results in everyday operation is one consisting of a regenerative detector followed by an audio amplifier. This type of receiver is adequate for headphone reception, and is quite easy to build and adjust. A dual tube may be used for both stages, thereby reducing cost.

Figs. 1101 to 1105 show such a receiver. It uses a 6C8G twin-triode tube, one triode section being the regenerative detector and the other the audio amplifier. The circuit diagram is given in Fig. 1103. The grid coil, L_1 , is tuned to the frequency of the incoming signal by means of condensers, C_1 and C_3 , C_1 being the band-setting or general coverage condenser and C_3 the bandspread condenser. Regeneration is supplied by means of the tickler coil, L_2 ; the variable plate by-pass condenser, C_2 , is the regeneration control. The receiver is coupled to the antenna through C_5 , a low-capacity trimmer condenser. R_1 and C_4 are the grid leak and grid condenser.

The audio amplifier section of the tube is coupled to the detector by the audio transformer, T_1 . Bias for the audio stage is supplied by a midget flashlight cell, this type of bias being quite convenient as well as cheaper than other methods. The choke, RFC , is necessary to prevent r.f. current from flowing in the primary winding of the audio transformer; without the r.f. choke, the regeneration control condenser, C_2 , may be ineffective. A switch, S_1 , is provided for turning off the "B" supply when transmitting.

This receiver is laid out so that it can be converted into the two-tube superheterodyne described in the next section, using most of the

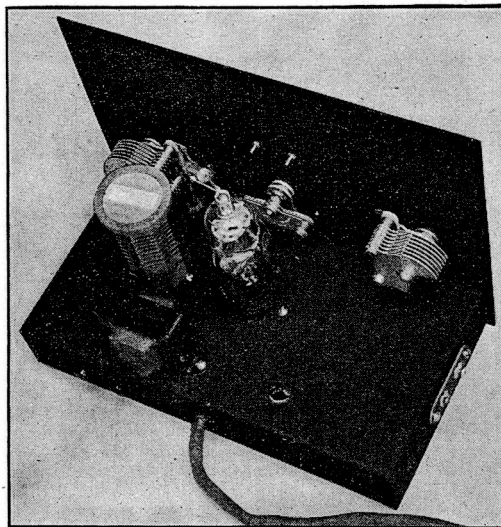


Fig. 1102 — Top view of the chassis of the one-tube regenerative receiver. The grid condenser and grid leak are supported by their wire leads between the stator plates of the tuning condenser and the grid cap on the tube.

same parts over again and utilizing the same chassis and panel. The superhet will give improved performance, but is a little more difficult to build and adjust. By building the one-tube receiver first, the beginner will acquire experience in the operation of regenerative circuits which will be helpful in building and using the two-tube receiver.

The construction of the receiver is shown in the photographs. The three variable condensers are mounted on the panel three inches from the bottom edge, with C_3 in the center, C_1 at the right and C_2 at the left. The condensers are $3\frac{1}{2}$ inches apart, center to center. The tube socket is directly behind C_3 , its center being $2\frac{1}{4}$ inches from the panel; the coil socket is $2\frac{1}{2}$ inches to the right. The a.f. transformer is mounted at the rear of the chassis, as shown. All ground connections may be made directly to the chassis, making sure that the paint is scraped away and that good contact is secured.

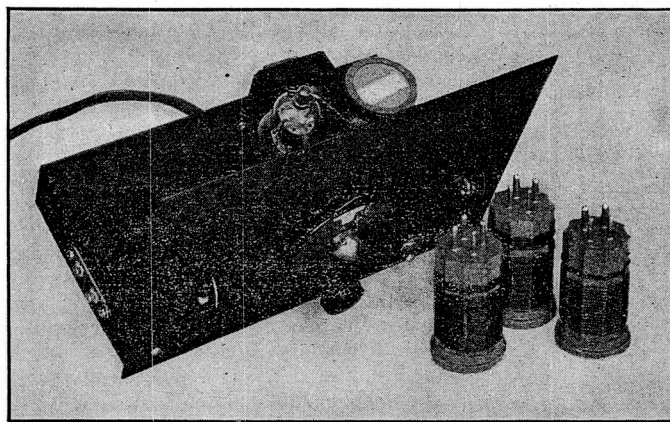


Fig. 1101 — A one-tube regenerative receiver, using a double triode with one section a regenerative detector and the other an audio amplifier. The chassis measures $5\frac{1}{2} \times 9\frac{1}{2} \times 1\frac{1}{2}$ inches; panel size is $6 \times 10\frac{1}{2}$ inches.

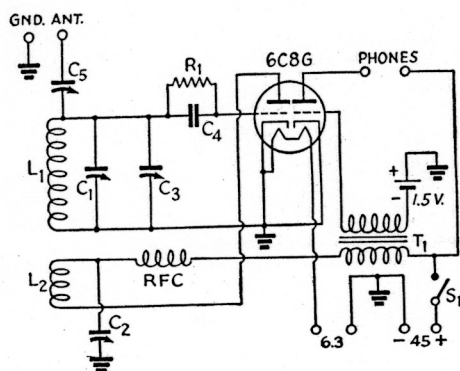


Fig. 1103 — Circuit diagram of the one-tube receiver.

C₁, C₂ — 100-μfd. variable (Hammarlund SM-100).
 C₃ — 15-μfd. variable (Hammarlund SM-15).
 C₄ — 100-μfd. mica.
 C₅ — 3-30-μfd. mica trimmer (National M-30).
 R₁ — 1 megohm, ½-watt.
 L₁, L₂ — See coil table.
 T₁ — Audio transformer, interstage type, 3:1 ratio (Thordarson T-13A34).
 S₁ — S.p.s.t. toggle switch.
 RFC — 2.5-mh. r.f. choke.

In the photograph, Fig. 1105, the antenna connection strip is at the left, with C₅ supported by the wiring to the antenna post. The ground connection is soldered to a lug under the nut holding the connection strip in place. The choke, RFC, also is supported by the wiring. The bias battery (the zinc can is the negative terminal) is soldered to a lug strip, as shown. The headphone connections are made by means of tip jacks mounted on the rear edge of the chassis. Filament and plate power are brought in through a four-wire cable which enters the chassis through the rear edge.

The coils are made as shown in Fig. 1104 and the coil table. Both windings should be in

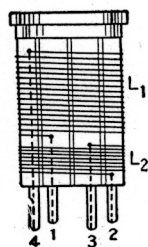
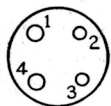


Fig. 1104 — Method of winding the plug-in coils for the one-tube regenerative receiver.



BOTTOM OF SOCKET
OR COIL FORM

Fig. 1105 — Bottom-of-chassis view of the one-tube two-stage regenerative receiver. Construction and wiring are extremely simple.

the same direction. Using the standard pin numbering for four-prong sockets, pin 1 connects to ground, pin 2 to the plate of the detector, pin 3 to RFC and the stator plates of C₁ and C₃, and pin 4 to the stator plates of C₁ and C₃. L₁ for the B, C and D coils should have its turns evenly spaced to occupy the specified length; the wire may be held in place when the coil is finished by running Duco cement along the ridges of the coil forms.

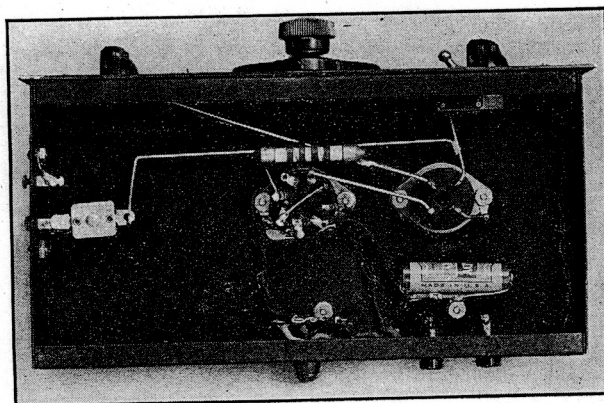
The heater supply for the receiver may be either a 6.3-volt filament transformer (the 1-ampere size will be ample) or a 6-volt battery. A 45-volt "B" battery should be used for the plate supply.

After the set is completed and the wiring checked to make sure that it is exactly as shown, insert the C coil in the coil socket and connect the headphones, antenna and ground, and the heater supply. After the heater supply has been connected for a few minutes, the tube should feel warm to the touch and there should be a visible glow from the heater. The "B" battery may now be connected and the switch, S₁, closed.

Now turn the regeneration condenser, C₂, starting from minimum capacity (plates all out) until the set goes into oscillation. This phenomenon is easily recognizable by a distinct click, thud or hissing sound. The point where oscillation just begins is the most sensitive operating point at that particular dial setting.

The tuning dial may now be slowly turned, the regeneration control knob being varied simultaneously (if necessary) to keep the set just oscillating. A number of stations should be heard. A little practice will make tuning easy.

If the set refuses to oscillate, the sensitivity will be poor and no code signals will be heard on the frequencies at which such signals should be expected. It should oscillate easily, however, if the coils are made exactly as shown. It sometimes happens that the antenna takes so much energy from the set that it cannot oscillate, this usually resulting in "holes" in the range where no signals can be picked up (and where the hissing sound cannot be obtained). This can



ONE-TUBE REGENERATIVE RECEIVER COIL DATA

Coil	Grid Winding (L_1)	Tickler (L_2)
A	56 turns No. 22 enameled	15 turns No. 24 enameled
B	32 " " " "	8 " " " "
C	18 " " " "	5 " " " "
D	10 " " " "	5 " " " "

All coils wound on $1\frac{1}{2}$ -inch diameter forms (Hammarlund SWF-4). Grid windings on coils B, C and D spaced to occupy a length of $1\frac{1}{2}$ inches; grid winding on coil A close-wound. Tickler coils all close-wound, spaced $\frac{1}{8}$ inch from bottom of grid winding. See Fig. 1104.

