TEN-TEC
Hercules II - Model 420
Vacuum Relay Modification

Prepared by Rick Williams, VE7TK

(**Note:** Those undertaking this modification **do so at their own risk**. The procedures outline show how to modify the Hercules II linear amplifier (Model 420), replacing the stock vacuum relay with Gigavac GH-1vacuum relay.
This procedure has not been approved by TEN-TEC, Inc. or any of its staff.)

Under no circumstances will the author be liable for any damage to your amateur radio equipment resulting from the installation of this modification.

History

My Hercules II (Model 420), circa 1990, began to suffer from, what I thought was, a "stuck" relay on receive. On occasion the receiver (TEN-TEC Orion 565) would suffer from a serious loss in sensitivity. This only happened when the Hercules was in line and it was intermittent. A search of the internet turned up a similar situation reported by Dave (K1FK) with another TEN-TEC linear amplifier.

> "Relay manufactures design the contacts of their relays for specific applications. Relays generally carry an application rating such as ***Make & Break Load Switching, No Load Switching, Make Only Load Switching***, etc. The selection of the proper relay for a specific application is crucial to the life of the relay and its performance in the circuit. Relays rated as 'Make and Break Load Switching' depend upon current flow through **BOTH** the normally closed AND normally open contacts in order to maintain a specified minimum contact resistance over the specified life of the relay. Use of such a rated relay in a circuit where no current flows through either the NC or NO contacts can cause contact resistance to increase over time and the relay will eventually fail to provide circuit continuity through the contacts. This is sometimes misinterpreted to be a sticking relay armature problem."

The Hercules II uses a **Kilovac K41C** vacuum relay. This is a ***Make & Break*** load switching relay. Dave goes on further to state:

> "Use of such a relay in a QSK amp where "hot switching" is prevented by circuit design but also no current flows through the NC contacts (on receive) will eventually cause these symptoms to occur, usually identified

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> as "no signal or a greatly attenuated signal on receive". Rapping the relay may cause the symptom to disappear (for awhile) and is often interpreted as a sticking solenoid versus a contaminated NC contact. A better choice for such an application would be a relay whose contacts are rated as No Load Switching."

These symptoms mirrored my receive problem and led me to investigate a suitable relay replacement. I finally settled on the Gigavac GH-1 with a 12 volt coil from Max-Gain Systems Inc. at a cost of $79 plus shipping and handling (prices as of October 2013). This is a **no load** switching relay. (The Kilovac HC-1 is a similar relay.) The specifications of the GH-1 are somewhat reduced from the stock relay but are well within the operating parameters of the Hercules II. In addition, this relay has a switching time of 6 ms versus 10 ms for the K41C.

Unfortunately, the GH-1 is not a drop in replacement for the stock relay and the fabrication of a new mounting bracket is required.

Getting to the Relay

Getting to the relay requires removal of the top and bottom covers of the Hercules. There are 6 screws in the top, 6 in the bottom and 6 on the sides. With the covers removed, place the amplifier upside down and remove the 4 screws holding the plate with the fan.

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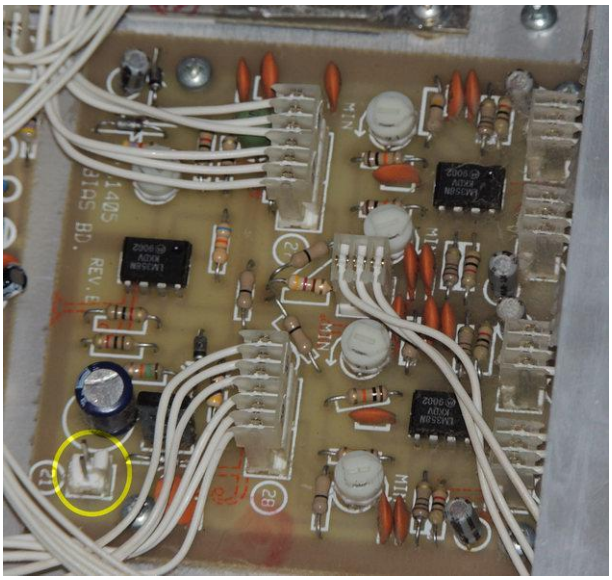
Carefully tilt the cover-plate and fan towards the rear. As you lift this plate you will notice that the fan is plugged into connector 21 on the left side of the Bias Board. Unplug the connector (circled in yellow in the following figure).



