View of the R-390A sitting atop the 51J-2 (R-388) receiver at the station of W3JHR.

# MODIFYING THE R-390A FOR S.S.B.

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*The R-390A receiver requires an outboard converter unit for satisfactory S.S.B. reception. The simple modification outlined below provides a product detector combined with the b.f.o. circuit at a low cost.*

As ORIGINALLY designed, the R-390A h.f. receiver is usable, to a certain extent, for s.s.b. reception without an external s.s.b. converter, but it performs very poorly because the a.m. diode detector contributes considerable distortion. The relative levels of signal *vs* b.f.o. injection voltage are not correct for proper s.s.b. detection. The levels can be made more optimum by reduction of the r.f. gain, but then the a.g.c. action is lost and weak signals are reduced so much that they are overlooked or unheard. The R-390A was designed to feed an i.f. signal to an external s.s.b. converter. However, by a simple and inexpensive modification of the internal b.f.o. stage to a product detector, the R-390A can be made to perform as an excellent s.s.b. receiver by itself, with no external converter being required for s.s.b. (For i.s.b., however, an external converter is required, in the form of 2 CV-591s or 1 CV-157.) The modification is very simple, inexpensive, and does not require any contract procurement action, nor does it involve any proprietary designs. The modification requires less than 2 hours work by one man. The parts required for the conversion are few and simple, and cost less than ten dollars.

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## Conversion Procedure

The conversion is performed as follows:

1. Remove the b.f.o. B+ wires from the BFO ON-OFF switch $S_{101}$. Remove and discard $S_{101}$, but retain the knob.

2. Cut three 20" lengths of single conductor shielded microphone cable. From one end of each of these three pieces, remove the outer plastic jacket and carefully unravel 1" of the shield braid and form a 1" pigtail lead. Twist the 3 pigtails together and solder them

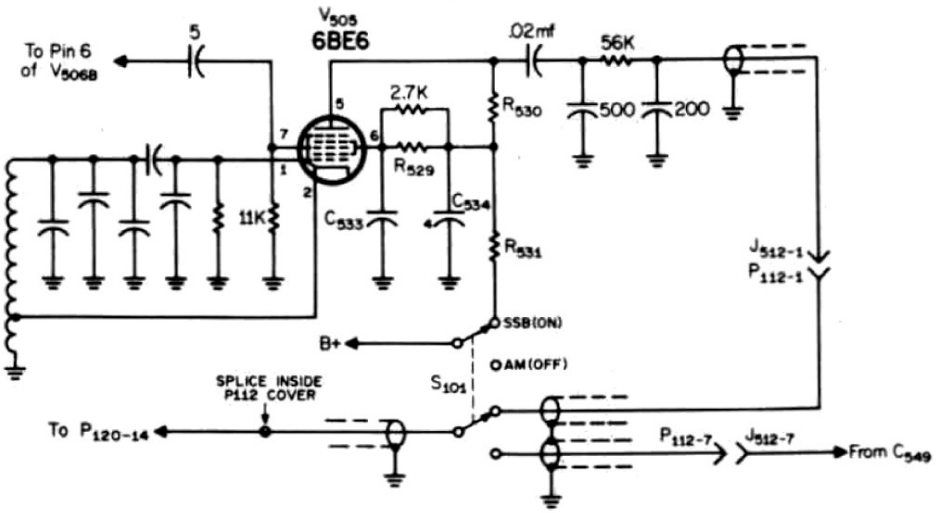


Fig. 1—Circuit of the product detector wired in place of the beat frequency oscillator. $S_{101}$ is the new b.f.o. switch.

together, being careful not to melt the plastic insulation on the inner conductor of each piece of wire.

3. Take the new switch, a 2 pole two to six position unit, (only 2 of the 6 positions are used) for $S_{101}$, and connect these three shielded leads to it to form the audio changeover circuit. See fig. 1. Under the head of the machine screw holding one side of the switch wafer to the switch frame install a small soldering lug. Solder the pigtail to it, to ground (at this end only) the individual shield braids of the 3 audio wires.

4. Insert the free ends of the 3 wires through the opening at the edge of the i.f. shelf, pull them upward above the i.f. chassis, and mount the new switch in the vacant $S_{101}$ hole in the front panel. Replace the knob. Connect the b.f.o. B+ wires to the other pole of the switch. The b.f.o. B+ is to be *on* in the B.F.O. ON position, which will become the SSB position of $S_{101}$. See the schematic in fig. 1.

5. Unplug all plugs from the i.f. subchassis, mechanically disconnect the 2 control shafts, and remove the i.f. subchassis from the receiver.

