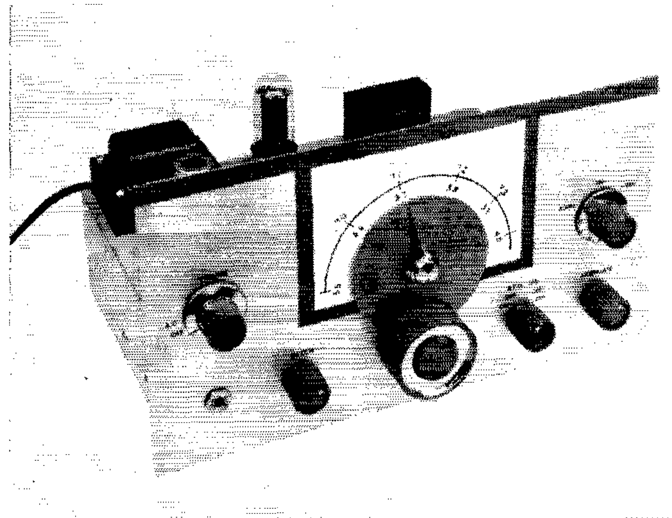


The SimpleX Super receiver uses three dual tubes and a crystal filter to cover the 80- and 40-meter bands, and it can tune to 5 Mc. for copying WWV. The dial scale is made from white paper held to the panel by red Scotch tape; the pointer is a slice of the tape.

The "SimpleX Super" Receiver

BY BYRON GOODMAN,* W1DX

On several occasions when the author has played around with one of the inexpensive (under $100) short-wave receivers, he has wondered how many new amateurs handicap themselves through the false economy of buying such a receiver. The mere thought of struggling through a QSO in a crowded band with one of these toys is enough to make seasoned amateurs weep. Any such experience would certainly justify a beginner's wondering how anyone can get enjoyment out of ham radio. Frankly, these receivers are aimed at the short-wave listener market, not the radio amateur. The receivers aren't too bad for their intended purpose of copying the louder short-wave broadcast stations, but they smell in spades as "communications receivers" if you have ham communications in mind.

The 3-tube receiver to be described will permit the single-signal reception [1] of code signals. Single-sideband phone can be handled with no difficulty at all, even though the tuning rate is a bit faster than we would like. With the b.f.o. turned off for the reception of a.m. signals, a threshold effect shows up that prevents your digging all the way down for the weak ones, but you can still copy plenty of a.m. signals. Since the receiver uses only three tubes, it doesn't have the more-than-enough gain of a big receiver, and its performance won't be very impressive on a poor (short or low) antenna. However, if you use your transmitting antenna for receiving, as you should, you will find yourself backing down on the volume control to save your ears.

* Assistant Technical Editor, *QST*.

[1] Single-signal reception requires a receiver with sufficient selectivity so that setting the b.f.o. frequency off the mid-frequency of the i.f. gives a stronger signal on one side of zero beat than on the other. An excellent c.w. receiver will show no trace of signal on "the other side" of zero beat.

Referring to the circuit diagram in Fig. 1, 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 the 7-Mc. amateur bands can be tuned merely by retuning the input circuit, L_1C_1. Since C_1 is large enough to hit the two bands without a coil change, the band-changing process consists of turning C_1 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 an additional capacitor across the oscillator circuit.

If you are disappointed because the receiver doesn't tune the 21-Mc. band, remember that the "under-$100" receivers don't either. Sure, the dials show 21 Mc., but try to use the receivers to hold a signal for any length of time! The SimpleX Super, with a crystal-controlled converter [2] be-

[2] McCoy, "The 'Bonus' 21-Mc. Converter," *QST*, Oct., 1958.

The name of this receiver derives from "simple," "X" for crystal (filter), and "super" for superheterodyne; hence a "simple crystal-filter superheterodyne." For about $50 and a few nights at the work bench 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 drag in. By the flip of a switch you can tune to 5 Mc. for WWV, a stunt some more-expensive receivers can't do!