Frequency range: Coil A — 1700 to 3200 kc.
 B — 3000 to 5700 kc.
 C — 5400 to 10,000 kc.
 D — 9500 to 18,000 kc.

be cured by reducing the capacity of C_5 (unscrewing the adjusting screw) until the detector again oscillates. If it still refuses to oscillate, the coil L_2 must be moved nearer to L_1 or, in extreme cases, a turn or two must be added to L_2 . This is best done by rewinding with more turns rather than by trying to add a turn or two to the already-wound coil. For any given band of frequencies, adjust C_5 so that the detector oscillates over the whole range, using as much capacity at C_5 as is possible. This will give the best compromise between dead spots and signal strength. It will be found that less advancing of the regeneration control, C_2 , is required at the high-frequency end of a coil range (C_1 at or near minimum capacity) than at the low-frequency end. The best adjustment of the antenna condenser, C_5 , and the feed-back coil, L_2 , is that which requires almost a maximum setting of the regeneration control at the low-frequency end (maximum capacity of C_1) of any coil range.

Coil A misses the high-frequency end of the broadcast band, but it is possible to hear police stations and the 160-meter amateur

band with it, as well as other services. The amateur band is most easily located by listening at night, setting C_3 at maximum and slowly tuning with C_1 until some of the police stations are heard. These stations operate on 1712 kc., so that once found they become "markers" for the low-frequency end of the band.

Locating the amateur bands on the other coils is done in much the same manner, by searching carefully with C_1 . The 3.5–4.0-Mc. amateur band will be found on coil B at about 80 per cent setting of C_1 . On coil C, the 7-Mc. amateur band will be found with C_1 meshed about 60 per cent; the 14-Mc. band (coil D) is found with C_1 meshed about 20 per cent.

A suitable antenna for the receiver would be 50 to 75 feet long, and as high and clear of surrounding objects as possible. The ground lead should preferably be short; a connection to a heating radiator or water pipe is usually good.

□ A Two-Tube Superheterodyne Receiver

Although all the advantages of the superheterodyne-type receiver cannot be secured without going to rather elaborate multi-tube circuits, it is possible to use the superhet principle to overcome most of the disadvantages of the simple regenerative receiver. These are chiefly the necessity for critical adjustment of the regeneration control with tuning, antenna "dead spots," lack of stability (both in the detector circuit itself and because of slight changes in frequency when the antenna swings with the wind), and blocking, or the tendency for strong signals to pull the detector into zero beat. These effects can be largely eliminated by making the regenerative detector operate on a fixed low frequency and designing it for maximum stability. The incoming signal is then converted to the fixed detector frequency before being detected.

A two-tube receiver operating on this principle is shown in Figs. 1106 to 1110. It employs the same chassis and panel, as well as most of the parts, of the one-tube regenerative receiver just described, with the addition of a converter tube and its associated circuits. The same coils may also be used, with a new winding and rearrangement of the pin connections for L_2 ; the windings and connections for L_1 need not be changed. One additional coil is needed to cover a frequency range of 1700 to 14,500 kc., including the four lower-frequency amateur bands.

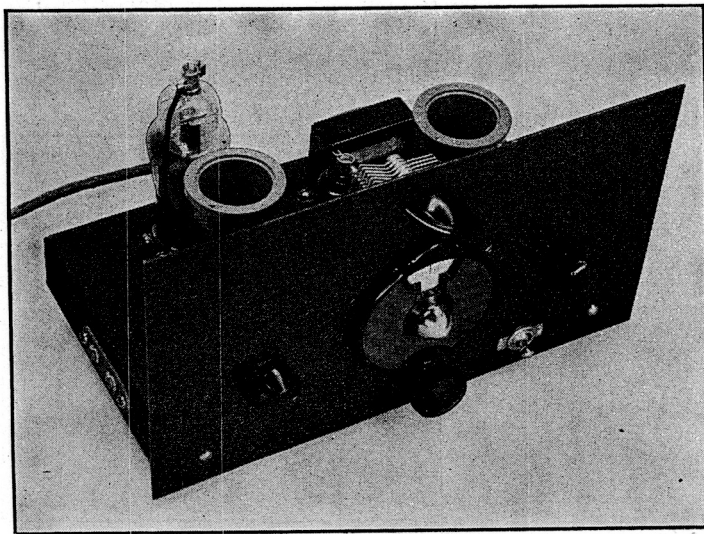


Fig. 1106 — This two-tube superheterodyne has one more operating control than the ordinary regenerative receiver, but it is more stable and easier to tune.

The circuit diagram is given in Fig. 1108. A 6K8 is used to convert the frequency of the incoming signal to the fixed or intermediate frequency, and the two triode sections of a 6C8G serve as the regenerative detector and audio amplifier respectively. L_1C_1 is the r.f. circuit, tuned to the signal, and L_2 is the antenna coupling coil. C_7 is a by-pass condenser across the 1.5-volt battery used to bias the signal grid of the 6K8. The high-frequency oscillator tank circuit is $L_3C_3C_4$, with C_3 for band-setting and C_4 for bandspread.

The i.f. tuned circuit (or regenerative detector circuit) is L_5C_5 . This must be a high- C circuit if stability better than that of an ordinary regenerative detector is to be secured. The frequency to which it is tuned should be in the vicinity of 1600 kc.; the exact frequency does not matter so long as it falls on the low-frequency side of the 1750-kc. band. L_5 and its tickler coil, L_6 , are wound on a small form, and L_5 is tuned by a fixed mica condenser of the low-drift type. Since these condensers are rated with a capacity tolerance of 5 per cent, it is sufficient to wind L_5 as specified under Fig. 1108. The resulting resonant frequency will be in the correct region. No manual tuning is necessary, and therefore the frequency of this circuit need not be adjusted. C_2 is the regeneration-control condenser, isolated from the d.c. supply by the choke, RFC . Only enough turns need be used on L_6 to make the detector oscillate readily when C_2 is at half capacity or more.

The second section of the 6C8G is transformer-coupled to the detector. The grid is biased by the same battery which furnishes bias for the 6K8.

Looking at the top of the chassis from in front, the r.f. or input circuit is at the left, with C_1 on the panel and L_1L_2 just behind it. The 6C8G is directly to the rear of the coil. The 6K8 converter tube is centered on the chassis, with C_3 and C_4 on the panel directly

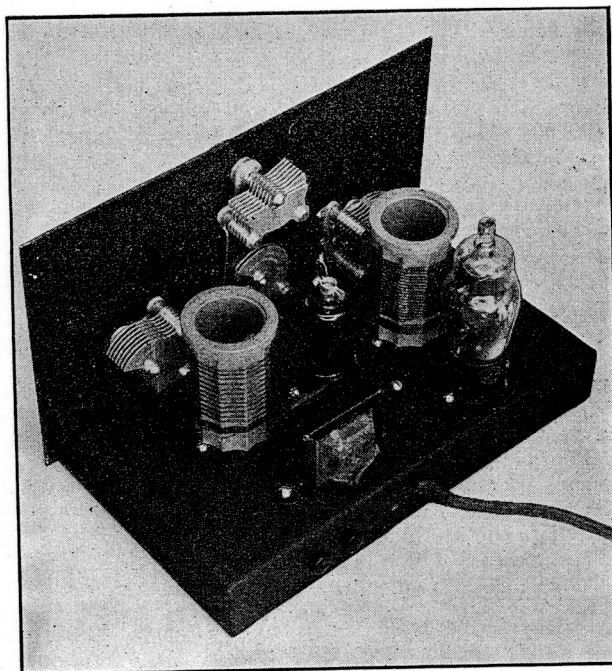


Fig. 1107 — A back-of-panel view of the two-tube superhet, showing the arrangement of parts on top of the $5\frac{1}{2} \times 9\frac{1}{2} \times 1\frac{1}{2}$ -inch chassis.

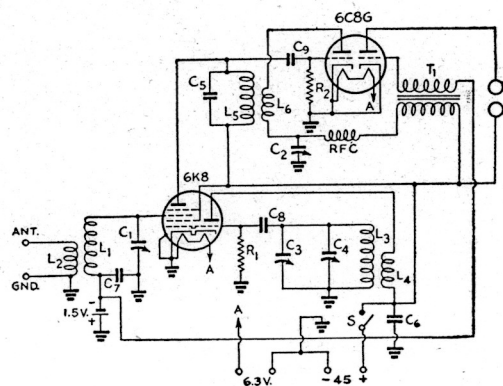
in front of it. C_4 is driven by the vernier dial and C_3 is toward the top of the panel. The coil at the right is L_3L_4 , in the oscillator tuned circuit. The regeneration-control condenser, C_2 , is at the right on the panel. The audio transformer, T_1 , is behind the oscillator coil.

Looking at the bottom of the chassis, the antenna-ground terminals are at the left, with a lead going directly to L_2 on the coil socket. The bias battery is fastened to a two-lug insulating strip by means of wires soldered to the battery. The zinc can is the negative end and the small cap the positive terminal. By-pass condenser C_7 is mounted on the coil socket.

The i.f. coil is mounted on the chassis midway between the socket for the 6C8G and that for the 6K8. In winding the coil the ends of the wires are left long enough to reach to the various tie-in points. The grid condenser, C_9 , is

Fig. 1108 — Circuit diagram of the two-tube superheterodyne.

- C_1, C_2, C_3 — 100- μ fd. variable (Hammarlund SM-100).
- C_4 — 15- μ fd. variable (Hammarlund SM-15).
- C_5 — 250- μ fd. silvered mica (Dubilier Type 5-R).
- C_6 — 0.01- μ fd. paper
- C_7 — 0.005- μ fd. mica.
- C_8, C_9 — 100- μ fd. mica.
- R_1 — 50,000 ohms, $\frac{1}{2}$ -watt.
- R_2 — 1 megohm, $\frac{1}{2}$ -watt.
- RFC — 2.5-mh. r.f. choke.
- T_1 — Audio transformer, interstage type, 3:1 ratio (Thordarson T-13A34).
- L_1-L_4 , inc. — See coil table.
- L_5 — 55 turns No. 30 d.s.c., close-wound on $\frac{3}{4}$ -inch diameter form (National PRF-2); inductance 40 microhenrys.
- L_6 — 18 turns No. 30 d.s.c., close-wound, on same form as L_5 ; see Fig. 1110.
- S — S.p.s.t. toggle switch.



supported by the grid terminal on the tube socket and the end of the grid winding, L_5 . R_2 is mounted over the 6C8G socket. The i.f. tuning condenser, C_5 , is mounted by its terminals between the plate and screen prongs on the 6K8 socket, the ends of L_5 being brought to the same two points.

