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R-390A Modifications for Improved Performance

Not for sale: One R-390A receiver, original cost $3,900. Depending upon condition surplus costs vary from $550 to as much as $1,500 each. The receiver features four mechanical filters, 2 kHz, 4 kHz, 8 kHz and 16 kHz, with additional bandwidth switching to 1 kHz and .1 kHz. The receiver has two individually controlled audio channels. One for conventional local reception, and a second 600Ω output for phone patch connection. The phone patch output has a vu meter that can be adjusted by a front panel line gain control, and a line meter level switch to read audio levels at -10 vu, 0-vu and +10 vu. A front panel carrier level meter is calibrated not in S-units but from zero to 100 dB. It features a 850 cycle audio filter, frequency digital readout accurate to 200 Hz or better, 100 kHz calibrator, a BFO that swings 3 kHz each side of center frequency with extreme accuracy. The receiver covers .5 MHz to 32 MHz in 1000 kHz segments. Muting, AGC output, space diversity connections, etc., are available at rear-end terminals. An on-off switch is provided to turn on temperature controlled ovens within the various oscillators. Except for the 455 kHz i-f stages, all other stages from the rf to the second and third conversion stages are permability tuned. This and many other features make this one of the best radio receivers available today. After having obtained one a number of years ago I decided that it had some unsatisfactory shortcomings that I needed for sniffing a gas-bubble out from under a hurricane of big pile-ups. In my opinion, it lacked sensitivity, had insufficient and poor audio quality and the limiter contributed nothing to DXing, SSB, or anything else for my modes of operation.

After studying the manual and its various diagrams for several weeks I decided that many improvements could be achieved by adding or subtracting components, and revising certain circuits. All modifications that would be made were with the intent for quick and easy restoration in the event that a sale or swap might be forthcoming at some later date.

After having made the modifications I've reached the conclusion that nothing I have tried in the way of other receivers even closely approaches a comparison of performance.

Modifications

For my applications the R-390A has unsufficient earphone volume. Inspection of the manual diagram shows that the earphone audio has been padded down purposely by a resistive network. Fig. 1, shows the simple modification for increasing earphone volume from 2 mW to 500 mW. As seen in Fig. 1, this modification is a jumper placed across terminals 6 and 8 on TB-102, located behind the rear main chassis.

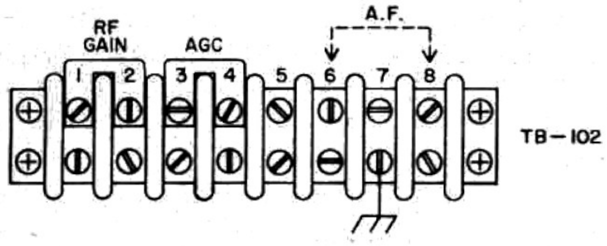

Fig. 1. Dotted line shows jumper to increase earphone volume from 1mW to 500mW.

For DXing and normal ham use the 8 kHz and 16 kHz bandwidths are useless unless one desires to listen to hi-fi broadcast, or other applications that require these excessive bandwidths. To meet these bandwidths the 455 kHz transformers have hi-Q coils which haves been swamped with 15K resistors to broaden their bandwidths. This lowers their gain capabilities and contributes to additional noise. The second modification is for the removal of the 15K resistors and bridge the 455 kHz primary and secondary windings in each of the i-f transformers.

Locate the 455 kHz i-f cans labeled T-501, T-502 and T-503. To get at the 15K resistors loosen the nuts atop each i-f can and lift off the shield can. At this point it is a good idea to drill small holes in the center of each i-f can so that i-f alignment can be performed later on. With the shield cans removed, the windings are visible and easy to get at. With the exception of T-503 secondary winding all other windings are bridged with a 15K resistor.

To prevent a shock and shorting of B+ voltages in the primary windings which could lead to a winding burn-out, be sure the receiver function switch is in the OFF position before attempting resistor removals. With small dikes, clip one end of each resistor from the most convenient terminal, and bend the resistor back out of the way. Before going too far it is suggested that only resistors in T-503 and T-502 be removed first, and that the set then be turned ON to the AGC position and checked for i-f ringing This can be accomplished by listening, or by the use of an oscilloscope connected across the audio output terminals. In my set, with the rf gain control completely open, ringing did not occur until R-115 across the primary of T-501 had been disconnected. Enough pigtail wire had been left on this particular resistor so that reinstallation was an easy matter.

The increased gain and audio recovery as individual resistors are removed can be measured by use of the vu meter. Using the 100 kHz calibrator as a fixed signal source, turn the BFO pitch control for a maximum vu meter reading. The vu line meter control should be set at 0 dB, and the line gain control adjusted to show a vu meter reading of -5 vu. Approximately 2 vu units of gain was obtained as each resistor was removed. The overall audio recover increased approximately 7 vu units at the stopping point of resistor removal. The carrier level meter will also show an increase as T-501 and T-502 are modified.

A better means of measuring an increase or decrease of gain other than using the carrier level meter (AGC) which curtails accuracy because of AGC action is to remove the AGC jumper bridging terminals 3 and 4 on terminal strip TB-102. With a short jumper, ground terminal 4 to the main chassis. This grounds the whole AGC bus line to zero potential, just as the FUNCTION switch does in the MGC position. Connect a VTVM to terminal 3 to read the generated AGC voltage produced by the AGC system. The FUNCTION switch must be in the AGC position in order to get AGC voltage readings. After assurance that no ringing is present, and that the i-f shield cans have dead center holes for alignment, replace the shield cans and their associated hold down nuts. Now, realign the 455 kHz i-f system for peak AGC voltage as read on the VTVM. Maximum AGC voltage will be approximately 35V when using the 100 kHz calibrator as a signal source, when the BANDWIDTH switch is in the .1 kHz position. This AGC voltage will reduce to normalcy when the AGC system is loaded down by the removal of ground from terminal 4 and restoration of the jumper between terminals 3 and 4. During alignment do not overlook peaking of Z-503 located between the AGC i-f amplifier and the AGC rectifier.

Product Detector

See Fig. 2a (before modification) and 2b (after modification) for the following instructions.

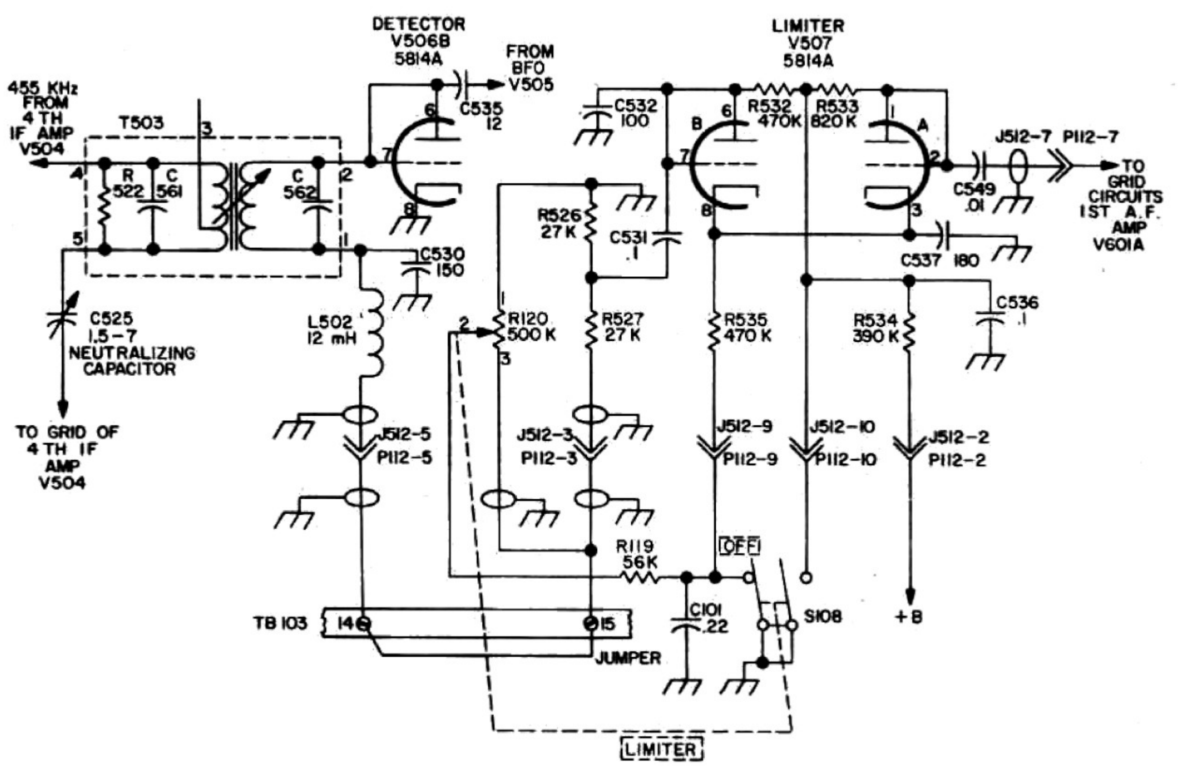

Fig. 2a. Detector V50613 and Limiter V507, original schematic diagram before modification

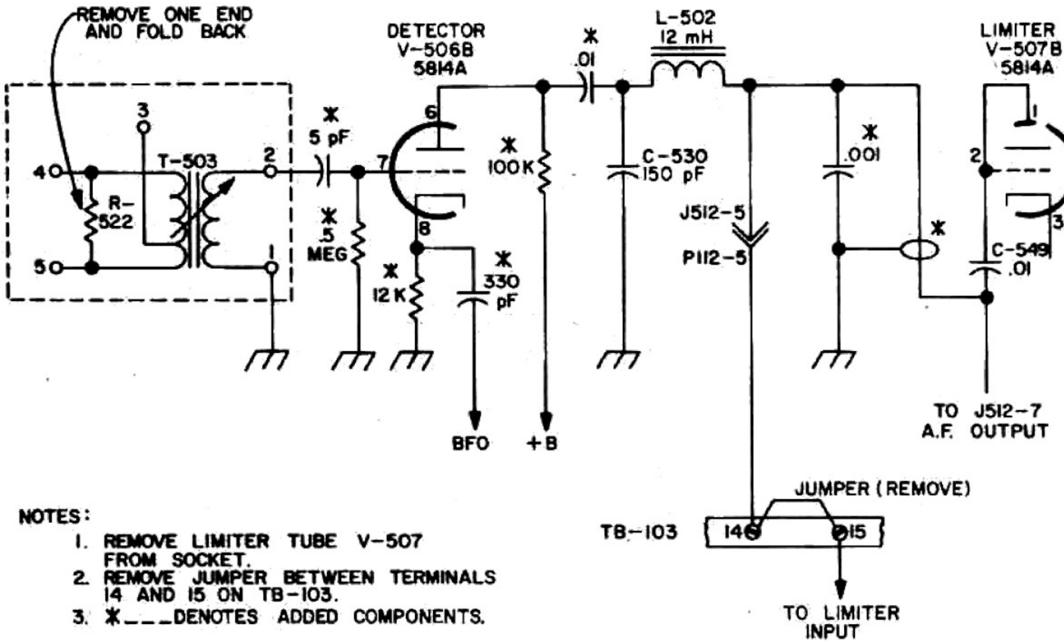

Fig. 2b. Diode detector modifications for product detection.

The last detector (V-506B) has pins 6 and 7 of the 5814 tube connected together to form a diode detector. Both the i-f signals and the BFO are injected at this point. This serves quite well for the reception of all emission modes and matches the voltage levels needed at the limiter input circuit. However, since little A3 or MCW is ever copied, and the limiter is seldom used and had a certain amount of attenuation, I felt that a product detector would best serve my needs. The diode detector was converted to a product detector by lifting the cathode at pin 8 from ground and using the cathode for BFO injection. The BFO coupling capacitor (C-535, 12pF) was replaced with a 330pF capacitor tied to pin 8. The BFO voltage measured 9V at pin 8. Readjustment of the BFO to zero beat the 455 kHz may be required because of this additional loading.

To break the diode feature remove the jumper between pins 6 and 7 of the detector. To pin 6 add a 100K resistor and a .01μF capacitor. Connect the 100K resistor to a source of B+ which can be found nearby on a standoff binding post. From the secondary of T-503, terminal 1, remove C-530 (150pF) and L-502 (12mH). To L-502 connect the 0.01μF capacitor that was attached to pin 6. Leave C-530 (150pF) attached at this point. The other end of rfc L-502 runs through connecting leads to terminal 14 (diode load) on TB-103, jumpered to terminal 15, and back to the limiter on the same chassis. To this end of the rfc install a .001μF, 600V dc capacitor to ground. The center post of the tube socket is grounded and makes a convenient grounding point. Also, to this end of the rfc run a shielded wire to C-549, which is connected to pins 1 and 2 of the limiter tube. Connection to C-549 should be on the side opposite to the C-549 connection to the limiter tube. Remove the jumper between terminals 14 and 15 (diode load) on TB-103 behind the receiver.

Now for the product detector grid circuit. With a short jumper ground terminal 1 of T-503. Remove the lead from terminal 2 of T-503 that goes to pin 6 of the original (V506B) a small .47MΩ resistor to ground, and a 5pF capacitor to terminal 2 of T-503. That completes the product detector modification, except for repeaking of transformer T-503 and removing the limiter tube from its socket.

As before, with the 100 kHz calibrator as a signal source, the measured i-f voltage at the grid of the product detector was 3V. This is only a 3 to 1 ratio, which is a far cry from the 10 to 1 or better ratios normally expected for best linearity. Many different ratios were experimented with and the end result is a detector that produces both AM and SSB with only moderate distortion on AM. The amount of audio recovery also proved best with this ratio. The added conversion gain also added a few more dBs to the output.

Power Supply

The original power supply incorporated a pair of 26Z5W rectifiers tubes. Some conservation of power and a great reduction of heat was gained by replacing the tubes with solid state rectifiers. 1000 PIV units at 2.5A only cost 35¢ each, which is a wise investment. The voltage increase through the conversion to solid state was slight, and no effort was made to change it.

Antenna Input Alignment

The nominal antenna input impedance is 125Ω. This can be maintained and matched to a 50Ω antenna system using any of the various forms of antenna tuners. Lacking a tuner, better performance can be accomplished by realigning the antenna input circuits to match your antenna system. I happened to have a small battery operated 100 kHz oscillator that I've used for antenna work that is set on the far side of my antenna. Its output is sufficient for signal pickup on all the ham bands up to 30 MHz. This steady fixed signal source is invaluable for antenna adjustments, and for matching my receivers to the antennas for best sensitivity. by this means of starting at the antenna and working through to the receiver a matched system is achieved.

Using this system with the R-390A receiver is simple. With the antenna trimmer set at zero, adjust the slugs and trimmer capacitors in the rf antenna input stages for all of the ham bands for maximum AGC voltage, as outlined previously, or for maximum carrier level meter readings. The antenna trimmer does tune out the reactances encountered at this QTH using trap vertical antennas. The improved signal to noise ratios are well worth the work involved.

Performance

First, let me stress the importance of any receiver that has a fixed frequency calibrator and an "S" meter indicator, as a means for judging receiver performance over prolonged periods. As time progresses a receiver's performance can be expected to fall off as tubes and components age. When I first received my R-390A I recorded the carrier level readings of the 100 kHz calibrator every 100 kHz from 500 kHz through 30 MHz. When atmospheric conditions prevail to a point that you begin to doubt whether or not your receiver has lost its sensitivity, it's then only a matter of referring to the original list of level readings to make this determination. With the R-390A these readings will average approximately 50 dB throughout its spectrum range. Lacking suitable test equipment, such as a calibrated signal generator and a distortion analyzer, performance could only be judged against before and after modifications, and against a comparative performance of other receivers that have been in the shack from time to time. Splitting and swapping antennas between the two receivers, and peaking each set to the same signal has shown that the R-390A has better sensitivity, better selectivity and is more versatile than anything compared with so far.

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