GUITAR ELECTRONICS
UNDERSTANDING WIRING

Timothy A. Swike

Please Read This FIRST

Terms of Use

Adjusting, changing, adding, or removing the electronics in any device can be dangerous and can cause injuries. This author assumes no responsibility for personal injury or property damage caused by the use of this guide, or products we sell, whether by accident, negligence, or otherwise. Please note that this book is for educational purposes only. Only qualified personnel should carry out any electrical work. USE AT YOUR OWN RISK.

Please send questions or comments to: indyebooks@aol.com

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WIRING A STRAT

Let's talk about the legendary Stratocaster guitar. Personally, I don't think you can find a better sounding guitar anywhere. The unmistakeable strat sound is more tapered, with less highs and lows than other guitars, and it has more midrange. Much of the strat's popularity comes from it's hollow pickup cavity, and it's neck and middle pickups. It is perfect for playing the blues, jazz, or rock. These guitars are described by many as having a quacky, or even smokey sound. Now let's wire one.

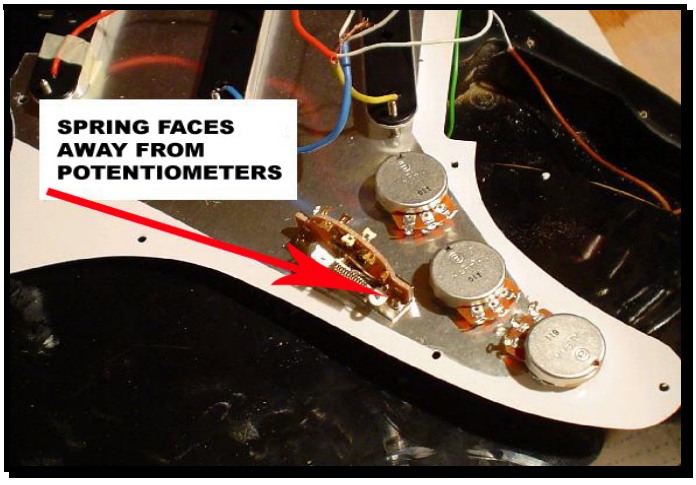
TOOLS FOR THE JOB

First, we need to talk about the tools you will need for changing your electronics.

1 - Output jack
3 - 250K pots
1 - .050µF capacitor
1 - 5-way lever switch
1 - guitar wire 22AWG, white
1 - guitar wire 22AWG, black
1 - 25+ Watt soldering iron
1 - phillips screwdriver
1 - wire cutting and stripping tool
1 - rosin core solder

ASSEMBLING THE PICKGUARD

Install the potentiometers, or pots, and the 5-way switch in the pickguard. When the pickguard is upside down, the spring on the 5-way switch will be facing away from the pickups. Align the two tone pots so that the lugs are facing each other. The volume control will be closest to the pickups.

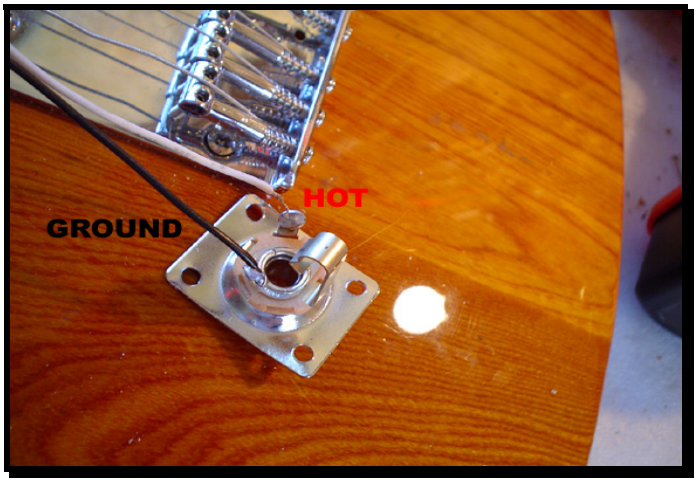


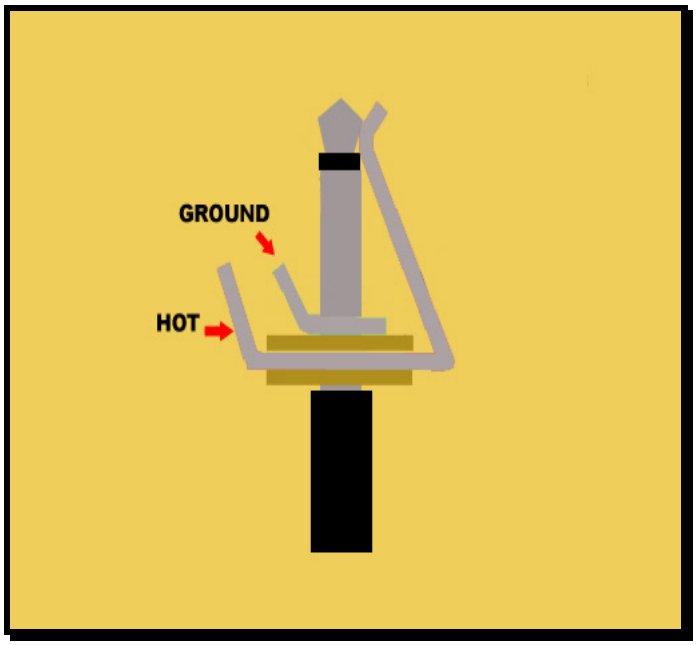
HEATING UP THE SOLDERING IRON

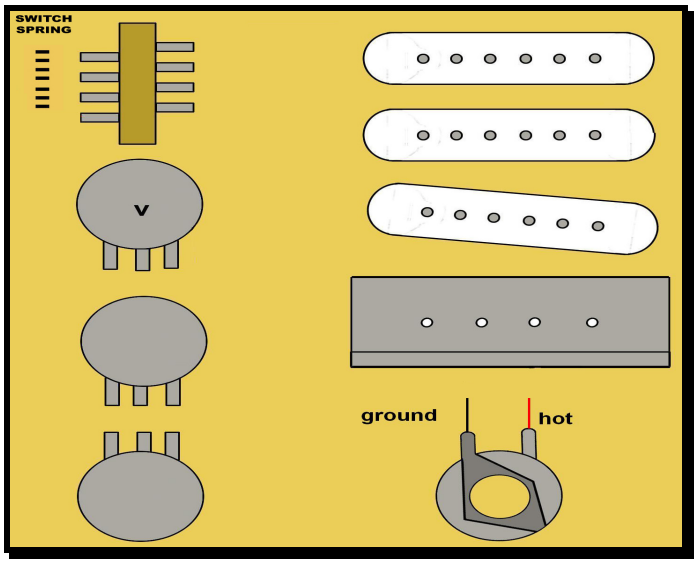
Lets get the soldering iron ready. Plug it in and let it heat up in its holder. Remember, your soldering iron can get up to 700 degrees, or more, so be careful.

SOLDERING THE OUTPUT JACK

Next, we are going to solder the ground wire and hot wire to the output jack. The lug that connects to the prong is the hot connection. Solder the hot and ground wires to the output jack. Then screw the output jack back into the guitar.

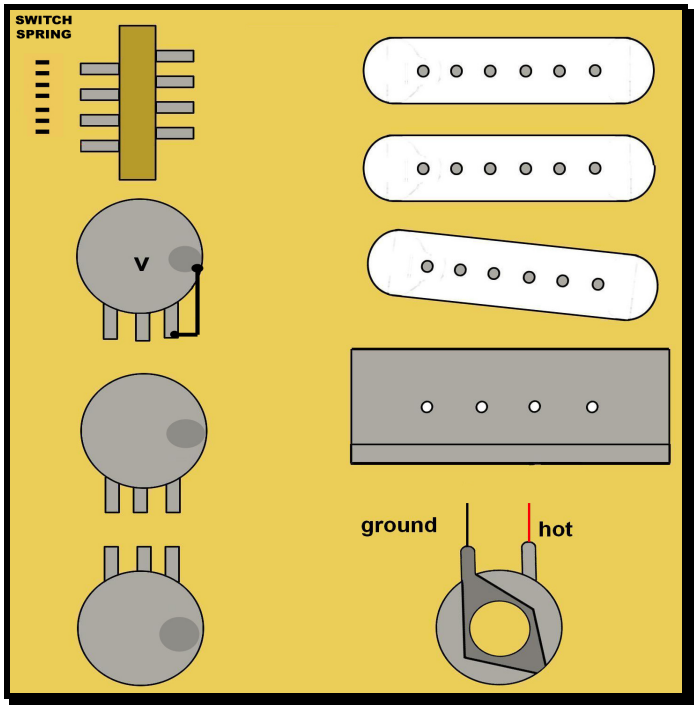






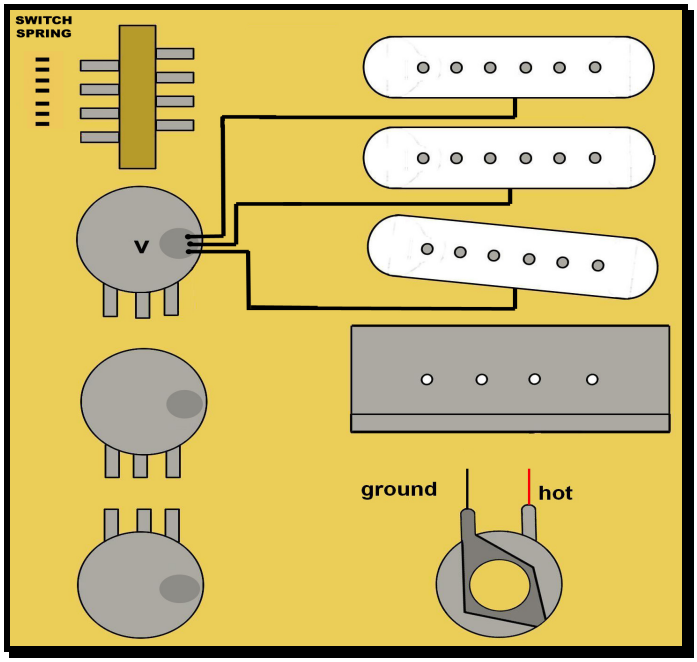
SOLDERING THE POTS

Add solder to the volume pot, and tone pot cases. All of the ground wires will be connected to each other on the pot cases. Now connect the far right volume pot lug to its own case. You can use a wire for this connection, or just bend the lug until it touches the case, and then add solder.



SOLDERING THE PICKUP GROUND WIRES

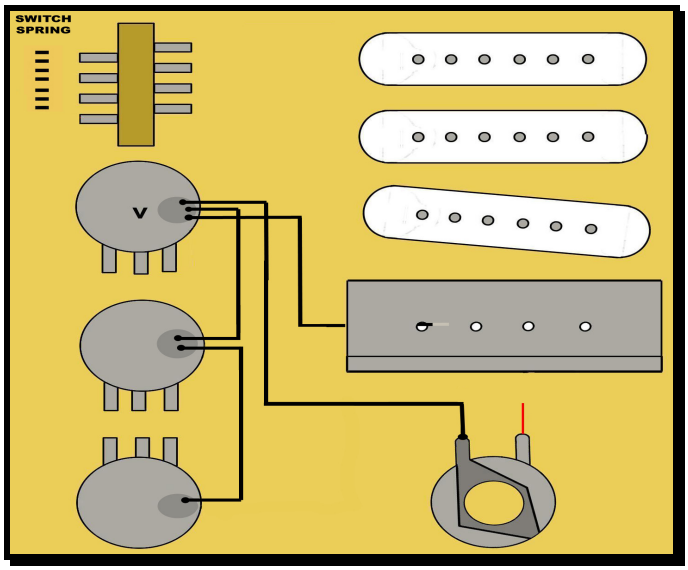
Find the 3 ground wires that come out of the pickups. Normally, they will be black wires, or they will be unshielded. The colored wires are usually the hot wires. Twist the three ground wires together and solder them to the volume pot case.



SOLDERING THE REST OF THE GROUND WIRES

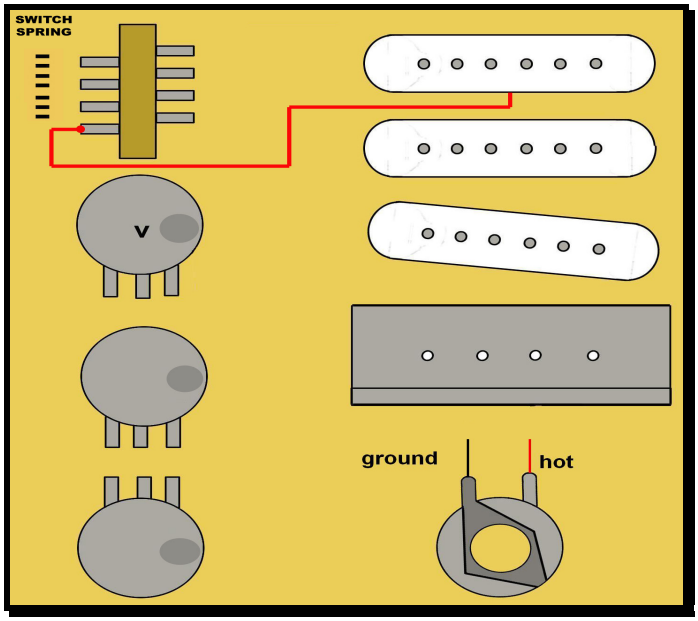
Next, you are going to find the bridge ground wire and solder it to the volume pot. You are also going to solder the output jack wire to the volume pot. After that, you will connect the volume and tone pots with 2 more wires. The bridge ground will probably already be connected to the tremolo claw on the back of the guitar if you have a whammy bar. If it is not connected, you can always attach it to the bridge. All you have to do is send the wire under the bridge, and put it through one of the screw holes on the bridge. Then wrap the wire around one of the screws while it is being tightened down. This will prevent the bridge ground from moving.

Now connect the rest of the ground wires.

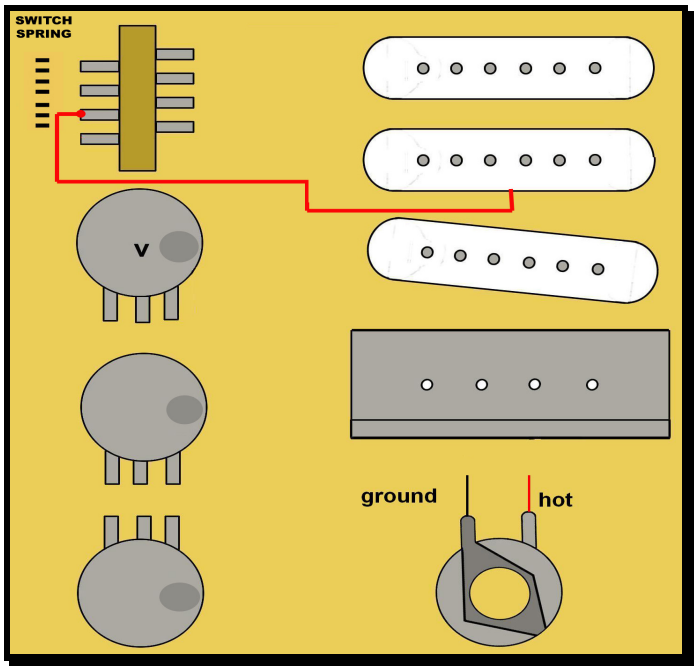


SOLDERING THE PICKUP HOT WIRES

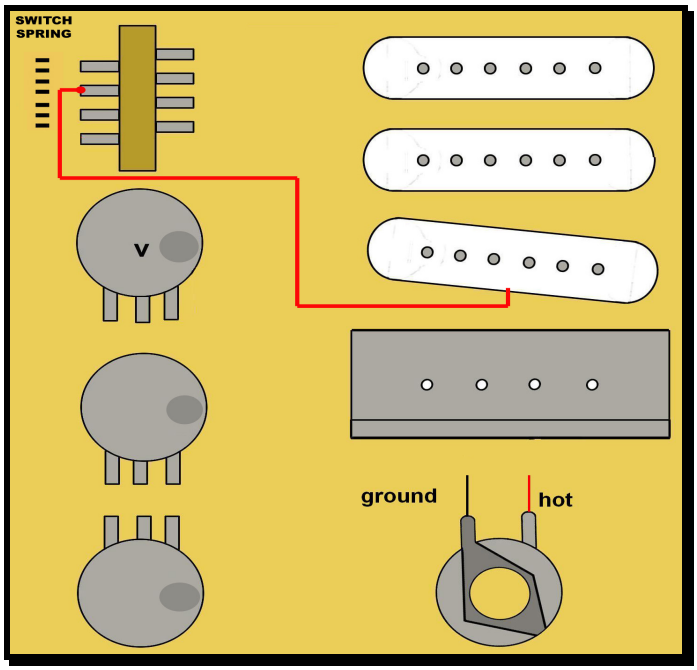
Next, you will solder the hot wires from the pickups to the left side of the 5-way switch. Connect the neck pickup. This diagram is uses a 5-way switch from **stewmac.com**. If you have a Fender or CRL switch, then the sides will be reversed on the 5-way switch. **Check out page 16 for an explanation of the different lever switches.**



Next connect the middle pickup.

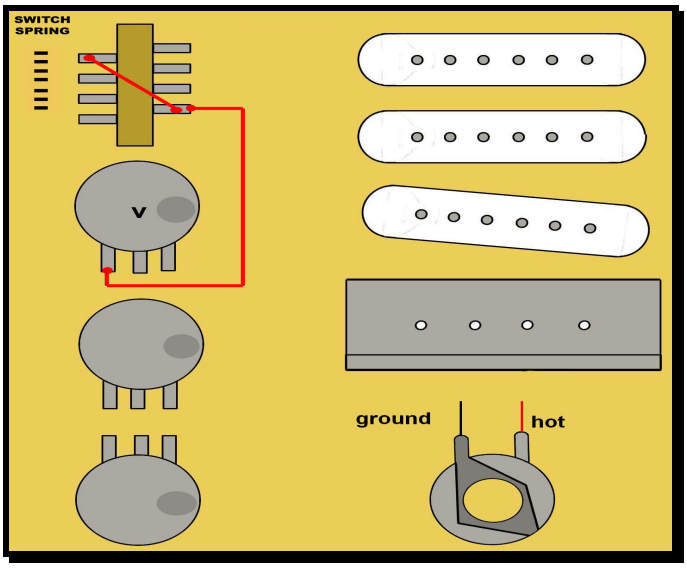


Now do the same to the bridge pickup.



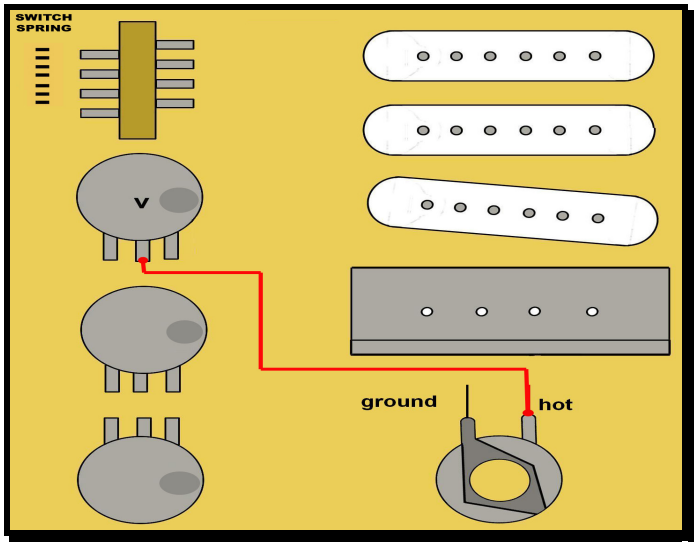
ADDING THE JUMPER

Now connect the top left lug to the bottom right lug on the 5-way switch. Twist another wire to the right lug wire, and solder it to the left volume pot lug. Also connect the left and right sides of the 5-way switch. Then connect them to the volume pot lug.



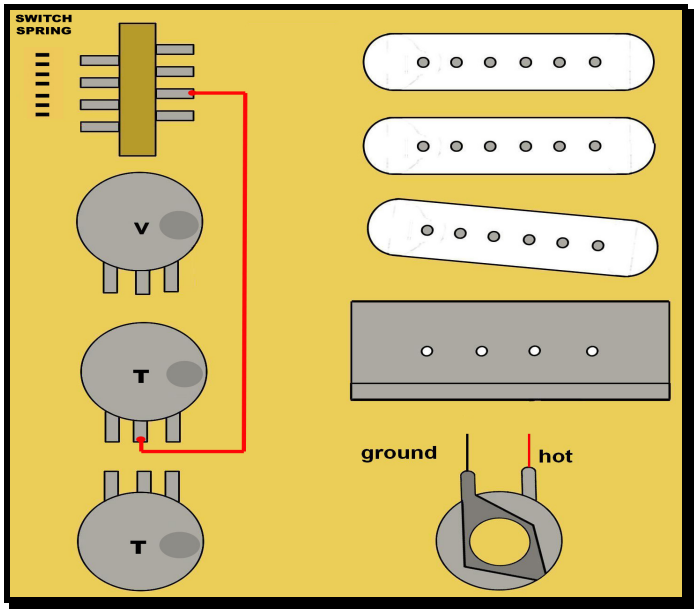
CONNECTING THE VOLUME POT TO THE OUTPUT

Now you can connect the middle volume pot lug to the output jack.

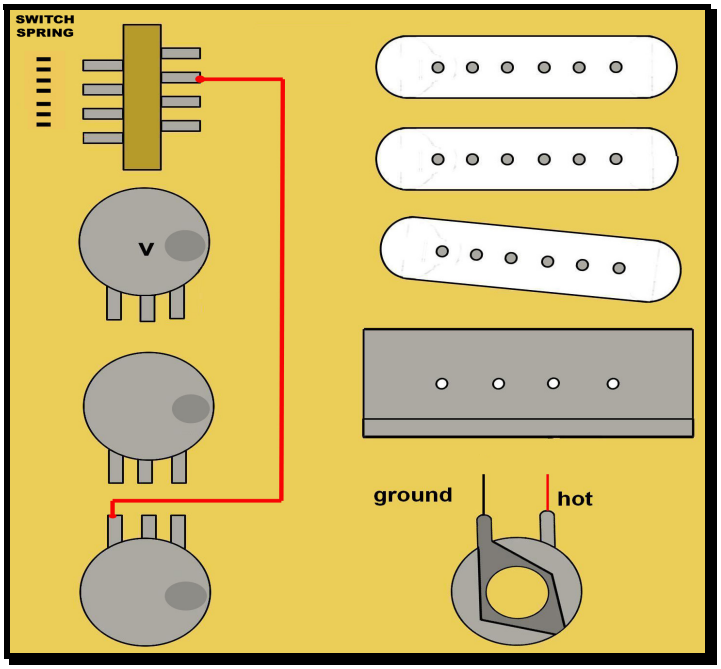


CONNECTING THE 5-WAY SWITCH TO THE TONE POTS

The next step involves soldering the lever switch to the middle tone pot lug.

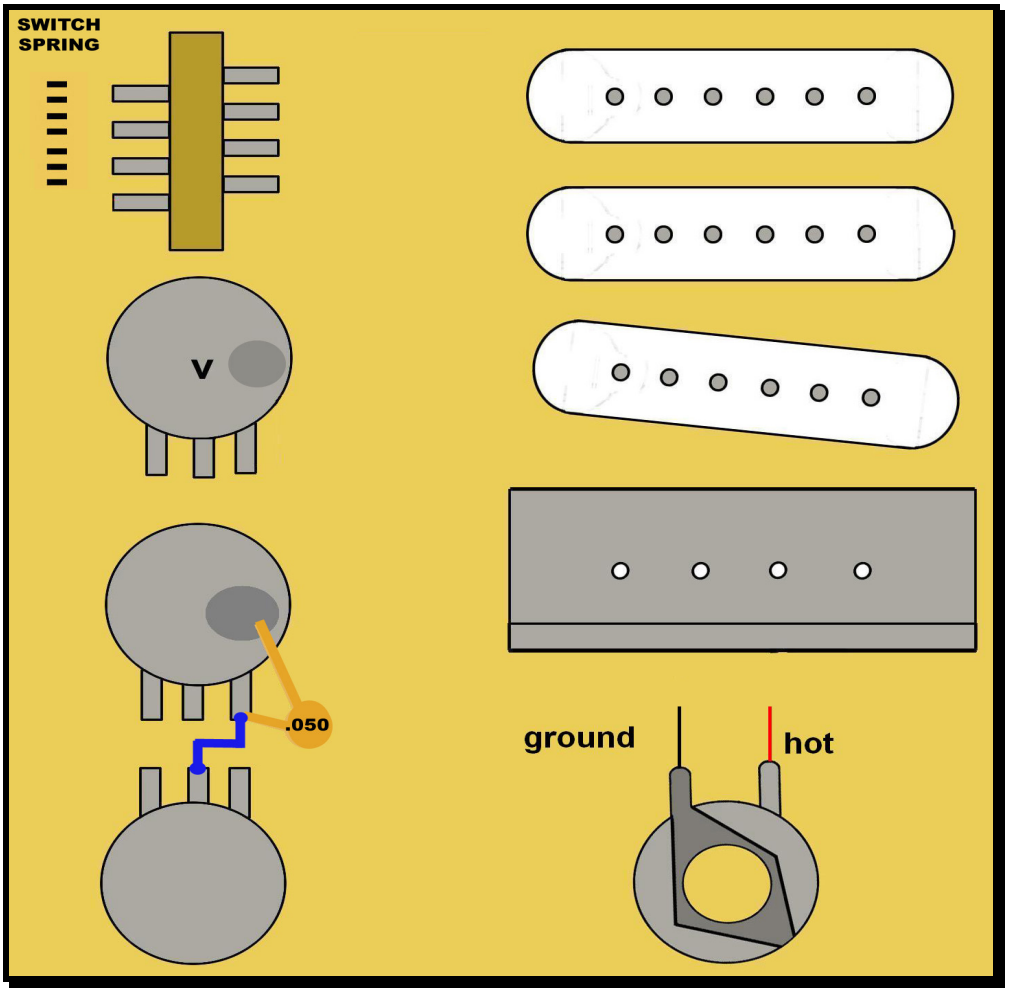


Next, you are going to solder the 5-way switch to the bottom tone control. Connect it to the left lug.

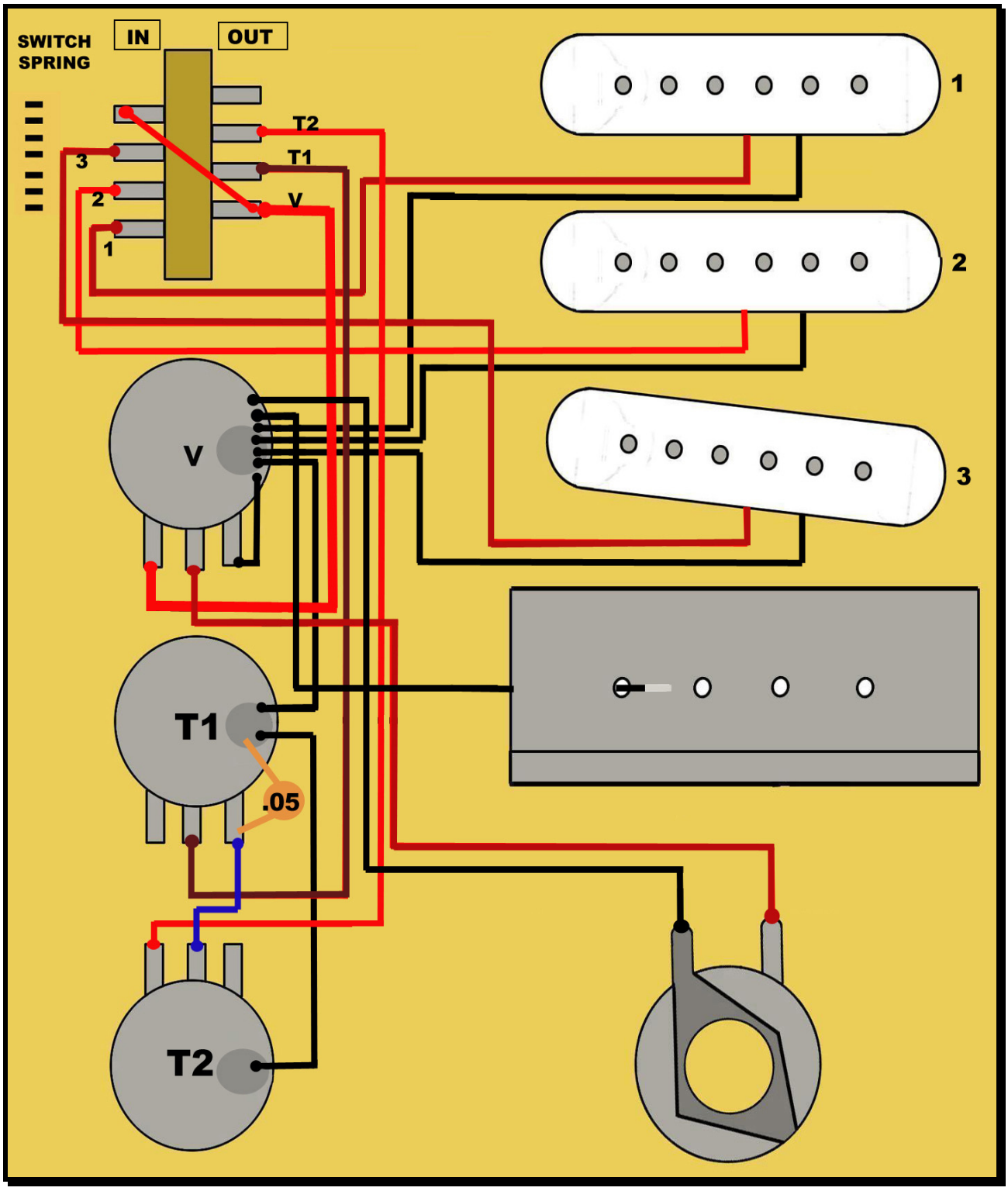


ADDING THE CAPACITOR

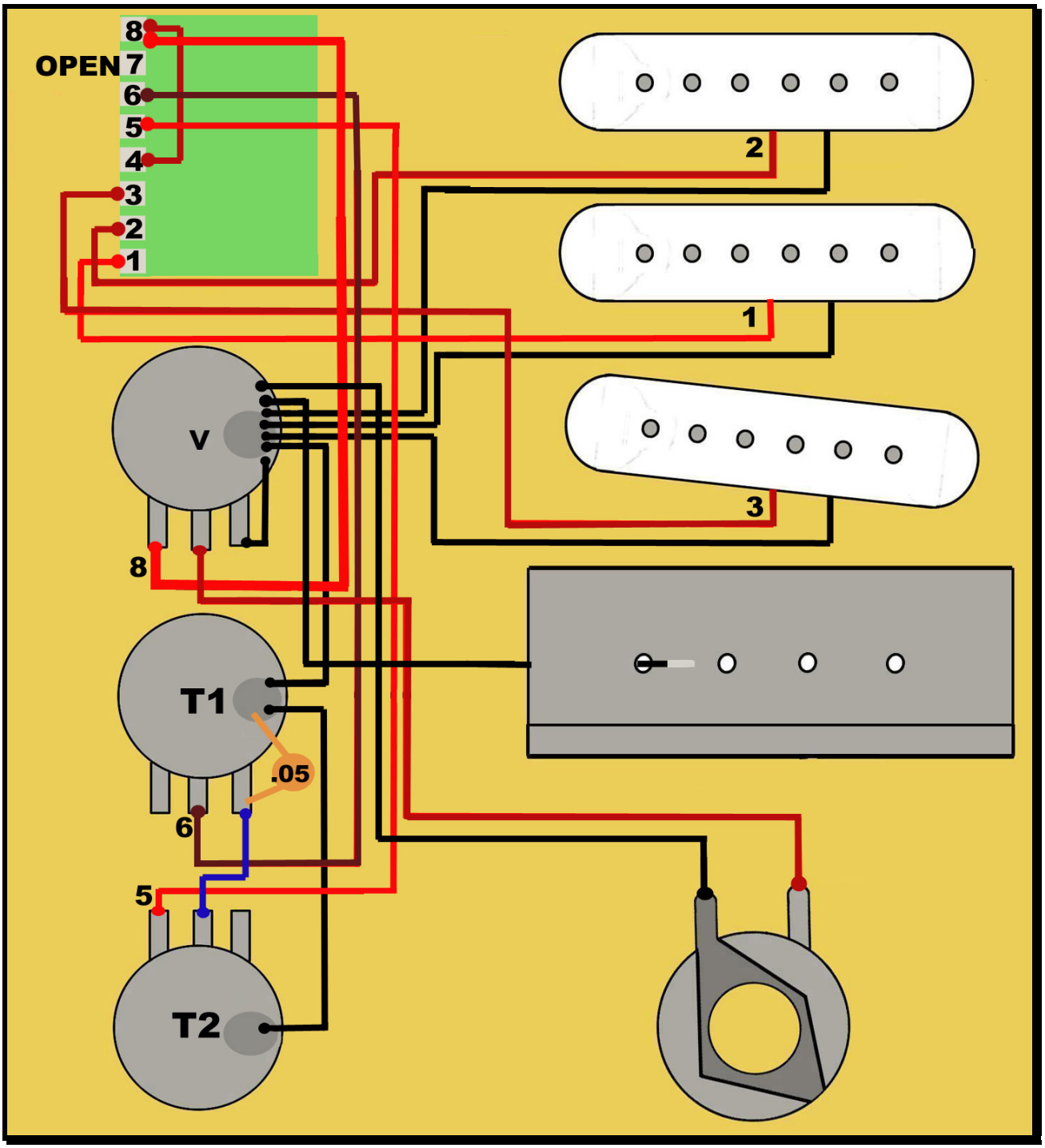
Solder the capacitor to the middle tone control. Remember, the stronger capacitor you use, the more bass your guitar will have. Connect the capacitor to the right lug on the middle tone control, then solder it to the case. That same lug will also connect to the middle lug on the bottom tone control.

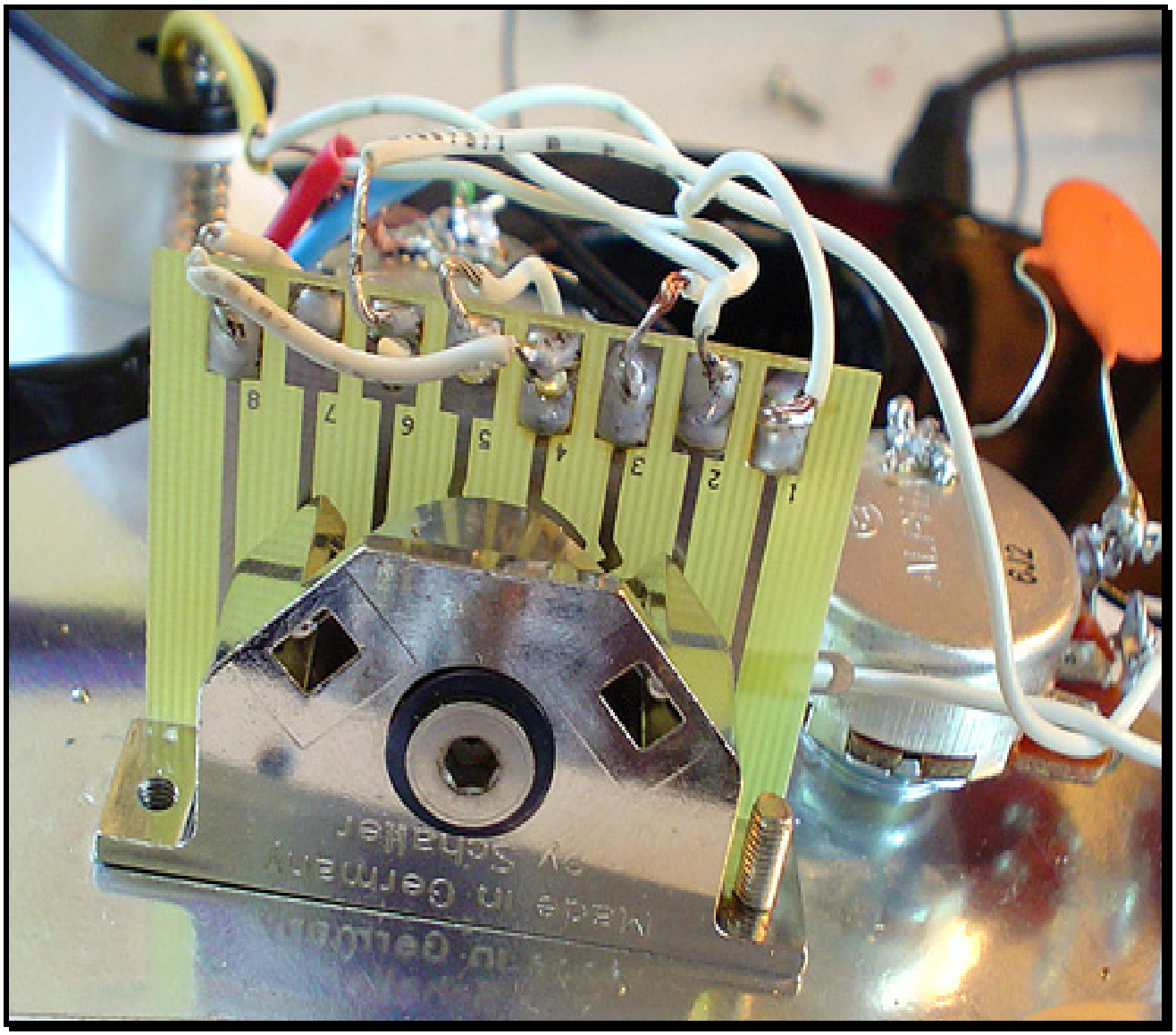


That's all there is to it. Here is the finished wiring.

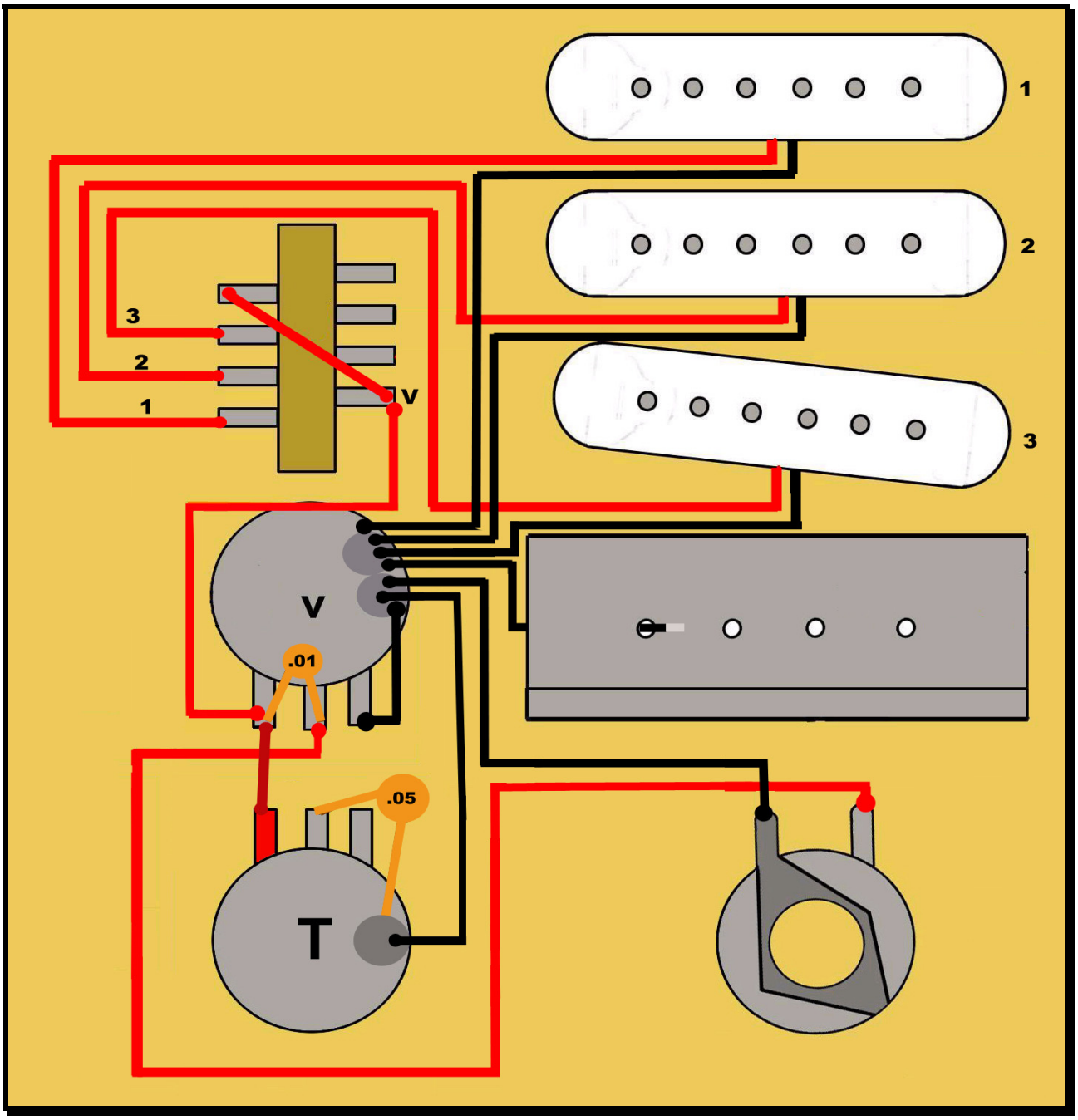


If you are using a megaswitch instead of a lever switch, then you can wire the guitar like this.



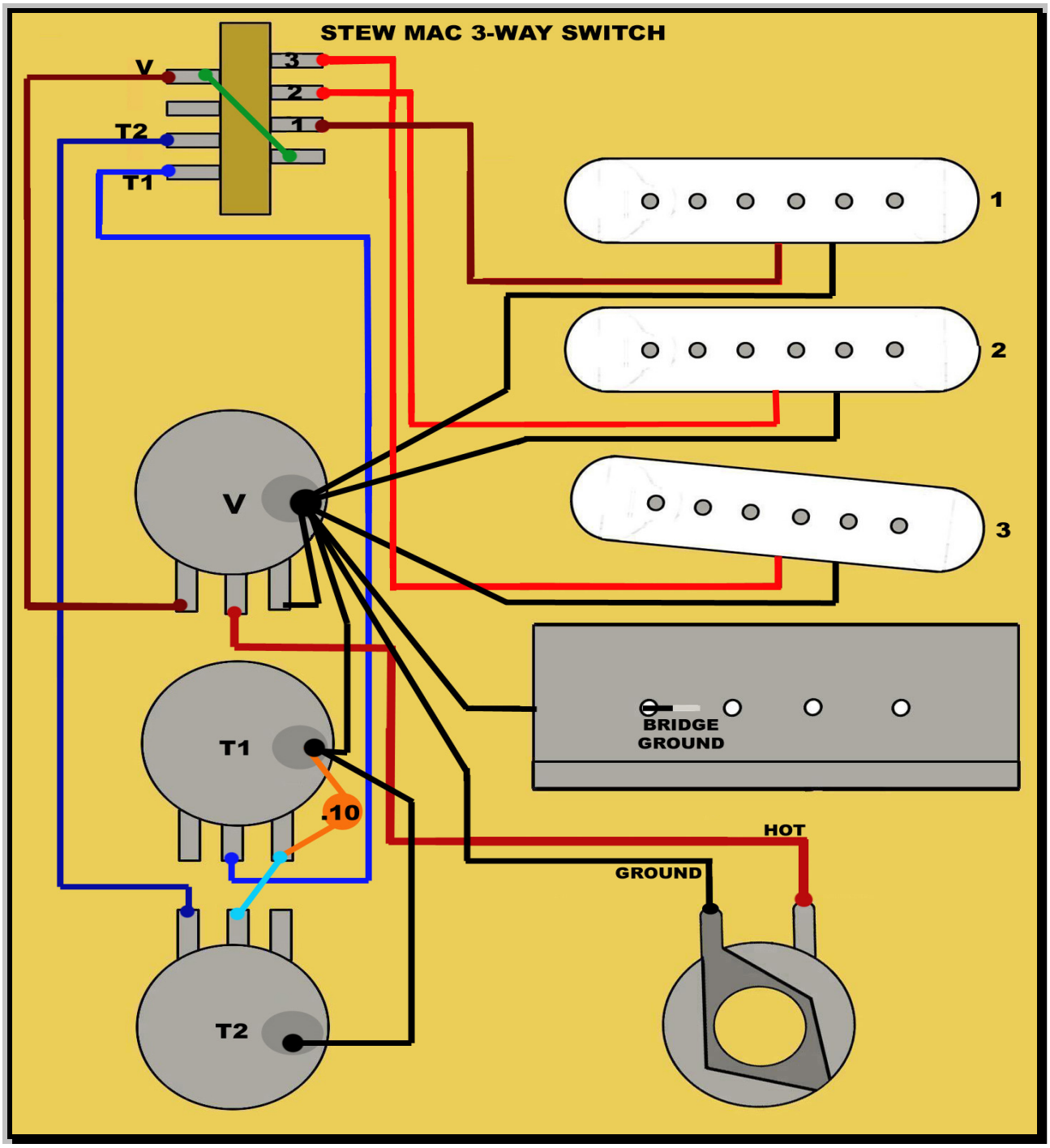


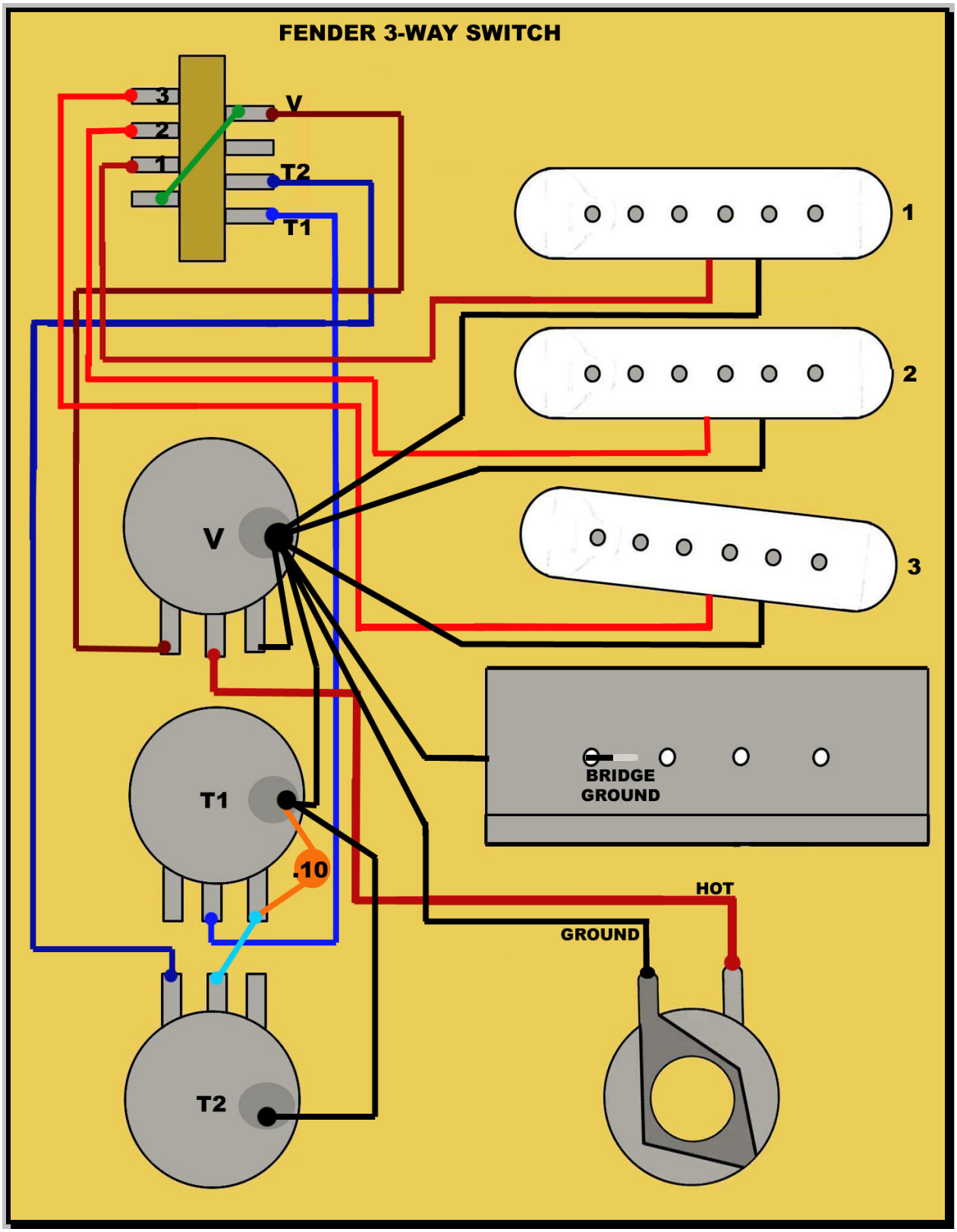
If you just wanted one master volume and tone control for all three pickups, you could wire the guitar like the diagram below. This would also give your bridge pickup a tone control. Notice a .01 capacitor has been added to the volume pot to take out some of the highs, and then put them back in the circuit before they go to the output. This prevents some of the highs from naturally bleeding out of a 250K pot.



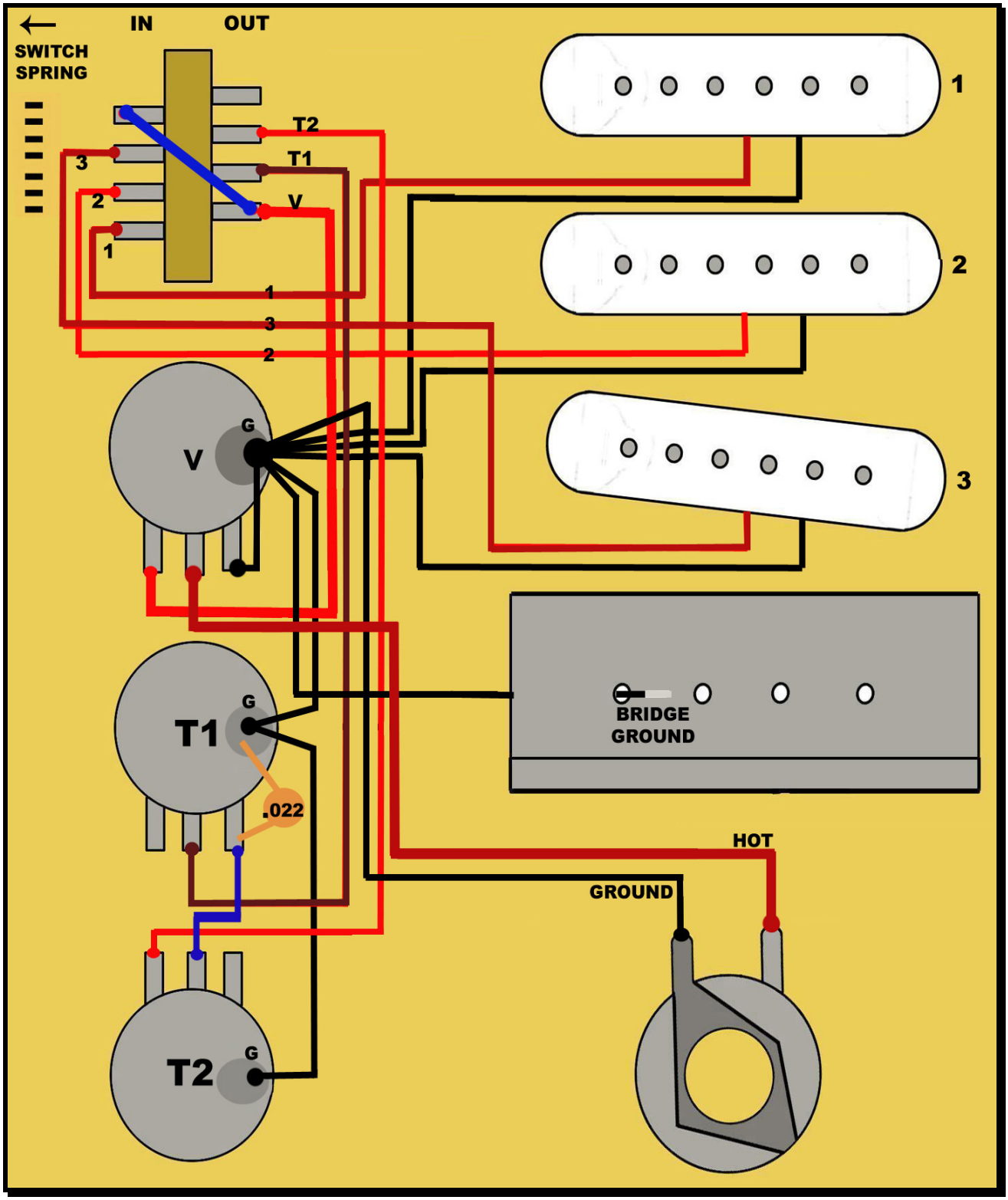
Question: I've noticed the Fender and CRL selector switches look different than the Stewart McDonald selector switches. Will this change how to wire a guitar? Yes, it will. Basically, the Fender and CRL switches and the Stew Mac switches have their sides reversed. So the left side of a Fender or CRL switch is actually the right side of a Stew Mac

switch. Fender and CRL switches look alike. Just pay attention to which side has the higher or lower set of lugs, and to what gets soldered to those lugs. Take a look at the diagrams on the next few pages.

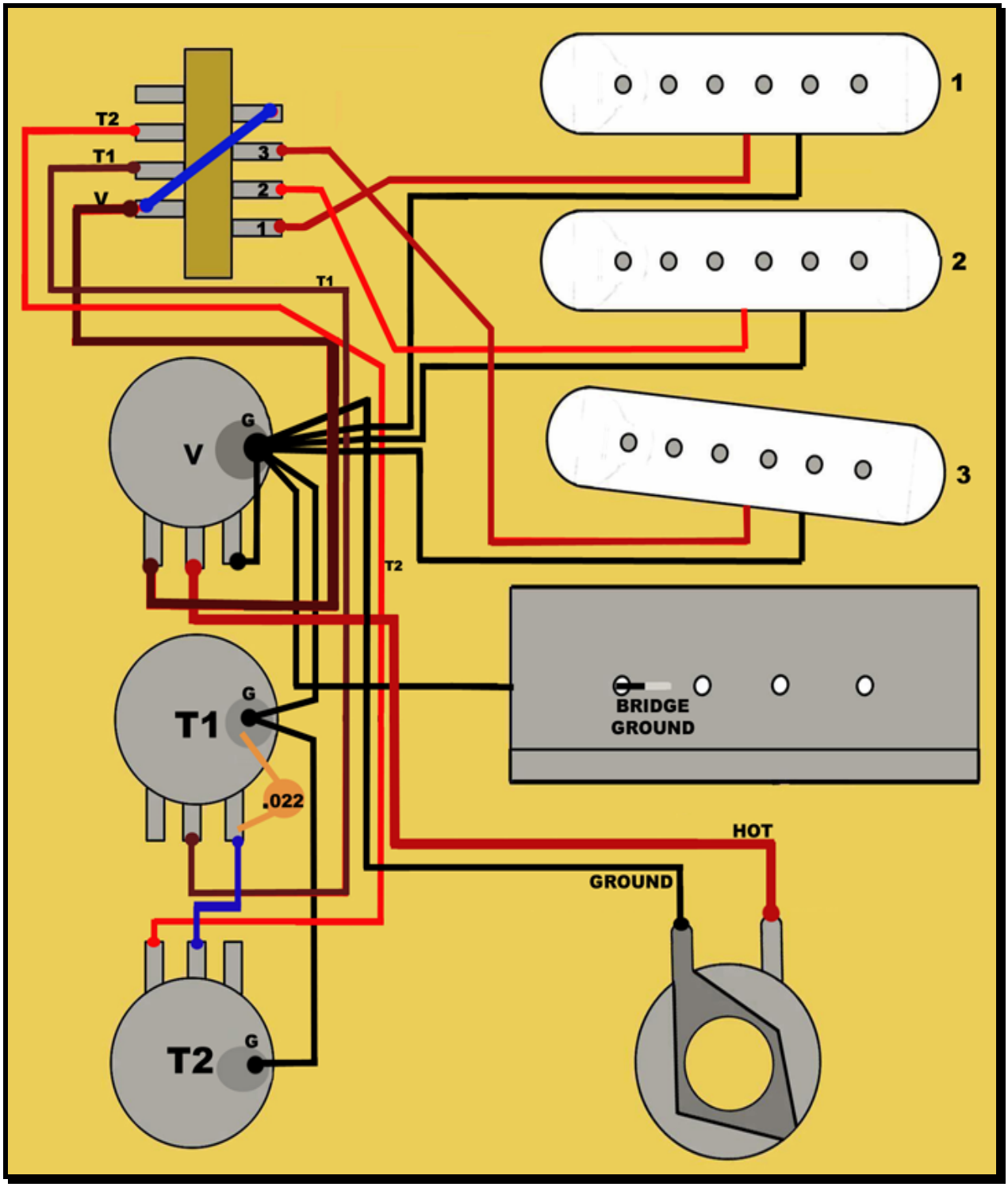




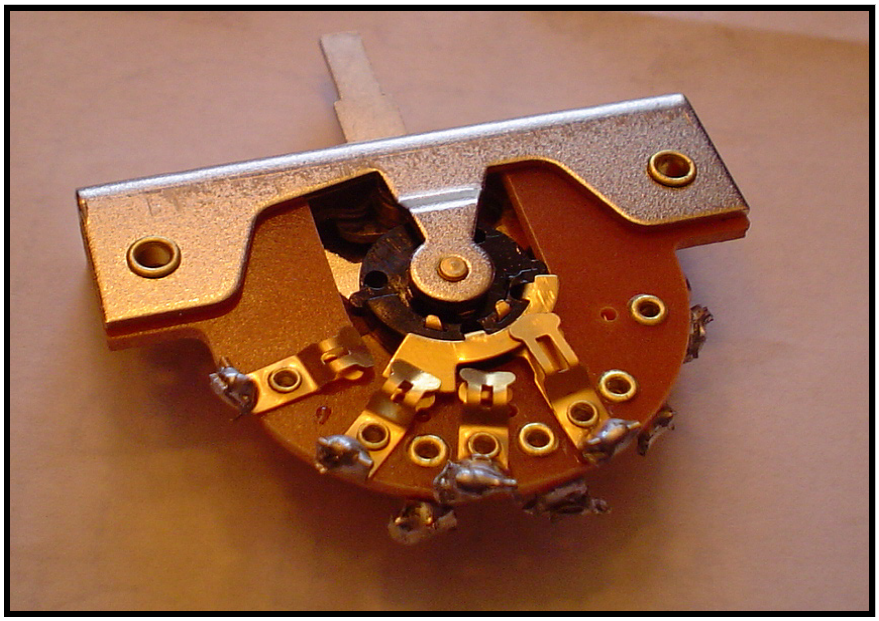
Stewart McDonald 5-way switch



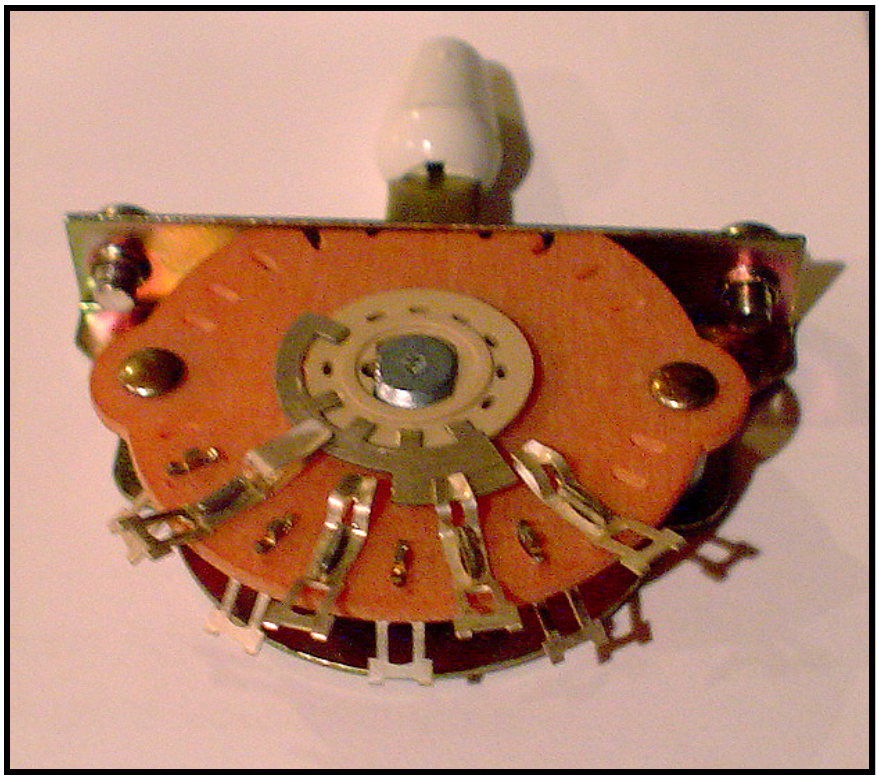
Fender and CRL 5-way switch



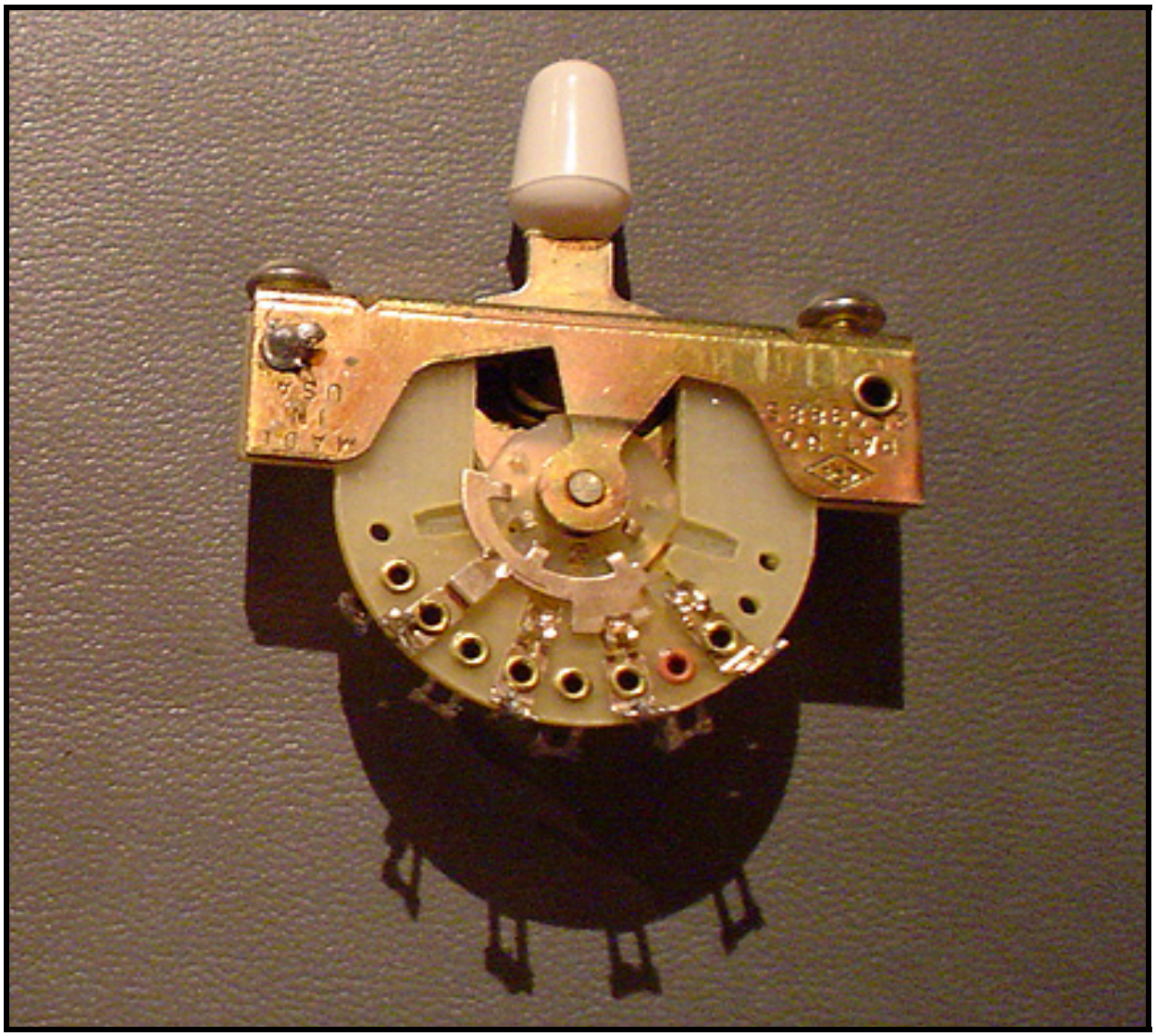
Stewart MacDonald lever switch from Japan



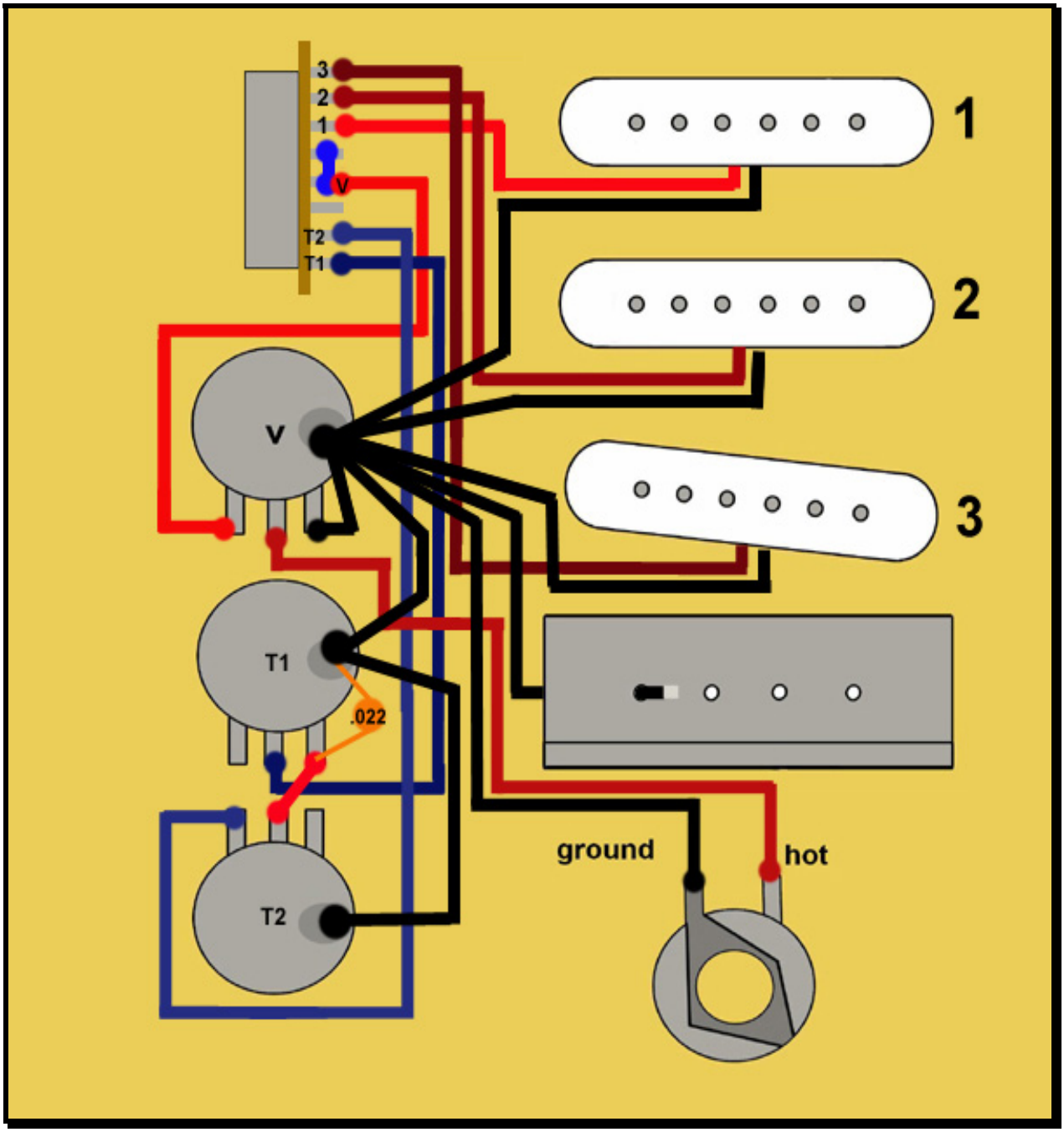
Fender lever switch



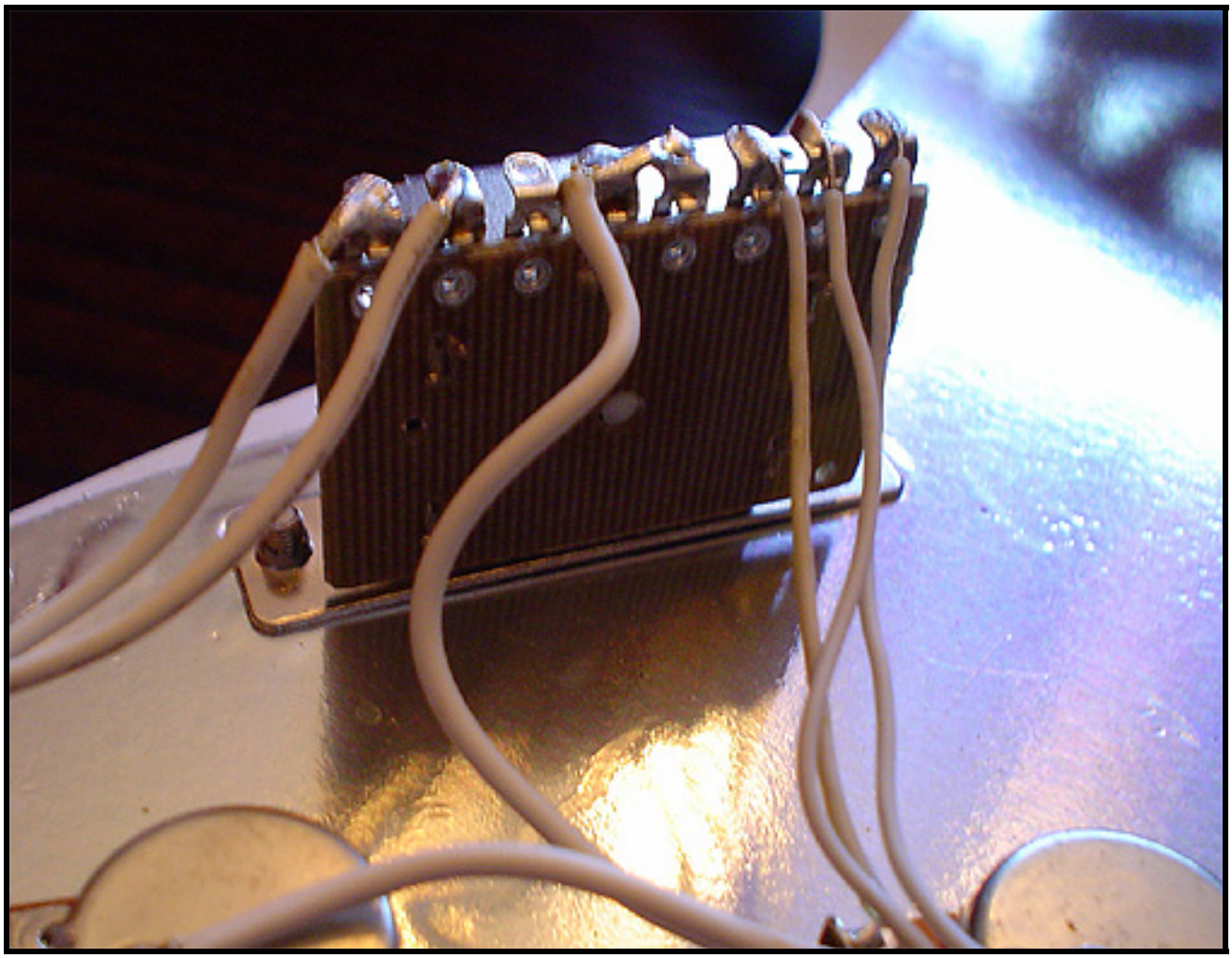
CRL lever switch from the USA



If you are using a **5-way import switch** with 8 lugs, then the wiring would look like this. In fact, the wiring is the same for an import 3-way switch as well. That would only turn one on pickup during each selection.



Here is a common import switch.



WIRING A TELE

The Telecaster guitar has a spiky sound, with more highs and lows than other guitars. It is well known for its bright and twangy sound that comes from the bridge pickup and solid body. It is loved by many for its ability to play country, bluegrass, and even the blues.

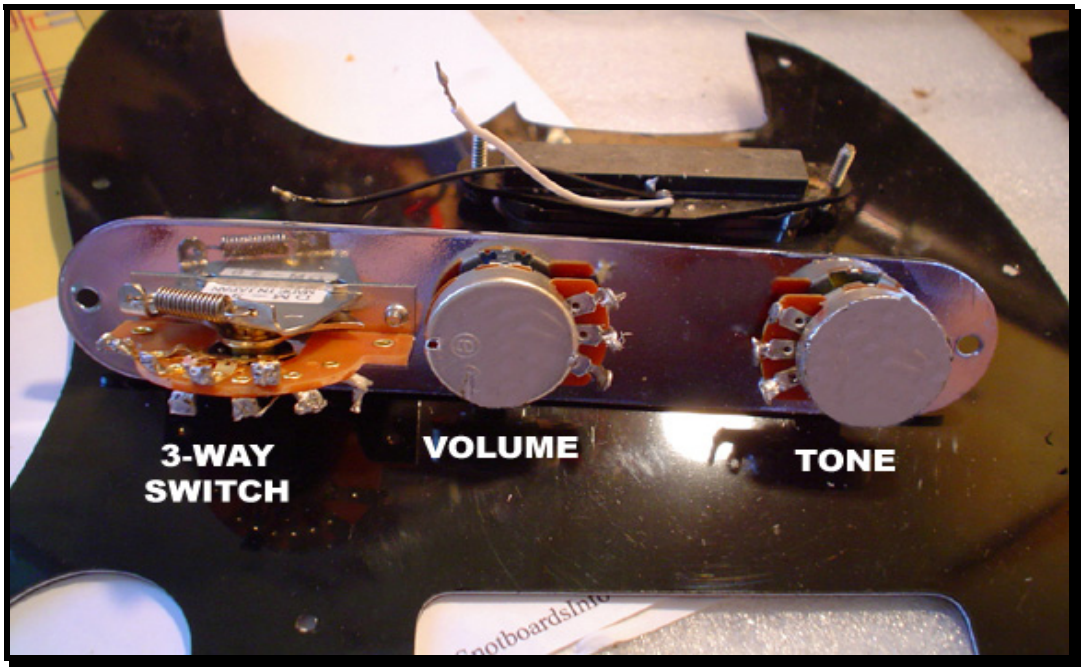
TOOLS FOR THE JOB

First, we need to talk about the tools you will need for changing your electronics.

1 - Output jack
2 - 250K pots
1 - .050µF capacitor
1 - .001µF capacitor
1 - 3-way lever switch
1 - guitar wire 22AWG, white
1 - guitar wire 22AWG, black
1 - 25+ Watt soldering iron
1 - phillips screwdriver
1 - wire cutting and stripping tool
1 - rosin core solder

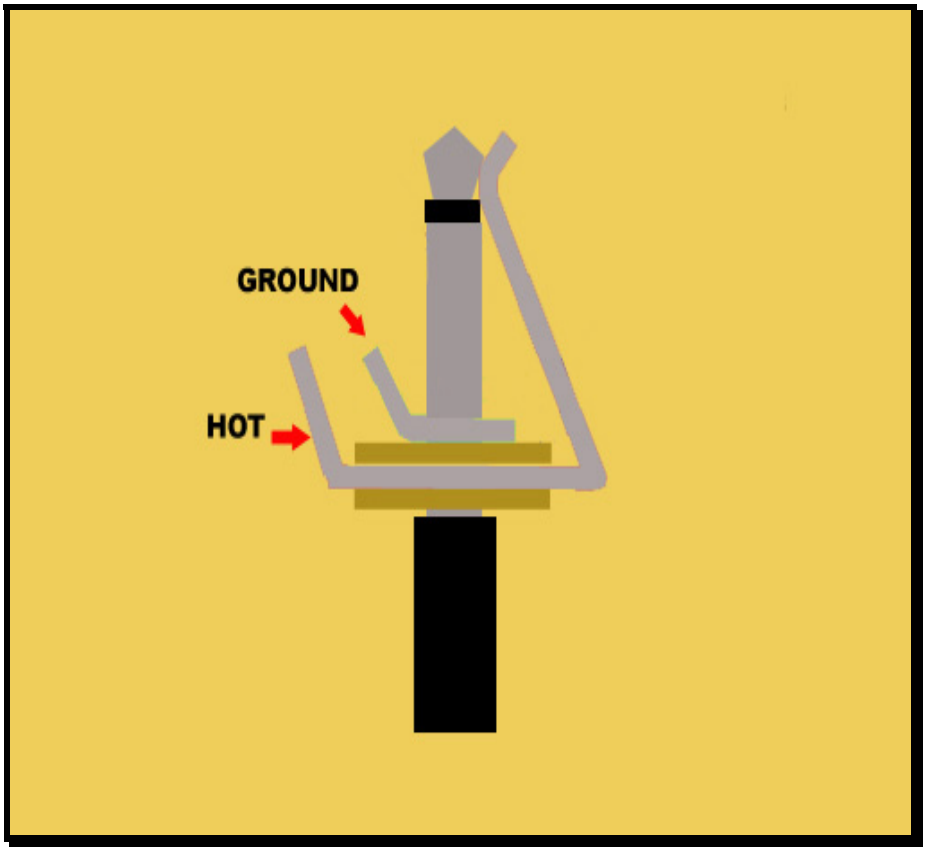
ASSEMBLING THE CONTROL PLATE

The first step will be installing the potentiometers and 3-way switch in the control plate. When the control plate is upside down, the spring on the 3-way switch will be facing away from the guitar body. Align the two pots so that the lugs are facing each other.