The oscillator grid condenser, C_3 , is connected between the coil-socket prong and the oscillator grid prong on the 6K8 socket. By-pass condenser C_6 is mounted alongside the oscillator coil socket, as shown. The connections to the rotors of the tuning condensers for both coils go through holes in the chassis near the front edge. Grounds are made directly to the chassis in all cases; make sure that there is an actual connection to the metal.

The "B" switch is a single-pole single-throw toggle. 'Phone-tip jacks on the rear chassis edge provide means for connecting the audio output to the headphones.

The method of winding coils is indicated in Fig. 1110; if the connections to the circuit are made as shown, there will be no trouble in obtaining the necessary oscillation. Both coils on each form should be wound in the same direction.

To test the receiver, first try out the i.f. circuit. Connect the filament and "B" supply and place both tubes in their sockets. Put a high-frequency coil in the r.f. socket, but do not insert a coil in the oscillator socket. The only test which need be made is to see if the detector oscillates properly. Advance C_2 from minimum capacity until the detector goes into oscillation, which will be indicated by a soft hiss. This should occur at around half scale on the condenser. If it does not occur, check the coil (L_5L_6) connections and winding direction and, if these seem right, add a few turns to the tickler, L_6 . If the detector oscillates with very low capacity at C_2 , it will be advisable to

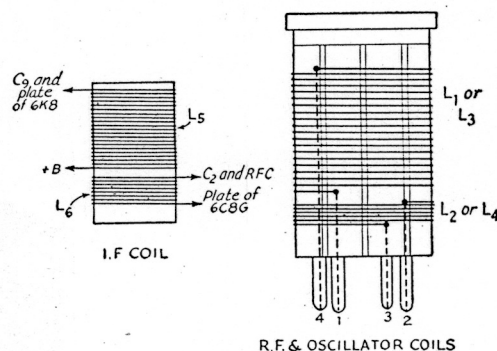


Fig. 1110 — How the coils for the two-tube superheterodyne are wound. The bottom end of the i.f. coil in this drawing is the end mounted adjacent to the chassis. L_5 and L_6 are wound in the same direction. On the r.f. socket, pin 4 connects to the No. 3 grid (top cap) of the 6K8 and stator of C_1 , pin 1 to C_7 , pin 2 to ground and pin 3 to the antenna post. On the oscillator socket, pin 4 goes to C_3 and the stators of C_3 and C_4 , pin 1 to ground, pin 2 to "B" + and pin 3 to the 6K8 oscillator plate. Both windings are in the same direction on each coil.

take a few turns off L_6 until oscillation starts at about midscale.

After the i.f. has been checked, plug in an oscillator coil for a range on which signals are likely to be heard at the time. The 5400–10,000-kc. range is usually a good one. The coils are arranged so that a minimum number is needed, even though two are used at a time. With coil C in the r.f. socket and D in the oscillator circuit, set C_1 at about half scale and turn C_3 slowly around midscale until a signal is heard. Then tune C_1 for maximum volume. Should no signals be heard, the probability is that the oscillator section of the 6K8 is not working, in which case the same method of testing is used as described above for the i.f. detector — check wiring, direction of windings of coils, and, finally, add turns to the tickler, L_4 , if necessary.

The same oscillator coil, D, is used for two frequency ranges. This is possible because the oscillator frequency is placed on the low-frequency side of the signal on the higher range. This gives somewhat greater stability at the highest-frequency range. Some pulling — a change in beat-note as the r.f. tuning is varied by means of C_1 — will be observed on the highest-frequency range, but it is not serious in the region of resonance with the incoming signal frequency.

The receiver will respond to signals either 1600 kc. lower or 1600 kc. higher than the oscillator frequency. The unwanted response, or

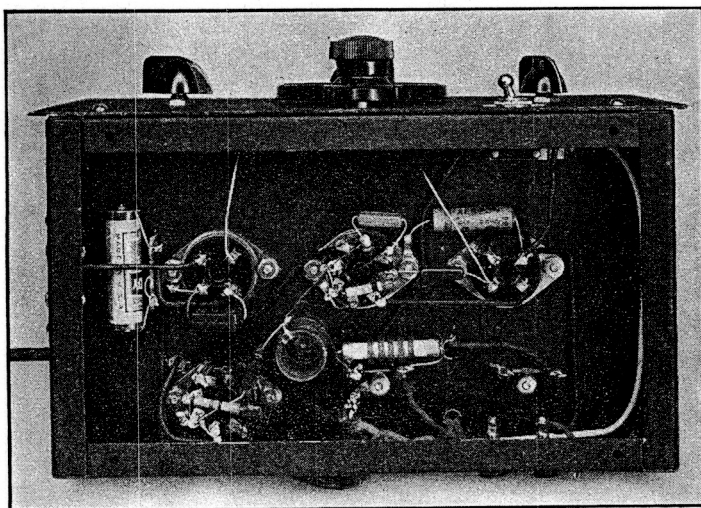


Fig. 1109 — Below-chassis view of the two-tube superhet. The i.f. circuit is underneath the chassis; no adjustment of its frequency is necessary. Since few parts are required, the construction, assembly and wiring are quite simple.

image, is discriminated against by the selectivity of the r.f. circuit. On the three lower-frequency ranges, when it is possible to find two tuning spots on C_1 at which incoming random noise peaks up, the lower-frequency peak (the one requiring the highest tuning capacity at C_1) is the right one. The oscillator frequency is 1600 kc. higher than that of the incoming signal on these three ranges. On the fourth range the oscillator is tuned 1600 kc. lower. Bandspread is not needed in the r.f. circuit, since the tuning is not very critical.

The regeneration control may be set to give desired sensitivity and left alone while tuning; only when an exceptionally strong signal is encountered is it necessary to advance it more to keep the detector in oscillation for code reception. It should be set just on the edge of oscillation for 'phone reception.

The heater requirements of the set are 0.6 amperes at 6.3 volts, approximately. Either a.c. or d.c. may be used. The "B" battery current is between 4 and 5 ma., so that a standard 45-volt block will last hundreds of hours (*Bib. 1*).

☛ A Three-Tube General Coverage and Bandspread Superheterodyne

A superhet receiver of simple construction, having a wide frequency range for general listening-in as well as full bandspread for amateur-band reception, is shown in Figs. 1111 to 1115. The circuit uses only three tubes and gives continuous frequency coverage from about 75 kc. (4000 meters) to 60 Mc. (5 meters). The receiver is intended for operation from either a 6.3-volt transformer or 6-volt storage battery for filament supply, and a 90-volt "B" battery for plate supply.

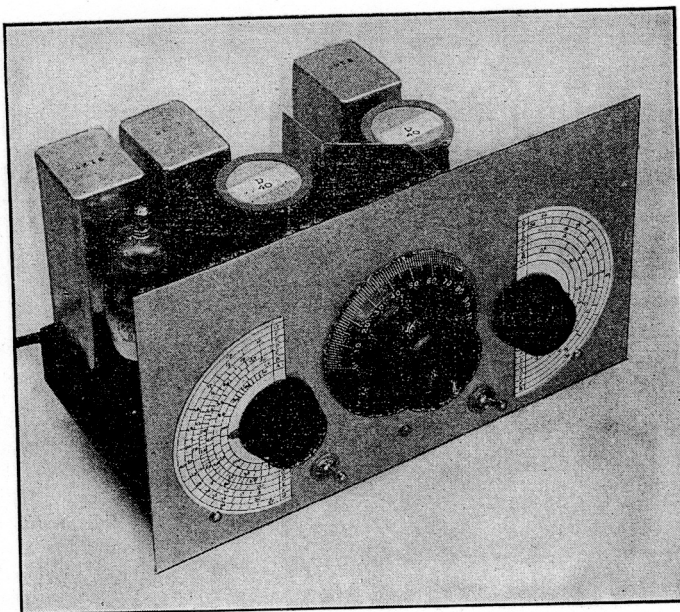


Fig. 1111 — A three-tube superheterodyne receiver, designed for either a.c. or d.c. heater operation and for 90-volt "B" battery plate supply.

The circuit diagram is given in Fig. 1112. A 6K8 is used as a combined oscillator-mixer followed by a 6SK7 i.f. amplifier. The intermediate frequency is 1600 kc., a frequency which reduces image response on the higher frequencies and simplifies the design for low-frequency operation in the region below the broadcast band. One section of the 6C8G double triode is used as a second detector and the other section as a beat-frequency oscillator. Headphone output is taken from the plate circuit of the second detector.

To simplify construction, the antenna and oscillator circuits are separately tuned. The antenna tuning control, C_1 , may be used as a volume control by detuning from resonance. The oscillator circuit, $L_3C_2C_3$, is tuned 1600 kc. higher than the signal on frequencies up to 5 Mc.; above 5 Mc. the oscillator is 1600 kc. lower than the signal. C_2 is the general coverage or band-setting condenser, C_3 the bandspread or tuning condenser. C_4 is a tracking condenser which sets the oscillator tuning range on each band so that it coincides with the tuning range in the mixer grid circuit.

The i.f. stage uses permeability-tuned transformers with silvered-mica fixed padding condensers. The second detector is cathode-biased by R_4 , by-passed by C_{11} for audio frequencies.

The second 6C8G section is the beat oscillator, using a permeability-tuned transformer. The grid condenser and leak are built into the transformer. The plate is fed through the b.o. on-off switch and a dropping resistor, R_5 , the latter serving both to reduce the "B" current drain and to cut down the output of the oscillator to a value suitable for good heterodyning. No special coupling is needed between the beat oscillator and the second detector.

TWO-TUBE SUPERHET COIL DATA

Coil Grid Winding (L_1 and L_2) Antenna (L_3) or Tickler (L_4)

A	56 turns No. 22 enameled	10 turns No. 24 enameled
B	32 " " " "	8 " " " "
C	18 " " " "	7 " " " "
D	12 " " " "	7 " " " "
E	10 " " " "	7 " " " "

All coils wound on 1½-inch diameter forms (Hammarlund SWF-4). Grid windings on coils B-E, inclusive, are spaced to occupy a length of 1½ inches; grid winding on coil A is close-wound. Antenna-tickler coils are all close-wound, spaced ½-inch from bottom of grid winding. See Fig. 1110.