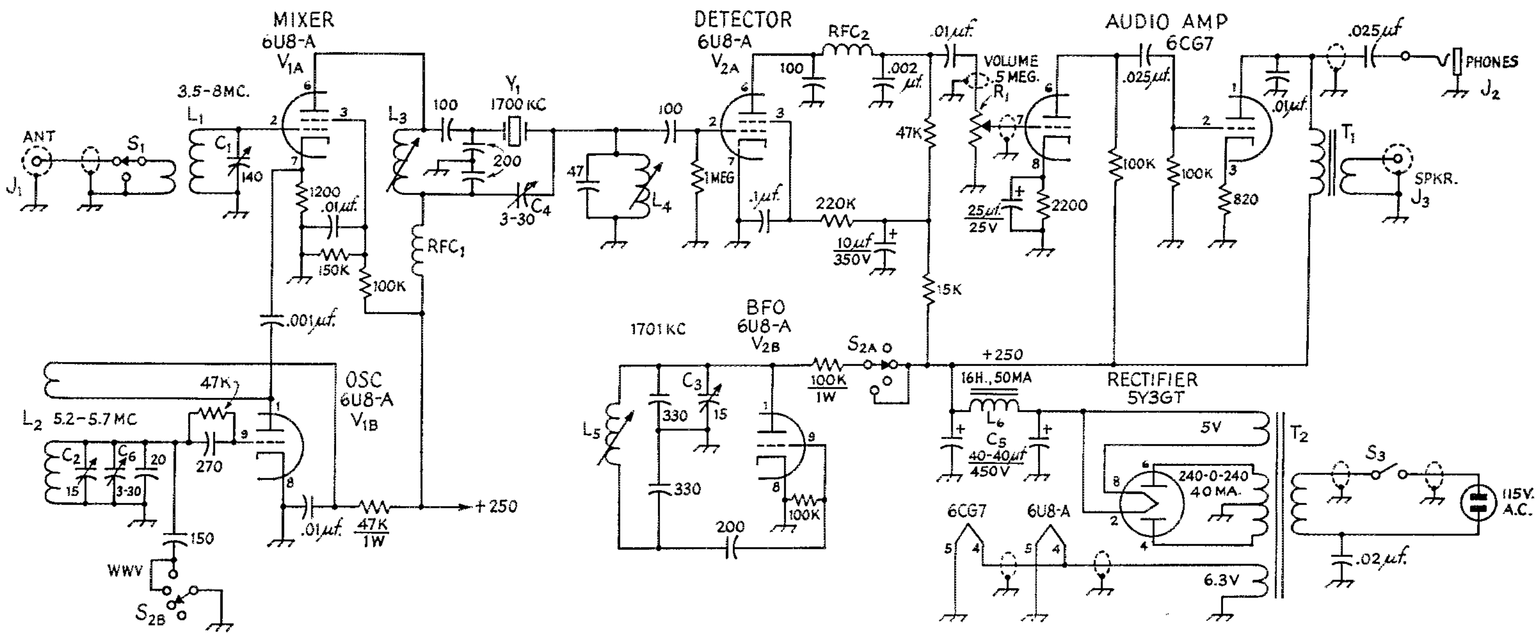


Fig. 1—Circuit diagram of the SimpleX Super receiver. Unless otherwise indicated, capacitances are in μμf., resistances are in ohms, resistors are ½ watt. Polarity shown on electrolytic capacitors; fixed capacitors 330 μμf. or less are silver mica or NPO ceramic. Nonelectrolytic fixed capacitors over 0.025 μf. are 400-volt molded tubulars. Fixed capacitors 0.001 through 0.025 are ceramic.

C_1—140-μμf. midget variable (Hammarlund APC-140-B).
C_2—15-μμf. midget variable (Hammarlund HF-15).
C_3—15-μμf. trimmer (Hammarlund MAPC-15-B).
C_4, C_6—3–30-μμf. mica compression trimmer.
C_5—Dual 40-μf. 450-volt electrolytic (Mallory TCD-78 or equiv.).
J_1, J_3—Phono jack.
J_2—Open-circuit headphone jack.
L_1, L_2—See Fig. 2.
L_3, L_4—105–200-μh. slug-tuned (North Hills 120-H coil mounted in North Hills S-120 shield can).
L_5—36–64-μh. slug-tuned (North Hills 120-F coil mounted in North Hills S-120 shield can).
L_6—16-hy. 50-ma. filter choke (Knight 62-G-137 or equiv.).
R_1—½ megohm volume control, audio taper, with switch.
RFC_1, RFC_2—2.5-mh. r.f. choke (Waters C1155).
S_1—1-pole 12-position (2 used) rotary ceramic switch (Centralab PA-2001).
S_2—2-pole 6-position (4 used) rotary ceramic switch (Centralab PA-2003).
S_3—S.p.s.t. switch, part of R_1.
T_1—10,000-ohms-to-voice-coil output transformer (Stancor A-3822 or equiv.).
T_2—480 v. c.t. at 40 ma., 5 v. at 2 amp., 6.3 v. at 2 amp. (Knight 62-G-034 or equiv.).
Y_1—1700-kc. crystal in FT-243 holder (E. B. Lewis or equiv.).