6. Carefully remove the cable clamp and cover from multi-conductor plug $P_{112}$, slipping it back out of the way. There is one spare pin, $P_{112\text{-}1}$. Remove the wire from pin $P_{112\text{-}7}$ and leave it hanging.

7. Twist the 3 shielded wires installed in step 2 into a 3 conductor cable, above the chassis. Wrap with plastic tape at 4" intervals. Cut this cable to the required length to reach plug $P_{112}$, leaving sufficient slack for clearance *over the i.f. chassis and tubes.* Strip back 1" of outer plastic jacket *and shield braid* on each of the 3 wires. Run the 3 wires through the cable clamp and plug cover.

8. Connect the shielded wire from the S.S.B. (B.F.O. ON) audio terminal of $S_{101}$ to pin $P_{112\text{-}1}$. Use an insulating sleeve for protection, as is done for the other wires on the plug.

9. Connect the shielded wire from the A.M. (B.F.O. OFF) audio terminal of $S_{101}$ to pin $P_{112\text{-}7}$. Use an insulating sleeve as in step 8.

10. Slip an insulating sleeve over the free end of the remaining wire, which should be the one connected to the rotary "arm" of $S_{101}$. This is the "audio input" lead. Solder it to the free end of the wire left hanging in step 6. Slip the insulating sleeve down over the bare connection. Carefully replace the cover and cable clamp on $P_{112}$. Tape these 3 wires to the existing cable just outside the clamp.

11. Turning the i.f. chassis over, carefully remove the bellows coupling on the B.F.O. PITCH control shaft. Remove the shaft by loosening the panel bearing. This step clears some working space around the socket of $V_{505}$, b.f.o. tube.

12. Remove and discard the $V_{505}$, 6BA6, b.f.o. tube.

13. Remove the ground (and all wires) from pin 2 of $V_{505}$. This may involve shifting several ground leads to other ground tie points on the chassis.

14. Move the existing lead from $V_{505}$ pin

7 to pin 2. (This is the cathode tap on the b.f.o. coil $Z_{502}$.)

*In the following steps, be sure to leave room for replacing the bellows shaft coupling.*

15. Connect the 11K ½ watt resistor from $V_{505}$ pin 7 to ground.

16. Remove and discard $C_{535}$.

17. Connect the 2.7K 1 watt resistor in parallel with the existing screen dropping resistor $R_{529}$.

18. Connect the 5 mmf capacitor between $V_{505}$ pin 7 and $V_{506B}$ pin 6. This is the i.f. coupling into the injection grid of the 6BE6 product detector.

19. With a pair of small metal shears cut a ¼" V-shaped notch in the lower edge of the interstage partition near the rear of the b.f.o. coil $Z_{502}$. Cover the edges of this slot with short pieces of plastic tape.

20. Mount the 200 mmf and 500 mmf capacitors on the grounded center post of the $V_{506}$ socket, letting them be supported in space by their own ground leads (about ¼" long).

21. Connect the 56,000 ohm ½ watt resistor between the free ends of the 200 and 500 mmf capacitors.

22. Connect the 0.02 mf capacitor from $V_{505}$ pin 5 to the 500 mmf end of the 56,000 ohm resistor.

23. Use 12" of the shielded microphone cable fo rthe s.s.b. audio lead. Remove 1" of the plastic jacket from one end, and make a 1" braid pigtail on this end. Slip a ⅞" insulating sleeve over the pigtail and ground the pigtail to the center ground post of $V_{506}$ socket. Connect the center conductor to the 200 mmf end of the 56,000 ohm resistor.

24. Lay the shielded wire in the V-shaped slot in the interstage partition, and tape it in position with a 2" length of plastic tape. Cut the wire to length to reach pin $J_{512\text{-}1}$ of the rear cable socket. This is the unused pin. It mates with Pin $P_{112\text{-}1}$ of the cable plug. Strip back ½" of the plastic jacket and braid from this end of the shielded wire. Connect the wire to pin $J_{512\text{-}1}$, using an insulating sleeve over it for protection.

25. Carefully replace the b.f.o. shaft and bellows coupling removed in step 11. Make sure the coupling does not accidentally ground any components or wiring.

26. Replace the i.f. subchassis in the receiver. Insert all the plugs removed in step 5. Reconnect the 2 control shafts and replace their front panel knobs. Make sure the BANDWIDTH knob is properly positioned on the shaft.

## Testing

27. Plug in the 6BE6 tube in socket $V_{505}$. Turn on the receiver. Leave the antenna disconnected.

28. With the b.f.o. switch $S_{101}$ in the ON (S.S.B.) position, a hissing sound will be heard in the loudspeaker. With the bandwidth switch in the 1 KC position, rotate the B.F.O. PITCH knob. The pitch of the hissing sound will vary from high to low and back to high again, as the oscillator portion of the 6BE6 is tuned through the center of the receiver i.f. bandpass. Set the B.F.O. PITCH control for the lowest pitch of the hiss. Without rotating the shaft, loosen the knob set screw, and set the knob pointer to "O." The pitch of the hiss should now rise equally at the −1 and +1 positions of the control.