Frequency Range	Coil at L_1 - L_2	Coil at L_3 - L_4
1700 to 3200 kc.	A	B
3000 to 5700 kc.	B	C
5400 to 10,000 kc.	C	D
9500 to 14,500 kc.	E	D

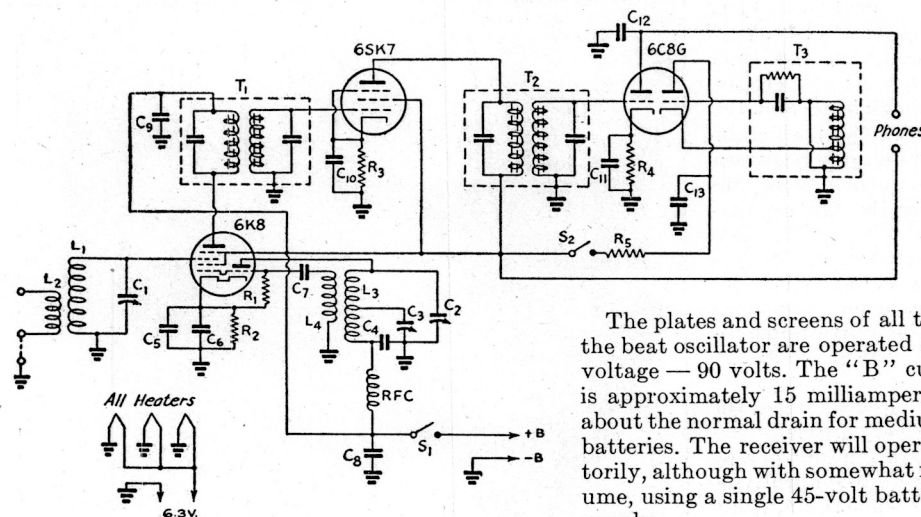


Fig. 1112 — Wiring diagram for the three-tube general and bandspread superheterodyne receiver.

- C₁ — 100- μ fd. variable (Hammarlund MC-100-M).
 C₂ — 140- μ fd. variable (Hammarlund MC-140-M).
 C₃ — 35- μ fd. variable (Hammarlund HF-35).
 C₄ — Oscillator padder; see coil table.
 C₅ — 0.1- μ fd. paper.
 C₆ — 0.002- μ fd. mica.
 C₇ — 250- μ fd. mica.
 C₈ — 0.002- μ fd. mica.
 C₉, C₁₀ — 0.01- μ fd. paper.
 C₁₁ — 5- μ fd. electrolytic, 50 volts.
 C₁₂, C₁₃ — 0.002- μ fd. mica.
 R₁ — 50,000 ohms, $\frac{1}{2}$ -watt.
 R₂, R₃ — 250 ohms, $\frac{1}{2}$ -watt.
 R₄ — 12,000 ohms, $\frac{1}{2}$ -watt.
 R₅ — 50,000 ohms, $\frac{1}{2}$ -watt.
 T₁, T₂ — 1600-kc. i.f. transformer (Millen 64161).
 T₃ — 1600-kc. oscillator transformer (Millen 65163).
 L₁, L₂, L₃, L₄ — See coil table on page 215.
 S₁, S₂ — S.p.s.t. toggle switch.
 RFC — 2.5-mh. r.f. choke.

Fig. 1113 — A plan view of the three-tube superheterodyne with the coils and tubes removed. The chassis measures $5\frac{1}{2} \times 9\frac{1}{2} \times 1\frac{1}{2}$ inches and the panel size is $10\frac{1}{2} \times 6$ inches.

The plates and screens of all tubes except the beat oscillator are operated at the same voltage — 90 volts. The "B" current drain is approximately 15 milliamperes, which is about the normal drain for medium-size "B" batteries. The receiver will operate satisfactorily, although with somewhat reduced volume, using a single 45-volt battery for "B" supply.

The parts arrangement is shown in the photographs of Figs. 1113 and 1114. The mixer tuning condenser, C₁, is at the right. The bandspread oscillator tuning condenser, C₃, is in the center, controlled by the National Type-A $3\frac{1}{2}$ -inch dial, and the band-set condenser, C₂, is at the left.

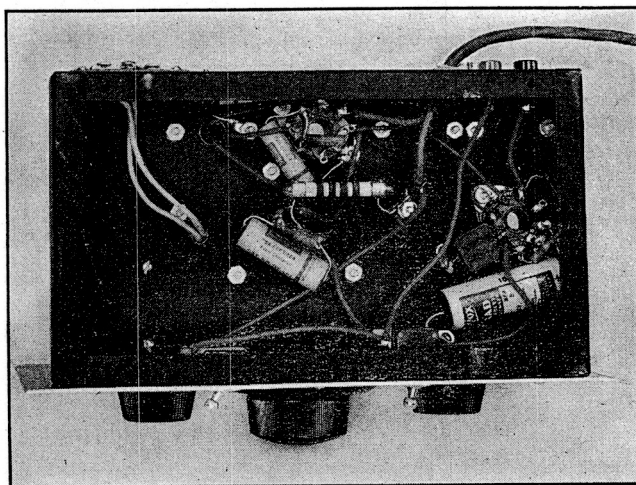
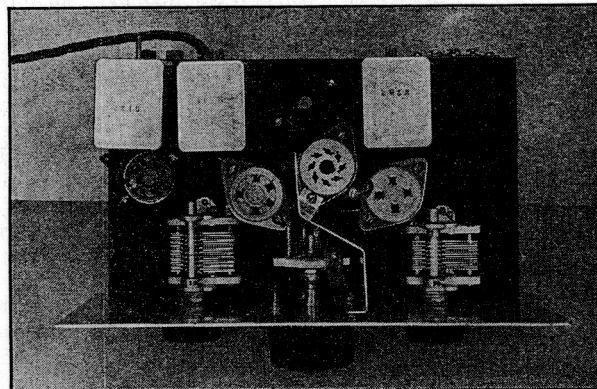


Fig. 1114 — Below the chassis of the three-tube receiver. The r.f. choke is mounted near the oscillator coil socket to keep the r.f. leads short. In the i.f. stage, care should be taken to keep the plate and grid leads from the i.f. transformer short and well separated. A four-wire cable is used for power-supply connections. The headphone tip jacks may be seen near the upper right-hand corner.

Referring to the top view, Fig. 1113, the i.f. section is along the rear edge, with T_1 at the right. Next is the socket for the 6SK7, then T_2 , and finally T_3 at the extreme left. The socket for the 6C8G is just in front of T_3 . The triode section in which the grid is brought out to the top cap is the one which is used for the beat oscillator.

The r.f. section has been arranged for short leads to favor high-frequency operation. The three sockets grouped closely together in the center are, from left to right, the oscillator-coil socket, socket for the 6K8, and the mixer-coil socket. All are mounted above the chassis by means of mounting pillars, so that practically all r.f. leads are above deck. The oscillator-grid leak, R_1 , and the high-frequency cathode by-pass condenser, C_6 , should be mounted directly on the socket before it is installed. So also should the oscillator grid condenser, C_7 , which can be seen extending to the left toward the oscillator-coil socket in Fig. 1113. Power-supply connections should be soldered to the 6K8 socket prongs before the socket is mounted, and these leads brought down through a hole in the chassis.

C_1 and C_2 are mounted directly on the chassis. C_3 is held from the panel by means of a small bracket made from metal strip, bent so that the condenser shaft lines up with the dial coupling. A baffle shield made of aluminum separates the oscillator and mixer sections; this shield is essential to prevent coupling between the two circuits which might otherwise cause interaction and poor performance.

The first step in putting the receiver into operation is to align the i.f. amplifier. This should preferably be done with the aid of a test oscillator, but if one is not available the circuits may be aligned on hiss or noise. The beat oscillator can also be used to furnish a signal for alignment. Further information on alignment may be found in Chapter Seven.

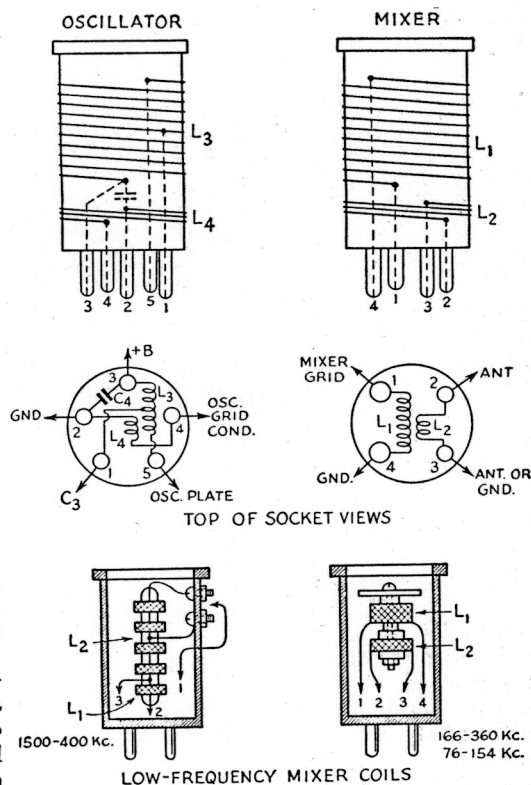


Fig. 1115 — How the coils for the three-tube superheterodyne are constructed. On the hand-wound oscillator and mixer coils, all windings are in the same direction.

The coils are wound as shown in Fig. 1115. A complete set of specifications is given in the coil table. Ordinary windings are used for all oscillator coils, and for all mixer coils for frequencies above 1600 kc. Below 1600 kc., readily-available r.f. chokes are used for the tuned circuits. For the broadcast band and the 600-750 meter ship-to-shore channels, the

COIL DATA FOR THE THREE-TUBE SUPERHETERODYNE

Range	Turns					C_4
	L_1	L_2	L_3	L_4	L_3 Tap	
A — 76-154 kc.	30 mh.	1 mh.	65	12	Top	300 μ fd.
166-360 kc.	8 mh.	1 mh.				
400-1500 kc.	2.5 mh.*	*				
B — 1.6 to 3.2 Mc. (160 meters)	56	10	42	11	Top	75 μ fd.
C — 3.00 to 5.7 Mc. (80 meters)	32	8	27	9	Top	100 μ fd.
D — 5.4 to 10.0 Mc. (40 meters)	18	8	22	9	12	0.002 μ fd.
E — 9.5 to 18 Mc. (20 meters)	10	8	12	3½	6	400 μ fd.
F — 15.0 to 30 Mc. (10 meters)	6	4	6	2½	2½	400 μ fd.
G — 30 to 60 Mc. (5 meters)	3	3	3½	1	1	300 μ fd.

* See Fig. 1115 and text for details. C_4 is mounted inside oscillator coil form; see Fig. 1115. Bandsread taps on L_3 measured from bottom ("B" + end) of coil. L_3 -A and L_1 -B coils close-wound with No. 22 enameled wire; L_3 -B close-wound with No. 20 enameled; all other grid coils (L_1 and L_3) wound with No. 18 enameled, spaced to give a length of 1½ inches on a 1½-inch diameter form (Hammarlund SWF) except the G coils, which are spaced to a length of 1 inch on 1-inch diameter forms (Millen 45004 and 45005). Antenna and plate coils, L_2 and L_4 , are close-wound with No. 24 enameled, spaced about ⅓th-inch from bottoms of grid coils, except for L_4 -G, which is interwound with L_3 .

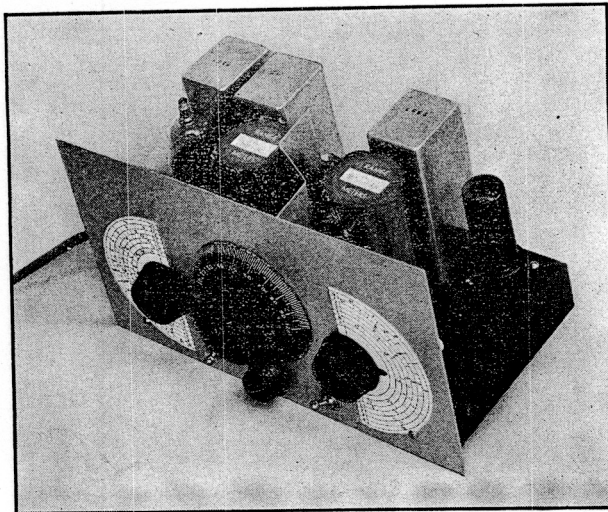


Fig. 1116—The modified three-tube superheterodyne receiver with the audio amplifier stage added for loudspeaker operation.

mixer coil is a Hammarlund 2.5-mh. r.f. choke, with the pies tapped as shown in Fig. 1115. The grid end and the intermediate tap are connected to machine screws mounted near the top of the coil form, and a flexible lead is brought out from the grid pin in the coil form to be fastened to either lead as desired. Mixer coils for the two lowest-frequency ranges are constructed as shown. The antenna winding in each case is a coil taken from an old 465-kc. i.f. transformer, having an inductance of about 1 millihenry. The inductance is not particularly critical, and a pie from a 2.5-mh. choke may be used instead.

With the i.f. aligned, the mixer grid and oscillator coils for a band can be plugged in. C_3 should be set near minimum and C_2 tuned from minimum until a signal is heard. Then C_1 is adjusted for maximum signal strength. If C_2 is set at the high-frequency end of an amateur band, further tuning should be done with C_3 , and the band should be found to cover about 75 per cent of the dial. C_3 can of course be used for bandspread tuning outside the amateur bands. It is convenient to calibrate the receiver, using homemade paper scales for the purpose as shown in Fig. 1111. Calibration points may be taken from incoming signals of known frequency, from a calibrated test oscillator, or from harmonics of a 100-kc. oscillator as

described in Chapter Nineteen. The mixer calibration need only be approximate, since tuning of the mixer circuit has little effect on the oscillator frequency. It is sufficient to make a calibration which ensures that the mixer is tuned to the desired signal rather than to the image.

On the broadcast band, the tuning range is such that, with C_2 set at 1500 kc., the entire band will be covered on C_3 . It is necessary, however, to change the tap on the mixer coil to make the antenna circuit cover the entire band. Only one oscillator coil is needed for the range from 75 to 1500 kc., but a series of coils is needed to cover the same range in the mixer circuit.

Adding an audio stage to the three-tube superhet—Very frequently the builder of a small receiver wishes it to operate a loudspeaker. The three-tube receiver just described is designed for headphone operation, but

readily can be converted to a four-tube set for use with a speaker. For this purpose a 6F6 pentode can be added to the circuit diagram, as shown

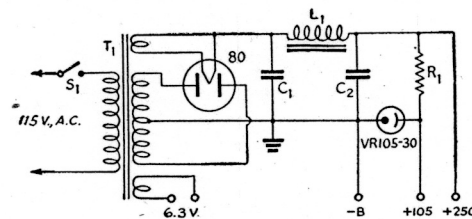


Fig. 1117—Power-supply circuit for the three-tube super.

C_1 —8- μ fd. electrolytic, 450 volts.
 C_2 —16- μ fd. electrolytic, 450 volts.
 R_1 —5000 ohms, 10-watt.
 L_1 —10 henrys, 65 ma.
 T_1 —275 to 300 volts each side center tap, 60–70 ma.; 6.3 volts at 1 ampere or more; 5-volt 2-ampere rectifier filament winding.
 S_1 —S.p.s.t. toggle switch.

A dual-unit electrolytic condenser may be used. Output voltage will be approximately 250 at full receiver load.

in Fig. 1118. Figs. 1116 and 1119 show how the receiver looks when completed.

For the purpose of driving the audio stage, resistance coupling is used from the plate of the second detector to the grid of the 6F6. A volume control is used for the grid resistor of the 6F6, and a jack is installed in the second-detector plate circuit so that a headphone plug may

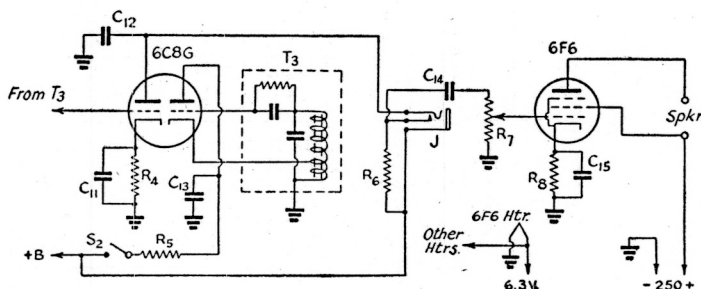


Fig. 1118—Circuit diagram of the pentode audio amplifier stage for loudspeaker operation of the three-tube superheterodyne. Except as noted below, values for components correspond to those bearing the same numbers in Fig. 1112.

C_{14} —0.1- μ fd. paper.
 C_{15} —25- μ fd. electrolytic, 50 volt.
 R_6 —120,000 ohms, $\frac{1}{2}$ -watt.
 R_7 —500,000-ohm volume control.
 R_8 —400 ohms, 1-watt.
 J —Closed-circuit jack.

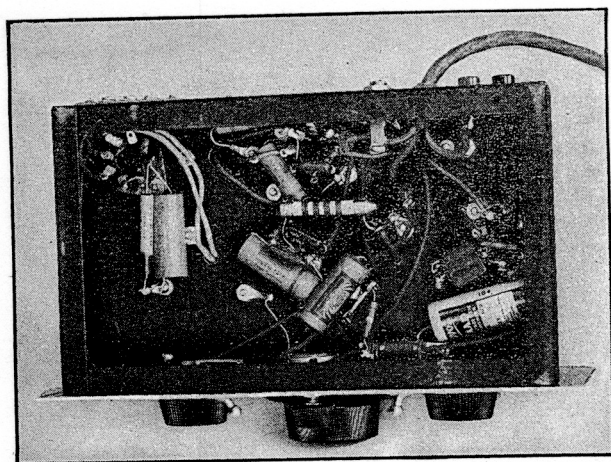


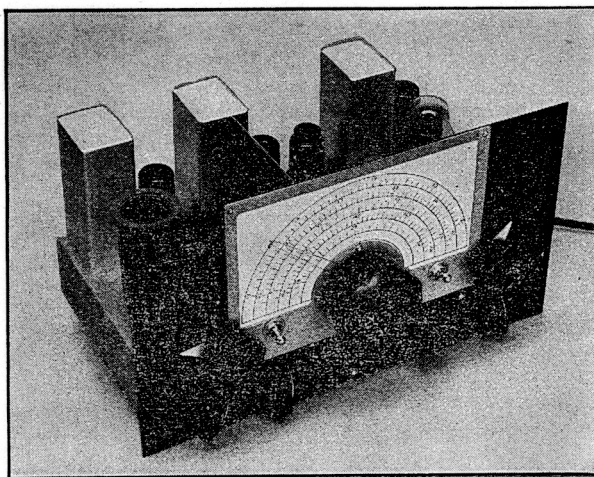
Fig. 1119 — The additional parts for the audio output stage can be identified in this sub-chassis view of the three-tube receiver.

be inserted. The volume control, R_7 , should be of the midget type so that it will fit in the chassis; it is installed with its shaft projecting under the tuning dial. In the bottom view, Fig. 1119, the 6F6 socket is in the upper left corner, along with the cathode resistor and by-pass condenser, R_8 and C_{15} . The coupling condenser, C_{14} , and the plate resistor, R_6 , are mounted on an insulated lug strip near the volume control.

The 6F6 will require a plate supply of 250 volts at about 40 milliamperes. This may be taken from a regular power pack, and a five-wire connection cable is used to provide an extra lead for the purpose. The first three tubes may be operated from a "B" battery, as before. Alternatively, the power supply may be constructed with a tap giving 90 or 100 volts for these tubes, the tap being connected to the proper wire in the connection cable. For best performance, the output voltage should be regulated by a VR105-30 regulator tube. A suitable power-supply circuit is shown in Fig. 1117.

