WIRING OF A GUITAR INSPIRED ON JERRY GARCÍA'S TIGER
Plus some notes on humbucking designs

I'll describe the wiring of my "Alma" guitar, based on Jerry's *Tiger*. It is an interesting subject by its own, because the wiring of his guitars was very clever. However, I know that humbucking circuits can be confusing beyond the most common notions, so I tried to complement this description with some notes on this. If you have comments, please send them to jaen@guitarrasjaen.com

Introduction

This is my first neckthrough model ("Alma"):

Figure 1.- Alma guitar

It was going to be inspired on Jerry García's Tiger. My client made me aware of it, and he also sent me some links to pages where the electronic circuits were described. This was my main reference:

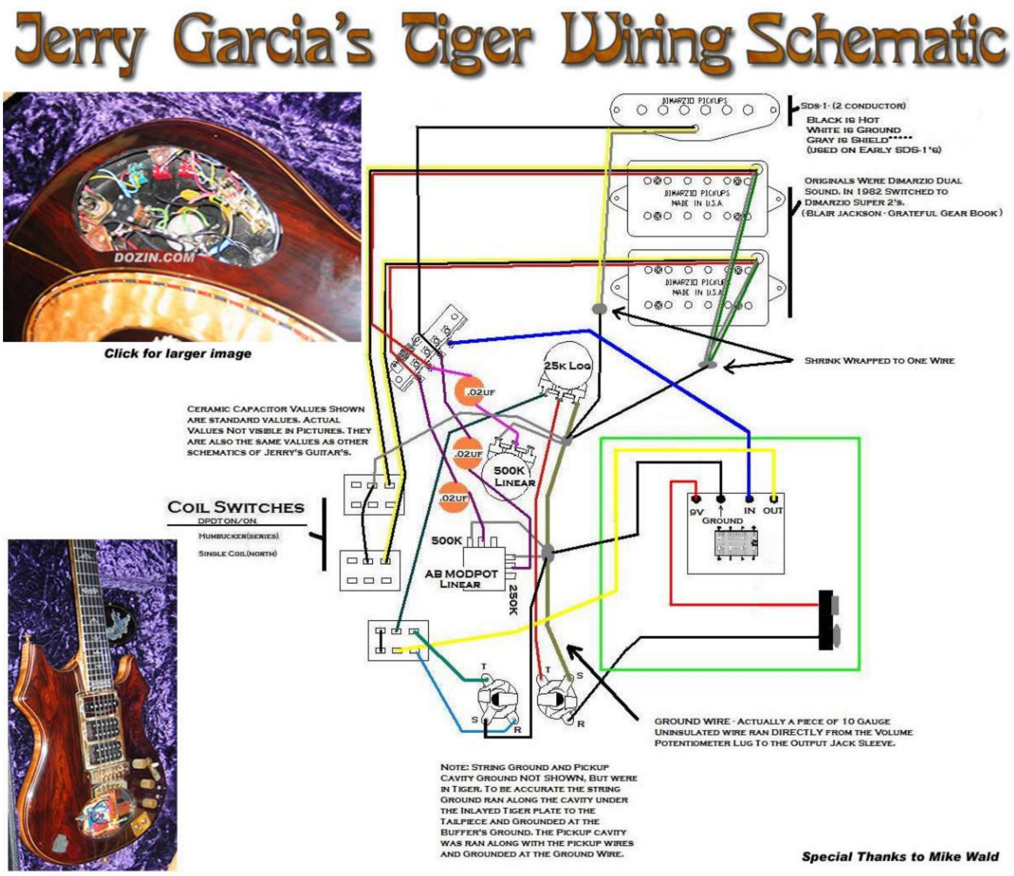


Figure 2.- The Tiger guitar circuit. Taken from http://dozin.com/jers/jers/guitars/tiger/info.html

Basically, that guitar had three pickups, two of them humbuckers and one single coil at the neck position. The middle humbucker had a tone control of its own, while the other two shared a dual-gang potentiometer, so they had separate tone pots with a single control knob. This appears in the schematics above as "AB MODPOT". The two humbuckers had coil tap switches (middle left) so that they could be used as single coil pickups. After these controls, the three pickups were routed to a Fender-style 5-way switch. Its output was then sent to a unity-gain buffer (enclosed in green line), which doesn't boost the level of the signal, but lowers its impedance so that longer cables can be used without the usual problems with the capacitance and noise. The output from the buffer is sent to a switch, below left, that routes it either to the volume control directly or through an effects loop. Thus, the guitar uses two jacks: one for the effects loop (SEND on the ring, RETURN on the tip) and the other for the output.