29. Set the BANDWIDTH knob at 2 KC, and at 4 KC. In each case, the pitch of the hiss will be lowest at the "O" position of the B.F.O. PITCH control, rising an equal amount on each side (−1, +1 or −2, +2).

## AGC Action

30. The original a.g.c. action is not satisfactory for s.s.b. voice reception. It is too fast in the FAST position and produces a "pumping" action. In the MED position it is a bit too slow for fast voice break-in operation.

31. From the unused terminal 10 of the a.g.c. switch $S_{107}$ (FAST position) connect the 1.0 mf capacitor to ground. See fig. 2. This may be done most conveniently by soldering one capacitor lead directly to the switch lug behind the front panel, and connecting the other lead to a ground lug placed under the r.f. section top cover screw just

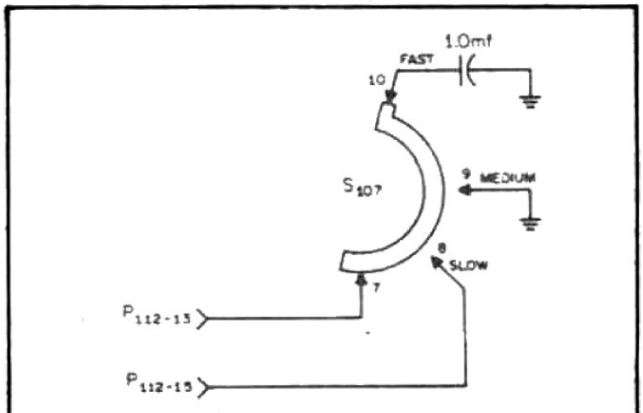

Fig. 2—Modified a.g.c. switch circuit.

back of the center of the front panel. This places 1.0 mf in series to ground with capacitor $C_{551}$ (2.0 mf) in the FAST position, making a total of 0.66 mf across $C_{548}$ in the grid circuit of $V_{506A}$, the a.g.c. time constant tube. The resulting time constant has been found by experimental use to be quite satisfactory, producing s.s.b. voice signals which are pleasing to the ear to copy. For multiplex or composite waveforms of essentially constant amplitude, the MED or SLOW A.G.C. may also be used, as desired.

## Air Test

32. The receiver is now ready to operate. Connect the antenna. With the A.G.C. switch set at FAST, and B.F.O. ON, tune in am s.s.b. signal in the 14 mc amateur band, with the B.F.O. PITCH control set at −2, and the BANDWIDTH control at 4 KC. It should sound very pure, clean, and undistorted (assuming the station's emission is clean and undistorted). The BANDWIDTH control may be set at 2 KC for interference reduction, with the B.F.O. PITCH set at −1 in this case.

33. Shift frequency to the 7 or 3.9 mc amateur bands. Tune in signals here in the same way, but with the B.F.O. PITCH set on the opposite (+) side of "O."

34. Most 14 mc amateur emissions are upper sideband, whereas those on 3.9 and 7 mc are usually lower sideband. Note that the B.F.O. PITCH must be set to the *opposite* side of the carrier ("O") for reception of the desired sideband (− for u.s.b., + for l.s.b.). When you do this, you are in effect placing the locally injected carrier from the oscillator portion of the 6BE6 in the proper position for demodulation of the s.s.b. signal and for positioning the signal correctly within the receiver passband.

C.w. may also be received with the b.f.o. switch on (SSB position), using B.F.O. PITCH and BANDWIDTH controls as desired. For a.m., the b.f.o. switch is OFF, unless a.m. reception in the s.s.b. mode is desired in which case it is ON.

The conversion is now completed, and the R-390A may now be used for s.s.b. with no external converter.

## Conclusion

*This detailed information applies only to the R-390A.* A similar conversion can be worked out for the R-390 or any other good superheterodyne receiver. It has been used with success in several Collins R-388 (51J) [1] receivers and AR-88 receivers by the writer. In the R-388, the oscillator portion of the 6BE6 has been crystal controlled, with 3 crystals (1 for u.s.b., one for exact i.f., and 1 for l.s.b.) selected by a switch in place of the B.F.O. PITCH control. Crystal control is not so practical in the R-390A because of the selectable i.f. bandpass. A multiplicity of crystals would be required. ■

[1] Lee, P. H. Cdr., "The Single Tube Product Detector," *CQ*, April 1961, p. 50.