The primary winding of the speaker output transformer always should be connected in the plate circuit of the 6F6. Operation without the plate circuit closed is likely to damage the screen-grid. Any speaker having a transformer with a primary impedance of 7000 ohms will be satisfactory; a permanent-magnet dynamic is convenient, since no field supply is necessary.

Fig. 1120 — A 7-tube superheterodyne using regeneration in the i.f. amplifier to give single-signal reception and improved image ratio. The dial (National ACN) may be directly calibrated for each amateur band. The chassis is $11 \times 7 \times 2$ inches and the panel 7×12 inches. The controls along the bottom edge of the panel are, from left to right, the mixer regeneration control, R_{15} , the i.f. gain control, R_{16} , the audio volume control, R_{17} , and the beat-oscillator vernier condenser, C_2 . The latter has the corner of one rotary plate bent over so that when the condenser plates are fully meshed the tuned circuit is short-circuited, thus stopping the b.f.o. oscillation.



A Regenerative Single-Signal Receiver

An inexpensive amateur-band receiver using i.f. regeneration for single-signal reception is shown in Fig. 1120. Fig. 1121 gives the circuit diagram. Regeneration also is used in the mixer circuit to improve the signal-to-image ratio and to give added gain. This receiver is designed to give the maximum of performance, in the hands of a capable operator, at minimum cost; selectivity, stability and sensitivity are the primary considerations.

The mixer, a 6SA7, is coupled to the antenna and is separately excited by a 6J5 oscillator. There is a single 460-kc. i.f. stage, using a 6SK7 and permeability-tuned transformers. The second detector and first audio amplifier is a 6SQ7, and the audio output tube for loudspeaker operation is a 6F6. The separate beat-oscillator circuit uses a 6C5. A VR105-30 voltage-regulator tube is used to stabilize the plate voltage on the oscillators and the screen voltage on the mixer and i.f. tubes.

To make construction easy and to avoid the necessity for additional trimmer condensers on each coil, the mixer and high-frequency oscillator circuits are separately tuned. Main tuning is by the oscillator bandspread condenser, C_3 , which is operated by the calibrated dial. C_2 is the oscillator band-setting condenser. The mixer circuit is tuned by C_1 . Regeneration in this circuit is controlled by R_{15} , connected across the mixer tickler coil, L_3 .

R_{16} is the i.f.-amplifier gain control, which also serves as an i.f. regeneration control when this stage is made regenerative. C_{15} is the regeneration condenser; it is adjusted to feed back a small amount of i.f. energy from the plate to the grid of the 6SK7, and thus produce regeneration. If the high selectivity afforded by i.f. regeneration is not wanted, C_{15} may be omitted.

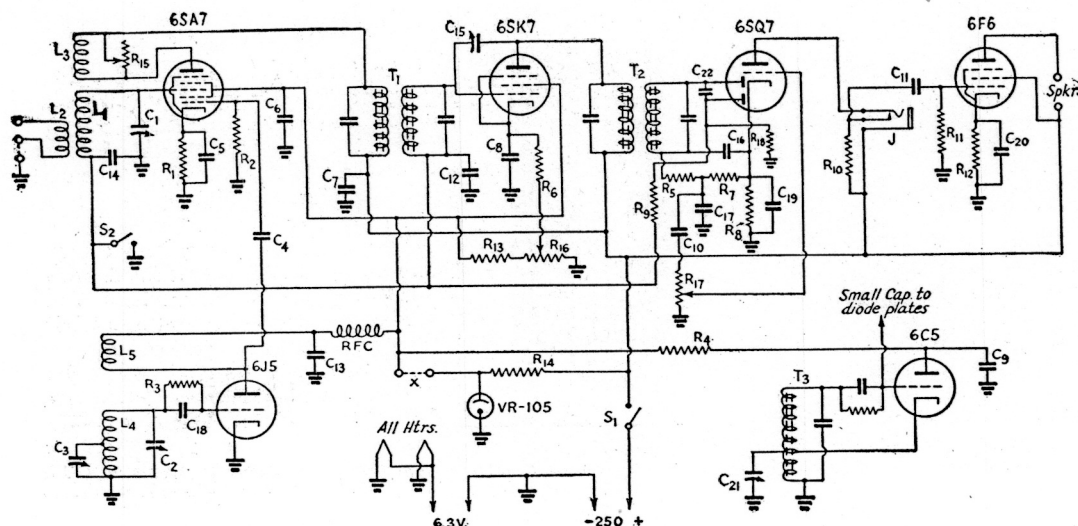


Fig. 1121 — Circuit diagram of the single-signal superheterodyne receiver with regenerative i.f. and mixer stages.

C₁, C₂ — 50- μ fd. variable (Hammarlund MC-50-S).
 C₃ — 35- μ fd. variable (National UM-35).
 C₄ — 50- μ fd. mica.
 C₅, C₆, C₇, C₈ — 0.1- μ fd. paper, 600 volts.
 C₉, C₁₀, C₁₁, C₁₂ — 0.01- μ fd. paper, 600 volts.
 C₁₃, C₁₄ — 0.005- μ fd. mica.
 C₁₅ — 3-30- μ fd. trimmer (National M-30); see text.
 C₁₆ — 250- μ fd. mica.
 C₁₇, C₁₈, C₂₂ — 100- μ fd. mica.
 C₁₉, C₂₀ — 25- μ fd. electrolytic, 50 volts.

C₂₁ — 25- μ fd. variable (Hammarlund SM-25).
 R₁ — 200 ohms, $\frac{1}{2}$ -watt.
 R₂ — 20,000 ohms, $\frac{1}{2}$ -watt.
 R₃, R₄, R₅ — 50,000 ohms, $\frac{1}{2}$ -watt.
 R₆ — 300 ohms, $\frac{1}{2}$ -watt.
 R₇ — 0.2 megohm, $\frac{1}{2}$ -watt.
 R₈ — 2000 ohms, $\frac{1}{2}$ -watt.
 R₉ — 1 megohm, $\frac{1}{2}$ -watt.
 R₁₀ — 0.1 megohm, $\frac{1}{2}$ -watt.
 R₁₁ — 0.5 megohm, $\frac{1}{2}$ -watt.
 R₁₂ — 450 ohms, 1-watt.
 R₁₃ — 75,000 ohms, 1-watt.
 R₁₄ — 5000 ohms, 10-watts.
 R₁₅ — 10,000-ohm volume control.
 R₁₆ — 25,000-ohm volume control.

R₁₇ — 2-megohm volume control.
 R₁₈ — 2 megohms, $\frac{1}{2}$ -watt.
 T₁ — 460-kc. permeability-tuned i.f. transformer, interstage type (Millen 64456).
 T₂ — 460-kc. permeability-tuned i.f. transformer, diode type (Millen 64454).
 T₃ — 460-kc. beat-oscillator transformer (Millen 65456).
 RFC — 2.5-mh. r.f. choke.
 J — Closed-circuit jack.
 S₁, S₂ — S.p.s.t. toggle.
 L₁–L₅, inc. — See coil table.
 X indicates the jumper inside the VR105-30 tube base.

Diode rectification is used in the second-detector circuit. One of the two diode plates in the 6SQ7 is used for developing a.v.c. voltage, being coupled through C₂₂ to the detector diode. The detector load resistor consists of R₅ and R₇ in series, the tap being used for r.f. filtering of the audio output to the triode sec-

tion of the tube. R₁₈ is the a.v.c. load resistor; R₉, C₁₄ and C₁₂ constitute the a.v.c. filter circuit. S₂ cuts the a.v.c. out of circuit by grounding the rectifier output. The headphones are connected in the plate circuit of the triode section of the 6SQ7. R₁₇ is the audio volume control potentiometer.

The top and bottom views, Figs. 1122 and 1123, show the layout clearly. The bandspread tuning condenser, C₃, is at the front center; at the left is C₁, the mixer tuning condenser; and at the right, C₂, the oscillator band-set condenser. The oscillator tube is directly behind C₃, with the mixer tube to the left on the other side of a baffle shield which separates the two r.f. sections. This shield, measuring $4\frac{1}{4} \times 4\frac{1}{2}$ inches, is used to prevent coupling between oscillator and mixer. The mixer coil socket is at the left edge of the chassis behind C₁; the oscillator coil socket is between C₂ and C₃.

The i.f. and audio sections are along the rear edge of the chassis. The transformer in the rear left corner is T₁; next to it is the i.f. tube, then T₂. Next in line is the 6SQ7, followed by the 6C5 beat oscillator, the b.o. trans-

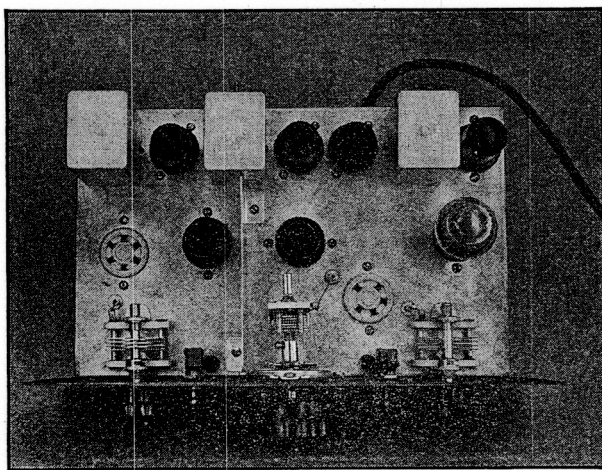


Fig. 1122 — Top view of the 7-tube superheterodyne with plug-in coils removed. Placement of the parts is discussed in the text.

former, T_3 , and finally the 6F6. The VR105-30 is just in front of T_3 . The i.f. transformers should be mounted with their adjusting screws projecting to the rear where they are easily accessible.

The beat oscillator is coupled to the second detector by the small capacity formed by running an insulated wire from the grid of the 6C5 close to the detector diode plate prong on the 6SQ7 socket. Very little coupling is needed for satisfactory operation.

In wiring the i.f. amplifier, keep the grid and plate leads from the i.f. transformers fairly close to the chassis and well separated. Without C_{15} , the i.f. stage should be perfectly stable and should show no tendency to oscillate at full gain.

