Some new findings about the AVO CT160A! Revision E5, 16 Feb 11

With help from my friend Mr. Yutaka Matsuzaka, who has photographed the insides of two AVO CT160A's, and who has also measured the components values and traced some of the wiring, I have some new information to report on the CT160A.

From the measurements it can be seen that AVO used two different sets of resistors for the relay shunt that was introduced in the CT160A, consisting of the pair of resistors numbered R37 (R37A & R37B). The same design was also used in the later AVO Mk IV and VCM163 to shunt the relay on the 120mA and 180mA ranges. In one of the CT160A's AVO used two resistors with a total resistance of 6.5Ω, this has been reported on earlier, but in the second CT160A AVO used two 27Ω resistors making a total resistance of 13.5Ω. The total resistance of 6.5Ω means that CT160A works identically to the AVO Mk IV in the way the relay is shunted, only 56% of the current flows through the relay. In the second CT160A where the total resistance of the shunt is 13.5Ω, the current flowing through the relay is 73%, thus tripping the over current relay earlier as more current flows through the relay coil. The colour bands, denoting the resistor values, could only been seen clearly in the second CT160A, but the total resistance was measured in both.

Modifications have also been made to the coil in the AC mains circuit of the over current relay, with the introduction of a silicon diode and an electrolytic capacitor across this relay winding. These components act as a holding circuit, preventing some of the "chattering" that this relay experiences when the current is close to tripping the relay, and it also delays the release of the relay by a small amount when power is cut to the tester after the relay has operated. This modification was observed in both CT160A's. The value of the capacitor used is 50µF with a voltage rating of only 35V, this capacitor had leaked in both of the testers and was replaced with a capacitor of higher voltage rating. The diode used was BY127 (Vrrm: 1250V, If: 1A)

Another modification observed was that a silicon diode (BY127) had been inserted into the Anode circuit of the tester, just after the switch SH1, before the over current relay; thus using half wave rectification for both normal valve testing and rectifier/diode testing. No resistor to ground could be seen, and the circuit can be improved by adding this; otherwise you will not get a correct reading with a high impedance meter when measuring the voltage on the anode or diode connections, owing to the build up of charge, which makes correct measurements impossible; just as my friend Euan MacKenzie found and also tested in his AVO CT160; which he modified in a similar way (a Silicon diode and a 100kΩ resistor were inserted after the Anode selector switch before SH1).

However, in my opinion the most important finding was that the wiring of the components in the calibration resistor path was found to differ substantially from the earlier AVO schematic, which was the only schematic known to exist at the time. In the earlier schematic, the components RV6, R41, D2 and R3 (the 1.22MΩ "calibration resistor") were not drawn correctly either. A modification was assumed by me, since the connection drawn in the schematic diagram would not work; as the voltage from the 66V winding drawn in the schematic was insufficient. This could easily be checked if you calculated the voltages needed for the circuit to work. The schematic showed that the circuit was powered from the 66V winding; calculations showed that it would need power from the 99V winding to work correctly. However the latest CT160A showed a totally different wiring; the wiring was traced by Mr. Yutaka Matsuzaka to check how it all was connected. I could see that

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something was not correct in the photos when I compared them with the schematic drawings, which led me to ask Mr. Yutaka Matsuzaka to check the wiring. In both of the CT160A's the potentiometer RV6 has one side connected to the 82.5V winding and the other side to the 110V winding, and the potentiometer wiper connected to the cathode of D2, the anode of D2 was connected to R3 & R41. The other side of R41 was connected to ground and the other side of R3 was connected to switch SG5 pin 1-6; which is used for the calibration voltage and leakage/isolation tests. This is a smart design change as it will make it possible to calibrate the tester over a wider voltage span than with the calibration circuit just connected to one voltage tap. This method of connecting RV6 was made in the original factory wiring; and was not something that had been changed later; this could be seen from the way the wires had been soldered, they had not been resoldered or altered in any way. The voltage levels used in the above description are RMS voltages; this means that the 66V winding corresponds to 60V Mean DC, the 82.5V corresponds to 75V Mean DC, the 99V corresponds to 90V Mean DC and the 110V corresponds to 100V Mean DC, where the Mean DC voltage is the voltage that is printed on the front of the tester, and also on the labels on the transformer.

This change of connection for the calibration resistor in the CT160A is necessary, since the voltage level, where the calibration voltage is tapped in an AVO CT160, had to be changed in the CT160A; owing to the introduction of the X1/X2 switch for the grid voltage. It is therefore no longer possible to use the grid voltage control in combination with another winding to obtain the calibration voltage needed. So AVO had to change the calibration voltage circuit.

In my opinion, the combined circuit used in the earlier AVO Valve Characteristic Meters (VCMs) was a better design, as it lets you know that both the grid voltage and the calibration voltage are correct; as the needle will not reach the SET ~ mark otherwise. The current necessary for the needle to reach the SET ~ mark is obtained by the addition of two half wave rectified voltages:- one half wave from the grid voltage winding (a separate transformer in the AVO Mk IV) and one half wave from the calibration voltage, which is taken from the Anode/Screen transformer. In the AVO Mk IV you will also get a check that the phase of the voltage from the separate transformer, for the grid voltage is out of phase with the Anode/Screen volts transformer! This information will also be present in the other AVO VCMs, but for the AVO Mk IV it shows that both the primary and the secondary windings have the correct phase relationship on the grid volts transformer compared to the Anode/Screen volts transformer; in the other AVO VCMs it shows that the secondary winding has the correct phase relationship! Now with the CT160A you will only know that the calibration voltage is correct and know nothing about the grid voltage. This should not be a problem, provided that the calibration is correct for the grid volts control, but you have no simple means of knowing if it is, as you have in the other models. In the CT160A you will have to measure the grid voltage separately if you want to check it, but this is also made simpler now since it only contains the grid voltage and not the calibration voltage, so there is a small advantage there.

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Unfortunately you can’t modify your CT160 to make it completely identical to the CT160A, because the additional switch wafer, for the modification to the120mA and 180mA ranges, is absent. However you can easily make two of the modifications:-

1. To the relay coil in the AC mains circuit and

2. Inserting a silicon diode, and associated 100kΩ resistor, in either only the Anode circuit, or in both the Anode and D/R circuits.

In my opinion there is not much to gain in making the modification of the calibration/leakage circuit, as you will then lose the dual check of both the grid voltage and the calibration voltage, that the original circuit makes possible; however it is possible to make this modification, if you wish to. Alternatively, if you would like to extend the range of the grid volts control to minus 80V, you will have to install an additional grid volts transformer, which has a 120V secondary.

You can see these corrections in the schematic, now that it has been corrected by comparisons with two actual CT160A Valve Testers. You can also see the modifications made to the relay circuit, the two extra resistors used to decrease the relay sensitivity, and the extra diode in the Anode circuit, in the photos provided.

I would like to thank my friend Mr. Yutaka Matsuzaka for taking all of the photographs, close to 250, and for all help and encouragement from my friend Euan MacKenzie. I would also like to thank Mr. Ippei Soma for letting us borrow his AVO CT160A for photographing while it was being checked for calibration and also thank the unknown contributor who offered to sell his AVO CT160A to Mr. Yutaka Matsuzaka, this meant that we were able to find out even more details about these instruments, as we were now able to compare two different specimens.

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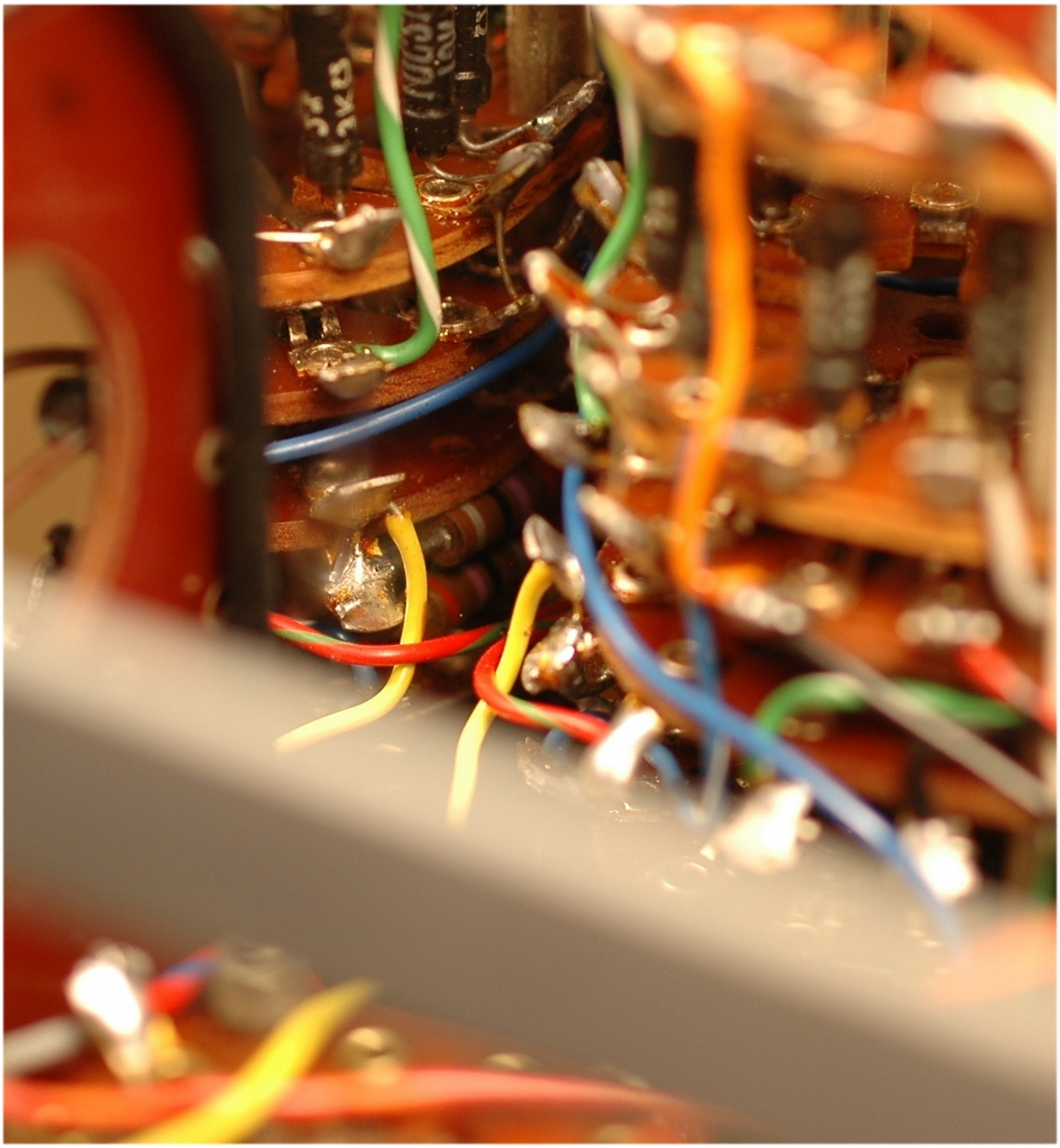

Photo 1: R37 (R37A & R37B) can be seen in the centre of the picture as two 27Ω resistors in parallel, close to the two yellow wires

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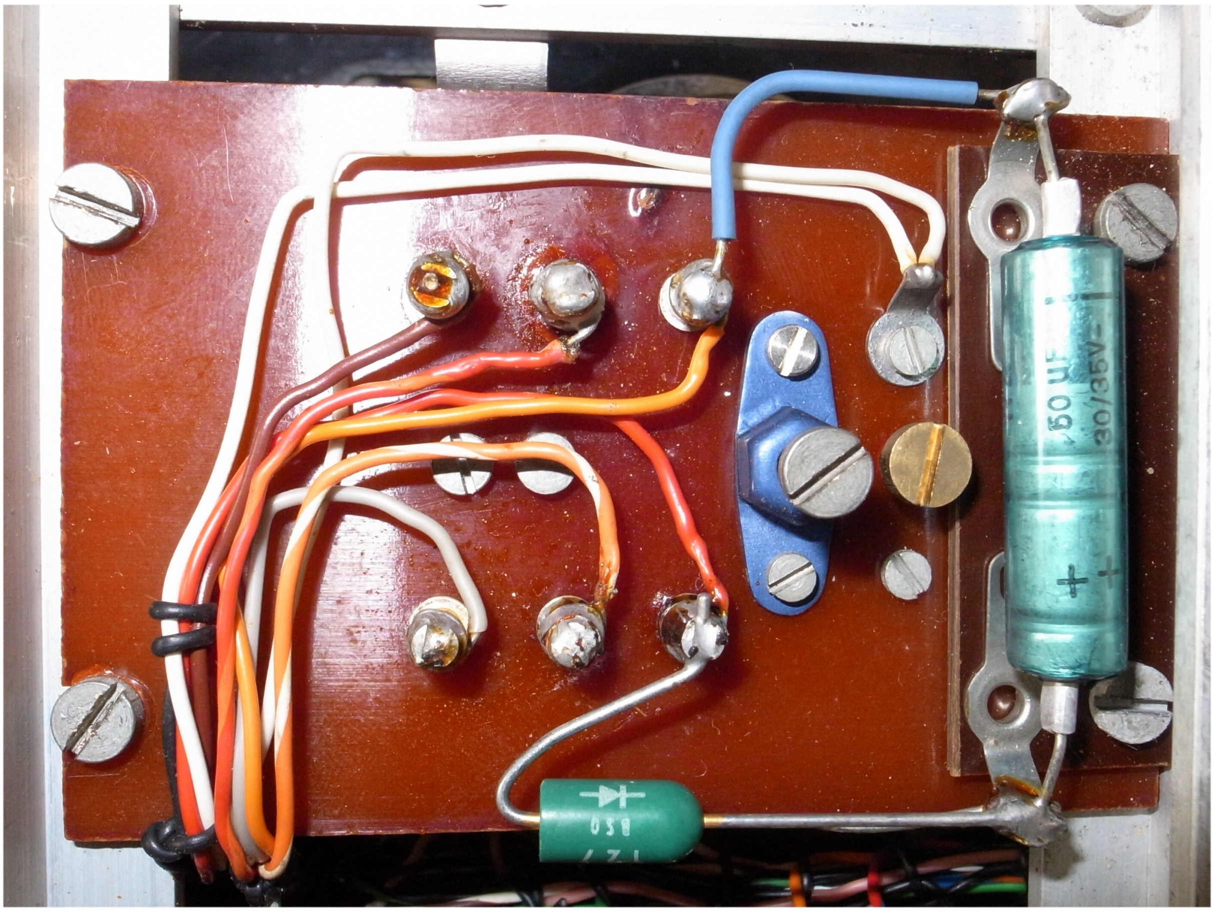

Photo 2: Diode D5, BY127, and capacitor C4, 50µF 30/35V, across relay coil in the AC mains circuit

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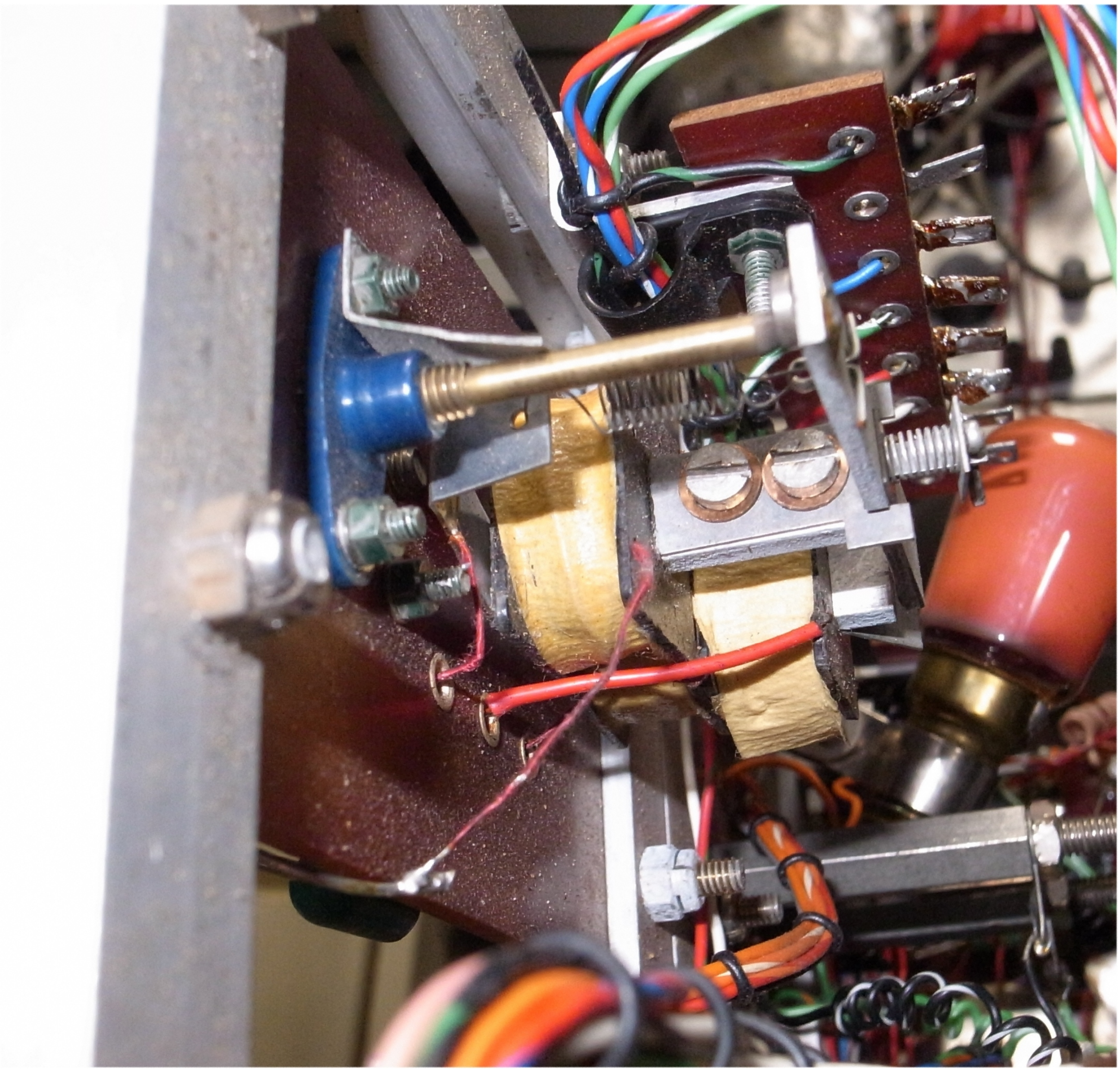

Photo 3: Modification to the relay coil in the AC mains circuit from behind, winding going to the point between diode and capacitor, to the cathode side of the diode D5

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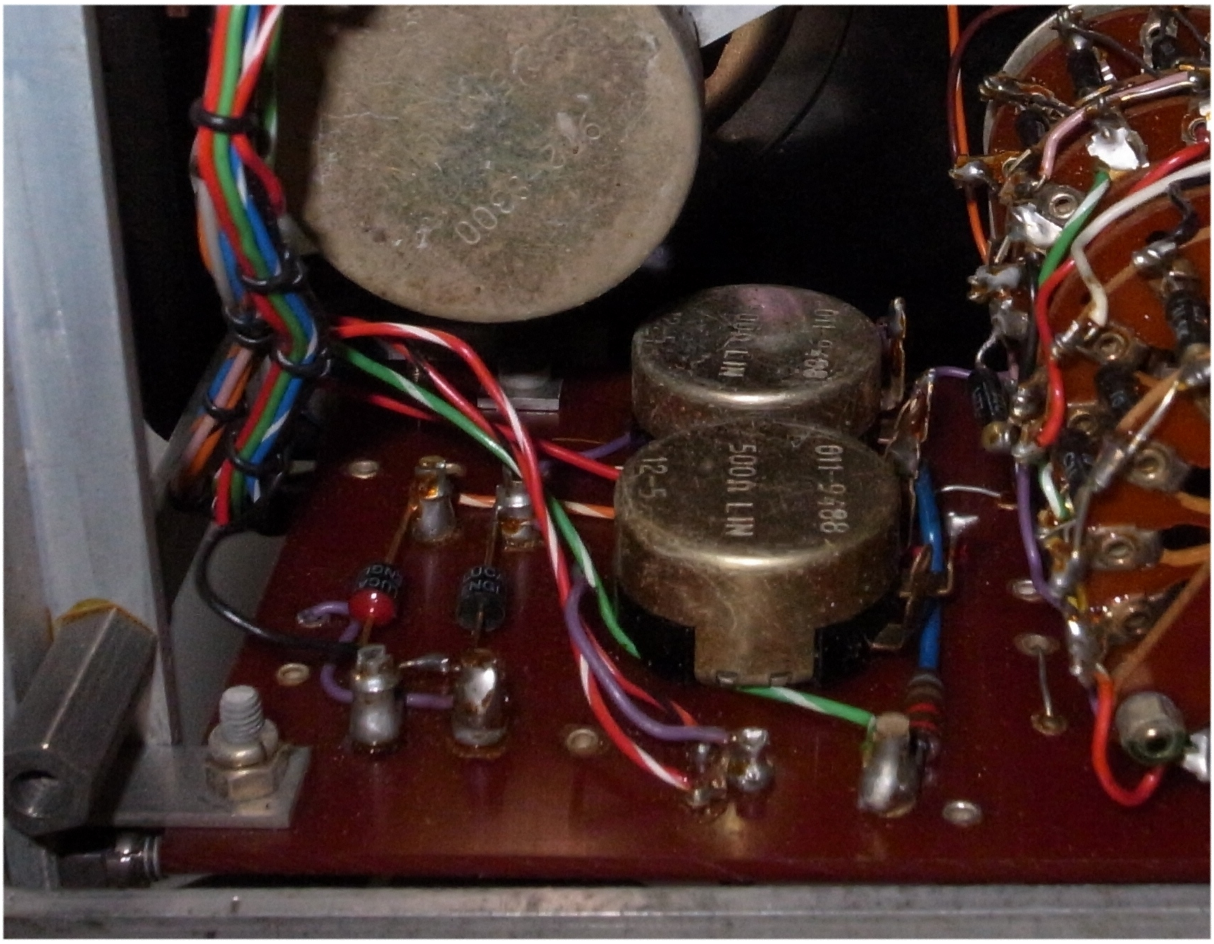

Photo 4: Diodes D2 & D3 (Lucas DD0058 was found in one CT160A, shown above and BY127 was found in the other CT160A) at the back of the PCB with Vg x 1 & Vg x 2 (RV3 & RV5) potentiometers and R4

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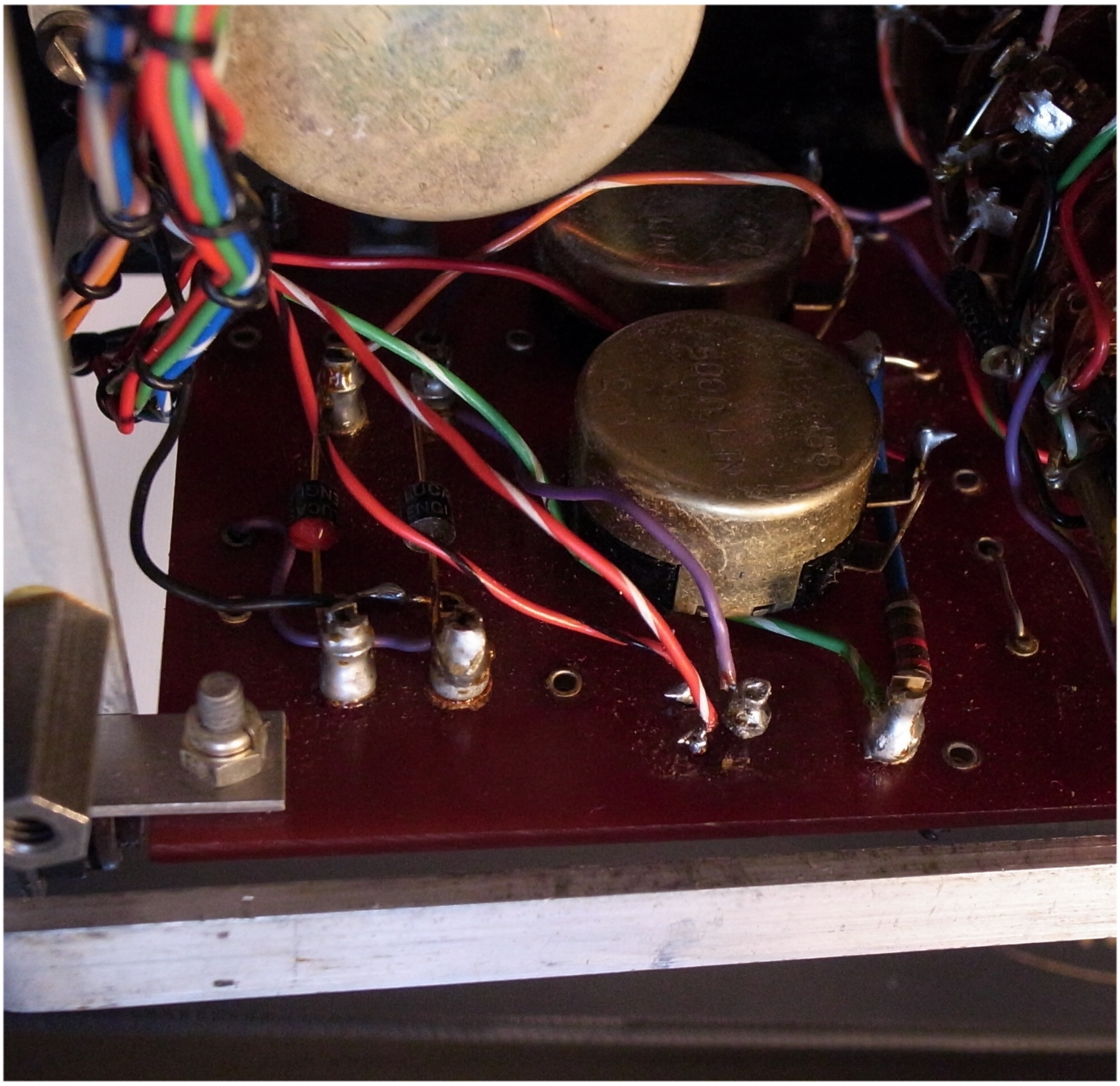

