THE "SimpleX Super Mark II" THREE-TUBE RECEIVER

The name of the receiver shown in Figs. 5-30 and 5-33 derives from "simple," "X" for crystal (filter) and "super" for superheterodyne; hence a "simple crystal-filter superheterodyne." It is an improved version of an earlier model (*QST*, December, 1958), hence the "Mark II." For less than fifty dollars and a few nights at the workbench, this little receiver will allow you to copy practically any c.w. or s.s.b. signal in the 40- or 80-meter band that a much more expensive receiver might bring in. By the throw of a switch you can tune in WWV on 5.0 Mc. for time signals and standard-frequency transmissions.

Referring to the circuit diagram in Fig. 5-31, the receiver is a superheterodyne with an intermediate frequency of 1700 kc. With the h.f. oscillator tuning 5.2. to 5.7 Mc., the 3.5- or 7-Mc. amateur bands can be tuned merely by retuning the input circuit. Since C_2 is large enough to hit the two bands without a coil change, the band-changing process consists of turning C_2 to the low- or high-capacitance end of its range. To copy WWV at 5 Mc., the oscillator must be tuned to 3.3 Mc., and this is done by switching in (via S_{2A}) a preset capacitor, C_5, across the oscillator circuit.

The advantage of a two-band receiver of this type is that the absence of coil switching makes it easy to build a stable high-frequency oscillator, and the stability of this oscillator then determines the stability of the receiver. Higher-frequency bands (14, 21 and 28 Mc.) can be listened to by adding a crystal-controlled converter; the construction of such a converter is described later in this chapter.

Selectivity at the i.f. is obtained through the use of a single crystal. This, in conjunction with the regeneration provided by the detector, is sharp enough to provide a fair degee of single-signal c.w. reception and yet is broad enough for copy of an s.s.b. phone signal.

In the detector stage, the pentode section of a 6U8A is used as a regenerative detector, and the triode section serves as the b.f.o. Stray coupling at the socket and in the tube provides adequate injection. The regeneration control is not mounted on the panel because, once set below the threshold of oscillation, it is not touched. The regeneration is not essential to good c.w. or s.s.b. reception, but it helps considerably on a.m. reception. Audio amplification is obtained from the two triode sections of a 6CG7. The primary of a small output transformer, T_1, serves as the coupling for high-impedance headphone output, and a small loudspeaker or low-impedance headphones can be connected to the secondary.

The power supply uses a small transformer and two selenium rectifiers in a full-wave voltage-doubling circuit. This is about as inexpensive a power supply as can be built, and it also has the advantages of not occupying much space and not generating much heat.

A switch, S_{1A}, at the input of the receiver is included so that the receiver can be used to listen to one's own transmitter without too severe blocking. Another section of the same switch, S_{1B}, shifts the mixer screen voltage from its operating value to zero, to reduce further the sensitivity of the receiver while one is transmitting. If it reduces it so much that the receiver has too little gain, this section of the switch can be omitted from the circuit and the mixer operated at full screen voltage at all times.

An 8 × 12 × 3-inch aluminum chassis takes all of the parts without crowding, and the location of the components can be seen in the photographs. The receiver is shown with a 7-inch high standard relay-rack panel, which leaves room at one end of the panel for auxiliary equipment or a small transmitter. If desired, a shorter panel of 3/32-inch aluminum can be used. The panel is held to the chassis by the two switches and the headphones jack. The tuning capacitor, C_3, is mounted on a small aluminum bracket, and the capacitor is driven by a Jackson Brothers Planetary Vernier (Arrow Electronics, N.Y.C.) via a Millen 39016 coupling. Before the bracket is finally fastened to the chassis the capacitor and bracket should be used to locate the center for the vernier hole. It pays to take care in mounting the tuning capacitor and its drive, since a smooth tuning drive is essential to any receiver. A National HRT knob is used to turn the vernier, and a paper scale is made as can be seen in one of the photographs.