The most obvious advantage of this circuit is that the player can control the volume of the guitar without modifying the maximum level at the loop SEND terminal. This is great when you have effects that depend on their input level, overdrives for example.

My client wanted this, but he also mentioned that he would like to have a piezo bridge, in principle separated from all the other circuits. My first thought when he mentioned the piezo was that he could integrate it with the other pickups using a blending circuit that could also work as a buffer by simply adjusting its output level. I found a simple commercial circuit for this, the Noll Mixpot (http://noll-electronic.de/guitar-electronics/mixpot/):

Figure 3.- The Noll MixPot circuit

And, just because he liked the tone of the middle pickup in the Stratocaster, he preferred a single coil between two humbuckers, in a configuration that some would call “HSH” these days. All the tone potentiometers were to be linear.

With all this in mind, this was the arrangement of the controls on the guitar:

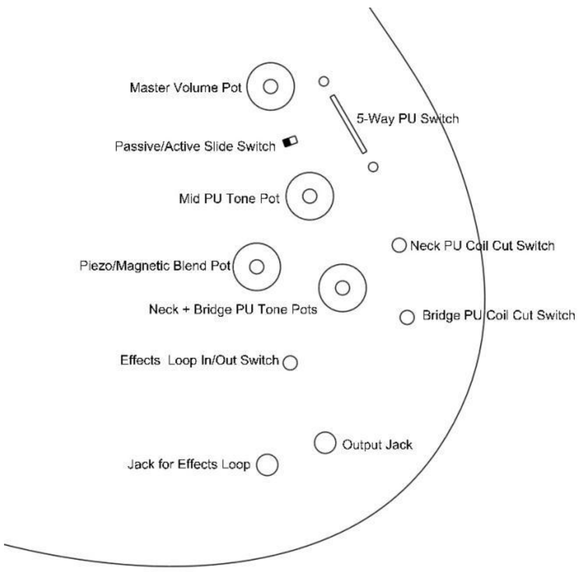


Figure 4.- The controls of the *Alma* Guitar

In this diagram you’ll see a feature that I haven’t mentioned yet, the Passive/Active Slide Switch. I’ll go back to this later; now it is time to speak about the pickups and their controls.

Connecting the Pickups

The pickups in this guitar are made by DiMarzio. The humbuckers are the DP100BK (neck) and the DP100FBK (bridge). The difference between them is simply the polepiece spacing, which is a little wider for the latter. The middle pickup is the single coil DP111BK.

As mentioned, this guitar has coil cut switches, which transform the humbuckers to single coils simply by grounding one of the coils. I didn't want to do this carelessly; instead, I wanted two things:

1.- The coils that are to be canceled with the coil cut switches should be the ones closer to the middle pickup. This way the remaining coils are far from each other, increasing the tone separation.

2.- In positions 2 and 4 of the 5-way switch, the middle pickup must form a humbucker with the remaining coil (after coil cutting) of the other two pickups.

I checked the Internet for this, but I couldn't find the answer, so I decided to find it by myself.

The notes by DiMarzio include some information for the humbuckers:

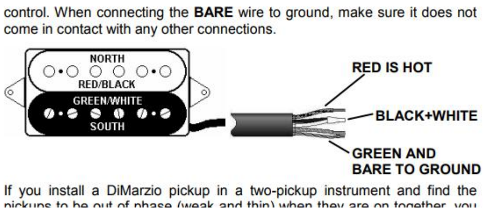


Figure 5.- Taken from "DiMarzio 4-Conductor Pickup Instructions"

I checked with a compass that this drawing was correct: the wires exit as shown, at the right of the South coil. I also found that the Red and Black terminals belonged to the North coil and the Green and White terminals belonged to the South coil.