(All radio stores do not handle the above components. For prices and names of dealers write to North Hills Electric Co., 402 Sagamore Ave., Mineola, N. Y.; Knight is handled by Allied Radio, 100 N. Western Ave., Chicago 80, Ill.; Waters Mfg. Inc., Boston Post Rd., Wayland, Mass.; E. B. Lewis, 11 Bragg St., E. Hartford, Conn.

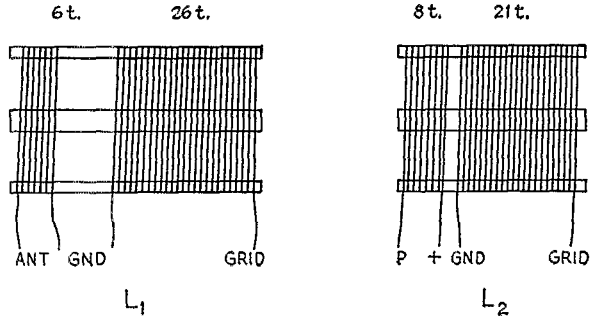


Fig. 2—Details of the coil construction. Each one is made from B & W 3016 Miniductor stock, which is wound 32 t.p.i. and 1-inch diameter. The separation between coils in L_1 is 7 turns; the separation between coils in L_2 is 1 turn. It is important that the coils be connected as indicated.
The Miniductor stock can be cut into 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, it is easy to peel away the wire with the help of long-nose pliers. When sufficient turns have been removed, the support bars can be cut with a fine saw.

tween it and the antenna, will handle 15 meters like 80.

Selectivity at the i.f. is obtained through the use of a single crystal. Although not as sharp as the usual 455-kc. crystal filter, it is sharp enough to provide a fair degree of single-signal c.w. reception and yet broad enough for good copy of an s.s.b. phone signal.

In the detector stage, the pentode section of a 6U8A is used as a grid-leak detector, and the triode section serves as the b.f.o. Stray coupling at the socket and in the tube provides adequate injection. 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 at the output winding of the transformer. Although the audio power output is less than a watt, it is sufficient to drive a loudspeaker adequately in a small quiet room.

The power supply uses a large choke and two 40-μf. capacitors, and the very slight hum that can be detected in the headphones with the volume full on is stray a.c. picked up by the detector grid; it doesn't come from inadequate filtering of the power supply. (The hum can only be heard with no antenna on; under normal operation the incoming noise will mask the slight hum.)

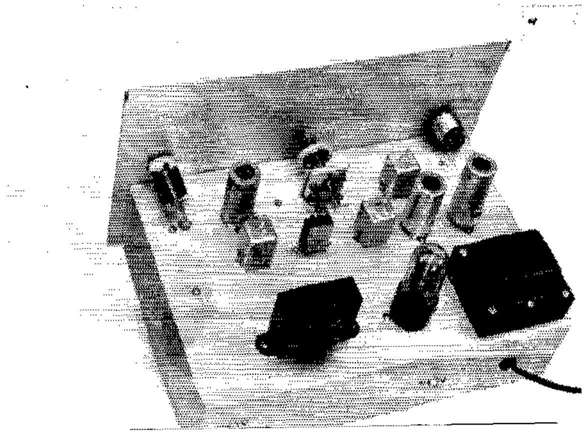
A switch at the input of the receiver is included so that the receiver can be used to listen to one's own transmitter without too severe blocking. Using the b.f.o. switch to cut in the WWV padder looks stupid, but it was done this way (instead of by the more logical S_1) to keep the input short-circuiting leads short.