SOLDERING THE OUTPUT JACK

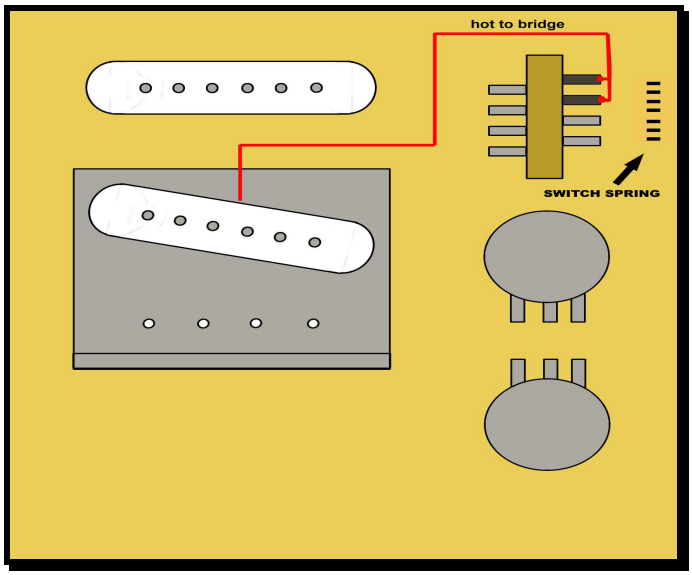
Next, we are going to solder the ground wire and hot wire to the output jack. In order to solder properly, you should first add solder to each part that is getting connected. Then touch the two parts together along with the soldering iron. Make sure both parts don't move until they cool down, or else you will get a bad solder joint. It should only take a few seconds for the parts to cool down after they have been soldered.



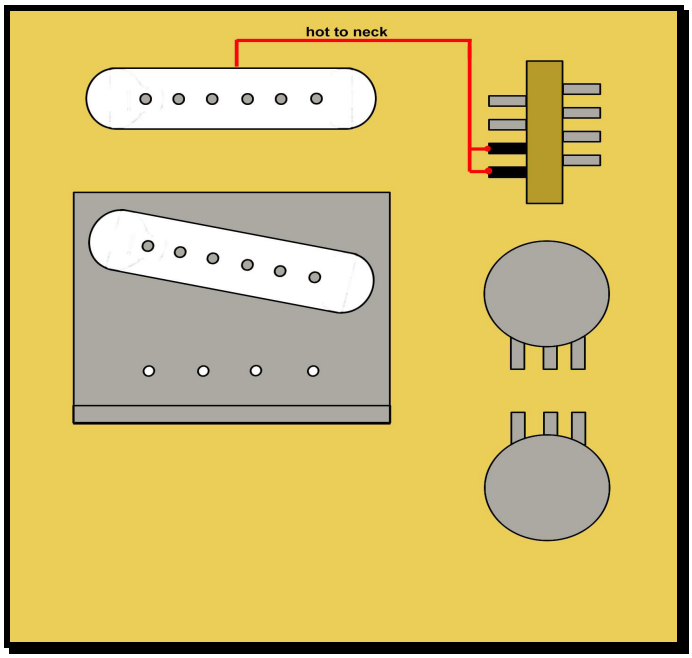
Next, fish all of the wires through the holes in the body. Pull in the output jack wires you just soldered, and screw down the output jack plate. Pull the bridge pickup wires through the hole closest to the bridge. Pull the neck pickup wires through the hole closest to the neck. Also add a black bridge ground wire that is going to go through the hole closest to the bridge. That wire will connect the bridge to the volume pot. Each pickup has a hot wire and a black ground wire. The output jack also has a hot wire and black ground wire.

SOLDERING THE PICKUP WIRES

The next step will be to connect the hot wires from the bridge pickup to the top two lugs on the right side of the 3-way switch. You can do this by twisting a small wire to the hot pickup wire. It is much easier to solder one connection to one lug. So if several wires need to be connected to the same lug or pot, twist them together before you solder them to the lug or case.

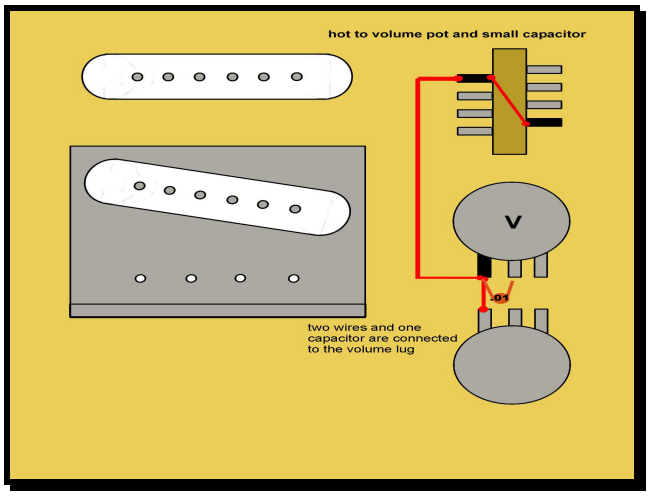


Next, connect the hot wire from the neck pickup to the bottom lugs on the left side.



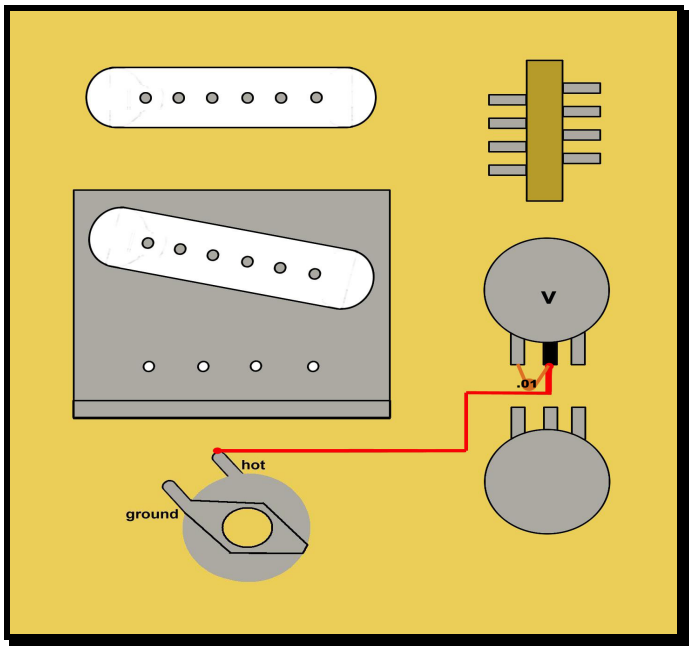
CONNECTING THE SWITCH TO THE VOLUME POT

Now you are going to connect the top left and bottom right lugs with a jumper wire. That wire will connect to the left lug on the volume pot, and also to a small treble bleed capacitor. You will have to twist a few wires together to do this. Make sure to cut and strip the wires to the correct size.



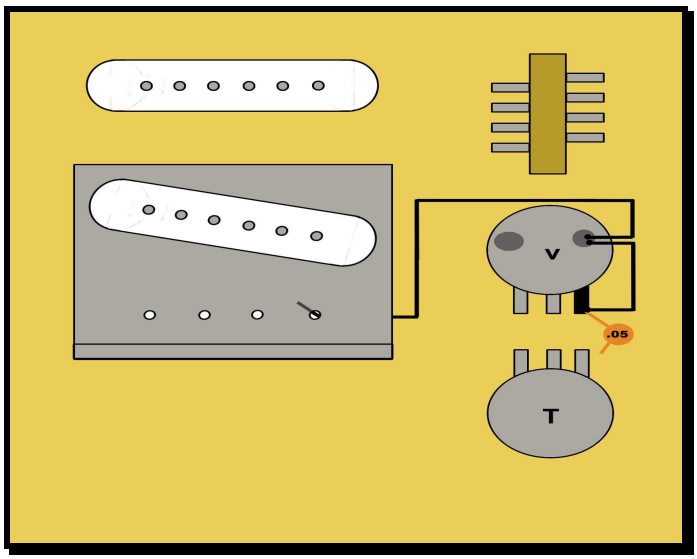
SOLDERING THE VOLUME AND TONE POTS

The next step involves soldering the hot wire from the output jack to the middle lug on the volume pot. You will also be connecting the other end on the capacitor to that same lug.

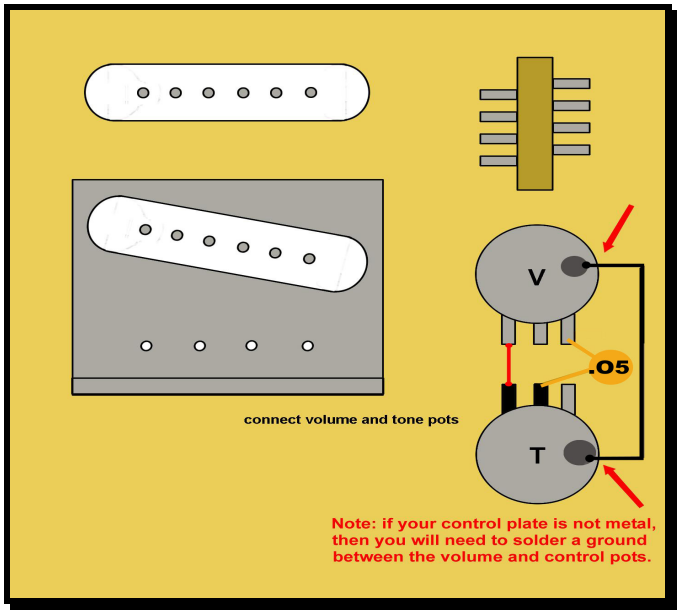


Now you will connect the loose bridge ground wire to the right side of the volume pot. Solder it to the metal casing. It will connect to another wire which goes to the right lug. That lug also will

connect to one of the prongs on the large capacitor. Before you do this, you will need to add solder to the bottom of the volume pot case. Add solder to the left and right side.

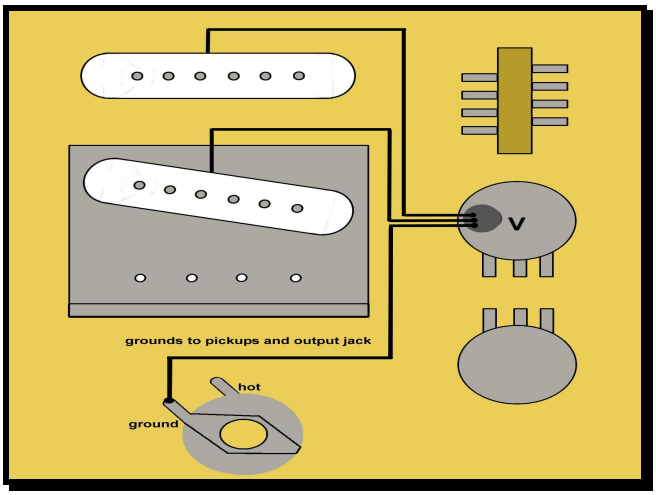


Next you are going to connect the left lug of the volume pot to the left lug of the tone pot. Also connect the right lug on the volume pot to the middle lug on the tone pot with a capacitor. You will also need to solder a ground wire connecting both pots as shown in the picture. All pots will need to be grounded, and all grounds will need to be connected to each other.



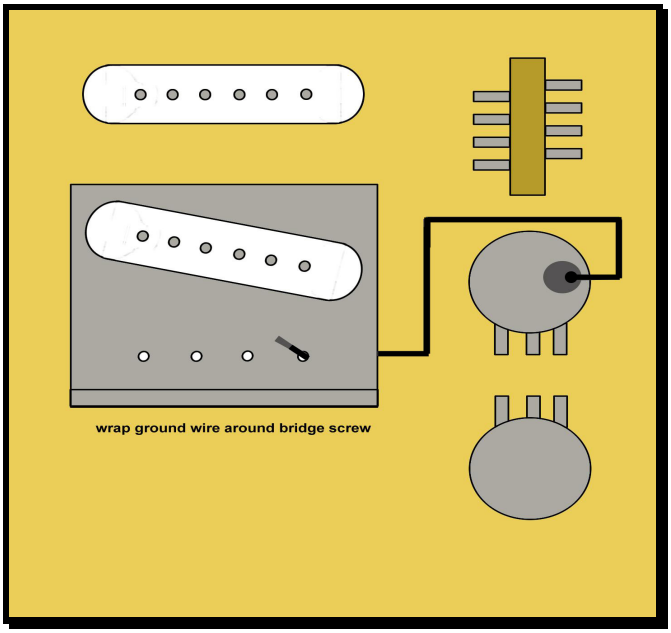
SOLDERING THE GROUND WIRES

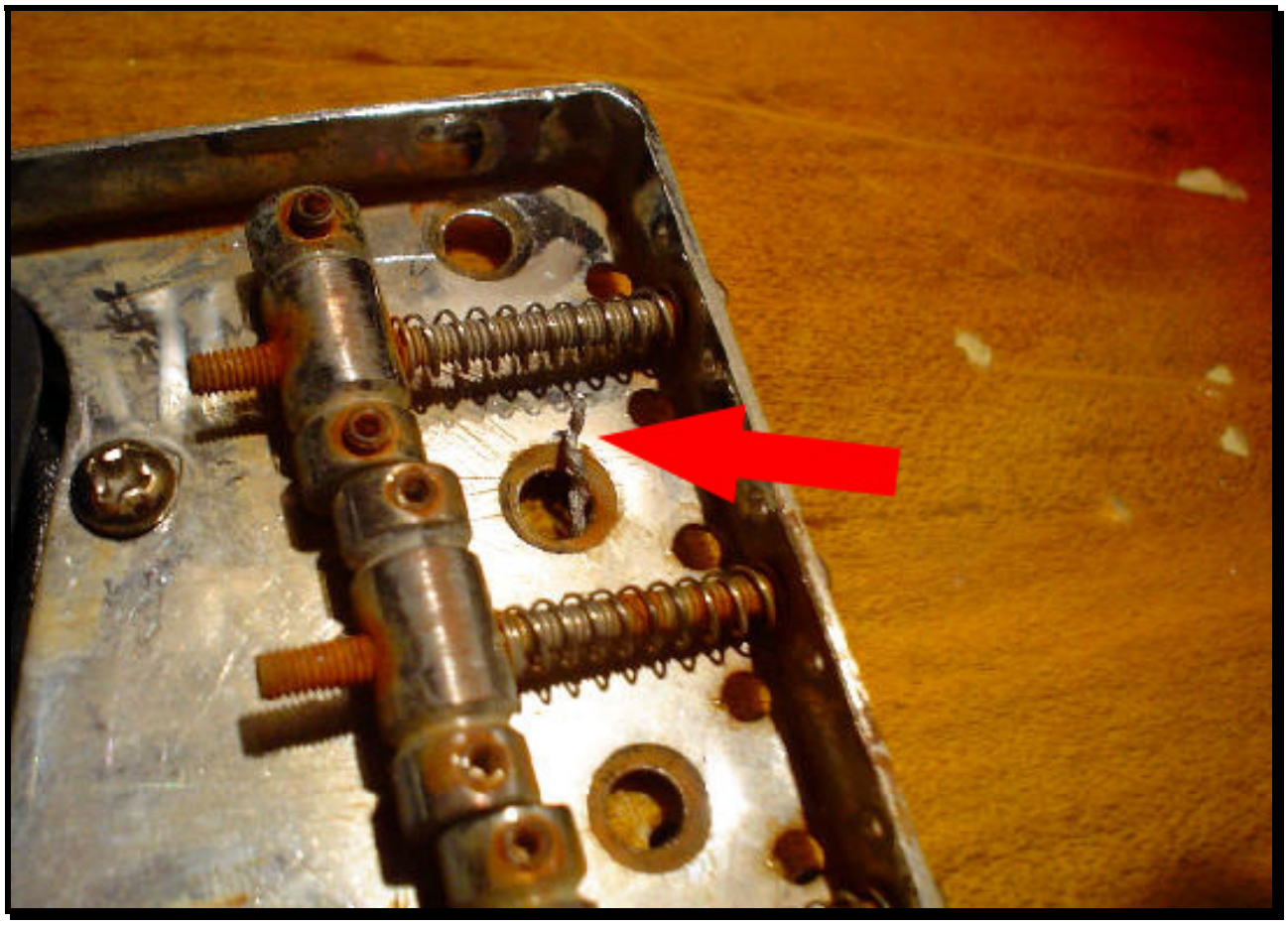
Next, you are going to connect the three ground wires from the neck pickup, bridge pickup, and output jack to the left side of the volume pot.



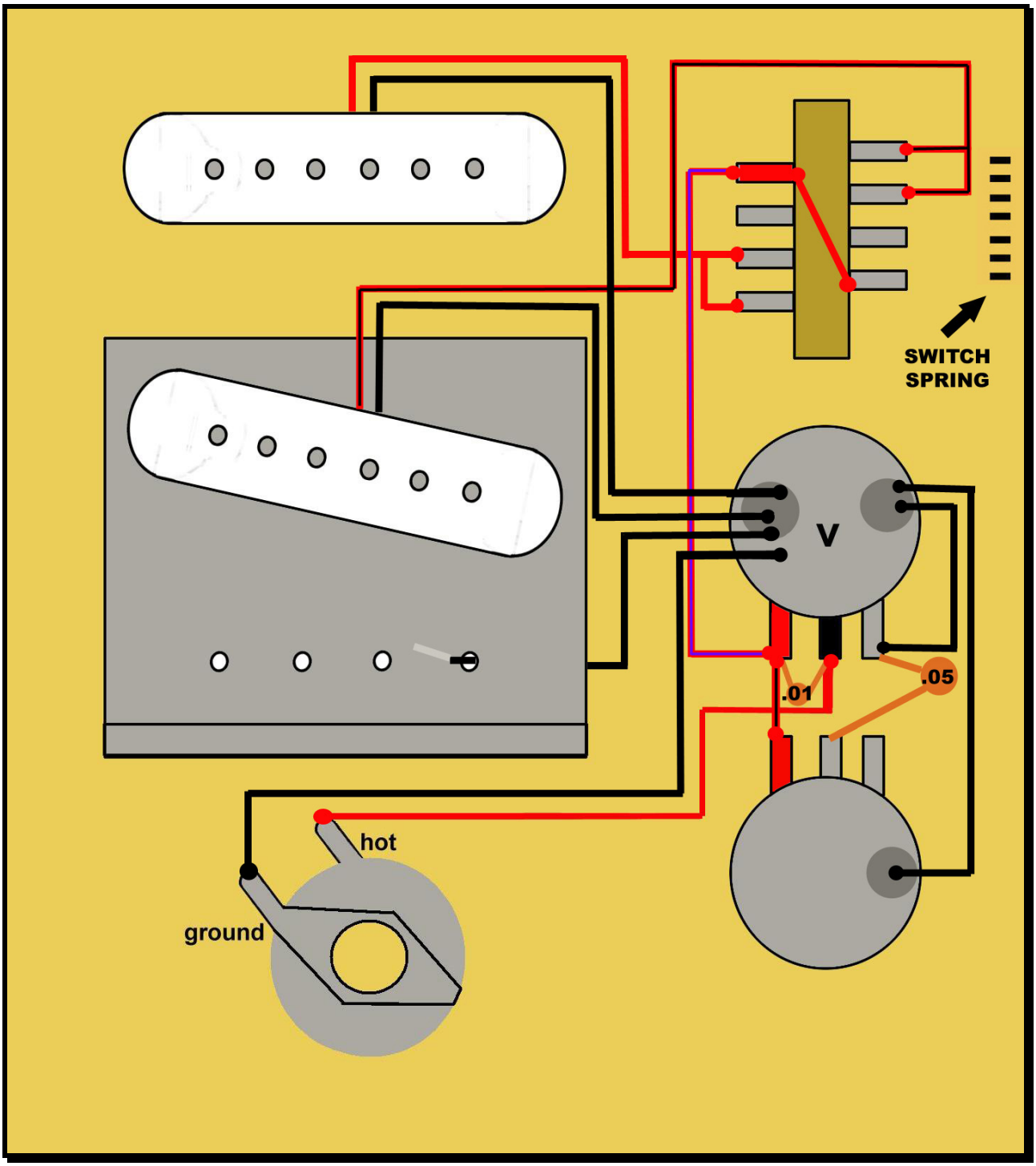
THE BRIDGE GROUND WIRE

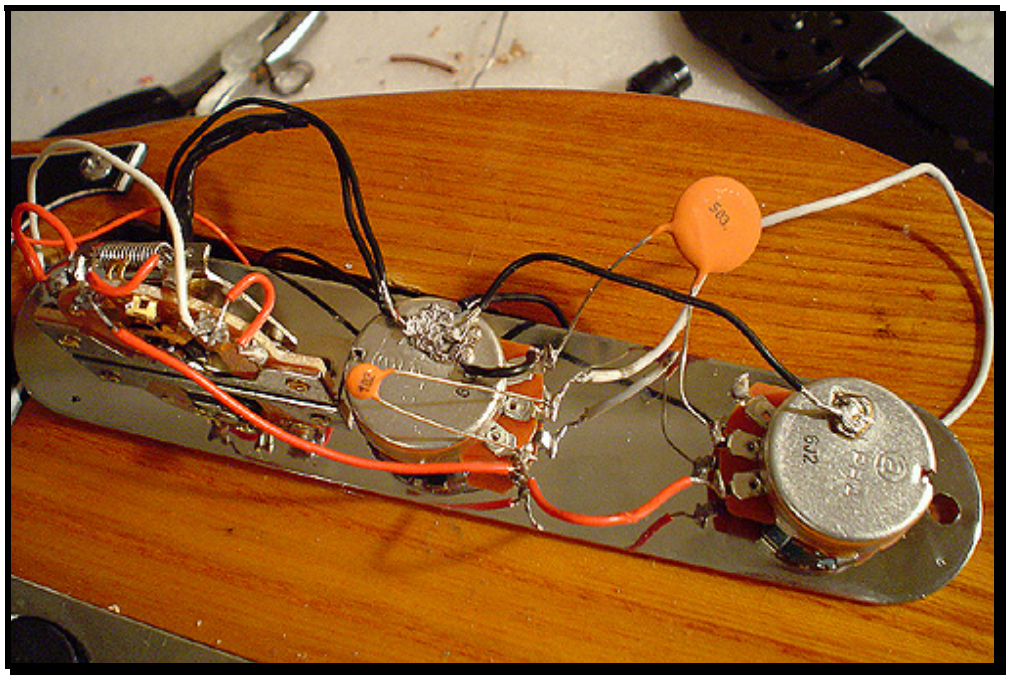
The last step involves putting the black bridge ground wire through one of the screw holes in the bridge. Wrap it around one of the screws and screw it down. This way it will stay in contact with the bridge and won't move.

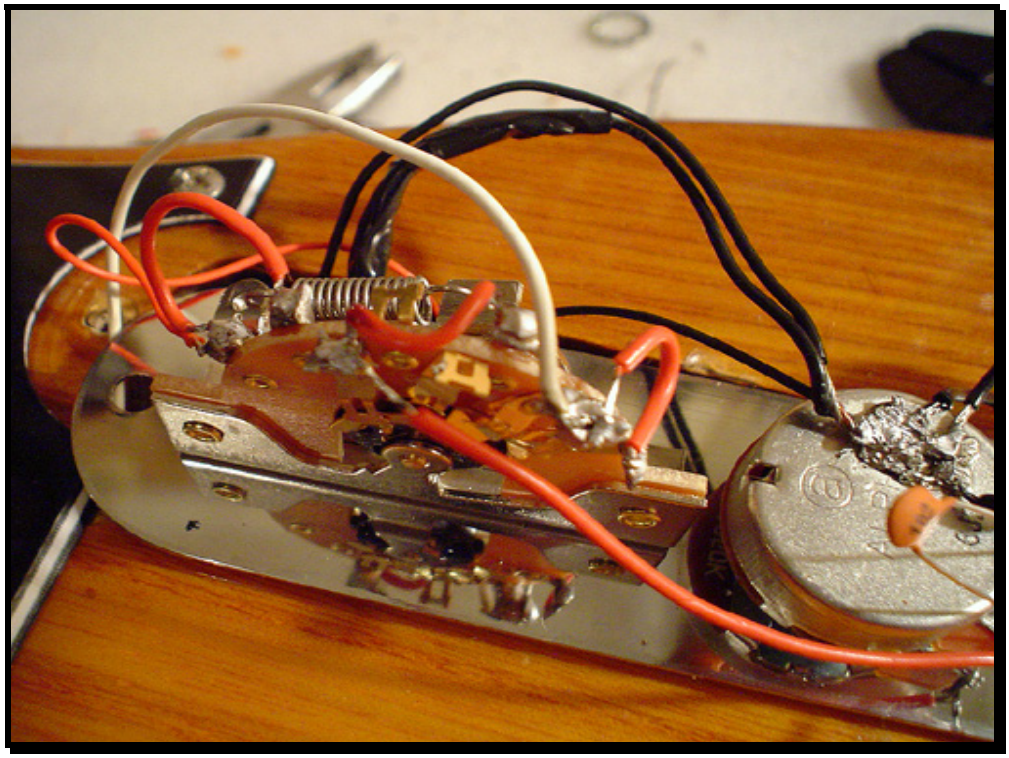




Here is the finished wiring.







WIRING A LES PAUL

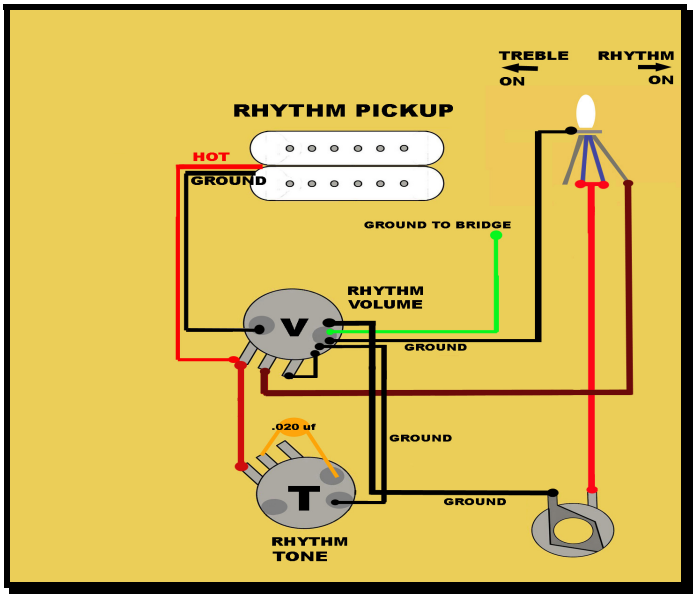
The Les Paul is THE guitar for playing rock music. Nothing will get your blood boiling more than one of these guitars combined with a vintage Marshall amp. The powerful Les Paul humbucking pickups eliminate unwanted noise and give the guitar a fat and crisp sound. The mahogany body also helps shape the sound on this amazing guitar.

TOOLS FOR THE JOB

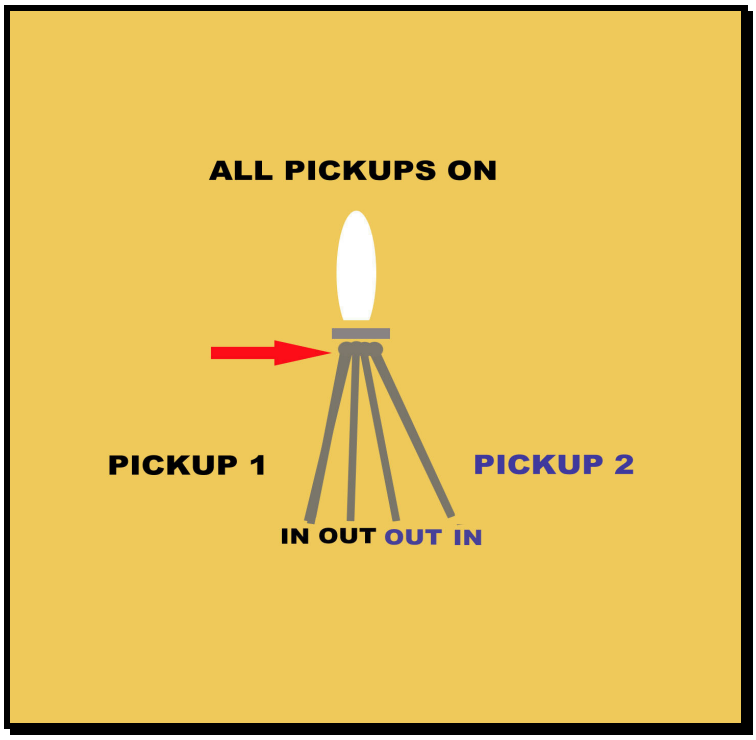
First, we need to talk about the tools you will need for changing your electronics.

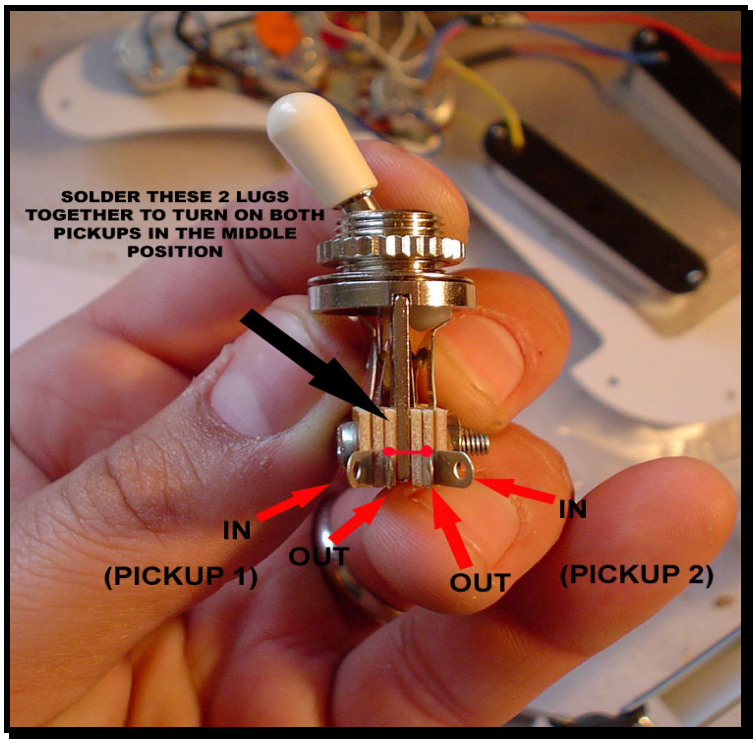
1 - Output jack
4 - 500K pots
2 - .020µF capacitor
1 - Gibson toggle switch
1 - guitar wire 22AWG, white
1 - guitar wire 22AWG, black
1 - 25+ Watt soldering iron
1 - phillips screwdriver
1 - wire cutting and stripping tool
1 - rosin core solder

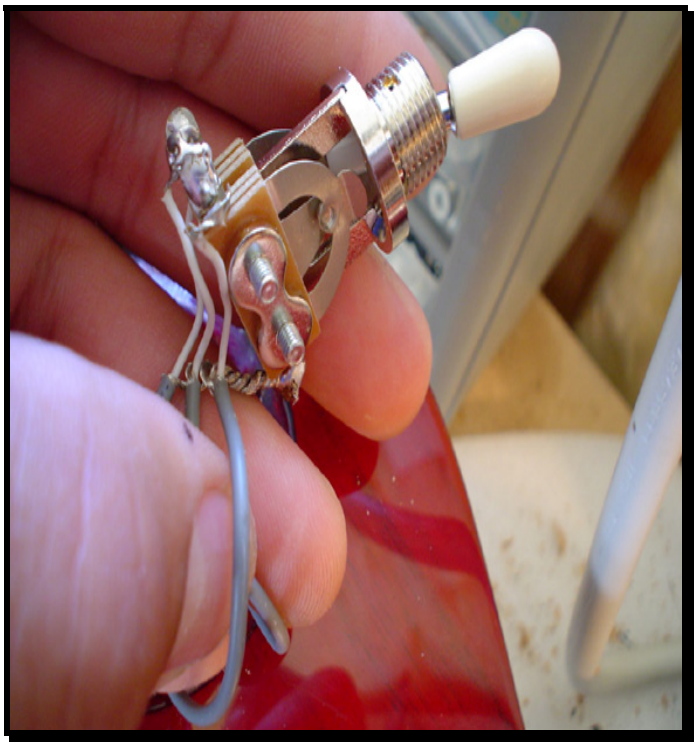
Now that you have an understanding of the strat and tele guitar wiring, let's look at the Les Paul. It's actually setup pretty similar to the telecaster wiring, with the addition of a toggle switch, and an extra volume and tone control. Also, the potentiometers are increased to 500K to bring out more of the highs. Take a look at how the rhythm pickup is wired. Each pickup follows this pattern. The pickup goes into the volume pot, then out to the tone control. The main output to the jack comes from the toggle switch. The tone pots have .020 uf capacitors which send the treble to ground.

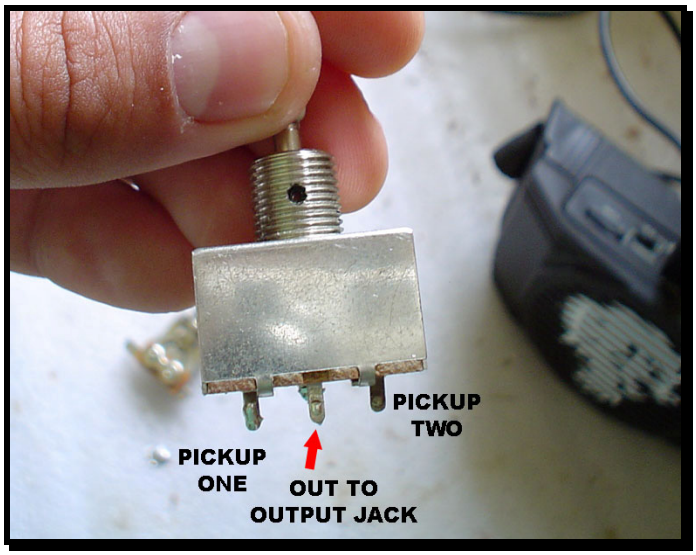


Notice how the toggle switch works. One side turns the treble pickup on, and the other side turns the rhythm pickup on. The two middle connections turn both pickups on. These inner two lugs need to be connected together. Some Gibson style toggle switches will have only three lugs, one for the treble pickup, one for the output, and one the rhythm pickup. The far left and far right toggle switch lugs will connect to the middle 2 volume pot lugs. Also, a ground wire will be attached to the back side of the toggle switch.





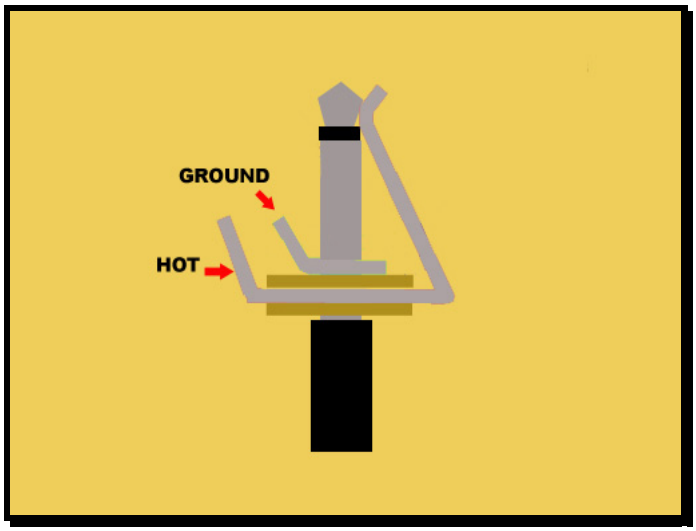




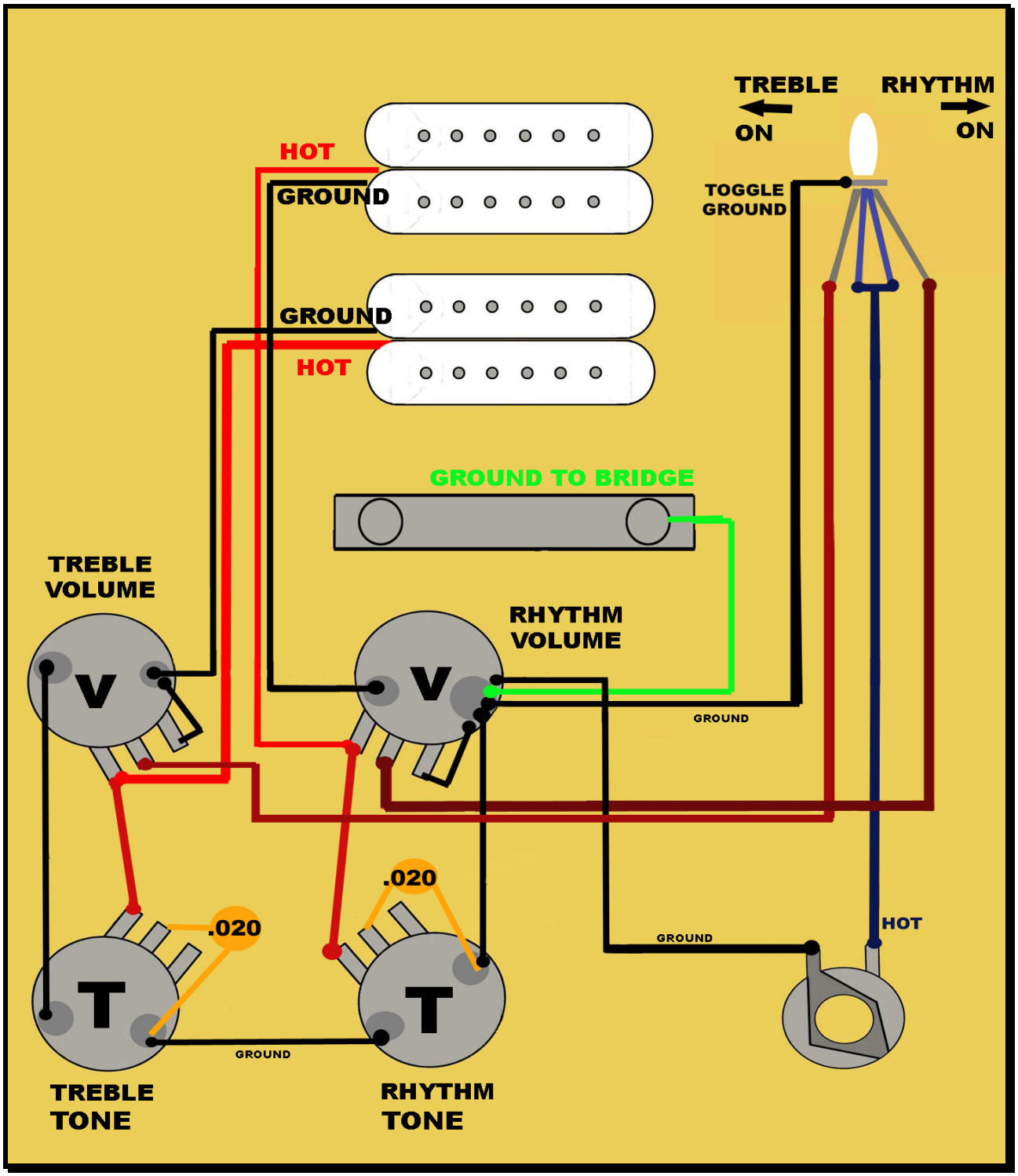
The rest of the wiring is pretty simple. Add the .020 uf capacitors to the tone pots and make sure that every pot has a ground wire soldered to its case. Also, solder the ground wire from the bridge post to one of the pots where the other ground wires are connected. The bridge ground wire needs to touch some part of the metal bridge, like one of the posts. All ground wires will need to be connected to each other. Don't forget to add a ground wire that connects to the ground lug on the output jack. And that's all there is to it.

Most of the wires in this photo are shielded in grey and black cables, so it is hard to see what's going on. The thick black cables house the pickup hot and ground wires.

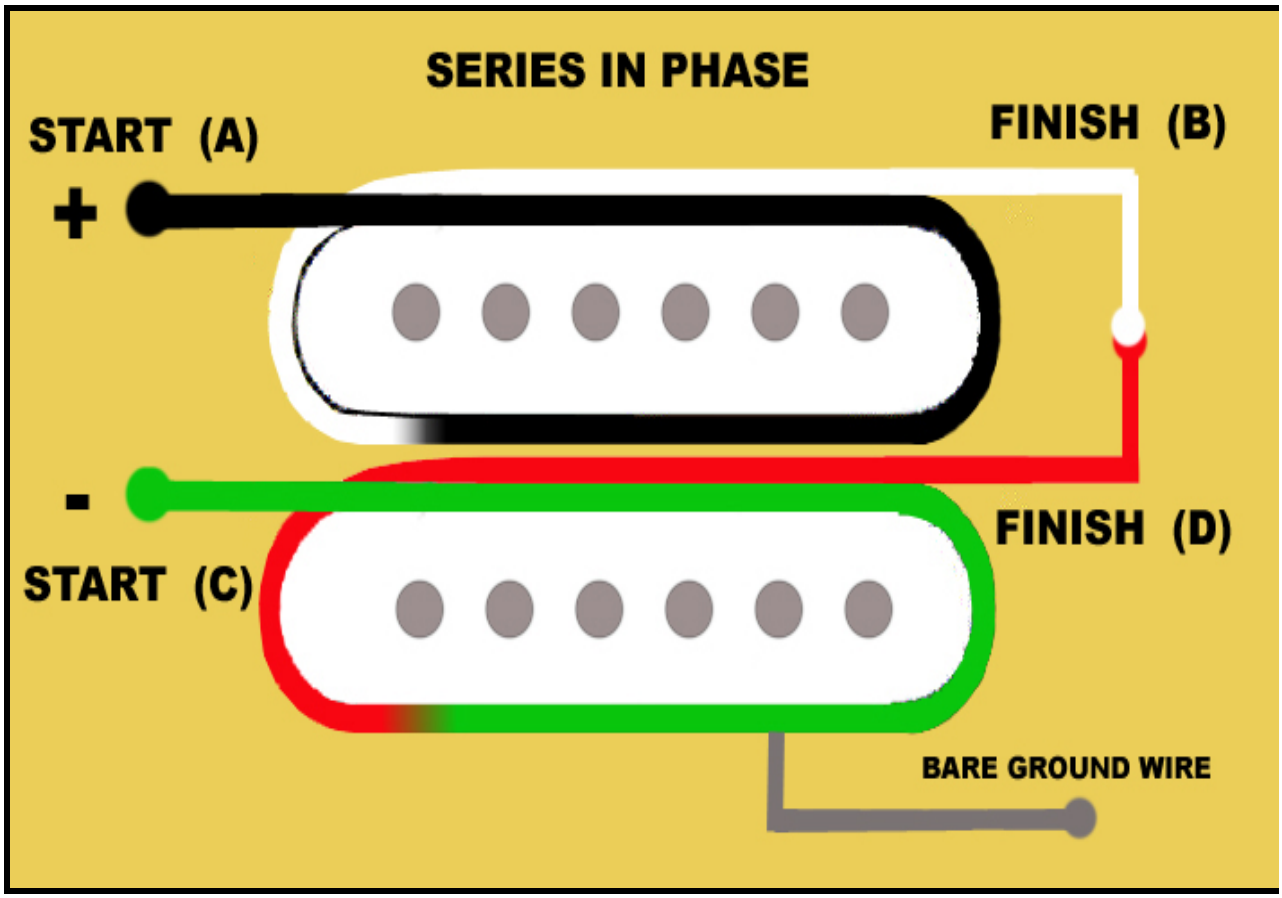
Now take a look at the output jack. Both wires are shielded in a grey cable.

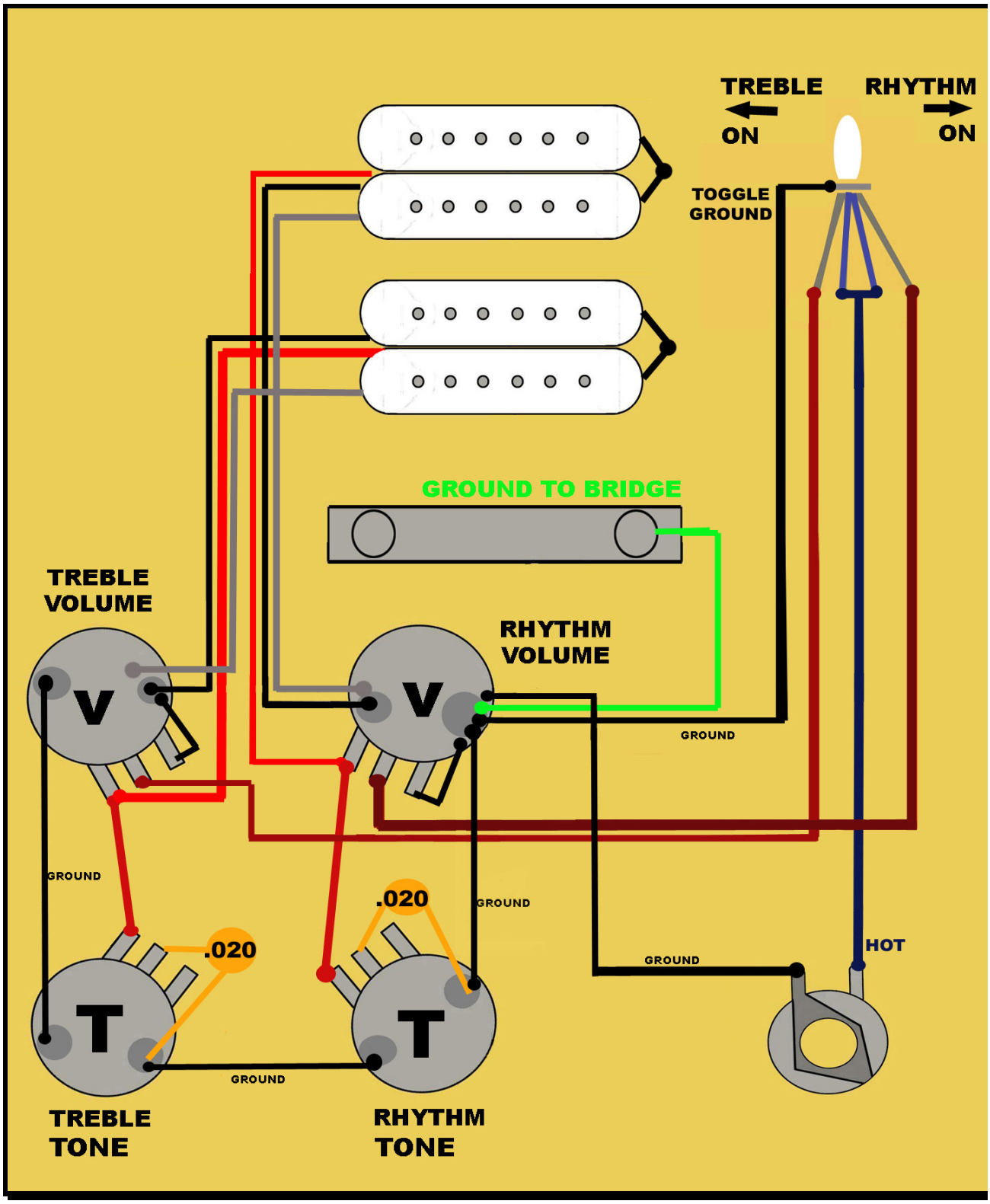


Here is the finished wiring.



Note: if you have a 4-wire humbucking pickup, then you will need to connect the two finish wires together, unless you plan on hot rodding your guitar. Once the finish wires are connected, they will form a series link, which will boost the output. This will leave you with a hot wire that goes to the volume pot, and 2 ground wires that go to the volume pot case. The diagram below shows a humbucker that uses the same wire color codes as a Seymour Duncan pickup. Check out the question and answers section for more info on wiring 4-wire humbucking pickups.





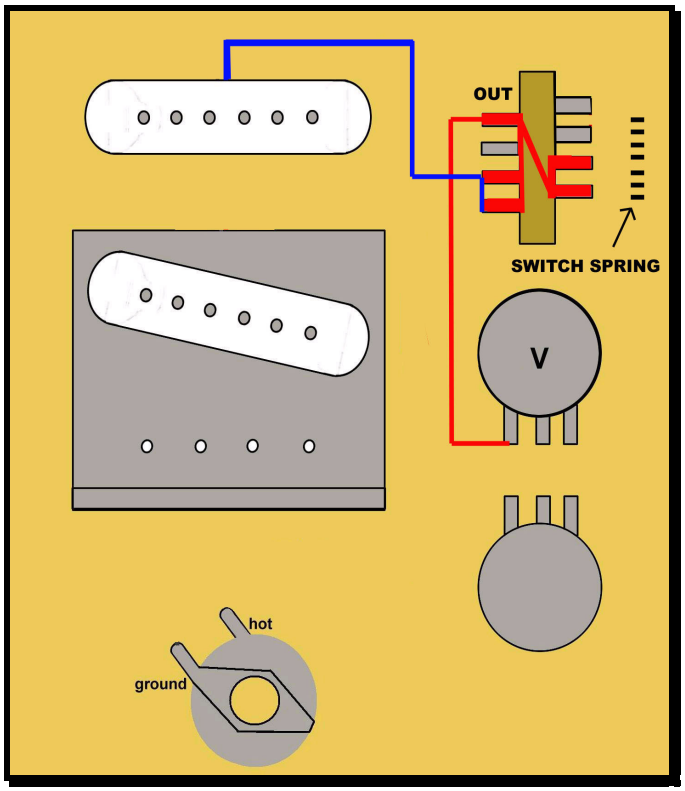
UNDERSTANDING SWITCHES

Almost every guitar has some type of switch on it. They are essential for turning electronics on and off. If you are going to be doing any type of wiring on your guitar, then you are going to have to know your way around switching.

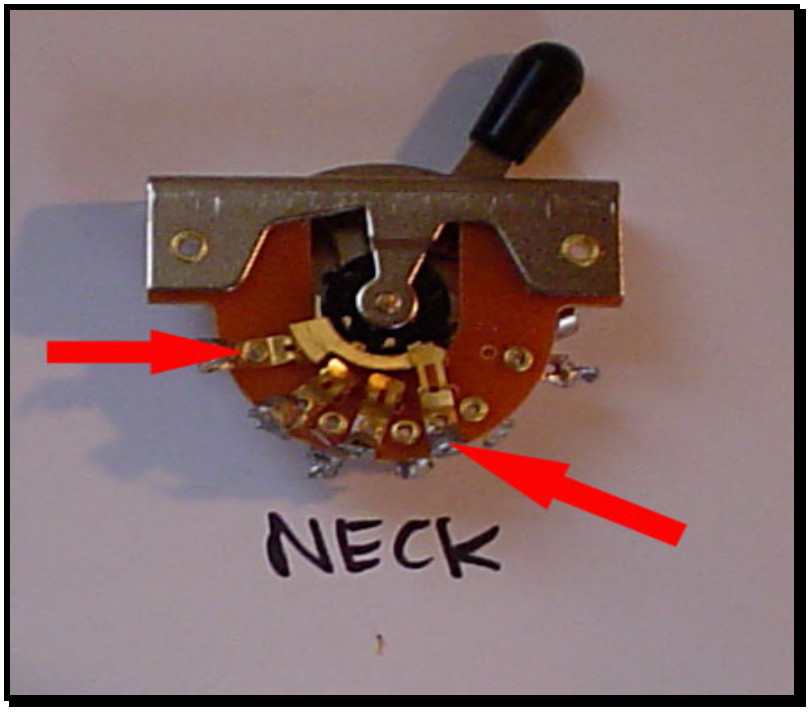
UNDERSTANDING 3-WAY SWITCHES

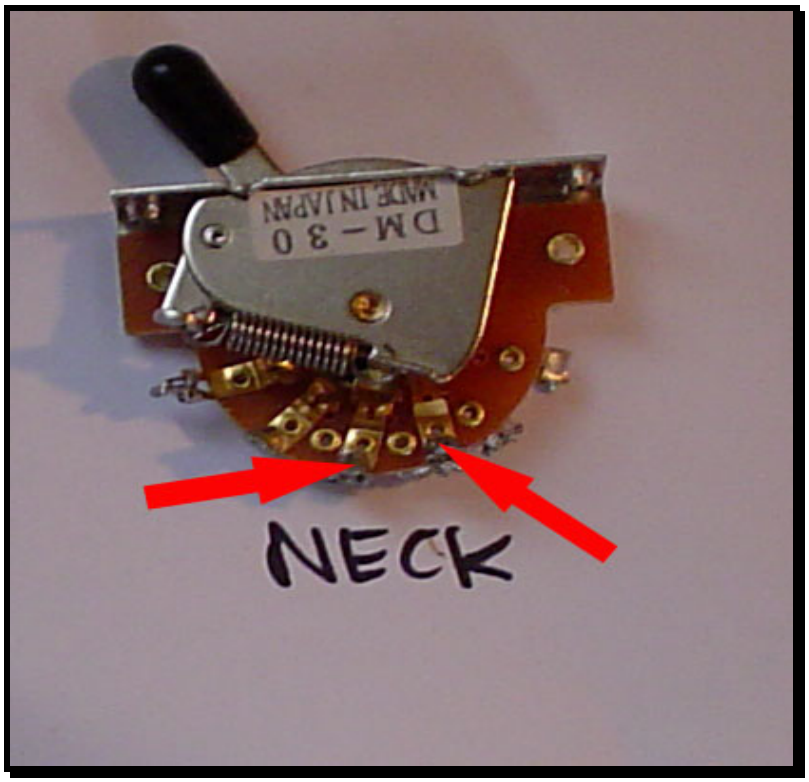
In order to wire 3-way switches, you first need to understand how they work. Basically, you have a hot wire from a pickup that goes into the switch, and a hot wire that goes out of the switch and into the volume potentiometer. From there, the signal goes out to the tone potentiometer and output jack. The 3-way switch will turn on or off each pickup. You have 3 combinations to choose from: the neck pickup on, both pickups on, or the bridge pickup on.

Now, notice where the neck pickup attaches to the 3-way switch. It attaches to two lugs. There are 8 lugs on the 3-way switch (4 per pole), so each pickup will need to hit 2 lugs. The lugs colored in red show where the hot signal travels in each setting. Any pickups connected to those red lugs will be on. Also, notice the jumper wire that connects the right and left sides (poles). This allows each pickup signal to exit out of the same lug, and connect to the volume potentiometer. Also, pay attention to where the switch spring is located when installing the 3 and 5-way switches. The following diagrams use Stewart MacDonald lever switches from Japan (stewmac.com). If you are going to be using Fender or CRL switches, turn to page 16 for an explanation on the various types of lever switches.

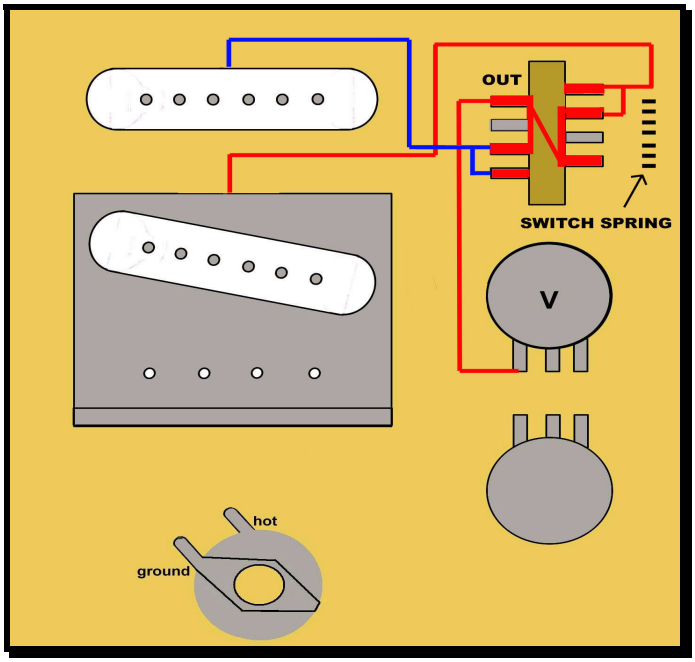


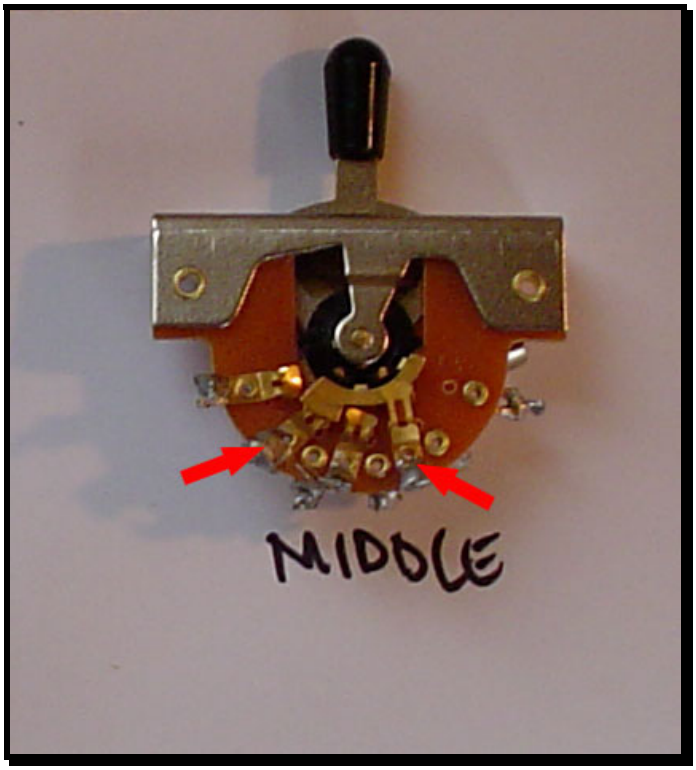
Here is a picture of the actual switch in the neck position. The red arrows show which lugs have the signal traveling through them.

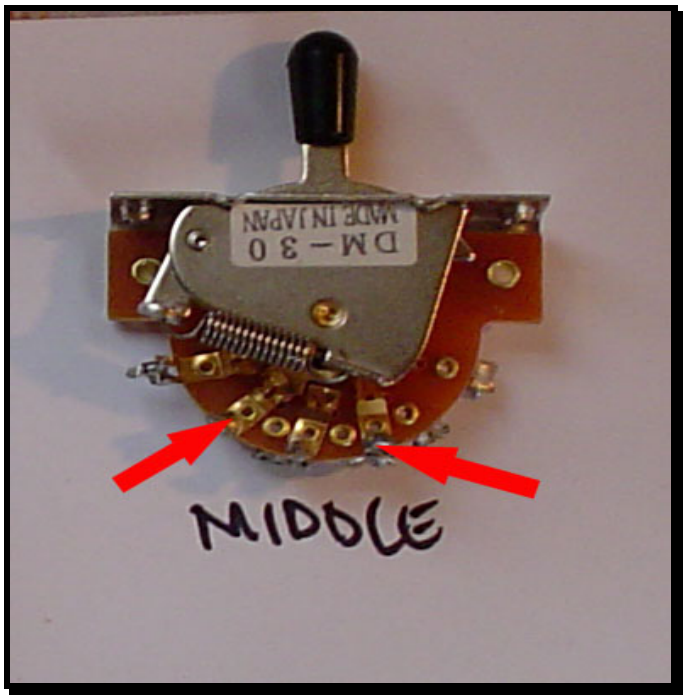




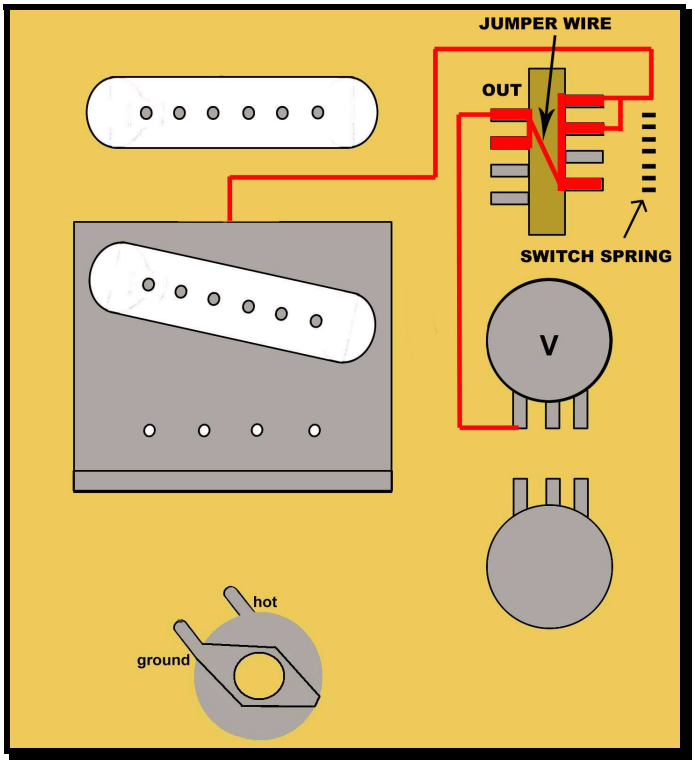
Now we are going to look at the switch when it is in the middle position. In this position, both pickups will be on. The bridge pickup connects to the opposite side of the switch.

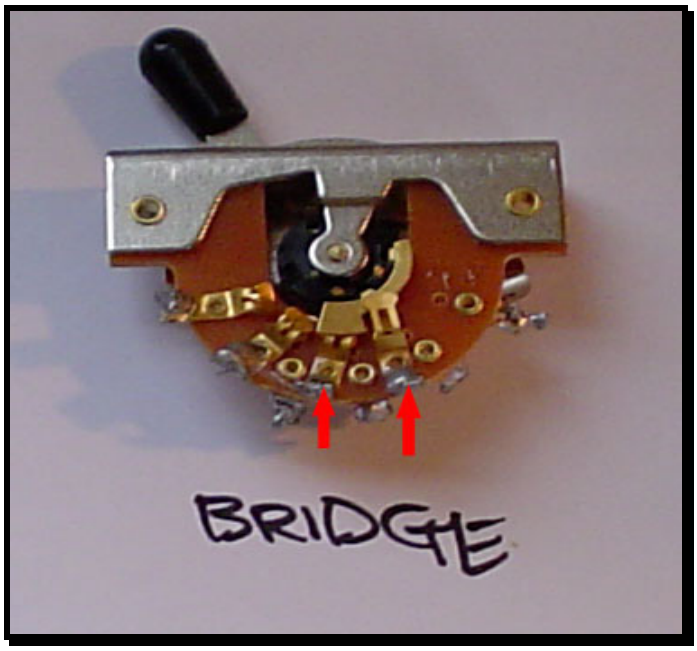


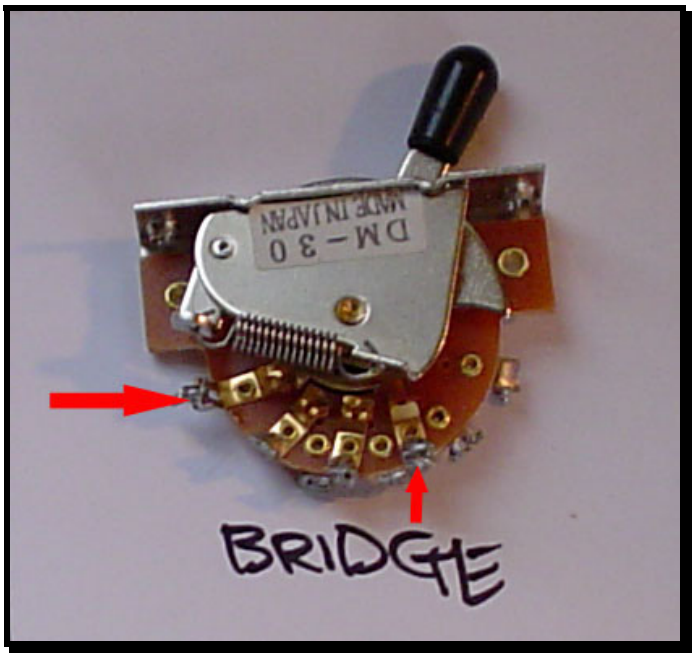




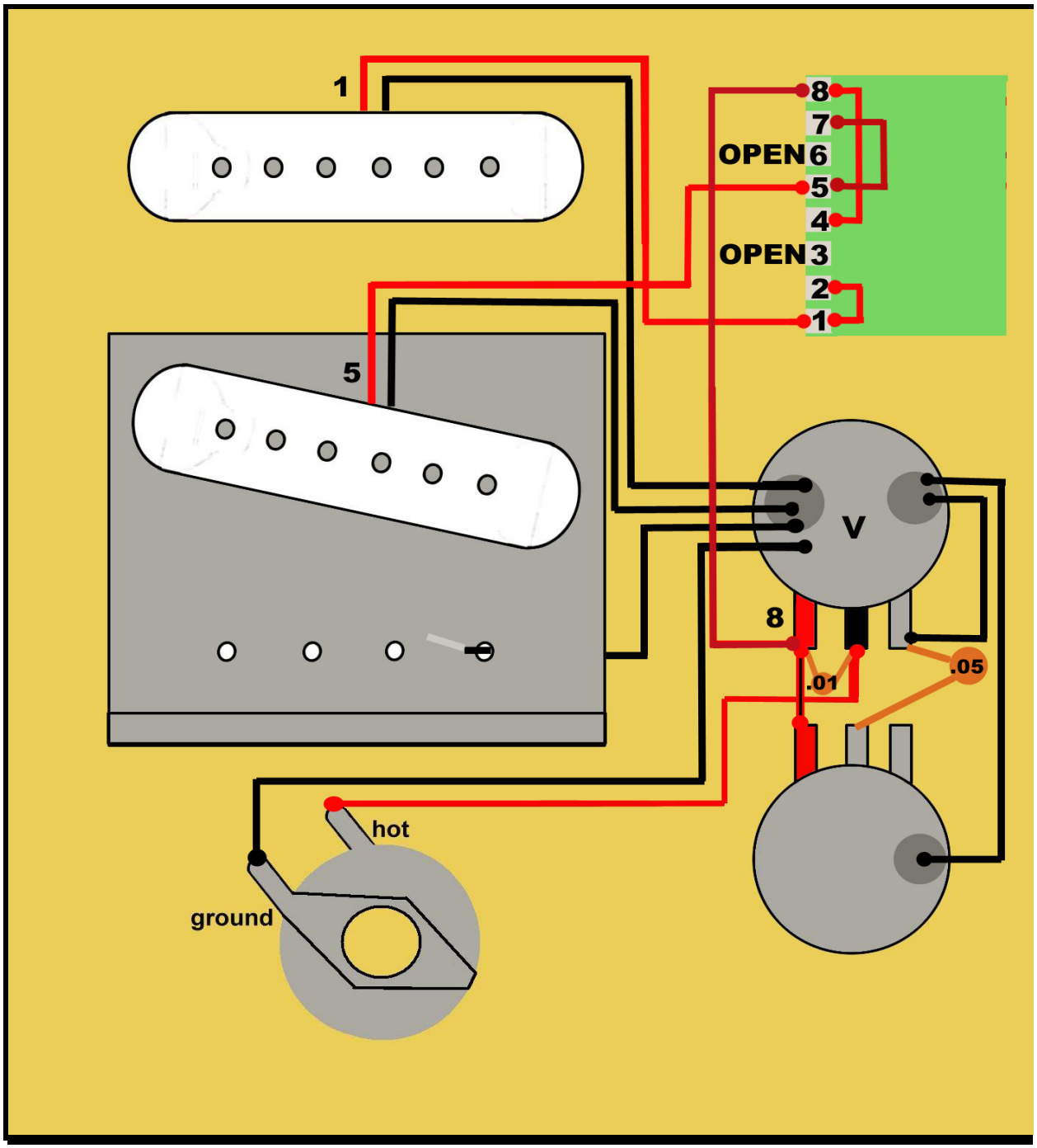
Now take a look at the bridge position.

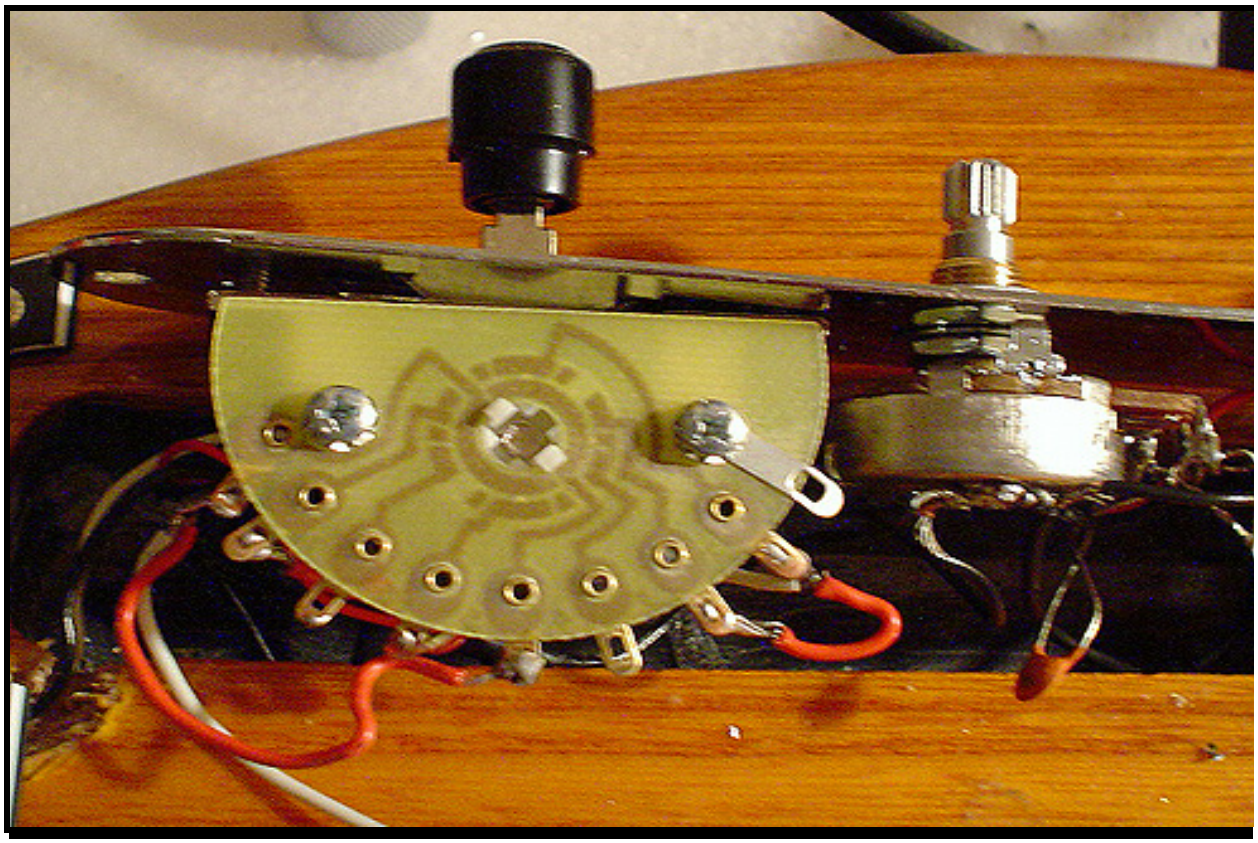


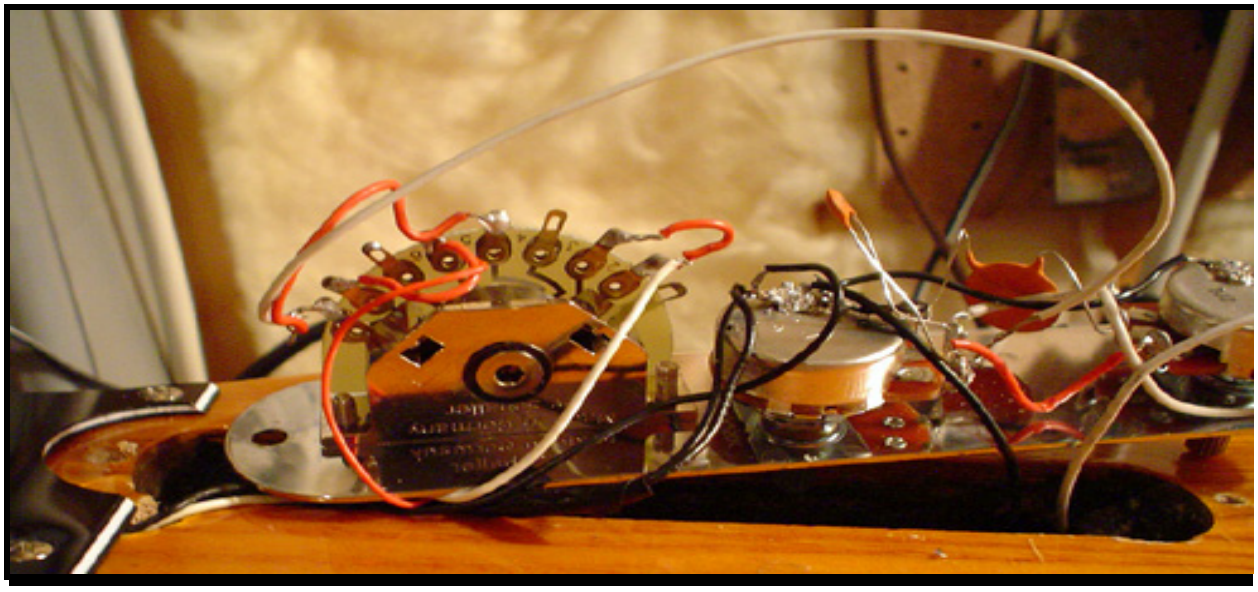




If you are looking for a 3-way switch designed to reduce unwanted noise, you can always try a **mega switch** by Schaler. Some guitarists prefer these to the standard spring action lever switches. I can't really notice much of a difference in these switches, besides the action in the lever. Wiring them is pretty simple, though.

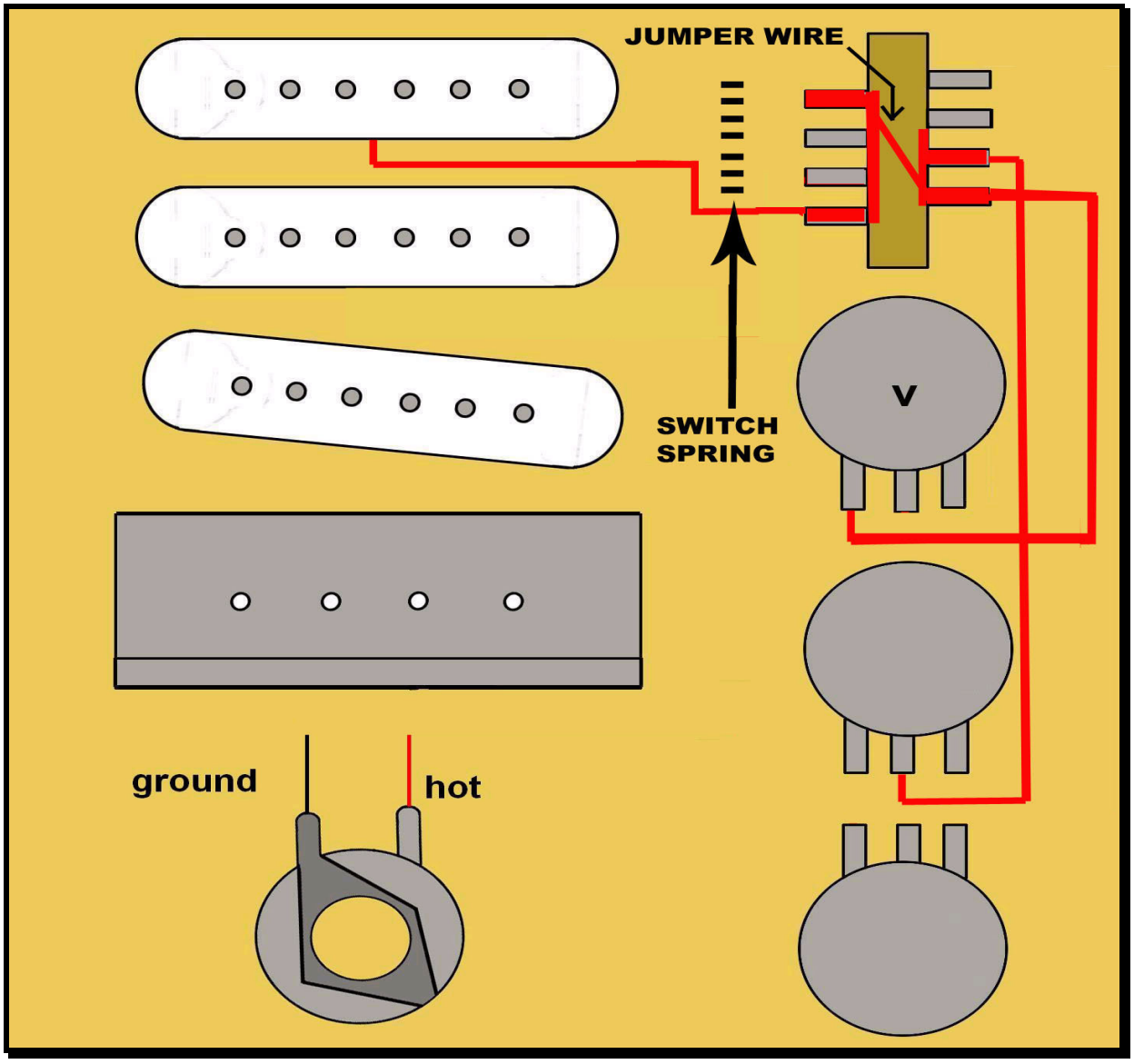


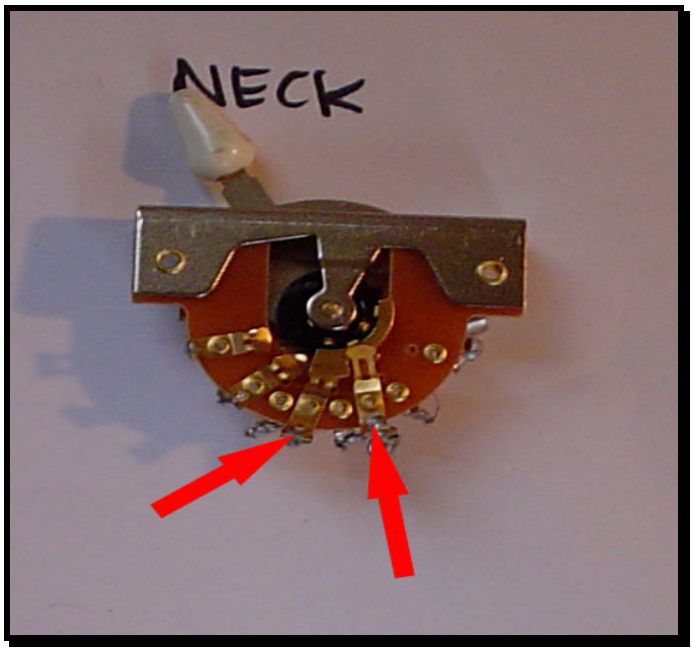


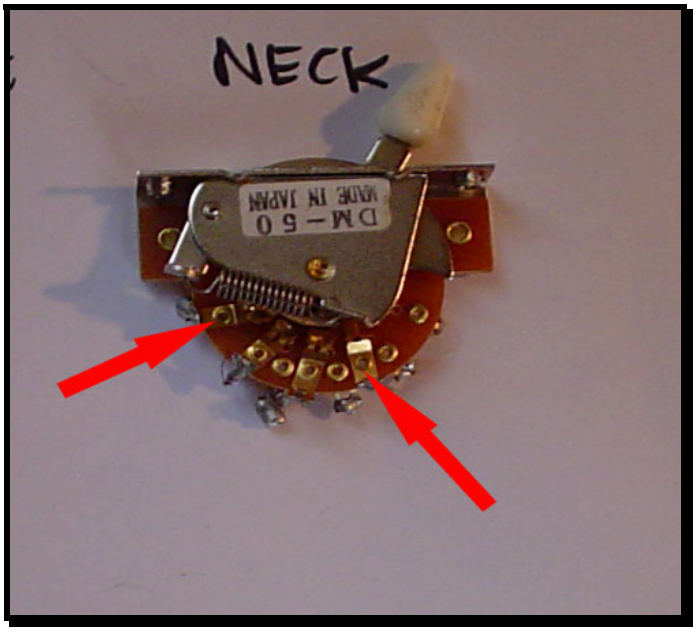


UNDERSTANDING 5-WAY SWITCHES

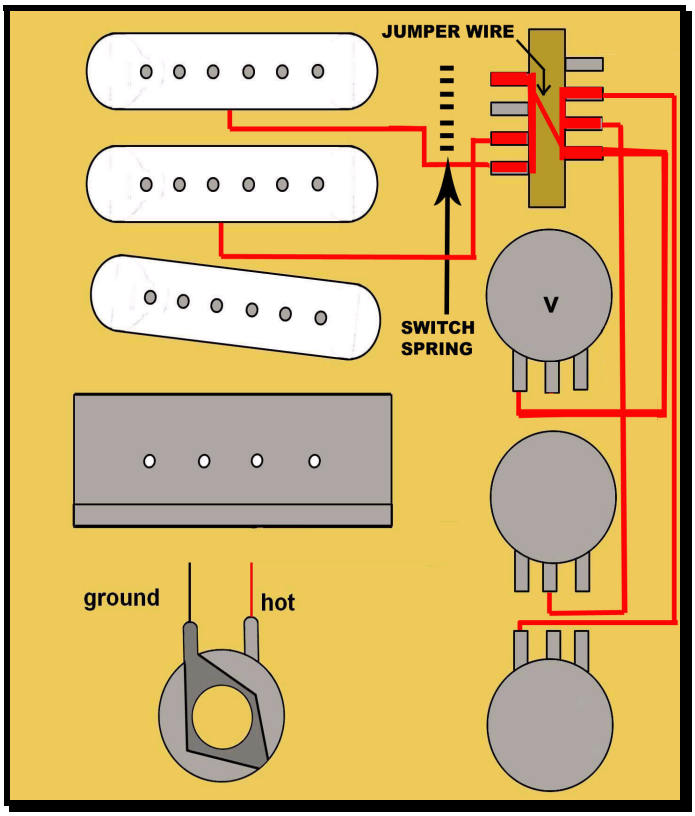
The 5-way switch is similar to the 3-way switch, with 4 lugs on each pole. The difference is it has more lugs touching each other to come up with more pickup combinations. Since there are 5 different pickup selections, each pickup connects to only one lug. The choices for this switch are: neck pickup on, neck and middle pickups on, middle pickup on, middle and bridge pickups on, and bridge pickup on. The following diagrams use Stewart MacDonald lever switches from Japan (stewmac.com). If you are going to be using Fender or CRL switches, turn to page 16 for an explanation on the various types of lever switches.