Tie points are used liberally throughout the

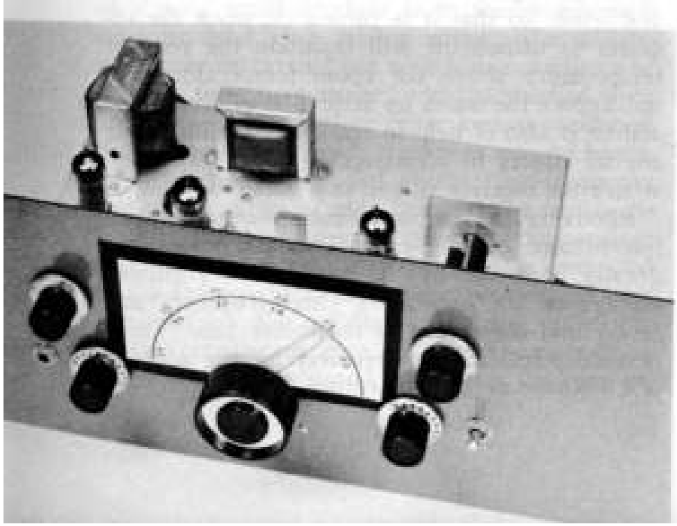

Fig. 5-30—The SimpleX Super receiver uses three dual tubes and a crystal filter to cover the 80- and 40-meter bands, and it can tune to 5 Mc. for copying WWV. The dial scale is made from white paper held to the panel by black tape; the index is clear plastic.

Extra panel space is provided for control circuits or a small transmitter.

