R-390A Full Wave Bridge AM Detector

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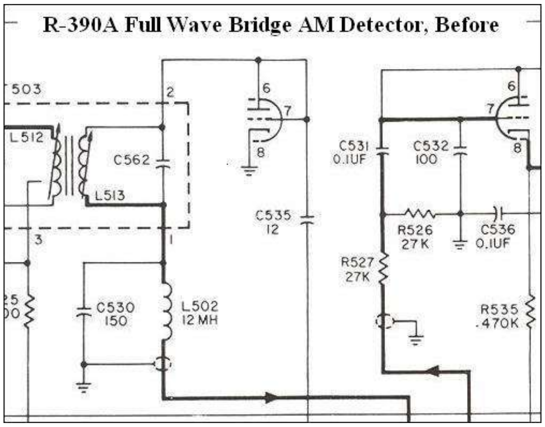

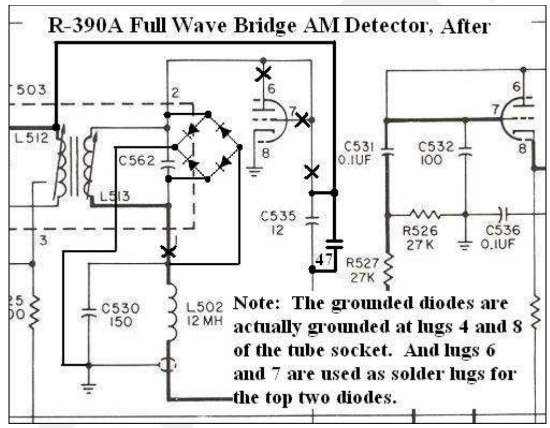

Recently I had the good fortune of using my friend Bjarne's Telefunken E 1501 communications receiver. Bjarne had sent it to me for repair, which I did, and after I repaired it I had the pleasure of DXing with it for a few days. On thing I noticed right away was that the E 1501 AM detector sounded much better than an ordinary detector, almost as good as an AM synchronous detector. Later, when I returned it to Norway, Bjarne said the same thing. The E 1501 manual merely said that the AM detector was an envelope detector. Inspection of the schematic revealed that it was not a simple diode detector. In fact, the E 1501 did not resemble any detector I had ever seen before. I looked through some electrical engineering books and discovered that this kind of detector is called a push-pull AM detector; cf. *Electronic Designers' Handbook*, by R Landee, D. Davis, and A. Albrecht, McGraw-Hill, 1957. Almost immediately I started wondering if a push-pull AM detector could be developed for R-390A's. A few days later, after several failures, I succeeded in developing a push-pull AM detector for one of my R-390A's.

But my design had a substantial defect, decreased audio output. Ideally the secondary of T503 should be rewound as a bifilar center tapped transformer. Rather than attempt such a complex change, I decided to split the internal 68K resistor (not shown on R-390A schematics) into two 33K halves. In effect this provides the necessary push-pull input to two 1N4148 silicon diodes. Later I used 1N34A germanium diodes which worked equally well. Rather than change the detector tube socket wiring, I cut pins 6 and 7 off the 5814A tube. C530 was unwired from the lug of T503 and a short jumper was added from that lead of C530 to the lug of L502. After these changes the push-pull AM detector worked very well, except that audio output was down about 6 dB. I was concerned that the push-pull AM detector might not work for SSB and CW, but it seemed to be at least as good as a single diode detector in that regard.

I didn't like the audio loss of my push-pull AM detector, but couldn't immediately think of any way to prevent it other than rewinding the IF transformer T503, which I wasn't about to do. A day later as I was driving in my car the solution popped into my head... replace the 33 K ohm resistors with diodes. I implemented this new mod and it worked fine for AM signals, with no audio loss. All of a sudden, in a delayed reaction, I recognized my new AM detector circuit for what it is... a full wave bridge rectifier, but with an IF transformer for the source AC voltage, and operating at RF frequencies instead of ELF frequencies which power supplies usually operate at. When I tried my new detector on SSB it had terrible distortion. I mentioned this to my good friend Wally K5OP during a phone conversation shortly after implementing the full wave bridge AM detector. He replied that the BFO injection was too low. Later I rerouted the BFO injection to the primary of the IF transformer T503 and SSB was fine. Years ago, following K5OP's advice, I had already increased the BFO injection for my unmodified R-390A diode detectors in all of my R-390A's by paralleling a 47 pF 500 volt silver mica across C535 12 pF. This mod was retained when I moved the BFO injection to the primary of T503. It was necessary to add a splice to the ends of C535 and the 47 pF cap in order to reach the appropriate lug of T503.