With the cover-plate and fan tilted out of the way the vacuum relay board is now visible at the right rear of the amplifier. The K41C relay is in the centre of the board in a metal bracket.

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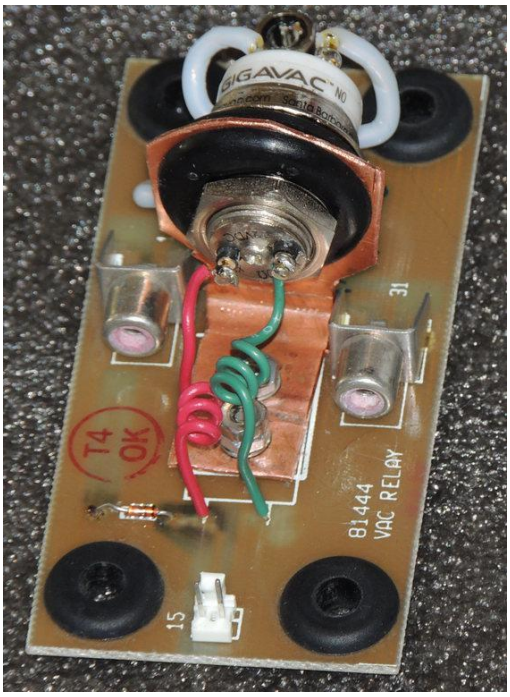
Note the position of the 3 coax connectors and power connector at plug 15 and unplug all. Remove the 4 screws holding the circuit board in place and remove the board.

The bottom of the board was covered in foam acting as a damping agent to reduce relay noise. In my case the foam had all but disintegrated. Unsolder and remove the relay from the board. Carefully drill out the stock mounting bracket.

Install the GH-1 Relay

Installing the GH-1 relay requires the fabrication of a new mounting bracket. I built my bracket out of some copper material. The bracket is a simple 90 degree bend with a 7/8^{ths} inch whole for the relay in the vertical portion and a pair of holes to accommodate 4-40 mounting screws in the narrower horizontal portion. The bracket was constructed to allow easy access to all the RCA connectors while still clearing these connectors. The 4-40 screws used the original rivet holes that held the K41C bracket. (The original holes needed to be enlarged slightly for the 4-40 screws.)

A large grommet was inserted into the new bracket's 7/8^{ths} inch hole to provide isolation for the relay. The threads of the relay were lightly coated with RTV silicone sealant and the 4-40 screws were coated with a thread locking compound.



Power connections to the relay were made with #22 hookup wire. The RF connections were made with short lengths of Teflon coated wire from some RG-142 coax.

As previously mentioned, the foam material on the back of the VAC Relay board was no longer serviceable and it was removed. As a replacement, I made a "sandwich" of 4 strips of silicone self bonding tape (available at *Home Depot*). The 4 pieces were cut to a similar length and stuck together un-stretched. This tape "sandwich" was positioned below the board during reassembly and provided some damping.

After re-installing the VAC Relay board, tighten the 4 isolated mounting screws. Re- insert the coax cables and power cable (connector 15) into the VAC Relay board connectors.

The remainder of the re-assembly is done in reverse order. ***DO NOT FORGET*** to attach the fan to connector 21 on the Bias board.

Results:

Wow – I was most impressed at how quiet the new relay was. I had to ensure that it was really working! So after some preliminary tests I thought it was time for a QSO. I went looking and found ZD8JR working a pileup on 80. The relay worked flawlessly and I made the 12,000 km contact without a hitch!

Acknowledgements:

Thanks to Dave Bowker, K1FK, for his suggestions and guidance.