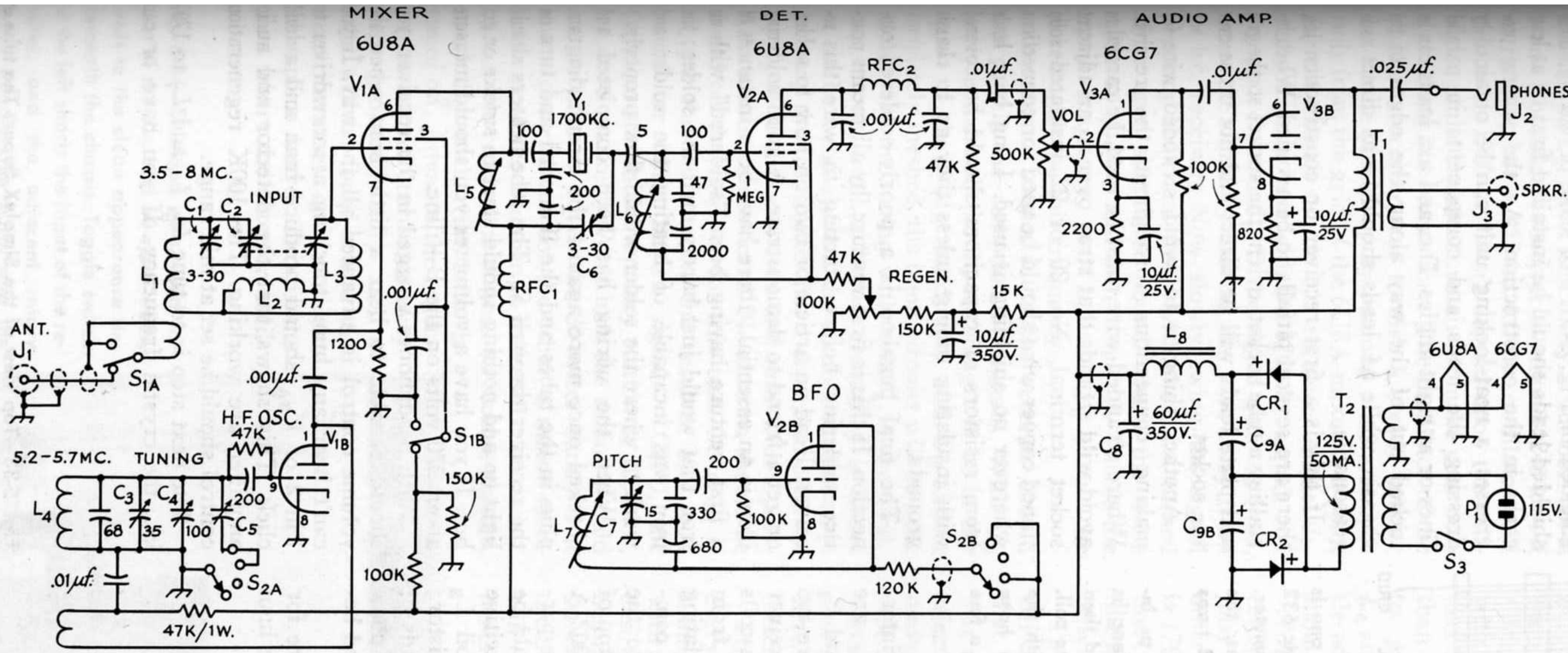

Fig. 5-31—Circuit diagram of the SimpleX Super receiver. Unless otherwise indicated, capacitances are in μμf., resistances are in ohms, resistors are ½ watt. Polarity is shown on electrolytic capacitors, 680 μμf. or less are silver mica or NP0 ceramic, 2000-μμf. fixed capacitor is mica. Capacitors specified in decimal-μf. values are ceramic.

C_1—3- to 30-μμf. mica compression trimmer.
C_2—140-140 dual variable (Hammarlund HFD-140).
C_3—35-μμf. midget variable (Hammarlund HF-35).
C_4—100-μμf. midget trimmer (Hammarlund MAPC-100).
C_5—180-μμf. silver mica in parallel with 150-μμf. mica-compression trimmer (Arco 424).
C_6—3- to 30-μμf. mica compression trimmer with adjustment screw removed.
C_7—15-μμf. midget variable (Hammarlund HF-15).
C_8—60-μf. 350-v. electrolytic (Mallory TC-68 or equiv.).
C_9—40-40-μf. 150-v. electrolytic, negative not common (Mallory TCS-48 or equiv.).
CR_1, CR_2—50-ma. 130-v. selenium rectifier (Tarzian 50 or equiv.).
J_1, J_3—Phono jack.
J_2—Phone jack.
L_1, L_3, L_4,—See Fig. 5-32.
L_2—18 t. No. 22 enam., closewound on ¼-diam. form (1-watt resistor, 100K or more).
L_5, L_6—105-200 μh. shielded inductor (North Hills SE-120-H).
L_7—36-64 μh. shielded inductor (North Hills SE-120-F).
L_8—16-henry 50-ma. filter choke (Knight 62G137 or equiv.).
P_1—A.c. line plug, preferably fused.
S_1—D.p.d.t. toggle.
S_2—Two-pole 6-position (4 used) rotary switch (Centralab PA-2003 or equiv.).
S_3—S.p.s.t. toggle
RFC_1, RFC_2—1-mh. r.f. choke (Millen J300-1000).
T_1—Small output transformer, 10K plate to voice coil (Stancor A-3879 or equiv.).
T_2—125-v. 50-ma. and 6.3-v. 2-amp. power transformer (Knight 61G411 or equiv.).
Y_1—1700-kc. crystal (International Crystal FA-5 or equiv.) (All radio stores do not handle all of the above components. North Hills coils and cans are available from Harrison Radio, N.Y.C. Knight is handled by Allied Radio, 100 N. Western Ave., Chicago 80, Ill.)

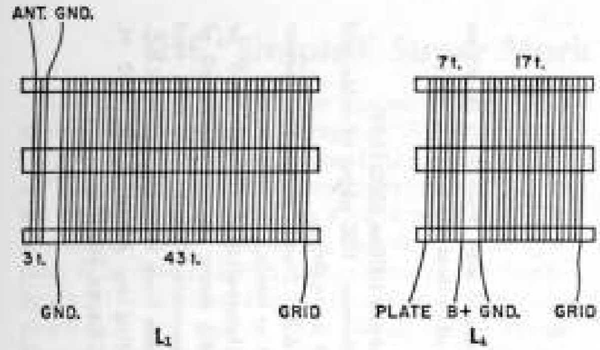

Fig. 5-32—Details of the coil construction. Each one is made from B & W 3012 Miniductor or Illumitronic 632 stock, which is wound 32 t.p.i. and ¾-inch diameter. The separation between coils in L_1 is 1½ turns; the separation between coils in L_4 is 1 turn. L_3 is 43 turns of the same stock.