Some sources mention that the North start is Red, the South Start is Green and the Black and White are their respective ends. This is a practical way to describe things (and I'll use it here in a moment), but it may lead to errors! The s*tart* of a coil must be the terminal deep behind all the turns of copper, and the *end* is the one at the surface. But this is confusing; look at these two coils from *above*:

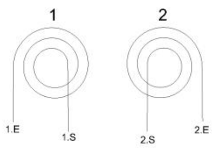


Figure 6.- Two coils

Coil #1 starts at terminal 1.S, while coil #2 starts at 2.S. If you follow the wires from S to E, you'll notice that you go anticlockwise for #1 and clockwise for #2. Consequently, these are opposed coils. You can still use them to make a humbucker with the orientation shown, but then you'll have to connect a Start to an End to get a correct humbucker, instead of the usual rule (End to End or Start to Start). The two coils in DiMarzio humbuckers are wound the same way, but you see that it is not safe to use the Start/End information alone without knowing more details of the manufacturing process.

The schematic representation of the two DiMarzio humbuckers, as seen from above, is:

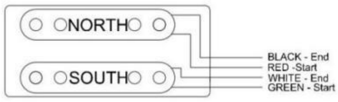


Figure 6.- DiMarzio 4-Conductor Pickup

The single coil pickup doesn't include any schematics in its documentation, but I examined it and found that it was NORTH from above. The terminal colors, black and white, suggested that the black was ground, but I couldn't say much more. Here is the diagram for this pickup:

Figure 7.- Dimarzio Single-Coil Pickup

Taking into account all this plus my two requirements, I built this circuit to find the correct polarity for the single coil pickup:

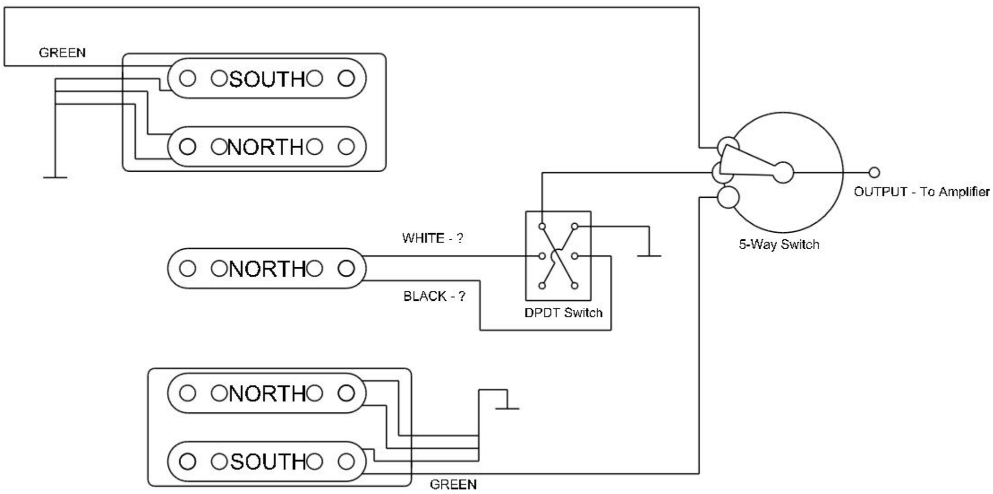


Figure 8.- Deciding how to connect the Single Coil pickup, i.e., finding the position of the DPDT switch for which the positions 2 and 4 of the 5-way switch will be humbucking

The drawings and instructions by DiMarzio (see Figure 5) work on the assumption that the North coil will be active, so the South coil will be the one to ground for making a coil cut. This is just one of four equivalent possibilities, but it is one that doesn't fit our purposes. The reason why it is not valid is that our middle pickup is North above. ***Conventional humbuckers need two coils of opposed magnetic polarities, and this is a rule that cannot be eluded***. So we'll use the Green wires from the two humbuckers as the live terminals; the others will all be grounded, emulating single coils. We could have used the White wires equally, but always the same color for both pickups.