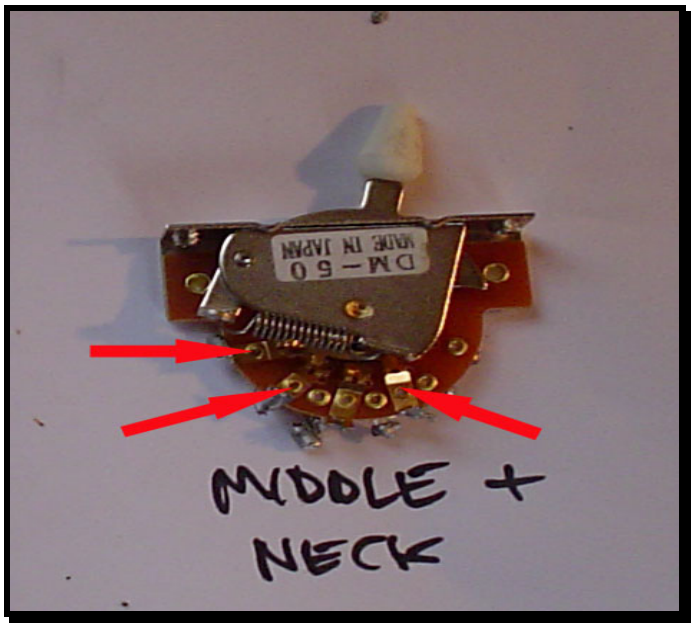




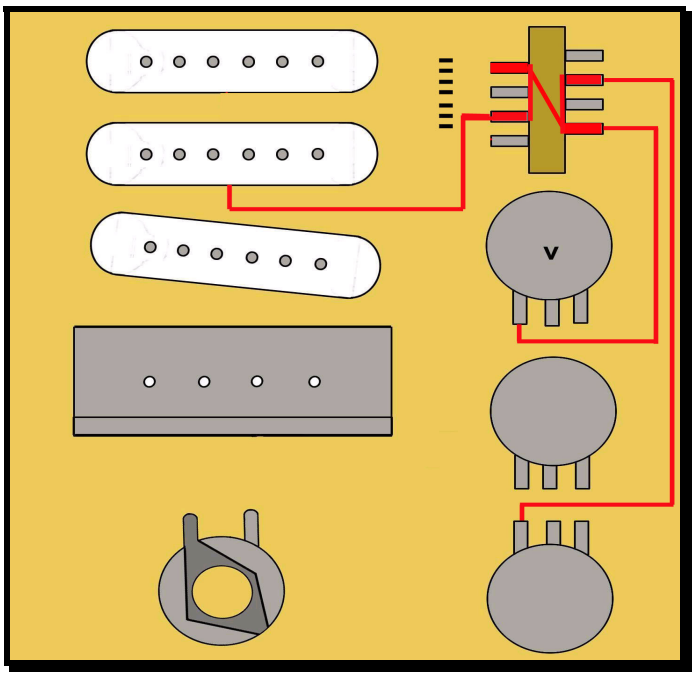


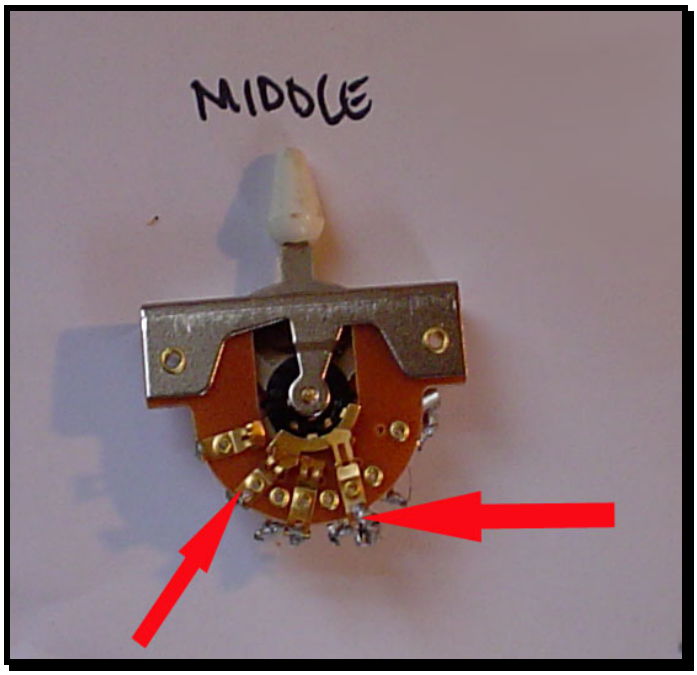
Notice the neck and middle position. Adding the middle pickup gives you more mid range.

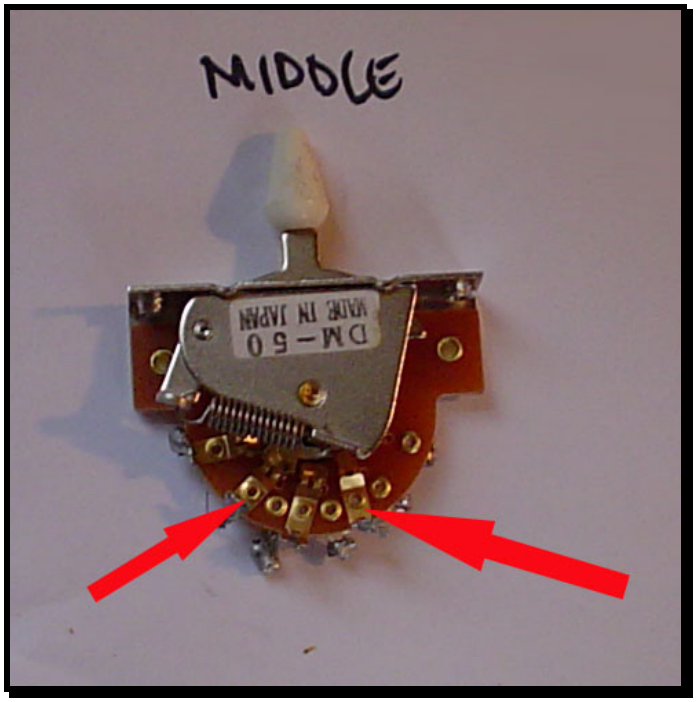




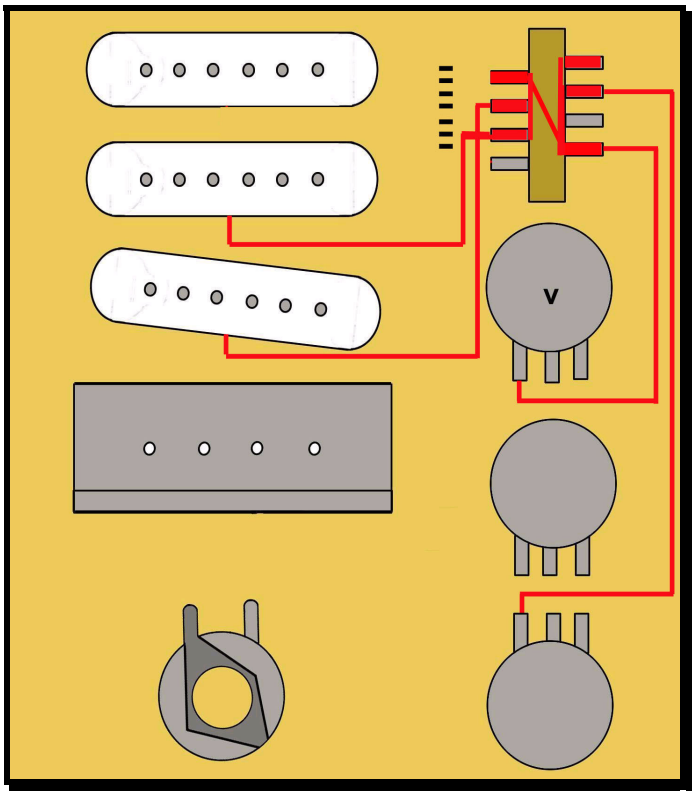
Let’s talk about the middle position. The hot signal enters the switch on one side and travels through the jumper cable and out to the volume and tone pots. The tone pot farthest away from the volume pot controls the middle pickup's tone. This pickup combination is probably the least exciting out of the 5 choices available. It lacks the highs and lows that the other combinations have.

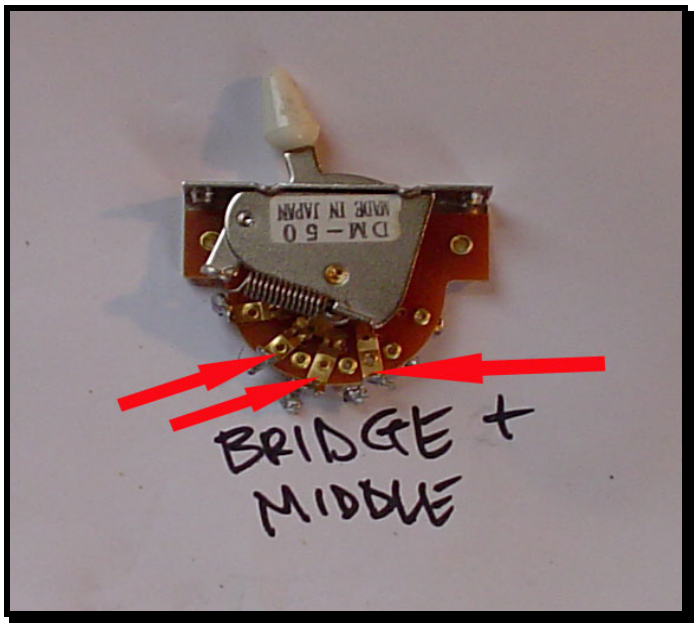




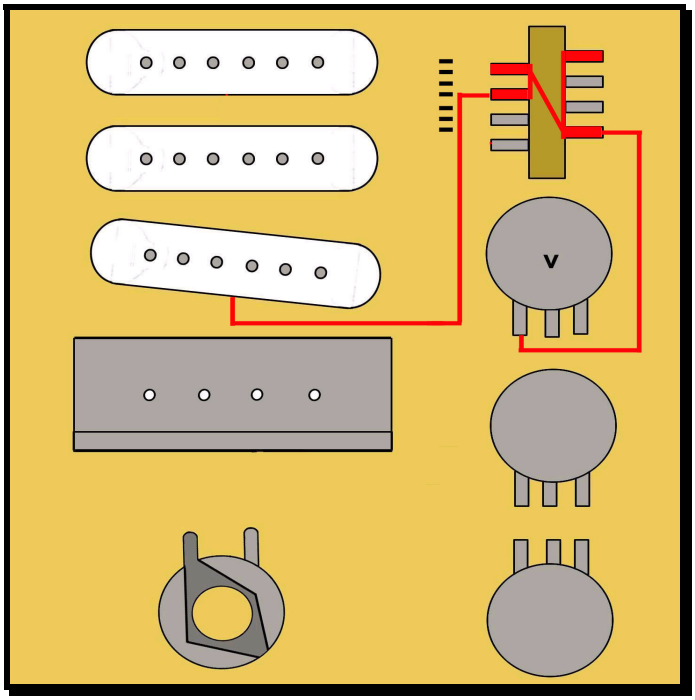


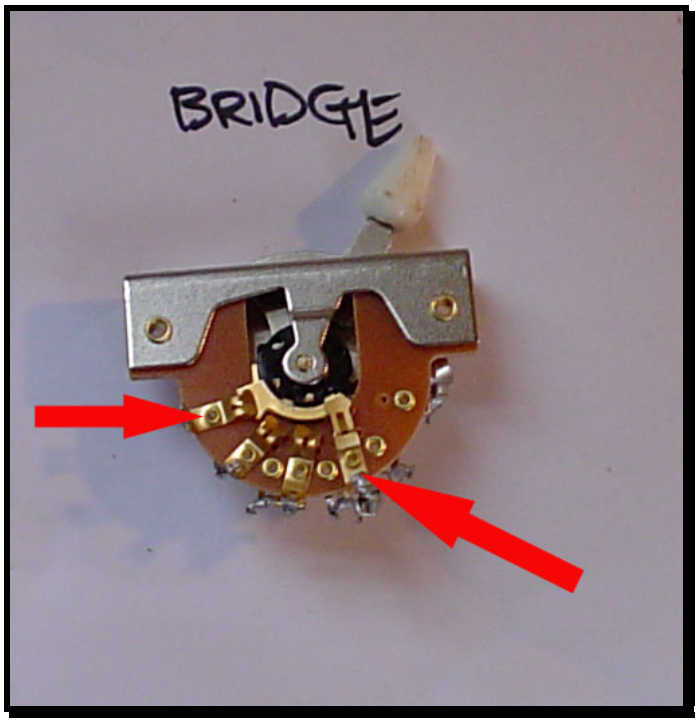
The next selection is the middle and bridge pickups on.

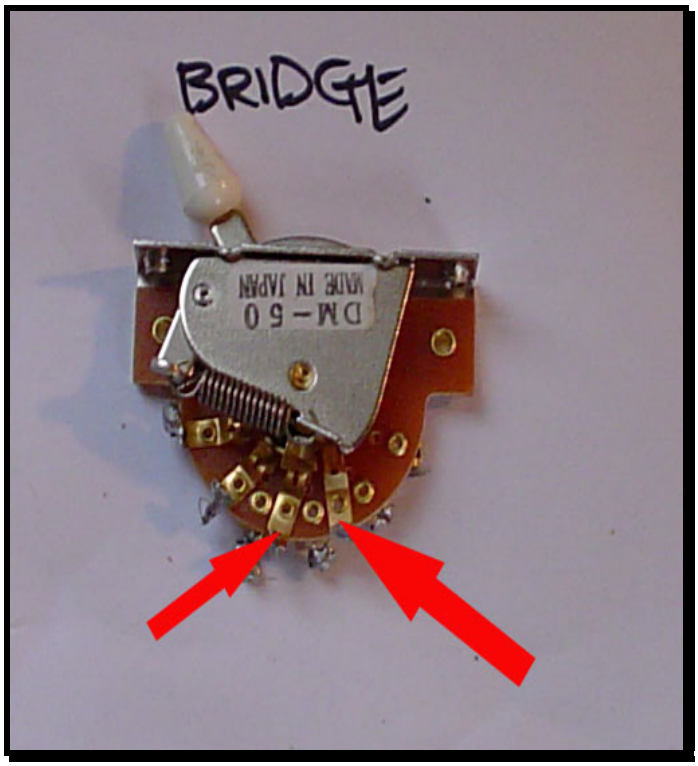




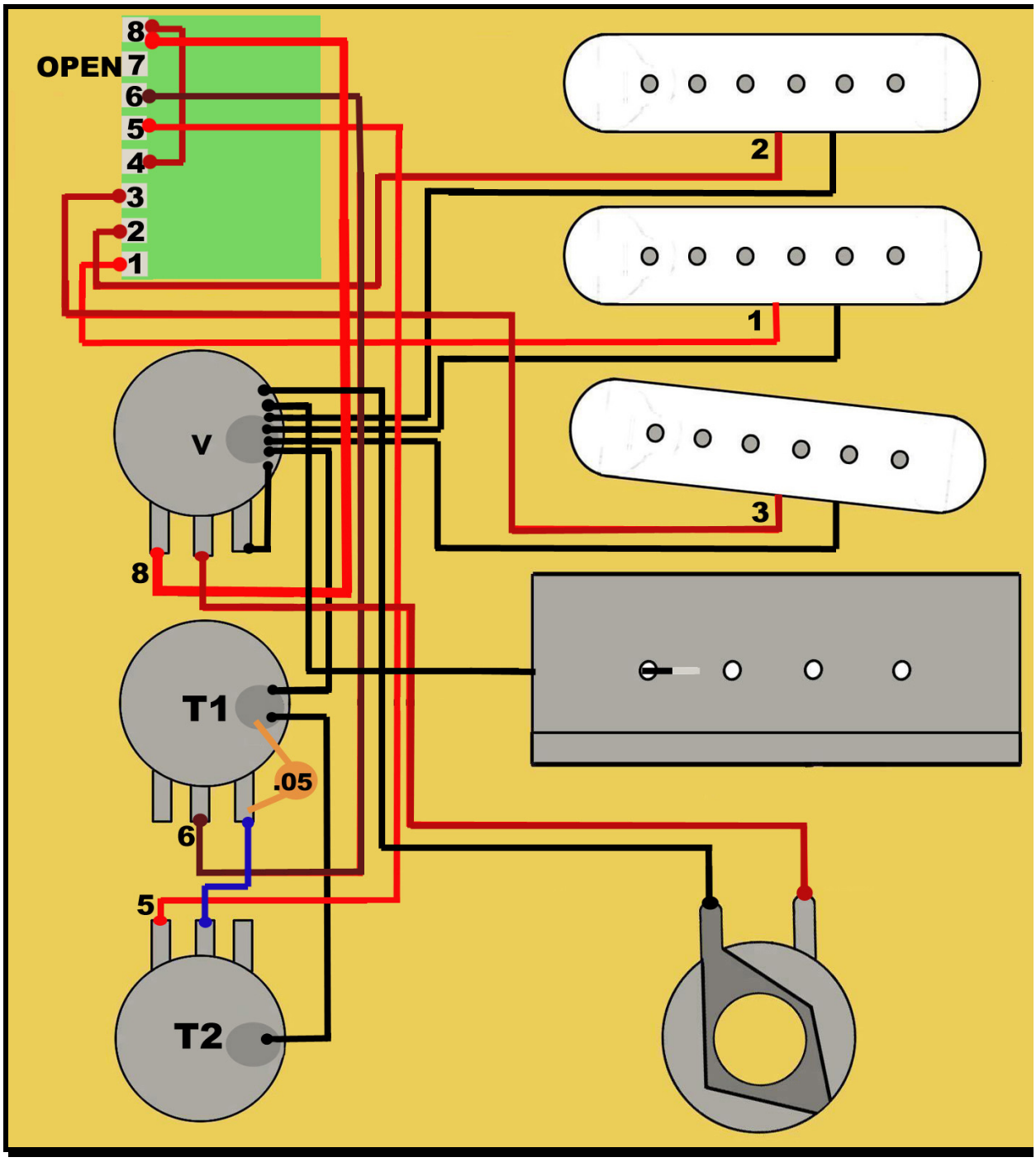
The last choice is the bridge pickup selection. This choice offers alot of treble, and is perfect for playing heavy distortion and artificial harmonics. You can make the guitar scream with the bridge pickup on. Notice that there is no tone control for the bridge pickup. If you want more bass or midrange in your bridge pickup, then you need to select a different pickup, or modify your guitar.

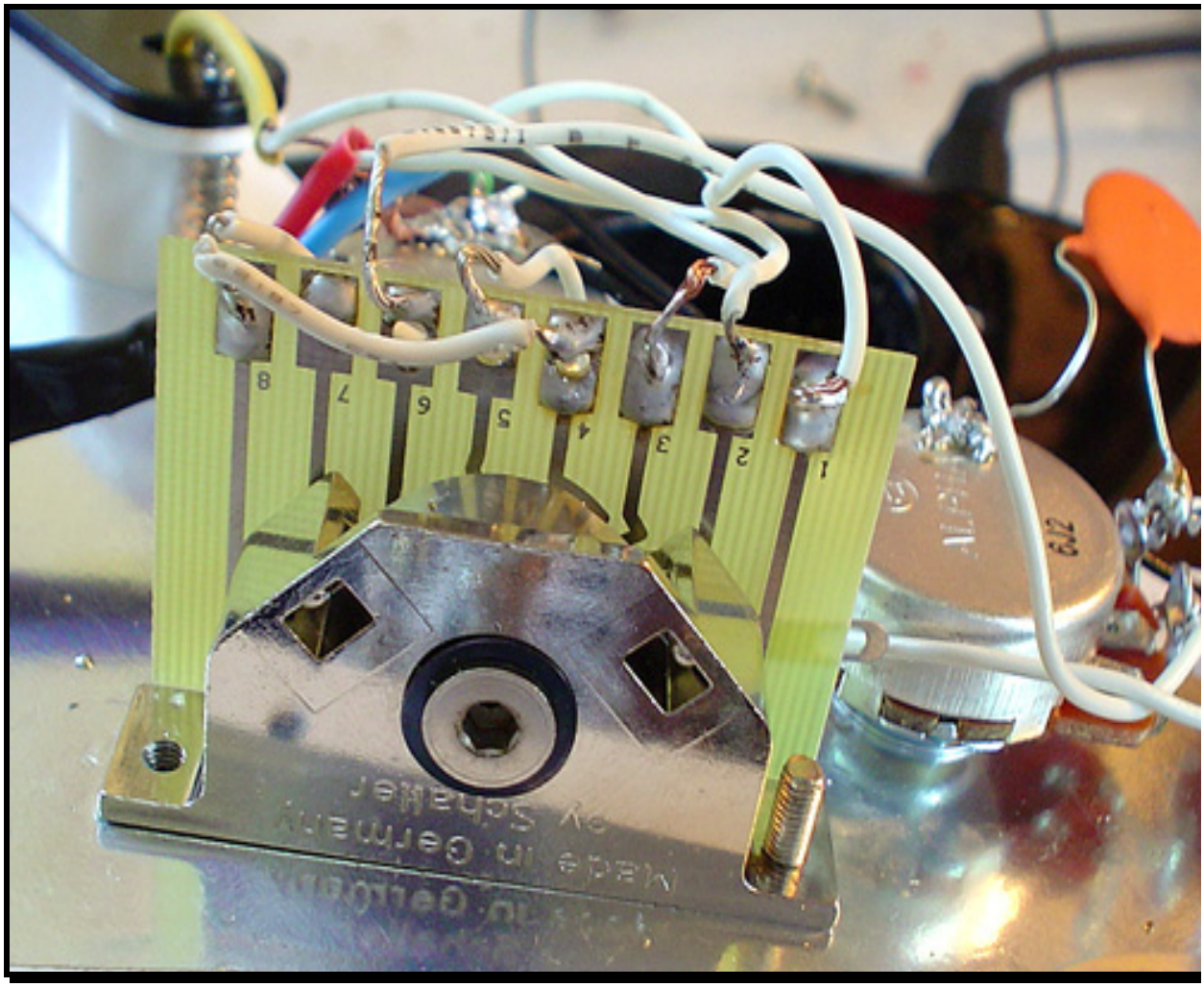






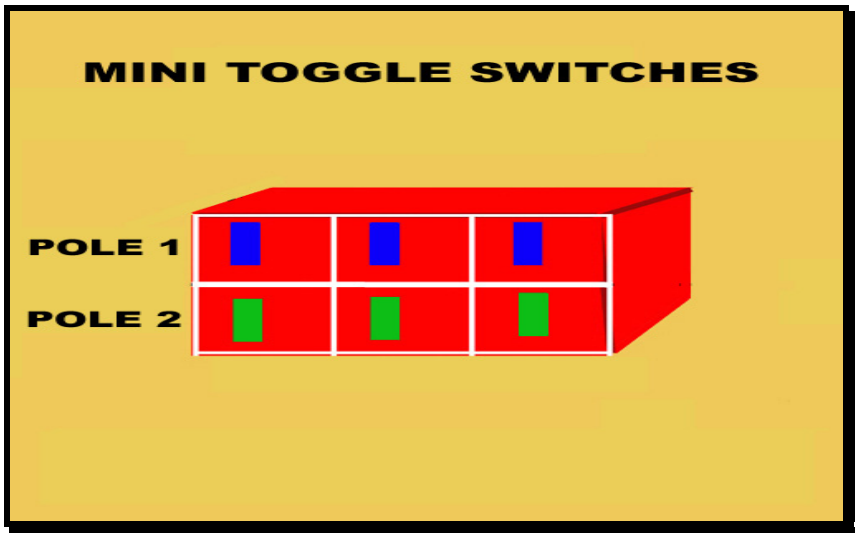
If you want to install a 5-way **mega switch** in your strat, then you can wire the guitar like this.



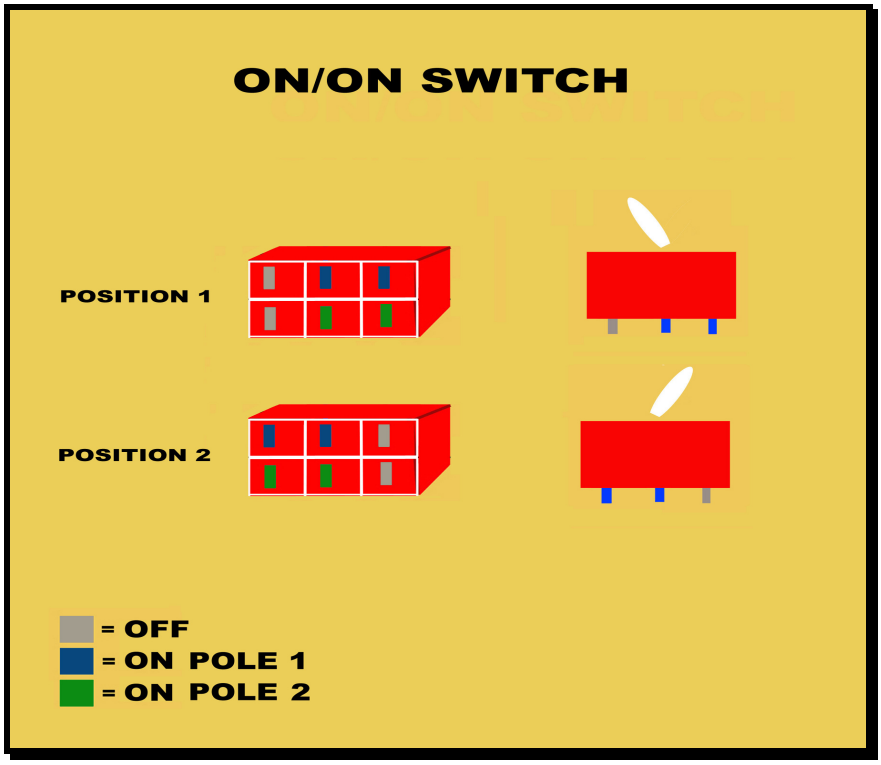


UNDERSTANDING TOGGLE SWITCHES

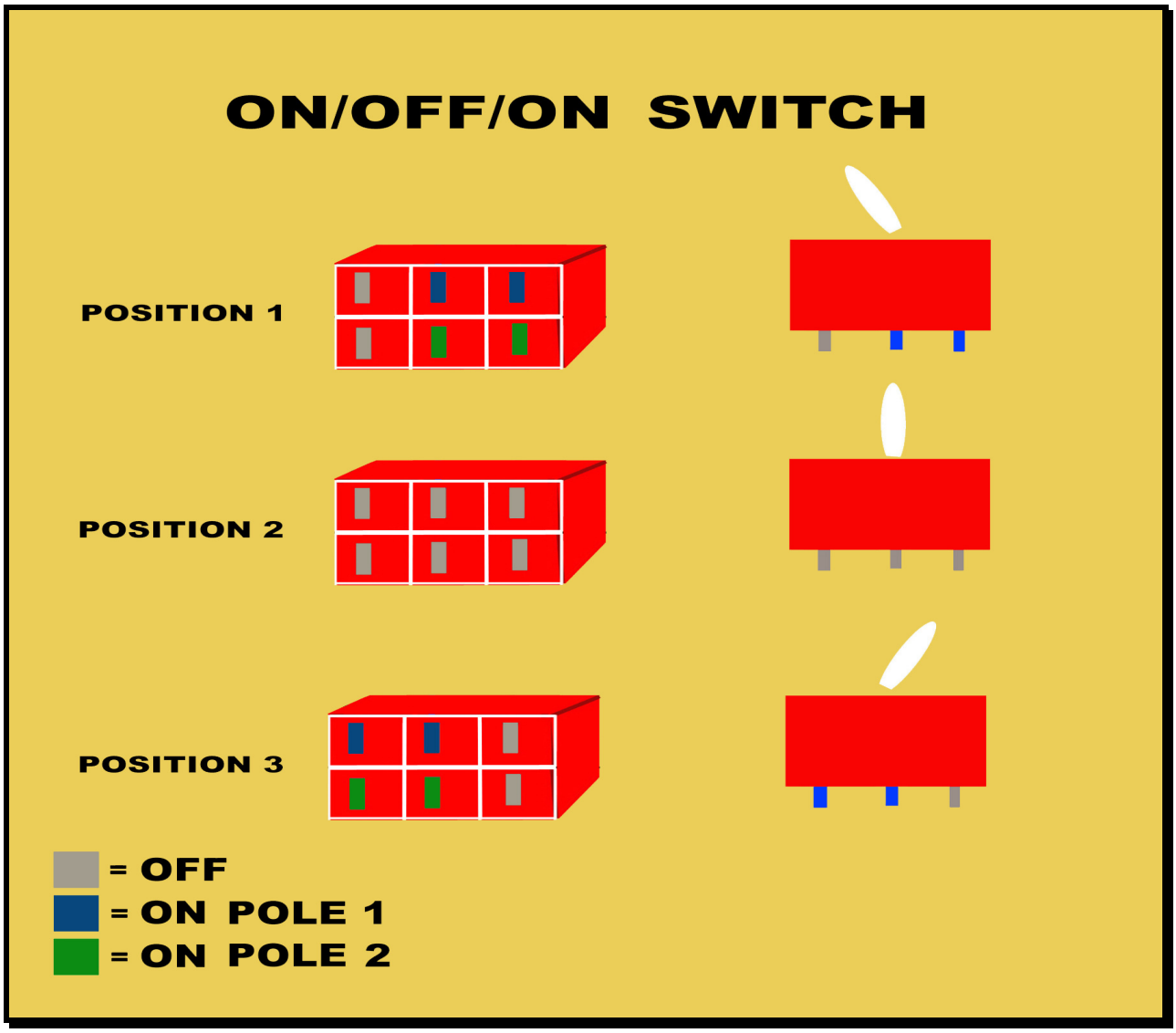
Toggle switches open or close a circuit. In other words, they turn a signal on or off. They can be used for all types of guitar modifications, including series/parallel wiring, phase reversal, and coil cutting. The mini toggle switches that we will focus on in this book are **DPDT (double pole, double throw) switches.** Since they have 2 poles, they have two separate channels that are not connected to each other, unless you add a jumper wire.



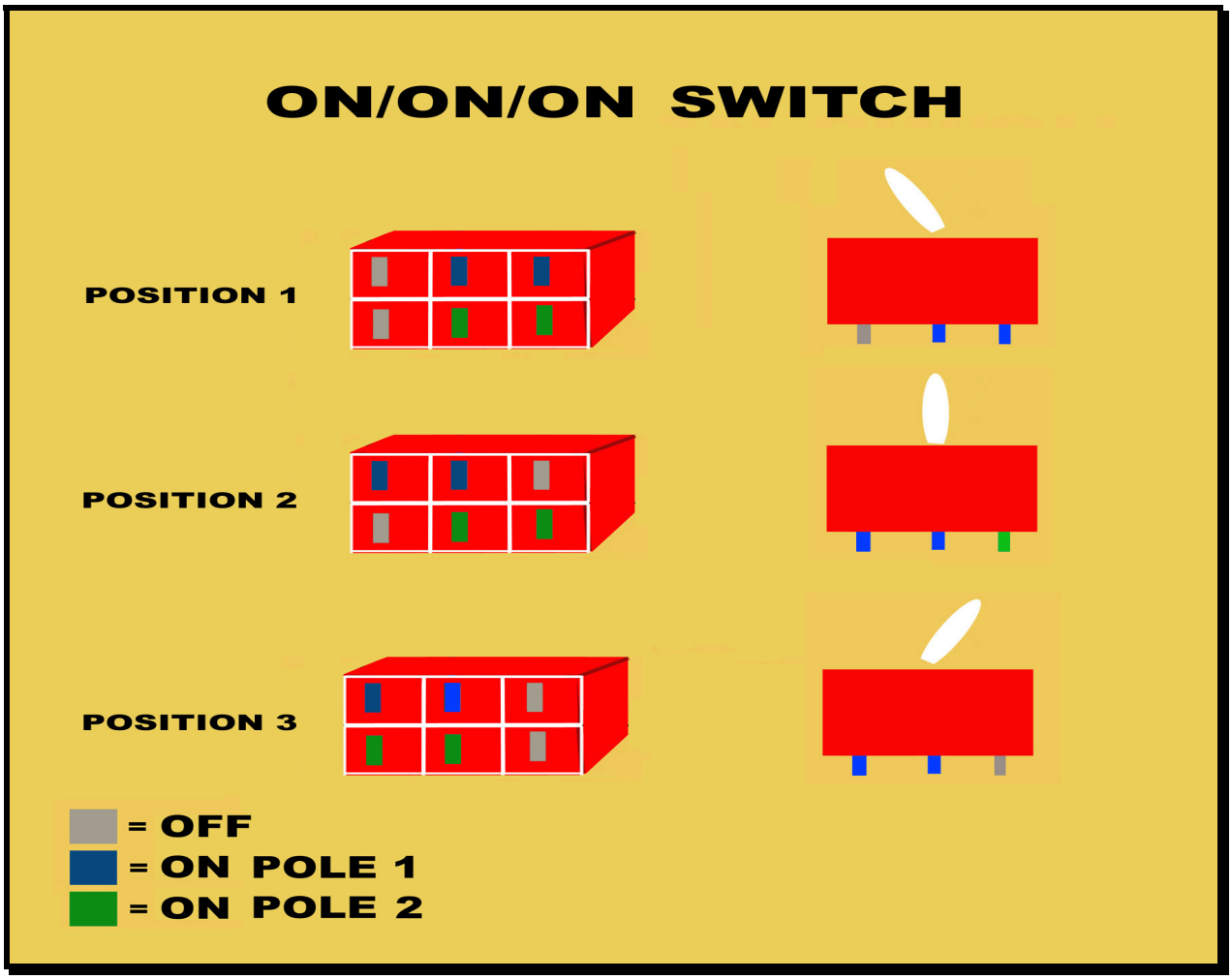
The 2 way mini toggle switch below is an **on/on DPDT (double pole, double throw) switch,** and you can purchase them online for a few bucks. This switch is an on-on switch, meaning it turns one side on, or the other side on. So when one pickup is turned on, the other pickup is turned off. It has six lugs, 3 on the top, and 3 on the bottom. The lugs that are hot, or "on", are colored in blue or green. Each color represents a different pole. The grey lugs are off.



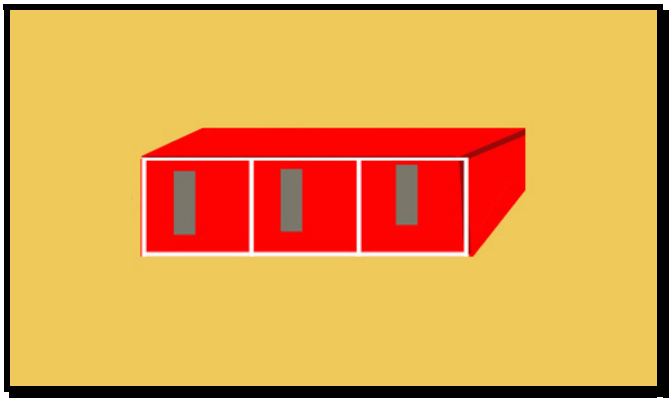
There are a few other types of 3-way mini toggle switches that can be useful in guitar wiring. Below is an **on/off/on DPDT center-off switch.** It is the same as the on-on mini toggle switch with an additional stop in between the left and right settings. The middle position cuts the power. So it is an on-off-on switch. Here is what it looks like.



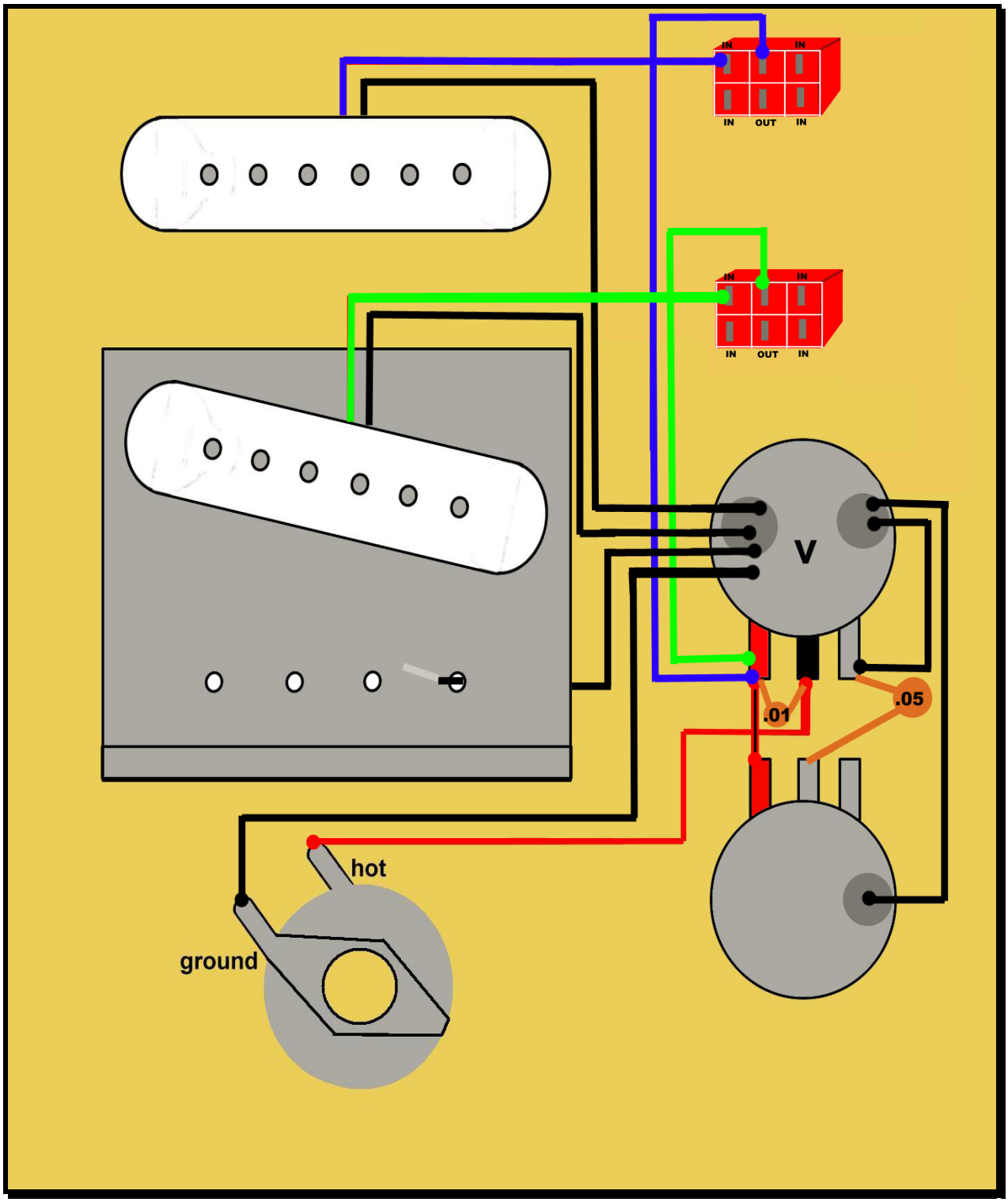
The next 3-way mini toggle switch is an **on/on/on DPDT center-on switch.** It is used for series/parallel switching, coil cutting, and phase reversal. It turns on the top left lugs and bottom right lugs while in the middle position.



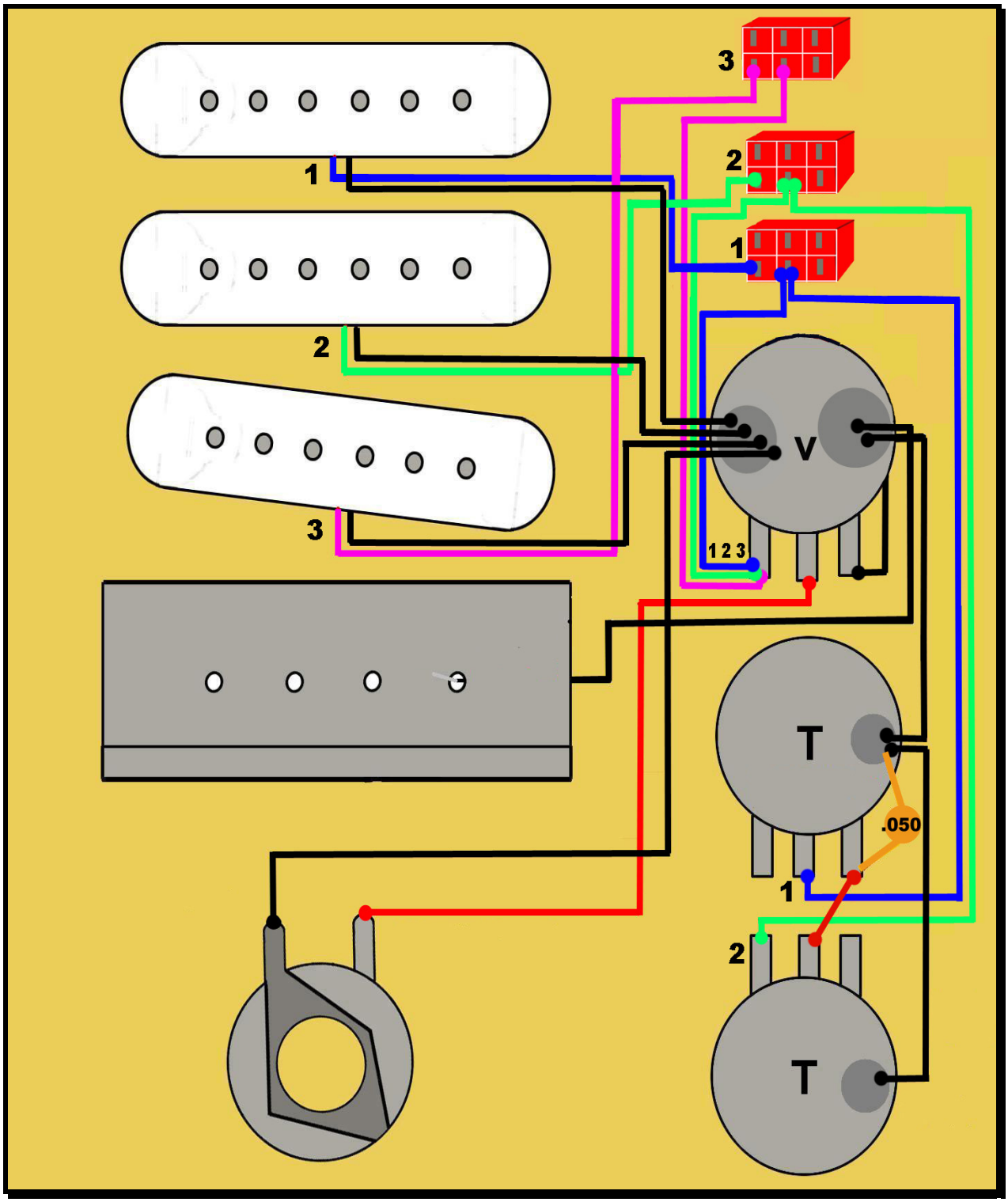
If you are wondering what a single pole double throw **SPDT switch** looks like, here is a diagram. It is the similar to the DPDT switches, except it only has one pole, or channel.



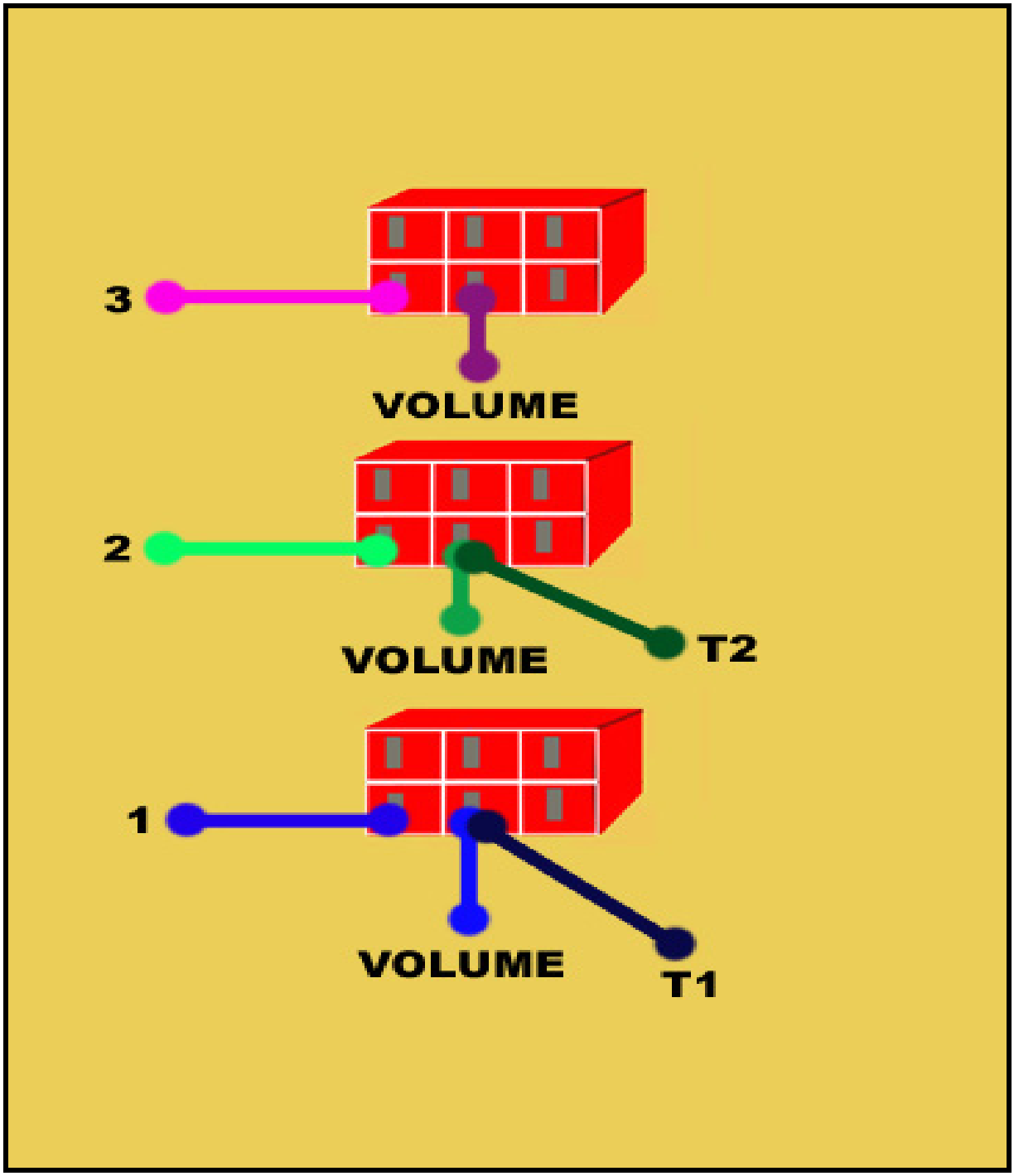
Here is the telecaster guitar wiring with two DPDT on-on toggle switches. Each toggle turns on one pickup.



Next is the wiring for the strat with three on/on/on mini toggle switches. Each switch turns on a different pickup. You can get seven different tones with this setup.

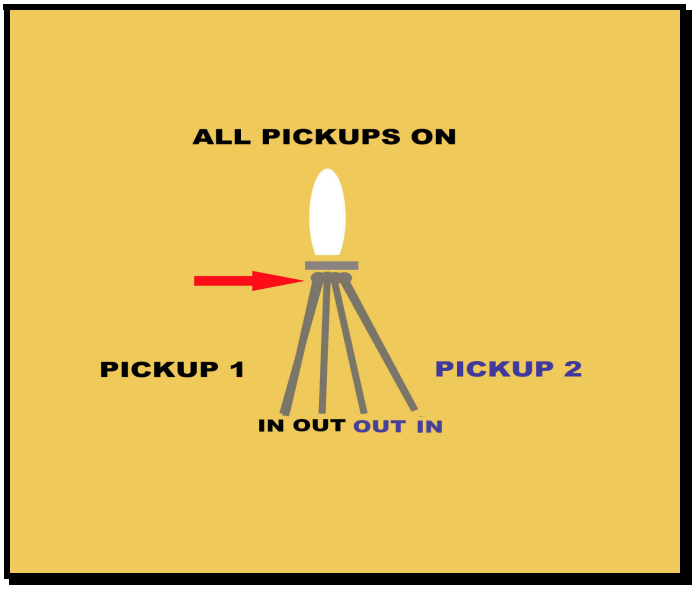


Here is a close up of the mini toggle switches. They connect the pickups to the volume pots and tone pots.

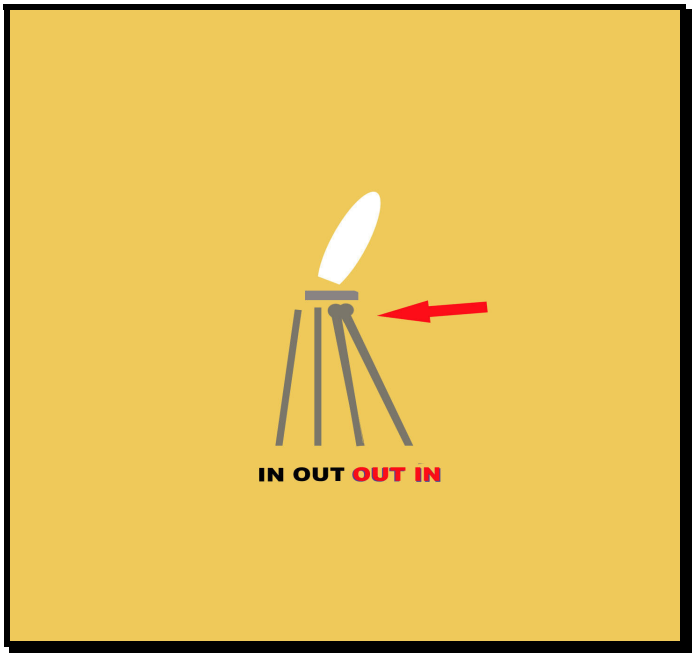


Not all toggles have 6 lugs. Some toggles have less. **Gibson style toggle switches**, for example, have 4 lugs and can turn on 2 separate devices at the same time (on, both on, on). Check out the Gibson style toggle below. Wiring them is fairly similar to the mini toggle. You have two inputs and two outputs. The ground wire gets soldered to the lug on the back. Solder the middle two output lugs together if you want both pickups on when the switch is in the middle position.

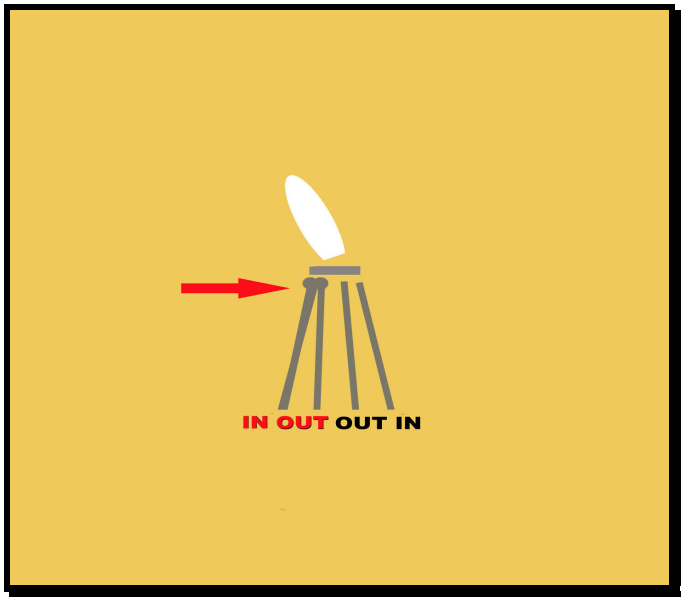
This next diagram will show you how the toggle works in the middle position. All lugs are touching, so both pickups are on.



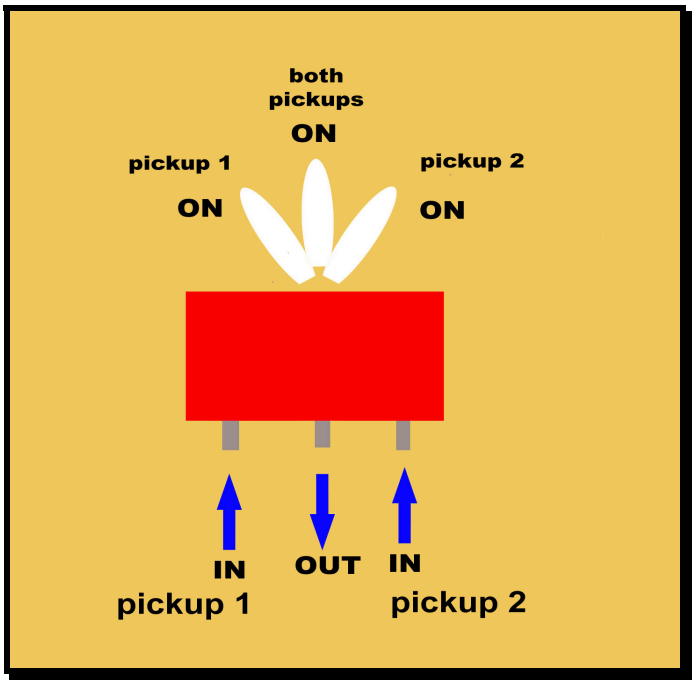
In this next example, the right two lugs are touching, completing the circuit. The pickup on the right is on, and the other is off.



This example shows what happens when the opposite side is turned on. The left pickup is now on.

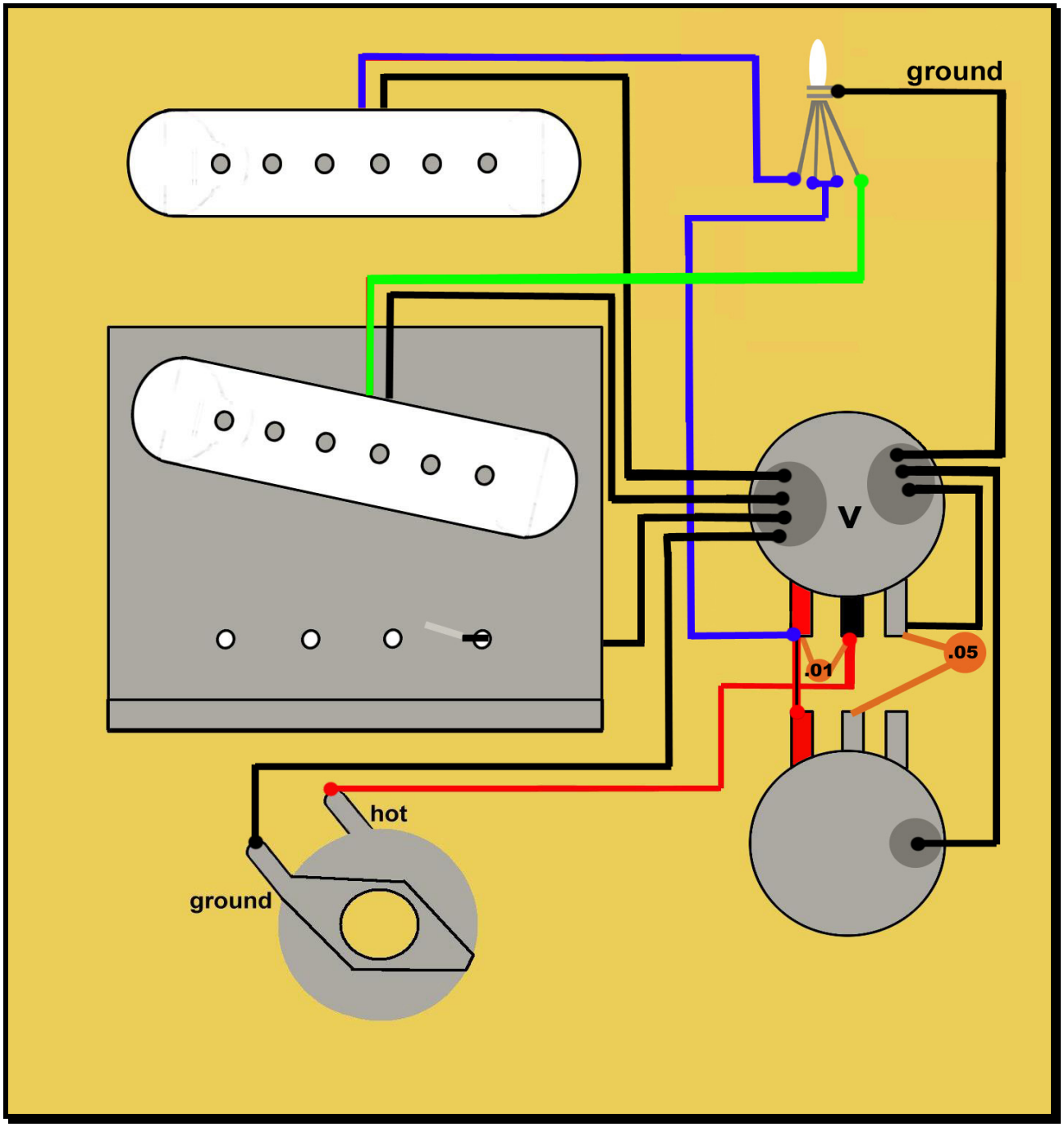


Some Gibson style toggle switches only have three lugs, but still work in the same manner.

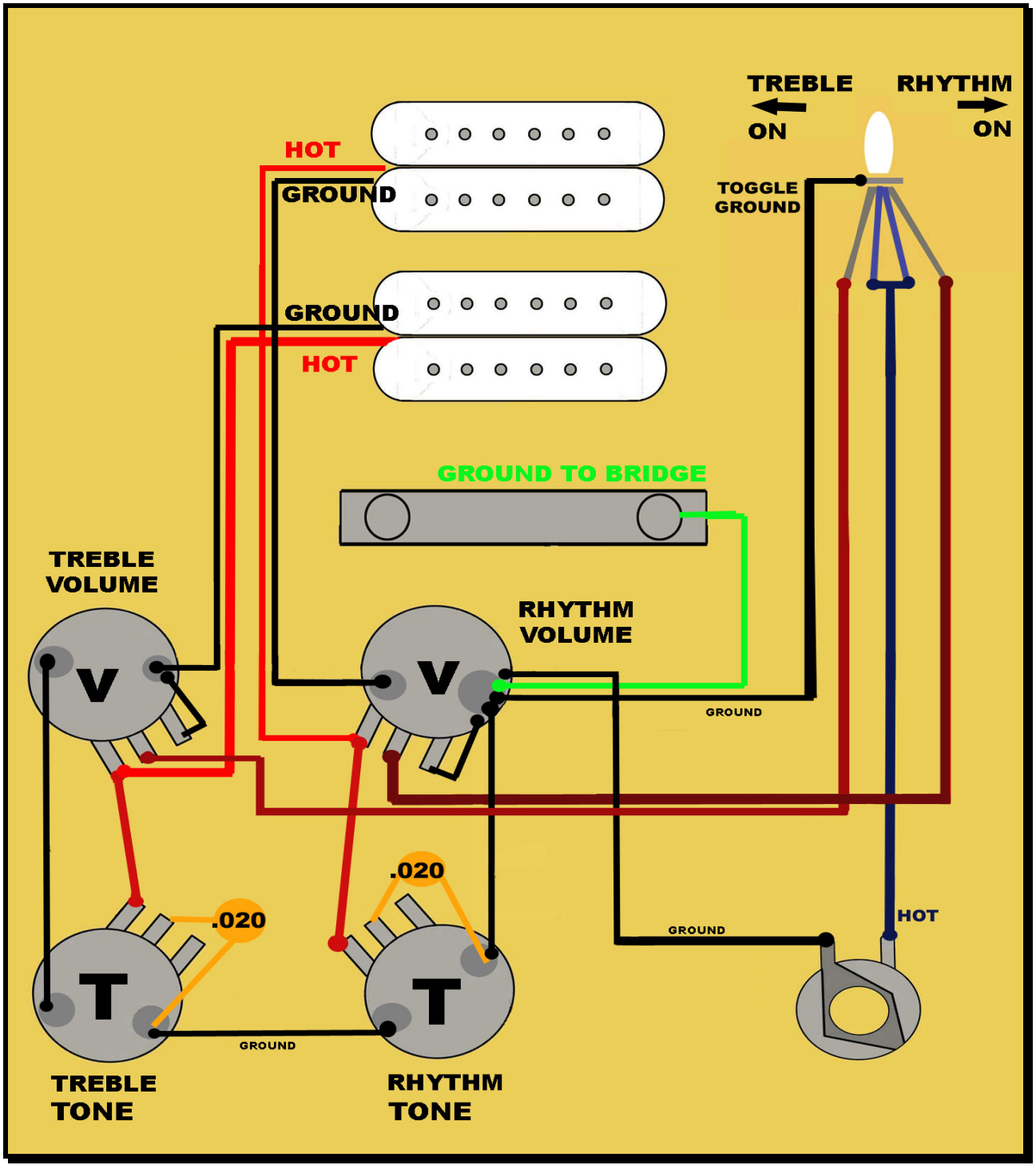


The next page shows one way to wire a tele style guitar with a Gibson toggle. It would also work with any 2 pickup guitar that had one tone and one volume control. This way seems

more practical than having a separate tone and volume knob for each pickup. But I guess that depends on how much time you want to spend changing settings while playing. This setup functions the same as a 3-way lever style switch. You can turn on each pickup individually, or both at the same time. Also notice that a ground wire has been added to the toggle switch to reduce unwanted noise.



Here is the Les Paul with the Gibson toggle switch.



UNDERSTANDING VARITONE/ROTARY SWITCHES

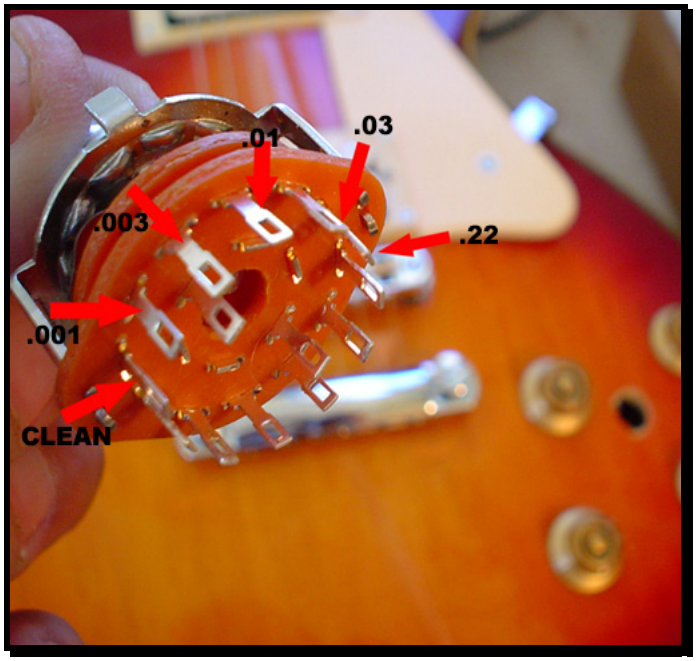
The next switch we are going to discuss is the Varitone, or rotary switch with the chicken head knob. This switch allows you to dial in specific tones for each setting, and eliminates any guesswork associated with the subtlety of tone potentiometers. This type of switch has 6 settings for 6 different tones. The first tone is usually clean, so that leaves 5 other tones to chose from. These 5 tones will be determined by the size of the capacitor that gets soldered to each lug on the rotary switch. These switches are very easy to wire. Just solder capacitors to each lug on the Varitone switch, then connect the open ends of the capacitors together, and send the signal out to the output jack. Also connect a ground wire to the common lug in the middle of the switch.

Below are some capacitor values used on the Gibson 345 Lucille guitar. These values are measured in microfarads. The bigger capacitors will give you a muddier sound. You can experiment to find the tones you want by using different capacitor values.

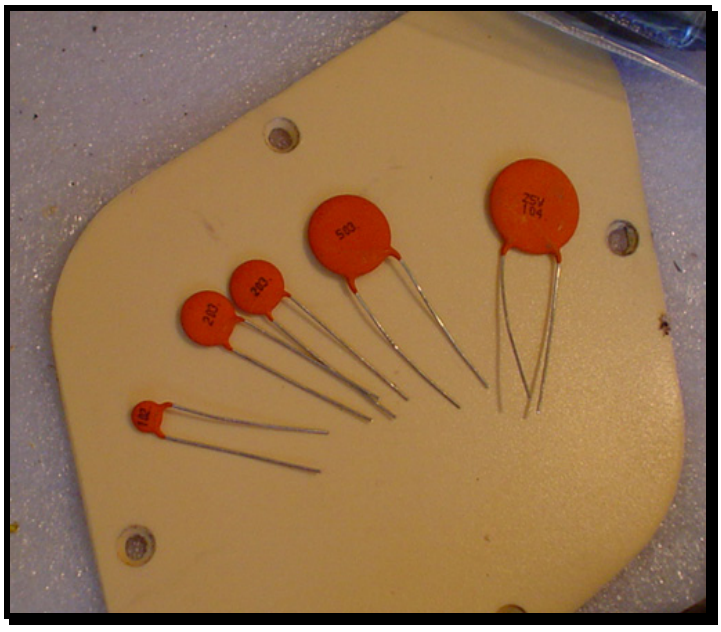
LUG 6 - 0.22 µF
LUG 5 - 0.03 µF
LUG 4 - 0.01 µF
LUG 3 - 0.003 µF
LUG 2 - 0.001 µF
LUG 1 - no capacitor (clean sound)

Here is how you install a Varitone in a Les Paul style guitar. First, drill a hole in the body. Then install the Varitone switch. Mark on the switch the lugs that you will be using. When you look at the side of the switch, you can see which lug is in use. This particular switch has 12 lugs (6 per pole). We will only be soldering capacitors to 5 of these lugs, so turn the switch through all 6 positions, and notice which lug is completing the circuit in each setting. Then you will know which 5 lugs need to have capacitors soldered to them. One out of those 6 settings is left open, so it gets a clean, unaltered sound.

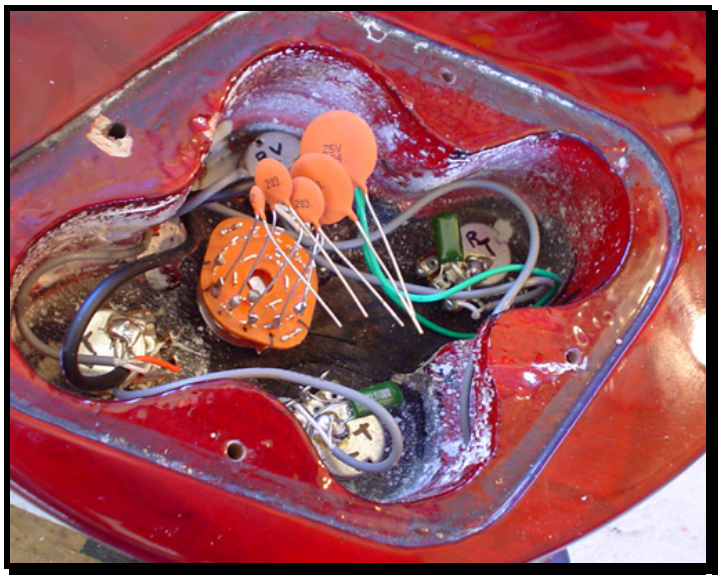
Here are the lugs that we will be using.



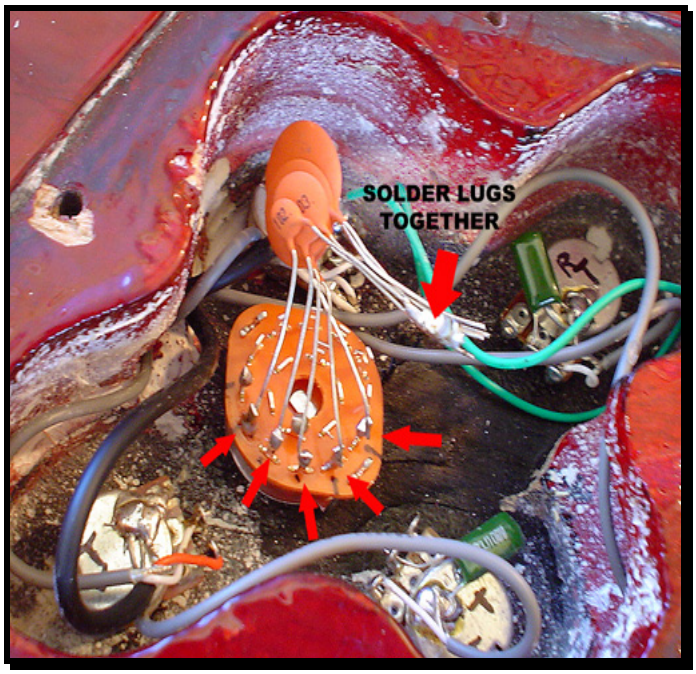
Here are the capacitors that I chose for this project.



Now solder one end of each capacitor to one of the lugs on the Varitone switch. Solder them in ascending order.

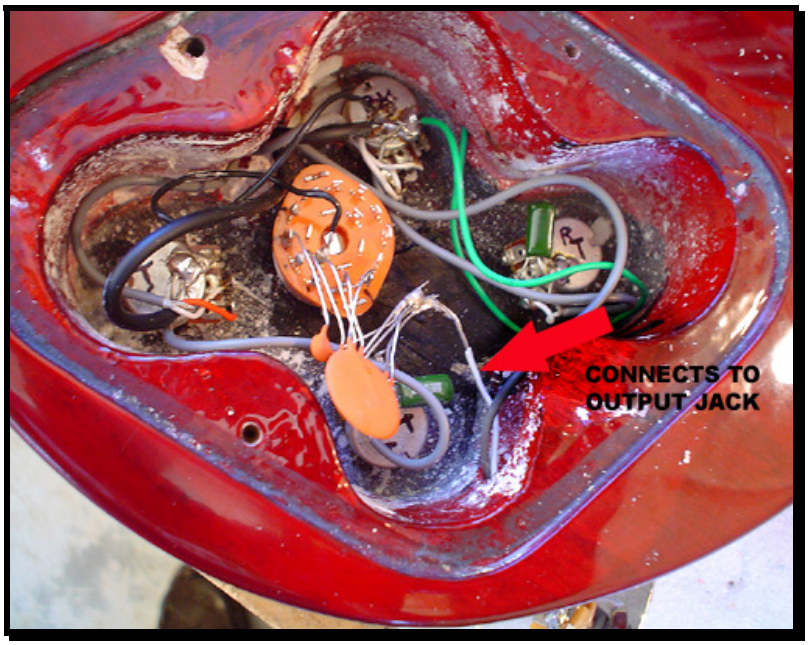


Now solder all of the open ends of the capacitors together. These will be soldered to a wire that connects to the hot lug on the output jack.

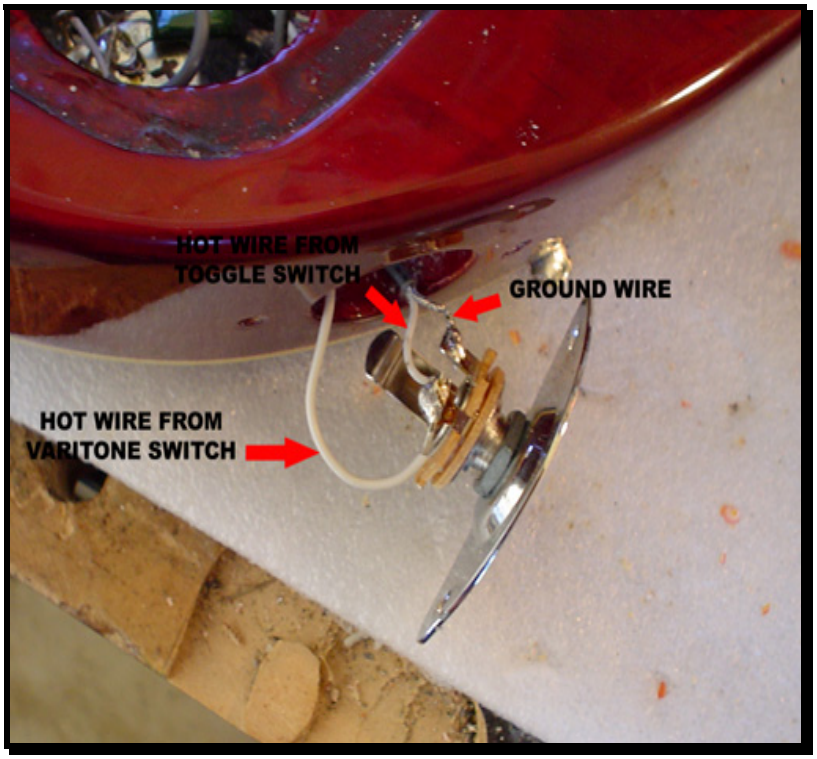


Solder the ground wire. It attaches to the common lug in the middle of the Varitone switch, closest to the lugs you just soldered. From there, it gets soldered to the bottom of one of the

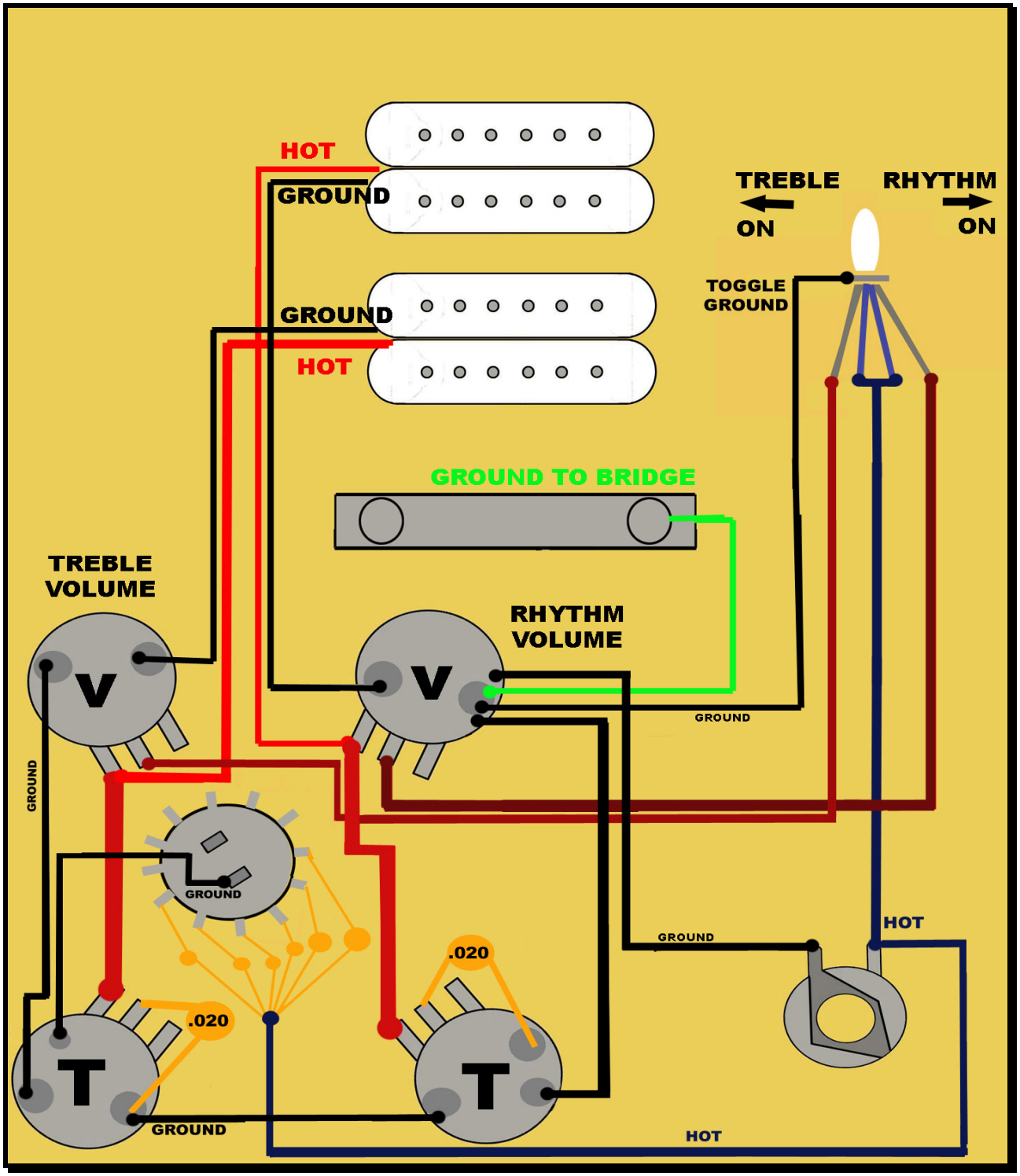
volume or tone pots. In other words, it gets connected to ground.