It is important that the coils be connected as indicated. The coil stock can be cut to the required lengths by pushing in a turn, cutting it inside the coil and then pushing the newly cut ends through to outside the coil. Once outside, the wire can be peeled away with the help of long-nose pliers. When sufficient turns have been removed, the support bars can be cut with a fine saw.

receiver, as junctions for components and interconnecting wires. The coils L_3 and L_4 are mounted on tie points, using short leads, and L_1 is mounted on S_{1A}. If the leads from L_4 are too long, the coil will be "floppy" and the receiver may be unstable. Fig. 5-32 shows how the coils are constructed and connected. The leads from C_2 are brought through the chassis in insulating rubber grommets. The 3- to 30-$\mu\mu$f. mica compression trimmer across L_1 is soldered to the associated section of C_2. C_2 is mounted on top of the chassis and surrounded by a Bud CU-3002-A Minibox, which serves as a dust cover. The partition between the two sections of C_2 should be grounded to the chassis, to prevent capacitive coupling between the two sections. The coil L_2 is wound on a high-resistance 1-watt resistor; the ends of the coil are soldered to the leads of the resistor, and the winding will stay in place readily if the resistor is notched at each end before the winding is started.

The receiver is wired with shielded wire for many of the leads, in an effort to minimize hum in the audio and feedthrough around the crystal filter. The shielded leads are marked in Fig. 5-31 where feasible; the simple rule to follow is to shield all B+ leads along with those shown shielded in Fig. 5-31. For ease of wiring, these shielded leads should be installed first or at least early in the construction. As the wiring progresses, a neat-looking unit can be obtained by dressing the leads and components in parallel lines or at right angles. D.c. and a.c. leads can be tucked out of the way along the edges of the chassis, while r.f. leads should be as direct as is reasonable.

If this is a first receiver or construction job, there are several pitfalls to be avoided. When installing a tube socket, orient the socket so the grid and plate leads will be direct and not cross over the socket.

Another thing is to avoid stranded wire for making connections throughout the receiver. Where stranded wire must be used, be careful to avoid wild strands that stray over to an adjacent socket terminal. No. 20 or 22 insulated solid tinned copper wire should be used for connections wherever no shielding is used. Long bare leads from resistors or capacitors should be covered with insulating tubing unless they go to chassis grounds.

The final bugaboo is a poorly-soldered connection. If this is first venture, by all means practice soldering before starting to wire this receiver. Read an article or two on how to solder, or get a friend to demonstrate. A good soldering iron is an essential; there have been instances of a first venture having been "soldered" with an iron that would just barely melt the solder; the iron was incapable of heating the solder and work to where the solder would flow properly.

When the wiring has been completed and checked once more against the circuit diagram, plug in the tubes and the line cord and turn on the receiver through S_3. The tube heaters should light up and nothing should start to smoke or get hot. If you have a voltmeter you should measure about 270 volts on the B+ line.

With headphones plugged in the receiver, you should be able to hear a little hum when the volume control is advanced all the way. If you can't hear any hum, touching a screwdriver to Pin 2 of V_{3A} should produce hum and a loud click. This shows that the detector and audio amplifier are working. The 100K regeneration control should be set at mid range.

