My fix to Dr. Dallas Lankford's 2-diode SSB AGC mod
2/23/2024 – Mod 5 Revision

It all started when I added a product detector to my R-390A daily driver many years ago - thank you Capt. P.H. Lee. It worked great, but the AGC of my R-390A was not good for SSB, the RF gain still needed to be turned down and adjusted according to received signal strength. The main benefit to the product detector is the improved s/n on SSB signals. When I heard of Dr. D. Lankford's 2 diode mod, I tried it right away, and it worked great. Thank you Dallas! SSB is now great. But, it did remove the 'delay' in the AGC. I was not aware of it right away, but did notice some side affects:

1. Weak signals did not come in as well as before (lower s/n ratio).
2. Audio output was reduced.
3. Noise limiter did not work quite as well (a little more distortion).
4. Carrier Level meter read too low.

The reason that the Noise Limiter does not work as well as it was designed is that the output of the audio detector is reduced. It needs a minimum signal level coming out of the diode load so that the audio loss going through the NL is negligible compared to the input signal. With the 2 diode SSB mod installed the doide load voltage is significantly reduced all the time.

I had a good idea what the AGC was supposed to do on weak signals, but could not find any measurements anywhere, so I took a few with the AGC mods off. Now I could see clearly what it was suppose to do on weak AM signals:

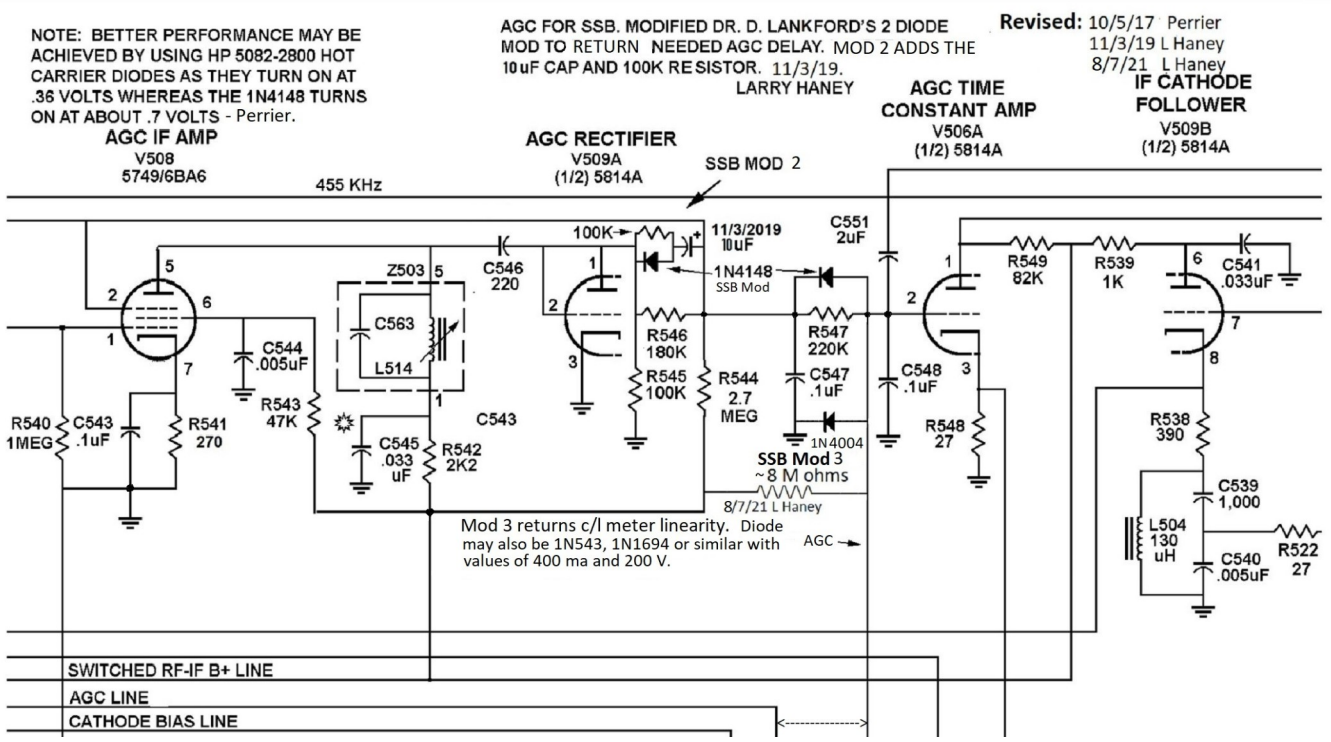
uV in balanced	AGC V det pin 1	AGC V TB102 t3
0	-0.4	-.15
.5	-1.7	-.18
1	-3.2	-.23
2	-4.9	-.65
3	-7.6	-1.25
4	-9.2	-1.6
5	-11.1	-1.9
10	-15.2	-3.2
20	-17.4	-3.6