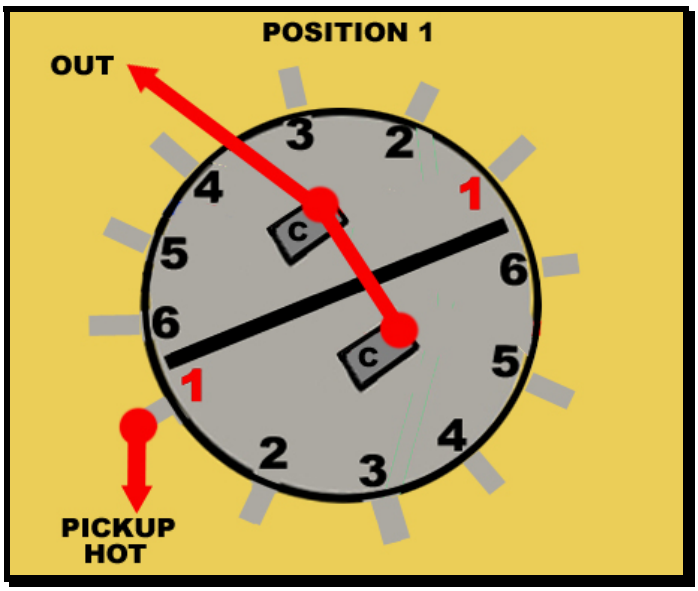
Here is the output jack with two wires connected to the hot lug.

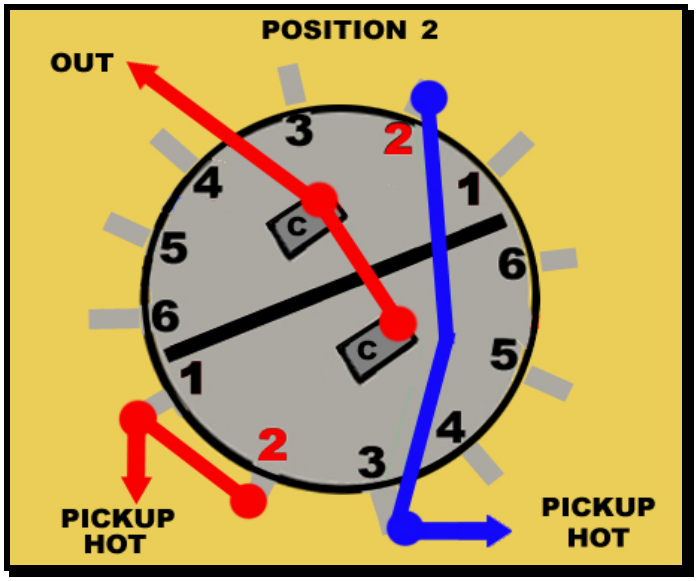


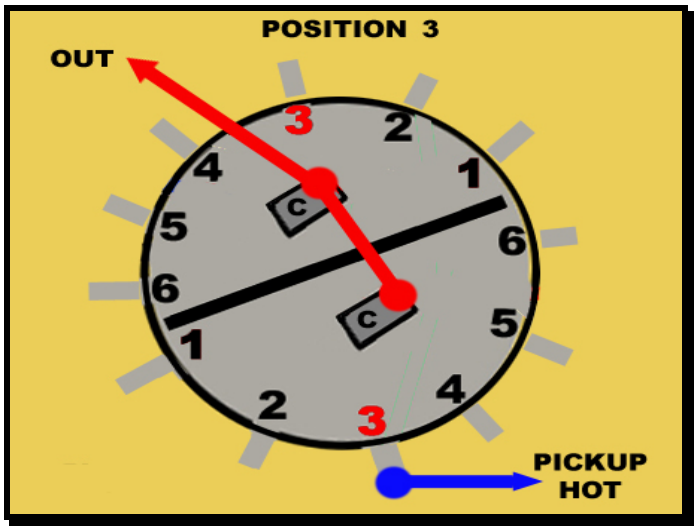
Here is the finished wiring.

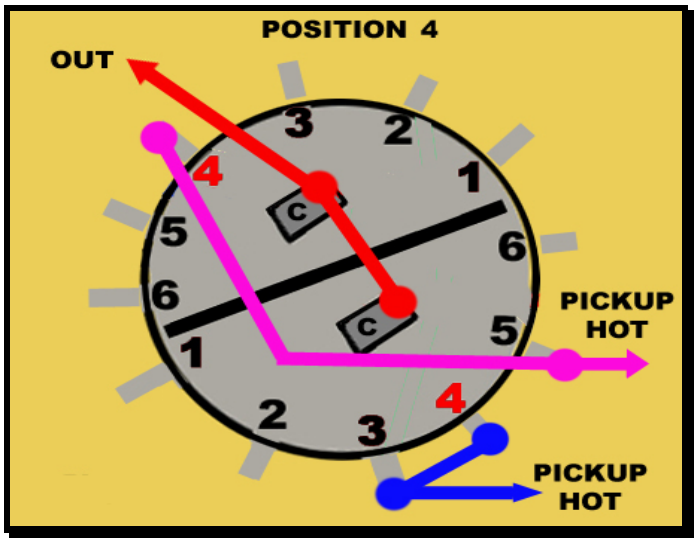


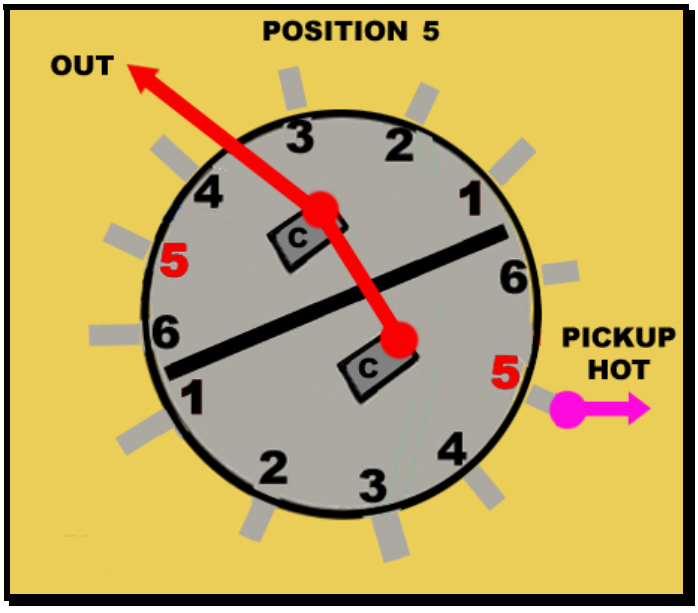
You could also use the Varitone switch to replace your existing 3 or 5-way switch. Rotary switches, like the Varitone, are very similar to lever switches. However, each side, or pole, only turns on one lug at a time. Some of the selections on 5-way switches turn on several lugs. In the diagram below, the switch is in position one. If you look closely at the Varitone switch, you can see which lugs are engaged in each setting. So the number one lug from the top pole and bottom pole will be active when the switch is in the first position. However, the top half sends the signal out only through the top common lug, marked with a "c". The bottom half sends the signal out through the lower common lug marked with a “c”. A jumper is often added to link the two sides together for turning on multiple pickups. The diagrams below show how a Varitone works in each position.

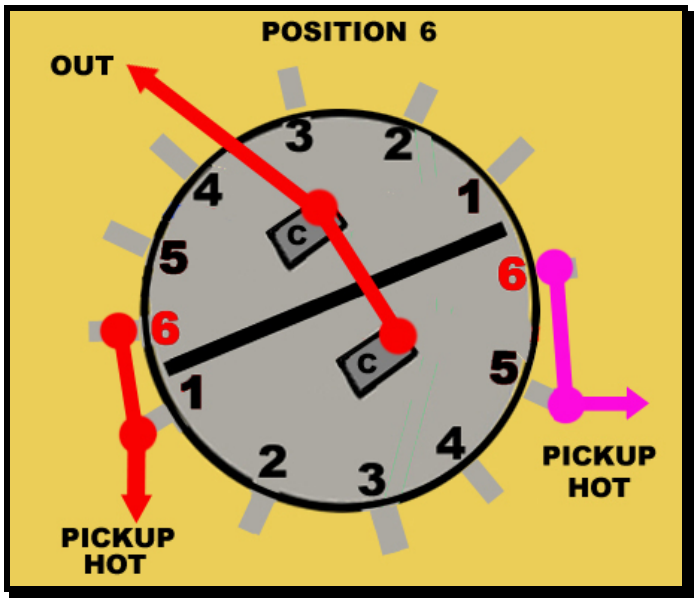












The next page shows a wiring diagram for a strat using a Varitone switch instead of a lever switch. Notice you get six different positions with the Varitone switch.

position 1 = neck

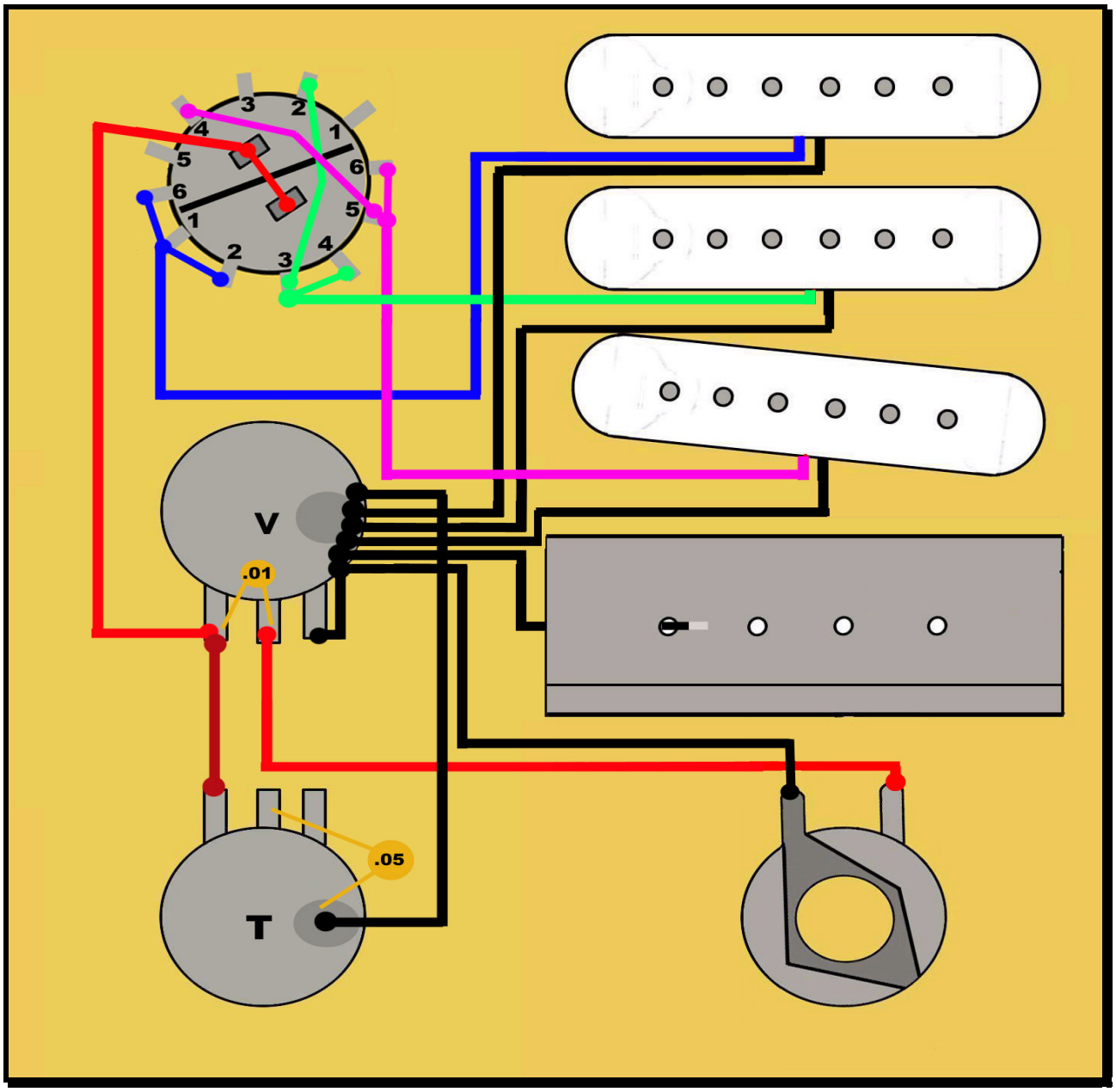
position 2 = neck and middle

position 3 = middle

position 4 = middle and bridge

position 5 = bridge

position 6 = neck and bridge



If you have a tele, or two pickup guitar, then you will have 3 additional positions that you can use if you want to. In the next diagram, capacitors are soldered to the lugs on the top half of the switch and then exit to ground. This setup will turn on the bridge pickup and a capacitor in positions 4, 5, and 6. The bigger the capacitor, the more bass your guitar will have.

position 1 = neck

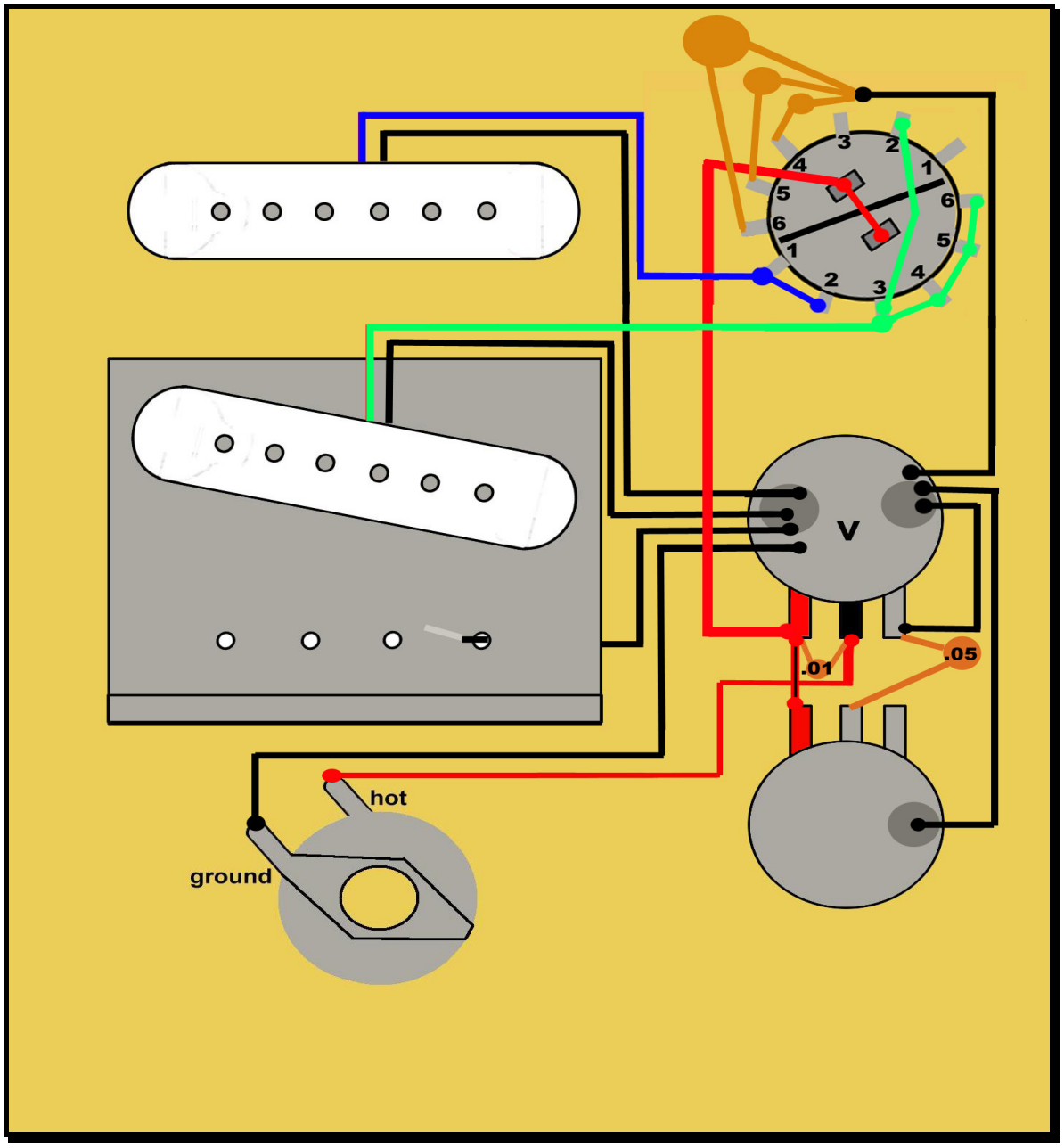
position 2 = neck and bridge

position 3 = bridge

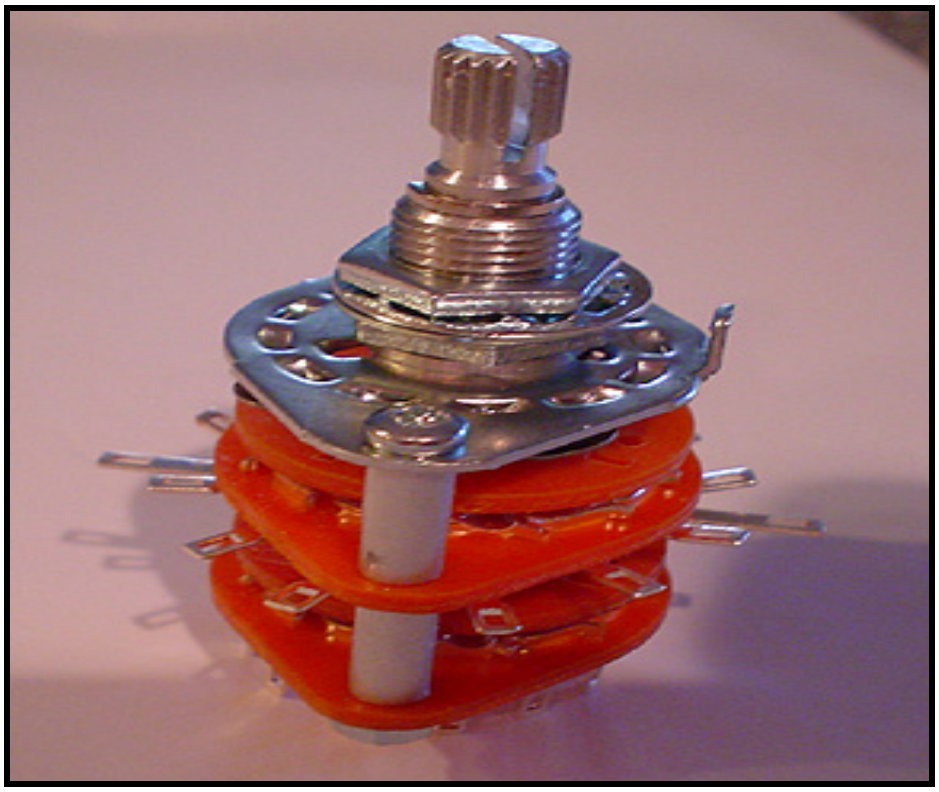
position 4 = bridge and capacitor .001

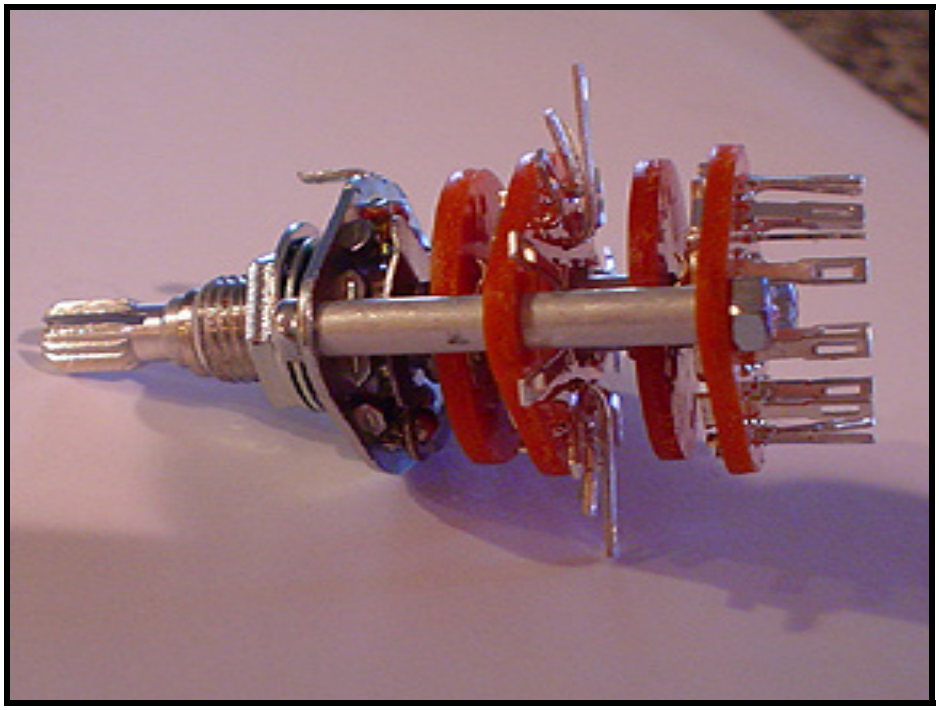
position 5 = bridge and capacitor .02

position 6 = bridge and capacitor .05



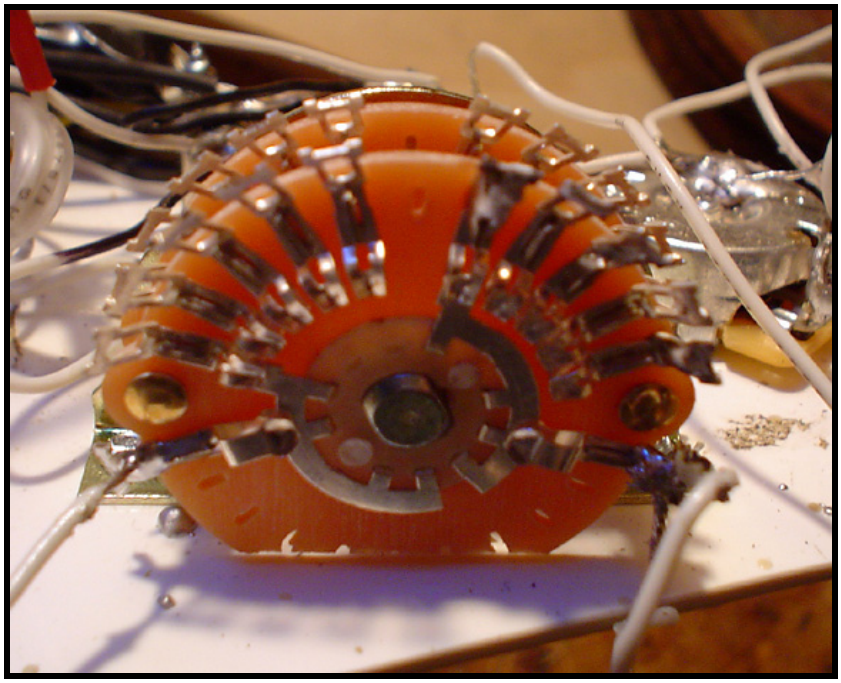
Here is a 2 level rotary switch with 4 poles (2 poles per level). You can wire the most complicated schematics with this type of switch.

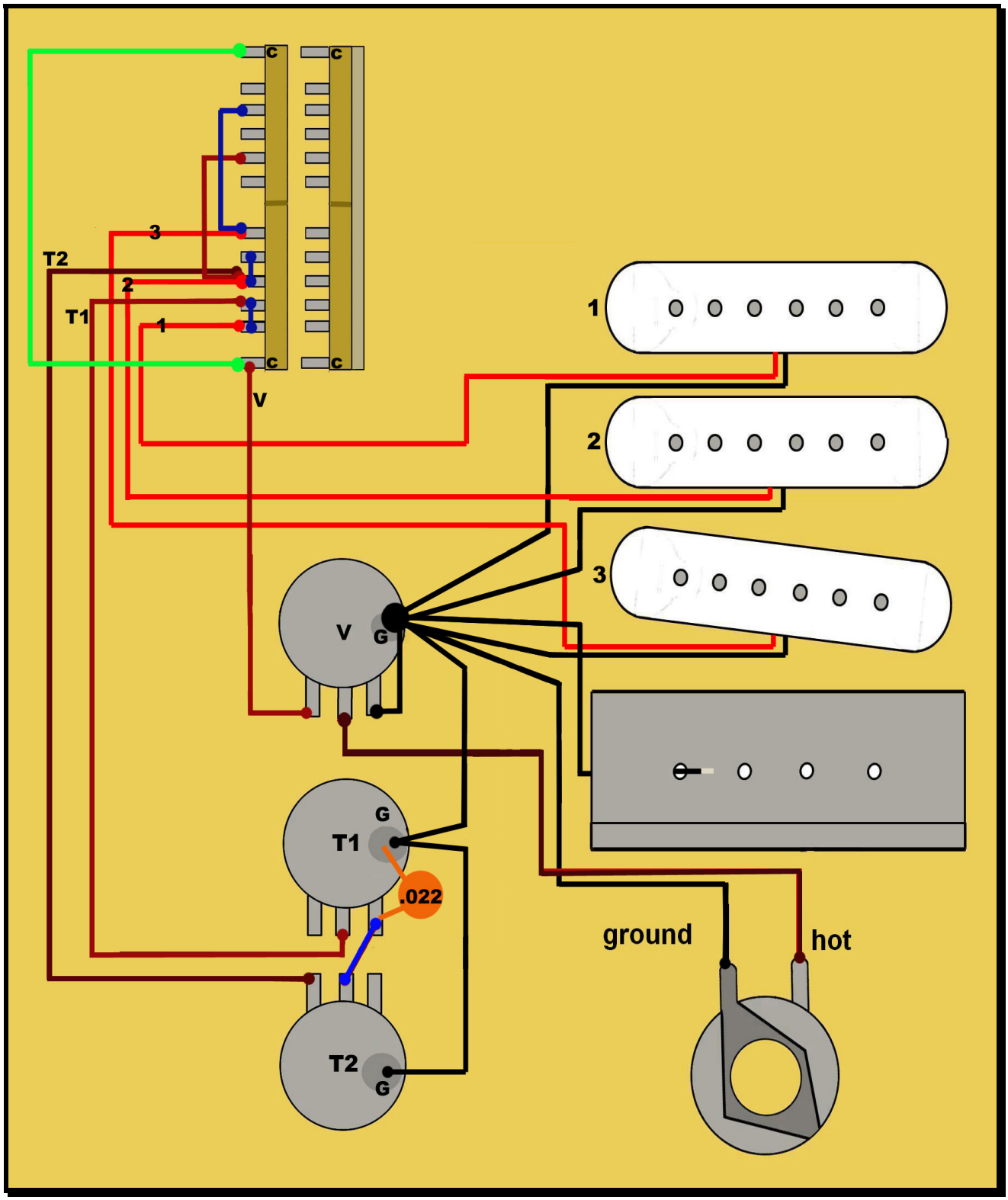




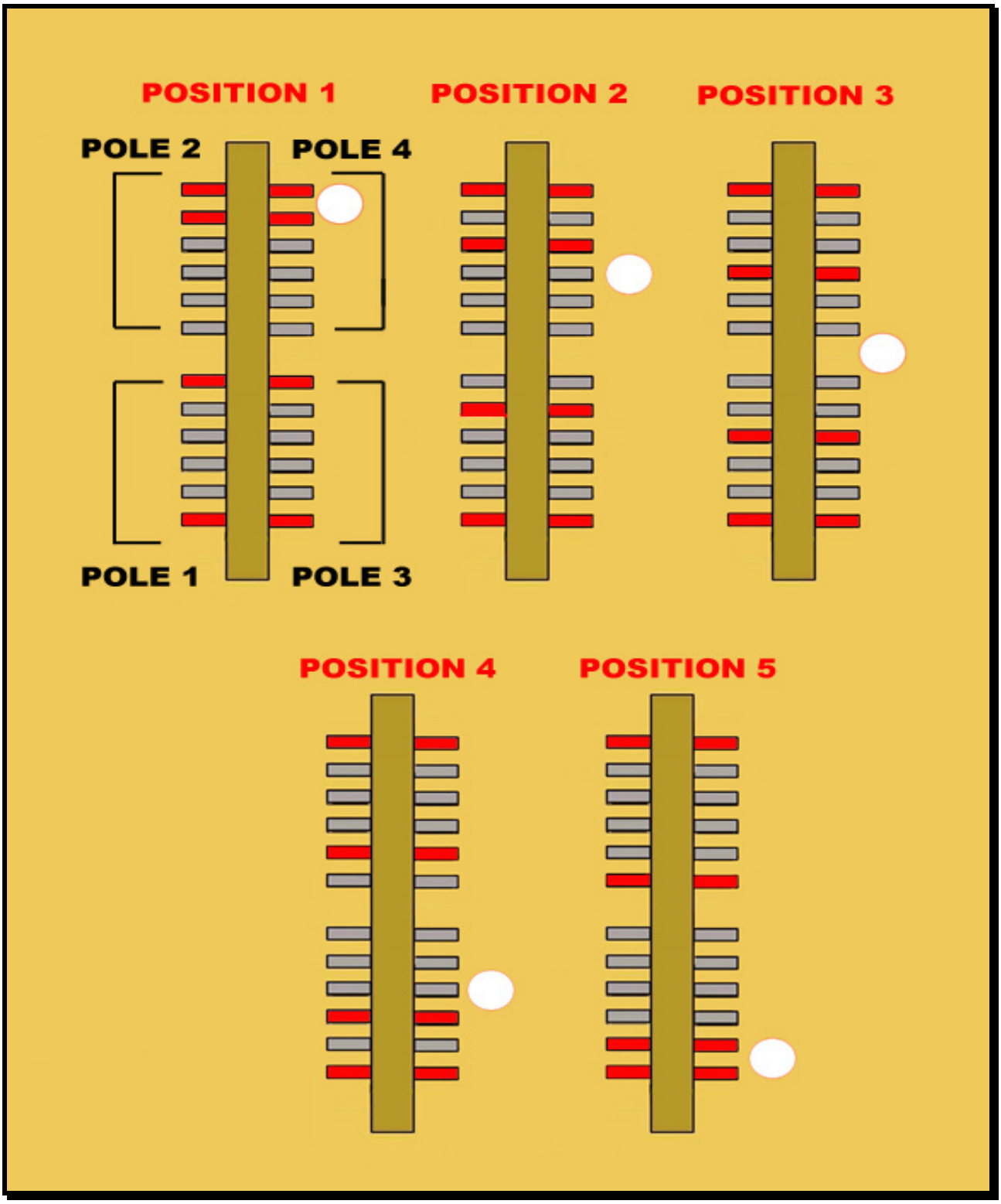
YAMAHA/SUPER SWITCHES

Another multiple pole switch is called a super switch, or Yamaha switch. It has 4 different poles, or channels. And each pole has 5 lugs and a 6th common lug that sends the signal to the output, or to the other poles. This allows for an unlimited number of wiring designs. The diagram on the next page shows one way to wire a strat using only two of the poles. Notice each setting touches only one lug per pole.

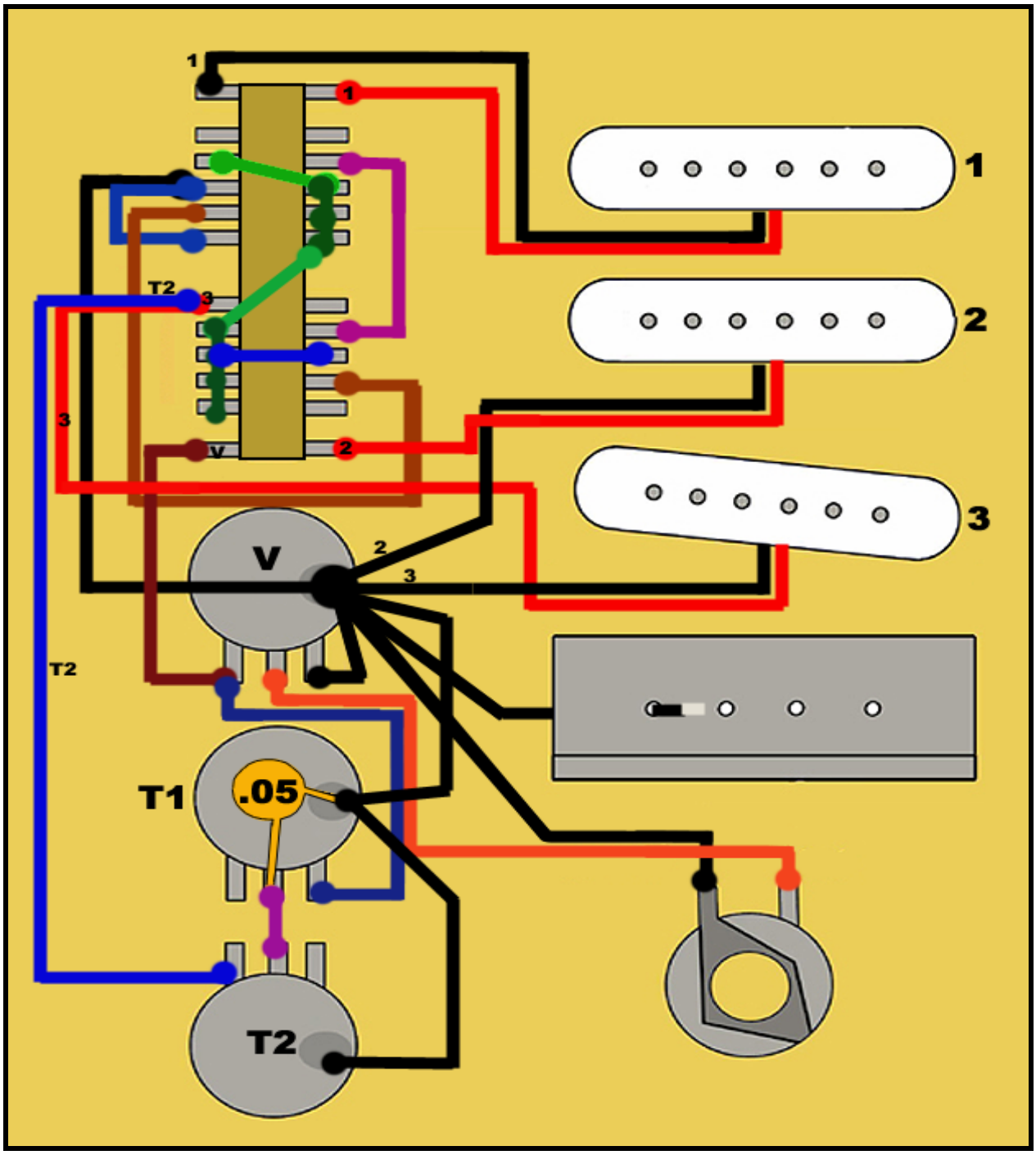




The hot lugs are colored in red. The white dots show you where the lever is located at in each position

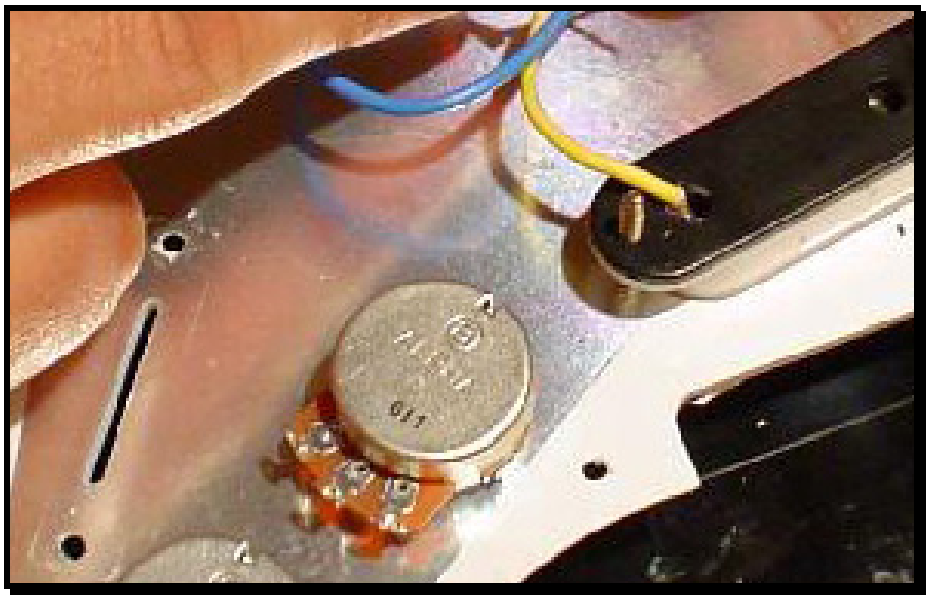


This next diagram is for someone like me who hardly ever uses the bridge pickup. It uses a 4 pole super switch. Be sure to take your time wiring this one. Position 1 turns on the neck pickup, positions 2 and 3 turn on the neck and middle pickups, position 4 turns on the neck and middle pickups out of phase with each other, and position 5 turns on the bridge pickup. The first tone knob (T1) is a master tone control, and the second tone knob (T2) is a separate tone control for the bridge pickup only.



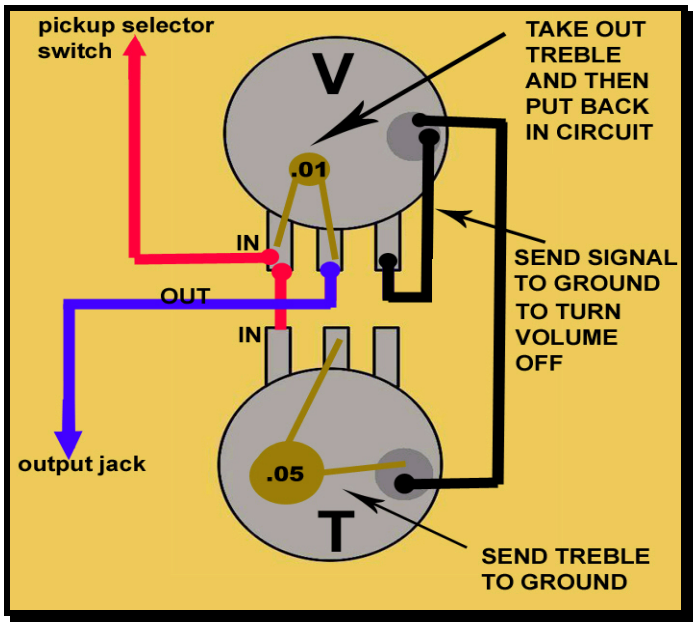
UNDERSTANDING POTENTIOMETERS

A potentiometer, commonly referred to as a pot, is a variable DC resistor. Basically, it decreases the signal that is going through it. As you decrease the signal in your volume or tone pot, you increase the signal that gets sent to ground. So if you have your volume set at 0, 100% of the signal will be sent to ground. Normally 250K Ohm pots are used with single coil pickups to add warmth to the sound, and 500K Ohm pots are used with humbucking pickups to add more highs to the sound. A 1 Meg pot will give you an even brighter sound. Part of the signal will always leak out to ground in any potentiometer, even when the volume is turned all the way up. A 1 Meg pot will leak the least amount of signal to ground, and a 250K pot will leak the most amount of signal to ground. In the case of the tone potentiometer, a capacitor is added to the circuit, which only allows the high frequencies to pass to ground, leaving a muddier sound with more midrange and bass.



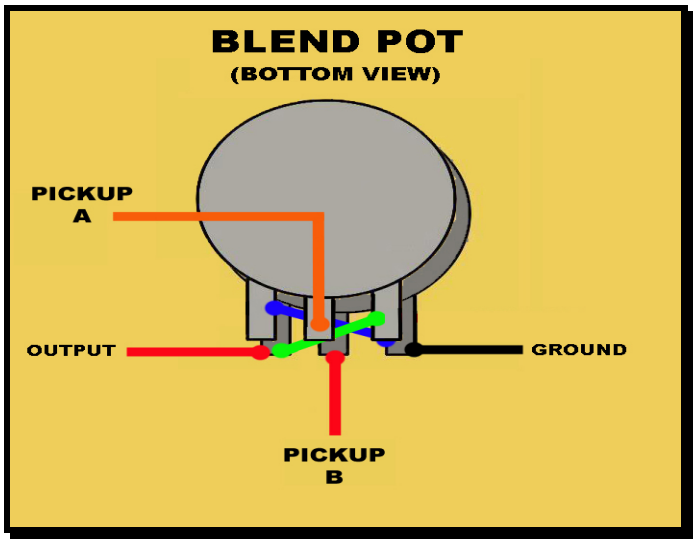
VOLUME AND TONE POTENTIOMETERS

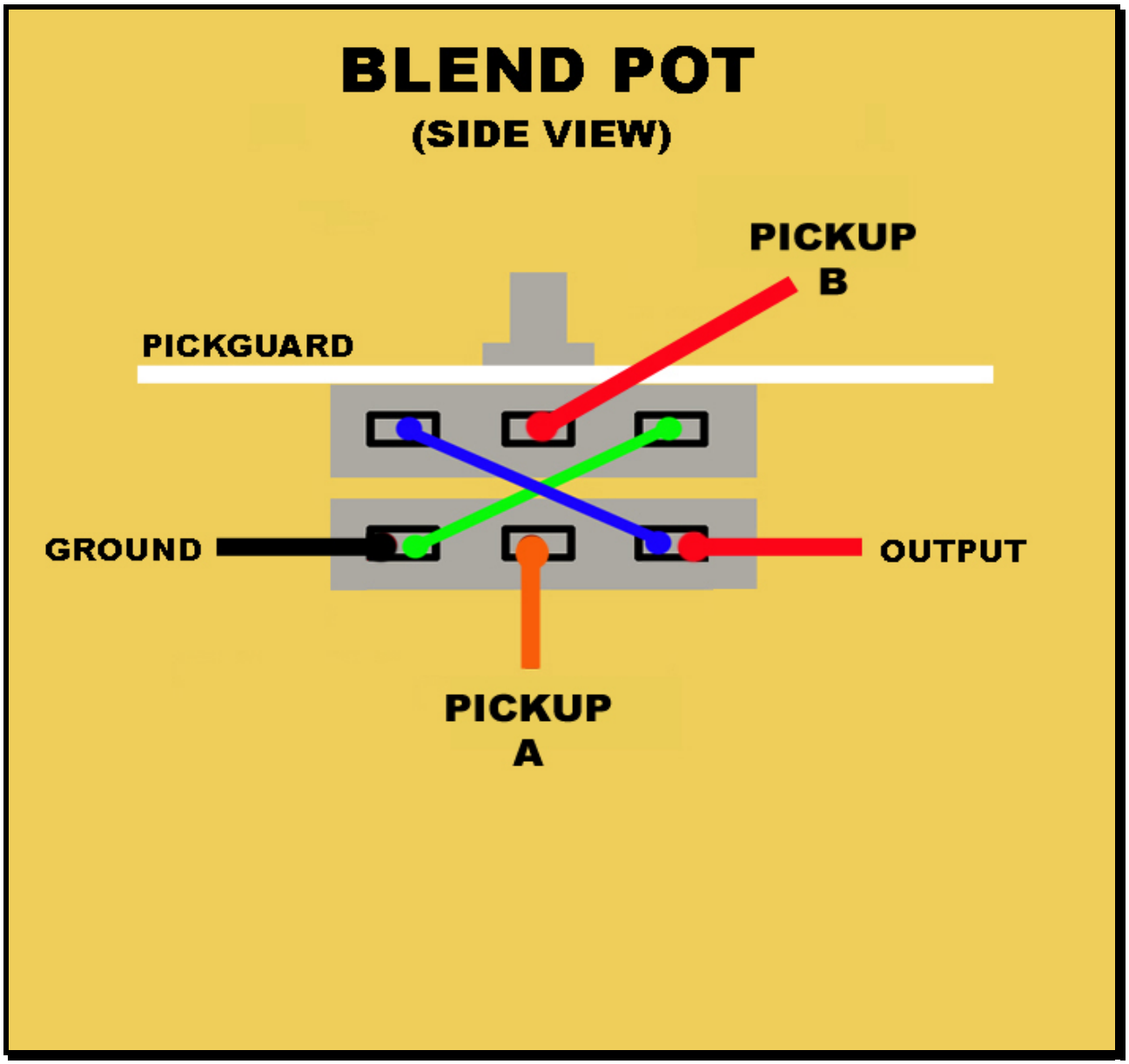
The volume pot receives the signal from the pickup selector switch. It then sends the signal out to the output jack and also to the tone pot. The tone pot receives the signal from the volume pot, and then sends the high frequencies out to ground via a capacitor. The telecaster is a perfect example of how you can wire any guitar with one master volume and tone control. The wiring on the pickup selector switch is the only thing that will change, depending on the number of pickups you have installed on your guitar. I think having one tone and one volume for all of your pickups is alot less confusing. Plus, if you have a strat, it also allows you to have a tone control for the bridge pickup. (Most strats don't have a tone control wired to the bridge pickup.) The next diagram shows how a volume pot and tone pot work together.



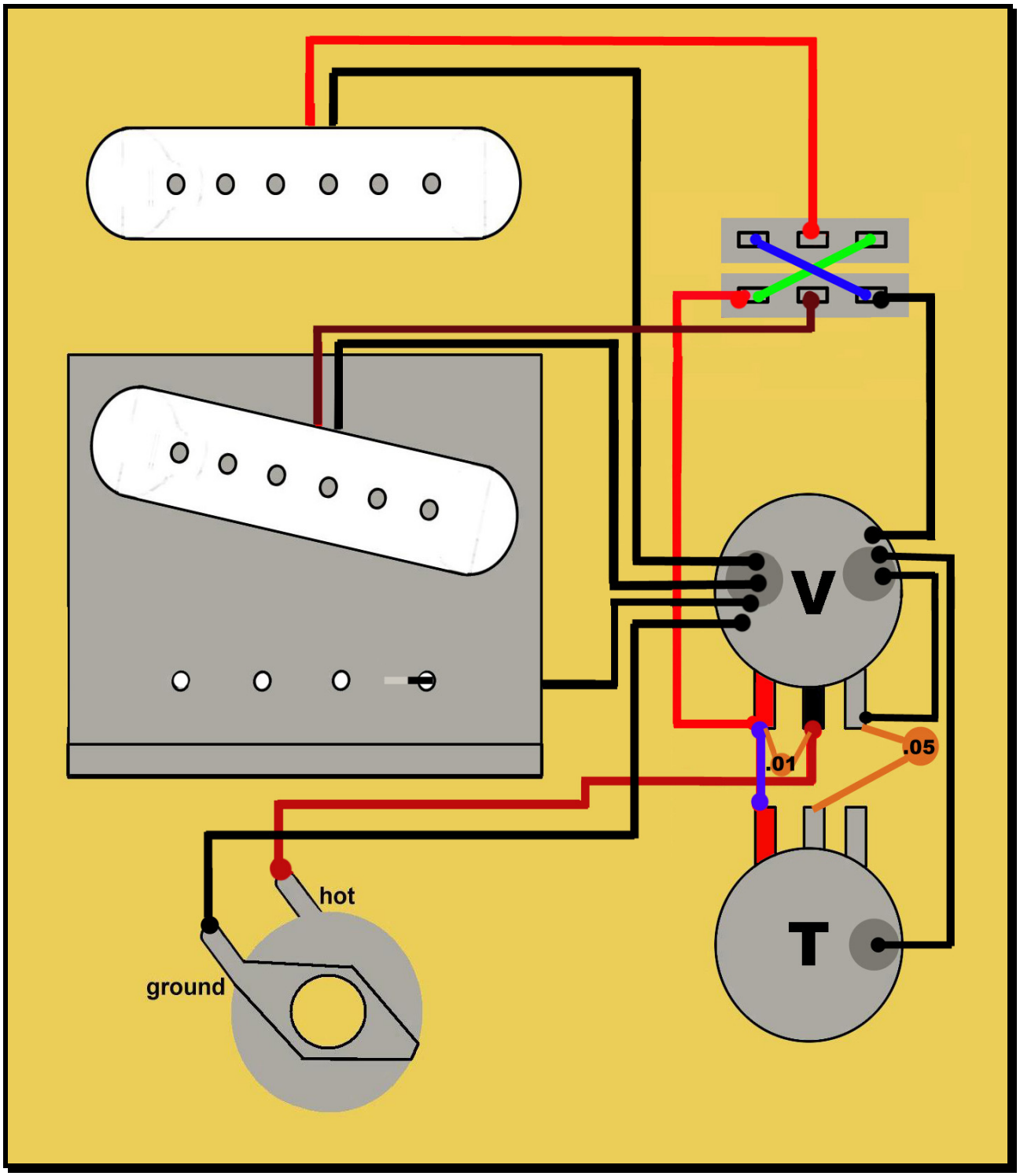
BLEND POTENTIOMETERS

A blend pot, or stacked concentric pot, is a potentiometer that controls two pickups. Its a unique substitute for a pickup selector switch. However, it doesn't just turn on a pickup like a switch does. It can turn on a percentage of a pickup's volume. Basically, one direction increases the volume of pickup A, while decreasing the volume of pickup B. Turn the knob in the opposite direction, and it increases the volume of pickup B, and decreases the volume of pickup A. In the middle position, both pickups are at 100% volume. A mini toggle switch can be added to turn on the bridge pickup when wiring a strat.

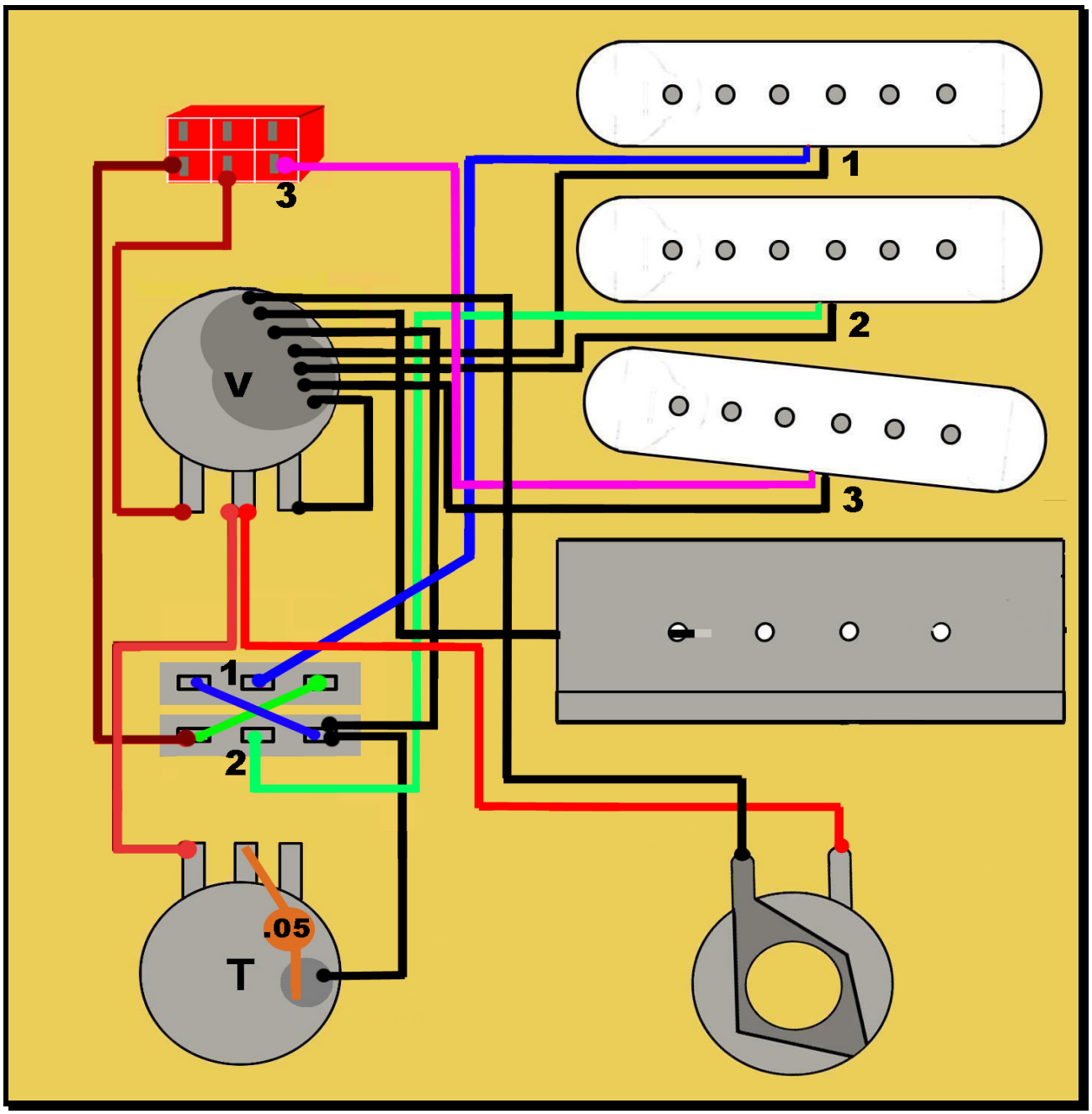




On the next page is a tele style wiring with a blend pot. You will have to drill a hole in the control plate to add this pot because there is still a master volume in the control plate. If you don't want a master volume control, you can always install the blend pot where the volume pot was. Check out the questions and answers section for info on where to get plastic control plates for your Telecaster that come in all kinds of styles and colors.



Here is a strat style wiring. There is one master volume and master tone for all three pickups. The toggle switch turns on the neck and middle pickups, or just the bridge pickup by itself. The blend pot controls the signal coming from the neck and middle pickups. This is a great wiring technique for strat players that mainly play with the neck and middle pickups on. That tone is often referred to as the strat's sweet sound.

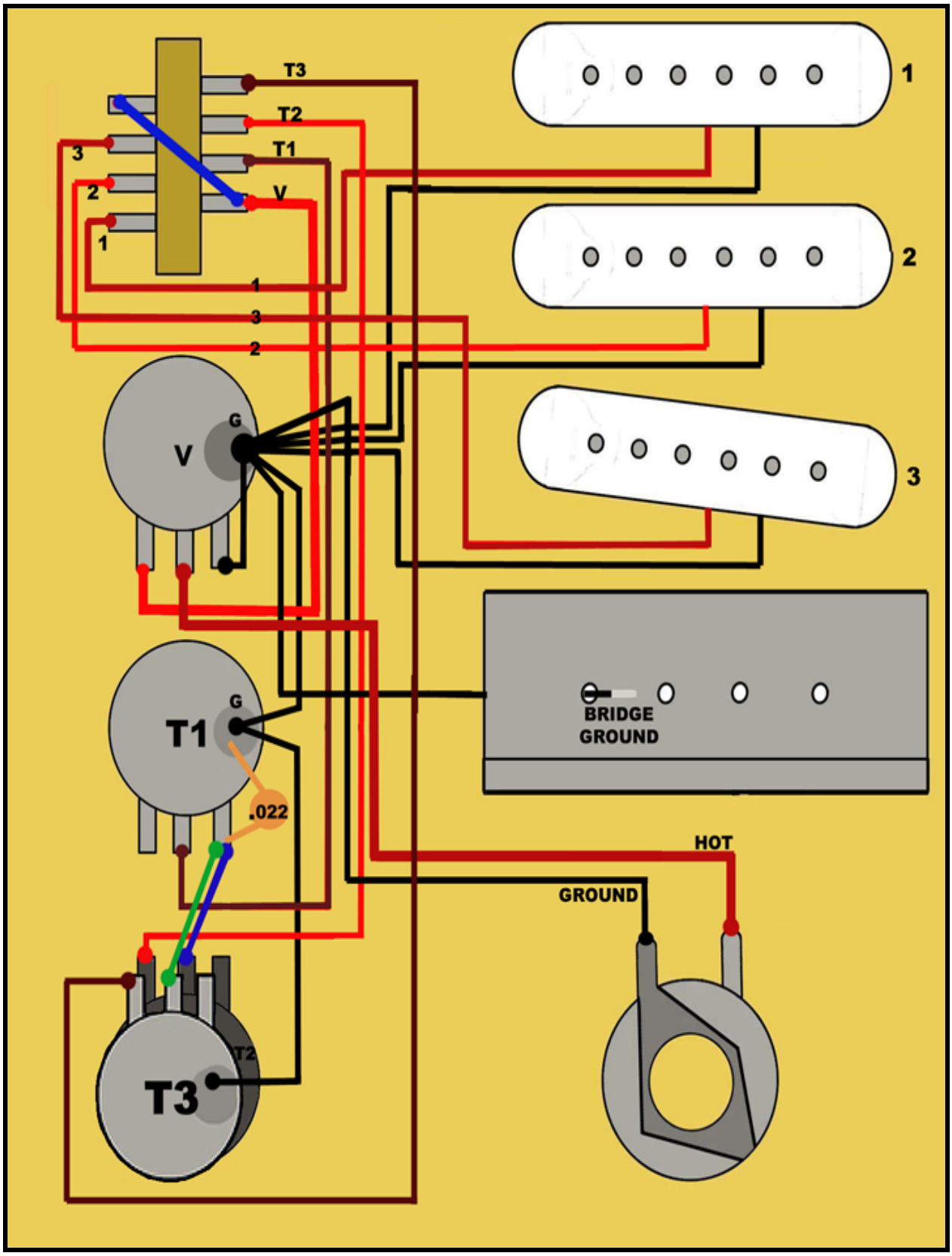


STACKED CONCENTRIC POTENTIOMETERS

Another type of potentiometer used in basses a lot is a stacked concentric pot. This is basically two potentiometers attached on top of one another, and controlled by two separate shafts (a thick one and a thin one), so unlike a blend pot, each pot is independent of one another. This allows you to pack in two potentiometers in the space of only one potentiometer. A special type of knob is used for this setup, one that has two moving sections for each shaft. You can find stacked concentric pots and knobs online at the ALLPARTS website.

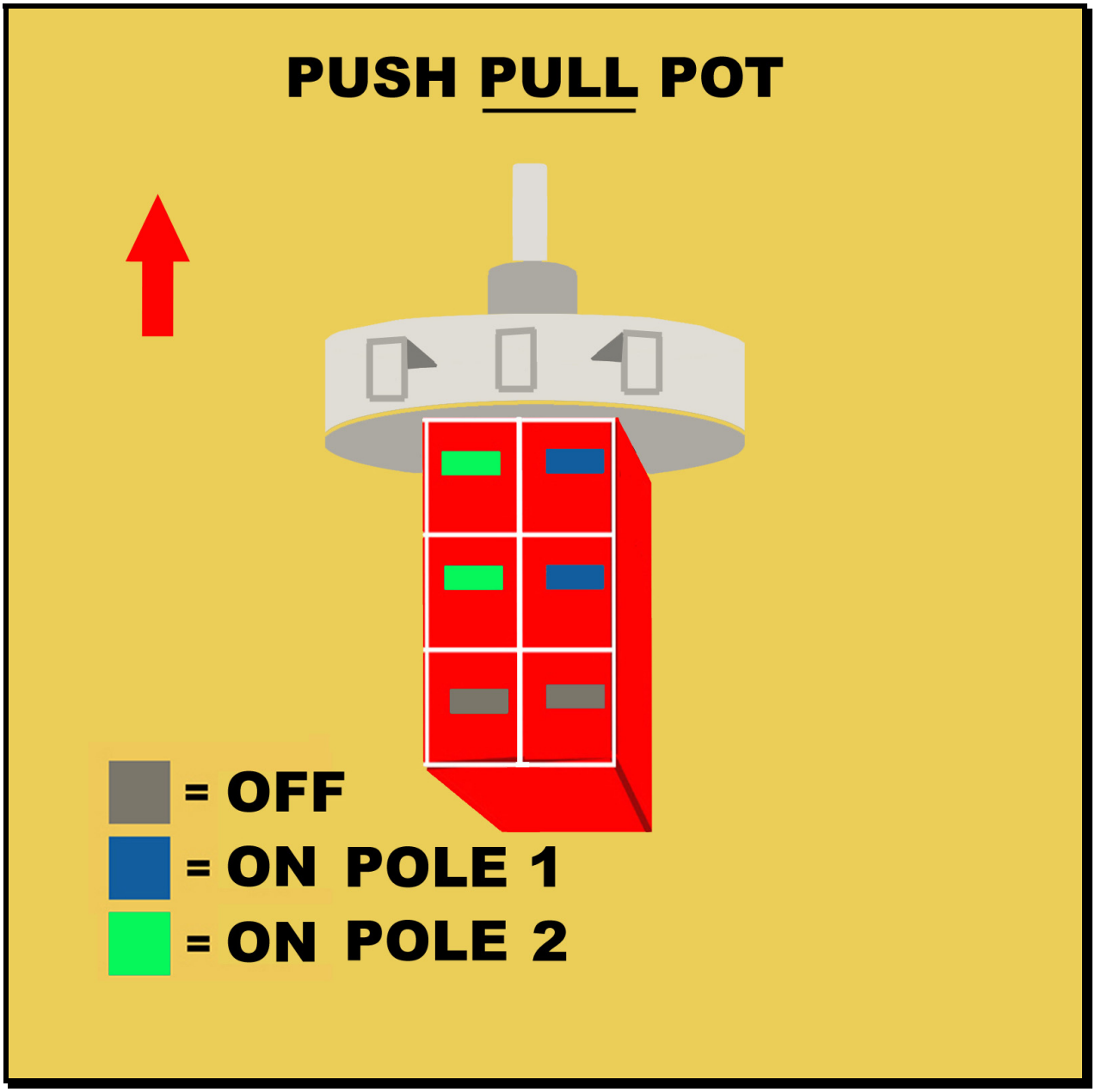
http://www.allparts.com

The diagram on the next page shows a strat with a concentric stacked pot being used as a tone control for the middle and bridge pickups (normally the bridge pickup on a strat doesn't have it's own tone control).

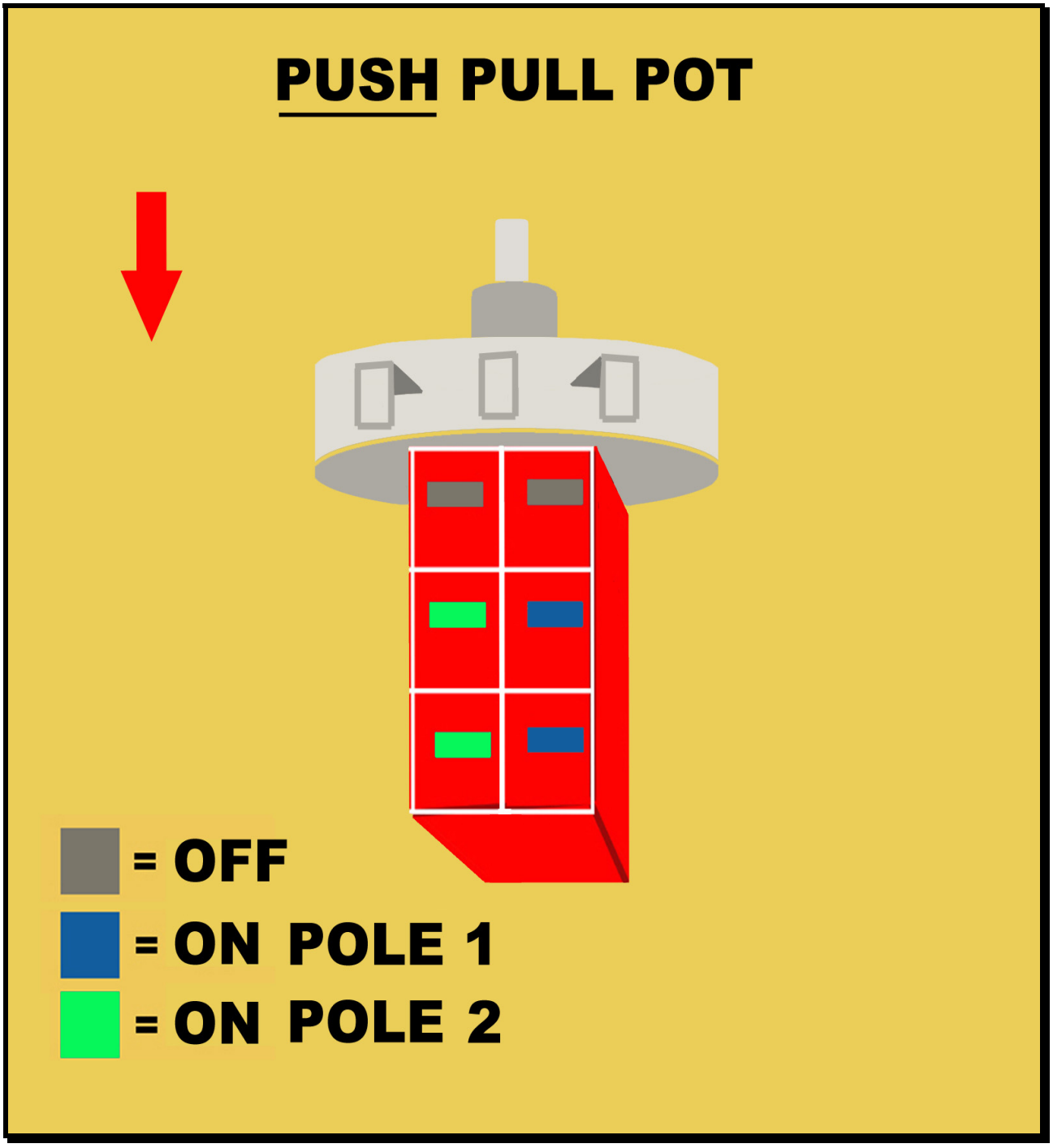


PUSH PULL POTENTIOMETERS

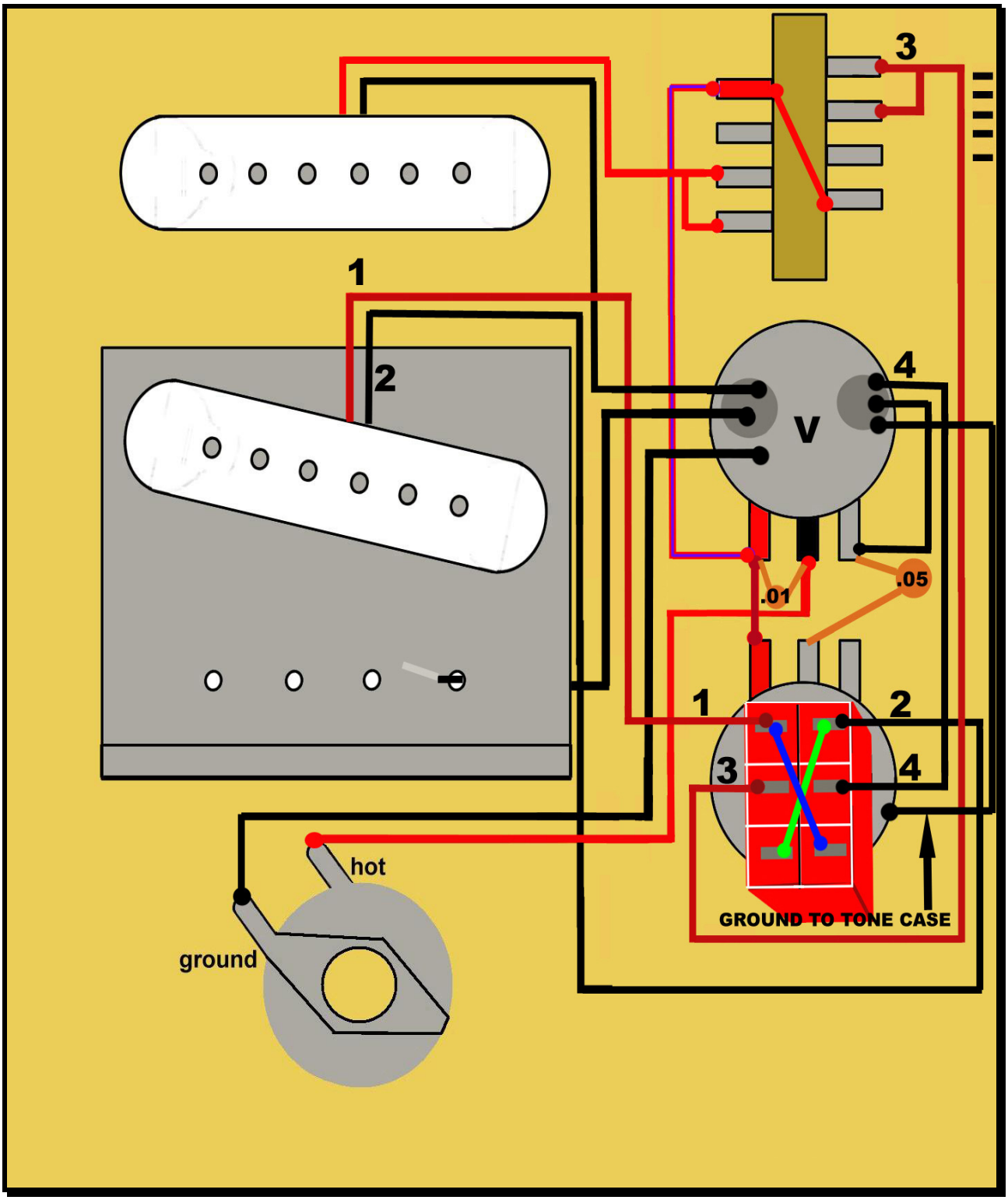
A push pull potentiometer is basically a combination of a DPDT on-on mini toggle switch and a potentiometer. This type of pot is designed to conserve space inside your guitar. Otherwise, you would need to drill a hole in your pickguard to add a mini toggle switch. Think of it like a separate potentiometer, and a separate DPDT mini toggle switch stuck together. When the knob is in the up position, it turns on the top 4 lugs. Note: there are two poles, or channels in each push pull pot switch (left 3 lugs and right 3 lugs). So in the diagram below, the green and the blue lugs are on, but they are not connected to each other. For more info on DPDT switches, check out the section on switches.



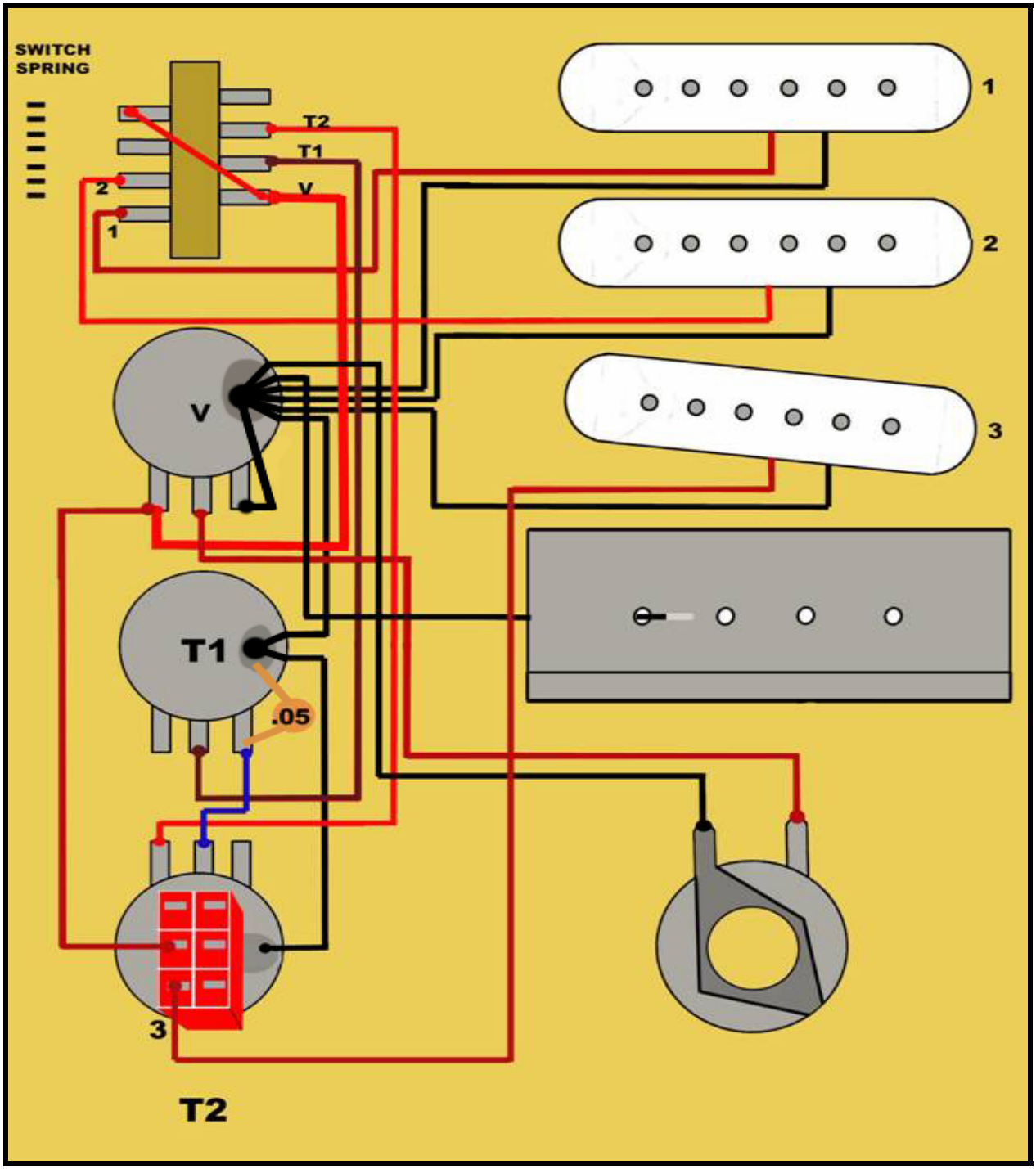
When the knob is in the down position, it turns on the bottom 4 lugs.



Next, is an example of a push pull pot that is being used as a tone pot and phase reversal switch.



Here is an example of a push pull pot being used as **a** separate **bridge-on switch**. This will allow you to add 2 more tones to your strat: all three pickups on, and the neck and bridge pickups on. To add separate switching for one pickup, just add an on/on mini toggle switch, or a push pull pot to your guitar. Then send the signal to the volume pot. Check out the diagram below, or read the section on switches for more info.



UNDERSTANDING CAPACITORS

Probably one of the easiest ways to change your guitar's sound is to change the tone capacitor. I am not just talking about adding more or less bass to the sound, but actually changing your guitar's character. For this task, you are not going to need just any capacitor, but a vintage style one. The vintage capacitors are considered to be less harsh sounding than the new caps on the market today, and are getting a lot of attention as of late. Luckily, there are companies that make replica capacitors, and they are just like the ones from the 50's and 60's.

First a little history. The .047 Bumble Bee capacitors, painted like a bee, are the holy grail of caps. They sound smooth and creamy, partly do to their oil content. These were used in guitars, TVs, and even stereos. You can also look for the Black Beauty Spragues, which were never installed in Fenders as stock, but they so work well in most strats.

Fender used Cornell-Dubilier brand .05/150v and .1/150v wax coated caps in all of the premier instruments from 1950 to 1961 (Tele, Strat, Jazz, Precision and Jazzmaster {.02 and .03}). The student models used the cheaper Astron Type AM capacitors in a 200v size from the amplifier assembly line. In 1961 they switched all lines to lower voltage ceramic caps from a variety of manufacturers.

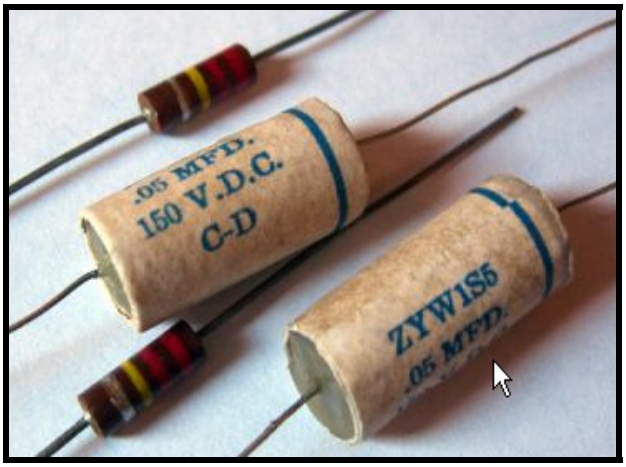
Gibson used Cornell-Dubilier brand .02/400v Grey Tiger caps from the late '40s until 1956, when they switched over to the Sprague made .022/400v Bumblebee Telecaps. These were replaced in 1960 with the Sprague .02/50v ceramic discs. Although the Sprague .022/400v Black Beauty Telecaps do turn up in some high end models, they were used exclusively in the re-launched Les Paul in '68 and '69.

Many people, especially Ebay sellers, will try to sell other kinds of capacitors as genuine, but they are simply taking advantage of the gullible, or un-educated. The original equipment manufacturers of the day ordered parts in large quantities to save money, so the types of capacitors used are fairly easy to keep track of over the course of the years. Genuine vintage caps are hard to find.

