

improving the R390A product detector

Most improvements in ham gear construction or design are built on a foundation of work done by others. The modification of the military surplus R390A receiver described here owes a lot to articles^{1,2} by Captain Paul H. Lee, W3JHR. Some comments by Harry Hyder, W7IV, were also helpful.

Captain Lee's conversion of the R390A to a product detector was tried, and worked satisfactorily except for two details. One of these was a regenerative effect that occurred at the frequency of the bfo, resulting in a peak in the audio response. The other was the loss of the noise limiter for the ssb and CW modes.

Disconnecting the shielded wiring suggested in that conversion and using short direct leads under the chassis to transfer the audio from the a-m detector to the product detector removed the regenerative effect. Restoration of the noise limiter action was not so easy.

When using the noise limiter with the a-m detector a negative bias voltage appears across the combination of R526 and R527 in series and thus, across R120, the limiter control. This voltage results, of course, from signal rectification through the a-m detector, V506B. Captain Lee's circuit omits the limiter entirely in the ssb/CW position as signals will not pass this stage without some negative bias on the cathodes of V507. A check of the similar noise limiter circuit in the Collins 75A4 receiver shows such a voltage switched into the limiter control circuit from the receiver bias supply.

Trying to operate both a-m and product detectors simultaneously without switching outputs did not work out. The product detector bfo is switched on and off from the front panel, but the a-m detector is not so easily disabled. Examination of the a-m detector circuit showed an i-f filter in the transformer T503 lead to R526 and R527. Part of this filter was a 12-mH rf choke. If one end of this choke could be switched from the a-m detector to the product detector it would provide the desired audio transfer, and by introducing a bias voltage in parallel with the product detector signal, the noise limiter problem would be solved.

circuit modification

To control a circuit at a distance, I think of relays. In the R390A, 225 volts is switched on and off from the front panel by the bfo *on-off* switch, and this switched voltage appears at a tie point near the socket for the bfo. Checking a junk-box relay with a 10k-ohm coil, it was found that a 51k resistor in series with the coil would provide reliable operation at sufficiently low current drain to avoid overloading the 225-volt supply.

A negative dc supply for limiter bias in the *ssb/CW* position was provided easily by rectifying the 25.2 volts ac found on the current-regulator ballast tube adjacent to the bfo socket. The last problem had been solved, and here's the step-by-step procedure by which the complete conver-

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sion was done. Tech Manual TM 11-856A is almost a positive must!

1. Remove power plug P112 from the i-f chassis along with the three rf plugs P114, P213 and P218. Disconnect the *selectivity* and *bfo tuning* shafts, loosen the mounting screws and remove the i-f chassis from the receiver.

2. Loosen the set screws on the flexible-bellows shaft coupler to the bfo transformer, remove the front shaft and bearing and remove the shaft coupler. Socket XV505 is now more accessible.

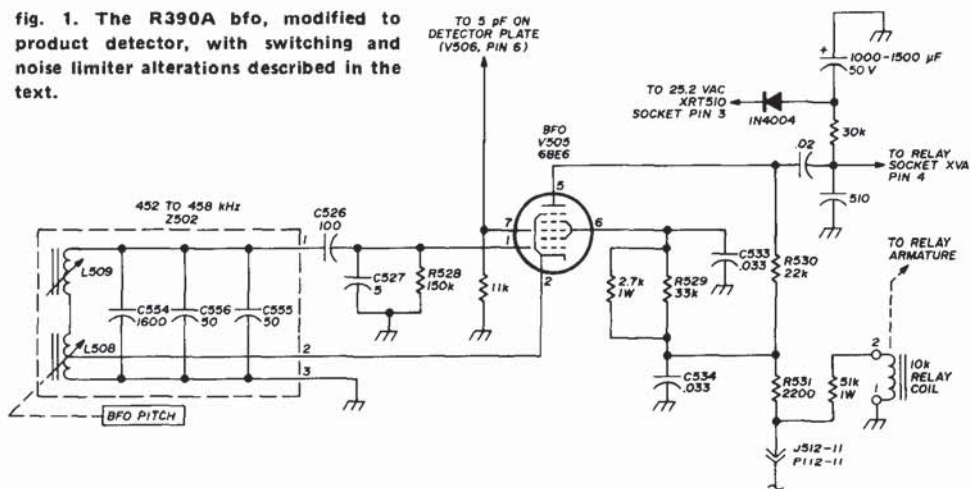
3. Between sockets XV502 and XV506 are three tie points in a triangle. The two

This requires a 5/8-inch (16-mm) hole for the socket and two number-33 holes for mounting bolts. On the chassis below XV503 there should be a dual ground lug holding leads from capacitors C528, 0.1 μ F, and C529, 0.033 μ F. Remove the nut holding this ground lug and mount the tie point saved from step 3 above.

5. Clear socket terminal 2 of XV505 of all leads. If other leads go to pin 2 for grounding, re-route them to other ground points.

6. Change the cathode tap from the bfo can from pin 7 to pin 2 of XV505. This is lead number 2 on the bfo can.

fig. 1. The R390A bfo, modified to product detector, with switching and noise limiter alterations described in the text.



nearest socket XV502 will not be disturbed. Unsolder resistor R518, 100 ohms, and the connecting wire from the third tie point and remove the tie point from the chassis. Save it. Connect the wire lead back to R518, providing insulating tubing over the joint, and leaving as much slack as possible. Train the resistor close to socket XV503 and the wire between the two remaining tie points and socket XV502. A clear space about 3/4 x 1 inch (19 x 25 mm) should be left between sockets XV502, XV503, XV506 and the bfo transformer can.

4. In the cleared space drill suitable holes and mount a 7-pin miniature tube socket, which we will call XVA, for the relay.

7. Connect a 11K, 1/2-watt resistor from pin 7 to ground.

8. Remove C535, 12 pF, and discard.

9. Connect 2.7k, 1-watt resistor in parallel with R529, the 33k, 1/2-watt screen-dropping resistor.

10. Connect a 5-pF mica capacitor from pin 7 on XV505 to pin 6 on XV506. This couples the i-f signal into the product detector.

11. Solder one end of a 510-pF mica capacitor to a ground lug near XV505 and one end of a physically small 0.02 μ F capacitor to pin terminal 5 of XV505. Join the two remaining capacitor terminals and attach a wire lead. The other

end of this wire lead connects to pin 4 of the new 7 pin socket, XVA. In doing these last operations near socket XV505, be sure to leave room for the bellows shaft coupling so nothing will be shorted out when the coupling is reinstalled.

12. Ground pin 1 on the new socket XVA. Connect a 51k, 1-watt resistor from pin 7 on this socket to the tie point nearest pins 3 and 4 on socket XV505. This tie point already has a lead and one end of R531, 2200 ohms, 1/2 watt, fastened to it. Insulate the leads on the 51k resistor and dress it next to the chassis to facilitate heat transfer.

regulator tube RT510, and has 25.2 volts ac on pins 2 and 3. Install a 1N4004 diode between pin 2 (cathode end) and pin 6, which also has a wire lead attached at this time. Use an ohmmeter to check that pin six is not connected inside the regulator tube, and is merely used as a tie point here. Connect the other end of the wire lead from pin 6 to the tie point you moved and reinstalled in **step 4** above.

15. Connect a 30k, 1/2-watt resistor from this same tie point to terminal 4 on socket XVA, which already has a wire lead from the output of the product detector. Connect a 1000- to 1500- μ F,

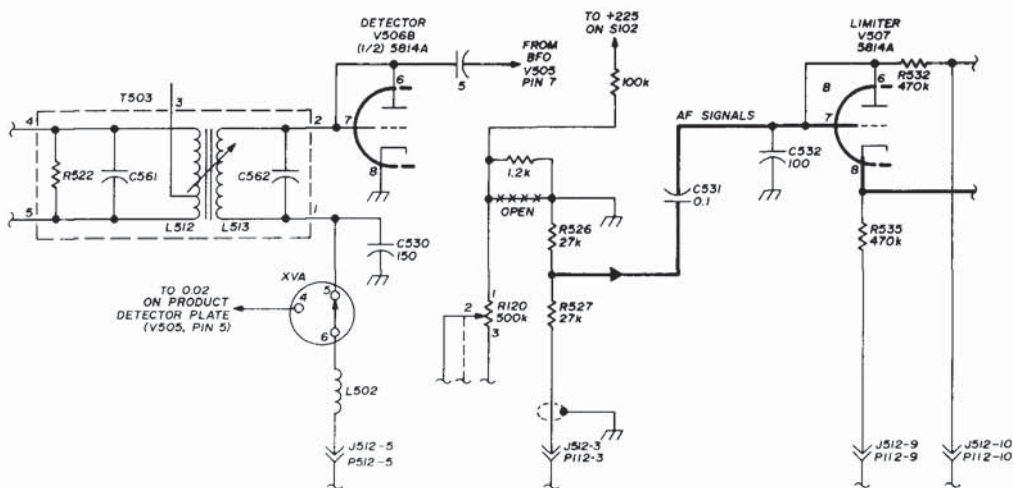


fig. 2. The R390A a-m detector and noise limiter circuits showing changes necessary to use the noise limiter with the product detector.

13. At the front of the chassis, between the *bfo tune* and the *selectivity* switch shafts, there is a molded 12-mH rf choke mounted on a spade bolt. One terminal of this rf choke connects to terminal 1 of transformer T503, which also has a capacitor C530, 150 pF, to ground. Disconnect the rf choke from the transformer, and run a wire lead from the rf choke to pin 6 of socket XVA. From pin 5 of XVA, run a lead to terminal 1 of T503.

14. Socket XRT510 is located in the corner of the chassis below the bfo tuning shaft. This is the socket for current

50-volt electrolytic capacitor from chassis ground (positive terminal) to the tie point just used for the wire lead from the diode. I found a lug under the spade bolt holding the 12-mH rf choke worked out fine for the positive (grounded) terminal.

16. Replace V505, a 6BA6, with a 6BE6. The new socket XVA is for a 7-pin plug-in relay with a 10k-ohm coil. The present Potter and Brumfield number for this unit is PW5LS, I believe, although SM5LS and XSM-1135-2 seem to be the same. About 35 volts of the 225-volt dc supply will appear across this relay coil when the bfo is turned on, switching the

audio input to the noise limiter from the a-m detector to the product detector. The output of the product detector is across the 30k resistor connected between pin 4 of socket XVA and the negative end of the electrolytic capacitor. About 20 volts dc will appear across this resistor. Audio output level should be just about equal for either detector system.

17. To provide a positive cutoff of audio feeding through the noise limiter tube, V507, when the limiter control, R120, is advanced, it is necessary to supply a small positive voltage to the normally grounded end of R120. To do this a small voltage divider must be installed, and it will help if the front panel is partially removed, or at least pulled forward a couple of inches on the tuning and bandswitching shafts. See instructions for panel removal in the Tech Manual. This is to provide access to the back of the *function* switch, S102, and to R120, the limiter control.

18. Remove the ground lead from the grounded end of R120 and the switch on the back of R120. Replace the lead with a 1.2k, 1/2-watt resistor. From the same terminal on R120 connect one end of a 100k, 1/2-watt resistor. The other end of this resistor must connect, either by its own lead or an extension wire, to the terminal on S102, the *function* switch, which turns on 225 volts dc when this switch is in *agc*, *mgc* or *cal* positions. This switch terminal is just below the ac line switch, a microswitch type with heavy terminals and two white and orange wires considerably larger in diameter than anything else nearby. A check with a voltmeter should confirm that you have found the right terminal.

check out

To check to see that things are going to work, you can reinstall the bellows coupler to the bfo can and the panel shaft bearing and shaft so the bfo can be tuned. Connect the rf input and output couplers, P114, P213 and P218, and plug in the power plug, P112. By placing a box or other support under the i-f chassis, it will be possible to turn it approximately 180

degrees from its normal operating position. This is best done by turning the receiver on end, the i-f end down. Now it should be possible to reach terminals inside the i-f chassis for voltage checks while the receiver is working.

Operating the receiver in this position is a bit awkward, especially turning the selectivity switch and tuning the bfo, but the selectivity positions may be counted from the stop at either end of rotation. With the receiver operating, rf and audio gains turned well up, but with no antenna, a considerable hiss should be heard. Set the selectivity switch to 1 kHz and adjust the bfo tuning for the lowest pitched hiss. This should be equivalent to setting the bfo to *zero* on the front panel.

A check of the voltages on the limiter pot should be made with the vom; one end should register about 16 to 20 volts negative, and the other end about two volts positive. With an antenna connected and any normal noise level, it should be possible to observe the limiting action as the limiter control is advanced in a clockwise direction. If everything checks out ok, shut off the power and put the receiver back together.

summary

I believe this modification is very worthwhile. The product detector action is good, the noise limiter is very good on CW, and the changes have a neat appearance. The diagrams show the changes in the schematic, and the step-by-step conversion is not difficult to make. One warning comment: Make sure your limiter pot does not have an open in it. I had one that was bad, and it really caused me a headache for a while.

The R390A makes a very good second receiver for the shack, is invaluable in the shop, and is really well built. If only it weren't so heavy!

references

1. Paul H. Lee, W3JHR, "The Single Tube Product Detector," *CQ*, April, 1961, page 50.
2. Paul H. Lee, W3JHR, "Modifying the R390A Receiver for SSB," *CQ*, January, 1968, page 55.

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