Construction

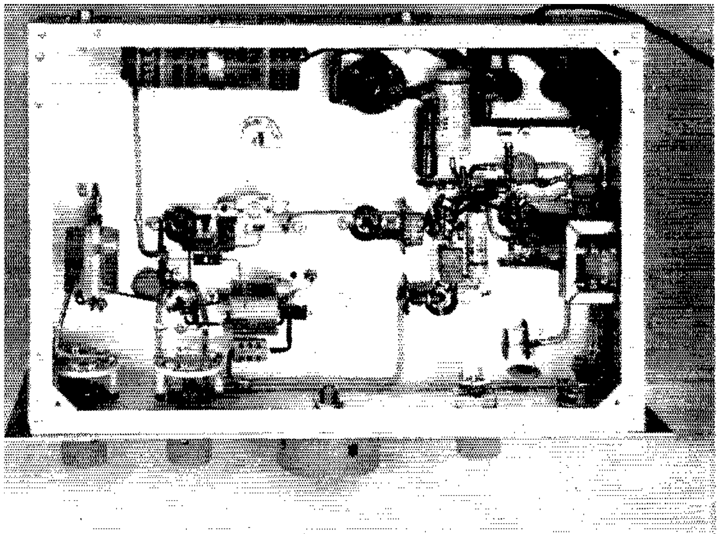
An 8 × 12 × 3-inch aluminum chassis takes all of the parts without crowding, and the location of the components can be seen in the photographs. The 7¼ × 13-inch aluminum panel (1/16-inch thick) is held to the chassis by the b.f.o. capacitor mounting screws, the phone jack, the dial drive and the two rotary switches. The tuning capacitor C_2 is mounted on a small aluminum bracket made from an extra strip of the panel material: before the bracket is finally fastened to the chassis the capacitor and bracket should be used to locate the dial hole on the panel. When drilling the hole for the dial drive, measure the dimension instead of using the template provided with the National K dial. It pays to take care in mounting the tuning capacitor and the dial, since a smooth tuning drive is an essential in any receiver. To facilitate tuning, a National HRT knob was used instead of the puny knob furnished with the K dial. The other knobs are gray National HR and HR-4.

Tie points were used liberally throughout the receiver, as junctions for components and interconnecting wires. The coils L_1 and L_2 were mounted on tie points, using short leads. If the leads from L_2 are too long, the coil will be "floppy" and the receiver may be unstable. Fig. 2 shows how coils L_1 and L_2 are constructed and connected. The leads from C_1 and C_2 are brought through the chassis in insulating grommets. The 3- to 30-$\mu\mu$f. mica compression trimmer across L_2 is soldered to the tie points that support the coil.

The receiver was 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. 1 where feasible; the simple rule to follow is to shield all B+ leads along with those shown shielded in Fig. 1. 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



Top view of the SimpleX Super. The tube between the two variable capacitors is the mixer-oscillator 6U8A; the 6CG7 audio amplifier is at the far right. The flexible insulated coupling between main tuning dial and the tuning capacitor is a Millen 39016.



Shielded wire, used for most of the d.c. and 60-cycle leads, lends to the clean appearance underneath the chassis. The switch at the left shorts the input of the receiver, and the adjacent switch handles the b.f.o. and the padding capacitor for WWV.

Phono jack at the top left is for the antenna; the other phono jack is for low-impedance audio output. The headphone jack (lower right) is for high-impedance audio output.

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 your first receiver or construction job, there are several pitfalls to be avoided. When installing a tube socket, first give a little thought to where the grid and plate leads will run, and orient the socket so that these leads will be direct and not cross over the socket. Believe it or not, we have seen i.f. amplifiers where each grid and plate lead had to cross over the socket to get to its respective transformer. The builder couldn't understand why the amplifier "took off" the instant the gain was advanced slightly.

Another thing to look out for is the well-meaning store clerk who sells you stranded wire for making the connections throughout the receiver. The only stranded wire in this receiver is in the leads from the transformers, filter capacitor and filter choke, and in the shielded wire, and all this only because there was no choice. Where stranded wire is used, be very careful to avoid wild strands that stray over to an adjacent socket terminal and short-circuit a part of the circuit without your knowing it. 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, of course, a poorly-soldered connection. If this is your first venture, by all means practice soldering before you start to wire this receiver. Read an article or two on how to solder,[3] or get a friend to show you how and to criticize your first attempts. A good soldering iron is an essential; we have seen 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 the point where the solder would flow properly.

There is no need to worry about the dial scale when the receiver is first built, because the receiver has to be checked. The scale is a sheet of white paper held in place by red or black Scotch tape. The pointer on the dial is a slice of the same tape.

Adjustment

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 and rectifier filament should light up and nothing should start to smoke or get hot. If you have a voltmeter you should measure about 250 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 should produce hum and a loud click. This shows that the detector and audio amplifier are working.

The next step is to tune L_3, L_4 and L_5 to 1700 kc., the crystal frequency. If you have or can borrow a signal generator, all you have to do is to put 1700-kc. r.f. in at the grid of the 6U8A mixer and peak L_3 and L_4. Lacking a signal generator, you may be lucky enough to find a strong signal by tuning around with C_2, 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 (possibly hum-modulated) 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_5 until you get a beat with the 1700-kc. signal, and then peak L_3 and L_4. 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

(Continued on page 198)

[3] McCoy, "How To Solder," QST, Sept., 1958.