The Bumblebee sound comes from the minutely slower response caused by the combination of large plates and the oil-soaked dielectric paper. They are a dry cap, unlike the Vitamin Q type caps, which have a very warm and creamy sound due in part to the foil and dielectric floating in a bath of oil inside the metal canister.

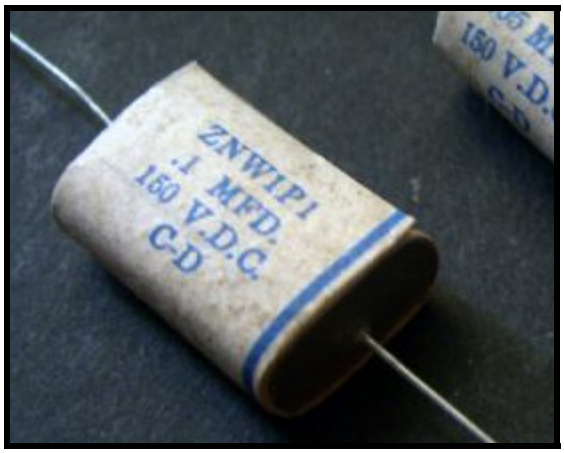
If you are looking for some good replica capacitors that are pretty much the same as the ones used on the strats, teles, and les pauls from the 1950's and 1960's, then you want to checkout **Luxe Radio & Musical Instrument Co.** They have the best selection of reproduction capacitors and resistors.

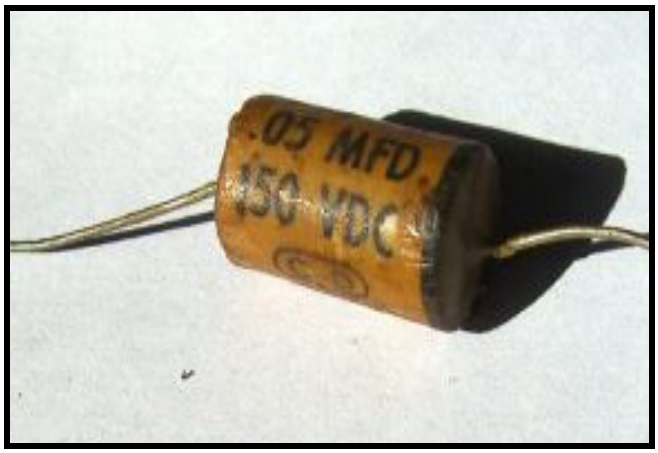
http://stores.ebay.com/Luxe-Guitars



Here is some info from Luxe on their vintage caps:

Each of my reproduction wax capacitors is made with the same materials and methods as the original. The only difference is that instead of a foil and paper “slug” at the core, I use a NOS Vitamin Q type paper and oil capacitor. These were manufactured from the 1950s through the 1980s by various companies, like Sprague, for military and aerospace use. Unlike other types of capacitors, the dielectric and foil in these are sealed in a metal and glass tube, making them impervious to heat and moisture. They do not degrade with time and they do not drift in value. They have the added bonus of having an oil-soaked paper as the dielectric, which (and this is a popular topic for discussion) has a more “musical” quality than any other dielectric. I confess that I do not understand how this can be, it’s only electricity, and electricity doesn’t care, but just like a record sounds better than a cd, and a ’55 Champ sounds better than a Peavey. PIO caps just sound better.

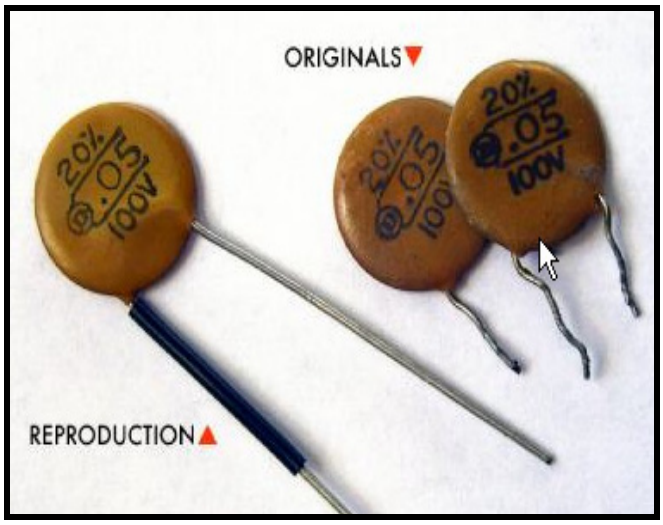




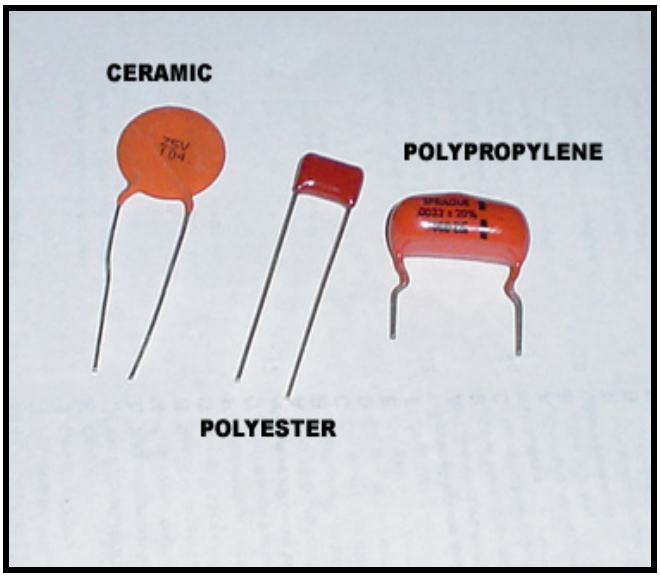
I do not use Dykanol or any other chemicals in my capacitors. Most capacitors made before 1956 were coated with a blend of pitch and petroleum jelly. This is the

nasty sticky stuff that radio guys hate. I make this coating with pitch and beeswax. It looks the same, but it doesn't get all over the place.

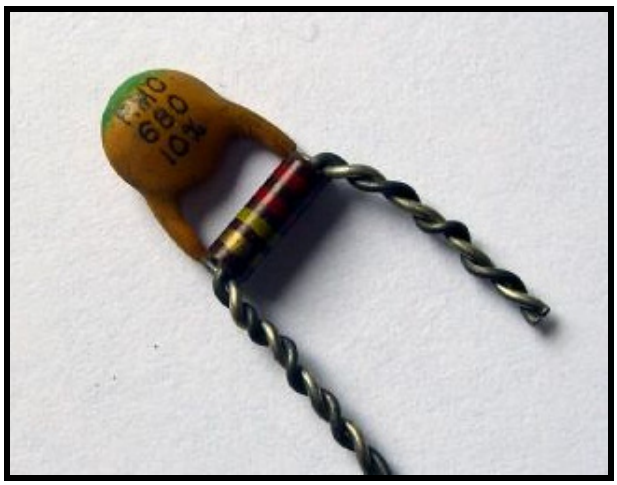
Each of these caps is handmade, to the original factory specifications.

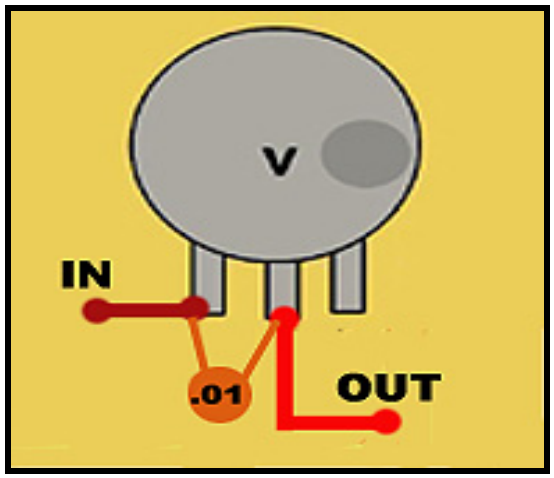


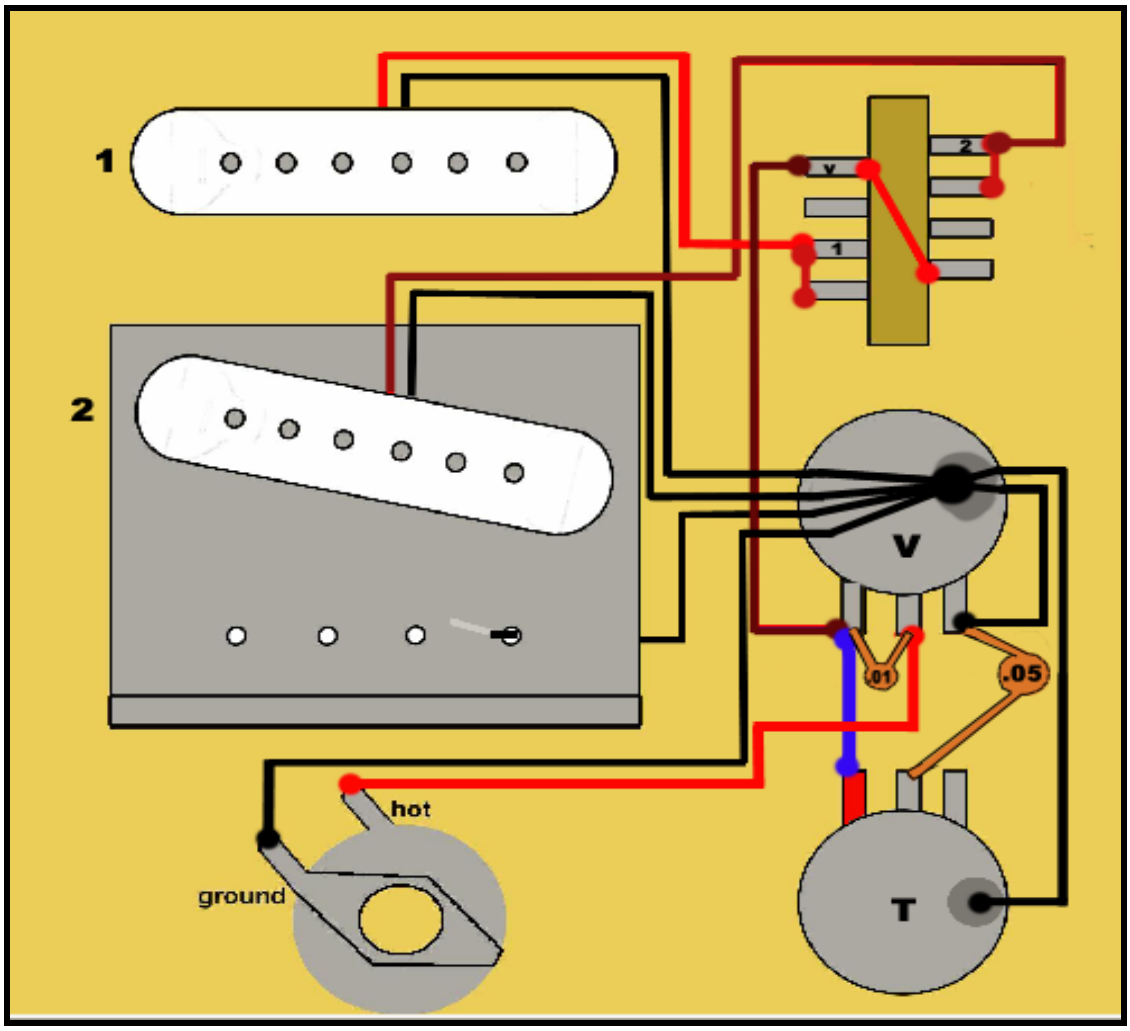
What types of capacitors are used in most guitars today?
Most guitars will either have ceramic disc caps, polyester caps, or polypropylene caps in them. The bright orange drop capacitors with the hockey stick leads are good examples of polypropylene caps that have a nice, warm, rich tone. These caps also have a higher tolerance than the polyester caps, which are very inexpensive. You can see the polyester capacitors in a lot of import guitars. The ceramic disc caps work pretty well, and can be used for higher frequencies. They are known to be pretty dependable.



What does a treble bleed kit do? Capacitors only let the higher frequencies pass through them. So the treble bleed kit is going to take the high tones out of the circuit at the volume pot, and then throw them back in the circuit as the signal leaves the volume pot. This prevents the treble from naturally bleeding out of the system as you turn down the volume. This is often seen in telecaster wiring. Some of the vintage treble bleeds also add a resistor to the capacitor, as shown in the example below.

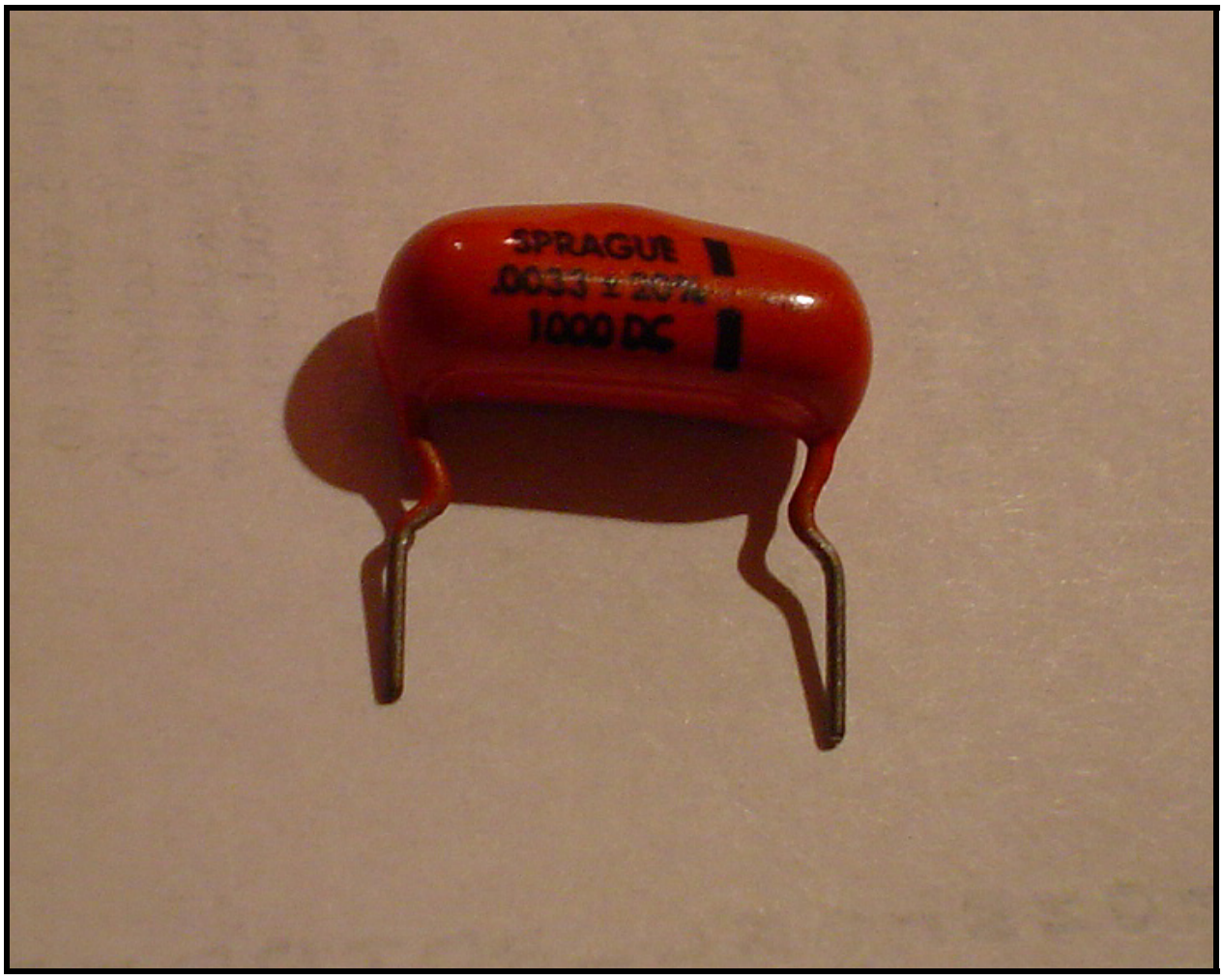






Does the capacitor voltage matter? A guitar circuit is only a few volts, so a small capacitor is all that is required. And the voltage does make a tone difference. The higher the voltage, the higher the “ceiling” of a tone cap. Gibson engineers preferred the 400 volt caps, never using the cheaper 200 volt versions, while Fender always used the lowest voltage available from their suppliers. A larger cap of 600 volts, or more, can also give the impression of increased capacitance, swallowing up more signal than you want it to.

Do some capacitors have polarity? All paper-in-oil, wax paper, mica, ceramic, film, polyester and polypropylene capacitors have no polarity. Old capacitors of these types are marked with an outside foil band which is meant to be wired to ground, but that is only for noise reduction in radios and amplifiers, and makes no difference in the metallized film capacitors of today. Only electrolytic caps have a specific polarity, and they should never be used in a guitar anyway.

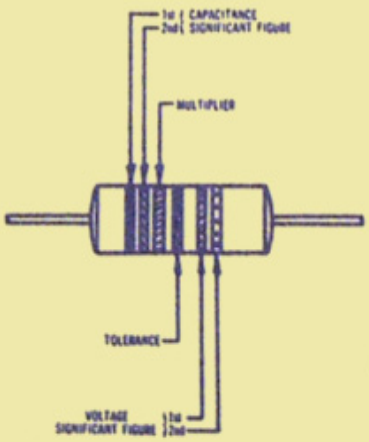


What do the colors on a Bumblebee capacitor mean? Here is an old Sprague chart. This chart is in micro-microfarads, so you have to move the decimal point 6 places to the left to get the regular mfd number. A classic Gibson style bumblebee is labelled: Red-Red-Orange-Gray-Yellow so it translates out to 22 times 1000 (22000 micro-microfarads {mmF or pF}) which is .022mF, and the grey band is actually black, standing for 20% tolerance, and the yellow marks a 400 volt rating. Check out the Sprague chart below.

SPRAGUE "QUICK AS A WINK" CHART for CAPACITORS

MOLDED PAPER CAPACITORS

CAPACITANCE IN MICROMICROFARADS



Color	Significant Figure	Decimal Multiplier	Tolerance ± %
Black	0	1	20
Brown	1	10	—
Red	2	100	—
Orange	3	1000	30
Yellow	4	10000	40
Green	5	10^5	5
Blue	6	10^6	—
Violet	7	—	—
Gray	8	—	—
White	9	—	10
Gold	—	0.1	—

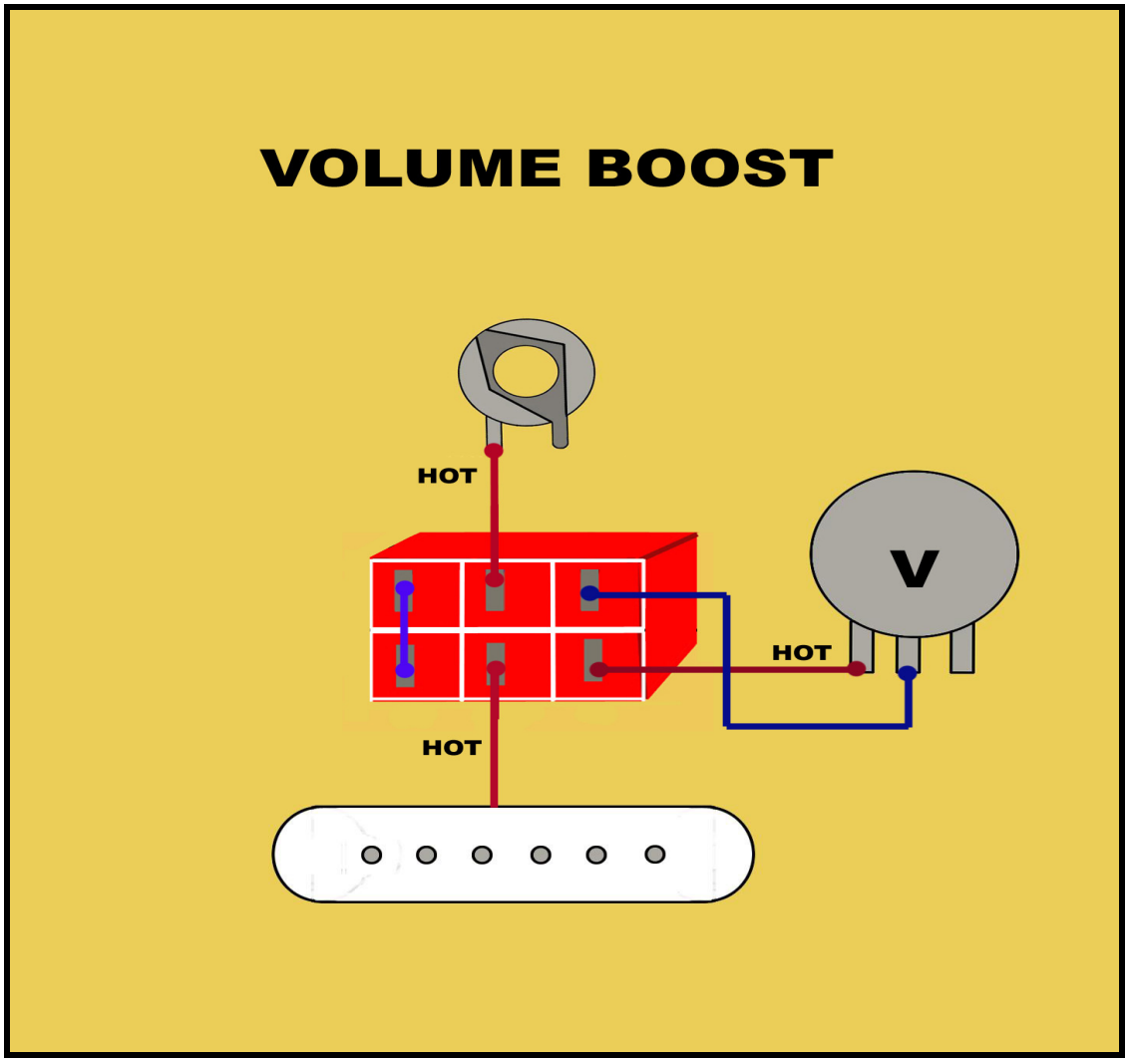
NOTE: Voltage rating is identified by a single digit number for ratings up to 900 volts; a two digit number above 900 volts. Two zeros follow the voltage figure.

HOT ROD TECHNIQUES

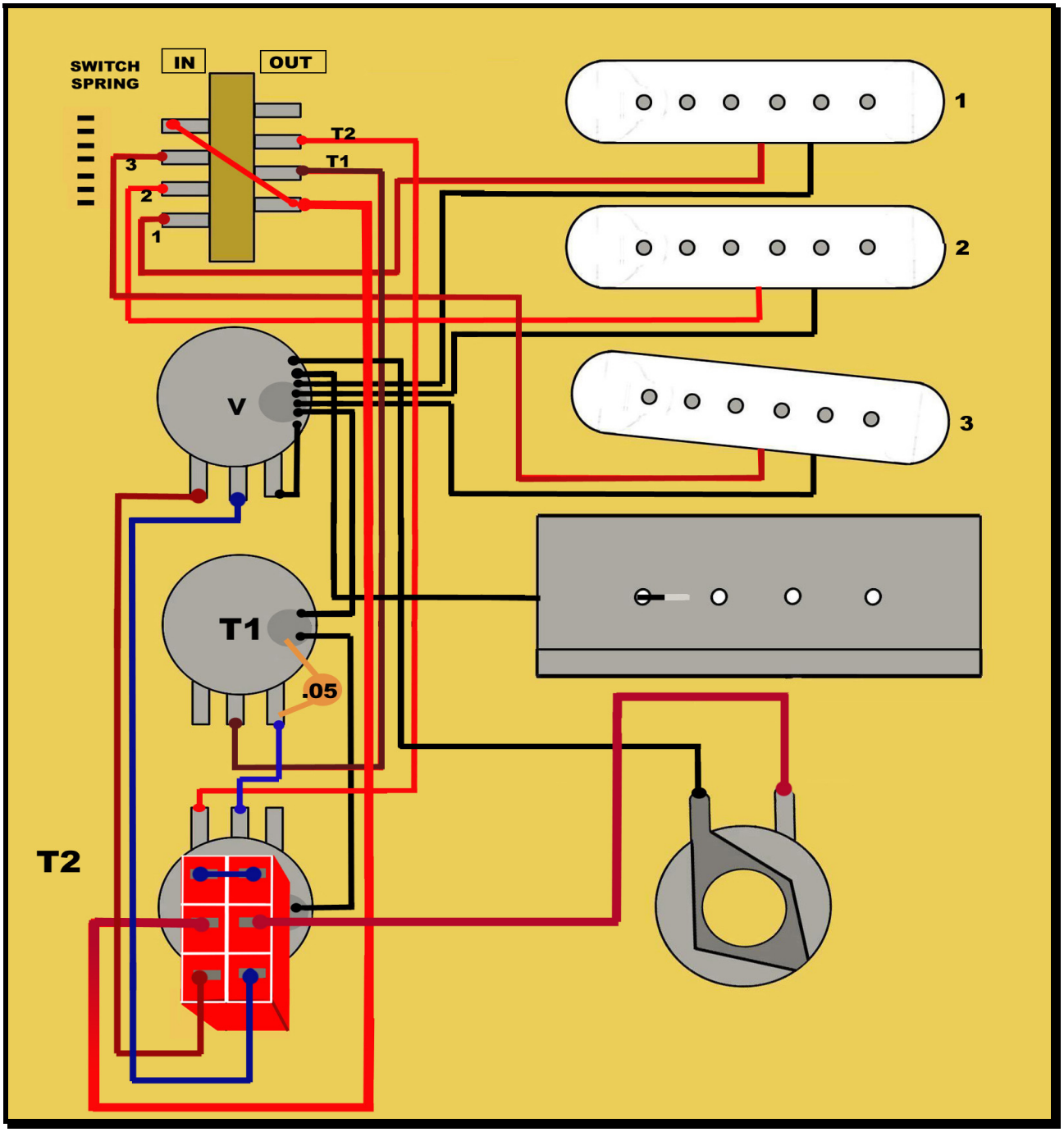
The pros rarely play stock guitars like you or me. They usually incorporate some type of modification to their guitars to get out more useable sounds. I am going to show you some of the hot rod techniques that are both inexpensive and easy to do.

VOLUME BOOST/BYPASS SWITCH

The volume boost switch is often called a bypass switch, or treble boost switch. It works by bypassing the tone and volume potentiometers, and sending the signal straight to the output jack. This reduces resistance in the circuit, and increases the output of the high tones. You can use a **push pull pot** with an **on/on switch** to activate this bypass. When you pull up on the switch, the signal goes straight to the output jack. When you push down on the switch, the signal goes to the volume and tone controls.



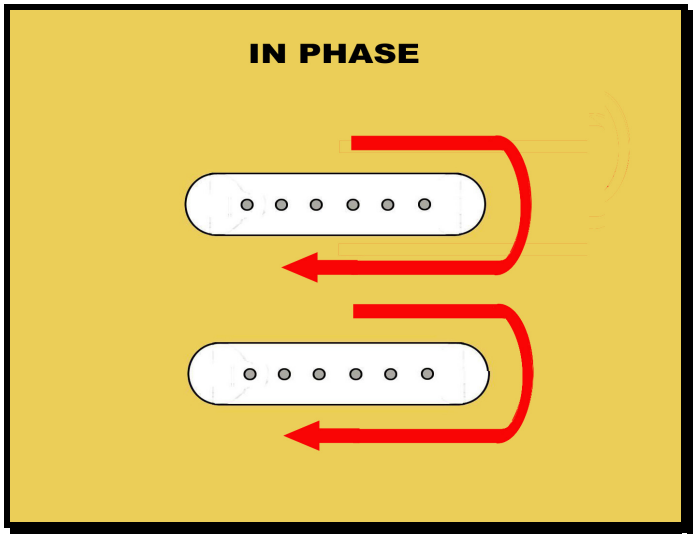
The example below shows a volume boost switch on a strat.

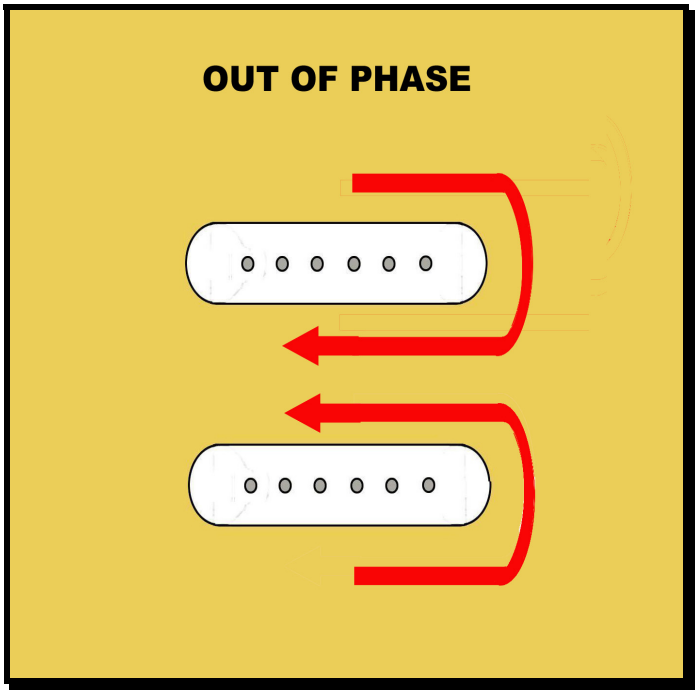


PHASE REVERSAL SWITCHES

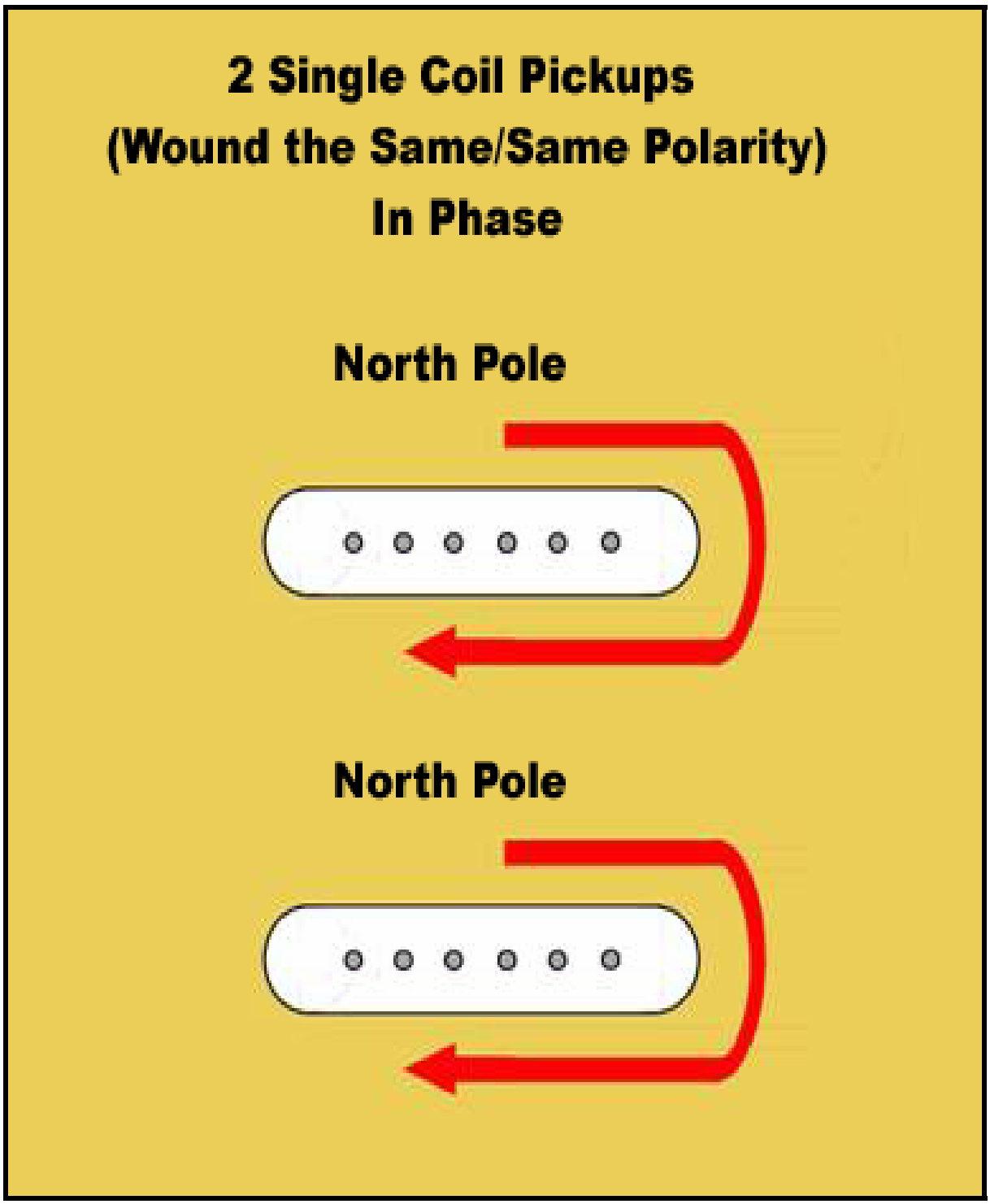
Another way to utilize mini toggle switches involves phase switching. When you change the phase of a pickup, you are changing the direction of the electrical current flowing through the copper wires.

Most pickups are wired to be in-phase with each other, causing their signals to move in the same direction. If a pickup is out of phase with itself, or another pickup, the signal will be moving in different directions in each coil, or each pickup. So at least two coils or pickups are needed to get a thinner, out of phase sound. The out of phase sound also has a lower output. Keep in mind that out of phase single coil pickups can sometimes produce an unwanted noise, or hum.

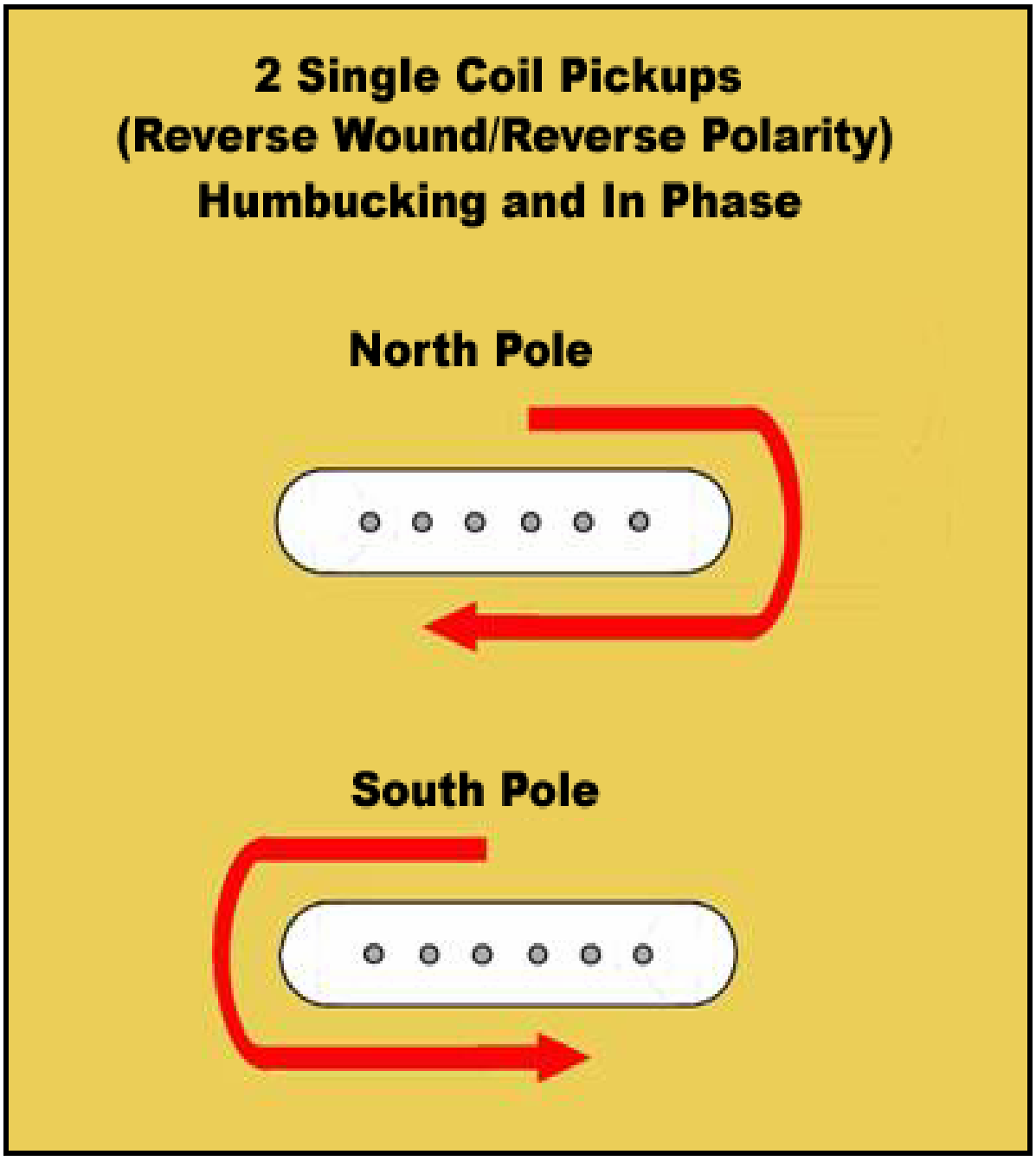




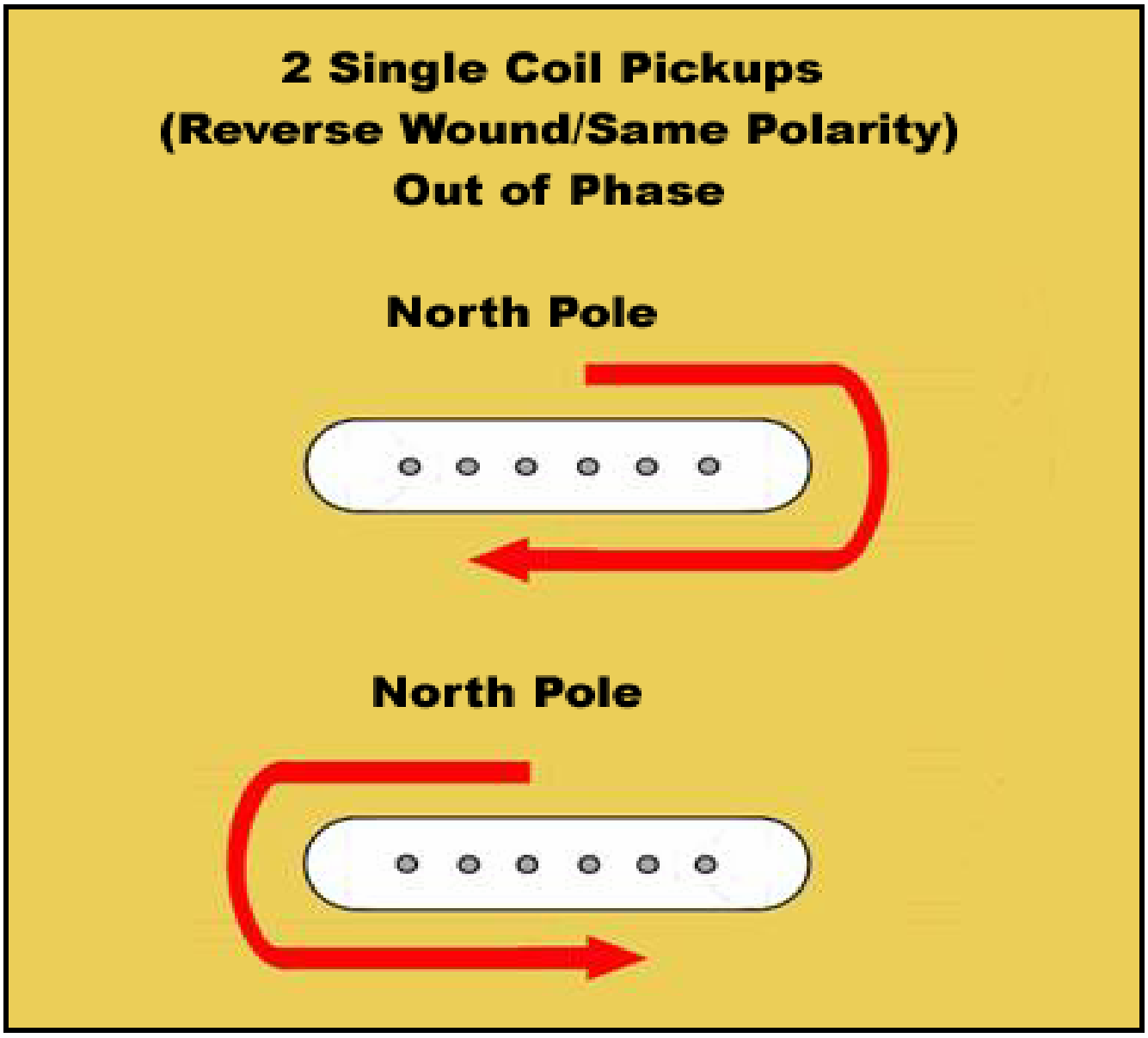
Here are two single coils wired to be in phase. This is typical for most single coil guitars.



Here are two single coils wound to be in phase and humbucking. The coils are actually out of phase with each other, but by having a reverse polarity on one of the coils, the signal gets put back in phase.



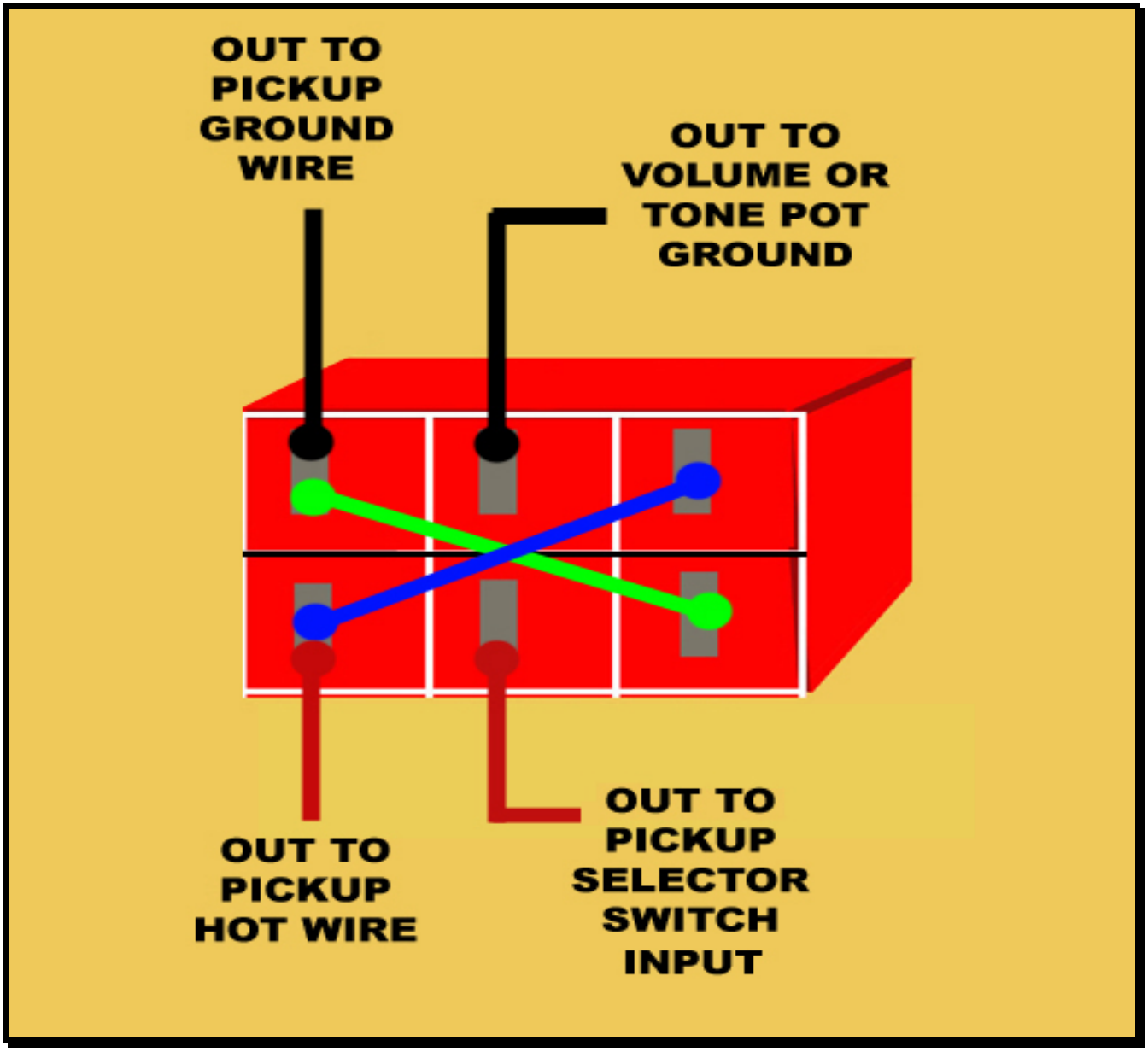
Here are two single coils wound to be out of phase.

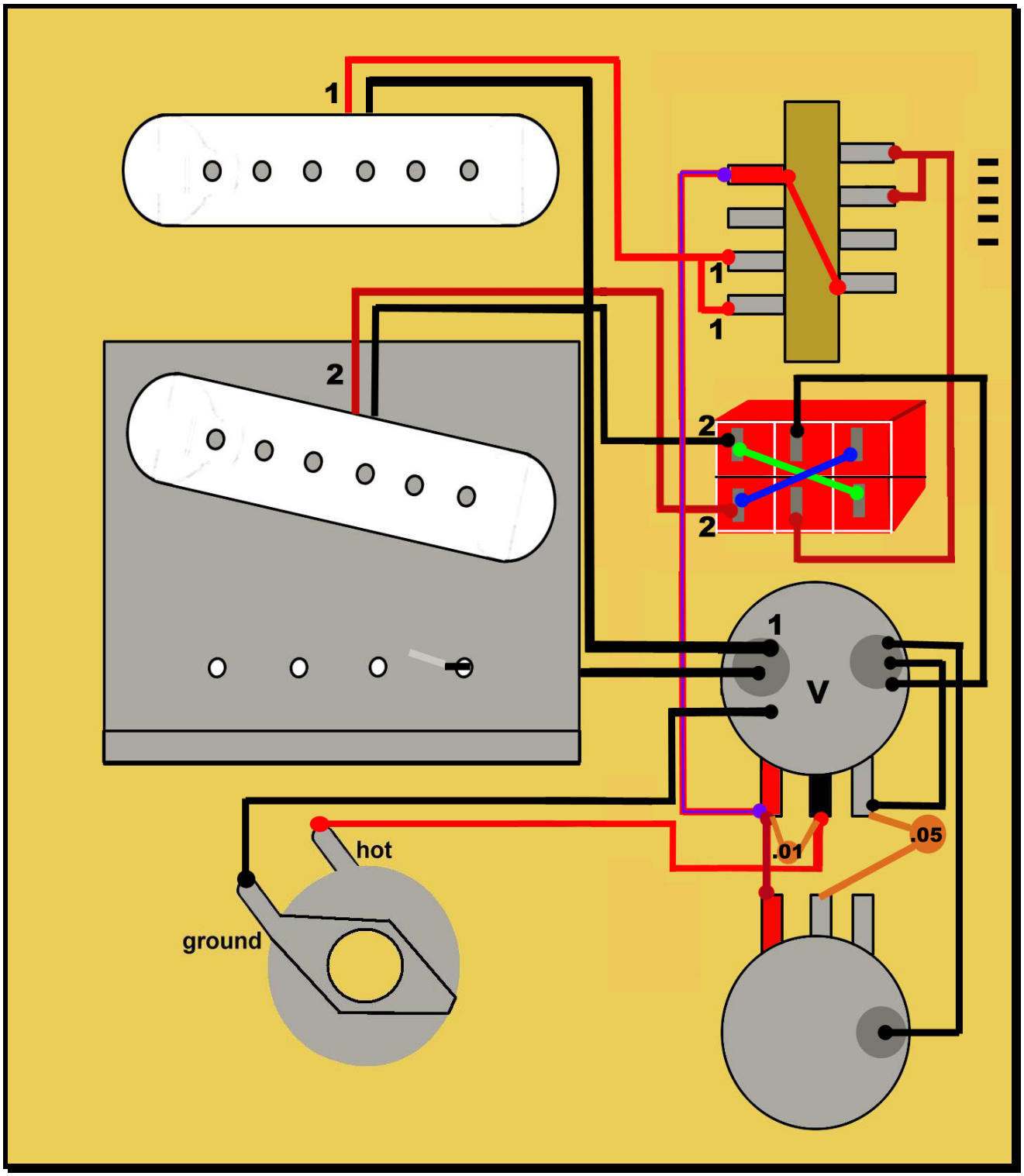


Here are some pictures of the polarity being tested on a strat with reverse wound/reverse polarity pickups. The polarity tester can be purchased from stewmac.com for a few bucks. The white side up on the neck pickup means north polarity.

The black side up on the middle pickup means south polarity.

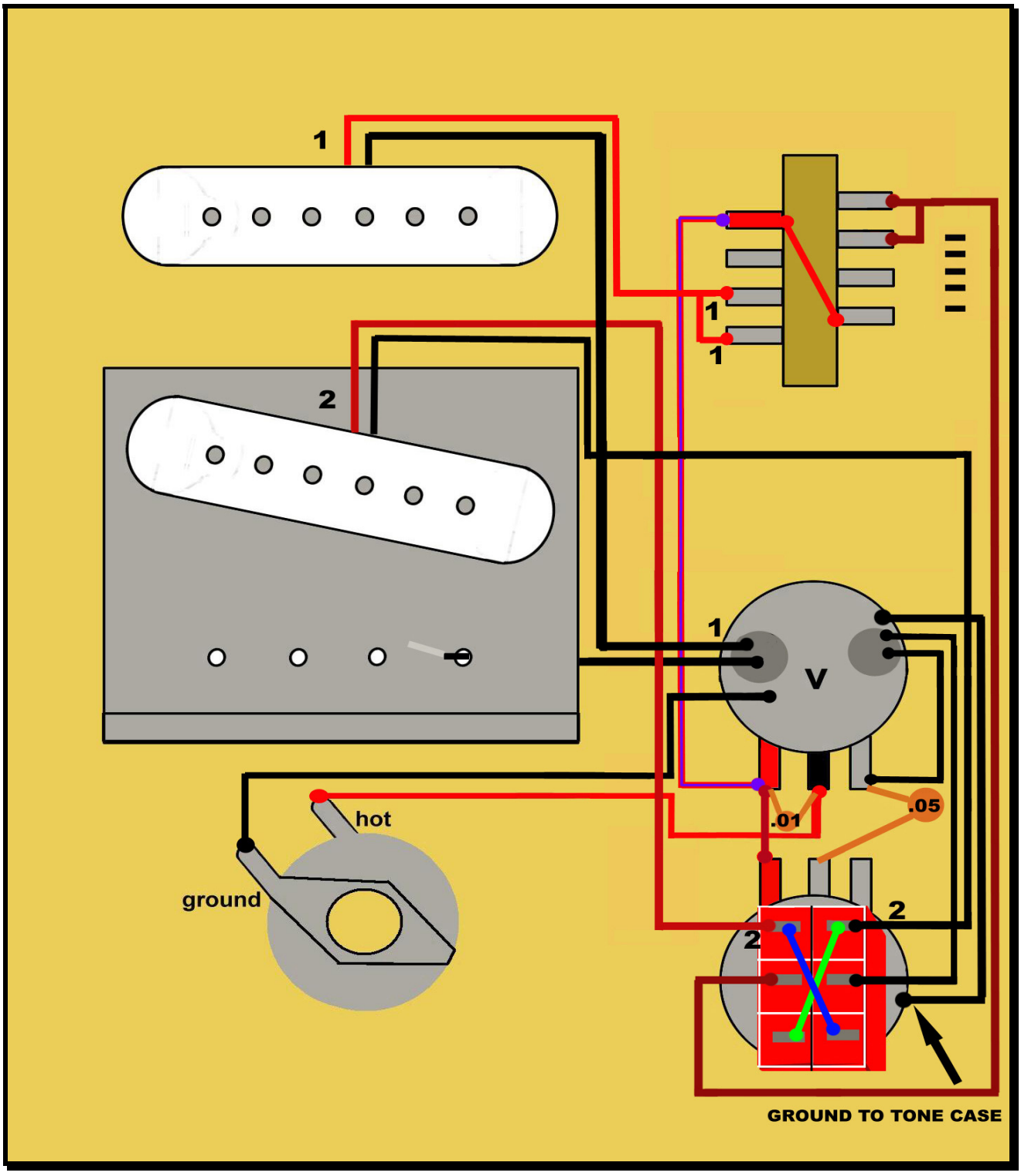
The example below shows how to change the phase of one pickup using a DPDT on-on switch. Just send the signal to the mini toggle before it enters the pickup selector switch, and also throw in some diagonal jumper wires. You only need to change the phase of one pickup to throw it out of phase with another pickup. It would be useless to change the phase of both pickups since it would just put them back in phase with each other.



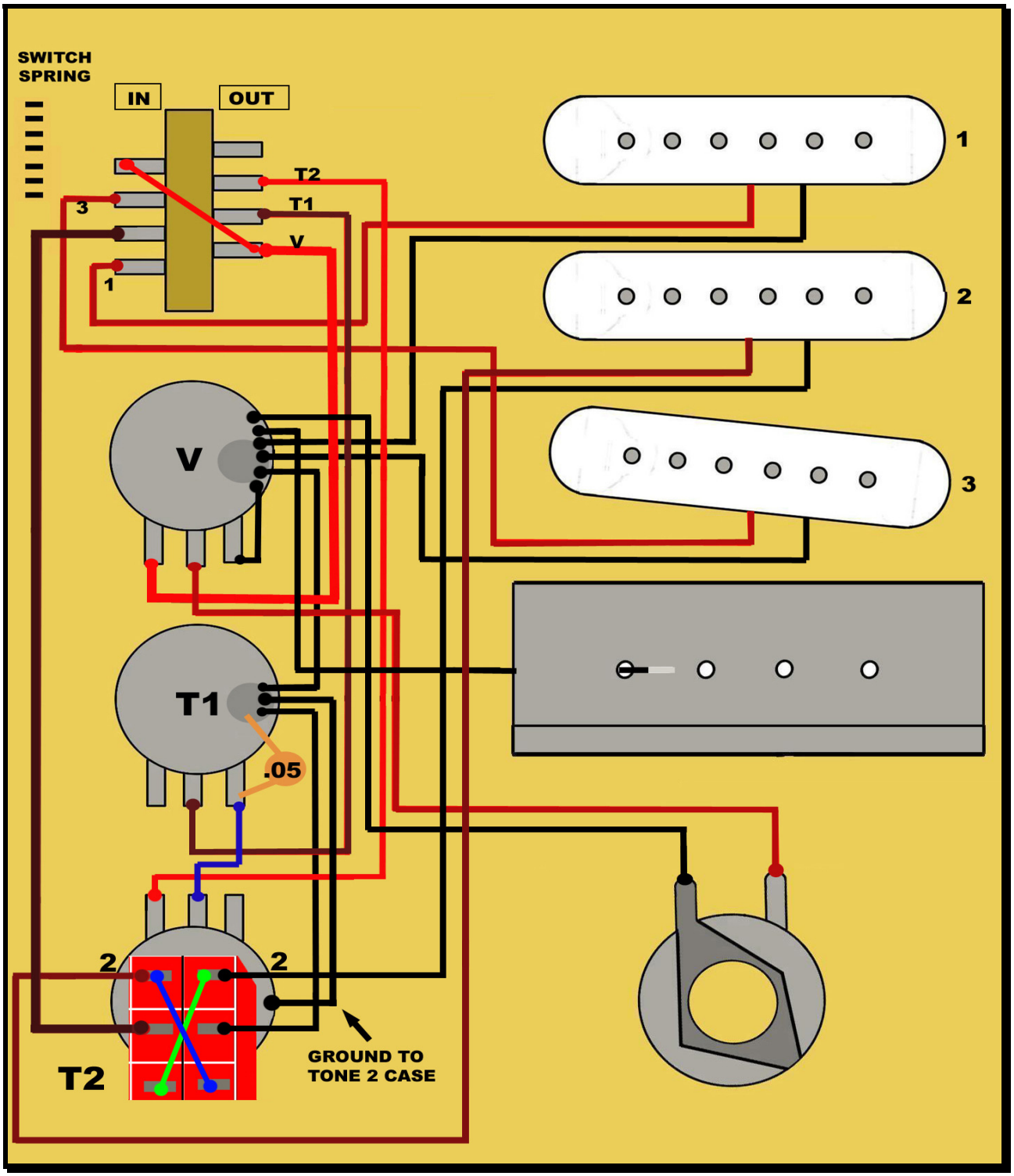


If you don't want to drill a hole for a mini toggle, you can use a push pull pot instead. It is a combination of a mini toggle switch and potentiometer.

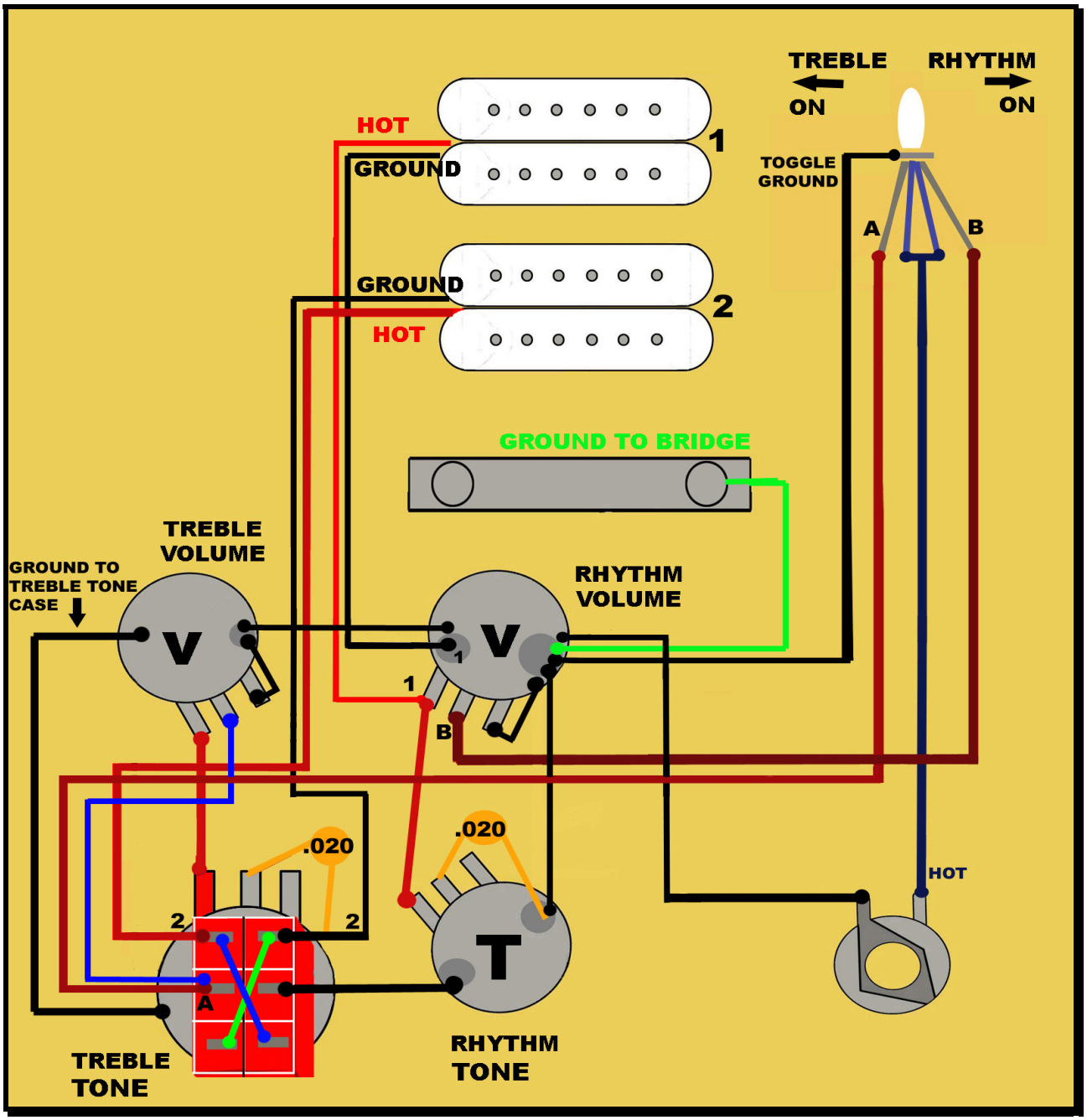
Here is the same wiring with a push pull pot. For more info on push pull pots, check out the potentiometer section in this book.



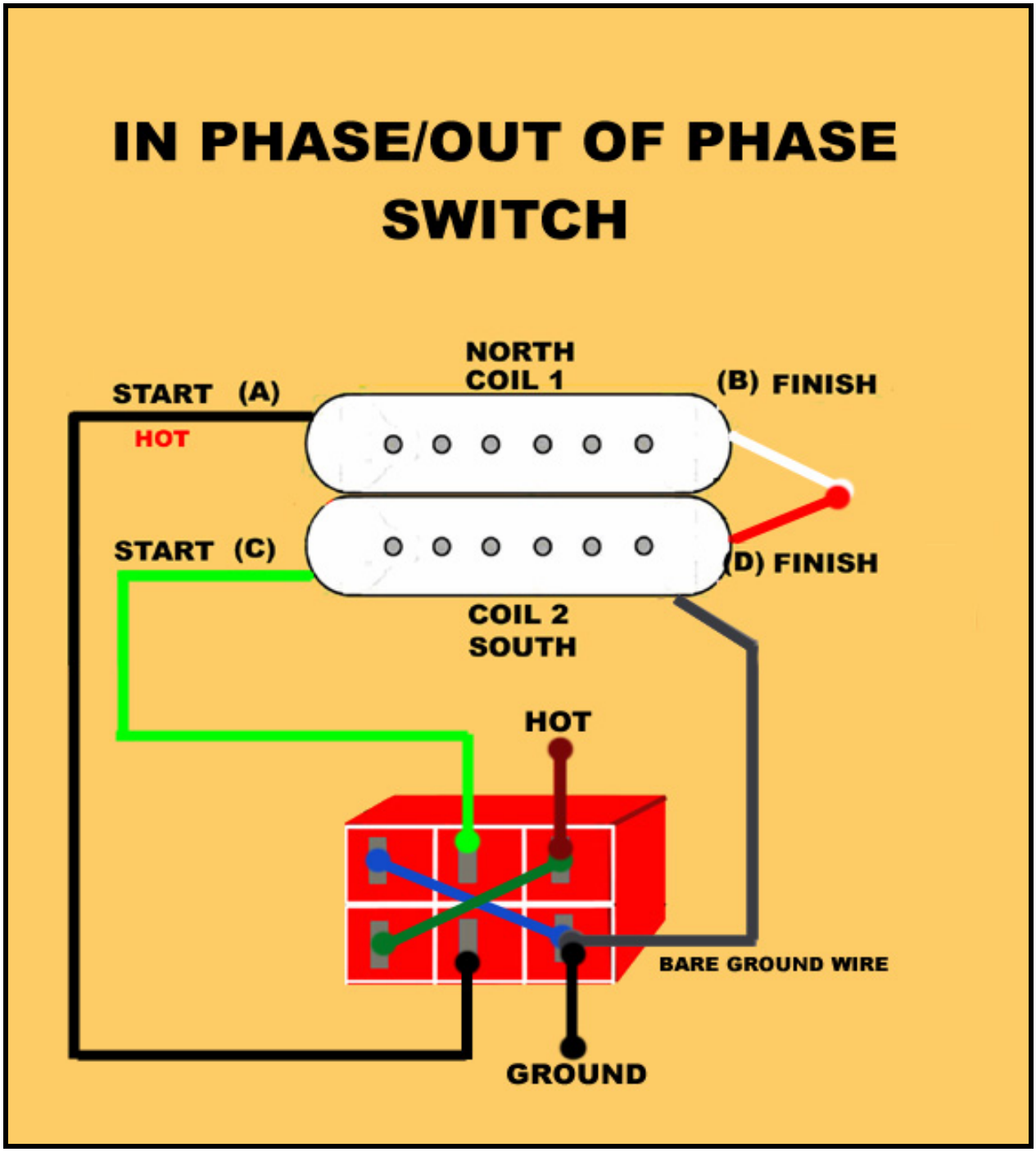
If you want the middle pickup to go in or out of phase with the neck and bridge pickups in your strat, then you can wire the guitar like this.



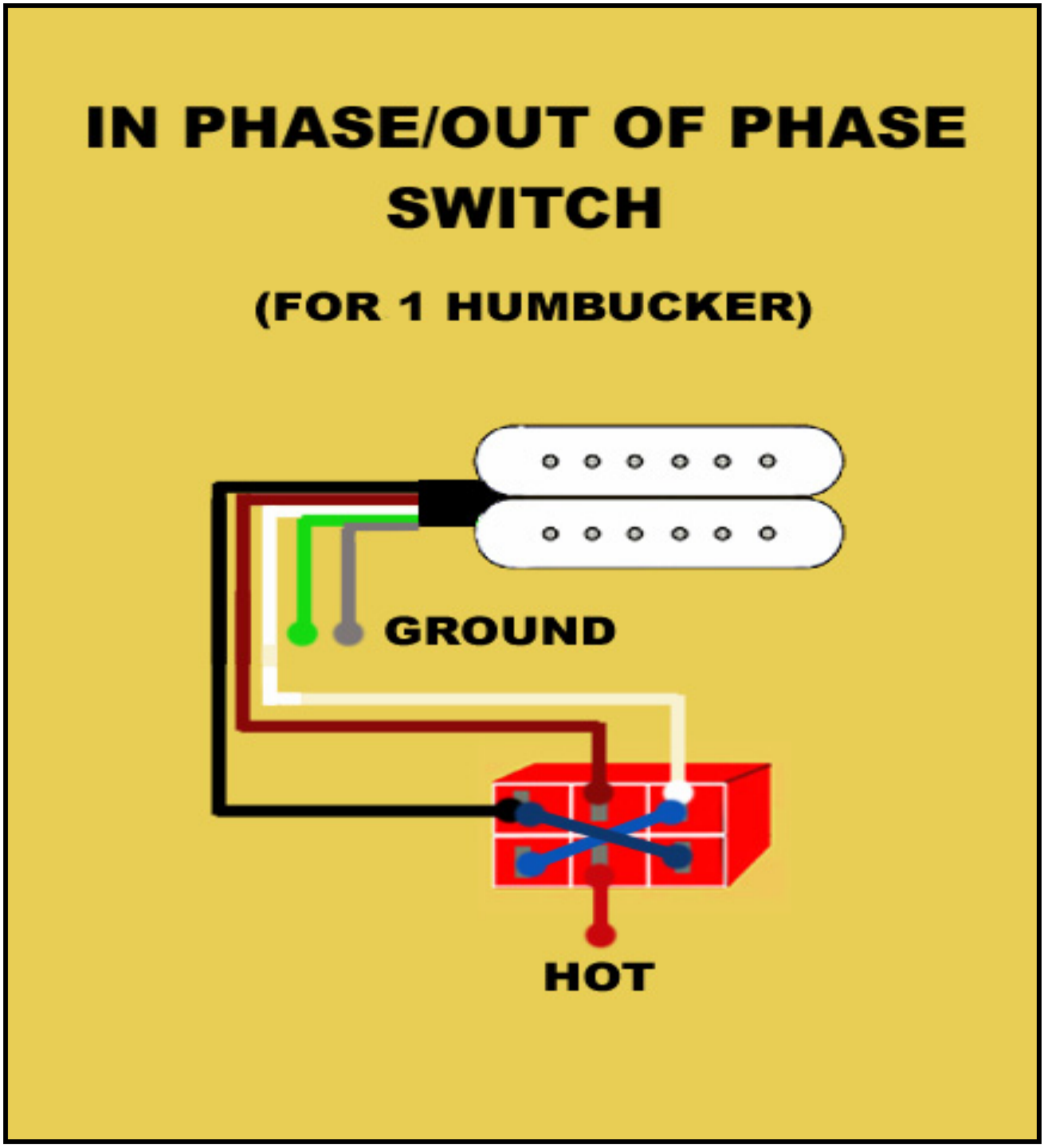
If you have a Les Paul, you can wire it this way to get the bridge pickup in or out of phase with the neck pickup. Notice how the 3-way switch sends the signal to the output jack. To make this wiring work, the push pull pot mini toggle switch sends the signal to the 3-way switch and volume pot, and then back to the push pull tone pot.



Here is the in phase/out of phase wiring on a 4-wire humbucker. Another pickup will need to be on at the same time in order to get the out of phase tones between two pickups. A simple on/on mini toggle switch is all you need. This diagram uses the same color codes as Seymour Duncan pickups. Black is hot, green goes to ground, and red and white form the series link.

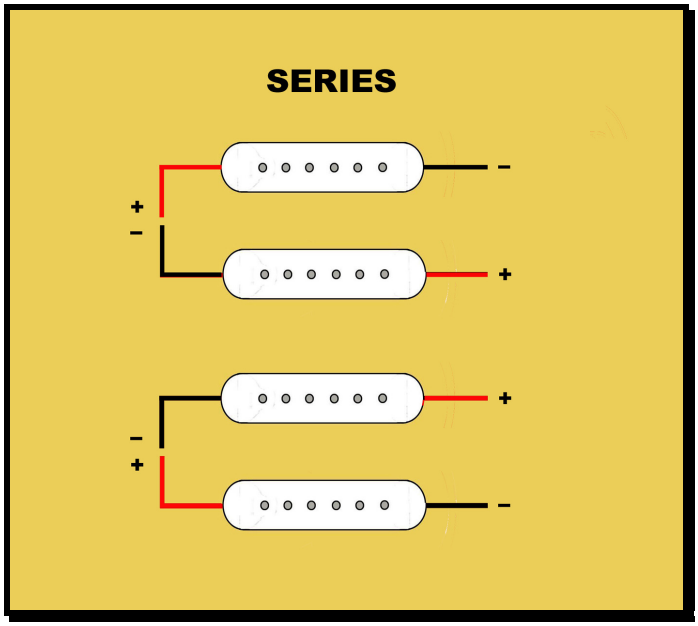


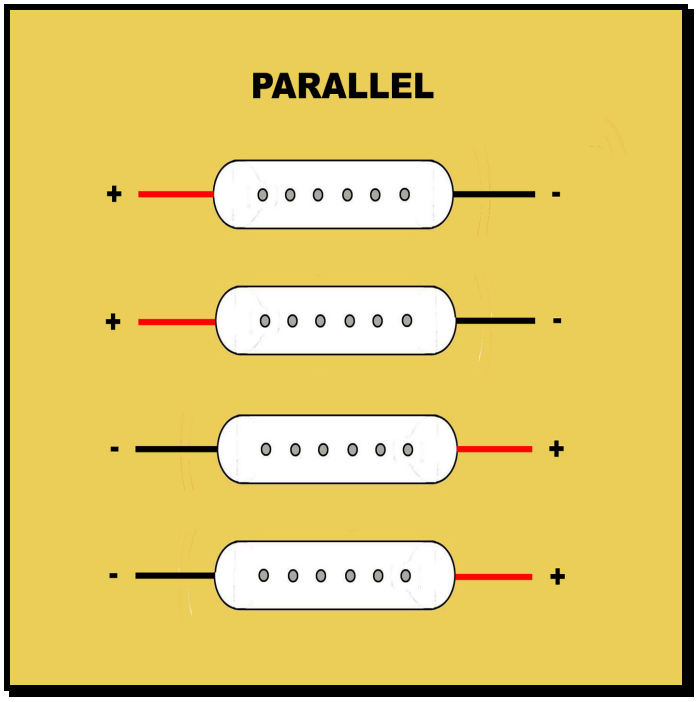
If you have a 4-wire humbucker, and want each coil to go in and out of phase with itself, then the on/on switch wiring would look like this. The unshielded grey wire and the green wire both go to ground. The hot wire goes to the pickup selector switch, just like a normal 2-wire pickup. This diagram uses the same color codes as Seymour Duncan pickups.



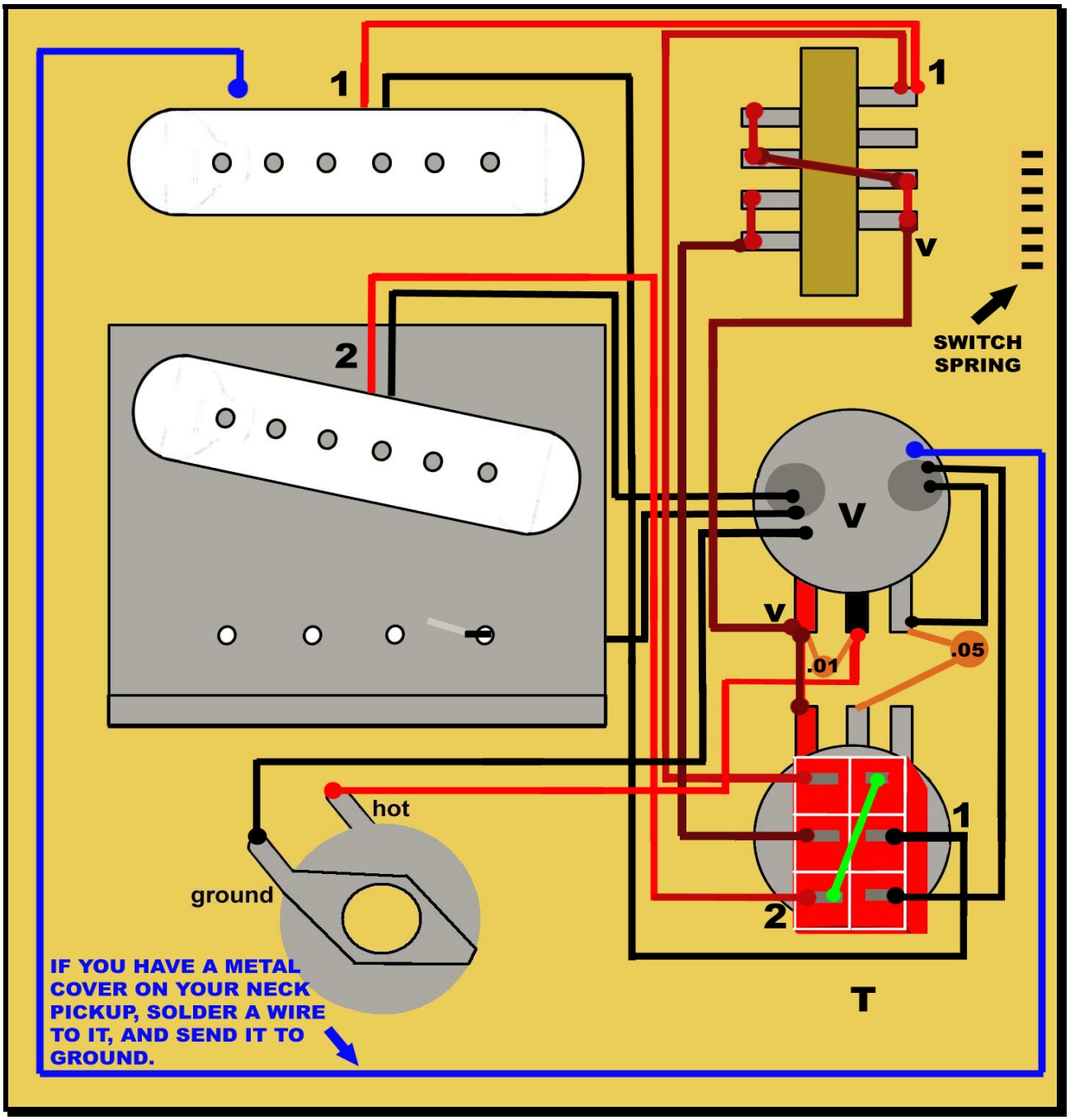
SERIES/PARALLEL WIRING

If you are looking to get more volume and midrange out of your pickups, you might want to try adding a series/parallel switch to your setup. Parallel wiring between two pickups is probably what you are used to by now. It's used in most guitars to add clarity to the sound. Series wiring is a little different. It produces a longer path with more resistance. This additional resistance prevents the higher tones from getting through the circuit, and allows more low/midrange tones to get through. In series wiring, the output of one pickup goes into the input of another pickup. In parallel wiring, each pickup takes its own path to the output.