Photo 5: Different angle of components at the back of the PCB

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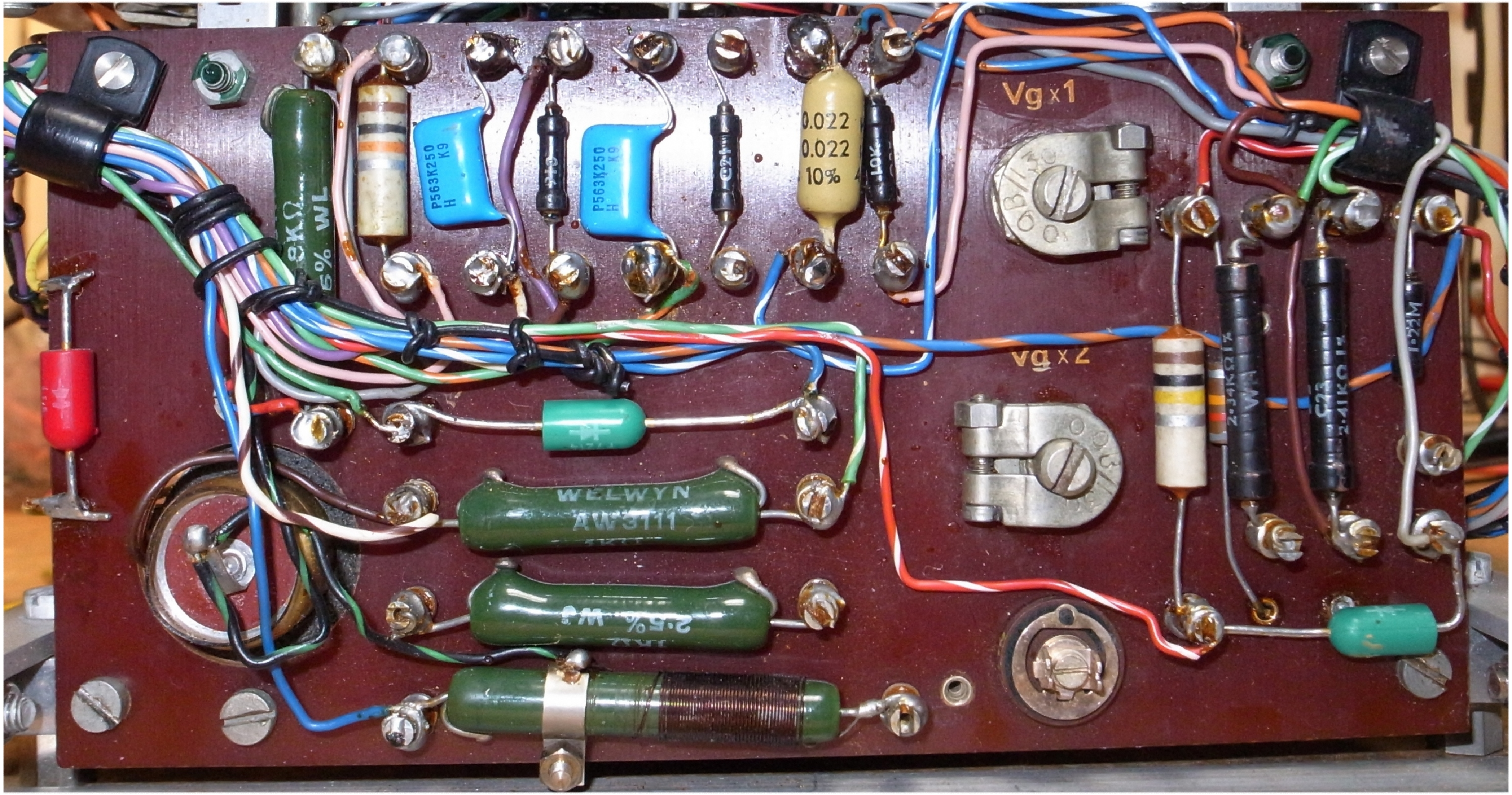

Photo 6: Front of PCB with components found in CT160A, to the far left RED diode D6 in Anode & D/R circuit, to the far right GREEN diode D1 in screen circuit, in the center GREEN diode D4 in “backing-off” Anode Current circuit. Resistor R41 at 82kΩ can be seen close to R38 at 100kΩ near the Vg x 2 potentiometer. RV6 is right below the Vg x 2 potentiometer.

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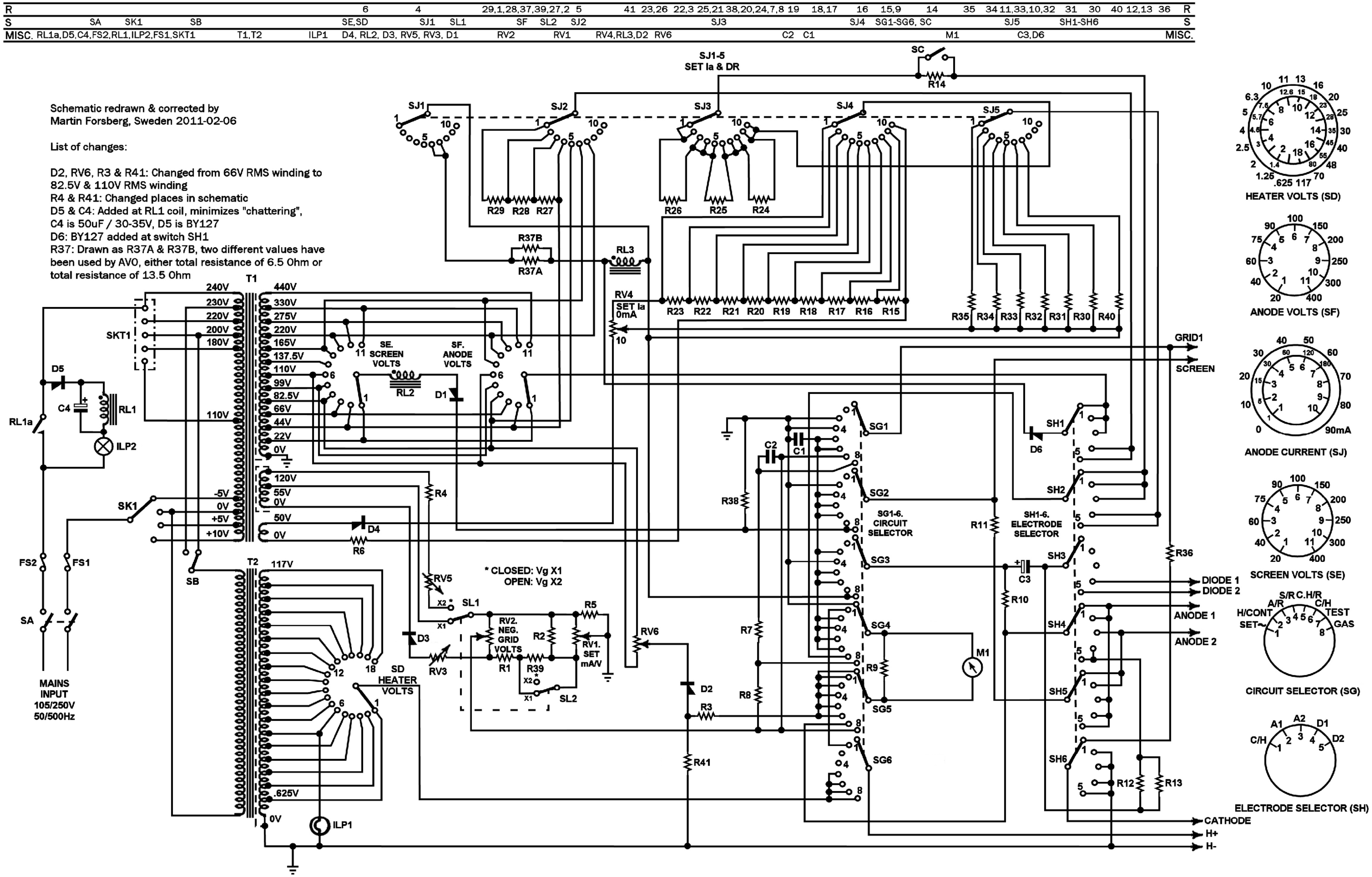

Valve Tester type 160A - Circuit Diagram ** Redrawn & Corrected!

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