"SimpleX Super" Receiver

(Continued from page 14)

forth with the b.f.o. turned off; you should find a spot where the noise rushes up quickly and then drops off. This is the crystal frequency, and L_3 and L_4 should be peaked again on this frequency if you were a little off the first time.

An antenna connected to the receiver should now permit the reception of signals. With C_1 nearly unmeshed, you will be in the region of the 7-Mc. band, and with C_1 almost completely meshed, you will be near 3.5 Mc. Do your tuning with the compression trimmer in the oscillator circuit, until you find a known frequency (it can be your own transmitter). Let's say your transmitter has a crystal at 3725 kc. Set C_2 at half capacitance and tune with C_6 until you hear your transmitter. You shouldn't need any antenna on the receiver for this test. Once you have the setting for the trimmer, 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 you should just be able to cover the 80-meter band; if you can get one end but not the other, a minor readjustment of the trimmer is indicated.

Once you have acquainted yourself with the 80- and 40-meter bands, and appreciate that you have to peak up the input circuit (C_1) fairly often as you tune across the bands, you are ready to trim up the crystal filter. Run the volume fairly high, so that you can hear noise from the properly-peaked input circuit, and turn C_3 until the noise takes on a higher-pitched characteristic. (The b.f.o. stage is originally set up with C_3 at midcapacitance and L_5 adjusted for lowest-pitched noise.) Now tune in a code signal with C_2 and swing back and forth through it. "One side" of the signal should be louder than the other. Tune to the weak side with a beat note of around 800 cycles and then adjust C_4 for minimum signal. After a few attempts, juggling C_3, C_4, L_3 and L_4, you should get a condition where the single-signal c.w. effect is 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, you will have to rely on other signals. If your crystal filter is 1700 kc. exactly, the 80- and 40-meter calibrations will coincide as they do on the receiver shown in the photographs; if not, the calibration marks will be offset on the two bands.

If you find that you can't get WWV at 5 Mc. with the 150-$\mu\mu$f. capacitor switched in, it is no cause for alarm. Simply substitute a 130-$\mu\mu$f. mica in parallel with a 30-$\mu\mu$f. compression trimmer, and adjust the trimmer so that WWV falls on scale.

Performance

As you acquaint yourself with the operation of the receiver, you will notice that tuning C_1 will have a slight effect on the tuning of the signal.

(Continued on page 180)

In other words, tuning C_1 "pulls" the oscillator slightly. To remedy this would have made the receiver more complicated, and the simple solution is merely to first peak C_1 on noise and then tune with C_2.

You will find this 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.

(Yes, Virginia, there is a Santa Claus. But there is no known way to add an S meter, a.v.c., noise limiter or Q multiplier to the SimpleX Super without additional tubes or semiconductors.)

Wide-Band Dummy Loads

(*Continued from page 23*)

Appendix

The possibility of wide-band compensation of slightly inductive resistors with shunting capacitors is shown in the following way:

1) Assume a resistance R_s in series with an inductive reactance X_s.

2) The parallel equivalent of X_s is

$$X_p = \frac{R_s^2 + X_s^2}{X_s}$$

3) If X_s is much less than R_s,

$$X_p = \text{approximately } \frac{R_s^2}{X_s} = \frac{R_s^2}{2\pi f L_s},$$

4) Where an inductance is paralleled with a capacitance, neither appears to be in the circuit when the capacitive reactance is equal to the inductive reactance. Thus the condition for cancellation of the inductive effect occurs when the parallel inductive reactance X_p equals some parallel capacitive reactance $X_c = \frac{1}{2\pi f C}$, which is another way of saying

$$\frac{R_s^2}{2\pi f L_s} = \frac{1}{2\pi f C}$$

or

$$\frac{R_s^2}{L_s} = \frac{1}{C}$$

5) This last expression has no frequency term in it, showing that a small inductive reactance can be nearly eliminated at all frequencies by a single fixed capacitor.

Technical Correspondence

(*Continued from page 44*)

band components produced by the telemetry frequencies. As these frequencies are rather closely spaced to the carrier frequency and each other, the result is the generation of at least two complete sets of spurious frequencies plus the original beat frequency, all of which are continuously changing from doppler shift and/or receiver instability.

If, in addition to this, harmonic distortion is present within the receiver or tape recorder, then to add to the existing woes a second-order collection of intermodulation products appears in the output. The result is similar to the "search for a needle in the haystack" with the needle being periodically moved.

Having rather thoroughly covered the dark side of the

(*Continued on page 182*)