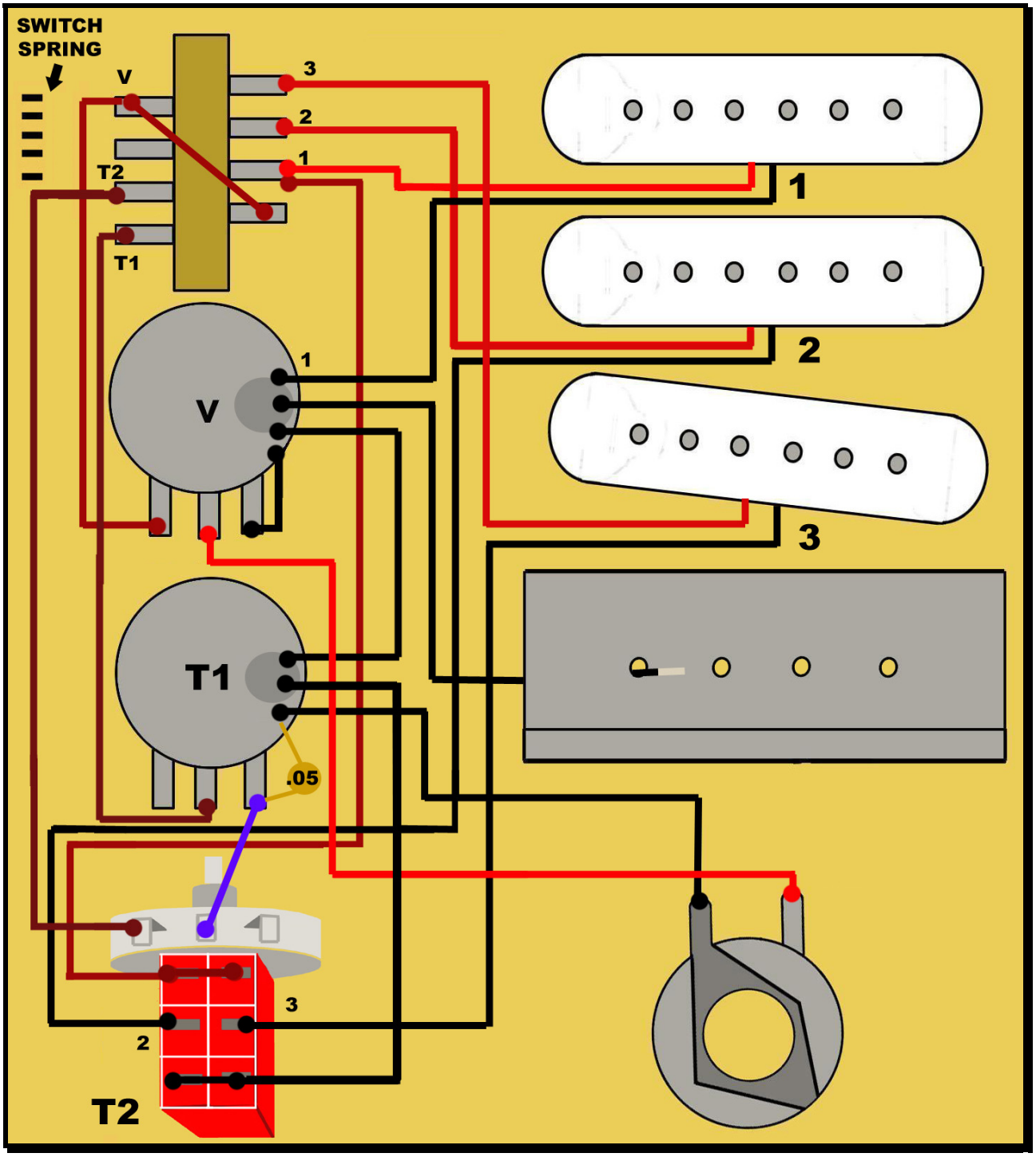




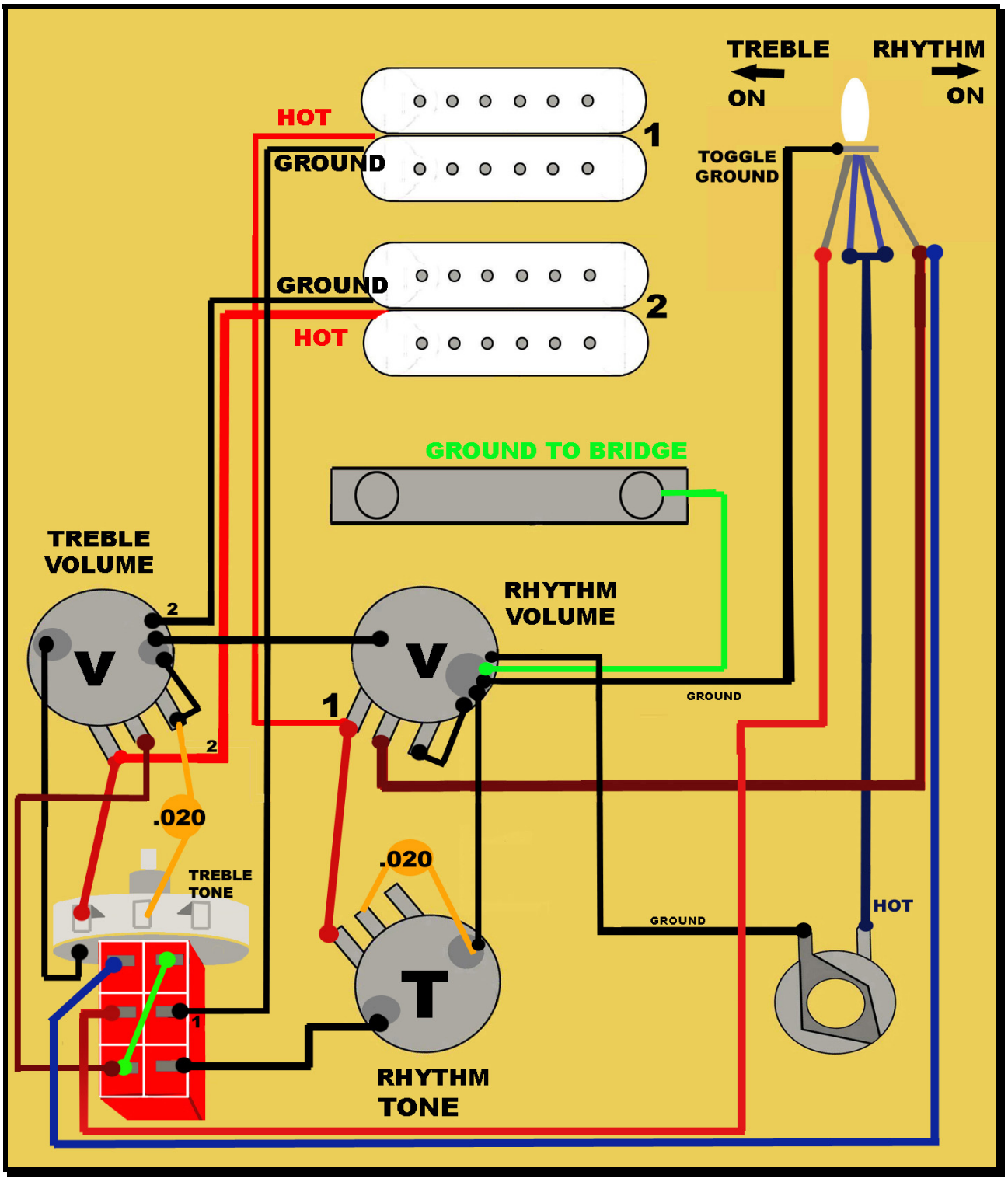
The diagram below shows how to wire a tele style guitar with a push pull pot that has a DPDT switch on it. When you have both pickups on at the same time, just pull up on the push pull pot, and the wiring will switch to series. The series wiring will be louder and have more lows than the parallel wiring. Notice the optional ground wire soldered to the neck pickup case. If you have a metal lipstick case covering your neck pickup, then can add this ground wire to reduce unwanted noise when using the series selection.



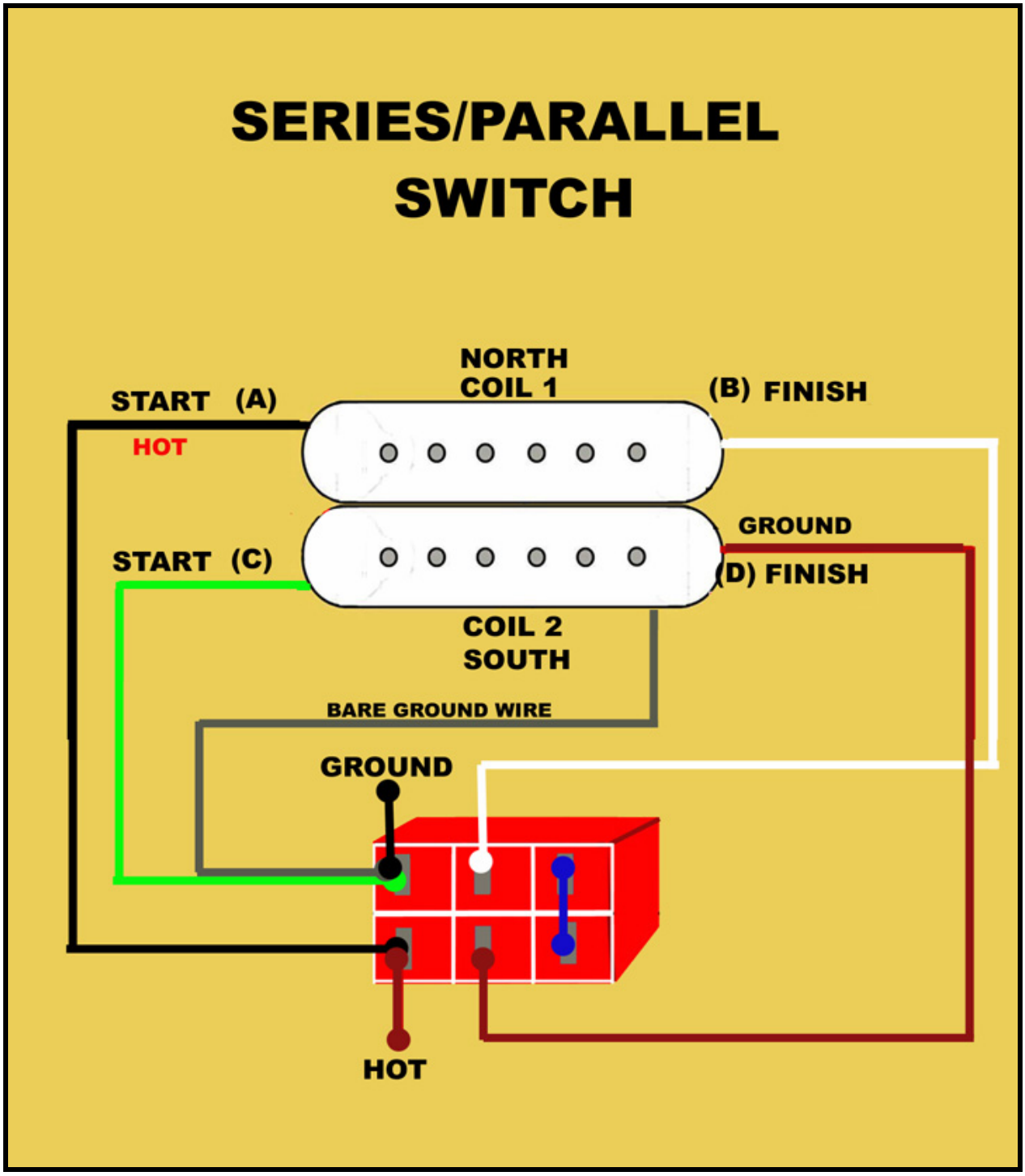
Now take a look at the strat style guitar with a series/parallel switch. It has 8 different sounds. When you pull out the push pull pot, you will have the neck and middle pickup in series in position 3, the bridge and middle pickup in parallel and in series with the neck pickup in position 4, and the bridge and neck pickup in series in position 5.



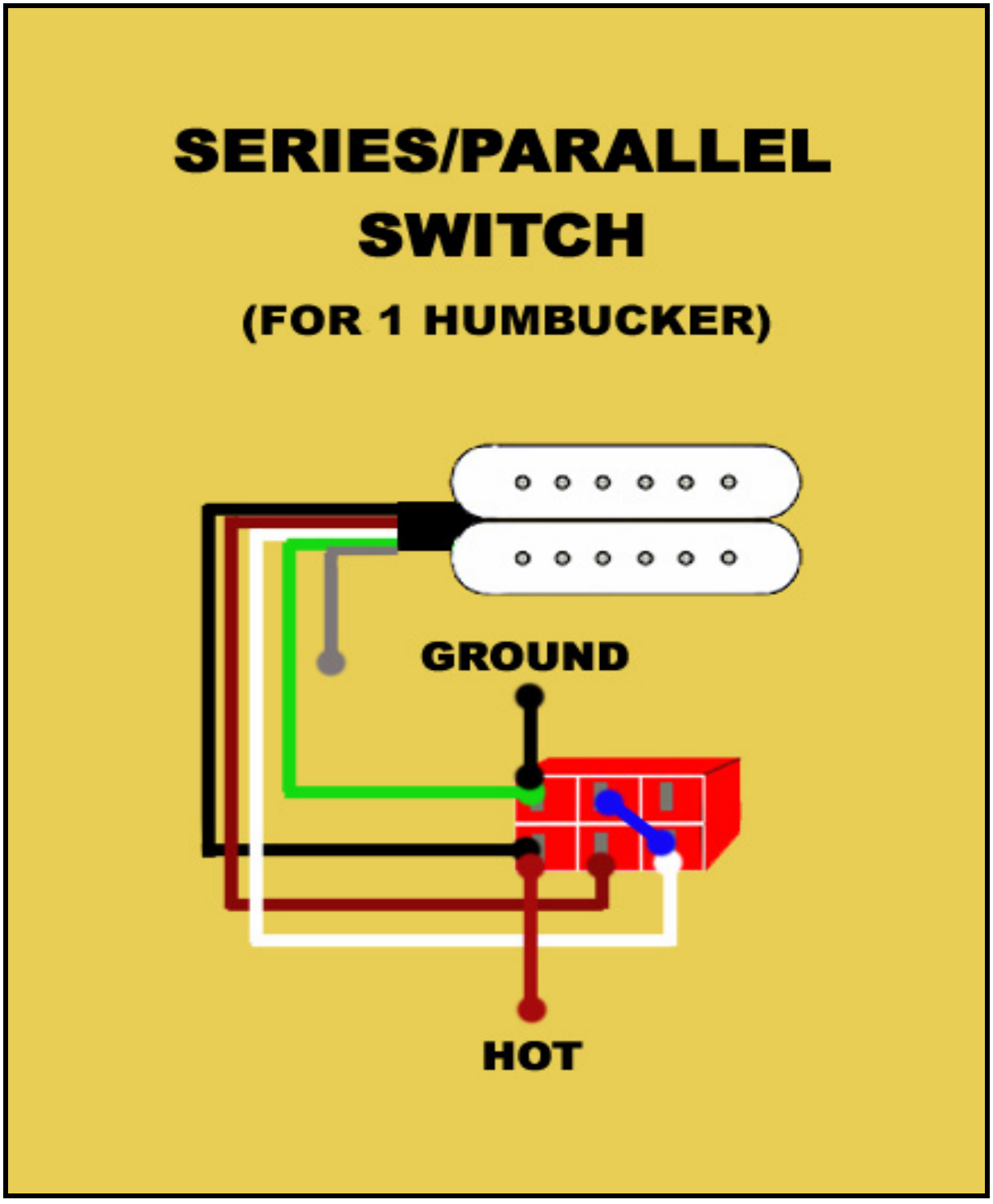
Finally, we have the Les Paul style guitar with the series/parallel wiring. When both pickups are on, just pull out the treble tone push pull pot, and it will switch both pickups to series.



If you have a 4-wire humbucker on your guitar, then you can add a series/parallel on/on mini toggle switch like this. Another pickup needs to be on in order to get the series wiring between the two pickups to work. The hot wire goes to the pickup selector switch, just like a normal 2-wire pickup.

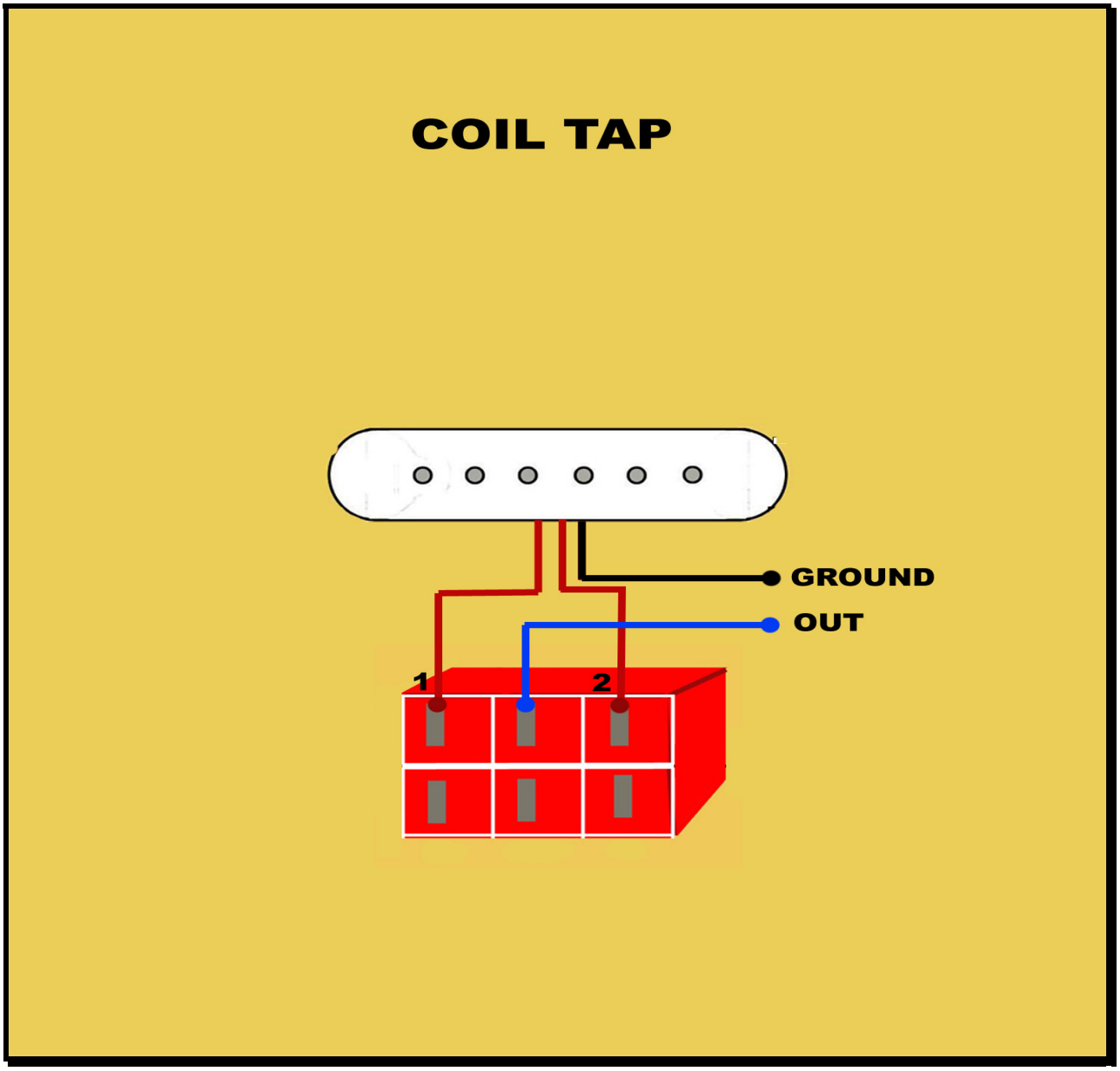


If you want each coil in the humbucker to switch from a series to parallel connection, then the wiring would look like this. The unshielded grey wire goes to ground. This also uses an on/on DPDT mini toggle switch.

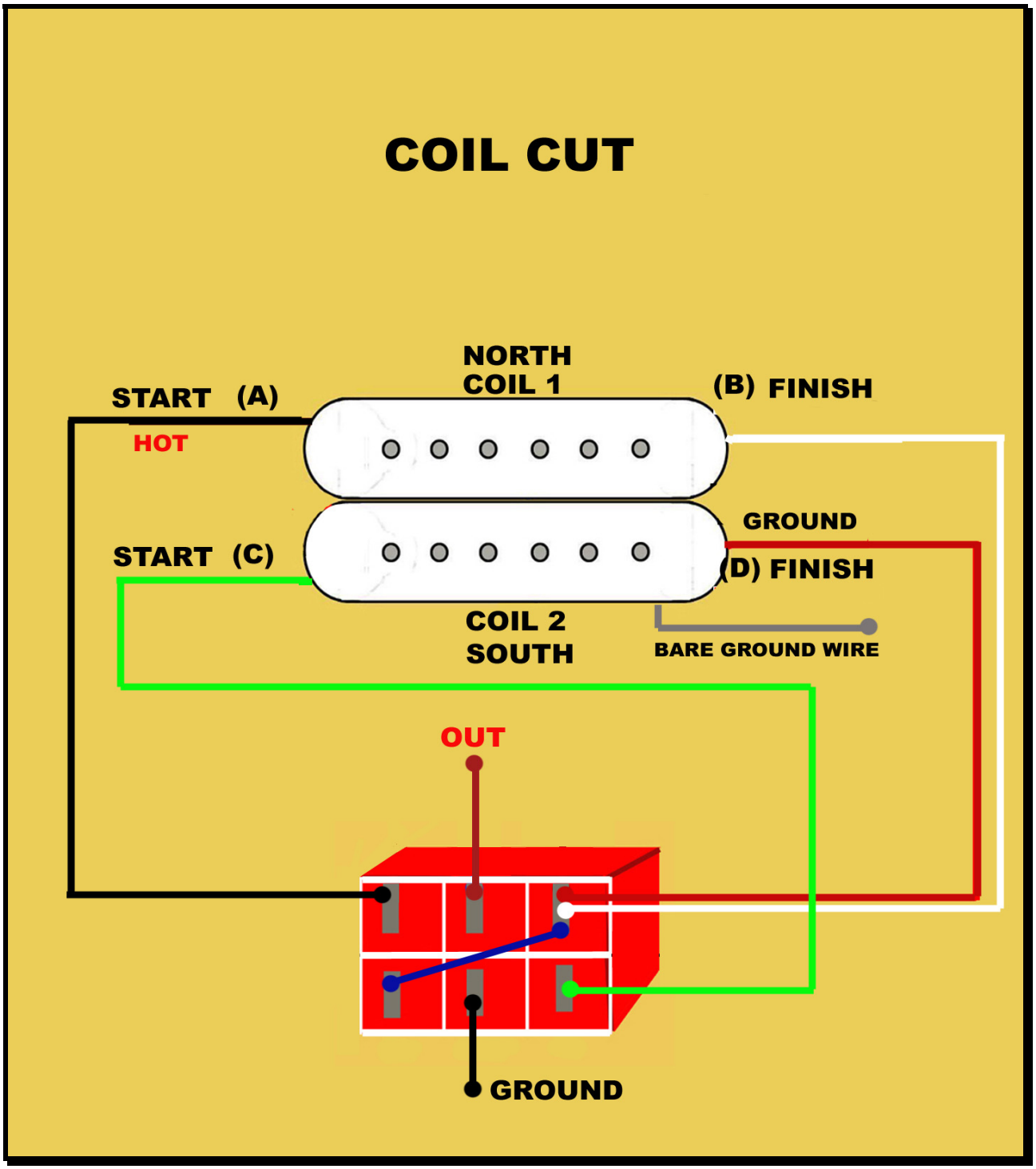


COIL TAP/COIL CUT

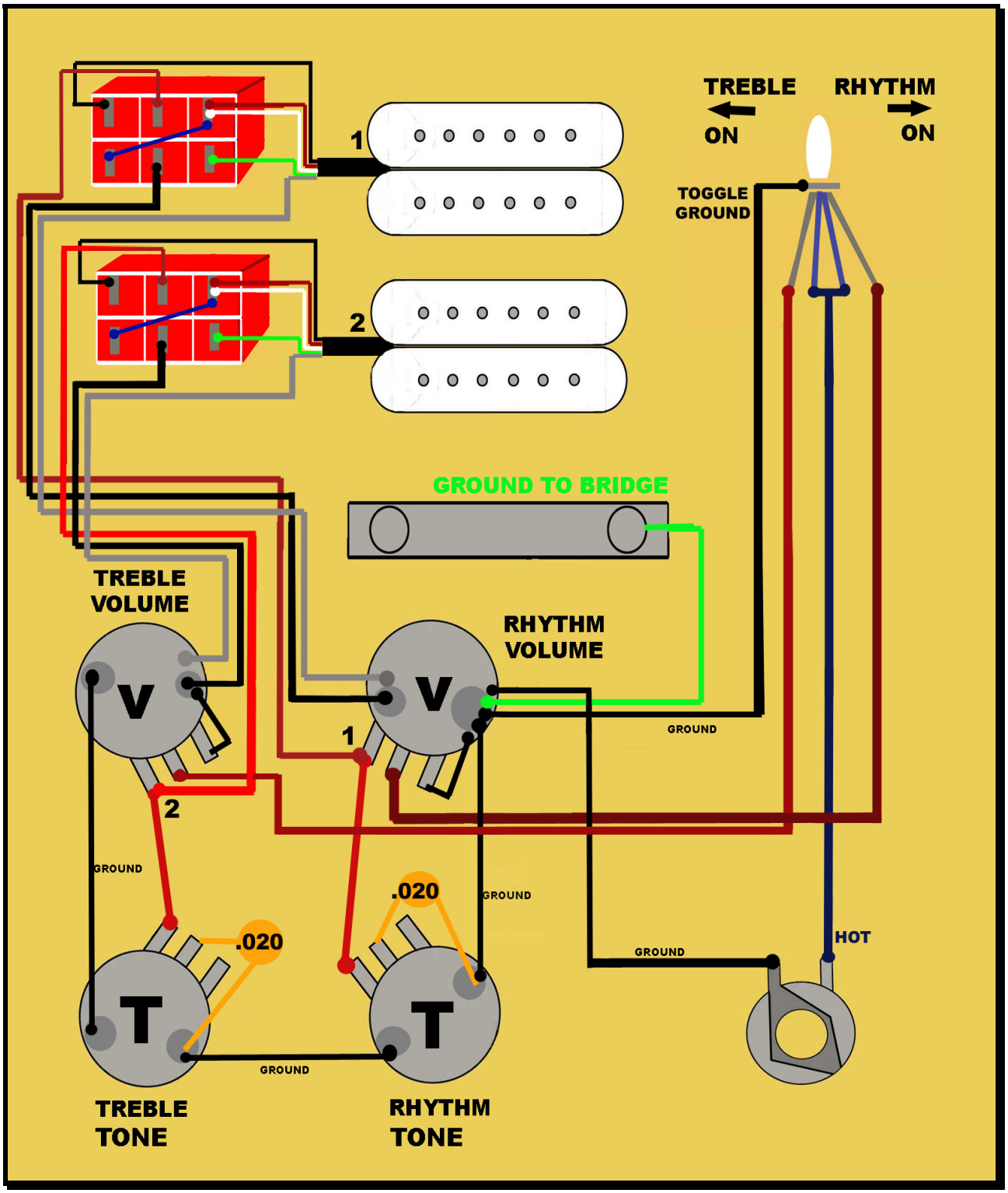
By far the most useful guitar hot rod technique is coil cutting. It gives you the benefits of both worlds. With a 4-wire pickup you can create a strat sound and a les paul sound at the flick of a switch. Note: coil cutting is often referred to as **coil tapping.** Coil tapping, however, involves single coil pickups that have 2 leads and a ground wire. Basically, the coil tapped pickup is wound halfway and a lead is added. Then it is wound the rest of the way and another lead is added. Below is a diagram of a coil tapped pickup hooked up to an on/on switch. These pickups are hard to find, especially since most sellers use the term "coil tapped pickups" to describe "coil cut pickups."



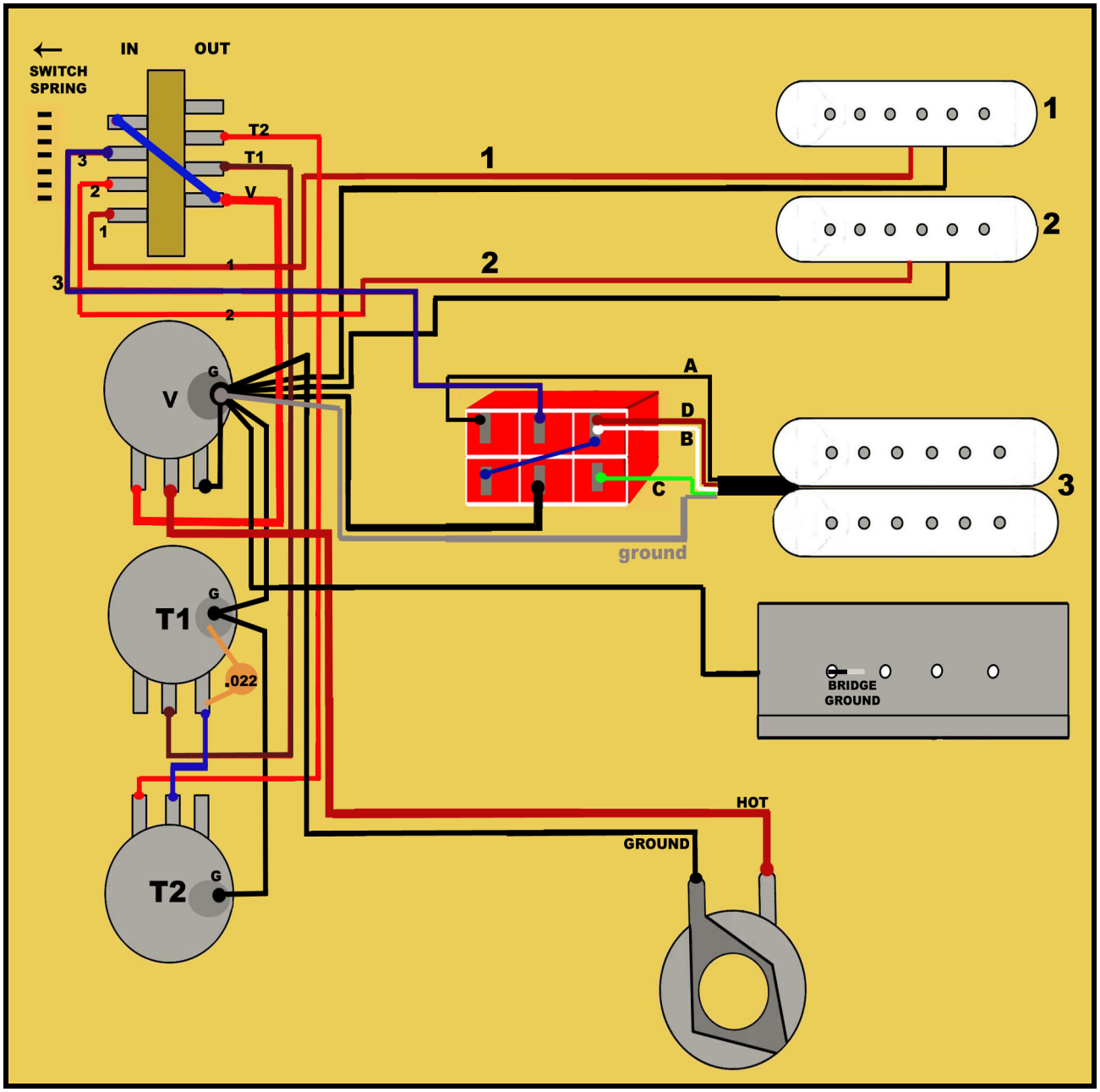
Coil cutting is fairly easy to do with an **on/on/on mini toggle switch** and a 4-wire humbucker. This setup will yield three different tones: north coil on, both coils on, and south coil on. Only two wires exit the on/on/on switch, a hot lead, and a ground lead. So it can be wired just like any 2 wire pickup once the signal leaves the switch.



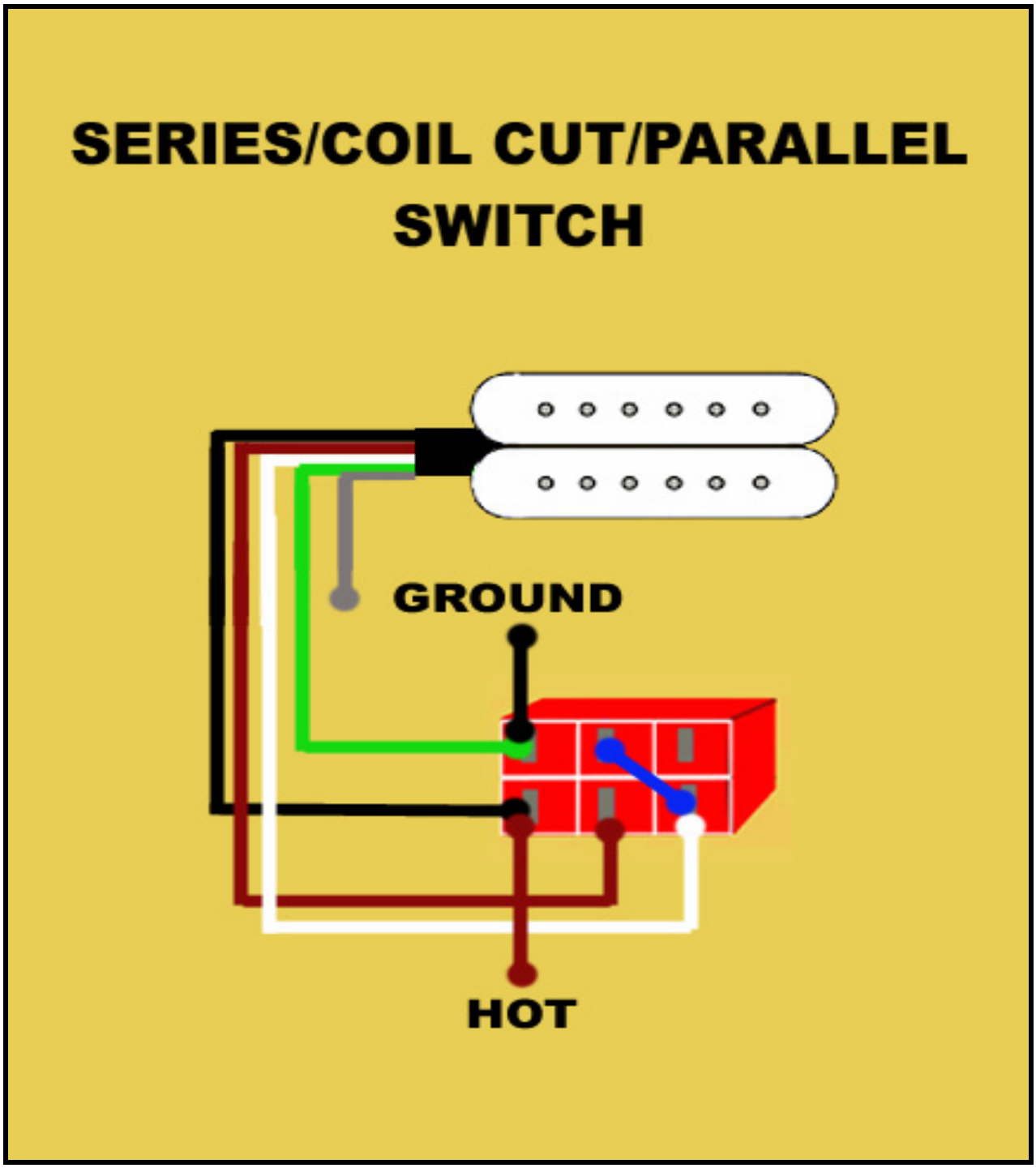
Here is a Les Paul style guitar wired with two **on/on/on mini toggle** coil cut switches. This setup has a ton of useful tone options.



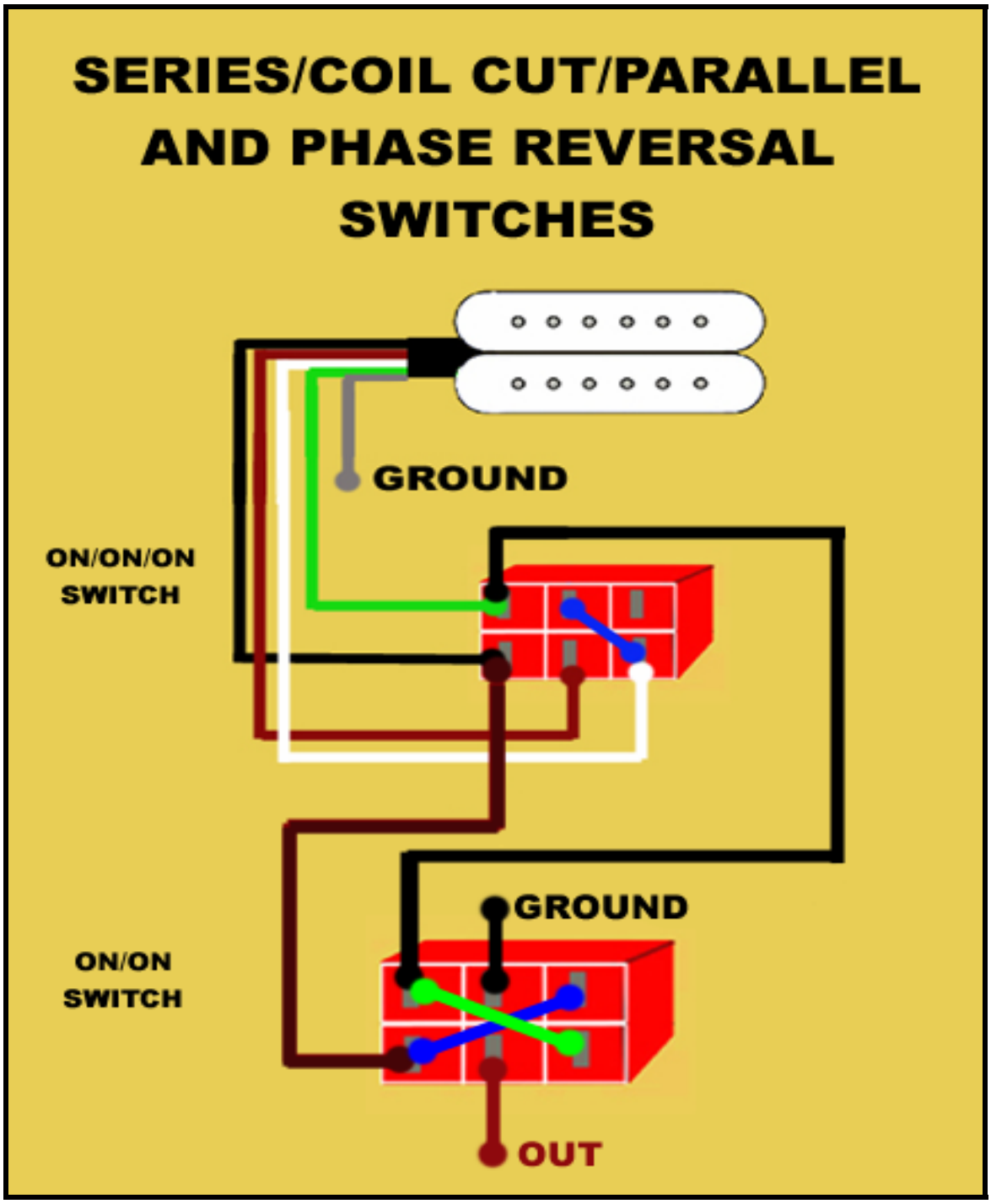
Next, is a fat strat with a 4-wire bridge humbucker. The color codes for this humbucker are based on a Seymour Duncan pickup. The north coil has a black start wire and a white finish wire. The south coil has a green start and red finish. The grey bare wire always goes to ground. This humbucker will be wired in series and in phase when both of its coils are switched on. An **on/on/on mini toggle switch** is used for this modification.



If you want to throw a few mods together on a 4-wire humbucker, try this. It's an **on/on/on** toggle that switches between series wiring, coil cutting, and parallel wiring. The bare grey wire and the black wire go to ground. The hot wire goes to the pickup selector switch, just like a normal 2-wire pickup. The color codes are the same as a Seymour Duncan humbucker pickup. The black wire from the pickup is hot, green is ground, and the red and white wires form the series link.

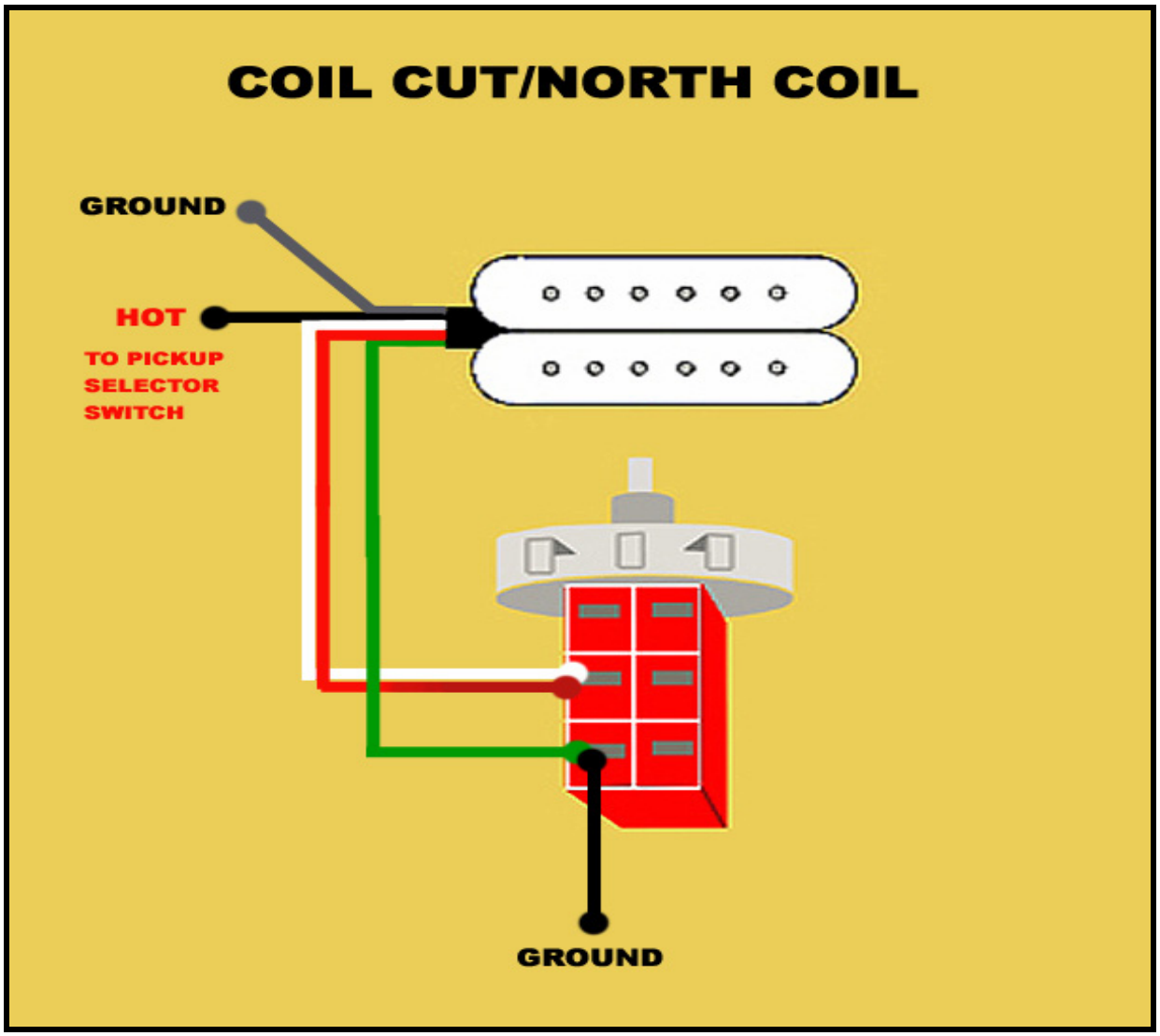


Add a phase a reversal switch to the mix, and the wiring looks like this. The top mini toggle switch is **an on/on/on** series/coil cut/parallel switch. The bottom toggle is an **on/on** phase reversal switch. You need two pickups on in order for the bottom switch to change to out of phase. The bare grey wire goes to ground. The hot out wire goes to the pickup selector switch, just like any normal 2-wire pickup. This pickup uses the same color codes as a Seymour Duncan pickup.

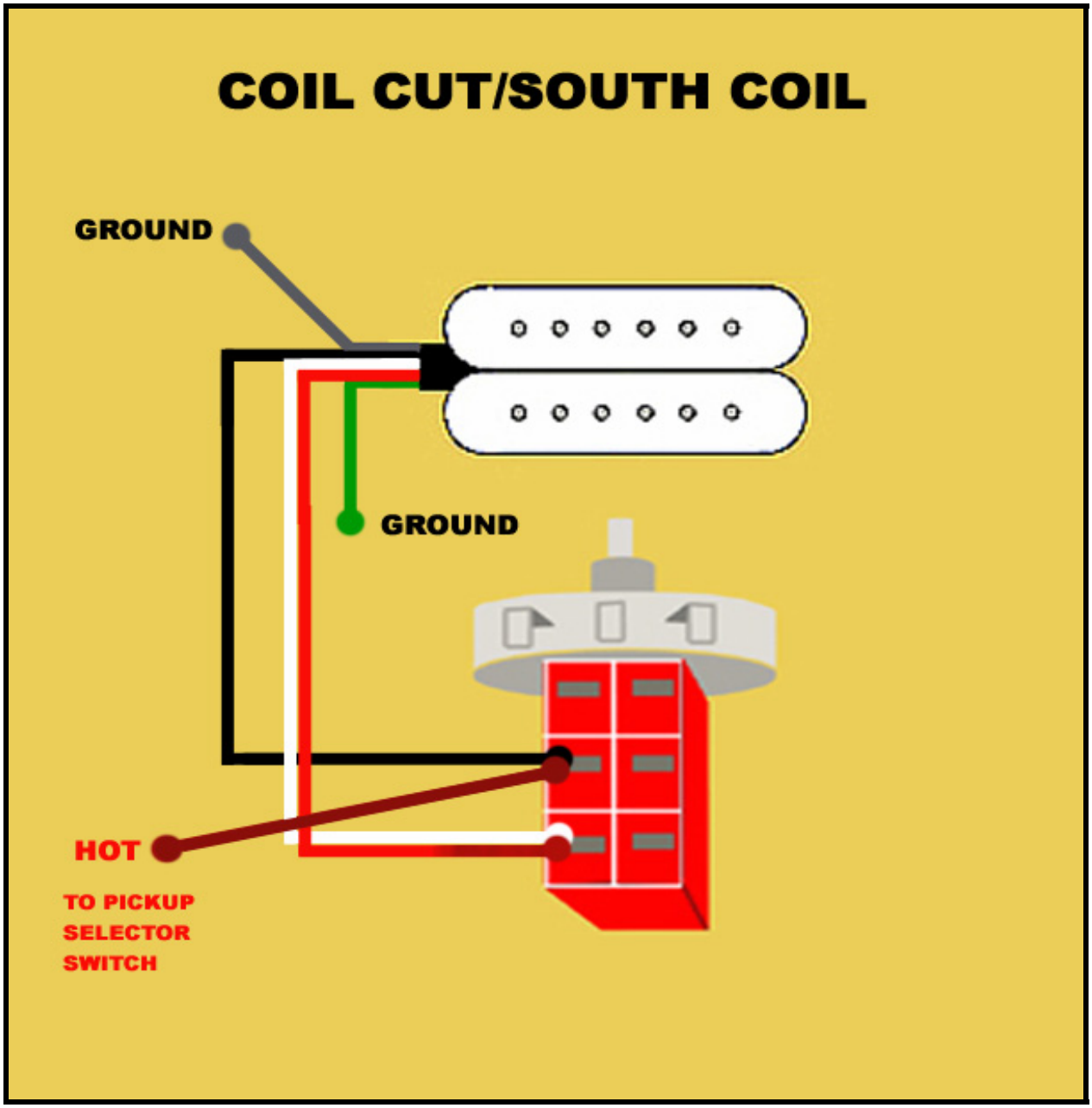


COIL CUTTING WITH A PUSH/PULL POTENTIOMETER

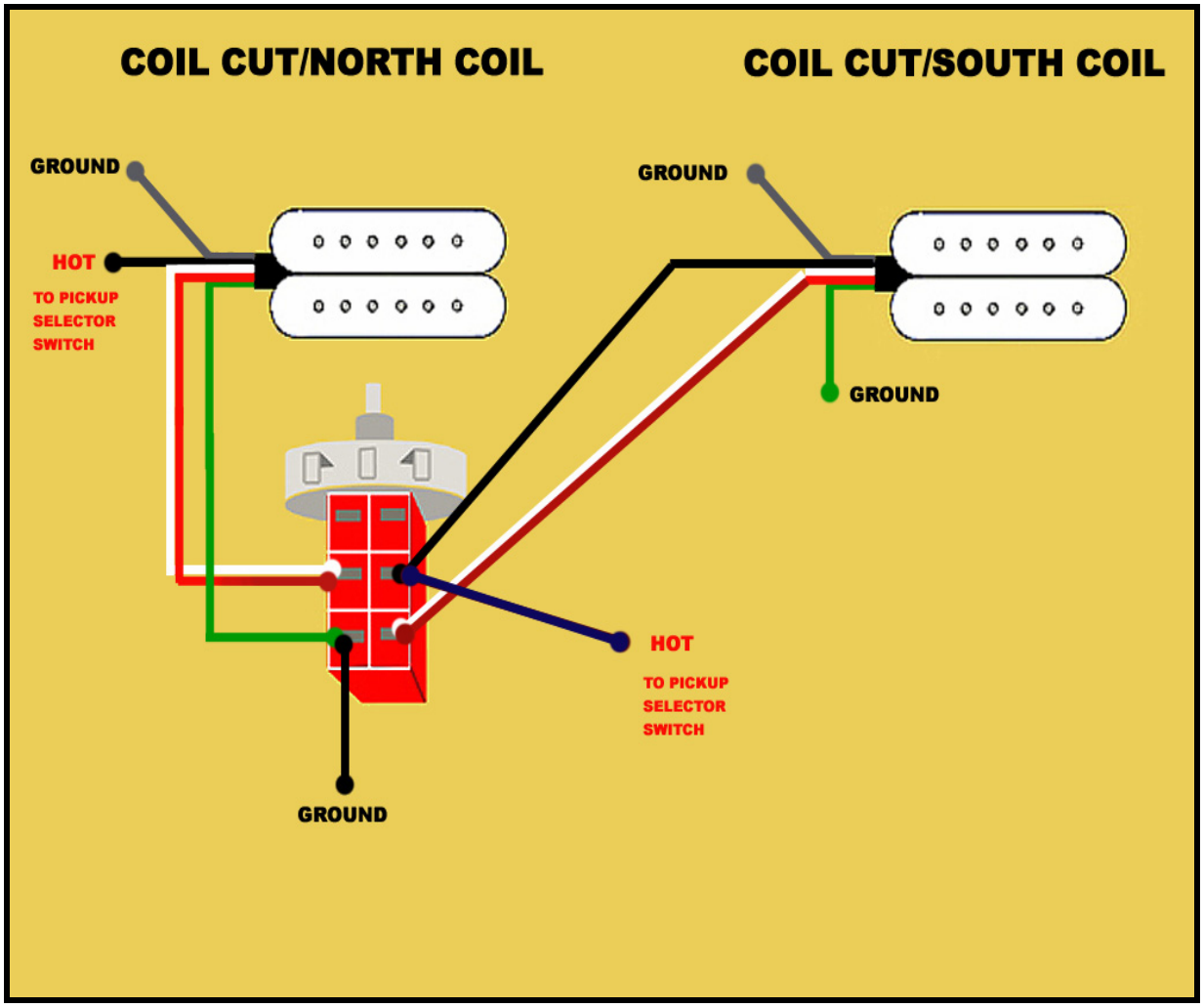
If you want to cut the coils on your humbucking pickup, but don't want to alter the appearance of your guitar, you can use a push/pull pot instead of a mini toggle switch to change from a humbucking pickup to a single coil pickup. The push pull pot is basically an on/on switch connected to a potentiometer, so you get only two selections with this setup (humbucking or single coil). The diagram below uses the same color codes as a Seymour Duncan pickup. Black is the hot wire, green is the ground wire, the red and white wires form the series link, and the bare grey wire goes to ground. You are left with one wire exiting the push pull potentiometer that also goes to ground. The top part of the push pull pot, or the actual potentiometer, can be connected just like any volume or tone potentiometer. Note: if you don't know which coil is the north coil, then you can buy a polarity tester from stewmac.com to find out which coil is north and which is south.



The wiring is a little different if you want to go from both coils on, to the south coil on. The hot wire from the pickup (black in this case) goes to the middle lug on the switch section of the push pull pot. Another wire connects to that same location and goes out to the pickup selector switch, where that pickup would normally be connected to. The diagram below uses the same color codes as a Seymour Duncan pickup. Black is the hot wire, green is the ground wire, the red and white wires form the series link, and the bare grey wire also goes to ground.

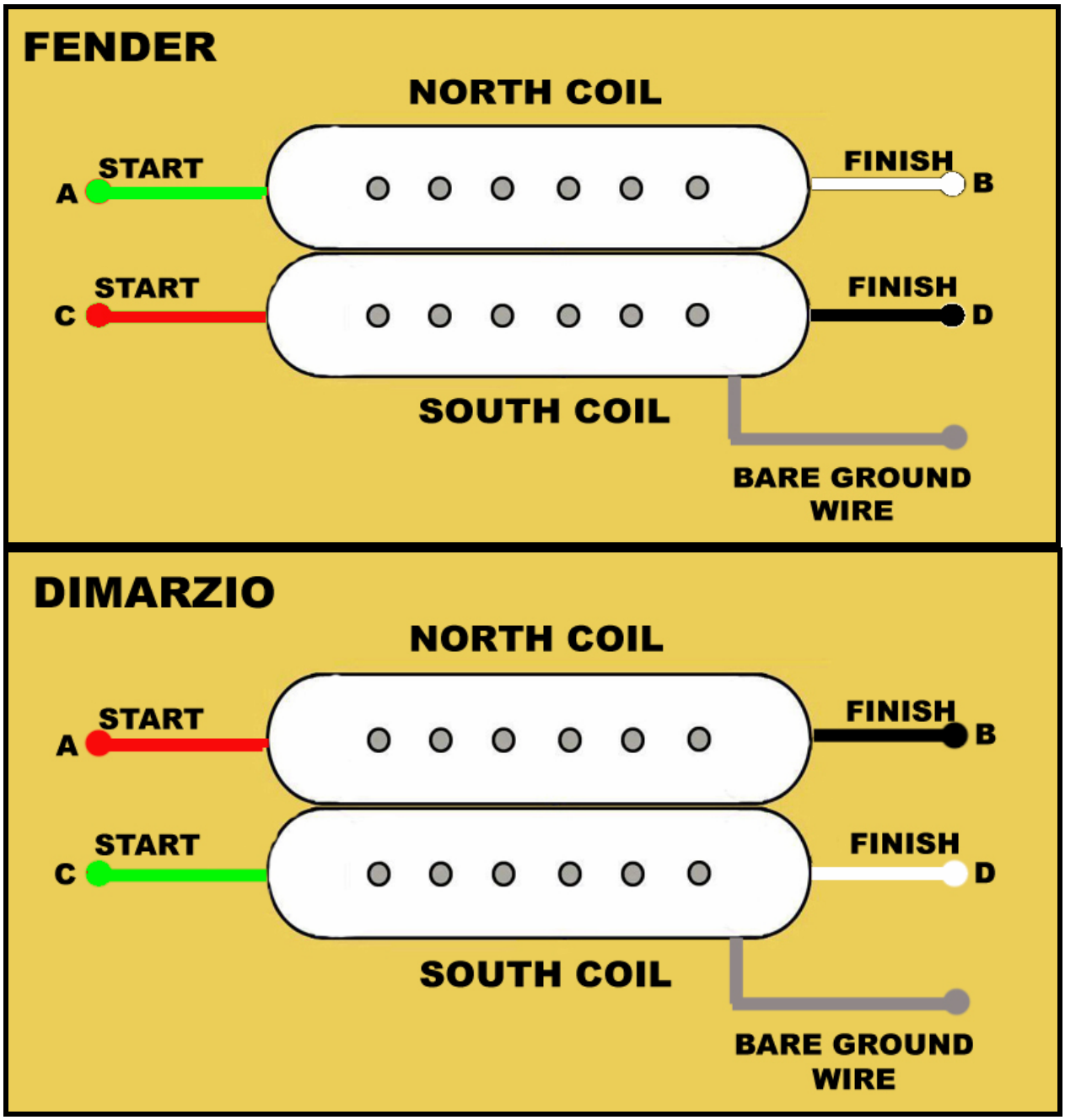


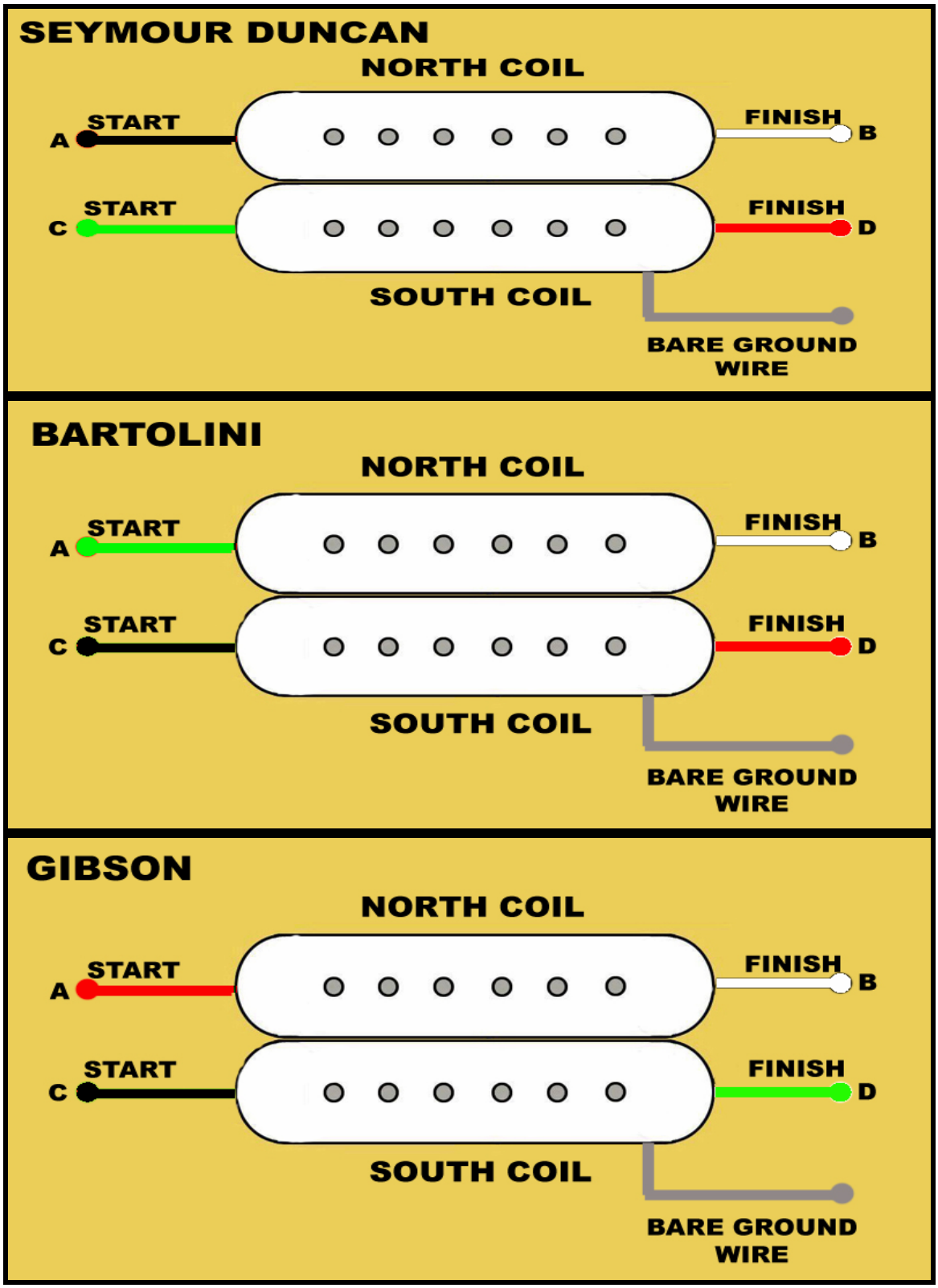
Next we are going to connect two 4-wire humbuckers to one push pull potentiometer. The on/on dpdt switch section of this potentiometer has two poles, one on the left, and one on the right, so it is easy to solder one pickup's connections to one pole, and the other pickup's connections to the other pole. In the example below, when the coil cut switch is turned on, the north coil will be on in the pickup on the left, and the south coil will be on in the pickup on the right. If you wanted the north coil to be on in both pickups in the coil cut position, then each pole would have the same connections, or mirror each other, but each side would be connected to a different pickup. By knowing which poles are north and south, you can arrange the coil cut switch to turn on any combination of coils (outside coils on, inside coils on, north coils on, or south coils on). You can easily mix pickups from different brands with this setup. Notice that the pickup on the left has a hot wire that exits out to the pickup selector switch, and the hot wire from the pickup on the right, exits out of the middle lug on the toggle switch, and connects to the pickup selector switch. The ground wires will go to the volume pot case. The diagram below uses the same color codes as a Seymour Duncan pickup. Black is the hot wire, green is the ground wire, the red and white wires form the series link, and the bare grey wire goes to ground.

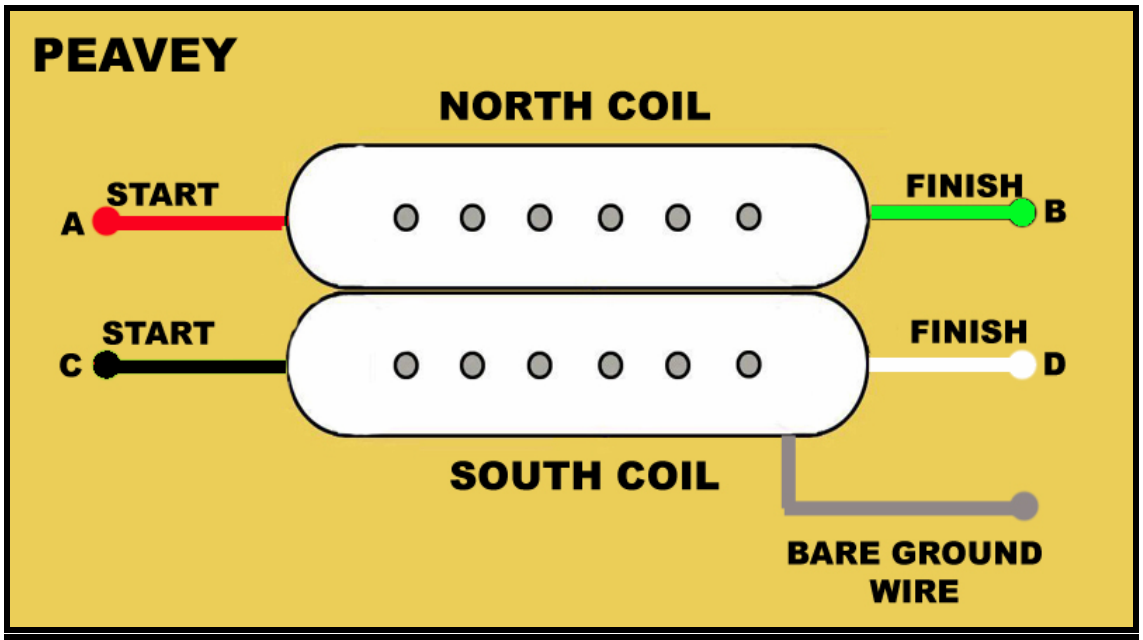


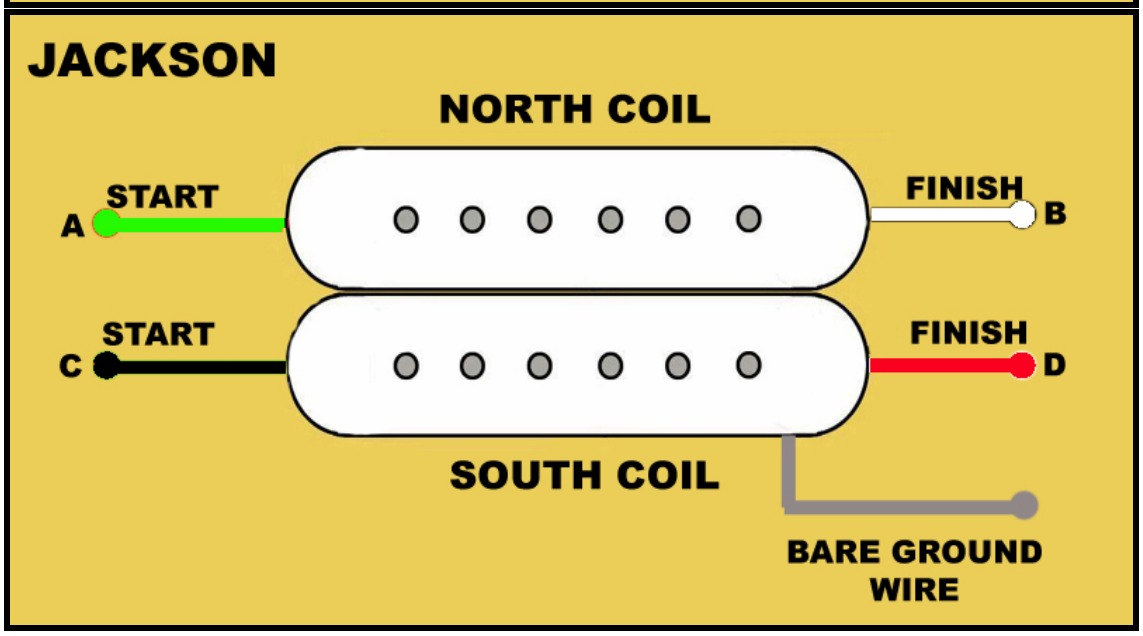
PICKUP COLOR CODES

Here are some of the common 4-wire humbuckers. Check out the questions and answers section for more info on how to wire them.



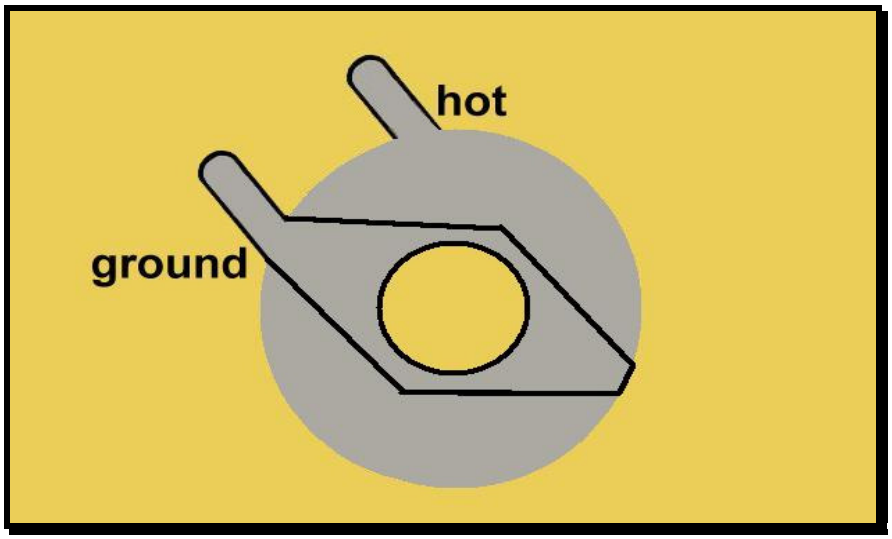


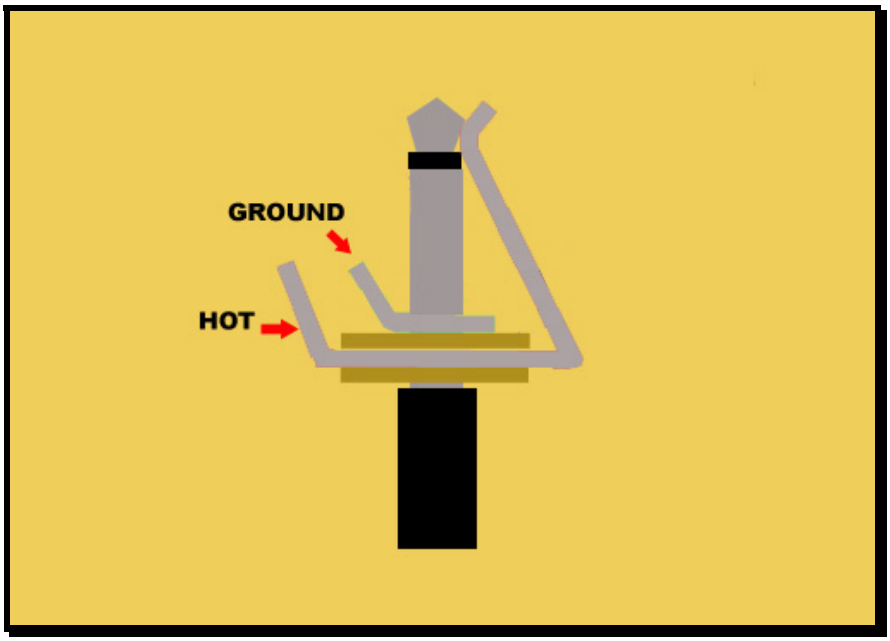




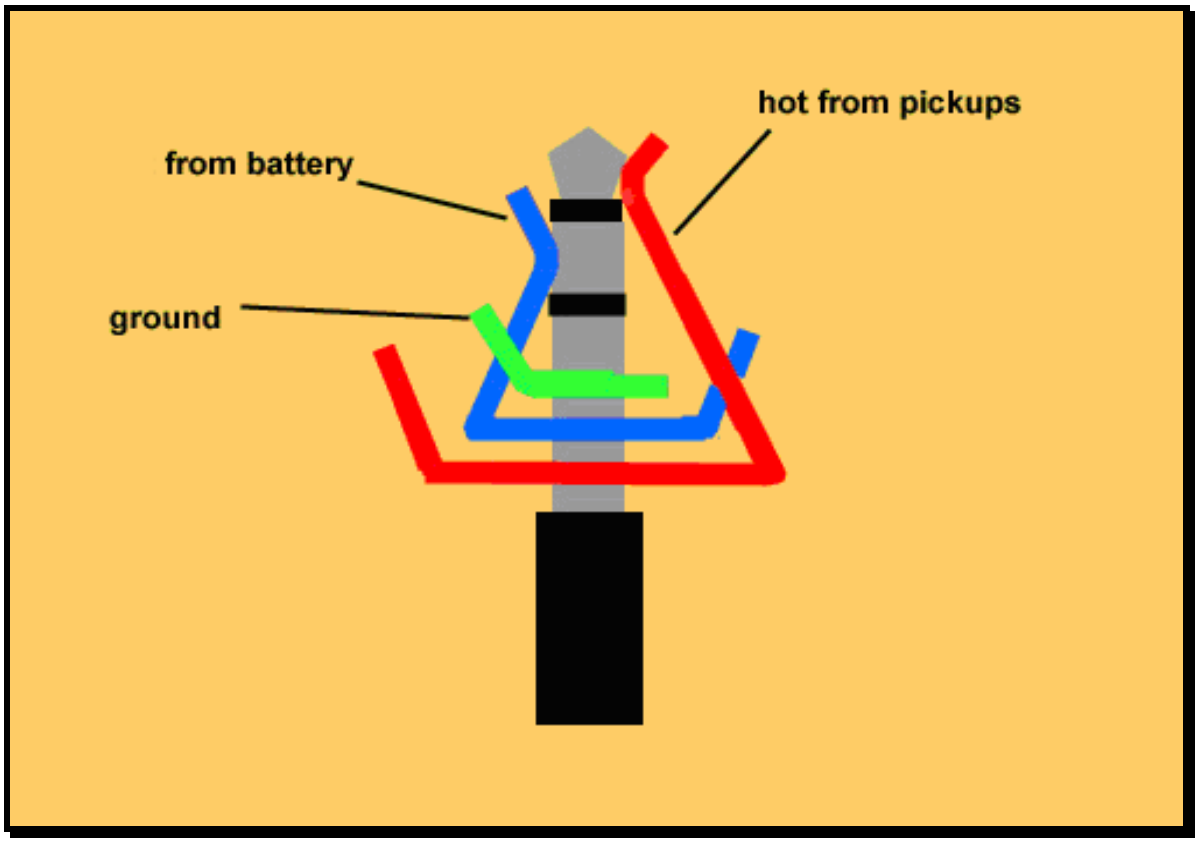
QUESTIONS AND ANSWERS

Question: Which lug on the output jack is hot, and which lug is a ground?
There are two lugs on the jack. One of them is attached to the prong. That one is hot. Sometimes the hot lug has a different shape, and is notched.





If you are using active pickups, or a preamp inside your guitar, then you will probably need to use a stereo output jack. It has one additional lug that receives the signal from a 9 volt battery.

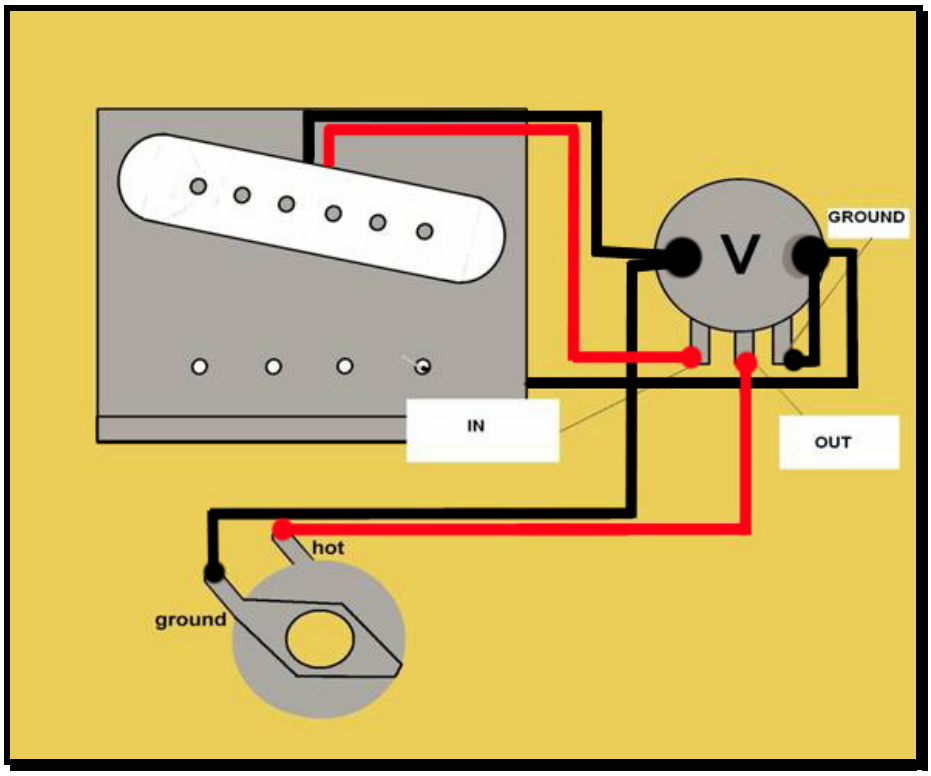


Question: What do the colors on the wires mean?

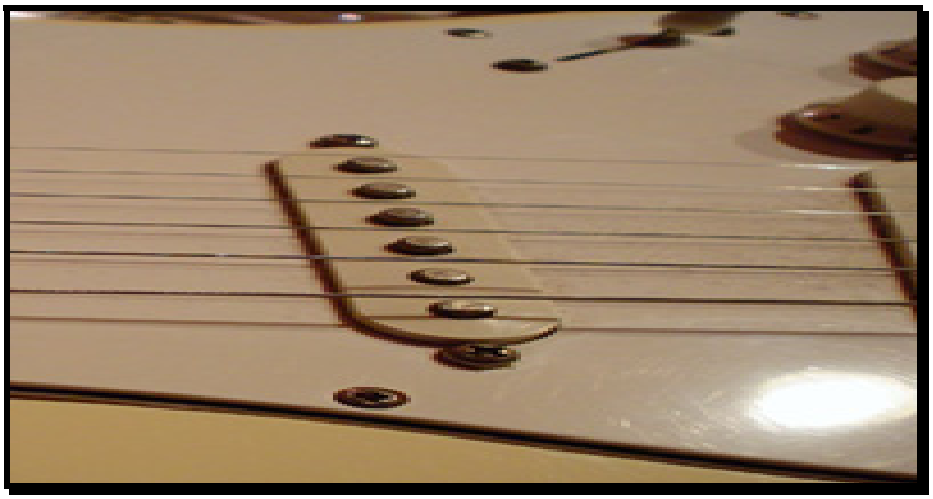
You have probably noticed by now that most hot wires on a guitar are colored, like white, red, or yellow, and most ground wires are black. Although most pickup companies do not use the same color codes, most ground wires will be black. You should check with the manufacturer to see what color codes your pickup wires use.

Question: How do pickups work?

Basically, pickups are magnets wrapped in copper wire. They pick up magnetic signals given off by vibrating strings. The signal gets carried through a volume potentiometer, which can send the signal to ground to decrease the volume if desired. Then the signal goes through a tone potentiometer connected to a capacitor. The capacitor sends only the high tones to ground as you turn the tone knob. Then the signal goes to the output jack and into the amp. In order to complete the circuit, you need to ground all parts with electricity flowing through them. The 3-way or 5-way switch turns different pickups off and on. The next picture shows a basic wiring diagram with one pickup and one volume control.

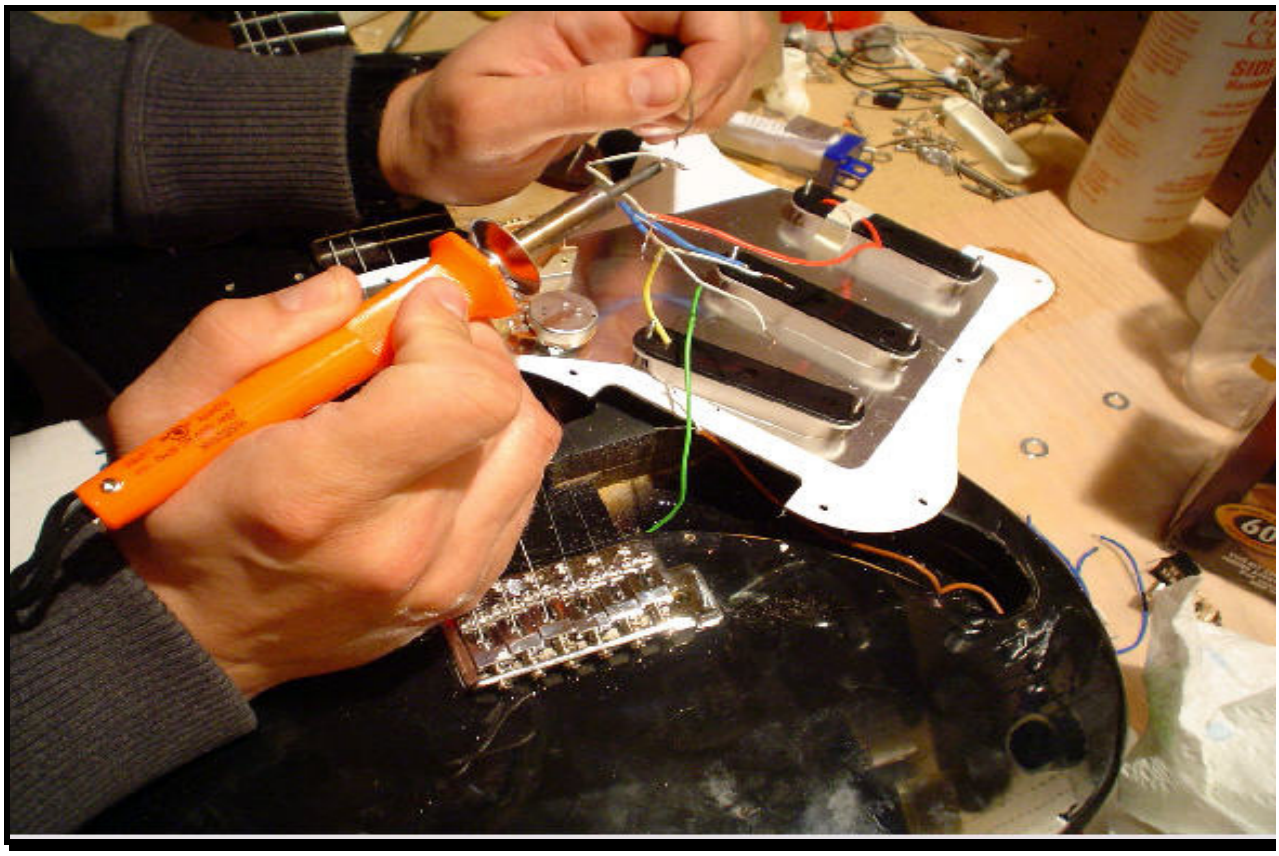


Question: Why do some pickups have staggered pole pieces?
Staggering the magnet poles increases or decreases the magnetic output of each string. So strings that naturally have a higher output should have lower magnets to give the guitar a balanced volume. For example, one of my strats has a higher output on the B and E strings, so to compensate for that, the pickups have lower poles on the B and E strings.