The next step is to tune L_5, L_6 and L_7 to 1700 kc., the crystal frequency. If you have or can

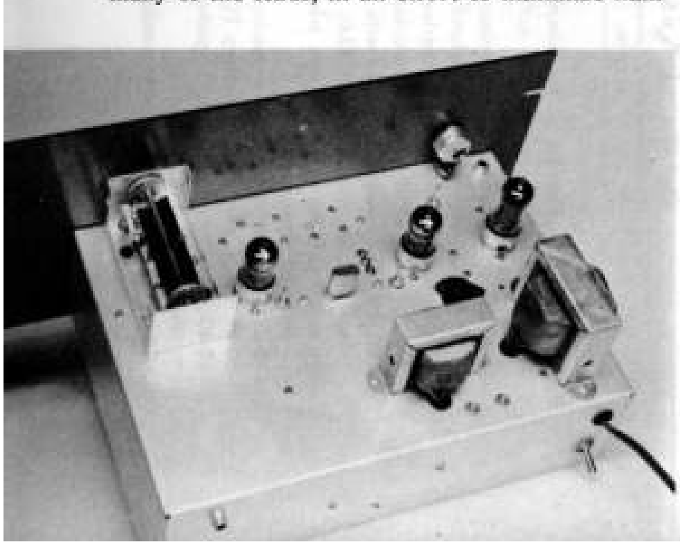

Fig. 5-33—Top view of the SimpleX Super. The tube at the left is the mixer-oscillator 6U8A; the 6CG7 audio amplifier is at the far right. The black knob is on the regeneration control. Toggle switch under the a.c. line cord is the a.c. line switch, S_3. Phono jack at left is the antenna terminal; phono jack at right near volume control is speaker jack, J_2.

borrow a signal generator, put 1700-kc. r.f. in at the control grid of the 6U8A mixer and peak L_5 and L_6. Lacking a signal generator, you may be lucky enough to find a strong signal by tuning around with C_3, but it isn't likely. Your best bet is to tune a broadcast receiver to around 1245 kc.; if the receiver has a 455-kc. i.f. the oscillator will then be on 1700 kc. Don't depend upon the calibration of the broadcast receiver; make your own by checking known stations. The oscillator of the broadcast receiver will furnish a steady carrier that can be picked up by running a wire temporarily from the grid of the 6U8A mixer to a point near the chassis of the b.c. receiver. Adjust L_7 until you get a beat with the 1700-kc. signal, and then peak L_5 and L_6. If the signal gets too loud, reduce the signal by moving the wire away from the b.c. receiver. Now slowly swing the signal frequency back and forth with the b.f.o. turned off; a spot should be found where the noise rushes up quickly and then drops off. This is the crystal frequency, and L_5 and L_6 should be peaked again on this frequency.

An antenna connected to the receiver should now permit the reception of signals. With C_2 nearly unmeshed, the input tuning will be in the region of the 7-Mc. band, and with C_2 almost completely meshed, the input circuits will be near 3.5 Mc. Do the tuning with the C_4 in the oscillator circuit, until a known frequency is found (it can be a signal from the station transmitter). Let's say the transmitter has a crystal at 3725 kc. Set C_3 at half capacitance and tune with C_4 until the transmitter is heard. No antenna should be needed on the receiver for this test. Once C_4 is set, put the antenna on the receiver and look around for other known signals. (CHU, the Canadian standard-frequency station at 7335 kc., is a good marker.) With luck the tuning should just be able to cover the 80-meter band; if it covers one end but not the other, a minor readjustment of the trimmer is indicated.

Once the receiver is aligned to receive signals, switch S_2 so that the b.f.o. is turned off. Advance the regeneration control (turn arm away from grounded end) and a point will be found where the noise increases and a slight "thump" is heard. This is the point where the detector oscillates; just below this is the most sensitive condition for the reception of a.m. phone signals. Set the regeneration control at this point.

Turn the b.f.o. back on and tune in a c.w. signal. Tuning through the signal with the tuning knob on C_3, note that the signal is louder on one side of zero beat than on the other. Experiment with the setting of the PITCH control until the maximum single-signal effect (louder one side than the other) is obtained. It may be necessary to pull up the plate of C_6 and to retune L_6 and L_5 before this is accomplished. After a little adjustment, however, the single-signal effect should be quite apparent.