The polarity of the diodes in the R-390A full wave bridge AM detector schematic above should be observed. Otherwise, when the R-390A noise limiter is turned on there will be little or no audio. I know because I made this mistake in some of the early versions of my R-390A full wave detector. When I started these mods I did not know that the original R-390A diode detector is part of the noise limiter circuit and that any R-390A detector mod must be functionally equivalent to the original with respect to the noise limiter.

I do not know of any other reference to a push-pull AM detector other than the brief mention in the book by Landee, et al. Push-pull AM detectors may be related to full wave AM detectors which have been discussed by K2CU; see www.amwindow.org/tech/htm/alowdisdet.htm. At one point I thought they were equivalent, but now I don't know. There are a few internet references to full wave AM detectors, but none of those resemble the push-pull or full wave bridge AM detectors described here. I do not know of any reference to a full wave bridge AM detector.

So what does a push-pull, full wave, or full wave bridge AM detector do for an R-390A? It sometimes reduces part of the distortion you hear on fading AM signals. The improvement is most noticeable for some, but not all, weak signals fading in and out of the ambient noise floor and for some, but not all, quickly fading signals. However, a push-pull or full wave AM detector does not eliminate distortion caused by total or almost total fading of the carrier, but neither does an AM synchronous detector despite claims to the contrary.

For many kinds of fading AM signals an appropriately slow release time AGC (2.0 - 3.0 seconds) provides much more reduction of distortion and noise than a push-pull or full wave bridge AM detector or an AM synchronous detector. Another technique for reducing fading distortion of AM signals which many are not aware of is to tune mostly one sideband or the other. This eliminates distortion caused by incoherent sidebands. But the best technique I have found for reducing AM distortion due to fading is to use an appropriate elliptic low pass audio filter. This method will be discussed in detail in a future article.

Some have claimed that a phase locked loop AMSD (like the SE-III, AMSD-1, and AMSD-2) is better than (has less distortion than) a synchro phase AMSD (like the Racals... RA6790/GM, RA6793(A), and RA6830). But I have used both types side by side for over 6 months now and have observed little or no difference in improved audio between the two types. I am also into my second day of using a modified RF notch filter as a fading simulator. With it I can generate realistic sounding fades with realistic sounding distortion. Whether or not my simulated fades are accurate approximations to the real thing I do not know. But they surely sound like the real thing. I have been using my fading simulator with many of my receivers... R-390A w/ external AMSD-2, unmodified R-390A, R-390A w/ internal full wave bridge AM detector, modified (MW and LW attenuator removed, Preamp 1 enabled) IC-746Pro, unmodified R8B, unmodified RA6790/GM, and modified (grounded tuning encoder shaft for microprocessor RFI elimination) WJ-8711A. It has been most instructive. None of these receivers eliminates much fading distortion in the case of an AM carrier which is mostly or completely eliminated durinmg the fade. If I slow down the fade (slow motion fading!), I believe I can hear that phase locked loop AMSD's hang onto the AM carrier longer than synchrophase AMSD's. Having said that, let me add that the distortion produced by a fading carrier is about the same in either case when a fade takes place at the usual rates. The bottom line, as I have said on many other occasions, is that one will not hear anything using an AMSD that one will not hear almost as well without an AMSD. The same is true for push-pull and full wave bridge AM detectors.

In my opinion, a full wave bridge AM detector, without other techniques such as slow AGC, tuining mostly one sideband or the other, and elliptic low pass audio filtering, is a marginally worthwhile modification for an R-390A or other receiver, similar to adding an AM synchronous detector. Nevertheless, it is a mod I which will remain in my R-390A and which I will do again because in difficult DX situations every little bit of improvement in recovered audio helps.