With the DPDT switch we can change the electric polarity of the middle pickup. The 5-way switch will let us connect the pickups as they will be in the guitar. We are interested in positions 2 and 4 of this switch, which combine the middle pickup plus each one of the other two. As represented in Figure 9, it is in one of these intermediate positions.

This is the arrangement for the real experiment:

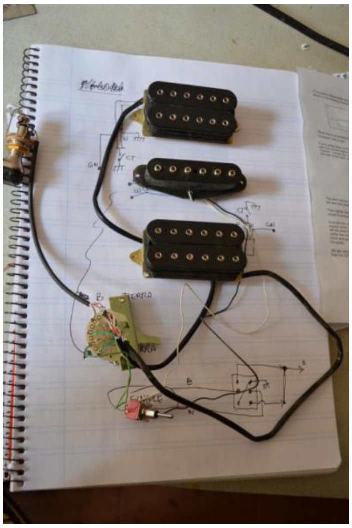
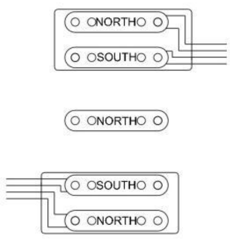


Figure 9.- The experiment

The result was clear: **The configuration shown will be humbucking when the Ground terminal in the middle pickup is BLACK.**

If you look at the photo above, you'll see that I tried to keep the pickups parallel, and there is a technical reason for it. Humbuckers need coils of opposed magnetic polarities and the correct connections between them, as mentioned above, but there are rules about their geometry also! Once you have a humbucking arrangement, you can rotate the coils (*vertical* axis) and not lose the humbucking effect, but the rotation must be in multiples of 180º (if the coils were circular, this limitation wouldn't exist). Rotation in other planes will also destroy the humbucking effect. You may also displace the coils freely as long as they are kept parallel. However, notice that all this assumes that the sources of noise are very far away. Unluckily for us, most noise comes from nearby sources. Humbuckers can only mitigate the effects of these nearby fields, they won't cancel them.

As a consequence of all this, if you don't like the excessive separation of the coils in the arrangement explained, you can rotate the pickups as long as you don't change any electrical connections. So, for example, if we rotate the two humbuckers, this is still humbucking in positions 2 and 4:



The circuit can be designed now but, due to the complication, we'll divide it in two parts.