All that remains is to install the dial scale and calibrate it. A 100-kc. oscillator is ideal for this job; lacking one or the ability to borrow one, other signals must be used. If the crystal filter is 1700 kc. exactly, the 80- and 40-meter calibrations will coincide as they do on the scale shown in Fig. 5-30; if not, the calibration marks will be offset on the two bands.

To find WWV at 5 Mc., set S_2 so that C_5 is switched in and the b.f.o. is on and adjust C_5 so that WWV falls on scale.

It may be noticed that tuning C_2 has a slight effect on the tuning of the signal. In other words, tuning C_2 "pulls" the oscillator slightly. To remedy this would have made the receiver more complicated, and the simple solution is merely to first peak C_2 on noise and then tune with C_3. If two peaks of noise are found in the 80- or 40-meter bands, adjust C_1 until they coincide.

This will be found to be a practical receiver in every way for the c.w. (or s.s.b.) operator. The tuning rate is always the same on 80 or 40, or 15 with a converter, and 21-Mc. s.s.b. signals tune as easily as those on 3.9 Mc. The warm-up drift is negligible, and the oscillator is surprisingly insensitive to voltage changes. Whether or not the oscillator is insensitive to shock and vibration will depend upon the care with which the components are anchored to their respective tie points.

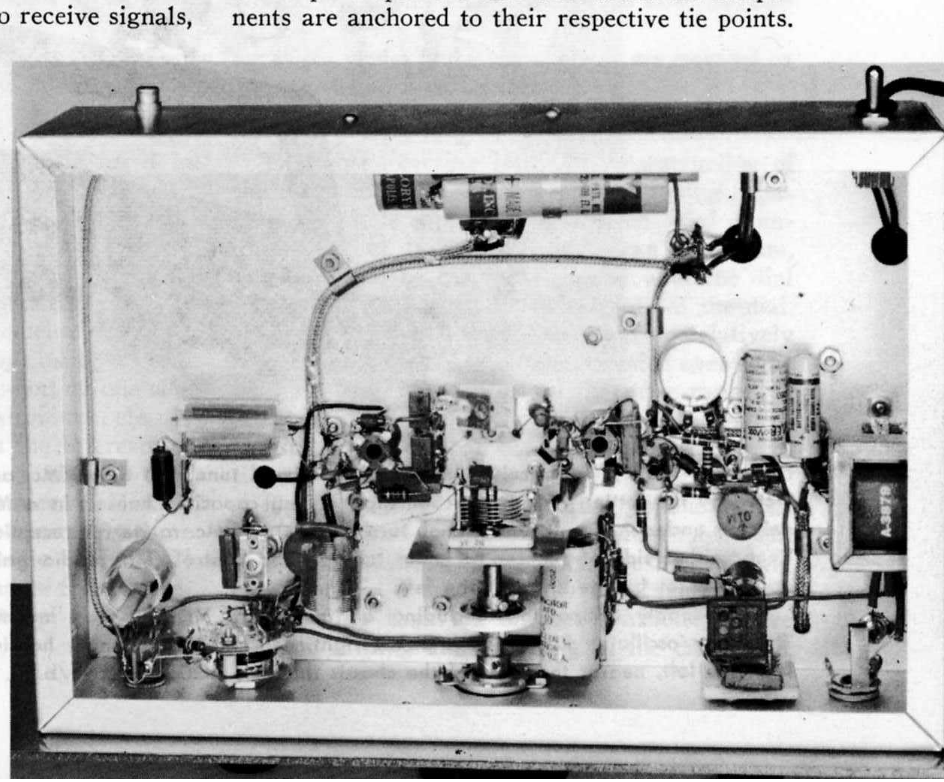

Fig. 5-34—Shielded wire, used for most of the d.c. and 60-cycle leads, lends to the clean appearance underneath the chassis. Toggle switch at the left shorts the input of the receiver, and the adjacent rotary switch handles the b.f.o. and the padding capacitor for WWV. The pitch control, C_7, is at the right, next to the headphone jack. Power supply components (C_8, C_9 and CR_1, CR_2) are mounted on or near rear wall of chassis.