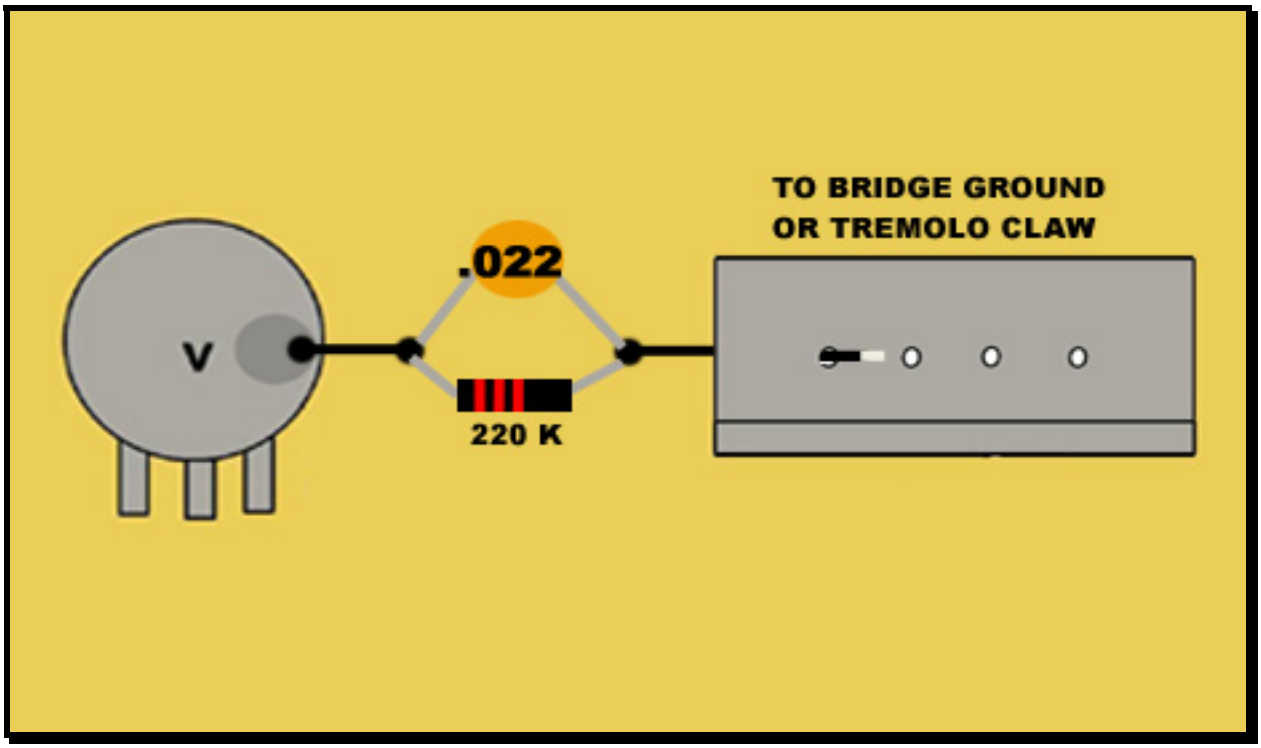
Question: Which pickups have more unwanted noise, single coil, or double coil?
This problem, called 60 cycle hum, is common among single coil pickups. It occurs when the pickup basically picks up interference from an alternating current electrical supply that is nearby. Proper grounding and proper wire shielding can reduce this unwanted noise. Double coil pickups have less noise, due to the in phase in series wiring, but also have less treble. Many guitarists prefer single coils for their vintage guitar sound, and humbuckers for their powerful southern rock sound.

Question: Do you have any soldering tips?
If you are using the twisted strand of wire, before you get started you will need to add solder to the ends of all lugs and wires. This will make the soldering job go much quicker. Don't take too long to solder a connection, or you can damage a potentiometer or capacitor. After you solder a wire to a lug, do not move it for at least 3 seconds. Any movement can cause a cold, or bad joint. If you re using the stiffer vintage style wire covered in cloth, just pull back on the cloth to expose the wire, put the wire in the lug hole, and touch the soldering iron and solder to the connection. Most switch and potentiometer lugs have holes in them that the wires can fit into.



Question: What is one way to prevent electrical shock?
Often, getting shocked while playing guitar is the result of faulty wiring, not necessarily in your guitar, but in the outlets that your equipment is plugged into. Faulty wiring has been a problem at some clubs. It all depends on who does the wiring, and if they know what they are doing. One way to protect yourself is to get an AEMC Outlet Tester. It can detect faulty wiring in three-wire receptacles, open grounds & neutrals, and reversed hot/ground connections. You can get one at Amazon.com. You can also get a wireless system for your guitar to increase your protection.

Or you can add a .022 capacitor and a 220K Ohms resistor in between the bridge ground and volume pot case to reduce the DC current. Check out the diagram below.



Question: What is the cheapest way to change the sound of my guitar?
Change the pickup height. The closer the pickups are to the strings, the stronger the signal. The farther away they are, the weaker the signal. If your pickups are too close to the strings, they can sound too thick and distorted. Or you can just change the strings on your guitar. The thicker the strings will give you a warmer sound. Or change the potentiometers. Higher value pots like a 500K or 1 Meg will give you a brighter sound. Most strats currently use 250K pots. Last but not least, change the capacitor on your tone control. A stronger capacitor will give you a muddier sound with more bass.

Question: What effect do magnets have on a pickup?
Basically, the stronger the magnet, the stronger the pull is on the strings. The stronger magnetic field will slow down the string vibrations and give your pickups a warmer sound. Weaker magnets will pull less, and give you a brighter sound. To test this out, raise your neck pickup so it almost touches the strings. Notice how the sound is muddier than usual?

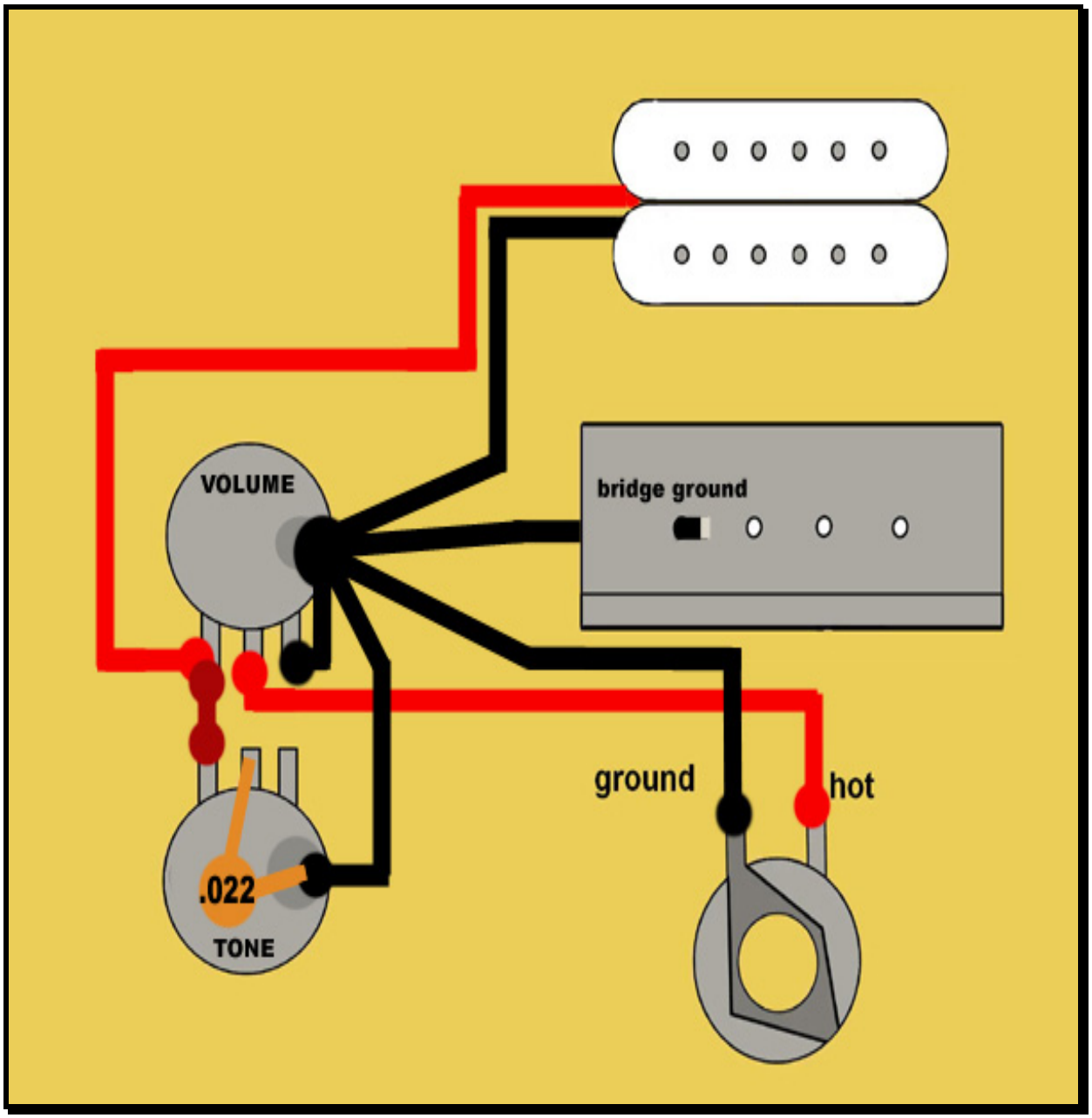
Question: What is impedance?
Impedance is the resistance in a circuit, and can affect the tone qualities of a guitar pickup. Adding more resistance in a circuit will cause a boost in volume, midrage, and bass levels. This is why humbuckers, which are wired in series, have a fat, powerful sound.

Question: What is an active pickup?
It is a pickup that has its own preamp to boost the gain and volume, while reducing unwanted noise. Emg 85 pickups, which are played by the heavy metal band Metallica, are a good example of some popular active pickups. Active pickups also have their own power source, like a 9 volt battery.

Question: What type of wire is used in guitar electronics?
Most guitars use a 22 AWG wire with a braided, or teflon shield.

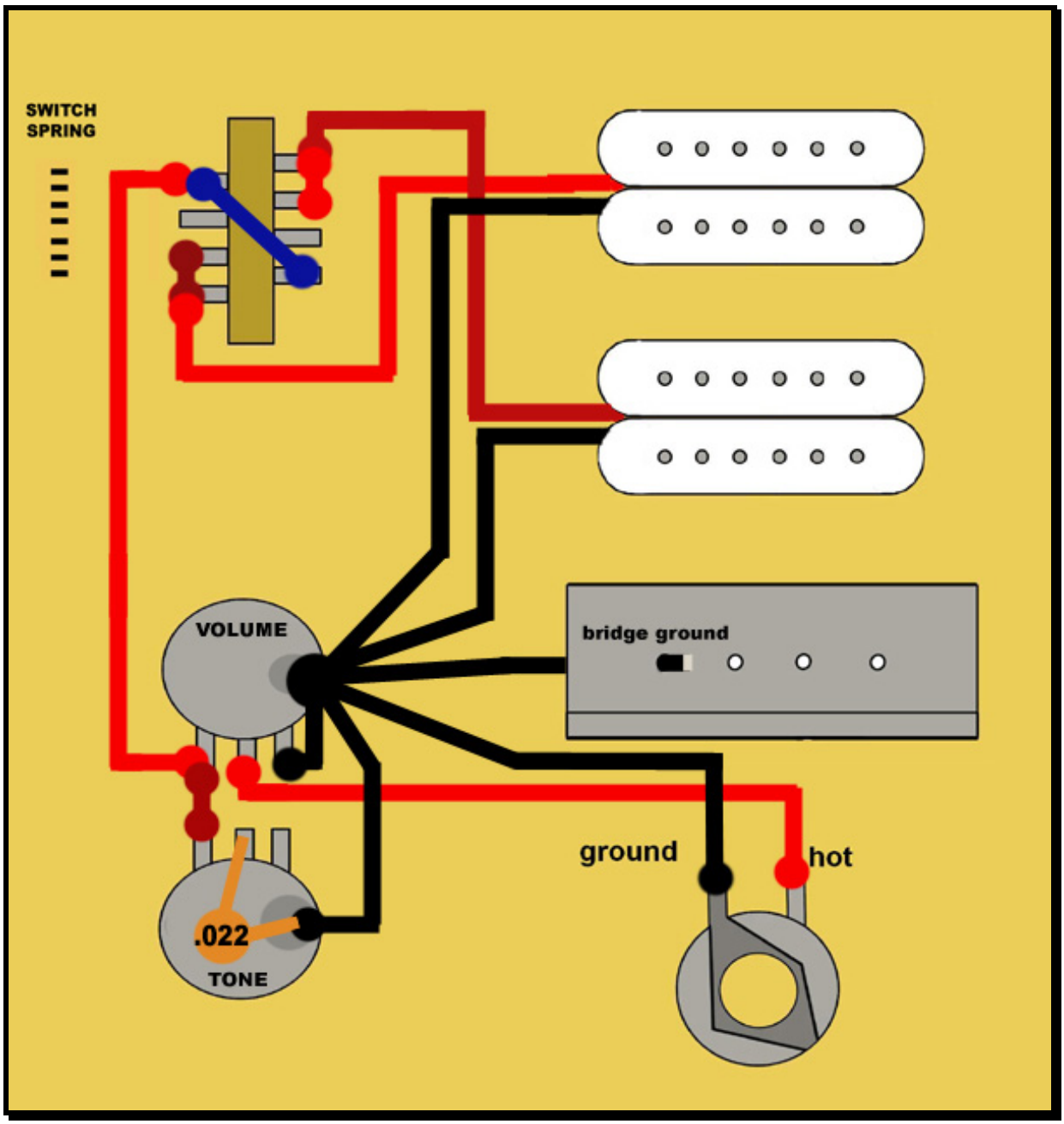
Question: Why does a telecaster have such a bright, twangy sound compared to a strat?
There are many reasons, but some of the main ones revolve around the electronics and the body. The tele guitar body is pretty solid. The strat body has more open space in the body cavity, which changes the sound. The telecaster also uses a copper plated steel bridge, which helps to increase the strength of the bridge pickup's magnetic field. This gives the tele a bright, twangy sound. Plus, the tele neck pickup uses 43 AWG copper wire, which has a smaller diameter than the 42 AWG wire that is found in a strat's pickups.

Question: How do you wire guitar that has only one 2-wire humbucking pickup?
Below is a basic wiring diagram using one humbucker. You can use this with either the bridge or neck pickup. The pickup will have a volume and tone control. You can get plenty of good sounds out of this setup. If you want to play around with the tone, you can use a stronger or weaker capacitor. Adding a stronger capacitor sends more treble to the ground, and gives you more bass tones.

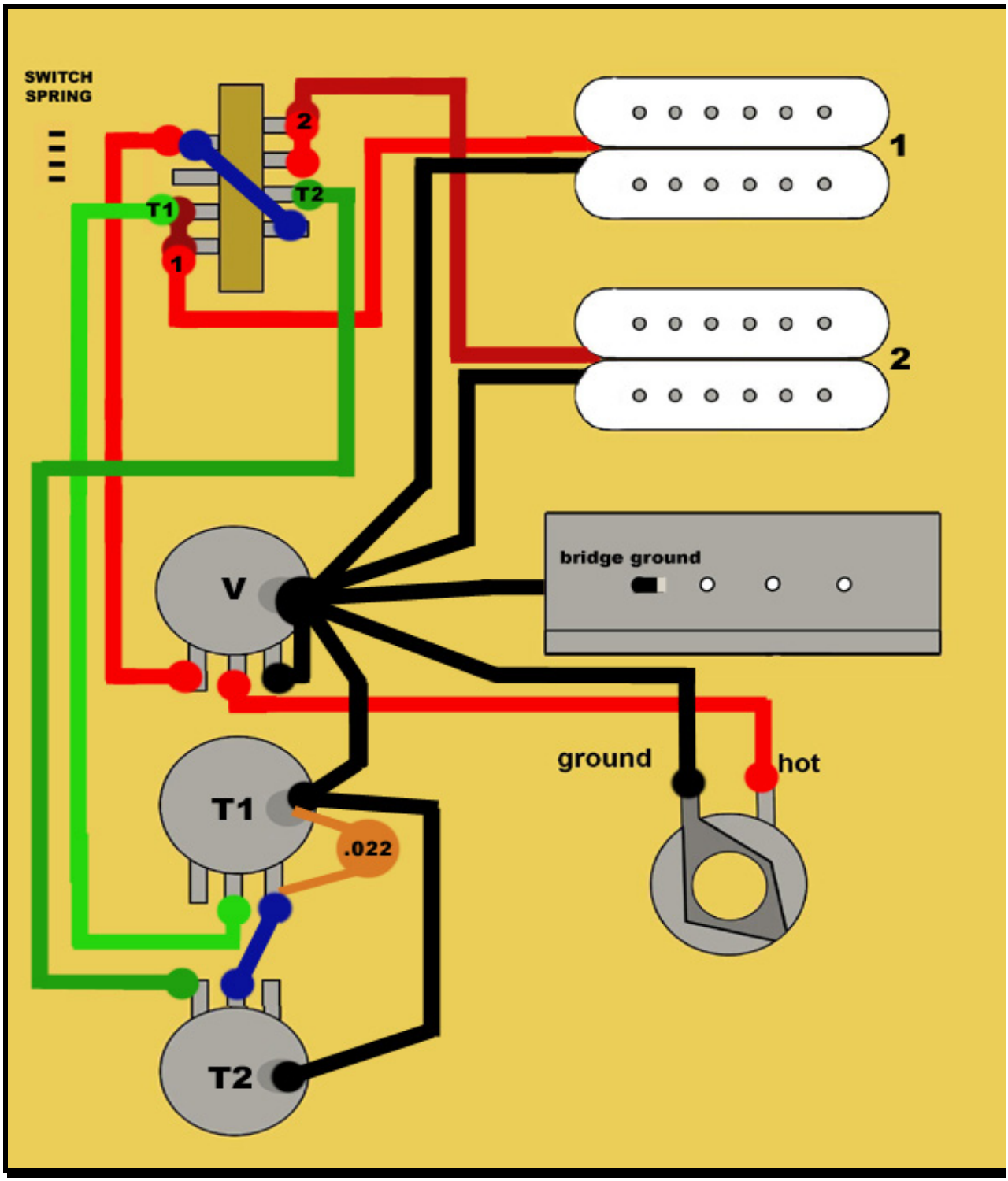


Question: How do you wire a guitar that has two 2-wire humbuckers?

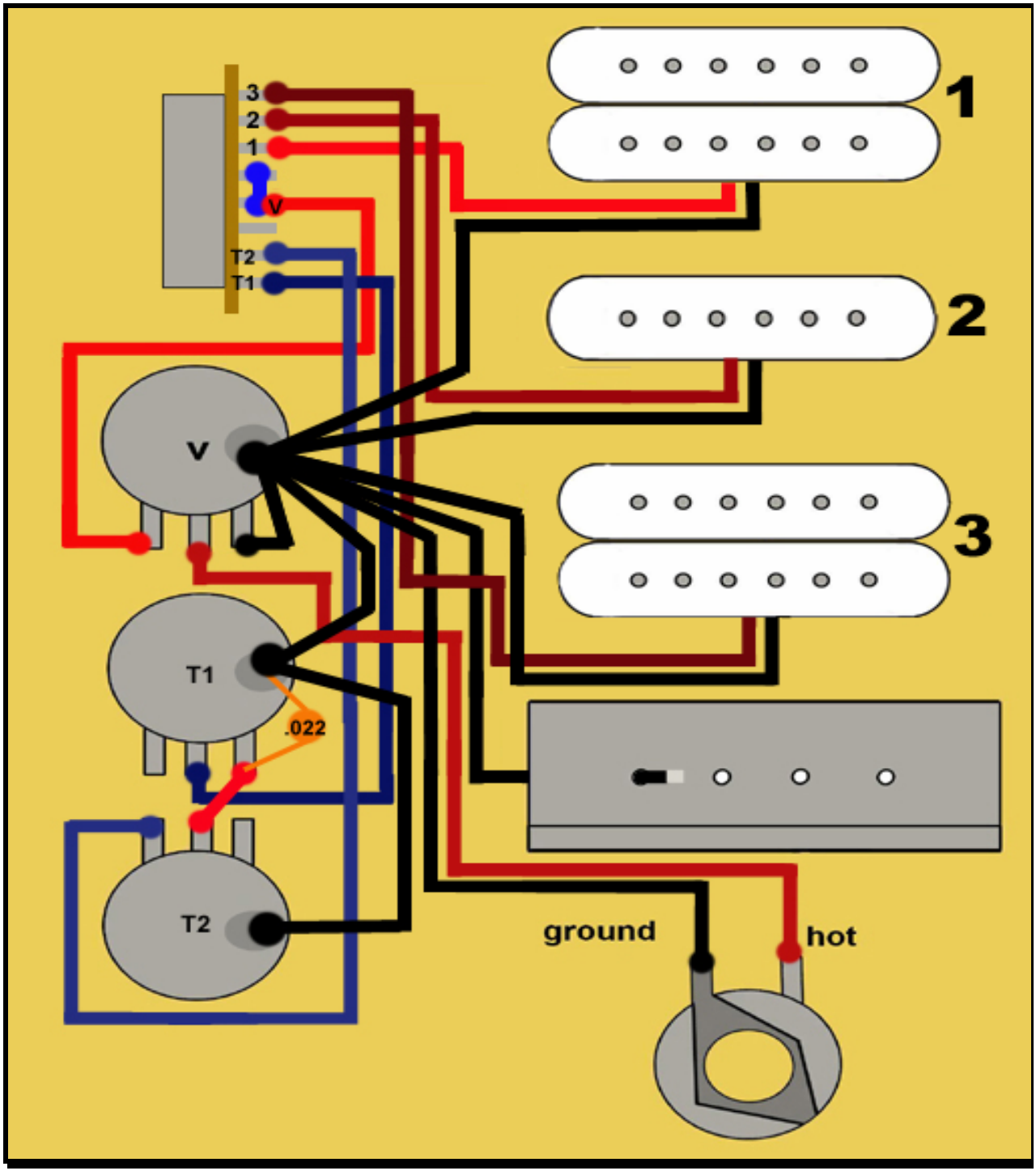
Here is an example using a 3-way switch and a master volume and master tone control. You can turn on either the neck pickup, both pickups, or the bridge pickup.



If you wanted a separate tone control for each pickup, then it would look like this.

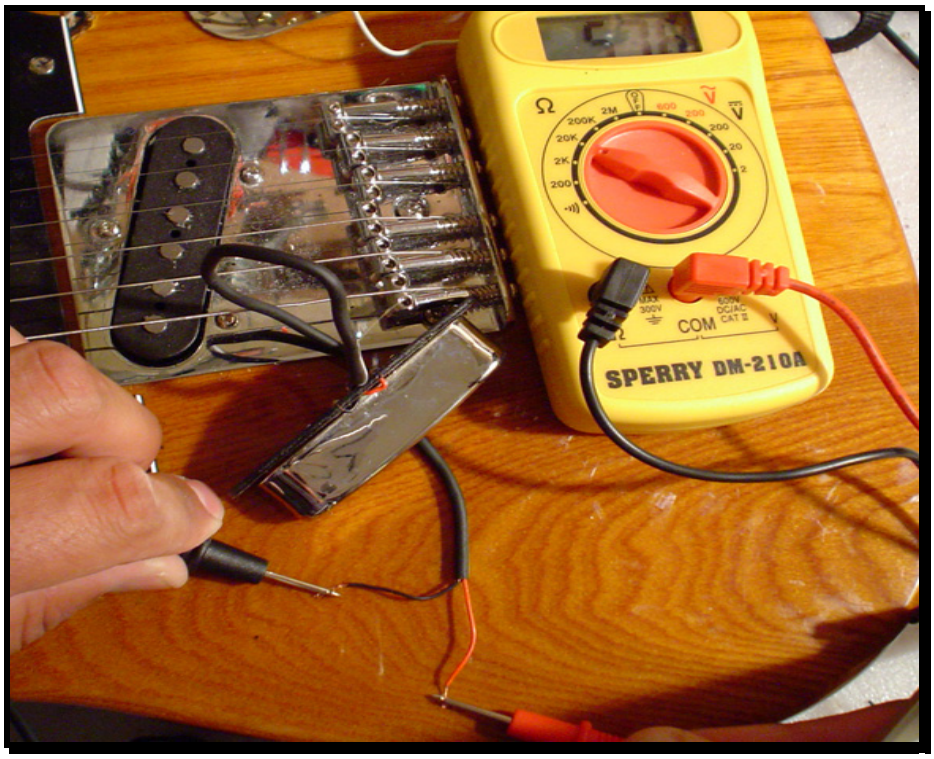


If you have a humbucker, single coil, humbucker, and 5-way import switch, then the wiring would look like this. If the humbuckers are 4-wire conductors, then just add coil cut switches to them. Check out the hot rod section for more info on coil cutting.

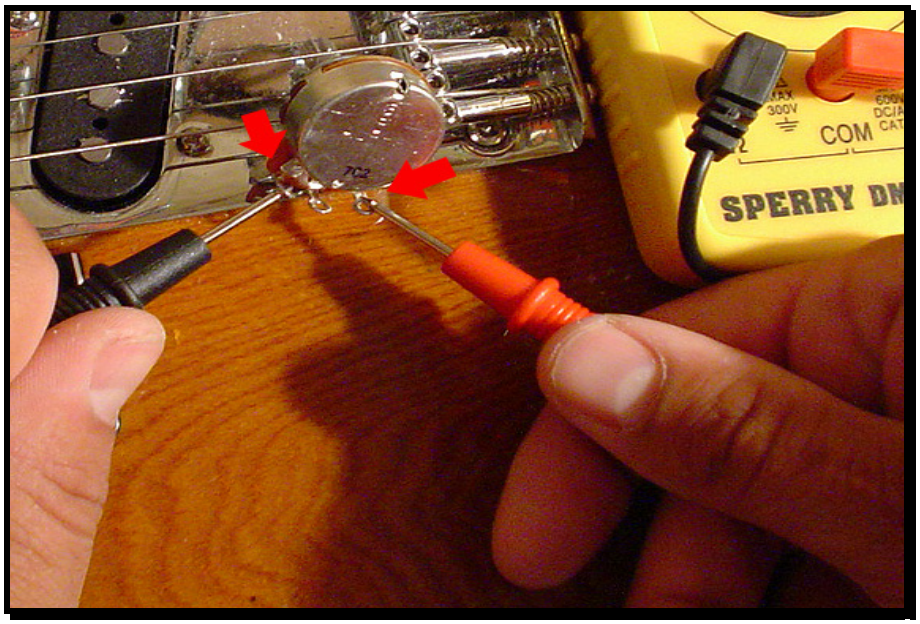


Question: How do you use a multimeter?

Multimeters can be used to check the resistance of pickups, potentiometers, leads, and speakers. If you need to know how "hot" a pickup is, then just connect each multimeter lead to the hot and ground pickup wire, and take a reading. Make sure the multimeter is set to the 20K Ohms setting. The pickup shown below came in at around 5.76K Ohms. If you don't get a reading, then the pickup needs repair. Hot pickups are usually 10-15K Ohms. The hotter a pickup is, the more volume, bass, and midrange it will have. Lower impedance pickups will have a broader range, and more sparkle, but a lower volume.

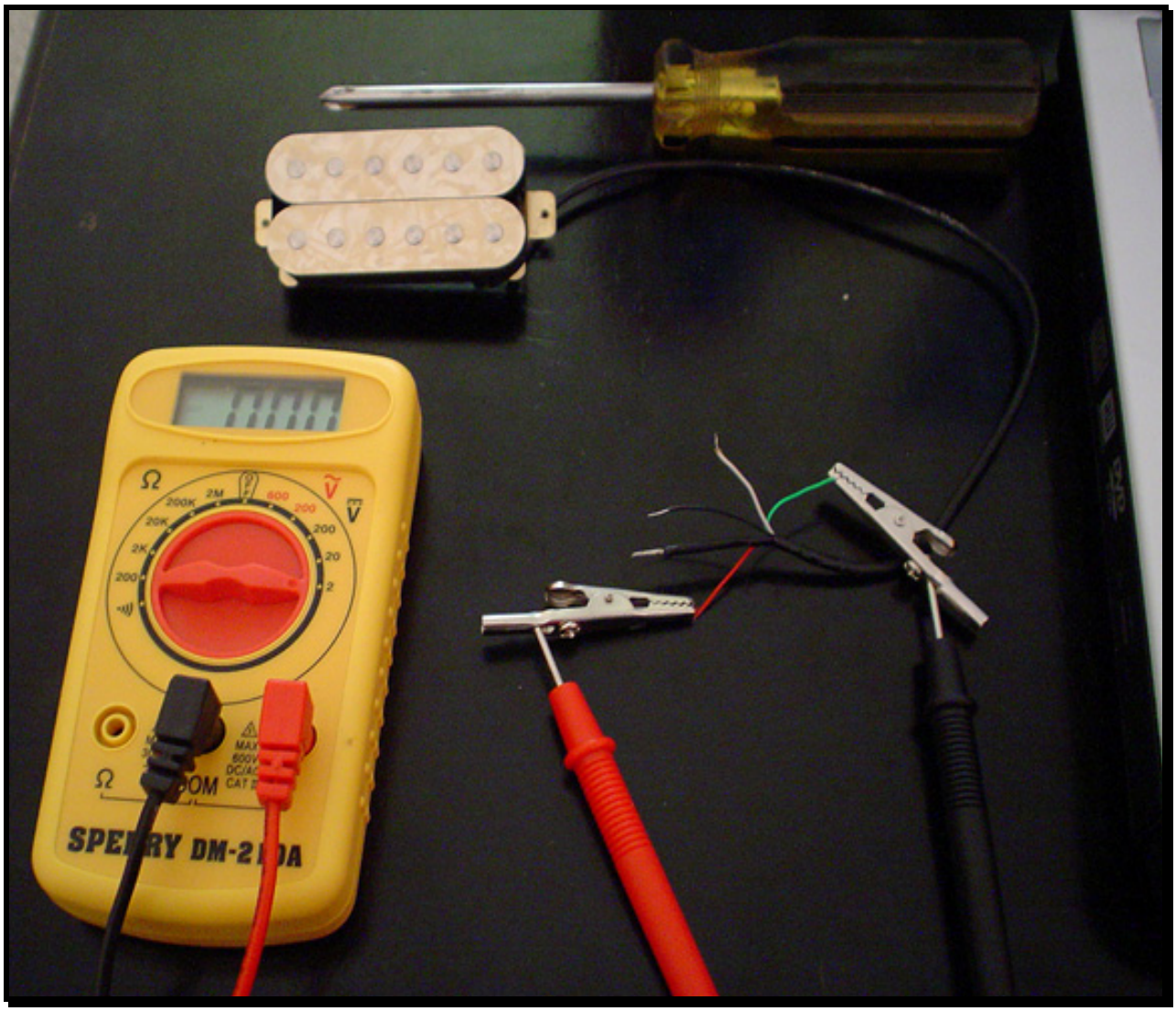


Is your tone or volume pot working? Check it out by placing a multimeter lead on the two end lugs. If you have a 250K pot, then you can expect a reading around 230K - 260K.



Question: How do you figure out the color codes on a 4-wire pickup?

You can use a multimeter to figure out which pickup wires belong to which coil. Switch the multimeter to the 20K Ohms setting. This will give you a reading up to 20,000 Ohms. Pick out one of the 4 shielded pickup wires, and then touch it to the red multimeter lead. Now touch the black multimeter lead to every other remaining wire. Out of those remaining wires, only one wire will give a reading on the multimeter. The two wires that give a reading belong to the same coil. The two wires that are left will also give a reading, and will belong to the other coil. The 5th bare wire always goes to ground. After doing this, I have determined that the black and white wires belong to one coil, and the green and red wires belong to the other coil.

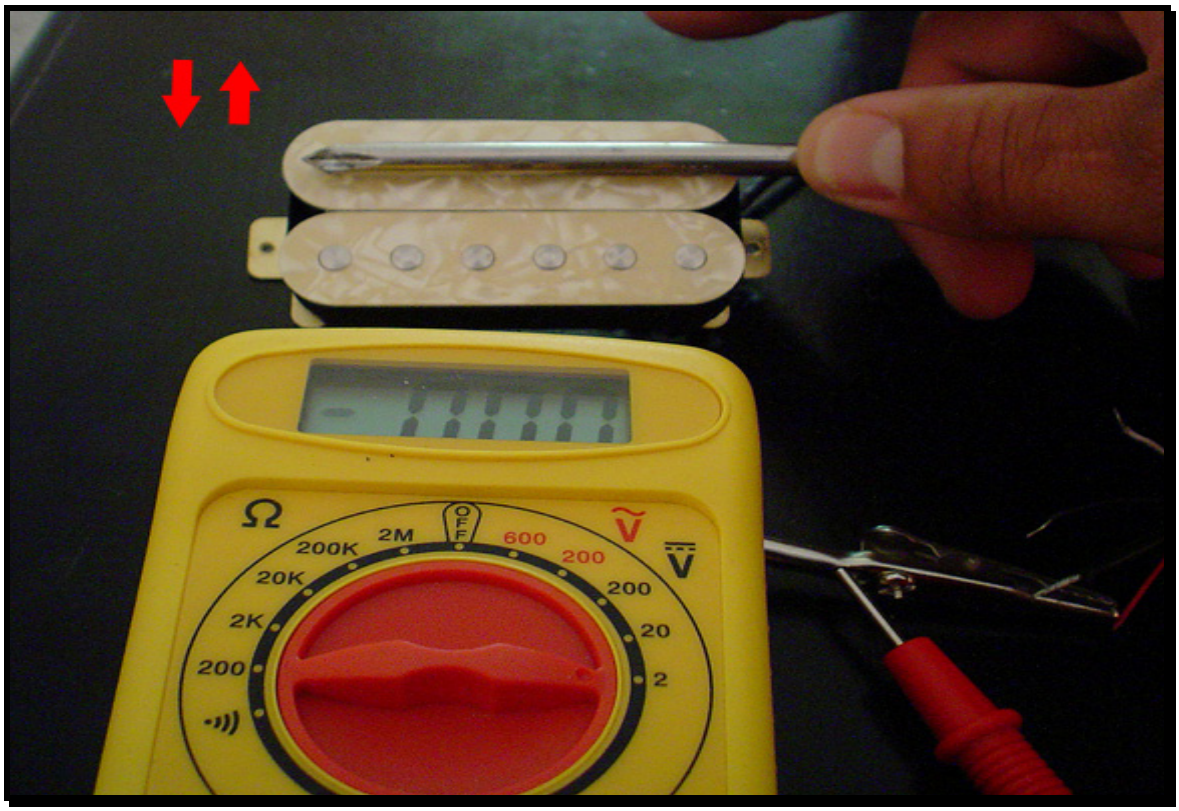


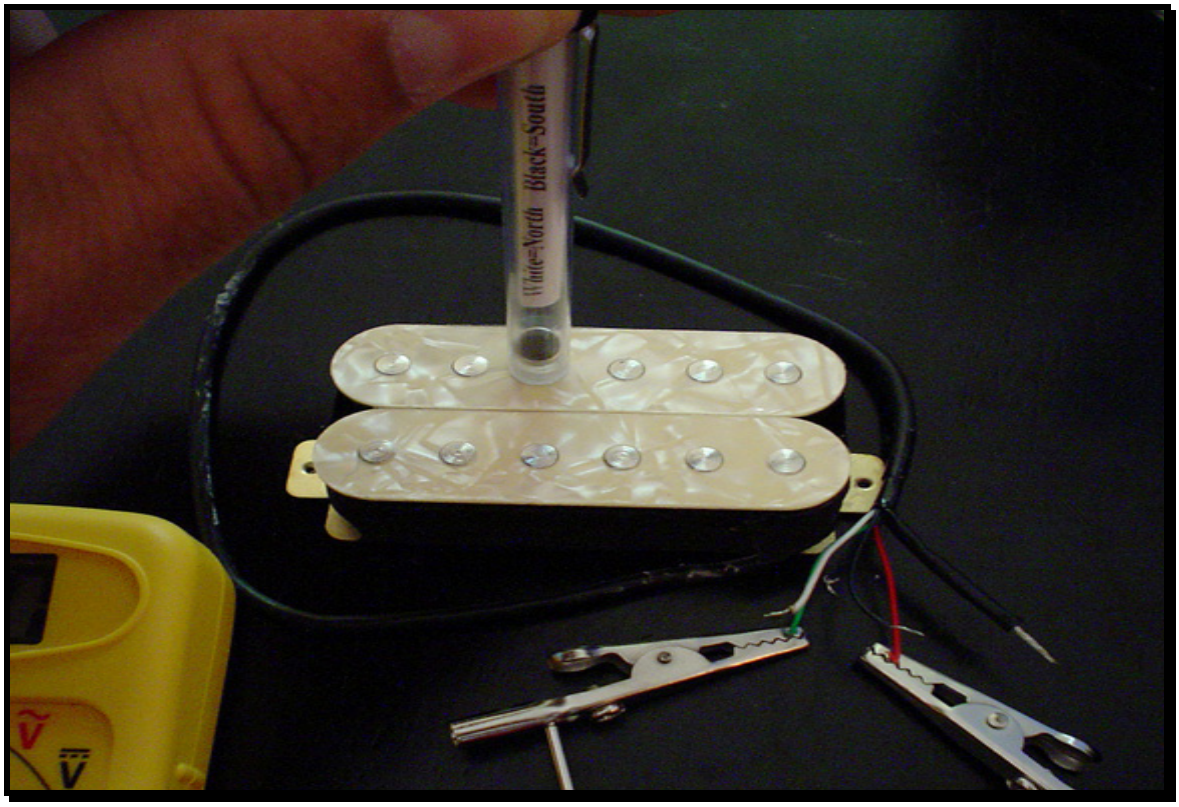
Now set your multimeter to the 2 Volts setting, and also switch the multimeter leads to the Volts input. Connect the leads to the wires which belong to the same coil. In the case below, I connected the white and black wires. The red multimeter lead was connected to the black wire, and the black multimeter lead was connected to the white wire. Now take a screwdriver and tap the poles on one of the pickup coils. Now remove the screwdriver. Notice how the reading on the multimeter goes positive, and then negative, or negative and then positive, and then back to zero? We are looking for the multimeter to give a positive reading first when the screwdriver touches the poles, and then a negative reading when it gets pulled away from the poles. This tells us the wires are in phase on that particular coil. If you are getting a negative first reading, switch the multimeter leads around. I connected the red multimeter lead to the black wire, and the black multimeter lead to the white wire. When the screwdriver taps the coil, it gives a positive reading first, and then a negative reading. So the black wire, which is connected to the red multimeter lead, is the start wire, and when the humbucker is installed in the guitar, this black wire will connect to the positive, or hot lead. Next, let's figure out which coil these wires go to. Do the screwdriver test on the top coil, and then on the bottom coil. You will notice that one coil always gives a stronger reading than the other coil. In this case, it is the top coil. It gets a reading up to .099 before going negative. The bottom coil only goes up to .014, so we now know that the black and white wires belong to the top coil. The black wire will be called the start, and the white wire will be the finish.

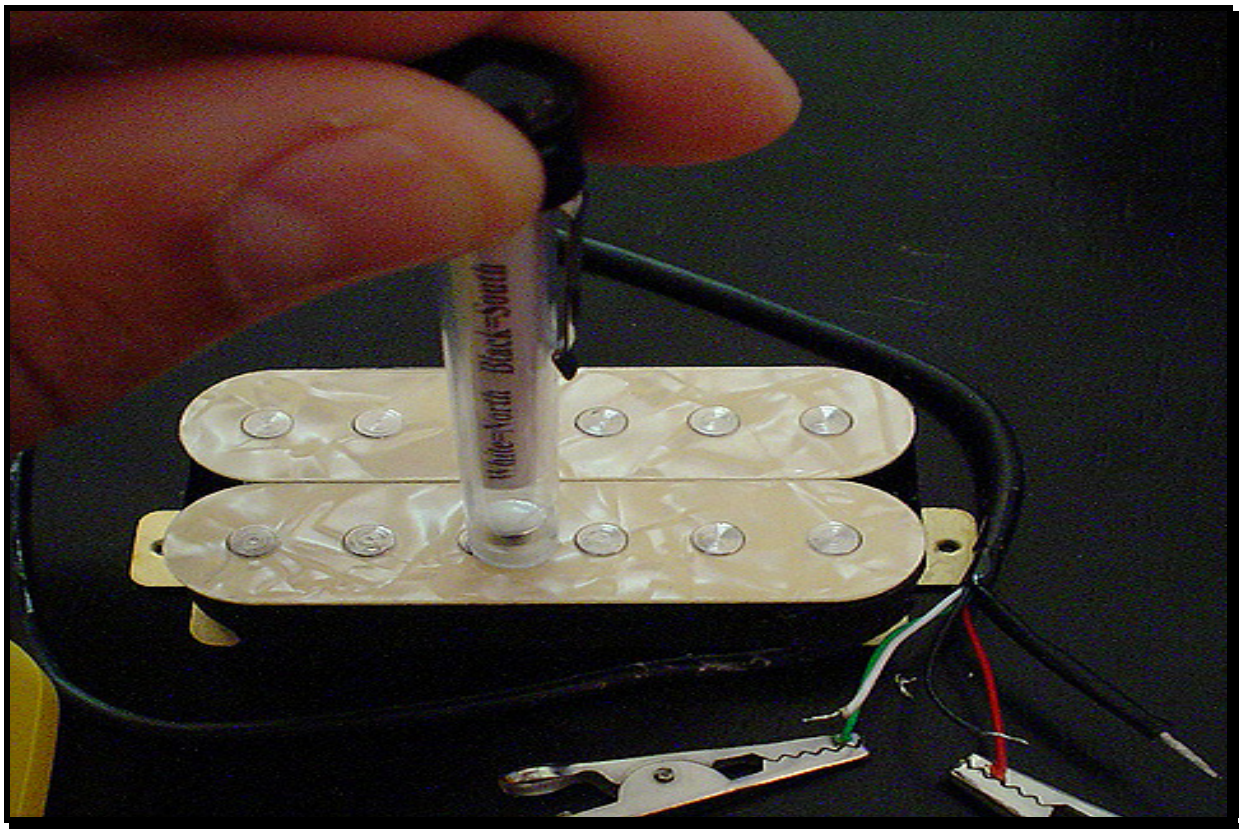
Next, you need to determine if the coil has a north or south polarity. This can easily be done with a magnet polarity tester from stewmac.com. They cost around $6. Just touch it to each pickup coil to determine the polarity. In this case, the top coil's polarity is north.

Let's move on to the next set of wires. We are now looking for a negative reading first, because one of the coils on a humbucker has a reverse polarity. I get a negative first reading when I connect the red multimeter lead to the green pickup wire, and the black multimeter lead to the red pickup wire. So lets say the green wire will be the start, and the red wire will be the finish. The bottom coil also gives a stronger reading (up to .135) than the top coil (up to .016), so these wires belong to the bottom coil. Now check the polarity. The polarity tester shows a south polarity. Coil one and two are now done.

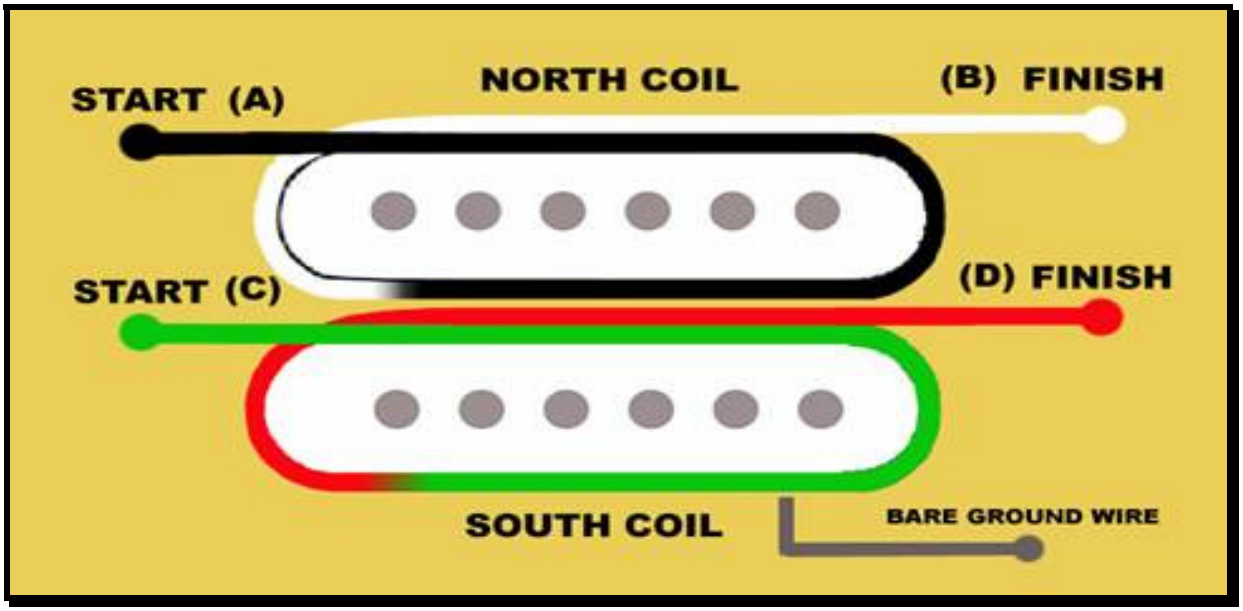
To summarize, this technique will determine which wires belong to what coil, and which wires are opposing one another. For example, if the black wire is the start of one coil, then the red wire will be the finish of the other coil. Likewise, if the green wire is the start of one coil, then the white wire will be the finish of the other coil. This technique does not, however, tell you which wire is hot, and which wire goes to ground. Determining the color codes is much easier if you already know what the series link connection is.





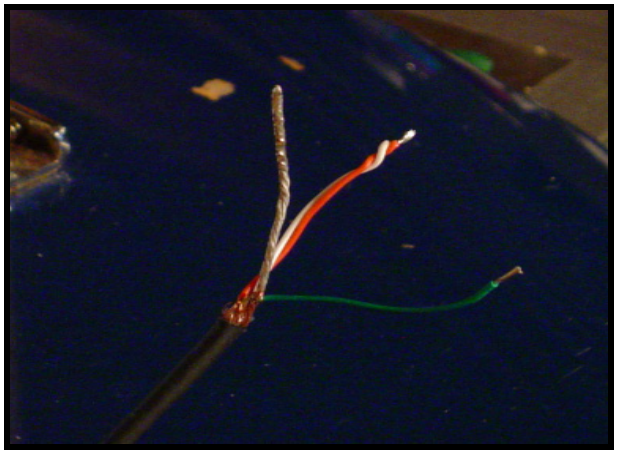
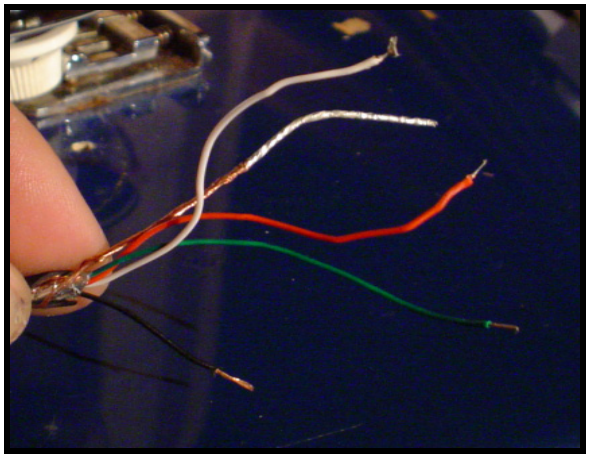


Here is the wiring diagram for this pickup. This pickup uses the same color codes as Seymour Duncan pickups.



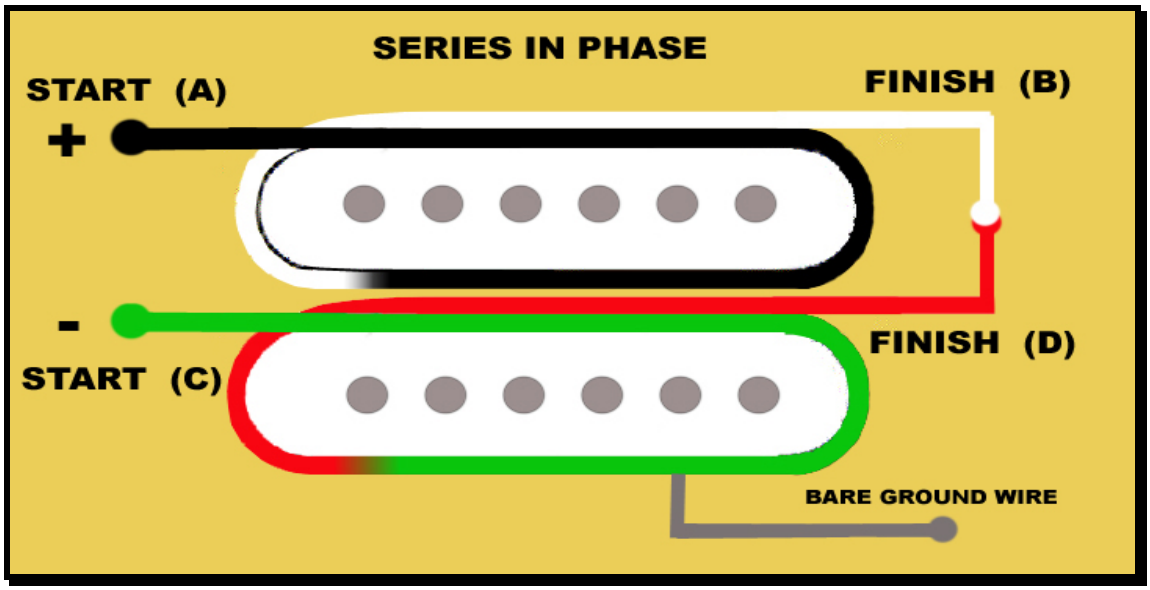
Question: What if I already know what the series link is?
If you purchase an unknown humbucker, and two of the wires are soldered and taped together, then they are the two finish wires that form the series link. This will save you the trouble of trying to figure out which wires belongs to what coil. If you know what the series link is, then you only have two options to chose from. Basically, you need to know which is the hot lead and which is the ground lead.

It does not matter which wire is the hot or ground when only one pickup is on, since the pickup will always be in phase with itself. But when another pickup is on, and the sound is out of phase, then you will need to change the hot and ground leads around. If that does not work, you need to take the pickup apart and flip the magnet over. Below is a pickup that I purchased online. You can see the red and white wires are twisted together. Those are the series link. The black and bare ground wires are twisted together, too. Those go to ground. That leaves a hot green wire to send to the pickup selector switch. This pickup has the same color codes as a GFS Lil Killer pickup and also a Jackson pickup. I separated the wires in the picture on the right.

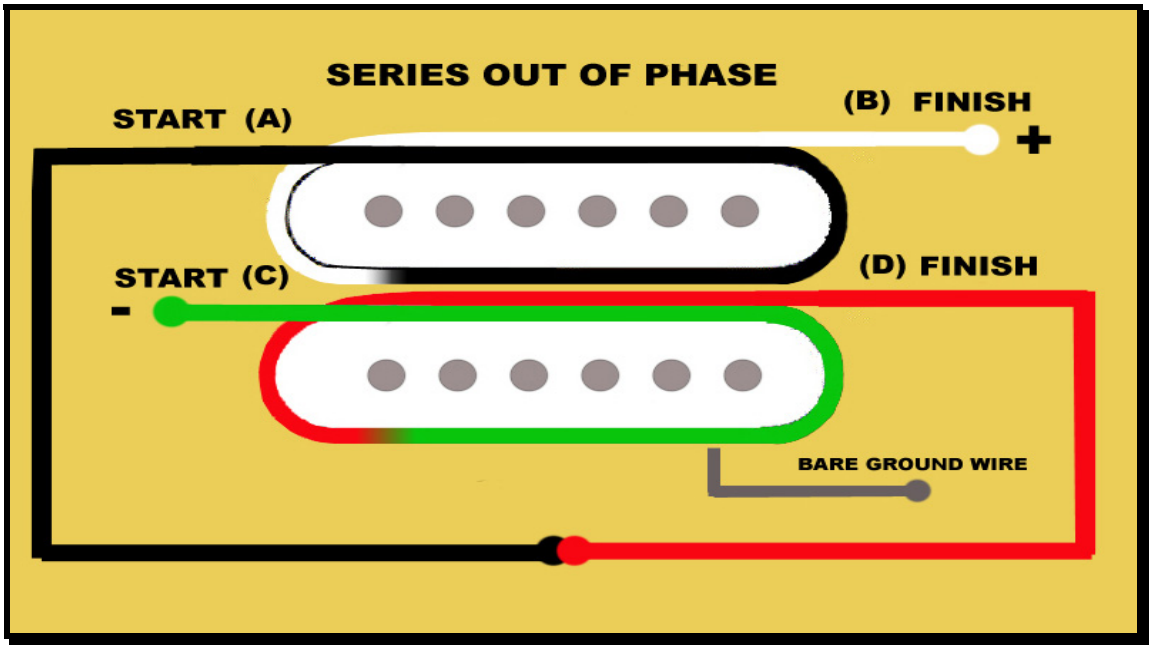



Question: What are some wiring options for a humbucking pickup?
I'm going to use the pickup I described earlier as an example (the same color codes as a Seymour Duncan pickup). The next diagram shows the series in phase wiring. The out of phase wiring cancels the hum, and the series link adds a low/midrange boost. There is quite a bit of confusion out there regarding in and out of phase humbucking pickups. While each pickup coil is wired out of phase, the signal is actually put back in phase. The out of phase 60 HZ signal ends up getting cancelled out. And only the in phase signal gets recorded by the magnetic pickups. This is due to the reverse polarity in each coil. To make things less confusing, we will refer to humbuckers as being wired in series and in phase. The white and red wires form the series link. The series link is formed by soldering a positive wire from one coil to the negative wire on another coil. (Wire B is negative and wire D is positive). Often, when you buy a new set of 4-wire humbuckers, two of the wires will be twisted together. Those are usually the negative

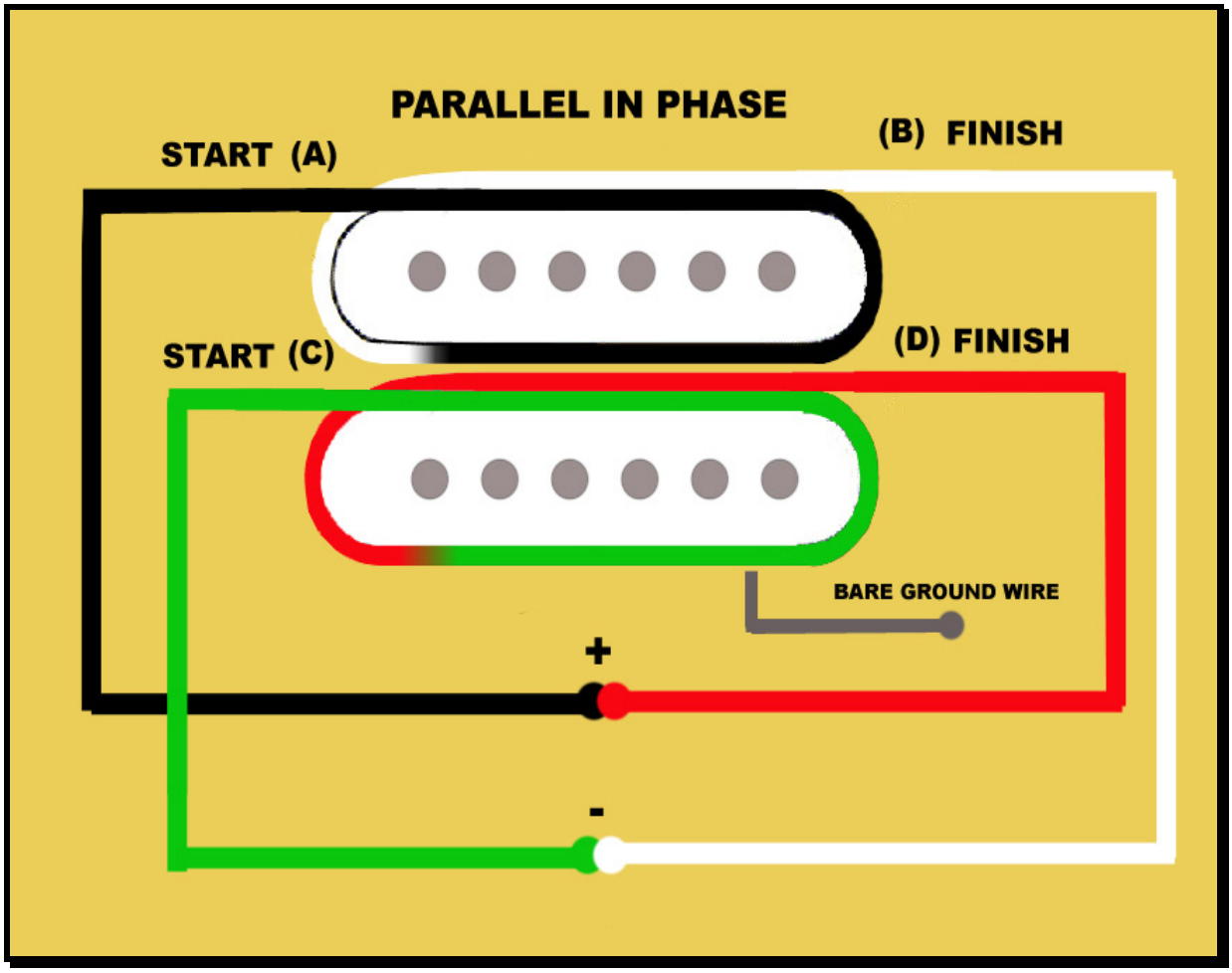
and positive wires that form the series link. The next diagram shows a typical humbucker, wired in series and in phase. It produces a fat sound with a lot of volume.



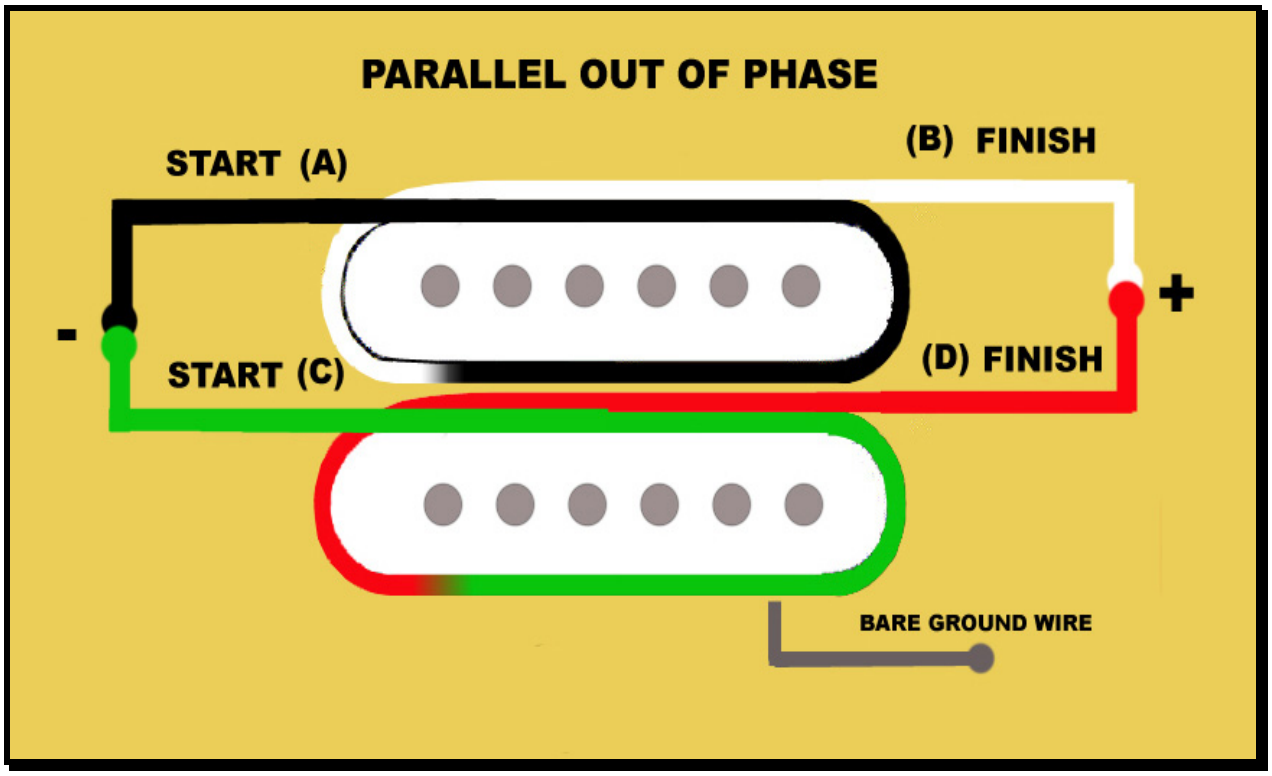
The series out of phase sound is weaker and not hum cancelling. It has more treble tones. This is a popular choice for funk music.



The parallel in phase sound is still humbucking, but with the tone qualities of a single coil pickup. It has more treble than the series in phase sound. If the middle pickup on your current guitar is reverse wound/reverse polarity, then it will yield the parallel in phase sound when the neck and middle, or the middle and bridge pickups are on. The parallel in phase sound is a popular way to wire a strat, especially if you prefer the range of a single coil pickup, but want the hum cancellation.



The parallel out of phase sound is not humbucking and is very weak and thin, sounding almost like an acoustic guitar. This type of wiring can cause 60 cycle hum, or unwanted noise.



Type these addresses in your web browser to hear these pickup wiring options.

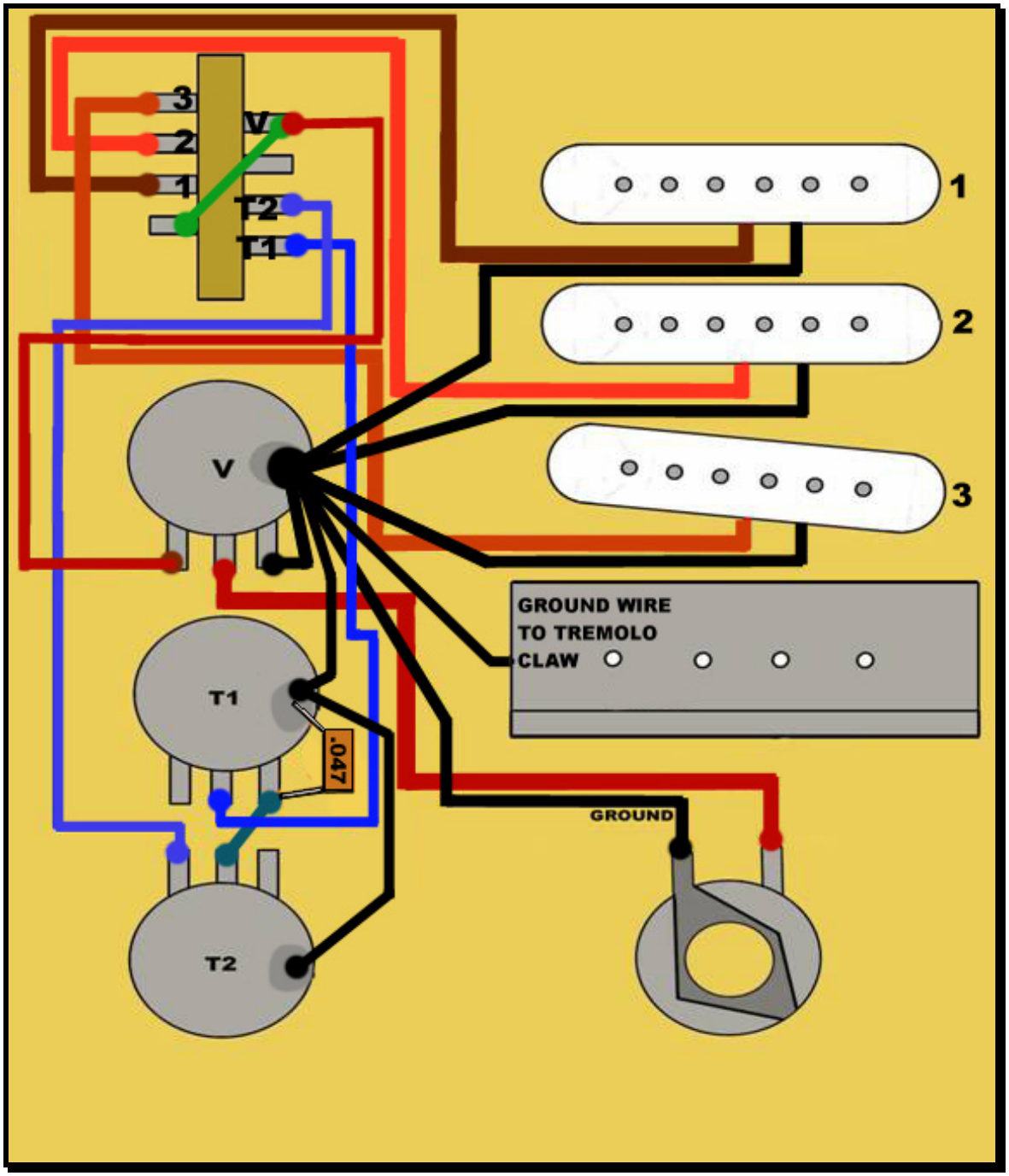
SERIES IN PHASE: **http://tinyurl.com/25OSQM**

SERIES OUT OF PHASE: **http://tinyurl.com/3Y7GHV**

PARALLEL IN PHASE: **http://tinyurl.com/3YZYWG**

PARALLEL OUT OF PHASE: **http://tinyurl.com/2EDOXM**

Question: How were the early 1950's stratocasters wired? If you were trying to replicate the early strats, then you would use Astrons, or Cornell-Dubilier capacitors, 22 gauge cloth wiring, 250K audio taper pots by Stackpole, and a Fender style (CRL 1452) 3-way switch.



Question: Where can I get good guitar parts and information? Here are some great places to find guitar bodies, necks, switches, pots, wires, pickups, and more.

http://www.smallbearelec.com/home.html Tons of parts, and cheap prices, too.

http://www.stewmac.com/ They have pretty much everything for the beginner to advanced luthier.

http://www.wdmusic.com/ Tons of stuff, even economy parts.

http://store.guitarfetish.com/ A great source for 4-wire humbuckers, mini humbuckers for strats, preamps you can add inside your guitar, and pretty much everything else you can think of, even electric guitars.

http://www.guitarpartsusa.com/ The name says it all. They have everything, even screws and pickup winding parts.

http://www.allparts.com/ Plenty of Fender factory parts and even concentric pots.

http://www.internationalluthiers.com/electricparts.php They have some good prices on switches and pickups.

http://www.warmoth.com/ High quality bodies and necks.

http://stores.ebay.com/Luxe-Guitars Incredible vintage style capacitors. They sound amazing.

http://stores.ebay.com/Classic-Clones-Amplification They have the vintage style cloth wiring. I love this stuff.

http://stores.ebay.com/musicpartsplus111 Plenty of parts, potentiometers, switches, knobs, etc.

http://stores.ebay.com/MMTG-Enterprises MMTG has tons of parts.

http://stores.ebay.com/MetalShopMusic-Guitars-Parts-Amps Amazing necks and bodies, and they also have plenty of parts.

http://pickguardian.com/ Great source for custom pickguards to fit your favorite pickups. They also have plastic control plates for telecaster guitars.

http://stores.ebay.com/Jamerson-Guitars A good source for necks and bodies

http://www.noahjames.com/books.html Great book on building guitars and basses from scratch.

www.stanhinesleypickups.com Great sounding hand wound pickups for your strat.

http://www.paintyourownguitar.com/ Everything you need to know about painting a guitar body.

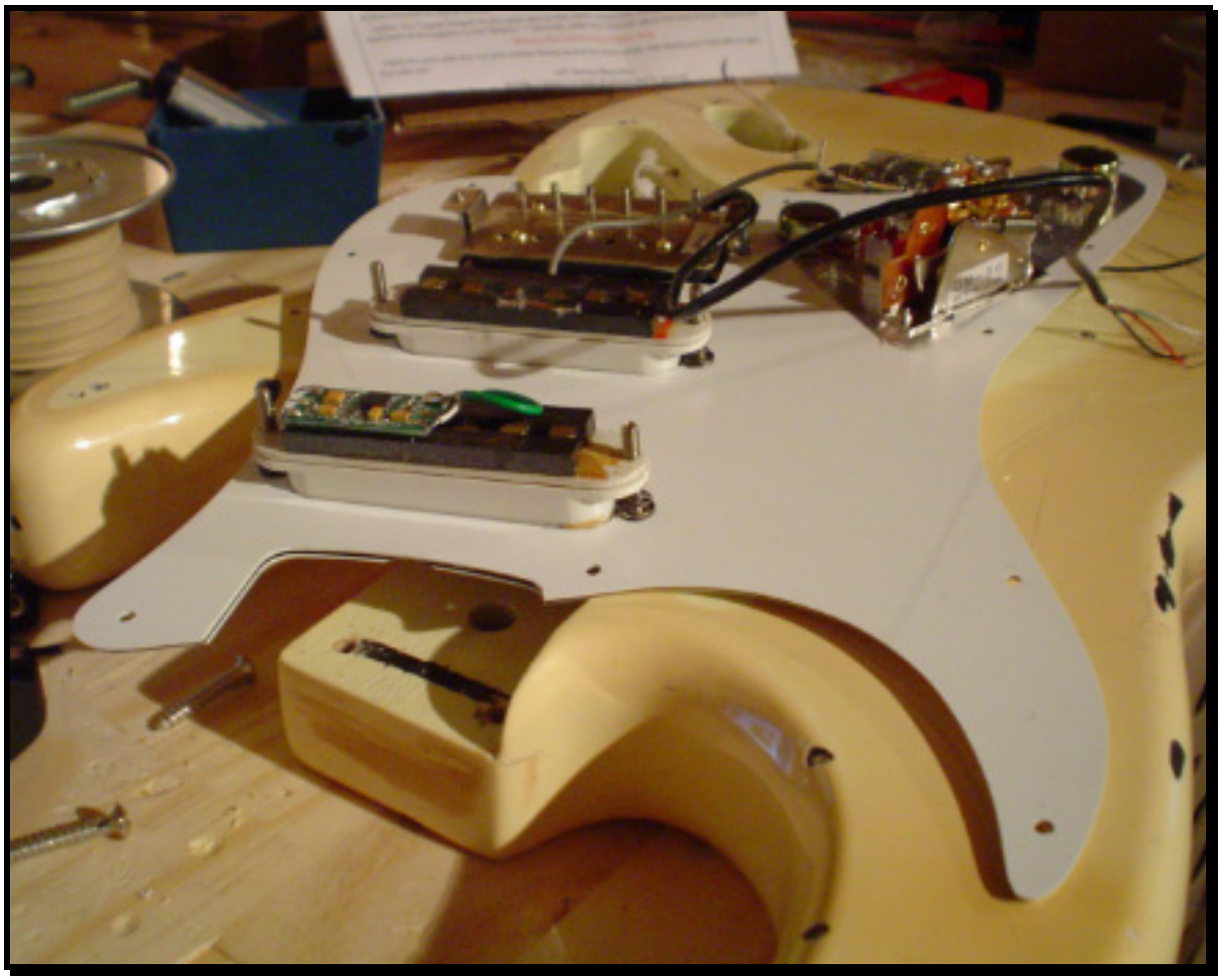
http://guitartone.net/ Modify your existing pedals, and turn them into boutique pedals.

http://www.langcaster.com Great sounding low impedance pickups by Joh Lang.

http://wamplerpedals.com/ Some great boutique pedals by gear geek, Brian Wampler.

http://buildyourownclone.com Build your own boutique pedals with these kits.

http://www.stratcollector.com/ Learn all about vintage strats.



Question: Where can I get hand wound pickups? There is nothing quite like the tone of a hand scatter wound pickup. You just can't reproduce that type of sound with a machine made pickup, no matter how much it cost to make. Stan Hinesley has been doing just this for years. All hand wound in the USA by Stan himself. Here is the Texas LaGrange pickup. It has a smooth Texas blues tone. The LaGrange Set features staggered hand bevelled Alnico 5 magnets. The middle pickup is reverse wound/reverse polarity for hum cancelling in positions 2 and 4. Check out **www.stanhinesleypickups.com** for more info.

Question: What are some popular pedals among guitar players? If you play electric guitar, odds are you have at least one of these pedals in your arsenal: the Boss DS-1 distortion because your amp's distortion just doesn't cut it, the Ibanez TS-9 Tubescreamer if you are into the SRV overdrive, or the Dunlop Fuzz Face for some 1969 Hendrix distortion. Besides that, I would say a good delay pedal is essential. Delay creates a rich, resonant sound that can make any guitar sound better.

Question: What are some good low impedance pickups for the strat? Try a set of Langcaster low impedance pickups. A Low resistance of +/- 100 Ohms means the widest frequency range without the hum. These pickups are loud and clean and you can play them in any Amp or PA. There have 8x magnets in the neck pickup, so no loss of tone when bending the strings. They also have a built in overdrive that gives a sweeter sound than most of the drives available in amps or pedals. They have an earthed copper laminate bobbin. And for better shielding, Langcaster plates them with chrome, and seals them in wax, leaving you with an incredible set of pickups.

Want a low impedance humbucker? Langcaster has come up with the answer, a humbucking pickup called the Ultimate Lo. The Ultimate Lo uses a much heavier gauge of wire with only a tenth of the number of turns. This makes the inductance 100th that of a conventional pickup. Self-resonance is as high as 56 KHz - way beyond the range of human hearing. The resistance is a mere 120 ohms because of fewer turns and thicker wire. Guitarists immediately react with favor upon hearing their first chord played on the Ultimate Lo®.

The preamp is designed with discrete transistors, so that an extremely low current is drawn from the battery. Long battery life is assured, so that the battery lasts almost as long as its shelf life. No compromise has been made in the output capability, either. The buffer stage has a capability of driving the volume pot to 2.5 Volts RMS, which is hardly ever likely to be required in normal playing. All Langcaster pickups are wax sealed and use a copper/chrome plated pickup cover. There is no loss of power caused by this cover, which happens often with high impedance pickups.

How can Lancaster use a pickup with so few turns? We have seen active pickup preamplifiers powered by 9 Volt batteries for many years now. Langcaster developed their own low noise preamplifier, matching the pickups to the guitar amplifier, and eliminating impedance from even the longest guitar cable. By designing a tone control that works

independently of pickup parameters, a consistent and smooth working range can be obtained. Loading and resonance can be selected and controlled to achieve a response that is just stunning.

More about the Joh Lang. Joh from Langcaster is an innovator, and inventor. So he knew the drawbacks of high impedance pickups, even his own, having a signal and frequency loss because of the guitar cable and winding capacitance. He also noted that most guitarists used stomp boxes in order to obtain their overdrive sound. Last year Mr. Lang decided to develop a solution for both problems. Signal losses from guitar cables can be minimized with a low impedance buffer amplifier in the guitar. A transformer can do this, too, but there are certain losses in transformers. So Langcaster started at the front end: the pickups. After countless experiments with magnets, wire gauges and techniques, Joh Lang created his Langcaster Ultimate Lo pickups and these are truly revolutionary.

Not only do they have a low resistance of around 100 Ohms, but they can also be made as a completely noiseless humbucking pickup in a single coil housing. Normal coil resistances are around 6,000 ohms. The inductance that those coils have is around 3 Henrys which is a very high impedance, getting higher as the frequency rises. The new pickups have less than a hundredth of the inductance of the high impedance pickups. This extends the range of response, and the self-resonance is in the supersonic range at over 56 KHz. The result is a pure clear, crisp and open sound, with no restriction or muddiness. The use of a 100 mt guitar cable with no loss in treble is no problem.

The next step was the development of an appropriate low noise preamplifier and a natural sounding overdrive circuit that would fit into the guitar cavity. After numerous, painstaking experiments, Joh Lang created an onboard overdrive, the Ultimate Drive, that is fully adjustable with the characteristics of a tube driven amp. This preamp was designed for a maximum dynamic range with an output capability of 2.5 Volts RMS and with a very low current consumption of only 450 microamps for long battery life. For example, a PROCELL Alkaline battery with a capacity of 580mAH should last at least 1000 hours of continuous playing time. The battery is only connected when a jack plug is inserted the output socket.

Langcaster also makes guitars out of 35,000 year old swamp Kauri. These are truly amazing. Check out **www.langcaster.com** for more information.

THIS GUITAR BELONGS TO THE GREAT JAN AKKERMAN.

Question: Can you explain the physics involved in pickup design and function?

INDUCTANCE: Inductance 'L' has an impedance which rises with increased frequency ($Z = 2 \pi f L$). This Z is called reactance in electronic terms. Guitar pickups wound in the conventional way may have an inductance of anywhere between 2.5 and 10 Henrys. High output pickups generally have a higher inductance, higher self-capacitance, and therefore a lower self-resonance.

CAPACITANCE: A capacitor 'C' has a reactance in the opposite way than an inductor; the impedance falls with increased frequency ($Z = 1 \div 2 \pi f C$). The value of C is in Farads. The coil windings have self-capacitance because the windings are very close to each other. Inductors, being wound layer upon layer, have a winding capacitance which resonates with the inductance at a frequency determined by the formula: $f_{res} = 1 \div 2\pi\sqrt{LC}$.

SELF-RESONANCE: This self-capacitance of the windings resonates with the coil's inductance. This is known as the coil's self-resonance. In the case of a guitar pickup coil,

the self-capacitance can be anywhere between 50pF and 300pF (pF = picofarads = Farads x 10^{-15}). Added to this capacitance will be the capacitance of the guitar lead, which may add another 250 to 1000pF. For example, a pickup with an inductance of 8 Henrys, used with a guitar cable at 800pF, and a winding capacitance of 150pf will have a combined resonance of only 1.8 KHz (1,800 Hz). This is sure to sound Ok for some guitarists, but most would feel robbed of tonal quality. Turning up the treble control on the amplifier will do little to help, except increase the hiss.

Q FACTOR: High impedance pickups range in self-resonance between 2 KHz to 5 KHz with a loaded Q of 0.8 to 4.0 or more. Q is a quality factor which engineers use to express bandwidth and is calculated with the formula: $Q = f_0 \div BW$ where BW is the bandwidth of resonance. It is the difference in frequency between the -3dB points of the resonant curve. The f_0 represents the resonant frequency. The Q factor is decreased by the resistance loading the coil (the volume and tone pots), and by the series resistance of the coil itself. A high Q factor gives a peak in the response, which may be quite prominent. The peak may even be as high as +12dB. High peaks can be annoying, as they emphasise only a narrow range of the frequency spectrum, but can add character to a pickup.

SUMMARY: All this means that the standard high impedance pickup frequency response will be limited by the self-resonant frequency, which can be as low as 1500 Hz or possibly as high as 5000 Hz, and is affected by the guitar lead capacitance. After peaking at resonance, the output drops rapidly at –12dB / Octave. This is a limit well within the audible range, and well within the range where the quality of sound can be degraded. It is also in the range where the human ear is most sensitive. The self-resonance characterises what a pickup will sound like. Of course, the position of the pickup on the body also determines which harmonics are most prevalent. Higher order harmonics come from the bridge pickup because of the way a string vibrates. Conventional pickup coils are a compromise between output level and tone. There is a need for a pickup that eliminates these compromises, and builds on quality and tone. One that will eliminate the effect of capacitance of guitar leads. It would be good, too, if the pickup sounds clear and precise. It should not sound too muddy or weak. It should make music.

Question: What are boutique pedals? Boutique pedals are effects pedals made by small, independent companies like Red Witch, Keeley, Zvex, Fulltone, and Wampler. These pedals tend to sound better, and usually have higher quality parts. If you are looking for the perfect tone, and haven't found it yet with stock pedals, then you might want to give the boutique pedals a try. On the next page is the Brent Mason Overdrive and Distortion pedal by Wampler Pedals. This is the exact pedal that Brent uses. I haven't seen anything else like it. You can find these pedals at:

http://wamplerpedals.com

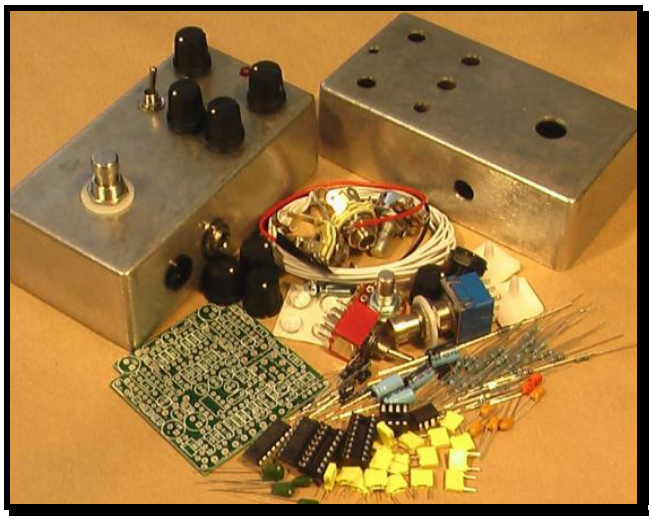
LISTEN NOW

Type this address in your web browser to hear this pedal.

HTTP://TINYURL.COM/3C7U52

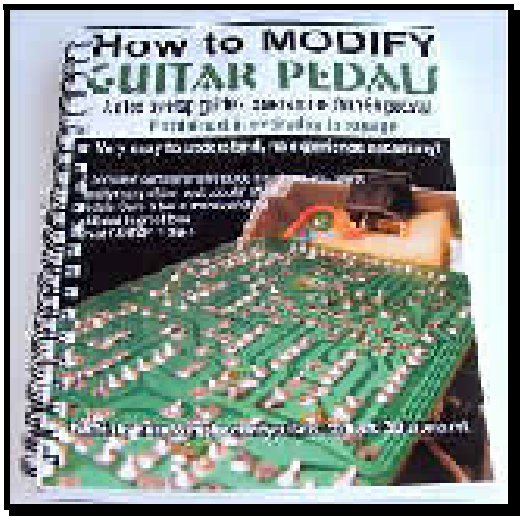
Question: Can you make your own pedals? You sure can. You can save some money by buying kits and doing all of the soldering yourself. Build Your Own Clone offers a full line of DIY guitar FX kits that are based on some of the most famous circuits ever, and use top shelf components to provide you with great sounding boutique quality effects. Check them out here.

http://buildyourownclone.com

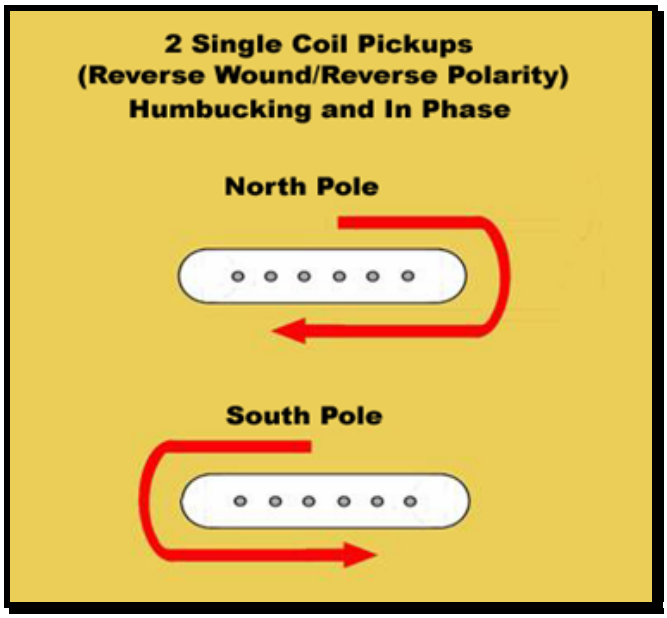


If you are interested in modifying your existing pedals, or even designing your own pedals, be sure to check out the Guitar Tone website. They have some great books that explain everything you've ever wanted to know about guitar effects pedals, and how to make them. Check it out here:

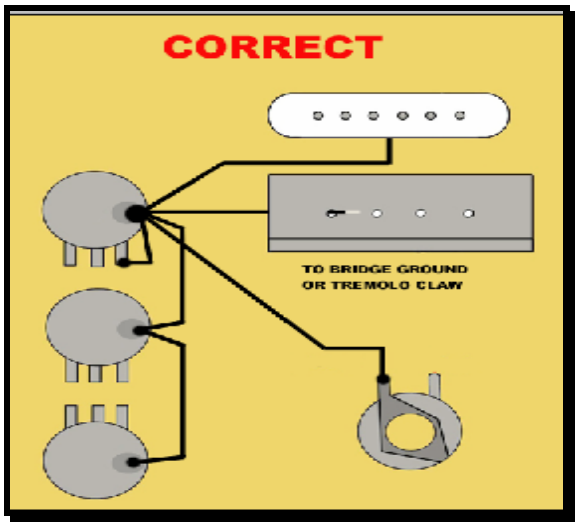
http://guitartone.net/

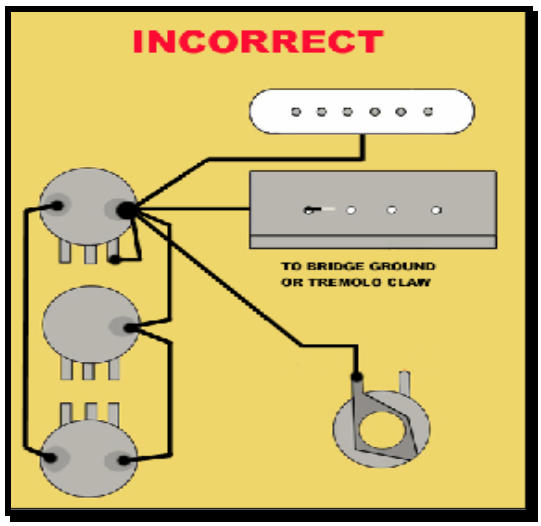


Question: Why do some guitars have reverse wound pickups? Many strat style guitars will have a middle pickup that is reverse wound with a reverse polarity. This actually creates a humbucking pickup when the neck and middle pickups are selected, or the middle and bridge pickups are selected. The reverse windings put the pickups out of phase, and the reverse polarity puts the signal back in phase, and eliminates hum. Here is a test. Take any two single coil pickups that are not wired yet, If their faces attract one other, then one of them is reverse wound/ reverse polarity.



Question: What is a ground loop? This occurs when you create more than one path to ground for a particular electronic device. Ground loops can cause unwanted AC hum. Notice in the diagram on the left that there is only one path to the output jack. In the diagram on the right, the bottom tone pot can take two paths to the output jack.



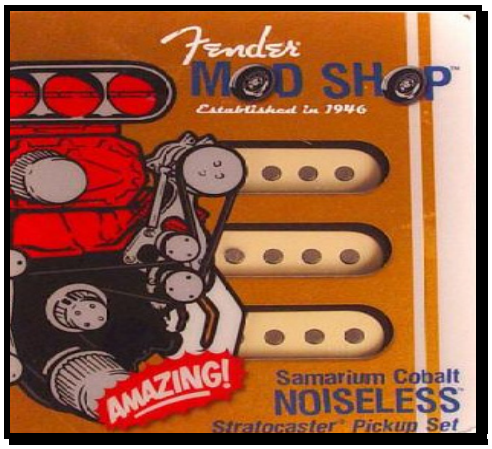


Question: What type of soldering iron do you use?
There is only one type of soldering iron that I like to use on my projects, a Weller. In my opinion, everything else is just second rate. I like to use the 100 to 350 watt gun handle

versions that can heat up in a few seconds with the push of a button. The good news is that you can find them on Ebay for around $20. Type in "weller soldering iron" and see what comes up.

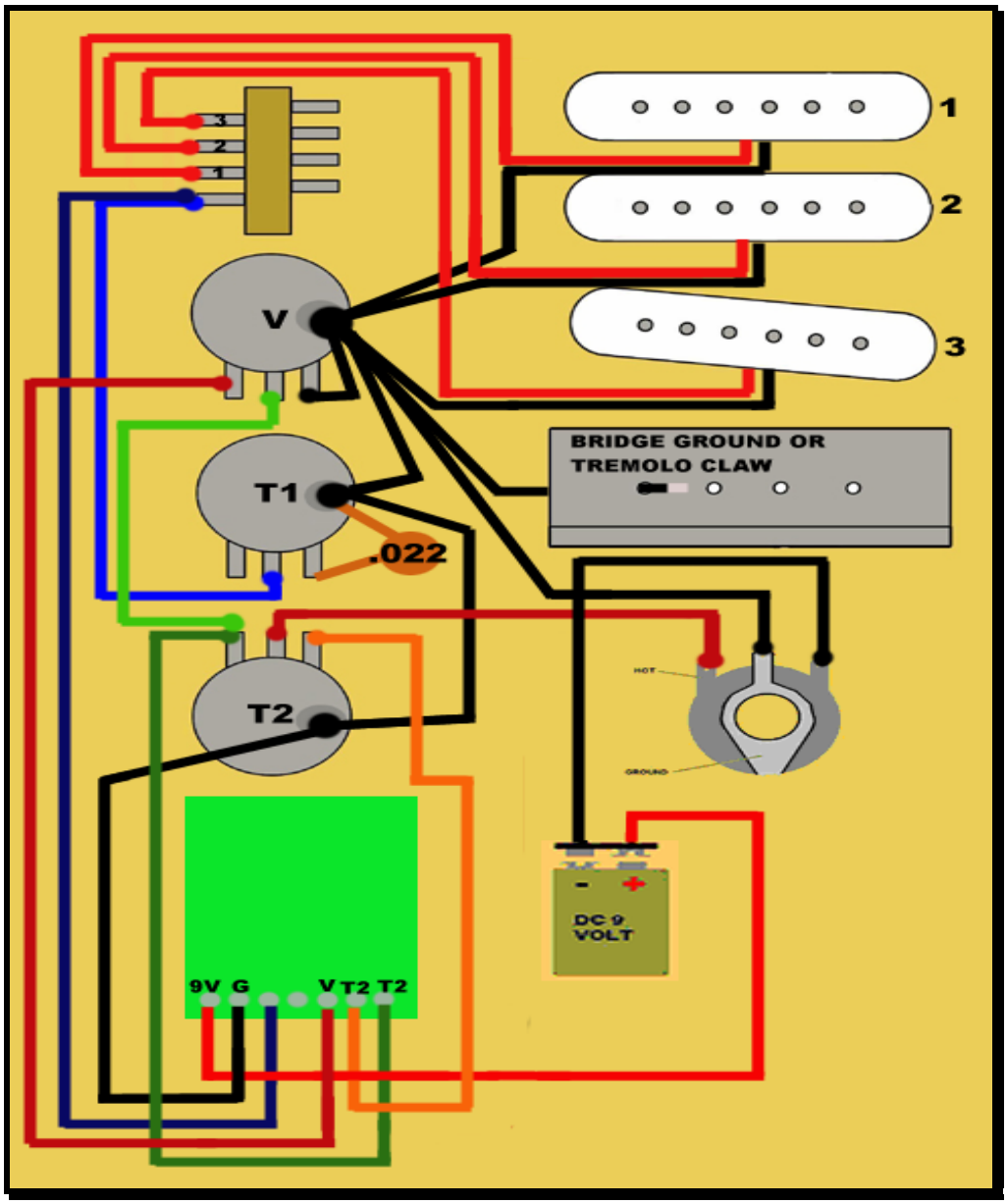
Question: What is the Fender S-1 switch with the SCN pickups?

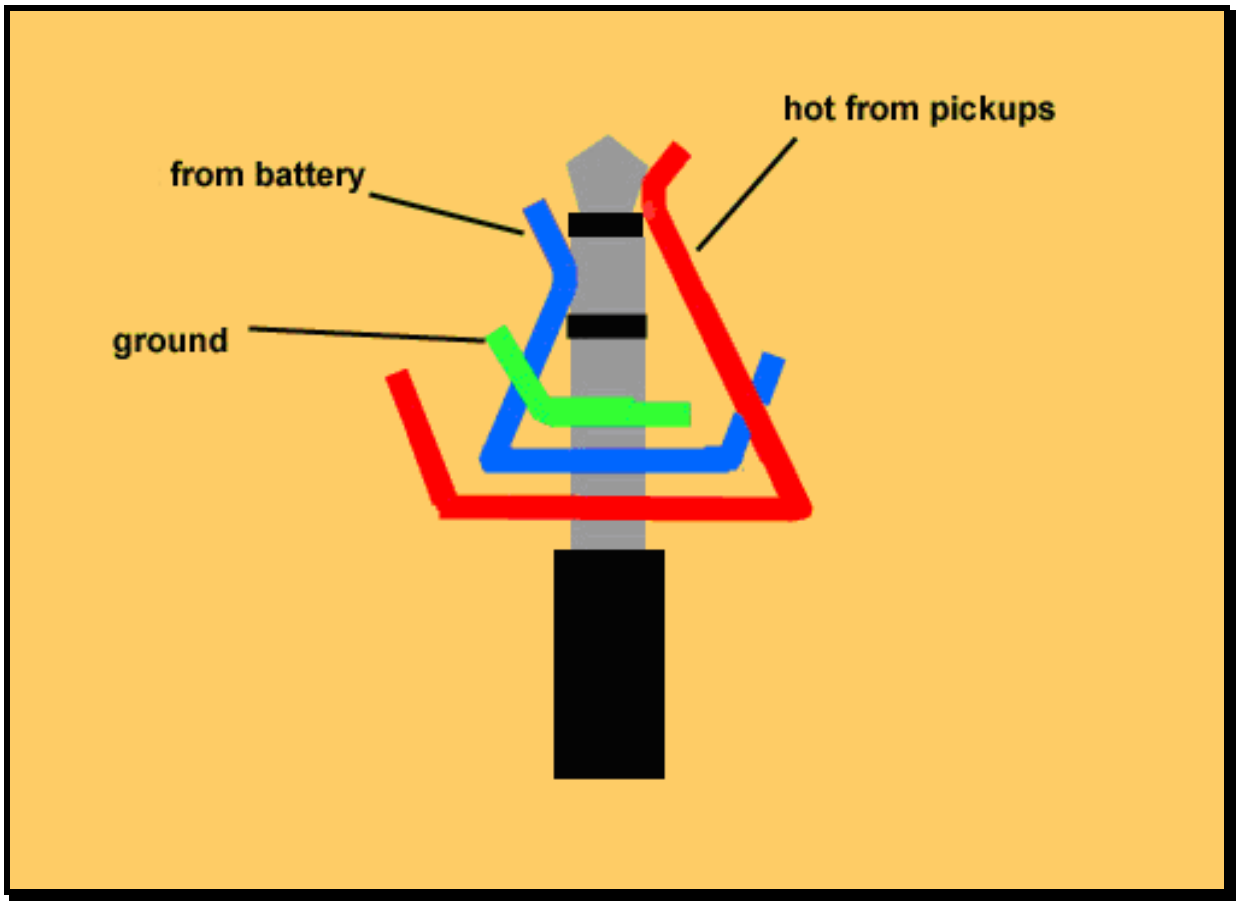
It is similar to a push pull pot, but a little more complicated. This switch is available on some of the more expensive strats, and is not available for sale by itself at this time. So if you want an S-1 switch, you need to buy a strat. The Fender American Series HSS strat is a good example of a guitar with S-1 switching. The S-1 switching changes from parallel to series wiring, giving you some fat strat humbucking sounds. These guitars also come with the Samarium Cobalt Noiseless Pickups designed by Bill Lawrence, which are an improvement on the Fender Vintage Noiseless Pickups. The SCN pickups offer the traditional bell-like tone with the power and quietness of a humbucker. The bridge pickup is rated at 11.6 K Ohms, the middle at 6.5K Ohms, and the neck pickup at 6.5K Ohms. These pickups come with three wires. The white wire is hot, the black wire is ground, and the green wire is an independent ground.



Question: How do you get the Eric Clapton "woman tone" on a guitar?
All you need is a small capacitor (.010 - .020 uf) on your tone control, and then just crank it up all the way for a warmer sound. A set of heavy strings will help, too. Listen to some of the older Cream albums to hear what I'm talking about.

Question: What is the Clapton mid boost?
It is a preamp inside your guitar that will give you more of a Les Paul sound on your strat. You can get a boost of up to 25 db with this kit. Check out the diagram to see how its wired. You can find these kits online for around $100.





Question: How hot are vintage sounding pickups?
If you want the vintage single coil sound, then you will probably want a pickup that is measured at 5K Ohms to 7K Ohms on your Multimeter. This is not a measurement of impedance, but a measurement of DC resistance. But both measurements are related. A low DC resistance will yield a lower impedance pickup. And a pickup with low impedance will give you plenty of treble and sparkle in your tone. The lower resistance is due to less windings of copper wire around the magnets. Now, if you are looking for a hotter pickup with more punch, then you might be looking for a pickup rated at 8K Ohms to 9K Ohms. And if you want a very hot, loud pickup, go with one rated at 10K Ohms to15K Ohms.

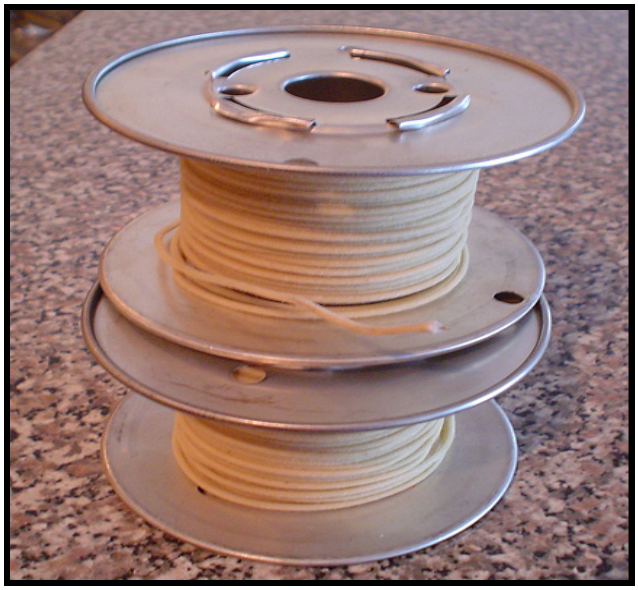
Question: Where can I get humbuckers that will fit into my strat pickguard? I like the LiL Killers from **Guitarfetish.com**. They are only $25, and have a great tone. Unlike the "Big Name" version of this pickup, the GFS Lil Killer has a real vintage FIBER BOBBIN. That means that, unlike plastic, they can really heat up the wax and vacuum impregnate the windings. The result? KILLER tone, great output, no noise, and NO MICROPHONICS! They come in 6K Ohms, 10K Ohms, and 15K Ohms. They use the same pickup color

codes as Jackson pickups. You might also want to check online for blade pickups, rail pickups, stacked pickups, and mini humbuckers.

Note: Guitarfetish, GFS, MODboards, and Xaviere Guitars are all trademarks of GF Sales LLC

Question: Where can you get vintage style 22 AWG wire? Bookmark this site **http://stores.ebay.com/Classic-Clones-Amplification**

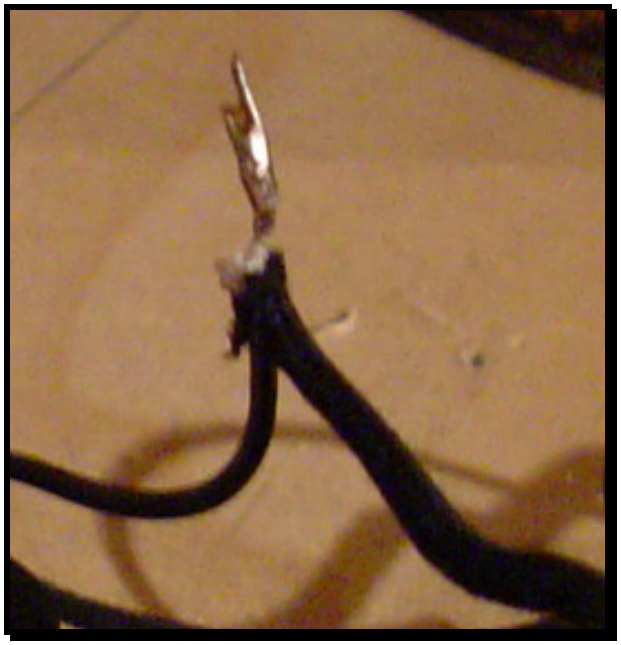
This wire is from the same manufacturer that supplied wire to Fender. It has a double-cloth jacket, waxed cotton outer braid, and a celanese inner braid. I love this stuff. It is stiff and bendable; making it a dream to use. It comes in several colors like red, vintage white, and black so you can keep your grounds all black and your hots all white or red. No need to strip your wires anymore, just pull back on the cloth to expose the wire. And when you are done soldering, just push the cloth back over the wire

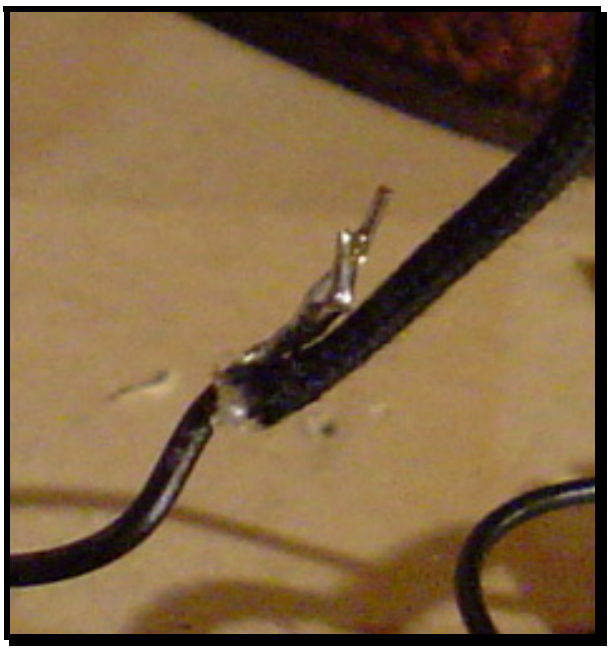


Question: Where can you get a custom made pickguard? **Pickguardian.com** will make you a custom acrylic, plexiglass, or tortoise pickguard and control plate for cheap. They offer a bunch of unusual colors, and can even make clear plastic pickguards and covers. Check out the example below. Now you can show off your hard work.

Question: What is desolder braid? A desolder braid or wick, when heated, absorbs old solder left on your switches and potentiometers. So if you reuse electronics parts often like I do, this stuff will keep your work neat and clean. Once a portion of the braid has been used to absorb solder, then that part of the braid is used up, and should be cut off and thrown away. Desolder braid can be found everywhere online.

Question: What is heat shrink tubing? Heat shrink tubing is a protective sleeve that is used to cover wire connections. So let's say you need to extend the length of your bridge ground, or tremolo claw ground wire. Twist the two wires together and solder them. Then fold back the bare wires.

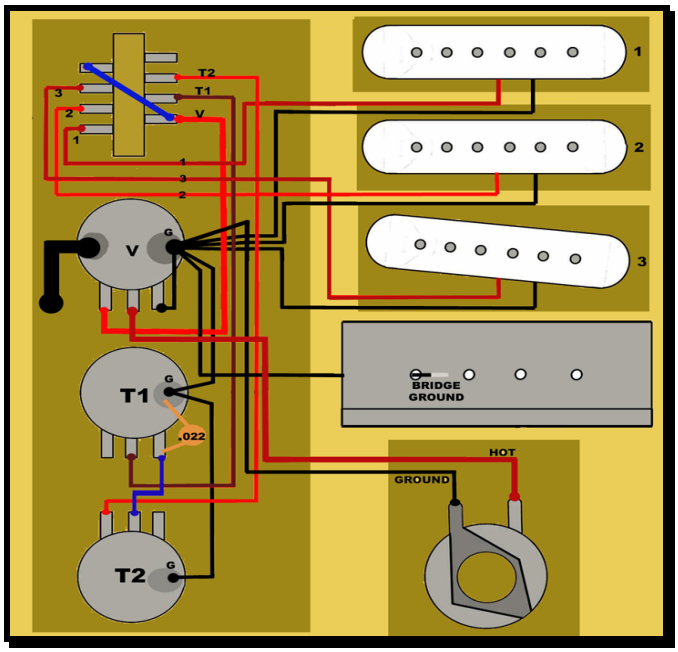




Next, take a piece of heat shrink tubing and place it over the open connection.

Now heat up the heat shrink tubing with a lighter. You will see that the tubing starts shrinking rather quickly. Be careful. Don't hold the lighter over the tubing too long, or you can start a fire.

Question: Why do some people use shielding in their guitar bodies? Because they have a problem with unwanted noise. Conductive shielding paint applied inside of the control cavity will help reduce the 60 cycle hum and unwanted noise. If you have a pickguard, you can use the conductive tape to shield it. For the body, you can use the conductive paint. Then solder a ground wire to the dried conductive paint inside the body cavity. If that doesn't work, you can always twist the ground wire around a wood screw, and then screw it into the body cavity. Make sure you paint a little bit above the body cavity hole, so that the pickguard tape touches the conductive paint inside the body. Stewmac.com sells the paint for $28 a can.



Question: What type of wood is normally used in strat bodies? Most of the strats, or strat clones use Alder or Ash in their bodies. These woods provide a rich, warm tone with a good amount of sustain. If these woods are not available to a manufacturer, then Basswood or Poplar is often used, which provides a similar tone. Here is an ash body that is available online at **http://stores.ebay.com/MetalShopMusic-Guitars-Parts-Amps**

Notice the conductive shielding paint applied inside the cavity.

Question: What are some good single coil pickups made by Fender? Fender has all kinds of pickups, but here are some of the favorites among strat players.

Texas Special Pickups – Great SRV blues tone with plenty of punch.

Tex-Mex Pickups – Overwound bluesy pickups with a warm tone.

Custom 54' Pickups - Vintage sound with some great bell-like tones.

Hot Noiseless Pickups – Plenty of power and clarity Jeff Beck style.

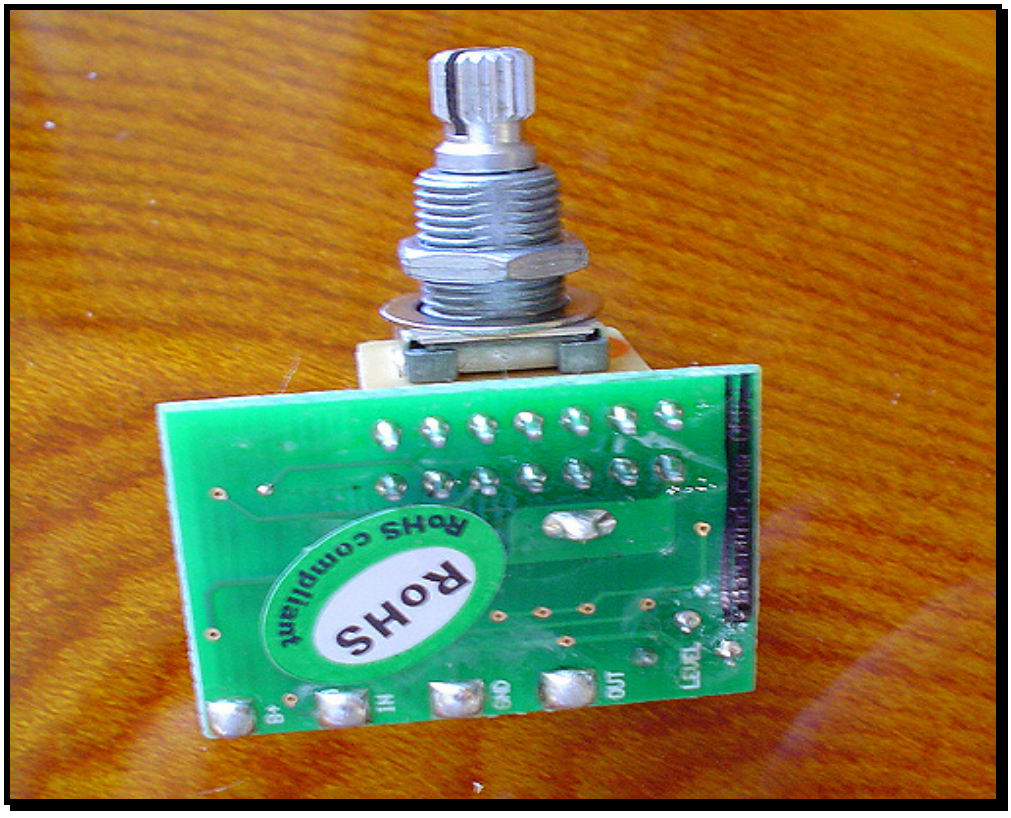
Vintage Noiseless Pickups – The classic Fender sound without the hum.

SCN Pickups – Samarium Cobalt gives you even more clarity and punch without the hum.

BONUS SECTION 1 – ADDING A DISTORTION PREAMP TO YOUR TONE CONTROL

Sick of hauling around distortion and overdrive pedals to all of your gigs? Why not just add the distortion directly to your guitar's wiring? Seems pretty logical to me. Yes, you can make your tone knob a distortion pedal.

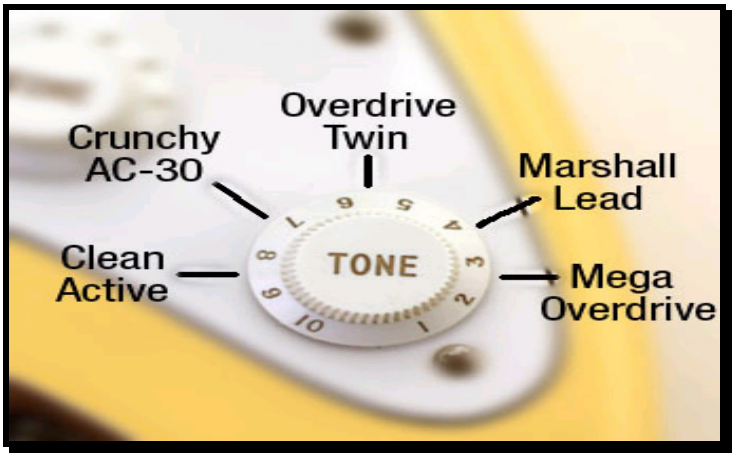
The distortion preamp is an onboard multi-circuit and will take the place of one of your tone knobs. It can be purchased at **www.guitarfetish.com** for around $30. It offers 5 killer tones: clean, crunchy, overdrive twin, marshal lead, and mega overdrive. To switch between the tones all you have to do is turn your tone knob. No matter what sound you are looking for, guitarfetish has a mini preamp to add to your guitar.

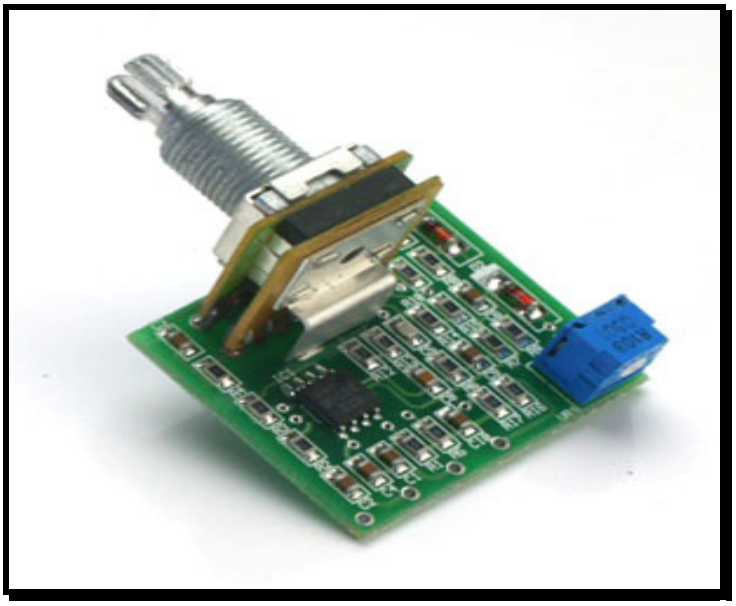


Here is what the Guitarfetish.com website has to say about this preamp:

"This is the single most versatile distortion effect in the whole world, and it mounts

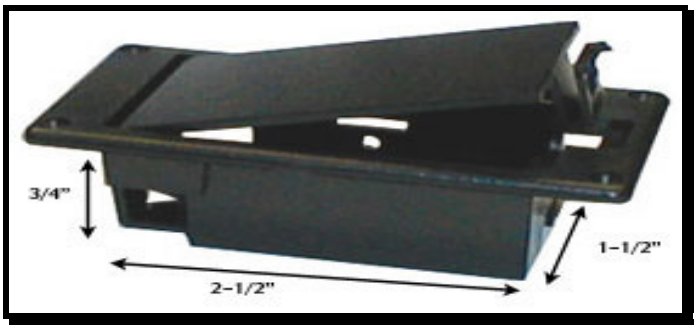
right IN YOUR GUITAR. DO NOT confuse these with similar circuits touted on ebay- we have these custom made to our specs. FOUR different distortion effects AND an active boost mode, right at your fingertips- the whole lot instantly swtichable, just turn the knob.. Drill NO holes, make no serious mods to your axe- just install the "Multi Drive Circuit" in place of one of your tone pots, and you're all set. The Multi Drive Circuit runs on a single 9 volt battery. Battery life is excellent, and the entire range of distortion sounds is adjustable via an internal level trimpot. The active mode is unity gain (No Boost) it's the exact sound of your guitar, but now you're Low Impedance! Run a mile of cord- and notice how full and punchy your stock pickups are! There's a small trim pot on the board that allows you to dial in how loud you want the boost effects- so you can either get unity gain distortion or give the distortions a noticeable boost. I like the distortions to have just a slight boost, but sometimes for playing out I'll goose that trim pot a bit to give me more boost for the lead songs."





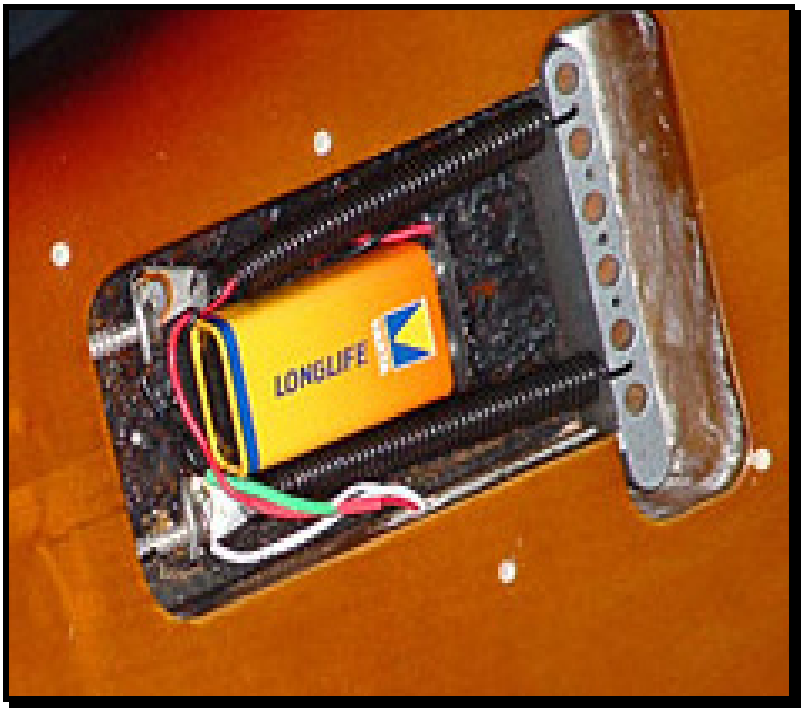
Installing the preamp is pretty simple. Only a few wires need to be switched around. The hardest part is finding room for the 9 volt battery. This is pretty easy if you have a guitar with a pickguard, you can just put the battery inside the body cavity, underneath the pickguard. You should be able to change the battery by unscrewing a few of the pickguard screws, lift the pickguard partially up, change the battery, push it back inside, and then screw the pickguard back down. Or you can route out space in the back of the guitar and install a battery box to make battery changes even quicker.

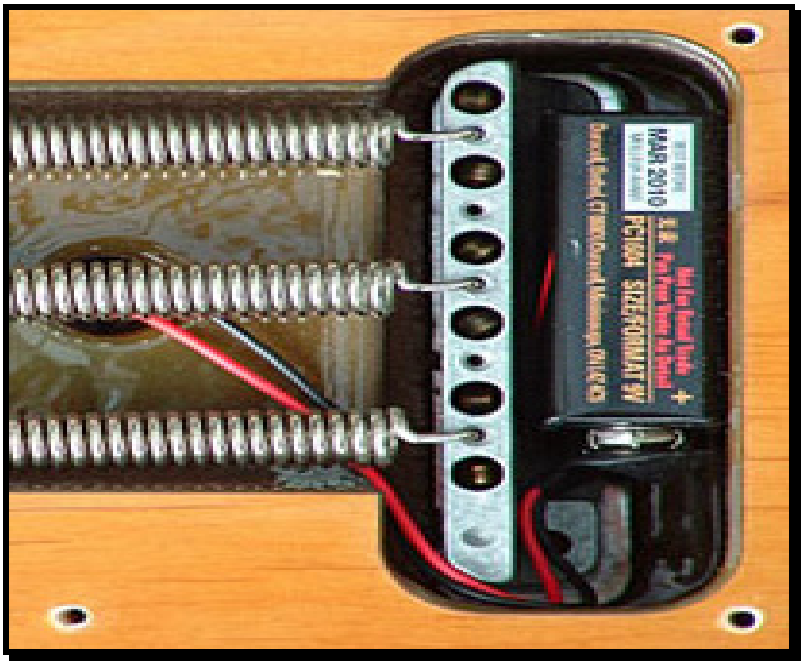
Here is what a battery box looks like. They can be purchased at **www.guitarnucleus.com** for around $10.



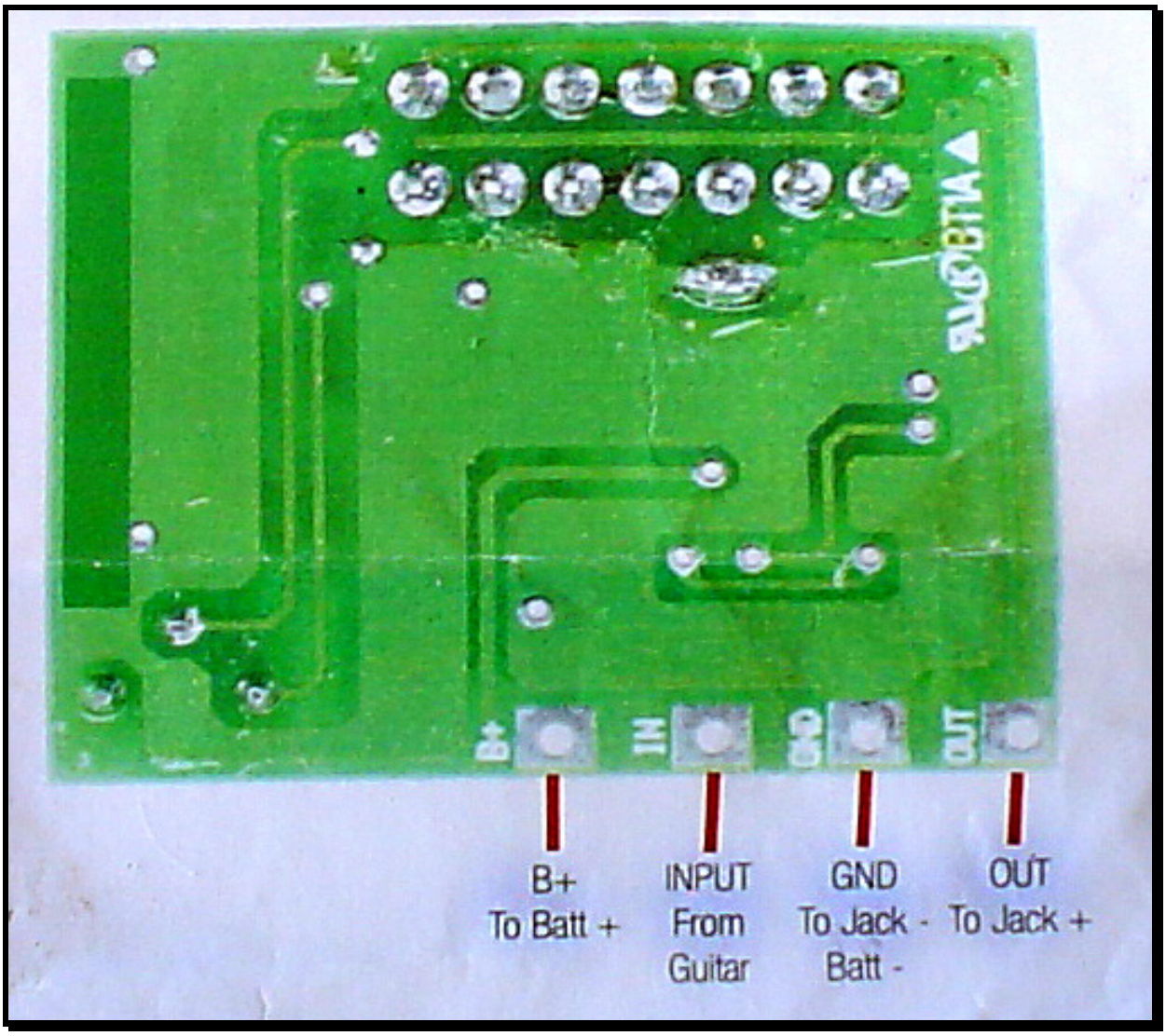
Or you could drill a hole in the back of the guitar, so the body cavity hole extends out to the backside of the guitar. Then place a Les Paul switch cover over the hole. You could also flip the output jack around to make room for the battery inside the guitar. Just unscrew the battery jack when you need to change the battery.

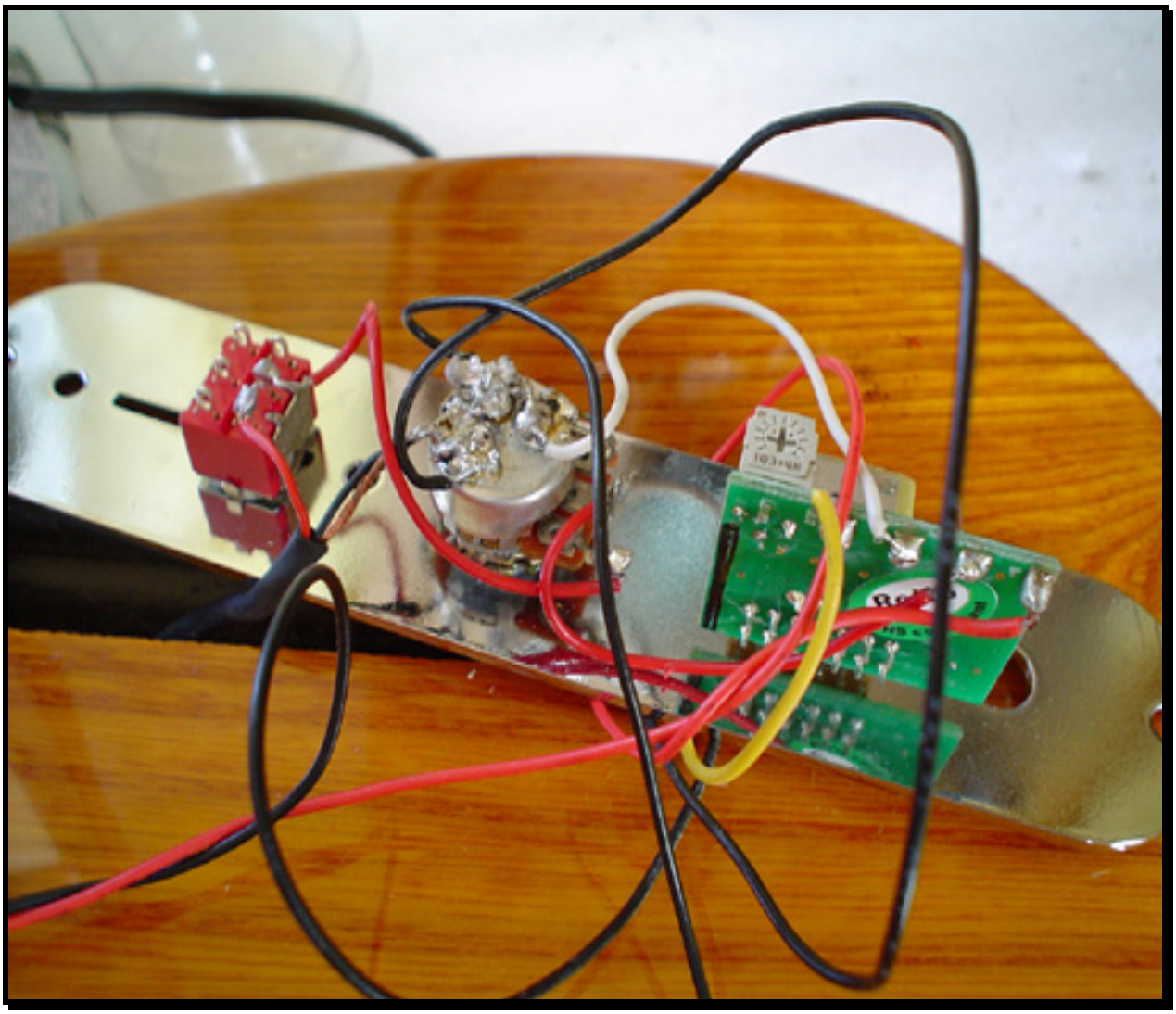
Here are a few more options for hiding the battery.





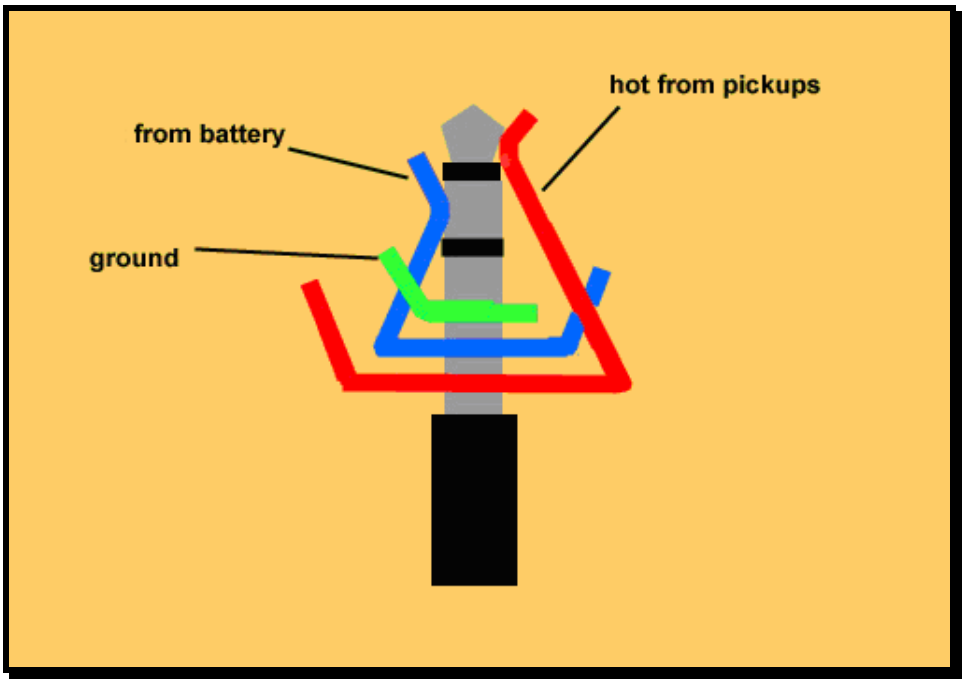
This preamp only needs to be wired in 4 spots.



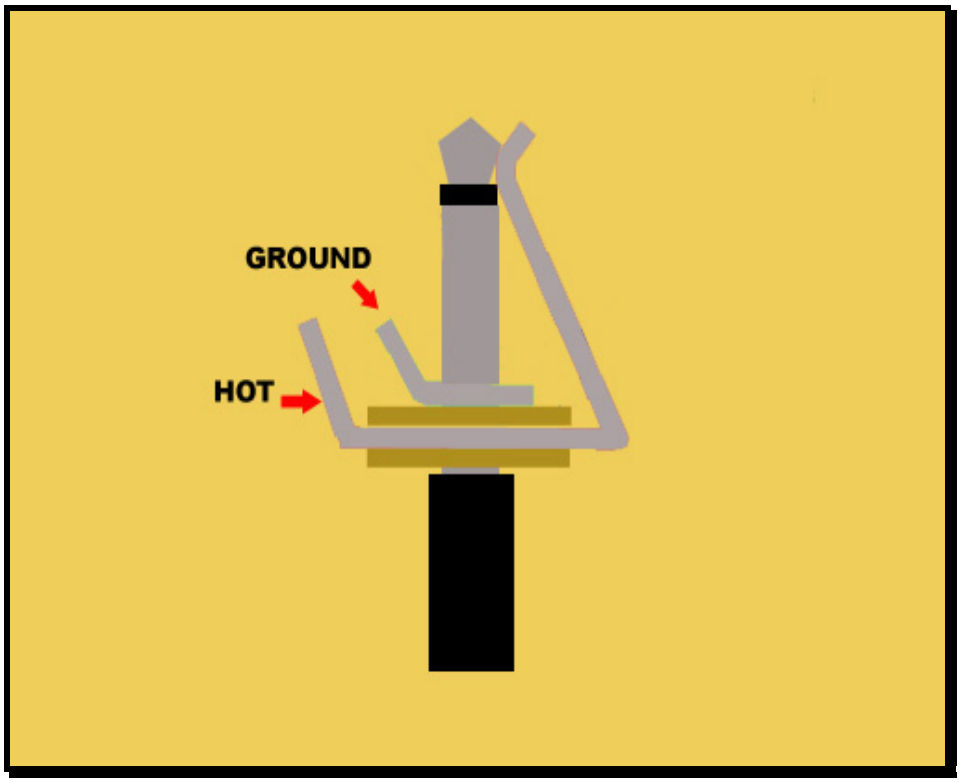


THE STEREO OUTPUT JACK

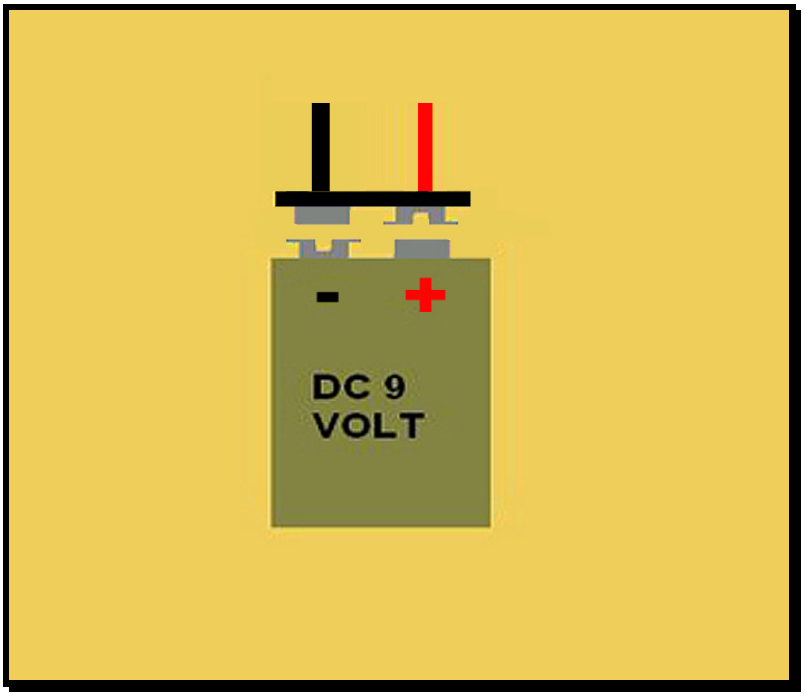
You might not be too familiar with a stereo output jack unless you have used active pickups before. The stereo output jack has one extra prong that gets connected to the 9 volt battery. The stereo output jack and 9 volt battery wires are included with the distortion preamp kit from guitarfetish.com. Notice the diagram on the next page. The longest prong gets power from the pickups. The shorter prong gets connected to the 9 volt battery. Note: you don't need a stereo cable for the distortion preamp to work. A mono guitar cable will work with the stereo output jack.



Below is a picture of a mono output jack, and not a stereo jack. Notice the difference.

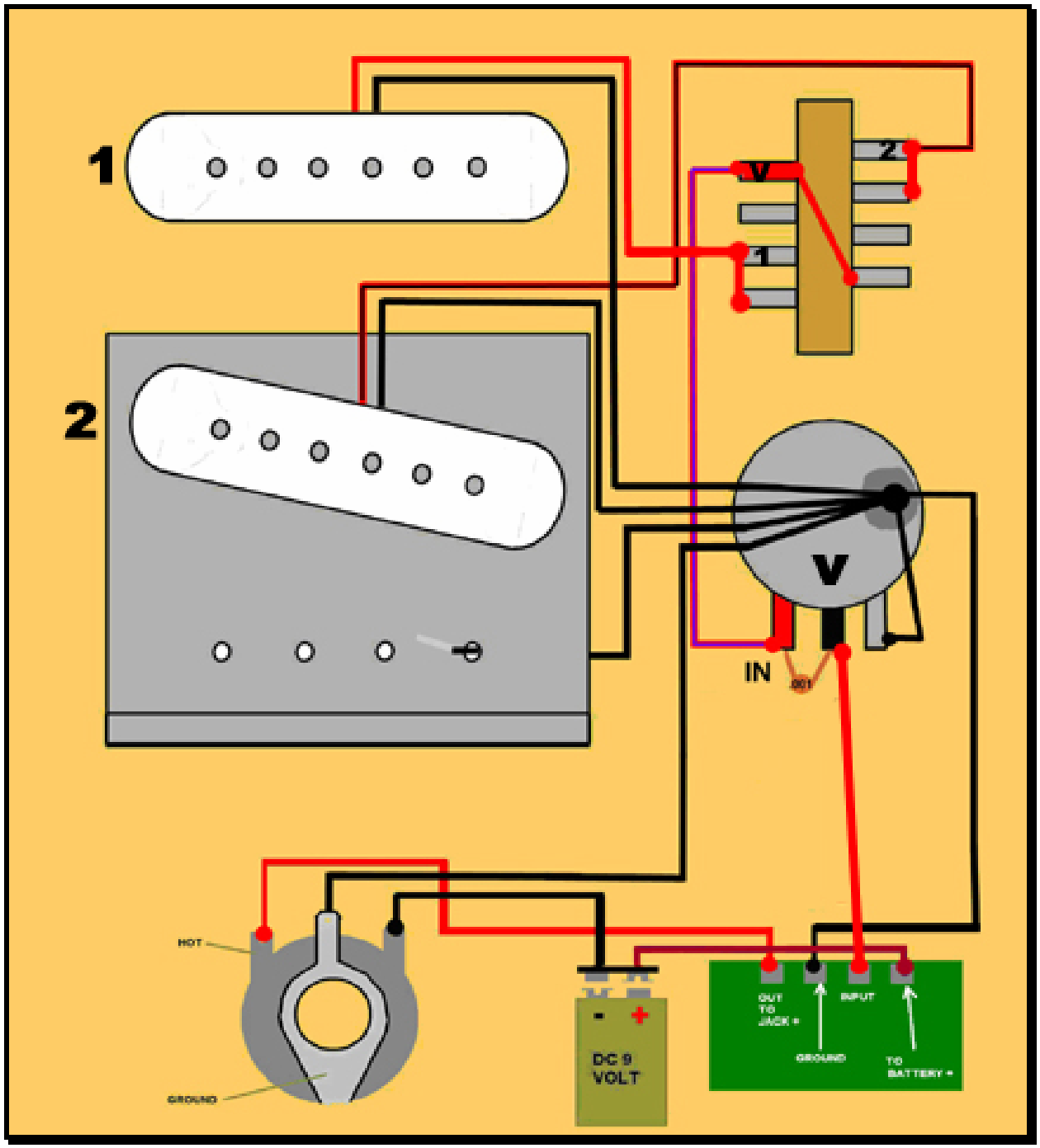


Here is a close up of the battery connection.



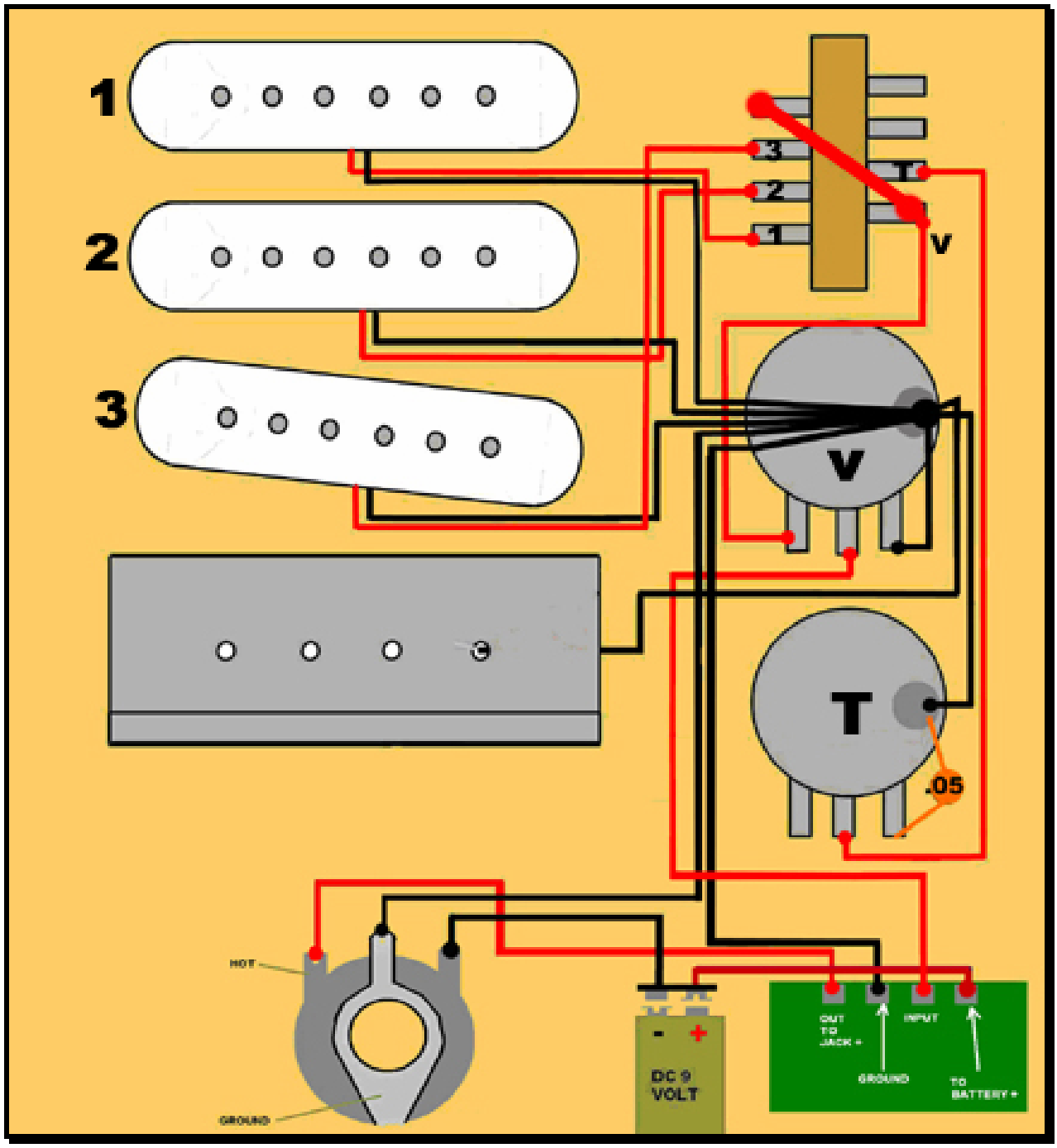
WIRING A GUITAR WITH TWO PICKUPS

If you have two pickups on your guitar, like a tele, the wiring is simple. The main difference is the removal of the tone control.

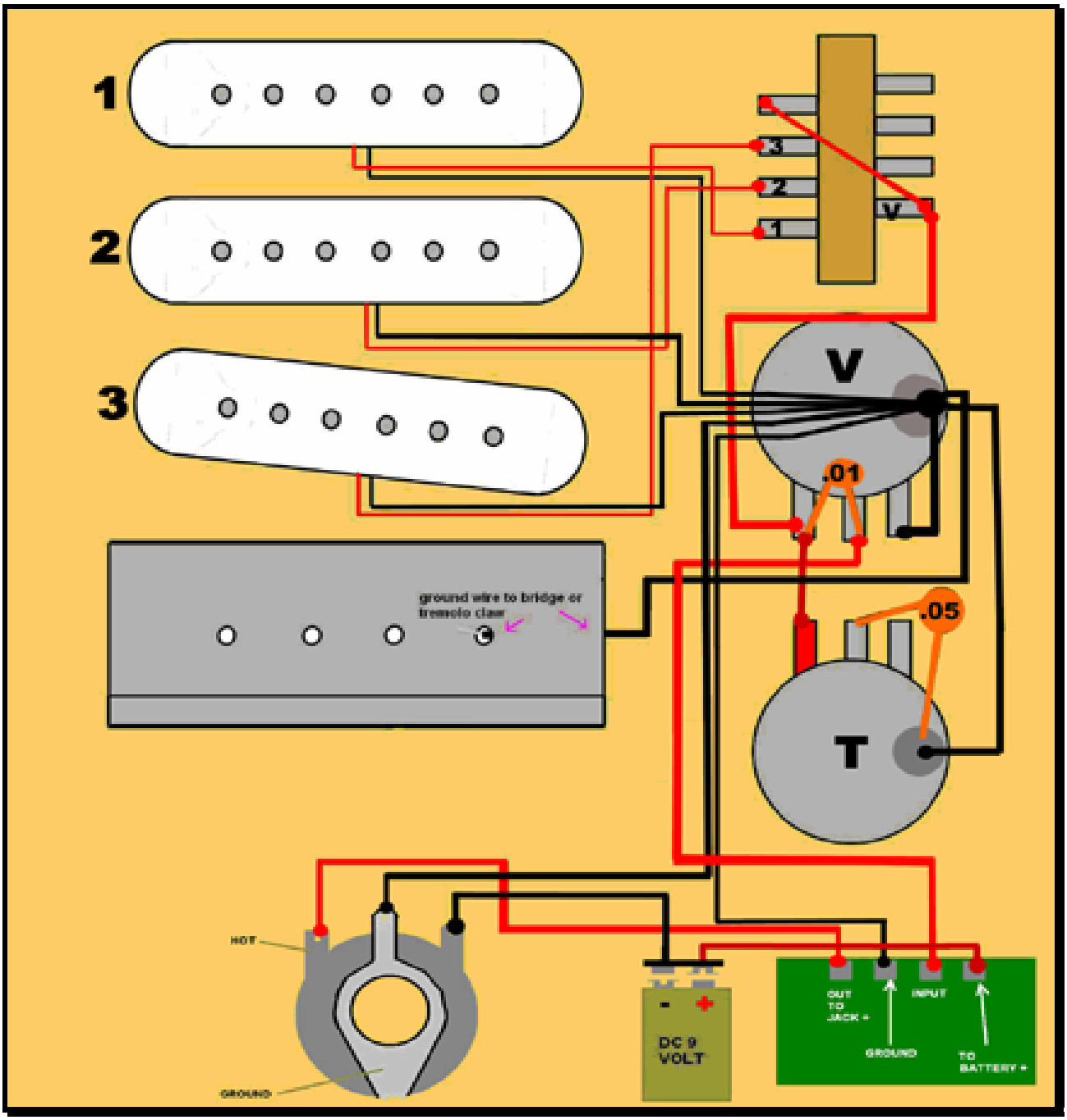


WIRING A GUITAR WITH THREE PICKUPS

If you have a strat, or 3 pickup guitar, it gets a little more complicated because you have three tone potentiometers, and will be removing one of them and replacing it with a distortion preamp. Therefore, the middle pickup will no longer be sending the signal to a tone pot. That leaves only the neck pickup with its own tone control.



If you wanted to add a master tone control for all of the pickups, you could wire it similar to a telecaster style guitar, where the signal goes into the volume pot, then out to the tone pot and preamp.



Note: Guitarfetish, GFS, MODboards, and Xaviere Guitars are all trademarks of GF Sales LLC.

BONUS SECTION 2 – HOW TO MODIFY A BOSS DS-1 PEDAL

If you've been in a music store anytime since 1978, you've no doubt seen the ubiquitous orange Boss DS-1 Distortion pedal. Universally recognized as a good, inexpensive distortion pedal, you've probably even owned one or two in the past. Although it houses a simple circuit design, it produces a very good sound, particularly for a mass produced pedal. Let's look a little more closely at the circuit and check out some changes that are available to make this great pedal even better.

The circuit is a buffered bypass circuit with electronic switching, as are all Boss pedals. The circuit comes in through R1, a 1K resistor, and then travels through C1, a .047 microfarad, or µF, capacitor into the first buffer. This buffer goes out through C2 and then into a JFET (**j**unction gate **f**ield-**e**ffect **t**ransistor), which is part of the switching. If the pedal is off, the signal goes out to the switching circuit and through the output through Q7, which is the other you can increase or decrease in value to adjust gain before the next stage. Increasing the value increases gain, while decreasing it will give you a little less gain overall but will tighten up the DS-1's low-end response, ridding it of the flubbiness many people dislike.

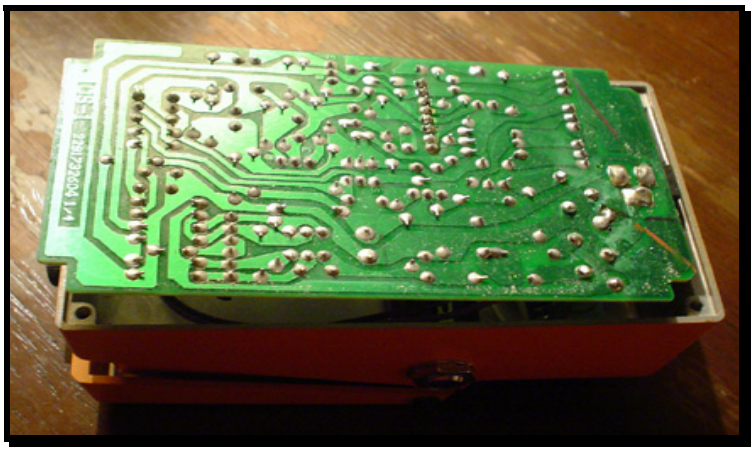
We can also decrease C3 to get this same effect by not allowing as much bass to come through. I like to change its value to either .022µF or .033µF if I'm looking for a less flubby tone. To clarify, to me "flubby" means a deeply compressed tonality. C4, which has a value of 250 picofarads (pF) also filters out some highs. Changing this won't do too much, although you may be able to coax a little more brightness by changing it to a 100 pF capacitor.

The signal then goes out through C5 into the opamp. This opamp is used in a unique way to clip the signal. R11 controls the gain in combination with the distortion knob, R13 and C8. The gain control is set up this way to enable the clipping of higher frequencies as you turn the distortion up. When it's turned down, it allows lower frequencies in – giving it a muddy sound since the signal is clipped beforehand through the transistor gain circuits, then clipped *again* when the distortion control is turned down. The first stage clipping is still occurring and as a result, the pedal doesn't sound as clear and articulate as many would like. R13 and C8 are part of this "non-inverting" opamp circuit which provides negative feedback to ground. This is important for several reasons. The resistor value of R13 and the capacitor value of C8 basically provide a frequency range where the signal is made to clip. In this case all frequencies above 33hz is being clipped. To contrast, a Tubescreamer only lets frequencies above 728hz clip. This means that none of the lower bass frequencies are being boosted and/or clipped in the Tubescreamer.

The signal goes out through R14, which is a 2.2k resistor, through C9, which is a .47µF capacitor running across two diodes – D4 and D5 – and then to ground. All the usual diode tricks can be done here to allow more asymmetric clipping or different clipping flavors. Here C10 JFET. These JFETs act as a switch, allowing the signal to either go through the distortion circuit or out through the buffers, producing a clean signal.

When the pedal is on, signal travels to Q6, through C3 and into a transistor gain stage. R7 controls the gain of this circuit by changing the voltage bias, consisting of a 470k resistor which is also in parallel with D4 and D5 and is used to filter out highs in conjunction with R14. R14 and C10 form a low pass filter, cutting out high frequencies.

Go to **indyguitarist.com/filter.htm** and scroll to the bottom. Plug these values into the corresponding fields to determine which frequencies are being filtered. With the current values you will find it's filtering everything above 7k, which helps to smooth things out a little bit. If it's too bright, replace R14 with a resistor valued at 3.3k, allowing more highs to be filtered out, or try a 4.7k resistor to filter out everything above 3.3kHz.

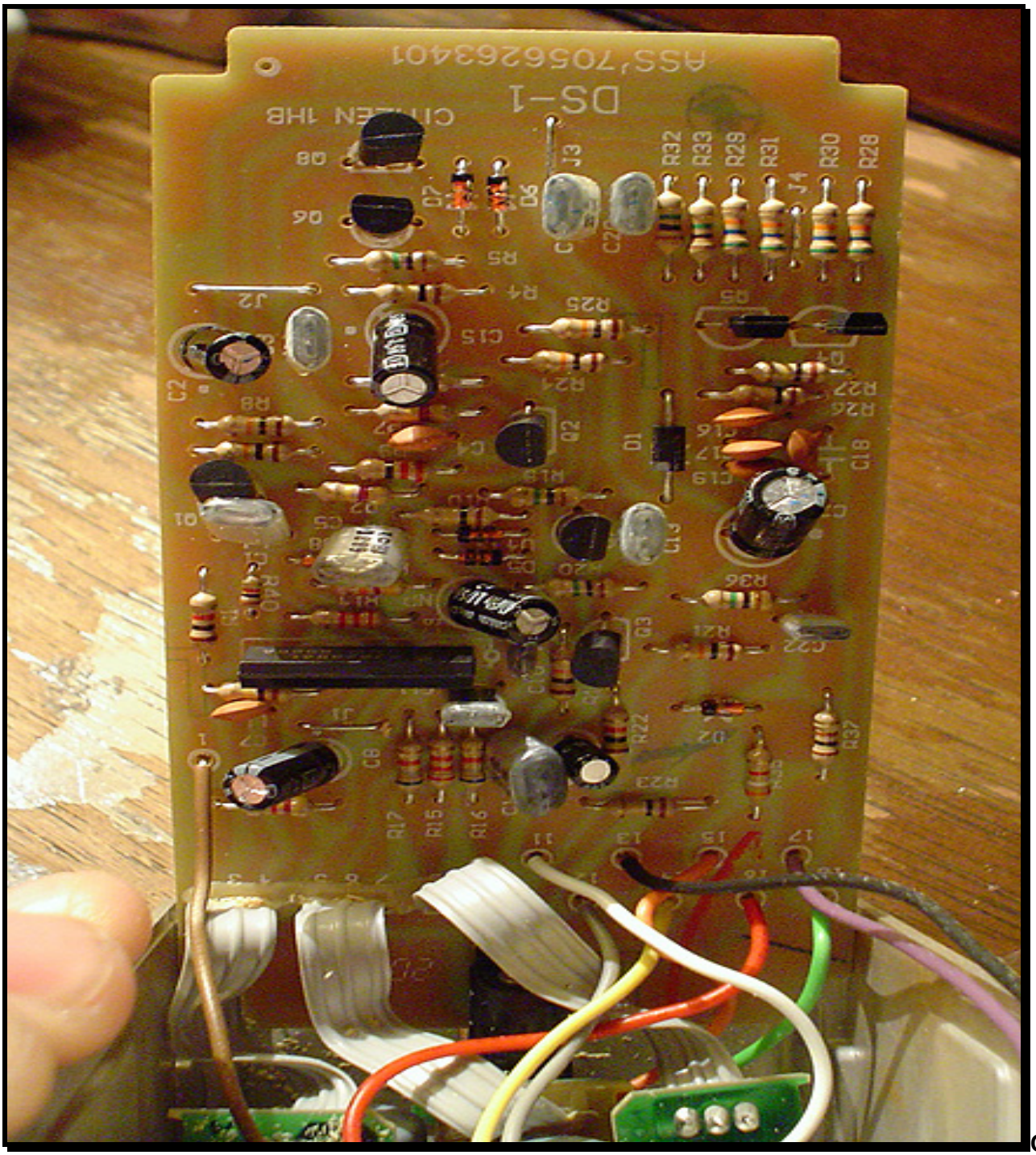


After traveling through the diodes and the capacitor, the signal goes through a Big Muff π inspired tone control. There are many things we can do to manipulate the tone here, and a great resource is the Duncan Tone Stack calculator, available at **duncanamps.com/tsc/**. Experiment with different values to find the tone you're looking for. In the stock version of the pedal, the tone is a bit "scooped" meaning that there is little mid frequencies allowed through making the tone a little "thin" sounding. We can change that quite easily however. Check out the suggested changes in the charts below to get a warmer tone, a scooped mid tone or simply less highs.

After the tone control the signal travels through the level control and then out through R18, which is a 10k resistor, and then on to Q7, which is the other side of the JFET switching circuit. In its on state, it goes past Q7, through C13 – which is a .047µF capacitor – through yet another output buffer and then a resistor, a capacitor and finally through the output.

Let's look at some modifications that will have your DS-1 doing your bidding in no time.

Note: It's a good idea to buy some desoldering braid to suck up the old solder when dealing with pedals. Then you can use fresh solder for the replacement capacitors and resistors, and will prevent tearing up the traces on the pedal.



C

Classic JCM-type Marshall Tones:

Location	Change to
C3	.033 µF
R17	15k
C2	1µF
D4	1N4148 CONNECTED IN SERIES TO ANOTHER 1N4148
D5	1N4001 CONNECTED IN SERIES TO ANOTHER 1N4001
C5,C9	1UF
R13	OPTIONAL – CHANGE TO 1k FOR TONS OF GAIN, IF YOU DO THIS, ALSO CHANGE C8 TO A 1µF

Modern distortion tones

Location	Change to
R16	1k
R14	10k
C10	.001µF
C5,C9	1µF
R13	3.3k
D4	LED

Vintage distortion tones

Location	Change to
D5	LED
C3	.033µF
R16	1k

Location	Change to
C11	.01µF

If you like the general sound of the DS-1 but are looking less highs and more of a tonal range change C10 to a capacitor with a larger value. Stock is .01µF for a frequency roll-off of 7.2kHz.

Less shrill highs

Location	Change to	FREQUENCY ROLLOFF
C10	.015µF	4.8kHz
C10	.022µF	3.2kHz
C10	.027µF	2.6kHz
C10	.033µF	2.1kHz
C10	.047µF	1.5kHz

To sum it up, the Boss DS-1 Distortion is an inexpensive pedal that can rival many of the best boutique pedals simply by changing the circuitry a little. While this may seem hard, technical, and out of reach, it really is very simple if you know **what** to change and **where** to change it. I hope that I've given you the knowledge and courage necessary to change your pedal from a mouse into a monster. Happy soldering!

You can get resistors, capacitors, and all the parts you need for this type of project right here:

http://www.smallbearelec.com/home.html

Written by Brian Wampler. Brian Wampler is an author, effects designer/builder and operates IndyGuitarist.com and Wamplerpedals.com. His books include How to Build Effect Pedals, How to Modify Effect Pedals, and Advanced DIY Effect Pedals available at ***http://www.guitartone.net/*** ***.***