Combining the pickups and their tone circuits into a single *magnetic* signal

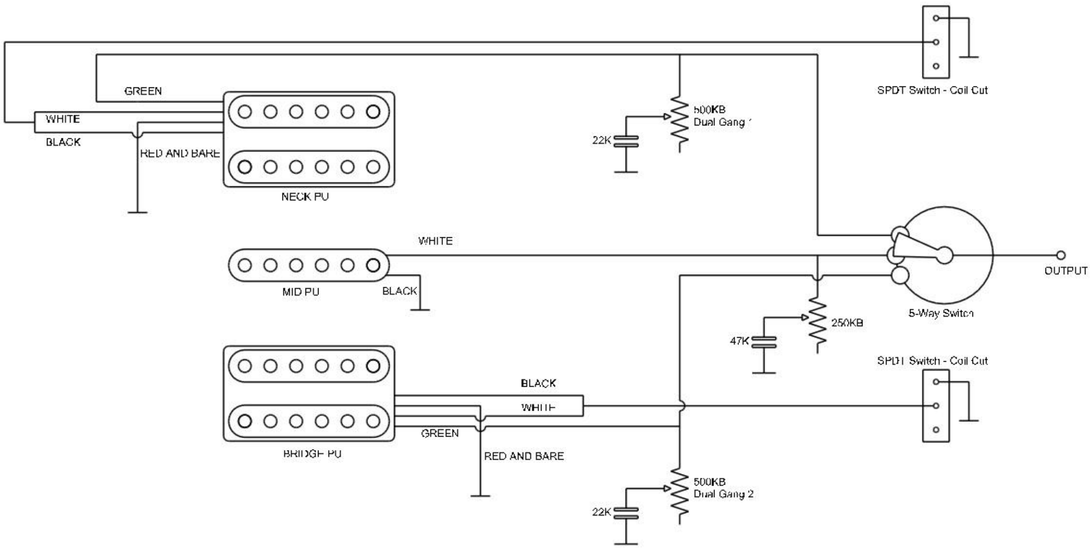


Figure 10.- Getting a single output signal from three pickups, after the tone shaping caused by tone pots, coil cuts and pickup switching

Figure 10 represents the first part of the circuit, where a single output is generated from the magnetic pickups. It is easy to follow, but I should mention a few things. As explained above, the pickups must be placed as shown, with their cables going out as in the drawing. The two 500K pots are on the same physical unit ("Dual Gang"). All the tone pots are linear, as were Jerry's. This is not a good choice in my opinion (they almost work as switches), but some players like that behaviour. The capacitors are 22K for the humbuckers and 47K for the single coil. Jerry's guitar used the same value for all three capacitors, but I decided on this larger value for the middle pickup after my client mentioned that it was there to emulate the Stratocaster middle pickup. Notice also that we use just one of the two rows of contacts available on the 5-way switch. Stratocasters use both in order to make independent tone controls for their pickups; this could be considered as a possible modification to this circuit, but I'll leave it as it was in the Tiger guitar.

Dealing with the single *magnetic* signal

Since the beginning, I didn't like the fact that the guitar was active all the time. If the battery was flat, the guitar was dead, but there was no reason why it had to work like that all the time. Since the times of Jerry García, guitarists are more conscious of what they lose when they go active (and what they win, also!), so I decided to modify the circuit in order to have the two possibilities. My idea was to still use the effects loop passively if it was desired, but this soon complicated the circuit as you'll see in a moment. The following diagram represents what's beyond the 5-way switch, once we have a single output for the pickups, their tone circuits and coil cuts:

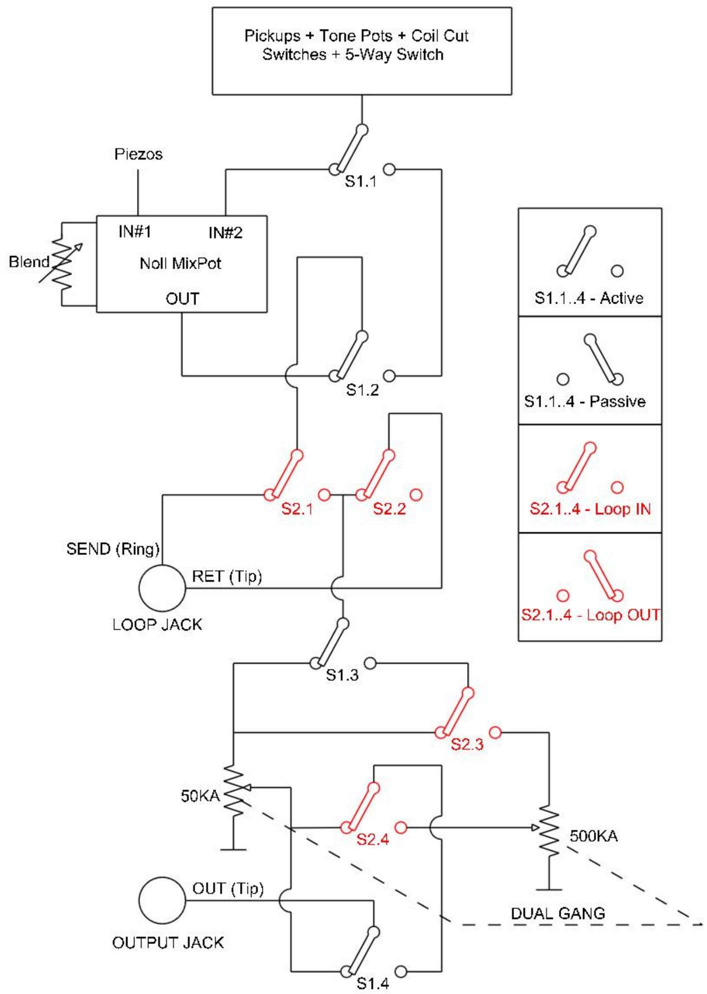


Figure 11.- The circuit beyond the output of the 5-way switch

You can see that there are eight individual switches from two 4PDT switch blocks. The one represented in black, S1, is the Active/Passive Slide Switch; the one in red, S2, is the Effects Loop IN/OUT switch. All the four sections of each 4PDT are used.

With the switches as represented, the guitar will be *Active* and the loop will be *IN*. Now, if you change S1 to *Passive*, that will take the Noll MixPot out of the circuit. However, the volume pot will still be the 50K to the left. A 500K could be used but, given the low output impedance of the standard guitar effects, a lower value is a better choice (see next paragraph). If we now move S2 to *Loop OUT* then the loop will effectively be left apart, but the working pot now will be the one to the right, with all its 500K. If we finally change S1 back to *Active*, the loop will be left out and the working potentiometer will be again the one to the left, 50K, which is fine for the low-impedance output of the Noll MixPot circuit.

From the above discussion you'll see that the volume pot has been specified as a dual-gang unit *with two different values,* 50KA and 500KA. This is not an off-the-shelf component, but it can be left as 500KA + 500KA. There will be some small side-effects that will affect the active signal at low volume, mainly increased noise and cable capacitance effects (the same problems that guitarists try to fix by going active) *[Notice that if you go this way you can also modify the lower part of the circuit in Figure 11 to use a single 500KA pot instead of a dual-gang]* However, you can make yourself a dual-gang potentiometer with two different values from two adequate dual-gang pots from Bourns or Alpha, as explained here: https://youtu.be/tHsaVkVa75k It is not difficult at all.

When the buffer is left out of the circuit, the piezos won't work, but that's something to expect from a passive guitar.

The Active/Passive switch is a **ALPS SSSU041700.** For the Loop IN/OUT you can use a 4PDT ON/ON lever switch, for example the **NKK M2042SS4W03**. I could have used the same component for both, but Jerry's Tiger guitar had a lever switch for the Loop IN/OUT function, and I wanted to keep that while also making the Active/Passive switch quite different.

For the Active/Passive switch, I made a small printed circuit board that makes it easier to deal with the many contacts in it, very close together. It also makes the connection between the terminals to the right (see figure 5) of S1.1 and S1.2.

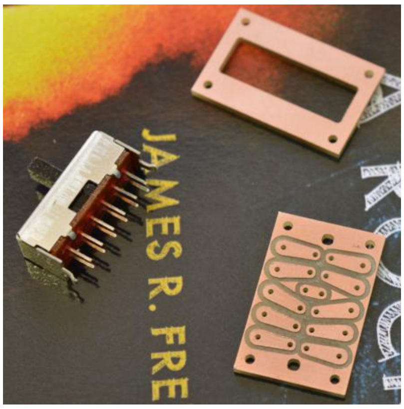


Figure 12.- The Active/Passive switch with accessories

There is a second board (above) that is epoxied inside the control cavity:

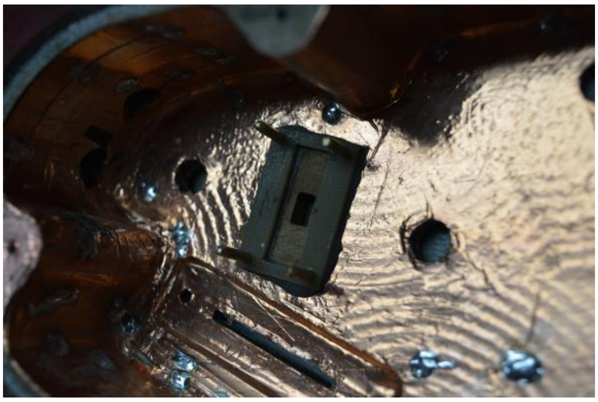


Figure 7.- The chassis for the Active/Passive switch

Both boards are joined together using four wires, visible in Figure 7. With this design, replacing the switch will be reasonably easy.