The method of winding the plug-in coils is shown in Fig. 1124, and complete specifications are given in the coil table. Ticklers (L_3) for the mixer circuit are scramble-wound to a diameter which will fit readily inside the coil form and mounted on stiff leads going directly to the proper pins in the form. The leads should be long enough to bring the coils inside the grid winding at the bottom. The amount of feedback is regulated by bending the tickler coil with respect to the grid coil. Maximum feedback is secured with the two coils coaxial, minimum when the tickler axis is at right angles to the axis of L_1 . The position of L_3 should be adjusted so that the mixer goes into oscillation with R_{15} set at one-half to three-fourths of its maximum resistance.

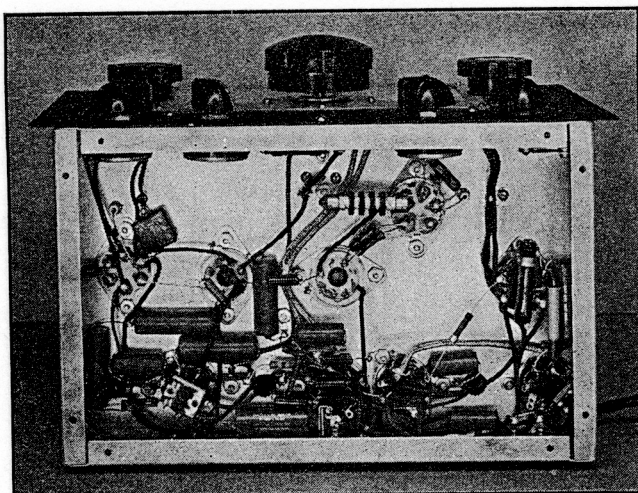


Fig. 1123 — The below-chassis wiring and location of parts is shown in this bottom view of the seven-tube regenerative single-signal receiver.

The oscillator circuit has been adjusted to make the proper value of rectified grid current flow in the 6SA7 injection-grid (No. 1) circuit on each amateur band. This calls for a fairly strong value of feed-back, with the result that when the band-set condenser is set toward the high-frequency end of its range the oscillator may "squeg." This is of no consequence unless the receiver is to be used for listening outside the amateur bands, in which case it may be corrected by taking a few turns off the tickler coil, L_5 . This can be done only at some sacrifice of conversion efficiency in the amateur band for which the coil was designed, however.

The i.f. amplifier can be aligned most conveniently with the aid of a modulated test oscillator. The initial alignment should be made with C_{15} disconnected so that the performance of the amplifier in a non-regenerative condition can be checked. Headphones or a loudspeaker may be used as an output indicator. The mixer and oscillator coils should be out of their sockets, and R_{15} should be set at zero resistance.

Connect the test oscillator output across C_1 , which should be set at minimum capacity. Adjust the test-oscillator frequency to 460 kc. Then, using a modulated signal, adjust the trimmers on T_1 and T_2 for maximum volume. R_{16} should be set for maximum gain, and the beat oscillator should be off. As the successive circuits are brought into line, reduce the oscillator output to keep from overloading any of the amplifiers, since overloading might cause a false indication.

After the i.f. is aligned, plug in a set of coils for some band on which there is a good deal of activity. Set the oscillator padding condenser, C_2 , at approximately the right capacity; with the coil specifications given, the proportion of the total capacity of C_2 in use on each band will be about as follows: 1.75 Mc., 90 per cent; 3.5

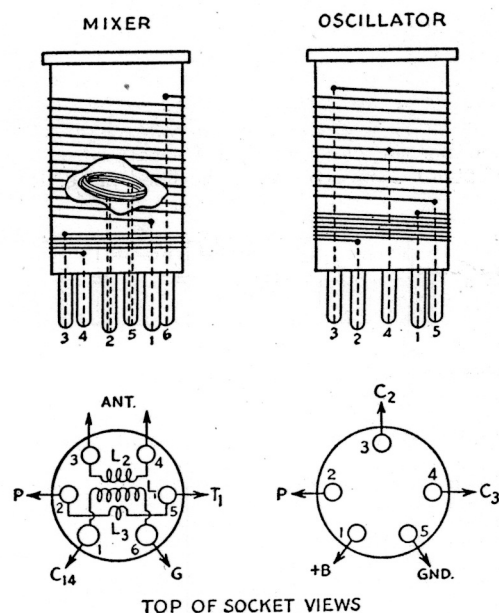


Fig. 1124 — Mixer and oscillator coil and socket connections for the seven-tube superheterodyne receiver.

COIL DATA FOR 7-TUBE SUPERHET

Band	Coil	Wire Size	Turns	Length	Tap
1.75 Mc.	L ₁	24	70	Close-wound	—
	L ₂	24	15	"	—
	L ₃	22	15	—	—
	L ₄	22	42	Close-wound	Top
	L ₅	24	15	"	—
3.5 Mc.	L ₁	22	35	"	—
	L ₂	22	9	"	—
	L ₃	22	12	—	—
	L ₄	22	25	1 inch	18
	L ₅	22	10	Close-wound	—
7 Mc.	L ₁	18	20	1 inch	—
	L ₂	22	5	Close-wound	—
	L ₃	22	9	—	—
	L ₄	18	14	1 inch	6
	L ₅	22	6	Close-wound	—
14 Mc.	L ₁	18	10	1 inch	—
	L ₂	22	5	Close-wound	—
	L ₃	22	7	—	—
	L ₄	18	7	1 inch	2.4
	L ₅	22	4	Close-wound	—
28 Mc.	L ₁	18	4	1 inch	—
	L ₂	22	4	Close-wound	—
	L ₃	22	1.5	—	—
	L ₄	18	3.6	1 inch	1.4
	L ₅	22	2.4	Close-wound	—

All coils except L₃ are 1½ inches in diameter, wound with enameled wire on Hammarlund SWF Forms. Spacing between L₁ and L₂, and between L₄ and L₅, is approximately ½ inch. Band-spread taps are counted from bottom (ground) end of L₄.

L₃ for 28 Mc. is interwound with L₁ at the bottom end. L₃ for all other coils is self-supporting, scramble-wound to a diameter of ¾ inch, mounted inside the coil form near the bottom of L₁.

Mc., 75 per cent; 7 Mc., 95 per cent; 14 Mc., 90 per cent; 28 Mc., 45 per cent. Set the mixer regeneration control, R₁₅, for minimum regeneration — i.e., with no resistance left in the circuit.

Now connect an antenna to the input terminals for L₂. Switch the beat oscillator on by turning C₂₁ out of the maximum position, and adjust the trimmer screw on T₃ until the characteristic beat-oscillator hiss is heard.

Next tune C₁ slowly over its scale, starting from maximum capacity. Using the 7-Mc. coils as an example, when C₁ is at about half scale there should be a definite increase in the noise level as well as in the strength of the signals which may be heard. Continue on past this point toward minimum capacity until a second peak is reached on C₁; at this peak the input circuit is tuned to the frequency which represents an image in normal reception. The oscillator in the receiver is designed to work on the high-frequency side of the incoming signal, so that C₁ always should be tuned to the peak which occurs with most capacity.

After the signal peak on C₁ has been identified, tune C₃ over its whole range, following with C₁ to keep the mixer circuit in tune, to see how the band fits the dial. With C₂ properly set, the band edges should fall the same number of main dial divisions from 0 and 100; if the band runs off the low-frequency edge, less capacity is needed at C₂, while the con-

verse is true if the band runs off the high edge. Once the band is properly centered on the dial, the panel may be marked at the appropriate point so that C₂ may be reset readily when changing bands.

To check the operation of the mixer regeneration, tune in signal on C₃, adjust C₁ for maximum volume, and slowly advance the regeneration control, R₁₅. As the resistance is increased, retune C₁ to maximum, since the regeneration control will have some effect on the mixer tuning. As regeneration is increased signals and noise both will become louder, and C₁ will tune more sharply. Finally the mixer circuit will break into oscillation and, when C₁ is right at resonance, a loud carrier will be heard, since the oscillations generated will go through the receiver in exactly the same way as an incoming signal. As stated before, oscillation should occur with R₁₅ set at from one-half to three-quarters full scale. In practice, it is best always to work with the mixer somewhat below the critical regeneration point and never permit it actually to oscillate. On the lower frequencies, where images are less serious, the tuning is less critical if the mixer is made non-regenerative. In this case, always set R₁₅ at zero, since there will be a range on the resistor where, without definite regeneration, the signal strength will be less than it is with zero resistance.

Should the mixer fail to oscillate, adjust the coupling by changing the position of L₃ with respect to L₁. If the two coils happen to be "poled" incorrectly, the circuit will not oscillate. This condition can be cured by rotating L₃ through 180 degrees. It is recommended that the mixer regeneration be tested first with the antenna disconnected, since antenna loading effects may give misleading results until it is known that L₃ is properly adjusted to produce oscillation.

After the preceding adjustments have been completed the i.f. regeneration may be added. Install C₁₅, taking out the adjusting screw and bending the movable plate to make an angle of about 45 degrees with the fixed plate. Re-

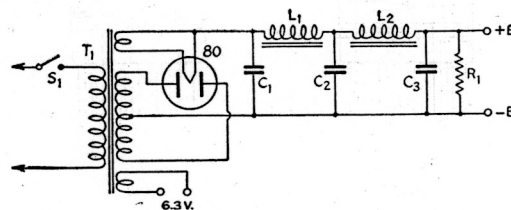


Fig. 1125 — Power supply for the regenerative superhet.

C₁, C₂ — 8-μfd. electrolytic, 450 volts.

C₃ — 16-μfd. electrolytic, 450 volts.

R₁ — 25,000 ohms, 10-watt.

L₁, L₂ — 12 henrys, 80 ma., 400 ohms.

T₁ — 350 volts each side of center-tap, 80–90 ma.; 6.3 volts at 2.5 amperes or more; 5-volt 2-ampere rectifier filament winding.

S₁ — S.p.s.t. toggle switch.

Dual-unit electrolytic condensers may be used. This supply will give 275 to 300 volts with full receiver load.

align the i.f. As the circuits are tuned to resonance the amplifier will oscillate, and each time this happens the gain control, R_{16} , should be backed off until oscillations cease. Adjust the trimmers to give maximum output with the lowest setting of R_{16} . At peak regeneration the signal strength should be about the same with this setting, despite reduced gain in the amplifier, as it is without regeneration at full gain. Too much gain with regeneration will have an adverse effect on the selectivity.

For single-signal c.w. reception, set the beat oscillator so that, when R_{16} is advanced to make the i.f. stage just go into oscillation, the resulting tone is the desired beat-note frequency. Then back off on R_{16} to obtain the desired degree of selectivity. Maximum selectivity will be secured with the i.f. amplifier just below the oscillating point. The "other side of zero beat" will be much weaker than the desired side.

A useful feature of the band spread dial is that it can be directly calibrated in frequency for each band. These calibrations may be made with the aid of a 100-kc. oscillator, such as is described in Chapter Nineteen. Ten-kilocycle points can be plotted if a 10-kc. multivibrator is available, but, since the tuning is almost linear in each band, a fairly accurate plot will result if each 100-kc. interval is simply divided off into ten equal parts when the dial calibrations are marked.

The power-supply requirements for the receiver are 2.2 amperes at 6.3 volts for the heaters and 80 ma. at 250 volts for the plates. Without the 6F6 pentode output stage, a supply giving 6.3 volts at 1.5 amperes and 250 volts at 40 ma. would be sufficient (*Bib. 2*). The circuit of a suitable power supply is given in Fig. 1125.

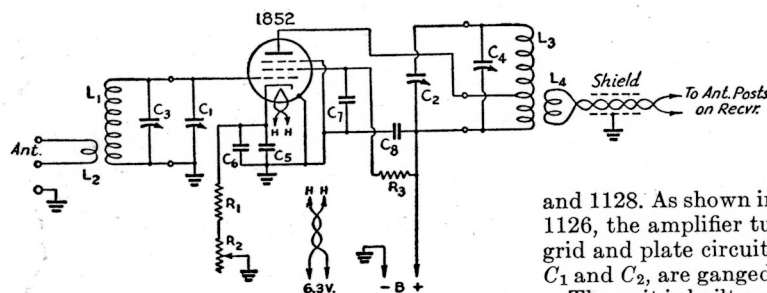


Fig. 1126 — Circuit diagram of the simple preselector.

C_1, C_3 — 15- μ fd. midget variable (National UM-15).
 C_2, C_4 — 3-30- μ fd. Isolantite-insulated mica padder (National M-30).

C_5 — 0.002- μ fd. mica.

C_6, C_7, C_8 — 0.01- μ fd. paper, 400 volts.

R_1 — 150 ohms, $\frac{1}{2}$ -watt.

R_2 — 5000-ohm variable.

R_3 — 60,000 ohms, 1-watt.

L_1 — 14 Mc.: 9 turns No. 20, diameter $1\frac{1}{2}$ inches, length 1 inch.

28 Mc.: 4 turns No. 20, diameter $1\frac{1}{2}$ inches, length 1 inch.

L_2 — Close-wound at ground end of L_1 ; 3 turns for 14 Mc., 2 turns for 28 Mc.

L_3 — Same as L_1 but tapped 3 turns from ground end for 14 Mc. and 1 turn from ground for 28 Mc.

L_4 — Same as L_2 , on same form as L_3 .

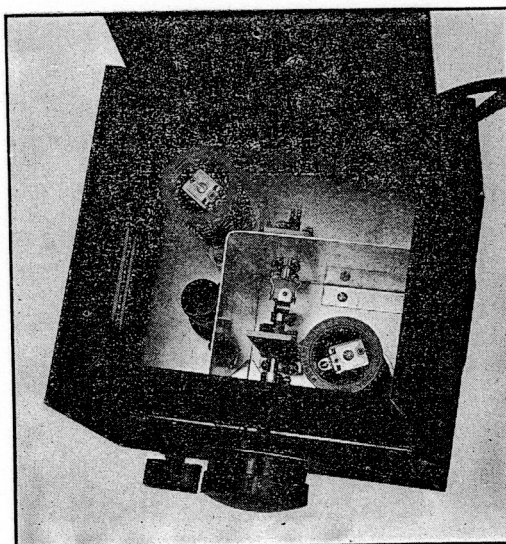


Fig. 1127 — Top view of the preselector. The padder condensers are mounted inside the plug-in coil forms.

Ⓐ A Regenerative Preselector

A separate preselector unit, consisting of an r.f. amplifier which may be inserted between the antenna and receiver, is an extremely useful device. Its use is especially beneficial on the 14- and 28-Mc. bands where image response becomes bothersome with superheterodyne receivers using intermediate frequencies of the order of 455 kc., since the added selectivity practically wipes out the image. Also, the gain of most receivers drops off on these two bands as compared with the gain on the lower frequencies, so that the additional amplification of the preselector is helpful in building up the weaker signals.

A simple preselector for these two bands is shown in Figs. 1127 and 1128. As shown in the circuit diagram, Fig. 1126, the amplifier tube is an 1852, with tuned grid and plate circuits. The tuning condensers, C_1 and C_2 , are ganged for single-control tuning.

The unit is built on a $7 \times 7 \times 2$ -inch chassis. Fig. 1127 shows the arrangement of parts on top. The grid-circuit coil is at the left rear corner, with the 1852 directly in front of it. An L-shaped shield partition separates the grid circuit from the plate coil, L_3 , which is in the right front corner. The sockets for both coils are mounted above the chassis on small metal pillars. The ganged tuning condensers are mounted in line in the center of the chassis. They are mechanically connected together, and to the shaft bearing on the front panel, by flexible couplings. The antenna binding posts and the cords for power and r.f. output come through the rear edge of the chassis. It is neces-

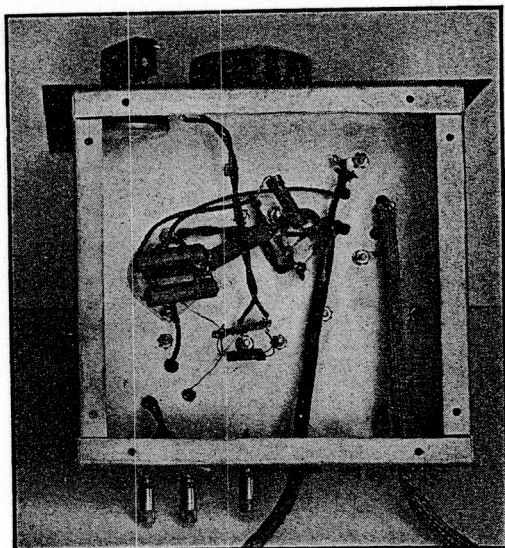


Fig. 1128 — Below-chassis view of the preselector. Note the manner of grouping the by-pass condensers about the tube socket to provide shielding between grid and plate.

sary to cut a rectangular hole in the lower part of the back of the cabinet to make the connections accessible.

The below-chassis view, Fig. 1128, shows how the condensers are grouped about the tube socket. The mica condenser, C_5 , is fastened vertically across the socket as close to it as possible (allow room for the tube-centering pin to project through the socket) to provide shielding between the grid and plate prongs. The additional cathode by-pass, C_6 , and the screen by-pass, C_7 , also are mounted across the socket on either side of the mica condenser, thus providing additional shielding. With the exception of the ground on C_1 , all r.f. ground connections are made to one lug on the side of the ring holding the tube socket to the chassis. Shielding about the output leads from L_4 is essential, to prevent unwanted feed-back and also to reduce signal pick-up on the line going to the receiver. The shield should be continued up to the antenna terminals of the receiver with which the preselector is used. The wires should be connected to the "doublet" terminals on the receiver, and the shield should be tied to the receiver ground terminal or chassis. The shield also must be grounded to the preselector chassis. This connection between the preselector and the receiver chassis is essential for good performance.

Because of the high transconductance of the 1852, very little coupling is needed between input and output circuits to cause self-oscillation when both circuits are tuned to the same frequency. The box containing the unit provides part of the shielding between the two

circuits, in addition to that provided by the baffle. This simple shielding is not complete enough to prevent self-oscillation, however, so the plate of the tube is tapped down on L_3 to reduce the feed-back. The tap should be located so that the circuit goes into oscillation with the gain control, R_2 , at about half scale or less. The controlled regeneration greatly increases the gain and selectivity over that obtainable without regeneration.

Initial adjustments are simple. With the receiver and preselector turned on, first tune the plate trimmer, C_4 (C_4 and C_3 are mounted inside the coil forms), for maximum noise, with R_2 near maximum (least resistance). This adjustment will be found fairly critical. The tuning condenser should be set at about half scale, and the receiver should be tuned to about the middle of the band. Then set R_2 at minimum gain (resistance all in) and adjust C_3 , the grid padder, for maximum noise output. The adjustments may be made on a signal as well as on noise. Next, advance R_2 a little at a time, simultaneously swinging C_3 through resonance, until oscillations commence. Back off R_2 to the point just below oscillation and readjust C_3 and C_4 for maximum output. When the lid of the cabinet is closed after completing this adjustment the feed-back will decrease, and R_2 must be advanced more to obtain oscillation. It is not necessary to work near the critical regeneration point under normal conditions, however, so that actual tuning is not critical. The preselector must, of course, be kept in tune with the receiver as the latter is tuned over the band.

Should the circuit oscillate at all settings of R_2 , the plate tap should be moved nearer the bottom of L_3 . If it does not oscillate at any setting, move the tap toward the plate end until oscillation starts with R_2 set at about half scale.

The improvement in gain and in reduction of image response will depend upon the amount of regeneration used. With average-strength signals and regeneration below the critical point for easy tuning, the signal-to-image ratio will be improved by a factor of 40 to 50 on 28 Mc., and by 100 or more on 14 Mc. Used with the average receiver having one r.f. stage ahead of the mixer, this means that the over-all image ratio will be of the order of 5000 on 14 Mc. and about 400 or 500 on 28 Mc. The voltage gain will be about 100 under the same conditions. Greater selectivity and gain can be obtained by working closer to the critical regeneration point.

Power for the preselector may be taken from the receiver, since the drain is small.

Bibliography

- 1 — "A Two-Tube Superhet," *QST*, February, 1941.
- 2 — Grammer, "Modernizing the Regenerative Superhet," *QST*, November, 1940.