It looks like the delay is overcome at about -4.5 detector V, which is fine as the input voltage is about 2 uV (usually enough to provide a good s/n). It took me a little while to put it all together and even longer to come up with a fix. I wanted something simple and easy to remove. I finally decided on the

following circuit (I added a 100k resistor and a 10 mfd cap identified as Mod 2). The value of either component is not critical, but the cap should have very low leakage and can be an electrolytic. Thank you Perry Sandeen for making the schematic look very nice.

Revision 1 start:
It was reported to me that the carrier level meter linearity has been adversely affected by this mod to the AGC. I noticed the same thing on all versions of the '2 diode' Lankford AGC mod and tried numerous different solutions. Mod 2 (described in the followiing schematic) helped some, but not enough. I tried a few other simple changes, but the only one that I found that made any reasonable difference is Mod 3, also described below. The problem that I identified is the AGC detector puts out a much higher voltage for the same level of noise coming in on the antenna. Before the mod, with 'no signal' on the input, the voltage on the grid of V506A (AGC line) was close to 0 vdc (even with an antenna connected with a little noise on it). But, with the '2 diode' mod and mod 2 on, and using that same antenna, it's too negative. The reason is that the original 'suppressor grid' clamping at the junction of R544, R546 and R547 is not effective enough to overcome the increased noise voltage created by the mod (even with the same antenna noise level). If you don't have a low noise antenna, the problem is even worse.

The clamping circuit provided by Mod 3, improves the situation considerably, but does not completely solve it for a high noise antenna. This problem has been there all along, but with the original design, it was not very noticable. With Mod 2 and Mod 3 on, it looks like the c/l meter noise tolerance operation is a little better than with none of the mods on. Mod 3 also improves the c/l meter linearity close to what it was without these mods on. How does this affect the c/l meter linearity, you say? Well, with mod 3 on, the meter 0 set point is different. This is what improves the linearity. The diode needs to be 200 volts at 400 ma with a .6 volt forward drop or less. There are a number of basic silicon diodes made that meet the requirements as they all have about the same Vf at low current as we see in this circuit. Ones I found are: 1N4004, 1N543, 1N1694, or 1N2092.



The following readings are taken with a signal generator attached (no antenna noise is considered here).
Revision 1 end:

After reinstalling Dr. Lankford's mod and my mod 2 fix (mod 3 not on), I took the following readings:

uV in balanced	AGC V det pin 1	AGC V TB102 t3
0	-0.4	-.15
.5	-1.6	-.18
1	-3.0	-.25
2	-4.8	-.7
3	-7.4	-1.3
4	-9.0	-1.7
5	-10.8	-2.0
10	-15.0	-3.3
20	-17.0	-3.7

With mod 3 on, I took the following readings:

uV in balanced	AGC V det pin 1	AGC V TB102 t3
0	-0.4	+.1
.5	-1.6	+.1
1	-3.0	+.1
2	-4.8	-.5
3	-7.4	-1.1
4	-9.0	-1.6
5	-10.8	-2.0
10	-15.0	-3.3
20	-17.0	-3.7

As can be seen, the AGC voltages are very similar and it is working very well for weak and strong SSB, CW and AM signals. The AGC delay is important in obtaining the best possible s/n on weak signals. And, with the way the R-390A is designed, in maintainig the correct diode load level and the correct audio and AGC level.

An important note about the Dr. D. Lankford 2-diode SSB AGC fix. He recommeds also adding a 47 pf cap across the 12 PF C535 BFO injection cap to provide sufficient BFO signal to prevent audio distortion in the detector using the BFO for SSB reception. The injection voltage needs to be higher than the SSB audio coming into the diode detector.

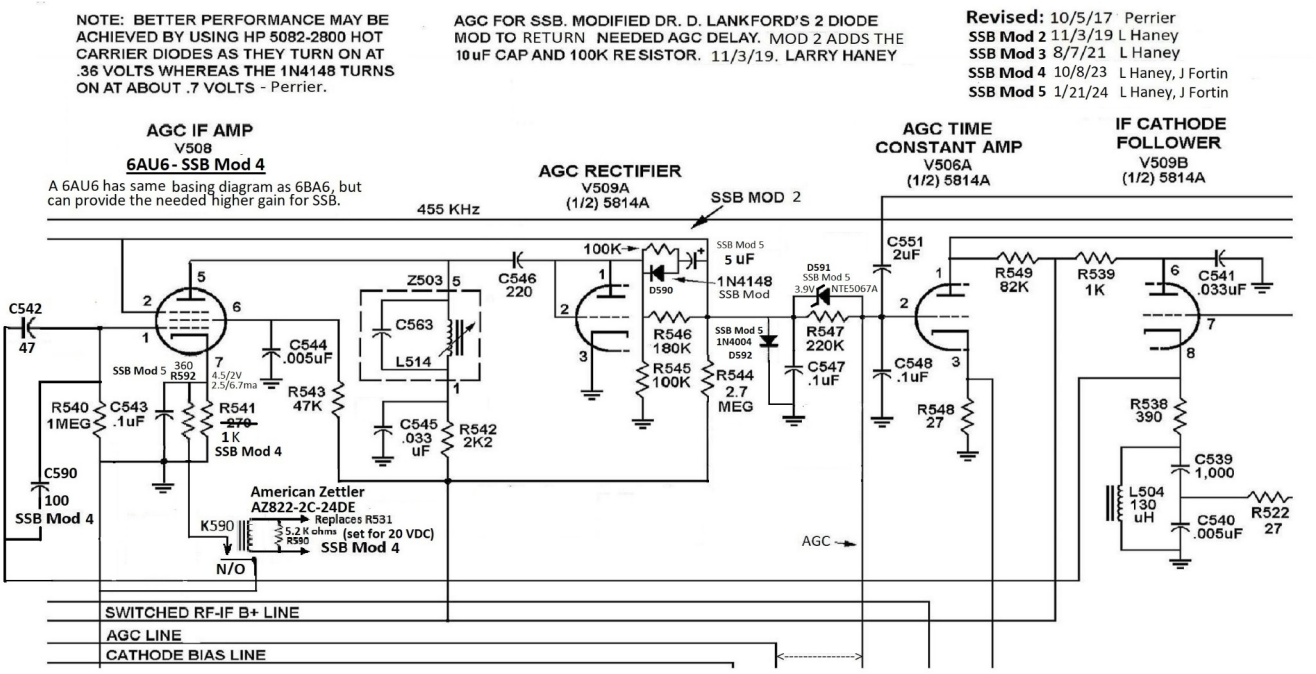
There's not much information about what the correct voltage level should be on the diode load in AGC mode. Its very important for one thing – operation of the Noise Limiter, it varies from weak to strong stations and can range from -5 VDC to -9.5VDC (with the NL on), but can go much higher and it is still OK. The voltage is about 1 volt less with the NL off. This is a good level to drive the audio amp correctly, but does not need to be that high for correct NL operation (it needs to be at least -3 VDC for it). Too high (above -20 VDC) is an indication that the AGC circuit is not working correctly.

2-23-2024, **SSB AGC mod 5:**

A drawback to this mod up to now (SSB mod 1 through SSB mod 4) is that there still is not enough AGC voltage developed in SSB mode (BFO on). Mod 5 improves on this situation, which improves audio quality and carrier level meter action on weaker SSB signals. Before, the audio quality was good only in the AGC FAST position. Now it is good there and in the AGC MED position. The following are Relay solutions and a Mosfet soution.

Relay solutions:

There are two relay solutions. It depends whether you are using the noise limiter circuit or bypassing it and if you are using a product detector mod. The difference is where the audio circuit is tapped into for using the relay for switching the the audio and/or AGC gain. The following updated schematic is used for all '2-diode' AGC mods for SSB using a relay:



K590 is an American Zettler AZ822-2C-24DE I obtained from DigiKey for about $1.55. Jacques Fortin led me to it – thanks. It's a DPDT signal relay. It's coil is 24 VDC, so I added R590 (5.2 k ohms) in parallel with it to drop to the correct voltage (it's now about 23 VDC). This is if you are using a Product Detector conversion of the original BFO, as the current through the tube will be different. It may also be diffeerent from one Product Detector to another. You will need to adjust R590 to compensate for them. The allowable voltage is 19 to 23 vdc (this allows for variance in B+ voltage due to main power differences).

I'm using half of it to switch the AGC amp gain circuit and the other half to switch the SSB/AM audio circuit. C590 and changing the 6BA6 to a 6AU6 (same basing diagram) increases the gain of the AGC amp, while the new value of R541 (1K ohms) reduces the gain so that the net gain in AM mode is not changed. This allows the gain of the AGC amp (in SSB mode) to increase quite a bit when R592 (360 ohms) is switched in (all while reducing the current through Z503 in both AM and SSB modes). The lower current used by this 6AU6 solution should extend the life of the 6AU6 and put less stress on

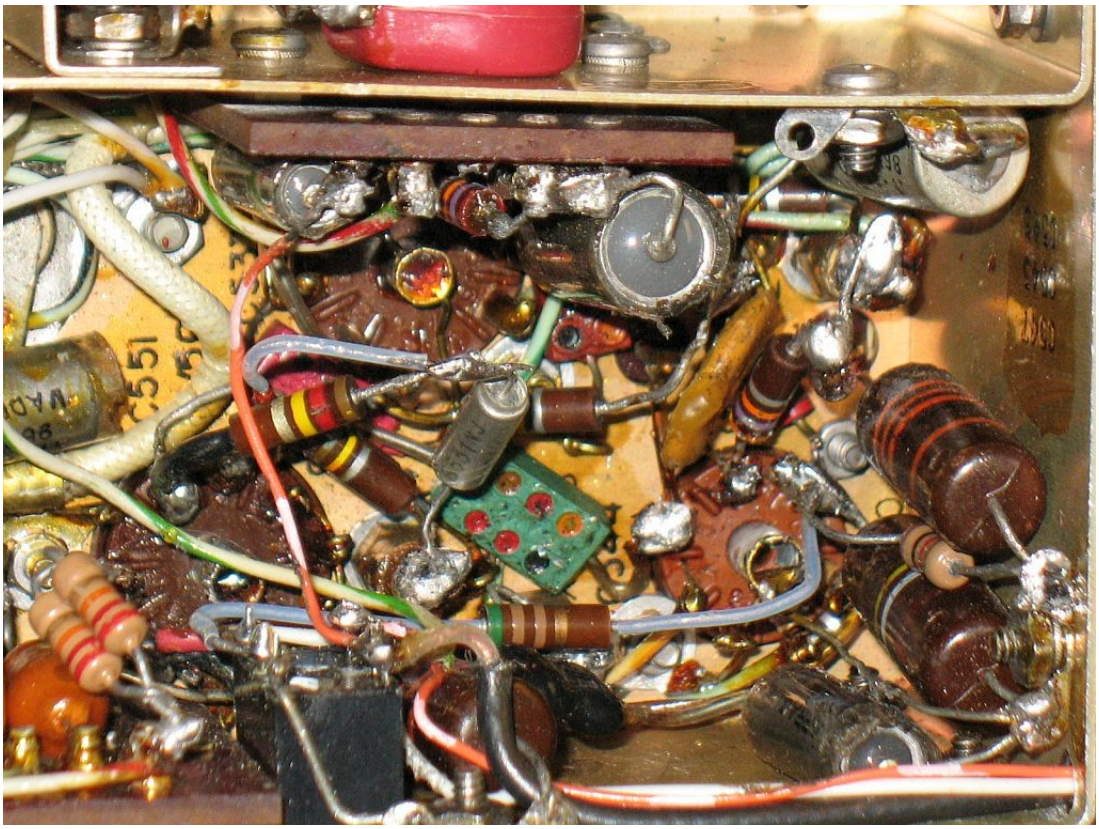
Z503. This level of gain increase seems to be enough to accomplish the goal.

You can see the specifications for the relay on DigiKey or in my document on our website called: Improving Lee Prod Det and SSB AGC.pdf (r-390a.net)

If bypassing limiter:

If you are using a product detector mod and bypassing the limiter circuit, here's the updated installation procedure for that:

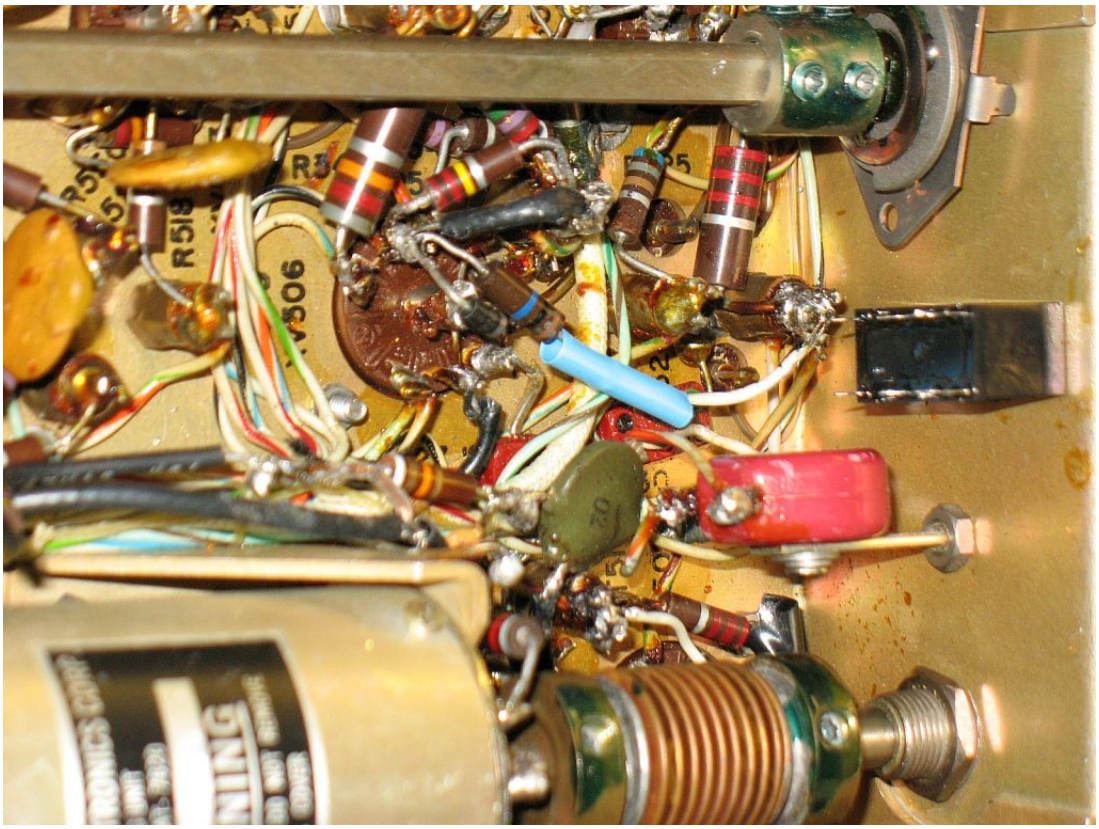
Next is a picture of the bottom of the IF deck showing the location of the relay (small black box about .5" x .5" x 1"). I chose the location based on the close proximity to audio and agc circuitry involved. It's at the bottom left in the following picture. This is a DPDT relay, half is used to switch the AGC gain from normal in AM to high in SSB mode. At the very bottom of the photo you can see the audio coax running horizontally from the relay to the right to the product detector in the BFO compartment. You can also see the 2 wires (solid white and orange with white tracer) that run from the relay coil to the right and next to the coax. They go through a hole I drilled in the compartment separator (you can see it in the very bottom right of this photo):



I've been using this new mod for a few months now and am pleased with the improved audio quality with the AGC switch in MED speed. Without this mod (SSB mod 4), the AGC was not strong enough to operate in MED due to audio distortion on strong stations, although the quality was good in FAST. Now, with this mod on, MED is better than FAST because it smooths out the audio between words. FAST sounds the same as before this mod (which was good). The benefit to the FAST mode is that it is easier to see the signal strength of the stations received on the c/l meter .

If using limiter:

If you are using the limiter circuit (and using a product detector mod or not), the audio wiring to tap into is located at the very front of the IF deck, so the relay will be relocated to there. The same schematic is used to control the AGC amp gain. The power for the relay coil is already there, so that's a plus. The wire for switching the AGC amp gain is nonsensitive, and is easy to run to the relay. Here's a photo of the relay in it's other location at the front of the IF deck:

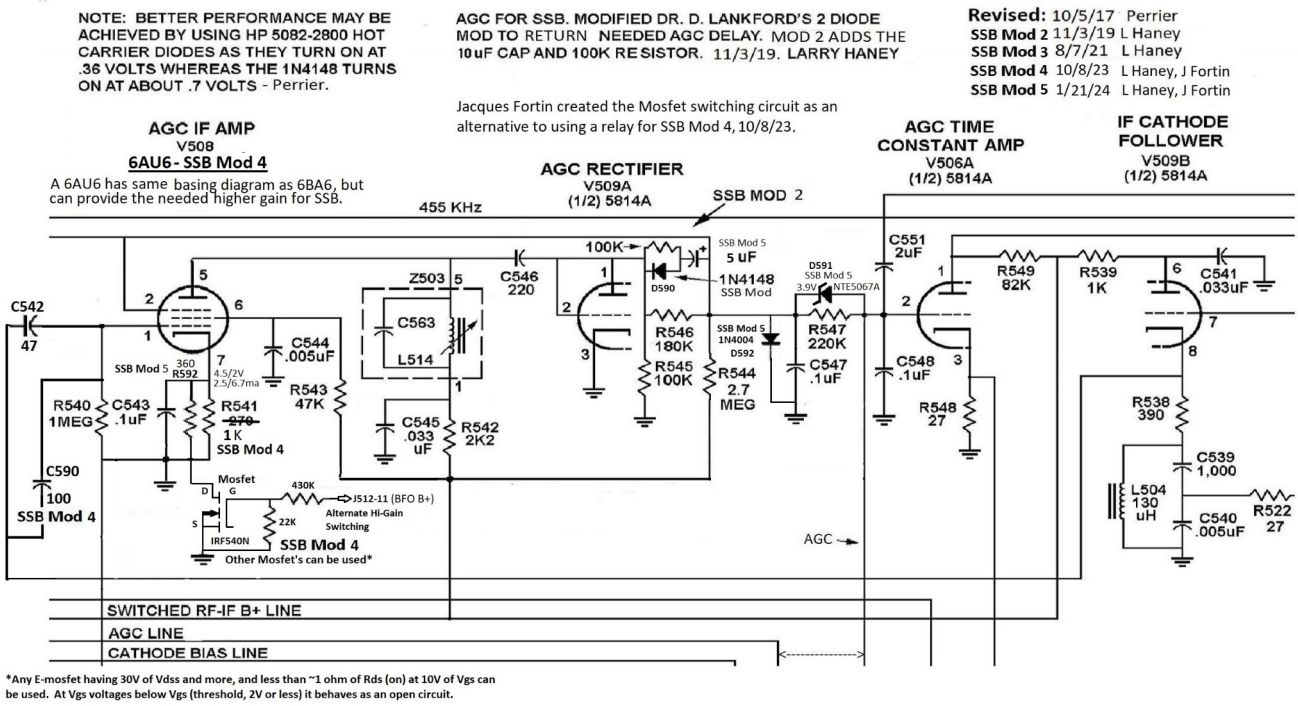


As can be seen, there are no wires to it, yet. When Jacques and I find a good solution, I'll rewire it and update this document. I currently recommend not using the W7DI limiter solution, the limiter bias is fixed and too high and the limiter loads the product detector too much (causing audio distortion).

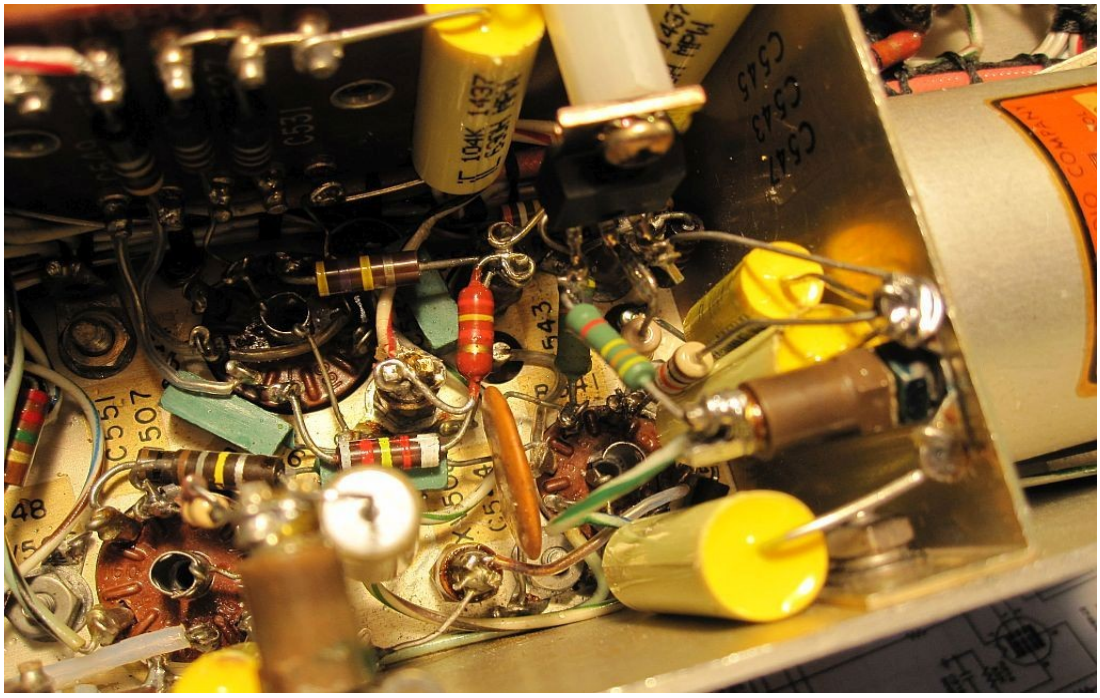
Mosfet solution:

And for you folks that don't want to install a relay or don't want to change a relay, Jacques Fortin came up with an **excellent Mosfet solution** to switch the AGC gain in SSB mode (BFO on). It's located in the same compartment in the IF deck that I put the relay in (to the left of the BFO tuning coil), but on the right end of it at the top (mounted on a short white hexagonal insulator). The white nylon standoff for the mosfet can be found here: https://www.digikey.com/en/products/detail/keystone-electronics/1902c/61868.

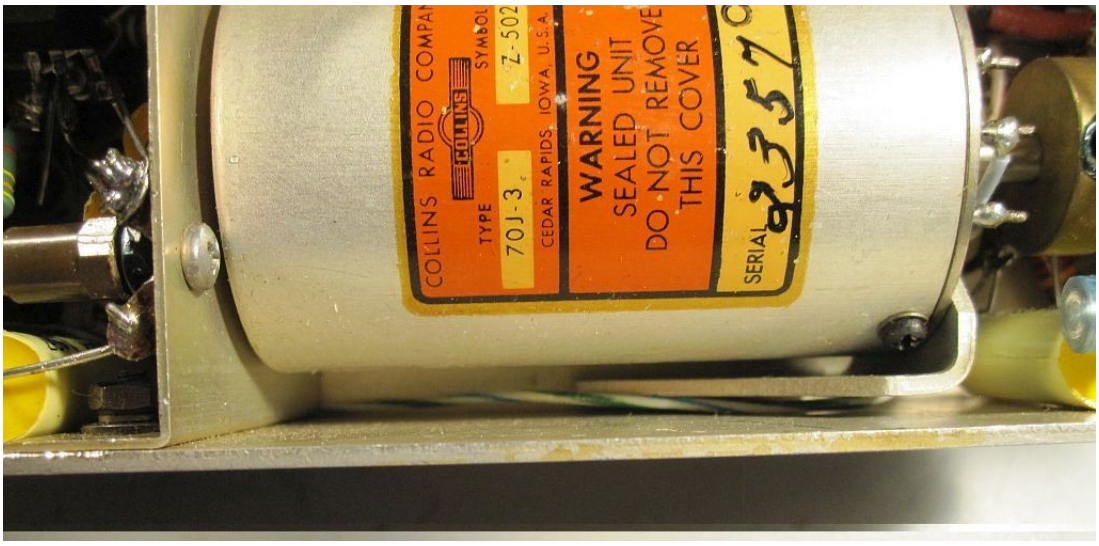
These Mosfet's are reasonably priced, so this is a very good solution, also. The schematic follows and then the pictures:



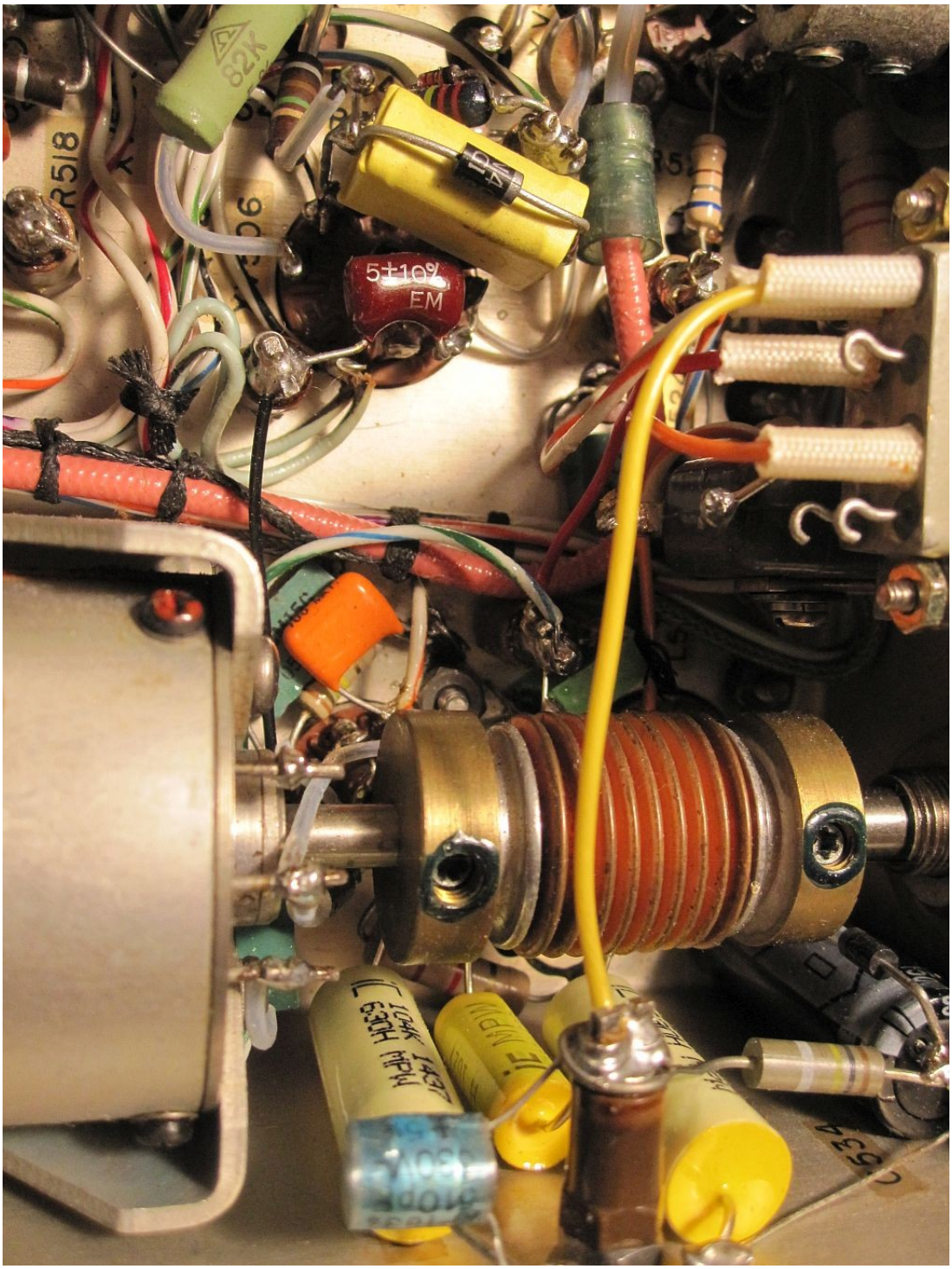
So you can see where it goes and what it looks like, I've included Jacques' pictures of it here:



Running the switched BFO B+ wire can be see in the above photo connected to the added terminal standoff (shown in the lower right). It's the white wire with the green and blue stripes. You can see the 430 K ohm resistor connected to it. The BFO B+ wire runs through the small opening in the lower corner between the BFO oscillator coil mounting bracket and the outer frame of the IF deck (shown in the next photo).



The wire continues to the right and connects to the switched BFO B+ standoff termnal (as shown in the next photo) just above the BFO shaft bellows. This is the terminal that the wire from the J512-11 connector contact goes to.



The rest of the installation should be easy to figure out.

As I see it, the Mosfet solution is good because powering it only requires running one wire to the switched BFO B+ line. But, if you are going to install a relay to switch a product detector audio line, then the relay solution may be better.

Whether or not you have a product detector mod on your rx, I recommend this mod if you listen to SSB. If you listen to SSB on your rx, I recommend a product detector such as Capt. Lee's. If you are going to put in Capt. Lee's mod, for education, I recommend you read the W7DI (Eugene Hubbell) article in Ham Radio, July 1974 , starting on page 12. Here's a link: July 1974 Ham Radio . I don't recommend installing it as there are some issues with the limiter.

Regards, Larry

Modificaton Revisions:

1. 11-3-2019, Mod 2 - Changed 68 mfd cap to 10 mfd. Prevents AGC and CL meter from drifting.
2. 8-7-2021, Mod 3 – Added diode 1N4004 and 8M resistor to clamp agc to ground.
3. 10-13-2023, Mod 4 – Added K590, C590, R591 and R592, changed R541 and replaced R531 with K590 and R590. Replaced R591 with a 10 Meg.
4. 2-23-2024, Mod 5 – Removed R591, changed D591 to Zener and added D592.