The following diagram translates the switches in Figure 5 into the real components:

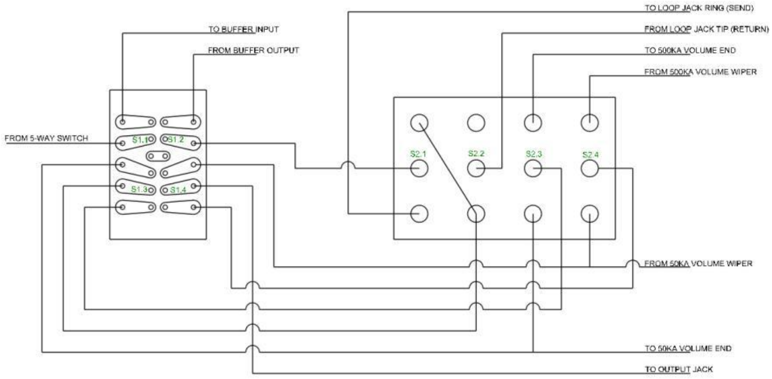
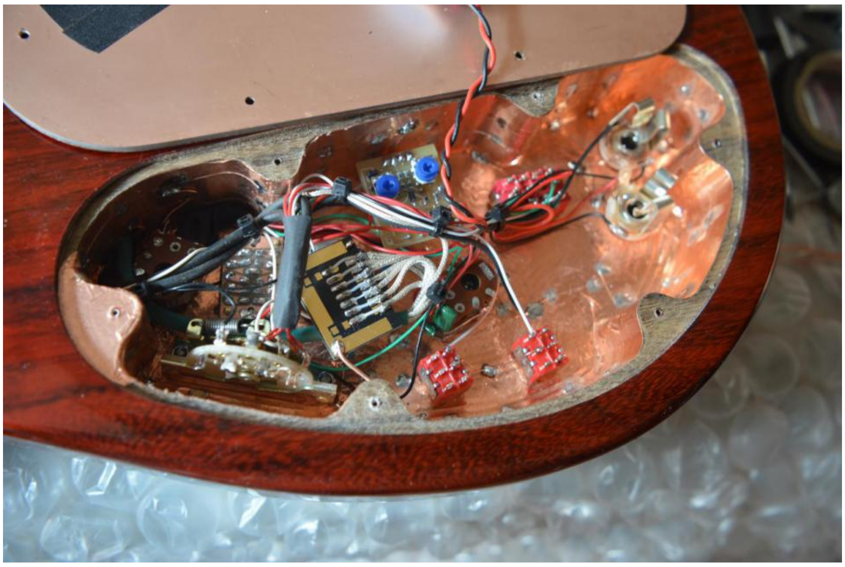


Figure 7.- The switches in Figure 5 with real components

And this is the way the control cavity looks in the end:



The Noll MixPot buffer + piezo/magnetic blender is at the center above; the blue trimming pots permit to modify the gain for each channel. Getting the desirable *unity gain* is straightforward, as we can change easily from active to passive and compare the output level at both settings. Below that board, a little to the left, is the summing board for the bridge piezo saddles. The tone control for the mid pickup is hidden below it. The Loop IN/OUT switch is located between the Noll board and the jacks. On the left there is the passive/active board, the double gang 50KA+500KA volume control and the Fender-style pickup switch. The two additional switches are for the coil cut of the humbuckers. They are ON/ON DPDT, but they could have been ON/ON SPDT equally (for example, **TE A101SYCQ04**).

All the cavity is shielded with copper foil. The cover is a laminate of wood and a fiberglass printed circuit board, so that it looks beautiful from the outside, it is extremely strong and it even has a copper surface to complete the shielding. The battery clip is here: