

Project 3

Build a Booster, Buffer, or Booster/Buffer

v01, 11.15.11

Introducing Project #3

This booster/buffer project is a bit more utilitarian than our previous efforts, but you'll end up with a great guitar tool. You'll also learn more about building switchable options into your projects, including our previous distortion and fuzz projects.

This project is actually two circuits in one: a simple but great-sounding clean boost, and an equally simple buffer circuit. In the pedal shown here, the knob controls the boost volume, and the switch turns the buffer on and off. But you could also build just the buffer, or just the booster.

If you've made pedals before, this project should be a breeze. If you haven't, I recommend starting with DIY Project #1, which explains basic theory and building techniques.



Question: What's a buffer?

Answer: The most *boring* circuit in the universe!

In fact, the only thing more boring than a buffer is listening to nerds argue about whether it's better to have a buffer on your pedalboard, or to simply use all true-bypass pedals.

I've studied the issue for ~~15 minutes or so till I fell asleep~~ extensively, so I'll cut to the chase:

1. Sometimes playing through a bunch of pedals and cables makes your tone lose high end, even if you're using only true-bypass pedals. A buffer fixes this.
2. However, a buffer can ruin the tone of some effects, especially Fuzz Face-style circuits. A formerly fat fuzz can become thin and weak.
3. Many stompboxes already have buffers—most Boss pedals, Tube Screamers, even boutique stuff like Klon Centaurs.

Much of the buffer debate stems from [this article](#) by Pete Cornish, effect builder to British rock royalty. Technically speaking, he's right. Practically speaking, well, it's not quite so clear.

Here's what *my* ears tell me: Adding a buffer at the beginning or end of your effects chain adds a little extra sparkle and presence—except when it doesn't. The more retro/vintage/primitive/gonzo your gear is, the more a buffer is likely to help.

Two solutions to the buffer debate:

1. Go online and read a bunch of boring articles.
2. Build a switchable buffer and let your ears decide.

I recommend option #2.

(If you *really* want a technical explanation, read [this article](#) from geofx.com or [this one](#) from muzique.com.)

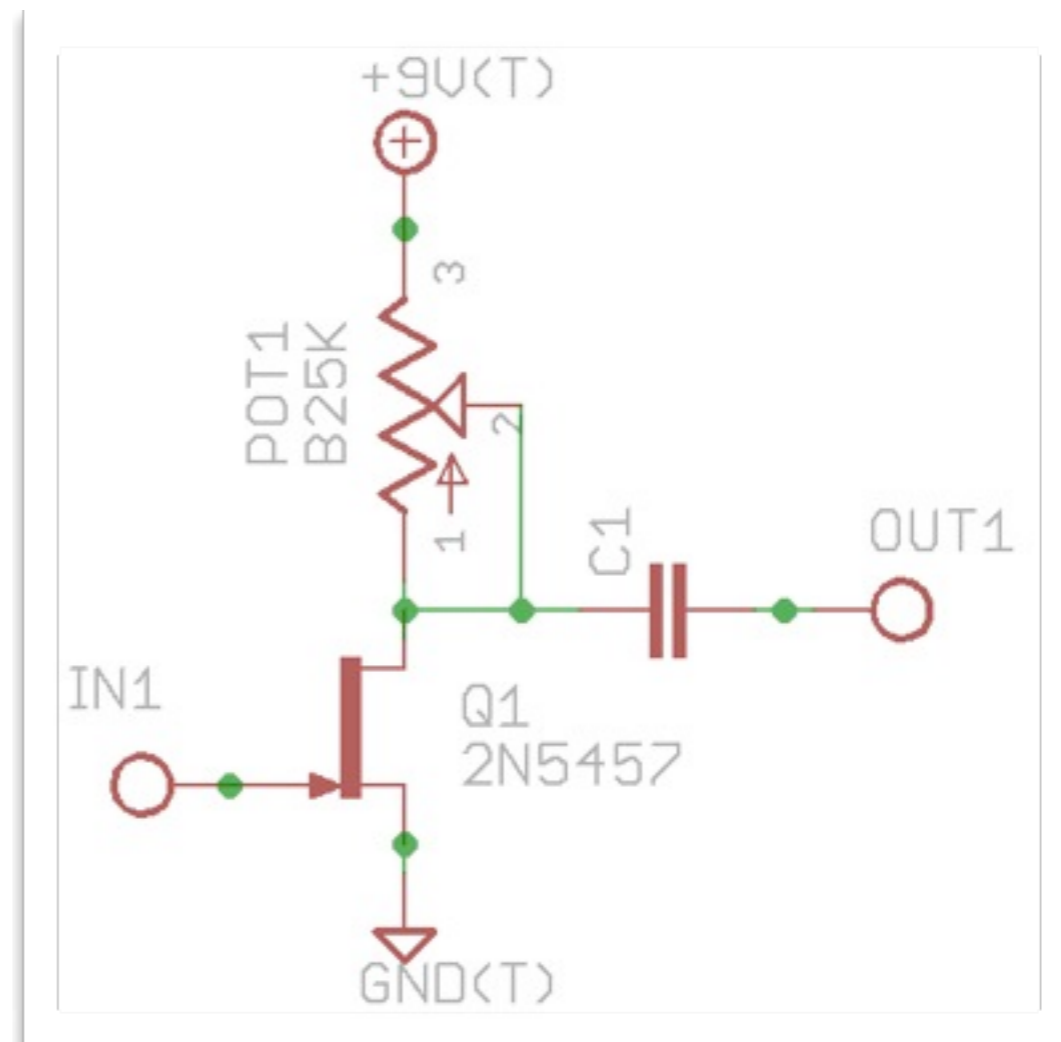
Part I: The Booster Circuit

It doesn't get much simpler than this! A pot, a transistor, and a cap.

But you may notice that the transistor symbol is slightly different than in previous projects. That's because the transistor in question is not a bipolar junction transistor (BJT) like we used in projects 1 and 2, but a junction field-effect transistor (JFET). (Technical explanation [here](#).)

JFETs are great for clean boosts like this one. They're also used in most of those amp-in-a-box pedals, which claim to imitate Marshalls, Voxes, Fenders, etc. Most of those boxes simply replicate the schematic of the amp in question, but use JFETs as stand-ins for vacuum tubes. They don't sound exactly like the amps they mimic, but they can definitely yield nice distortion tones.

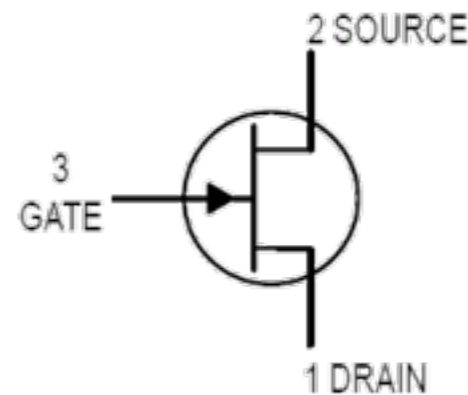
But JFETs have a few quirks ...



Working with JFETs



BJT (2N5088, 2N3904, etc.)

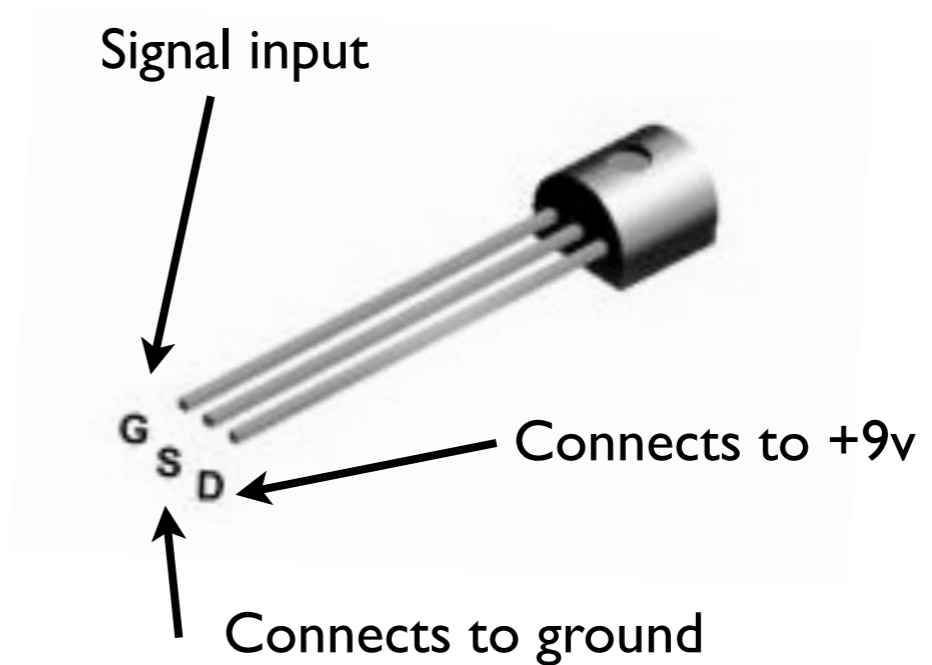


JFET (2N5457, J201, etc.)

It's not just the schematic symbol that's different: the three pins also have different names! The one that connects to the power bus is called the source (not the collector). The one that connects to ground is called the drain (not the emitter). And the one where your signal enters is called the gate (not the base).

But wait, there's more!

Also, the pinout of the two most commonly used JFETs, the 2N5457 and J201, differs from that of the previously used transistors. (Unlike before, the *middle* pin connects to ground.)



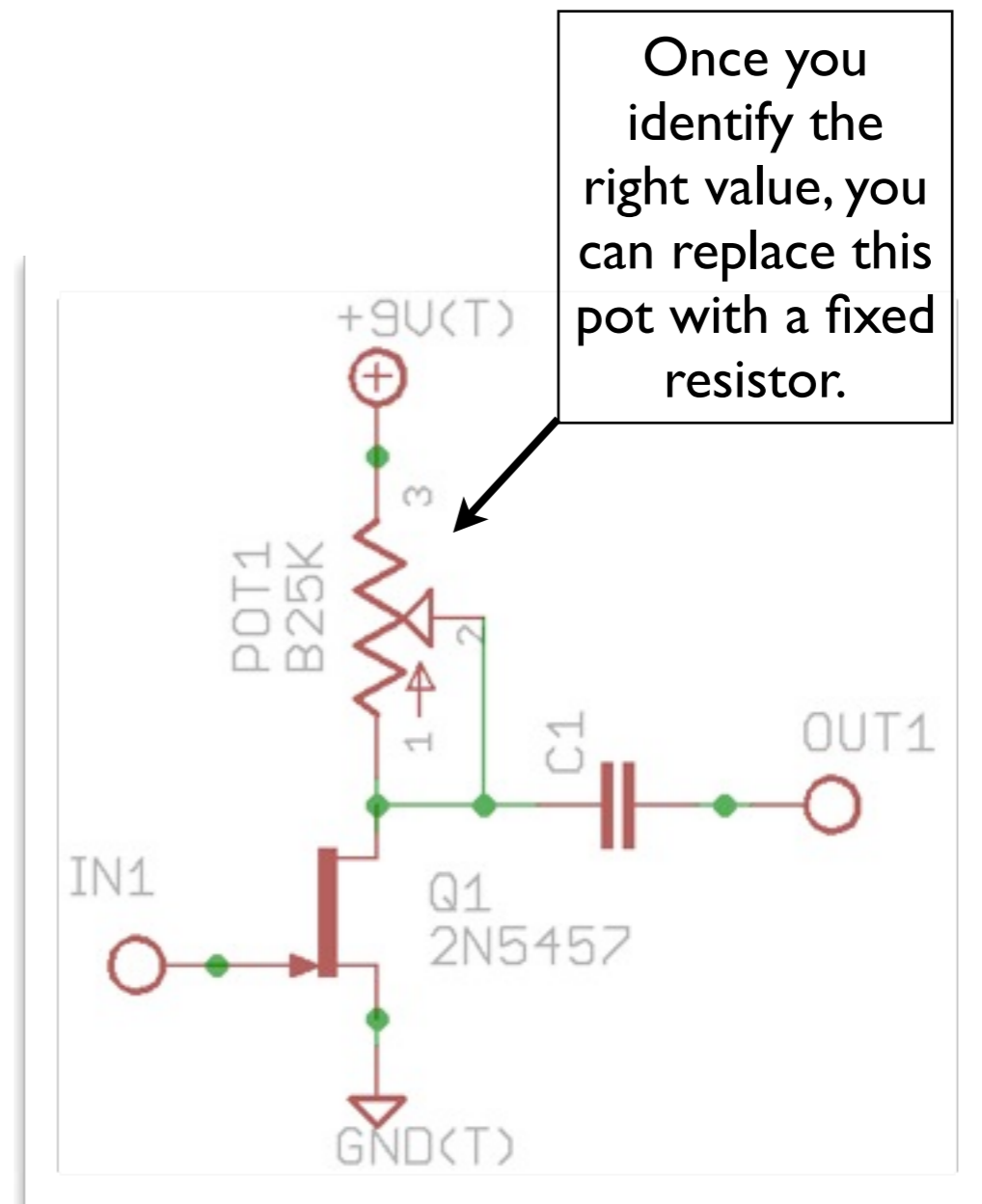
But wait, there's even MORE more!

As if that weren't enough of a headache, JFETs vary a LOT from unit to unit, so much so that you often have to "tune" the value of the resistor that connects the drain pin to the 9v bus.

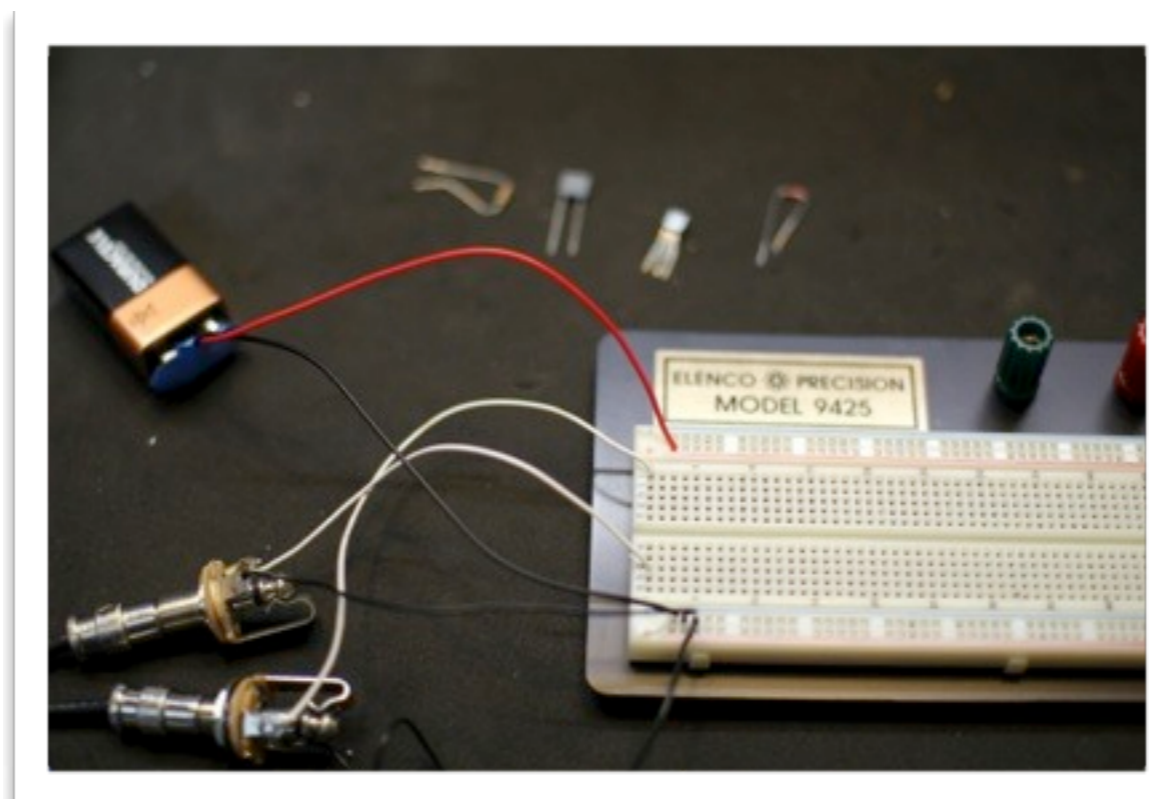
That's why the schematic uses a potentiometer (AKA "variable resistor") instead of a fixed value resistor. That means you have two options as a builder:

1. Use a small, board-mounted trimpot, and manually dial in the best tone.
2. Build the circuit on breadboard, dial in the perfect sound with a using a pot, measure the pot value with your multimeter, and use the fixed resistor of the nearest value.

We'll cover both methods.

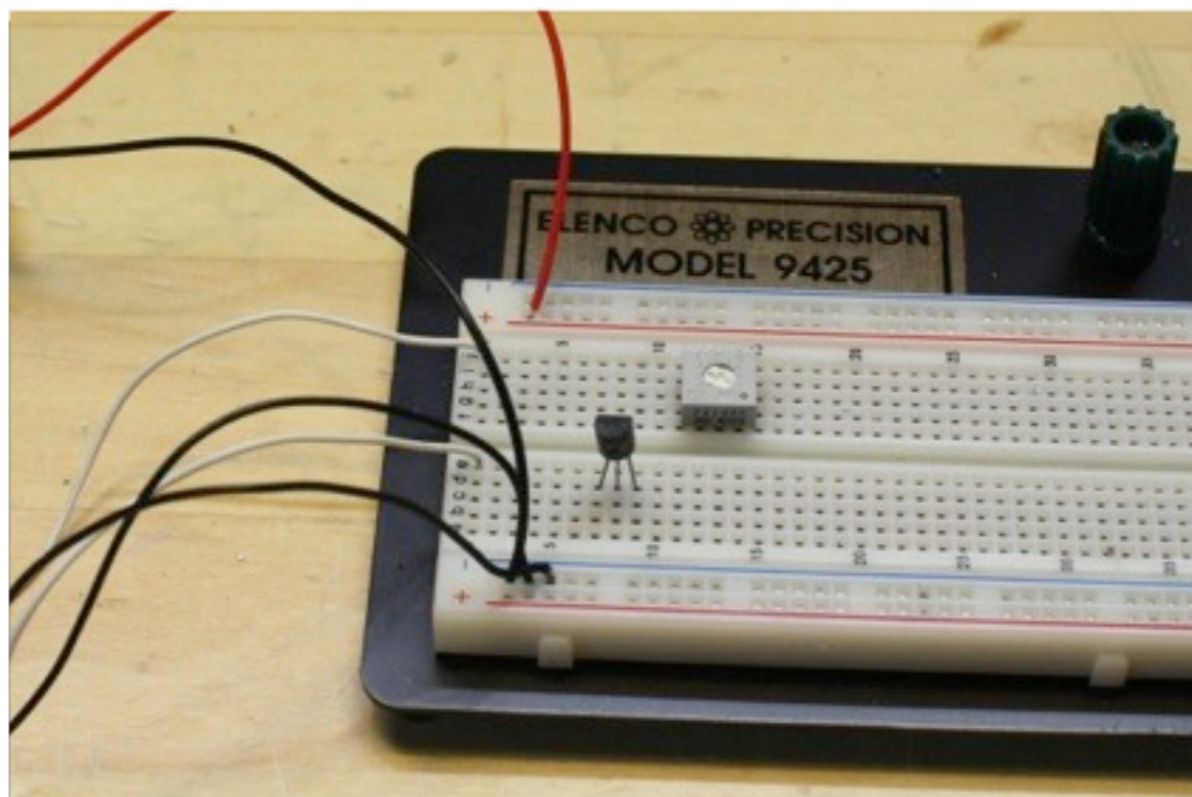


Let's breadboard it!



Connect jacks and a battery to your breadboard, as detailed in Project #1.

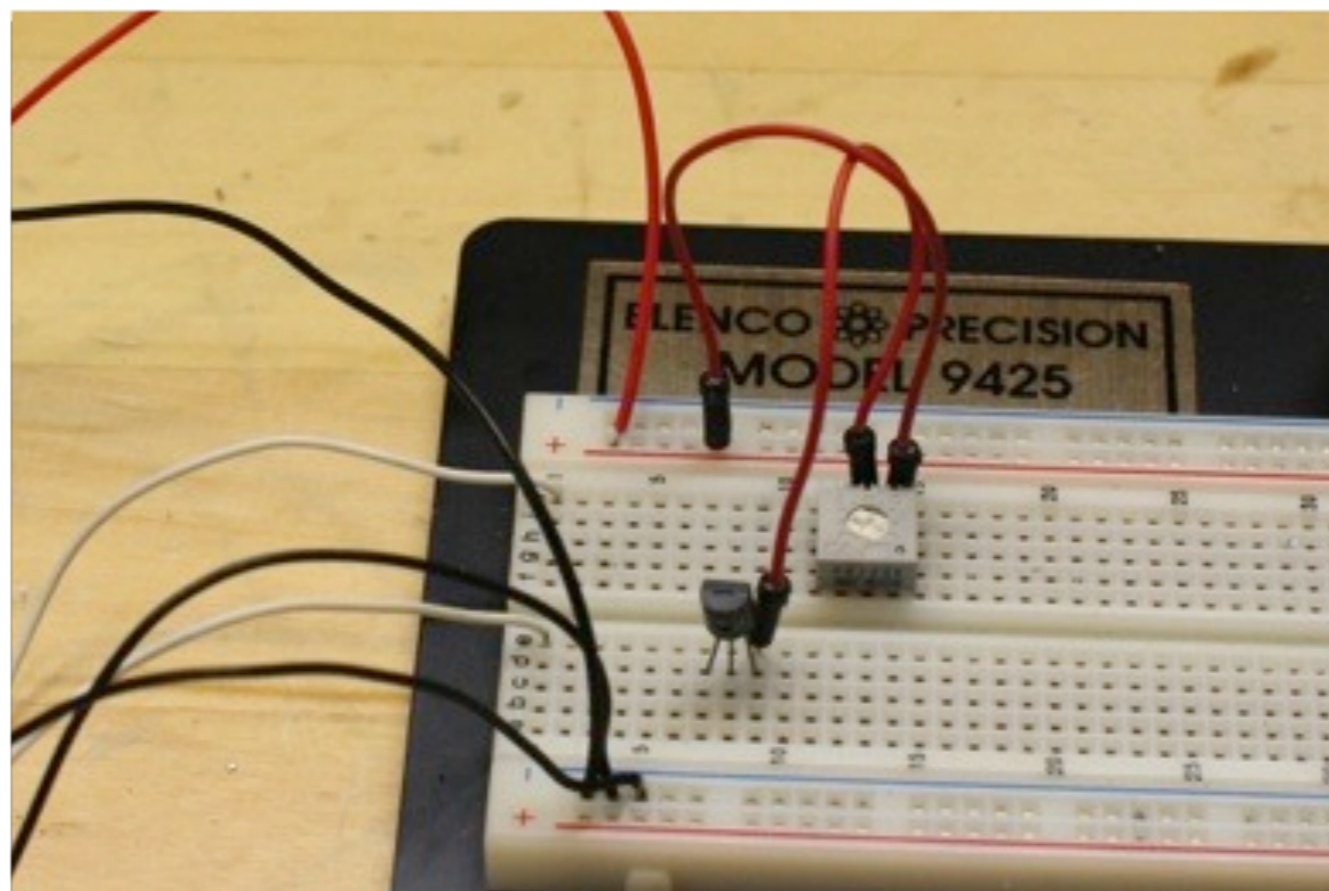
Connect the JFET



Place the JFET in the breadboard, flat side facing north. Place a 25K or 50K trimpot roughly as shown.

A J201 will also sound great in this circuit. If you have both JFET types, try both and choose your fave.

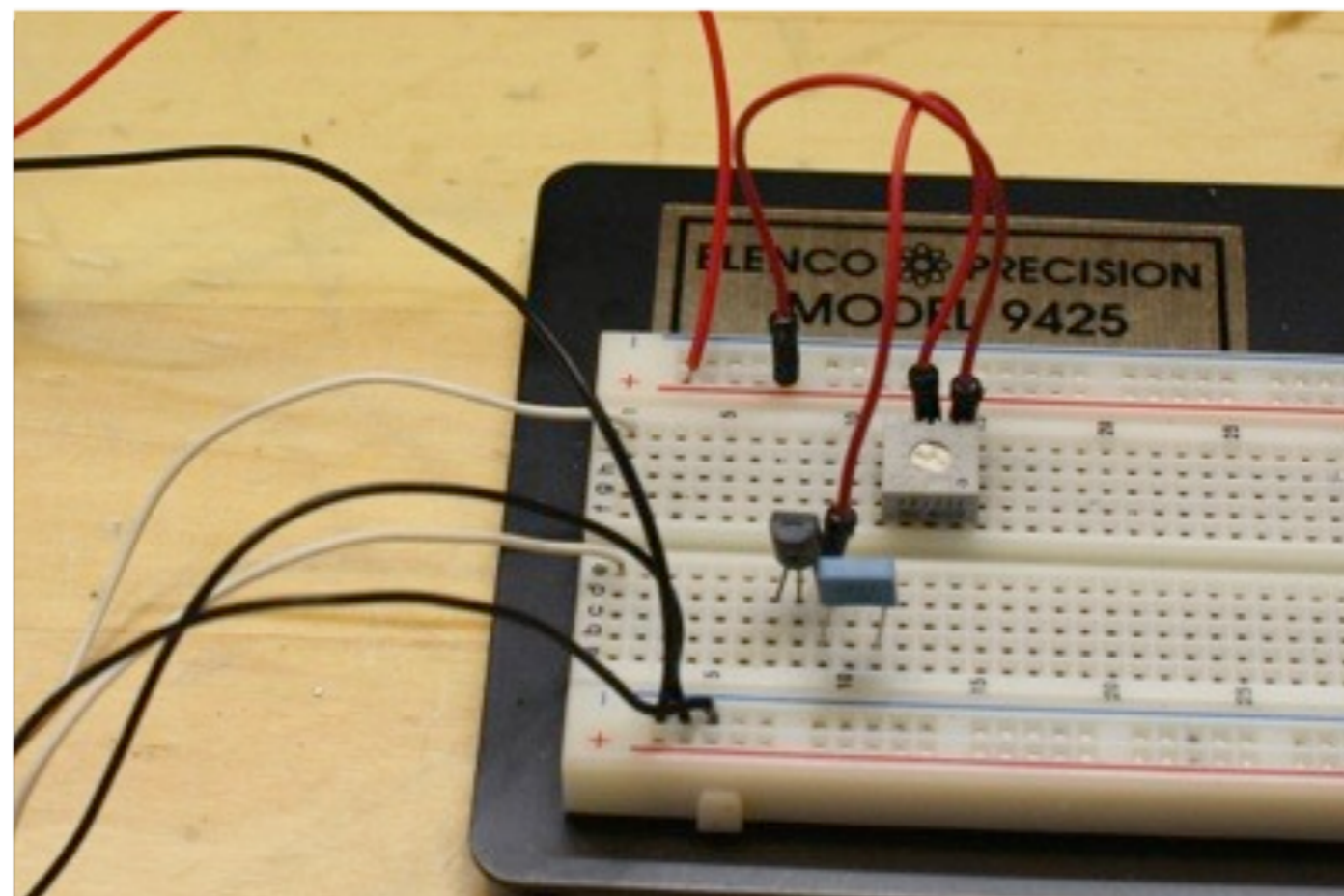
Connect to JFET to the +9v bus



Use a jumper wire to connect pin 3 of the trimpot to the +9v bus, and another to connect pin 2 of the trimpot to the JFET's drain (the rightmost pin, as oriented here.)

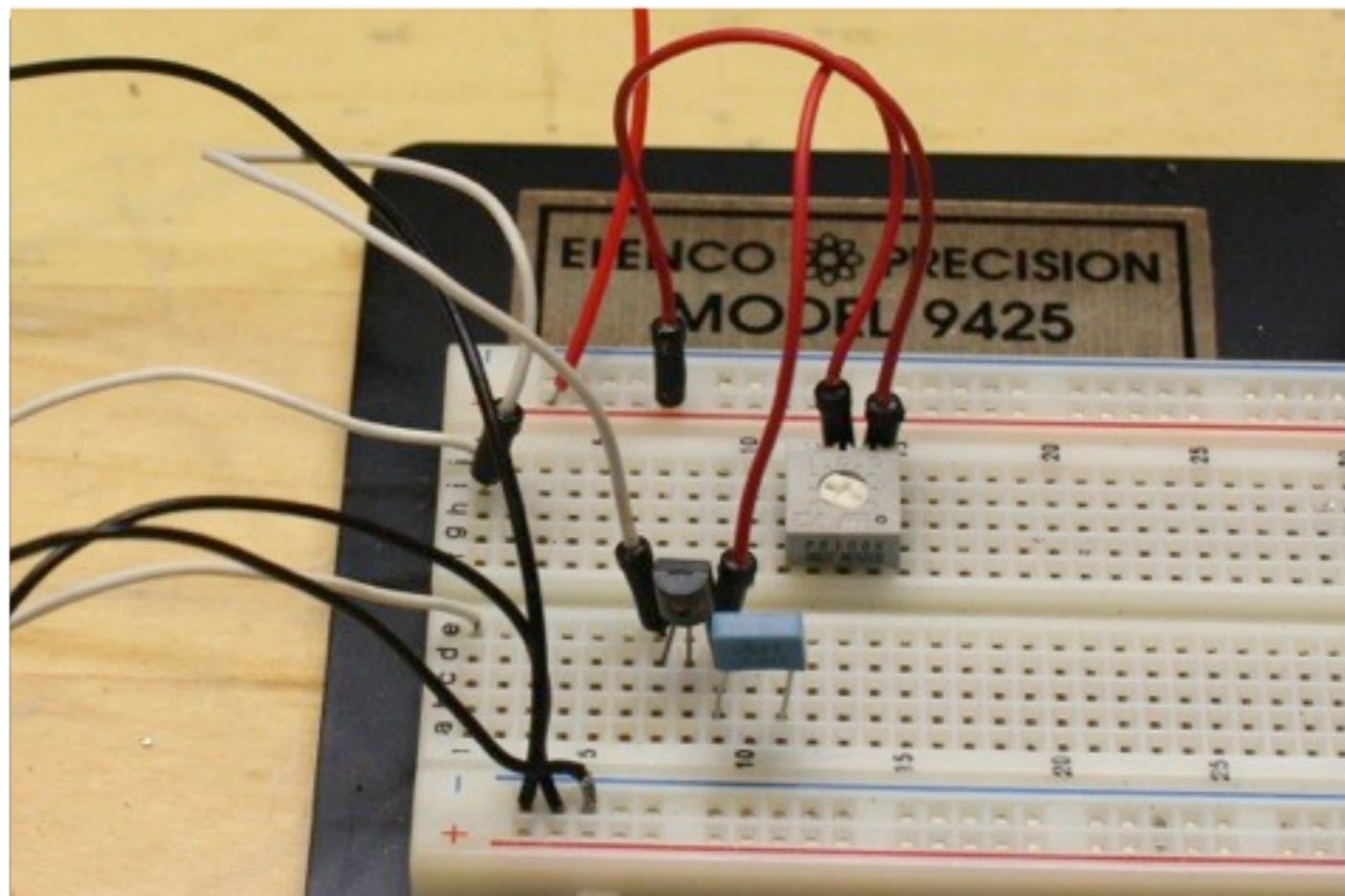
BTW, these little trimpots work exactly like larger pots.

Add the capacitor



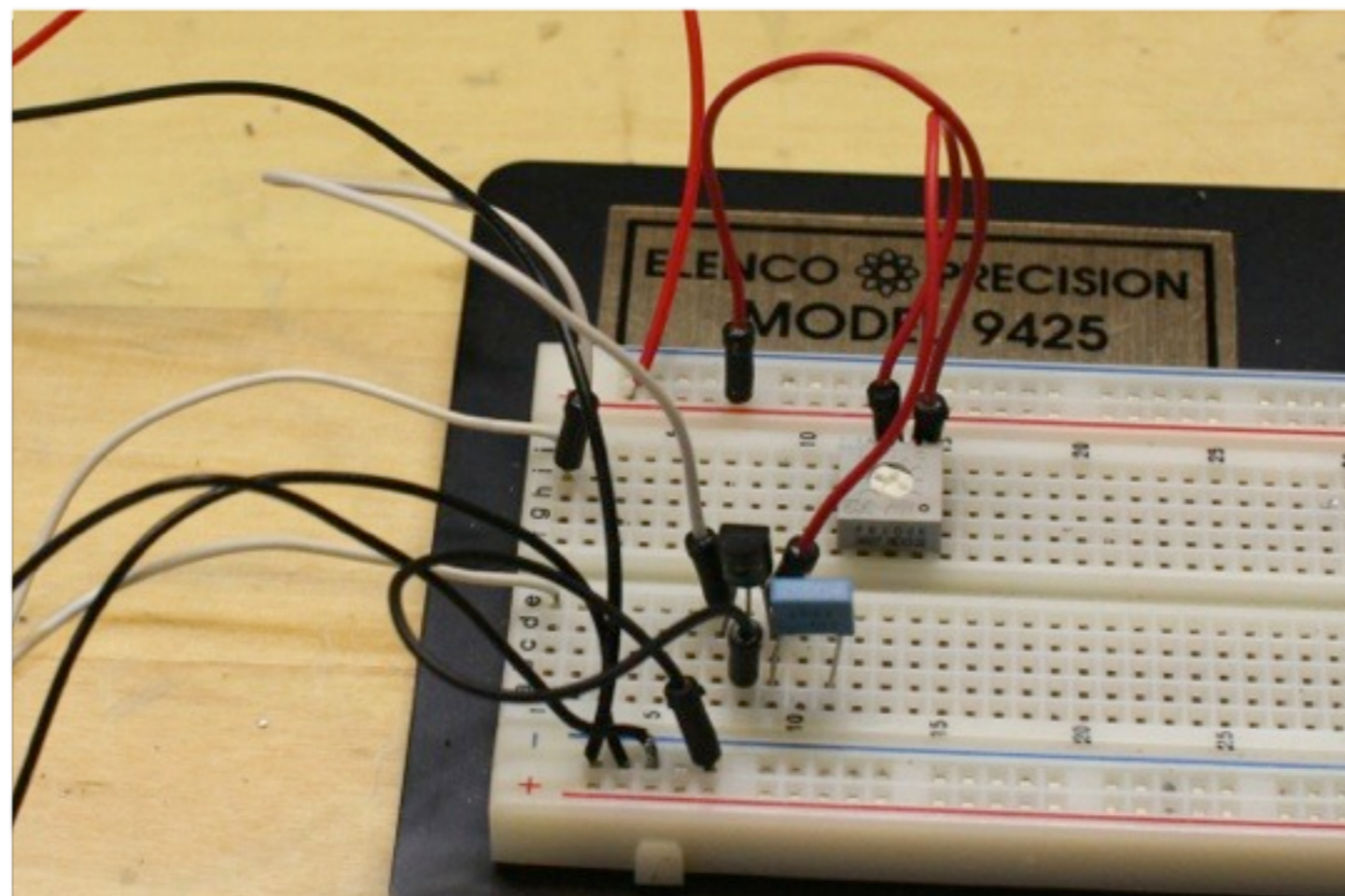
Position a .1uF capacitor so that one leg is connected to the same bus as the JFET drain and jumper wire. This cap is not polarized, so it doesn't matter which leg connects to the JFET.

Connect the Input



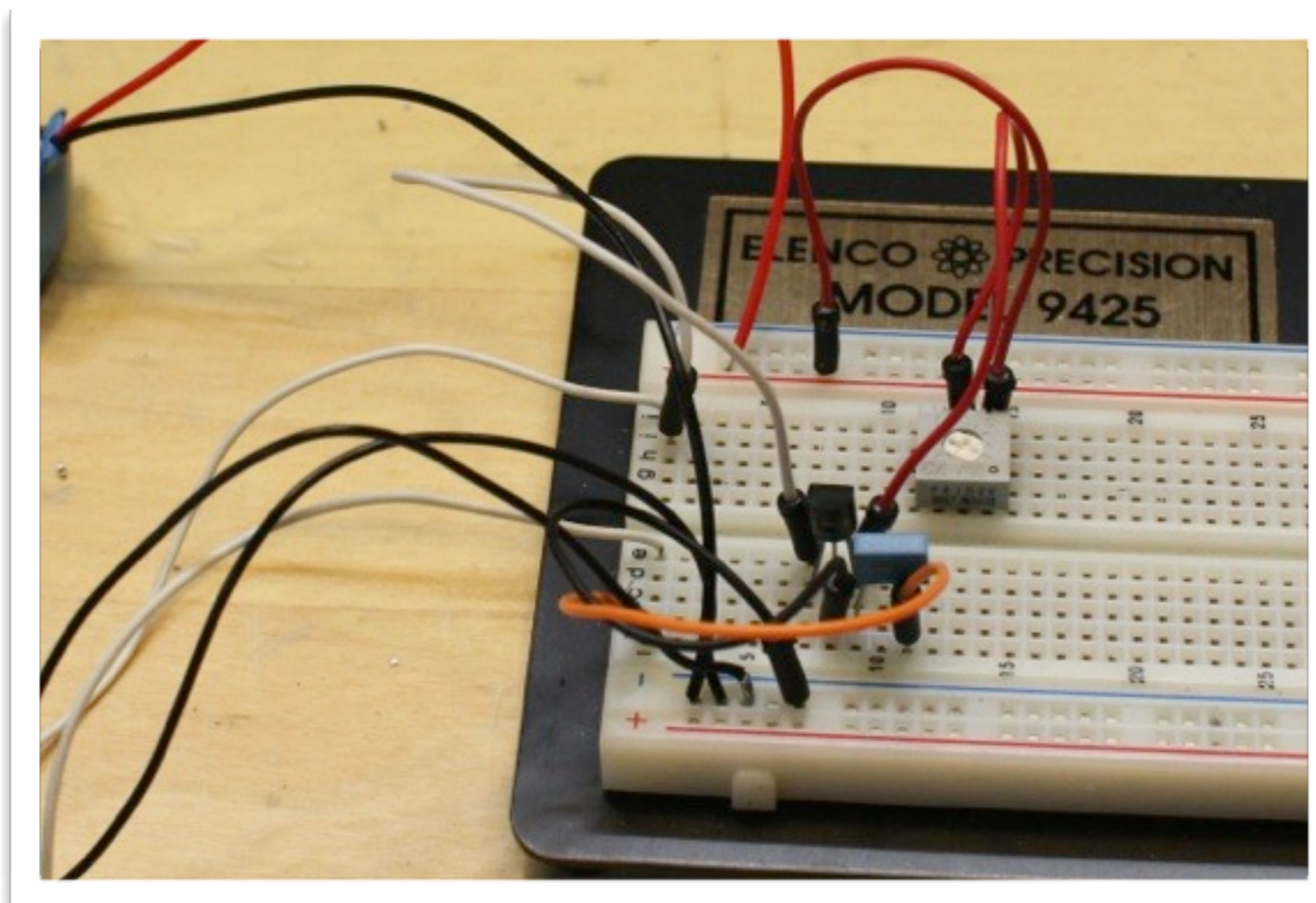
Use a jumper wire to connect your input to the JFET's gate. Note that this is the leftmost pin, as oriented here, rather than the middle pin we used for the transistors in projects 1 and 2.

Make the ground connection



Use a jumper wire to connect the JFET's source (the middle pin) to the ground bus.
(The short black wire above.)

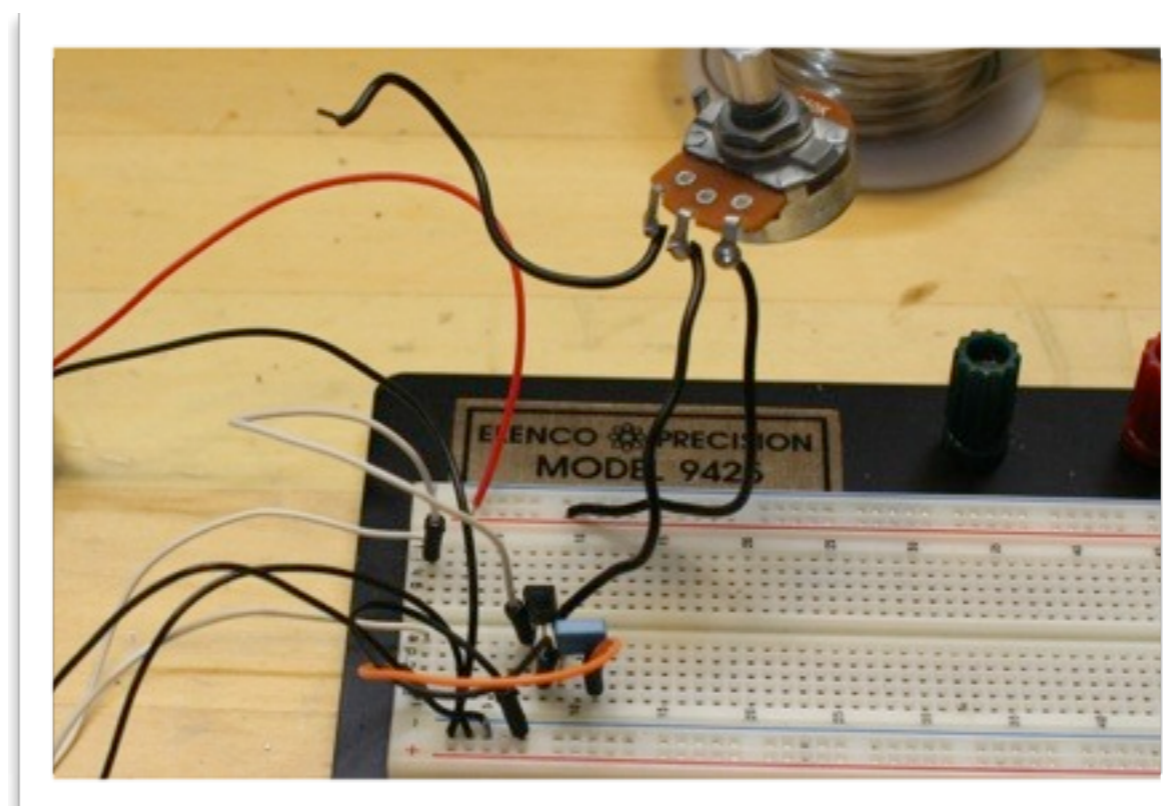
Connect the output



Connect the rightmost leg of the capacitor to your output.

You may not hear anything yet. Using a small screwdriver, slowly rotate the trimpot. You should find one “magic spot” where the signal sounds loudest and clearest.

If you don't have a trimpot (or just don't want to use one)



Connect lug 3 of a 25K or 50K pot to the +9v bus. Connect lug 2 to the JFET's drain (the rightmost pin, as oriented here). Adjust the knob till you hear the loudest, clearest tone.

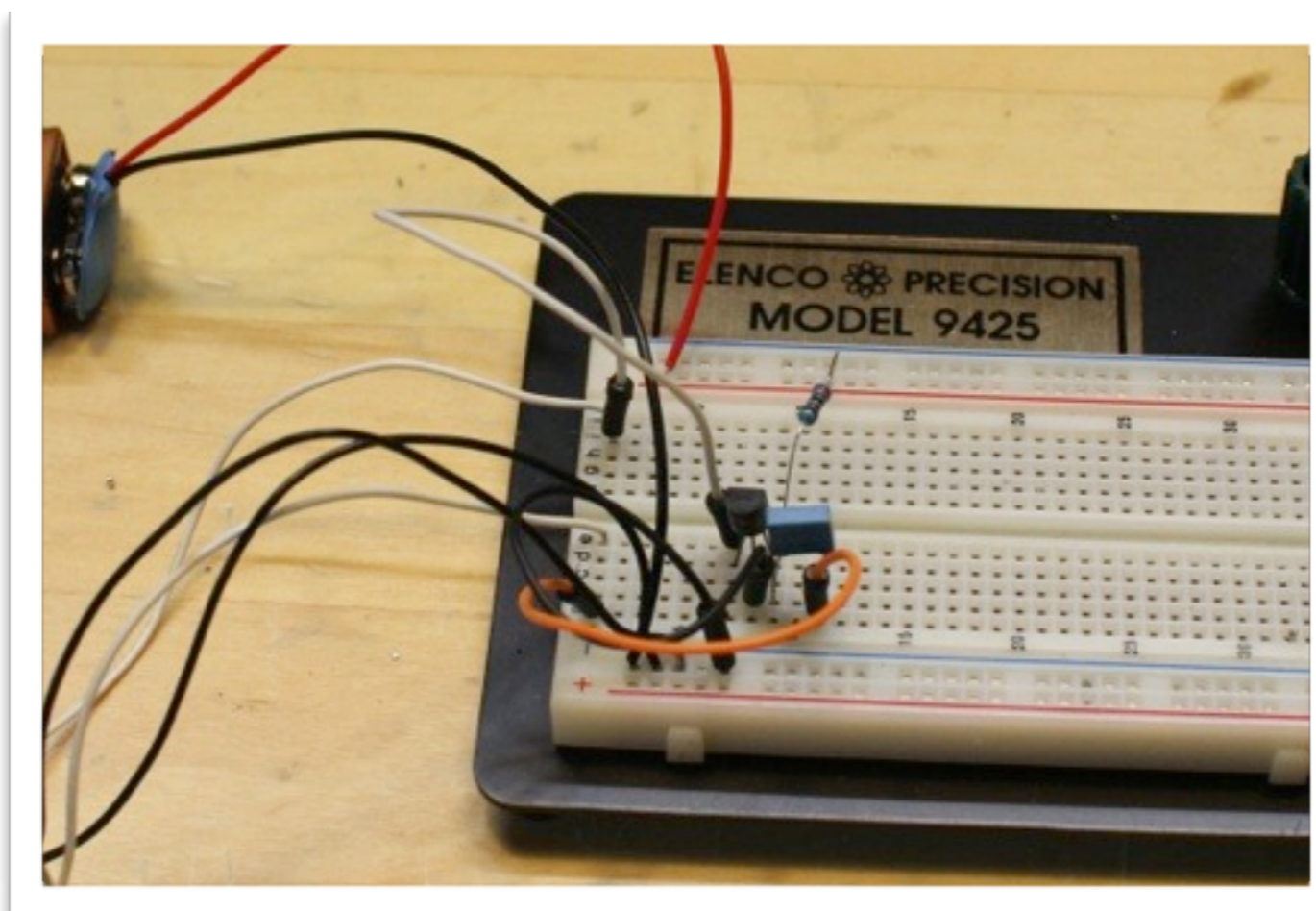
The exact pot value doesn't matter. But the larger the value, the harder it can be to dial in the perfect setting.

Measure the pot's resistance



Set your multimeter to its ohmmeter function (Ω). Measure the wires connected to lugs 3 and 2 of the pot you just set.

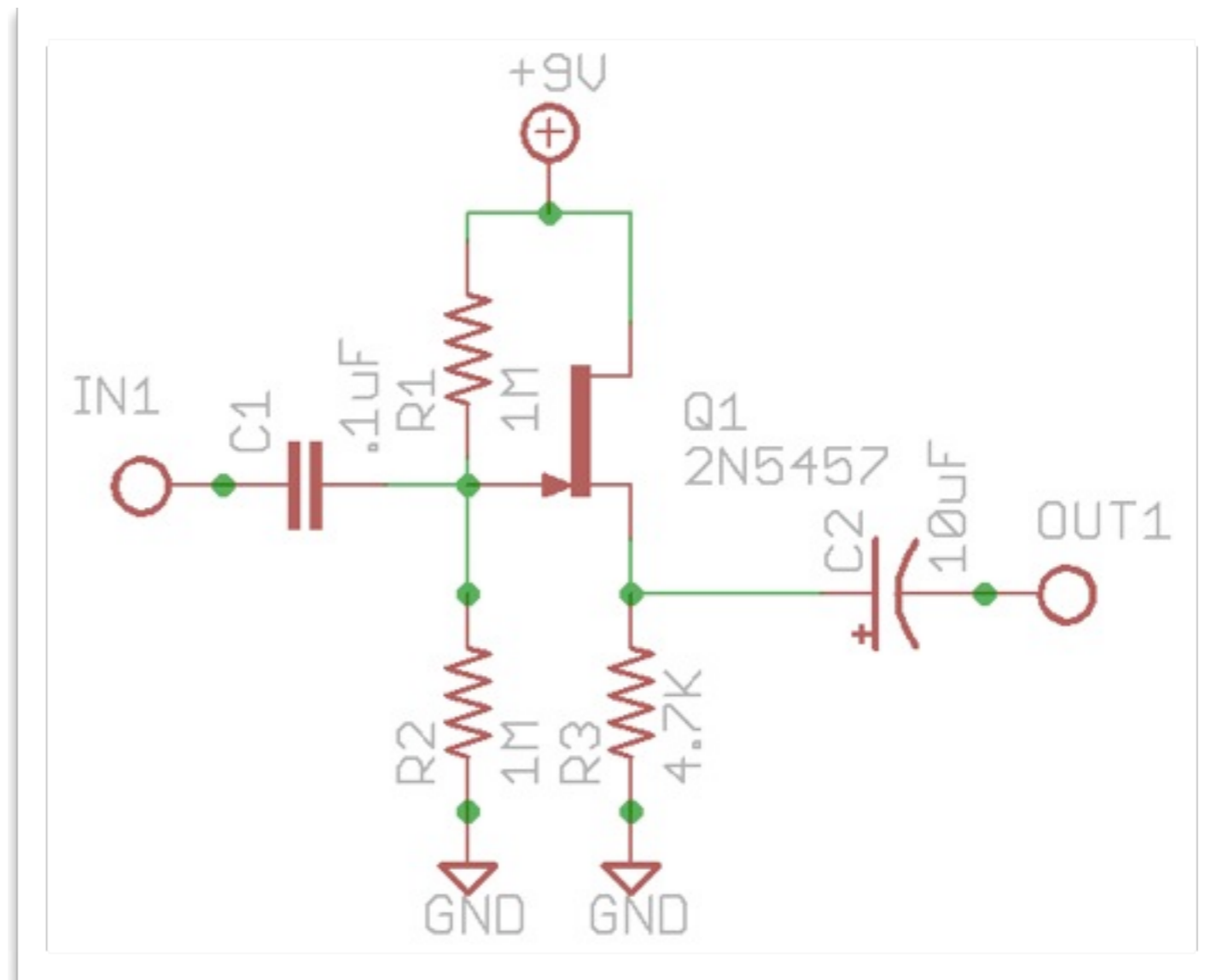
Add the appropriate resistor



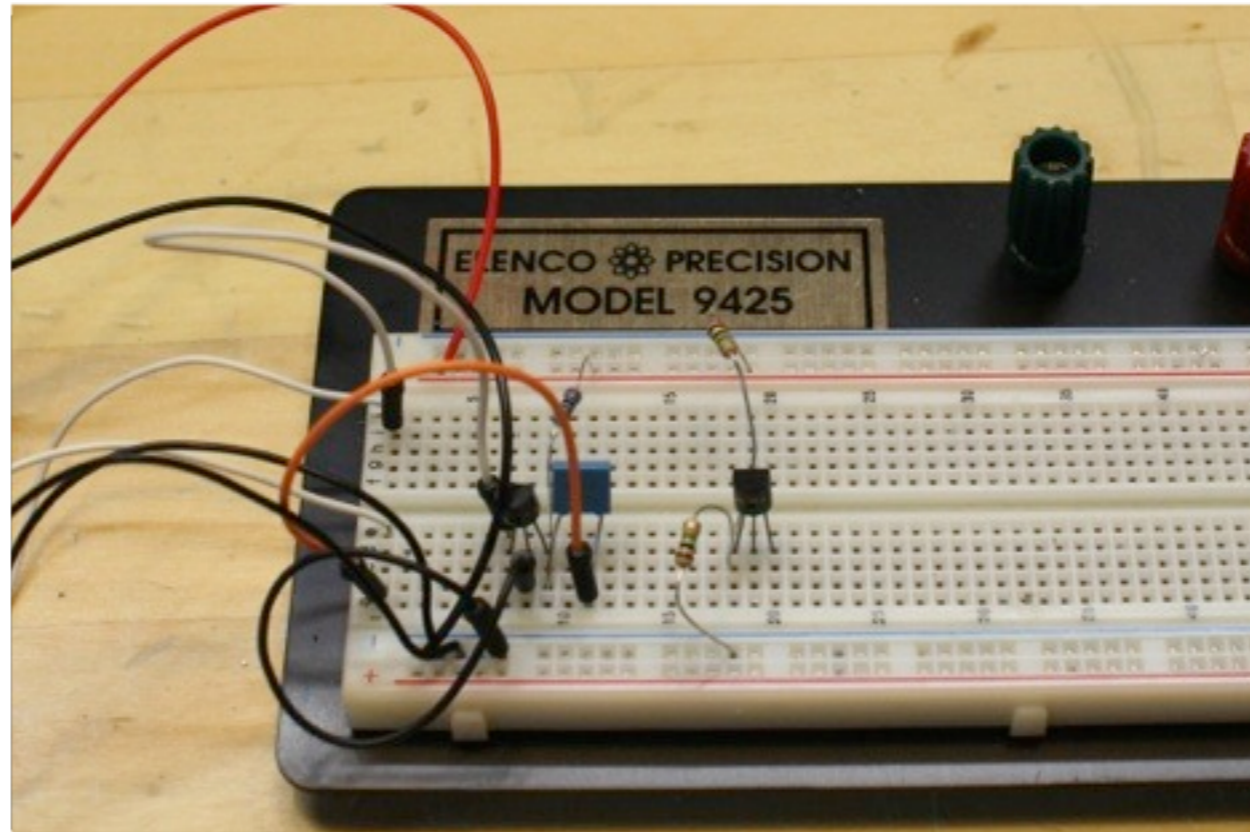
Since my meter reading was 2.21K, I placed a 2.2K resistor between the +9v bus and the JFET drain. (Your reading may vary.) Works great!

Part 2: The Buffer Circuit

This circuit is almost as simple as the booster. It too uses a single JFET.



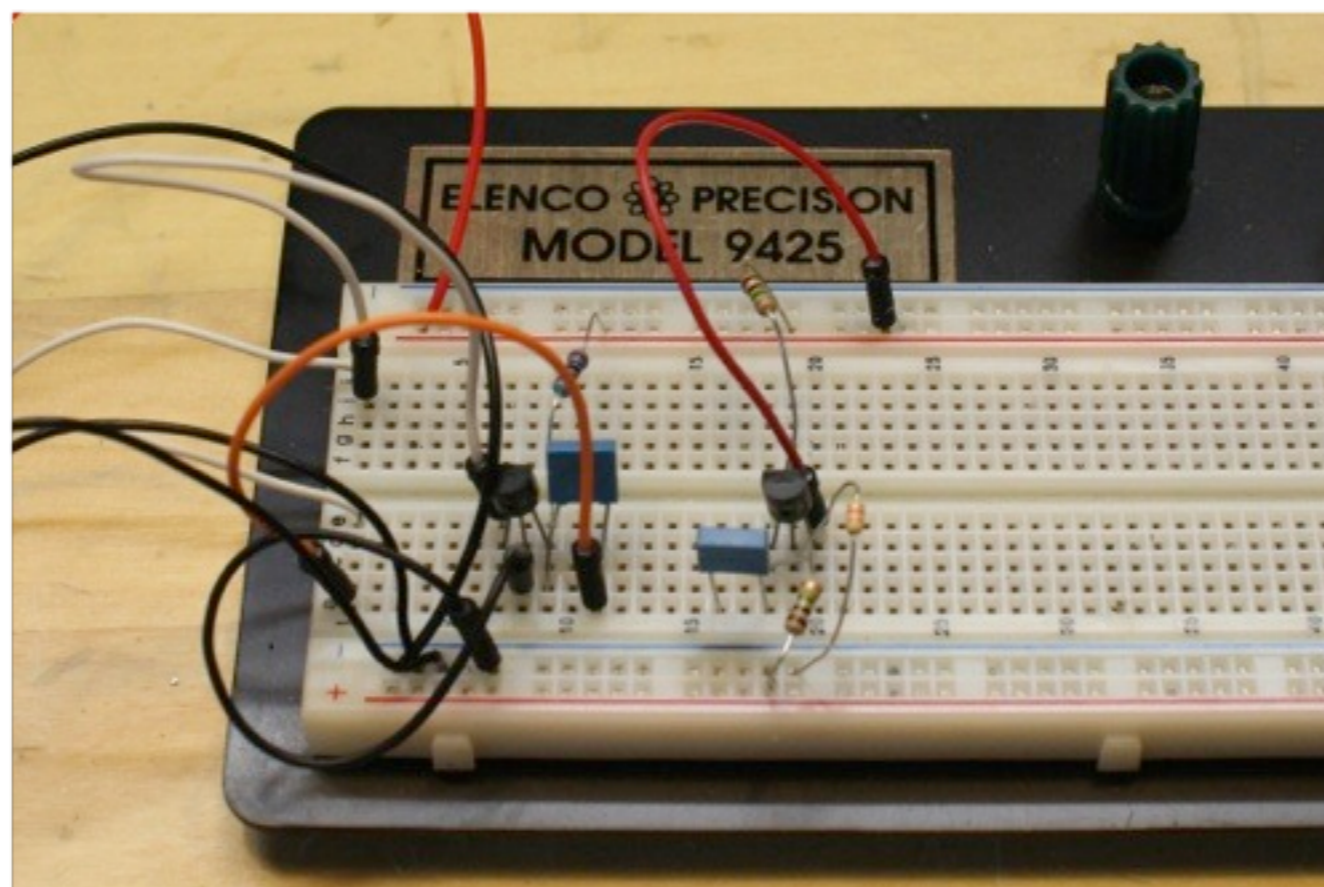
Breadboarding the Buffer



We're going to breadboard the buffer circuit alongside the booster, so we can audition the two circuits together and set up the switching.

Orient the second 2N5457 JFET (or J201) as you did the first one. Use a 1M resistor to connect the JFET's gate (leftmost pin, as oriented here) to the +9v bus. Use a second 1M resistor to connect the same pin to the ground bus.

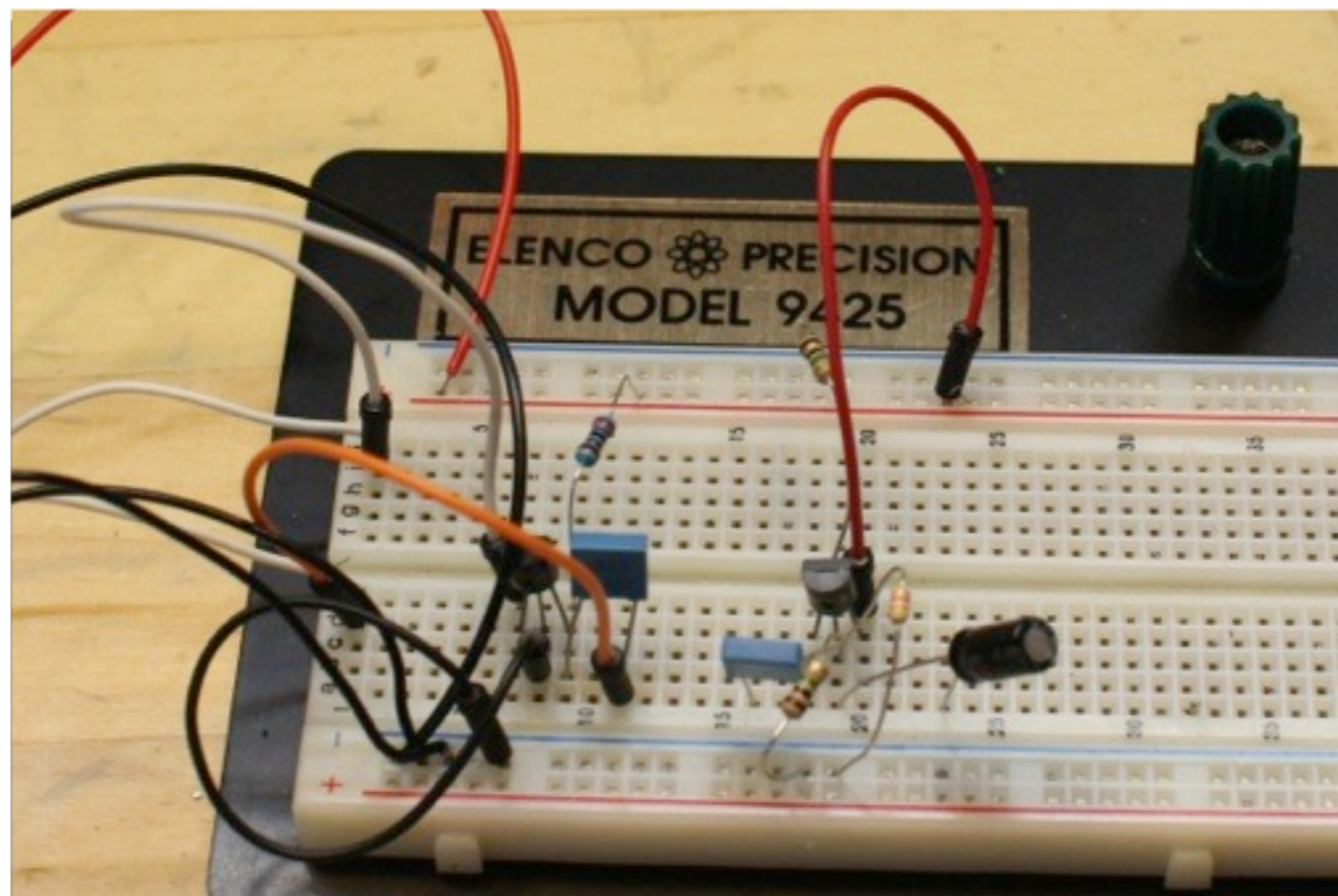
Continue the JFET connections



Use a jumper wire to connect the JFET's drain (rightmost pin as oriented here) to the +9v bus. Use a 4.7K resistor to connect the JFET's source (middle pin) to ground.

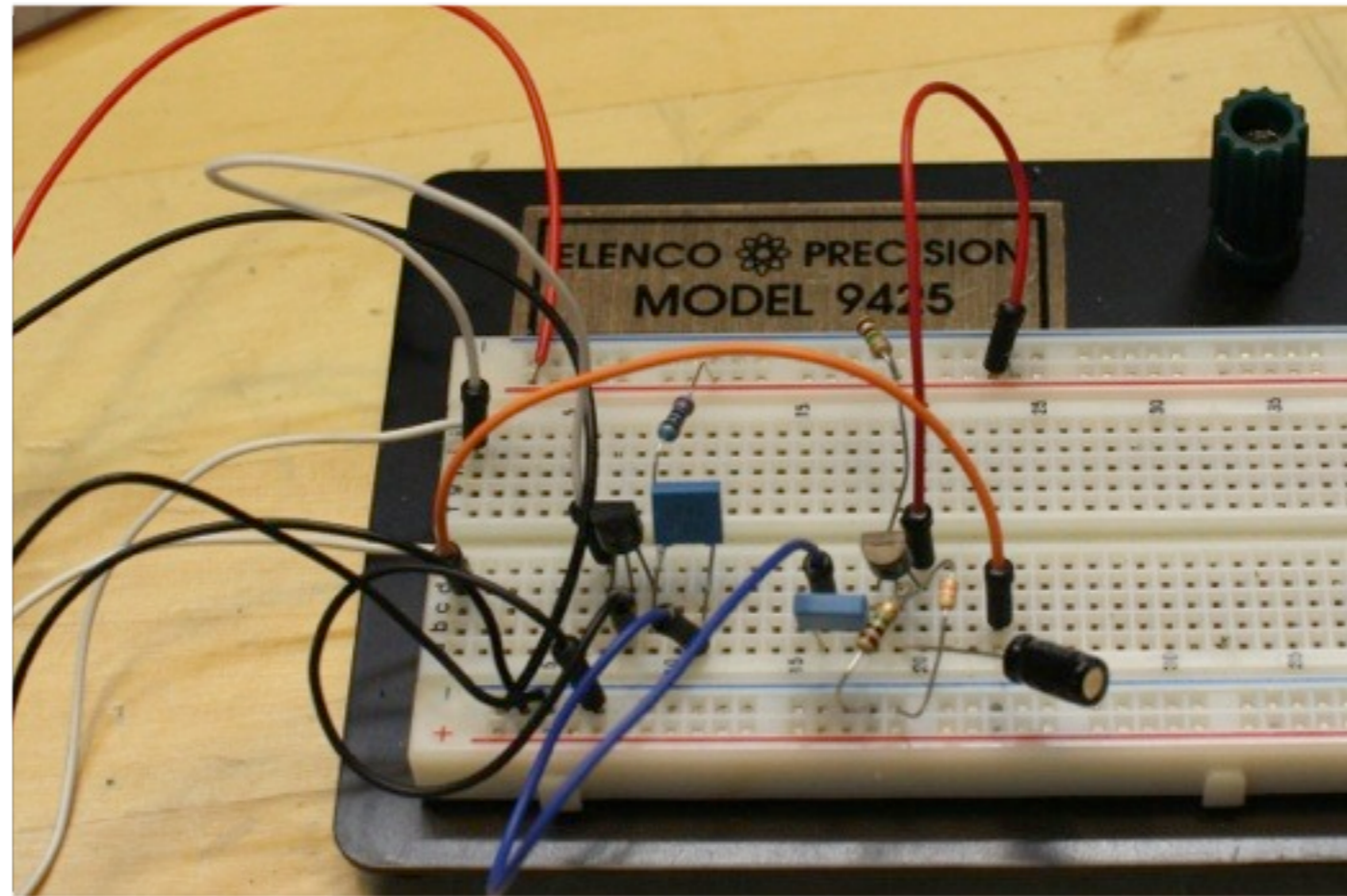
Place a .1uf capacitor so its rightmost leg connect to the JFET's gate, on the same bus where the two 1M resistors meet. Place the other leg on an empty bus.

Add the output cap



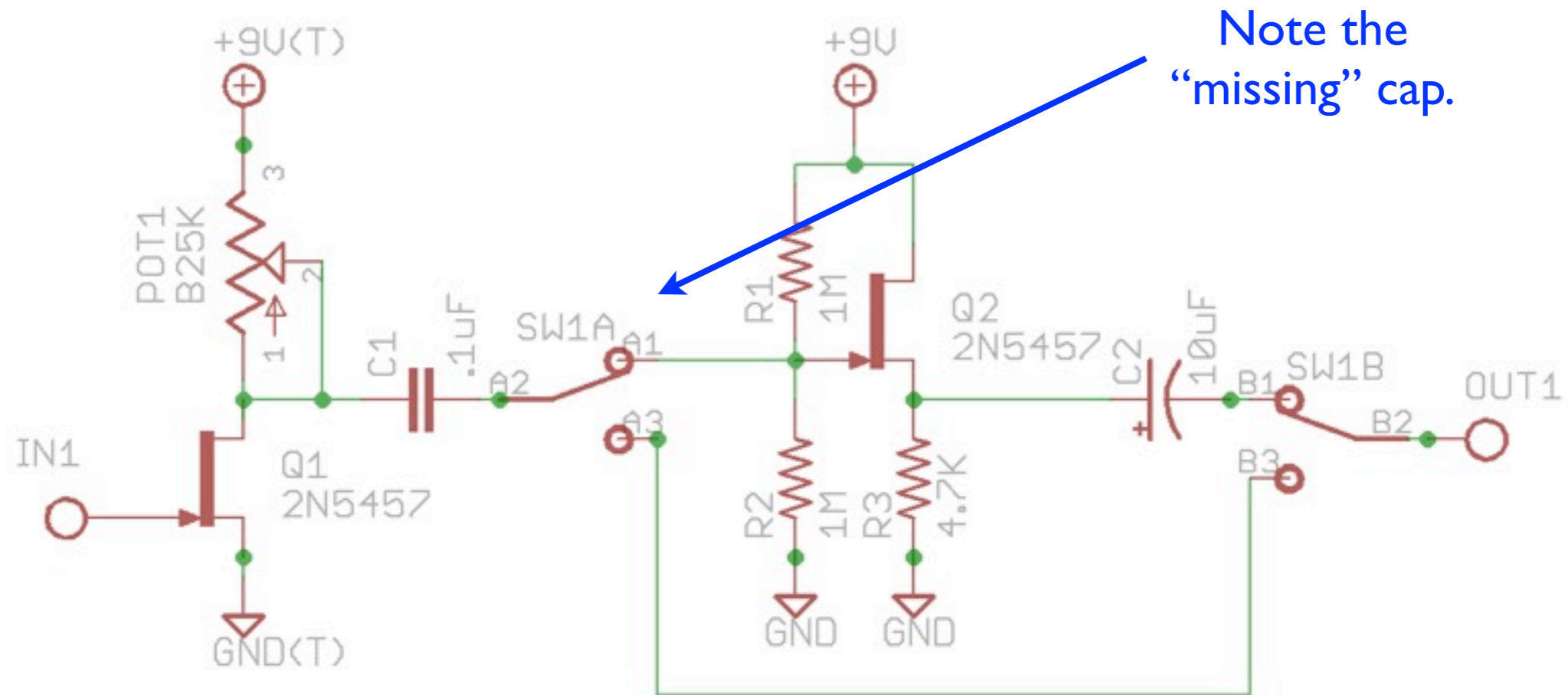
Position a 10 μ F electrolytic capacitor so its positive (longer) leg connects to the JFET's source (middle pin). Place the negative (shorter) leg on an empty bus.

Connect the two circuits.



Disconnect the jumper cable that had previously connected the booster's output cap of the output jack. Reconnect it so that one end connects to the negative leg of the 10uF cap, and the other connects to the output jack. (The orange wire above.) Connect the rightmost leg of the booster's output cap to the leftmost leg of the buffer's input cap. (The blue wire above.) You should now hear the boost effect as before. Chances are you won't yet hear any audible difference from adding the buffer. (See? I *told* you it was a boring circuit!)

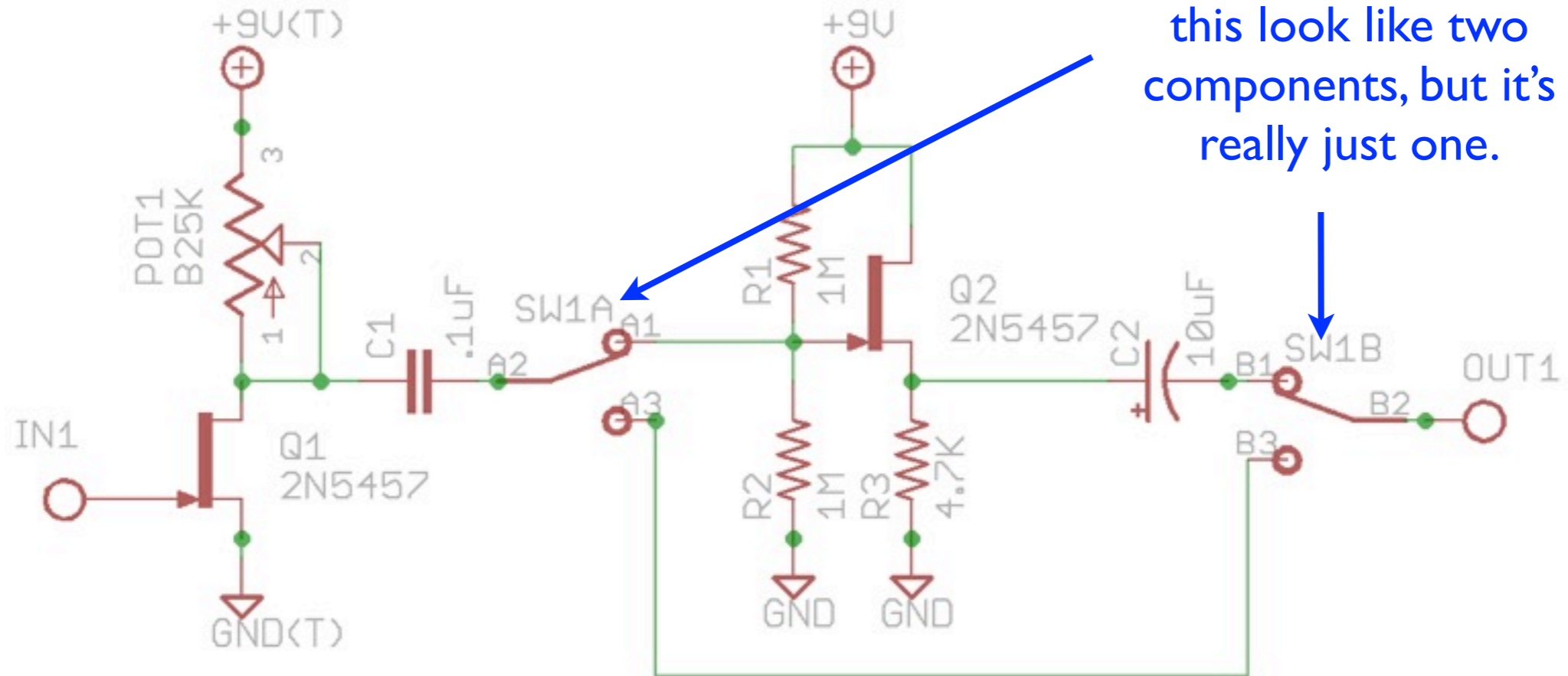
Schematic version 2



Here are the two circuits side by side. The new components (SW1A and SW1B) represent the switch we'll use to let us turn the buffer on and off. (More on this is a moment.)

Also, note that the buffer's input cap is "missing." With two effects in series, we don't need both an output cap from effect #1 and an input cap for effect #2. (But if you leave it in, it won't hurt anything.)

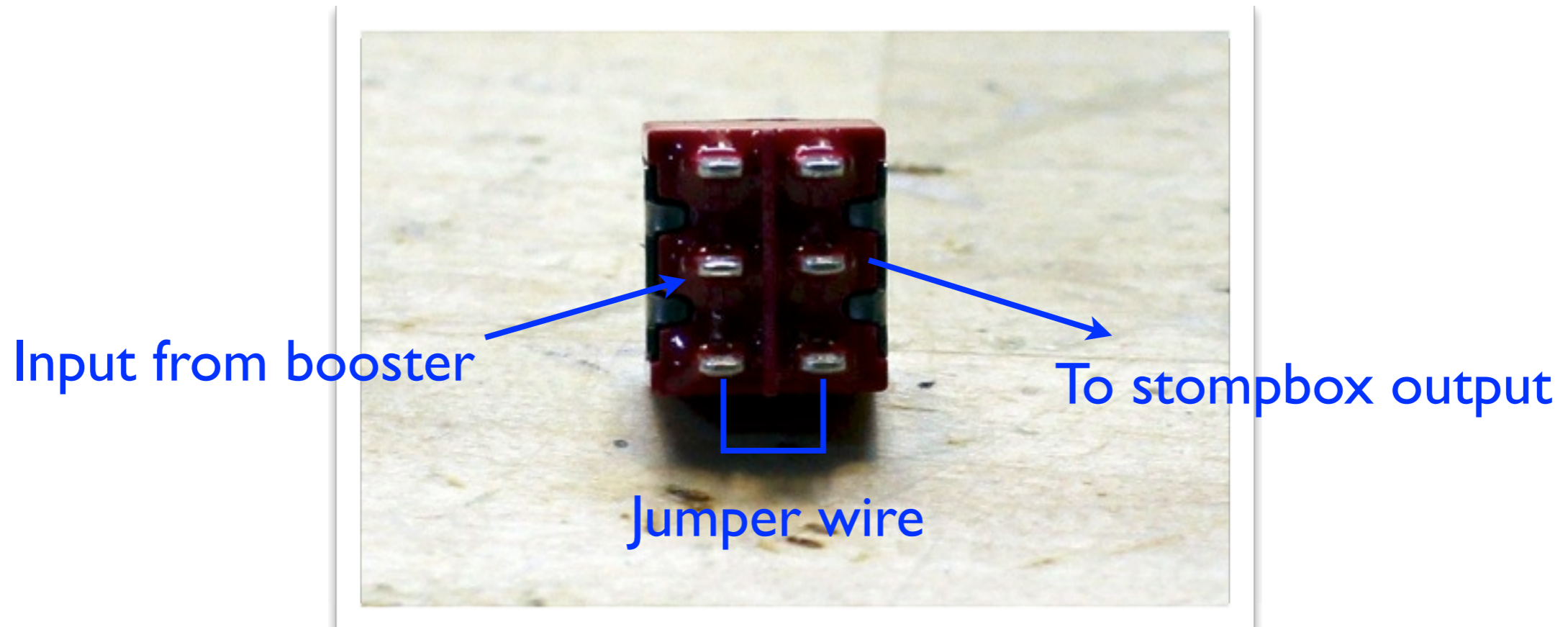
Schematic version 2



The schematic makes this look like two components, but it's really just one.

The switching is easier to visualize if you look at the actual part.

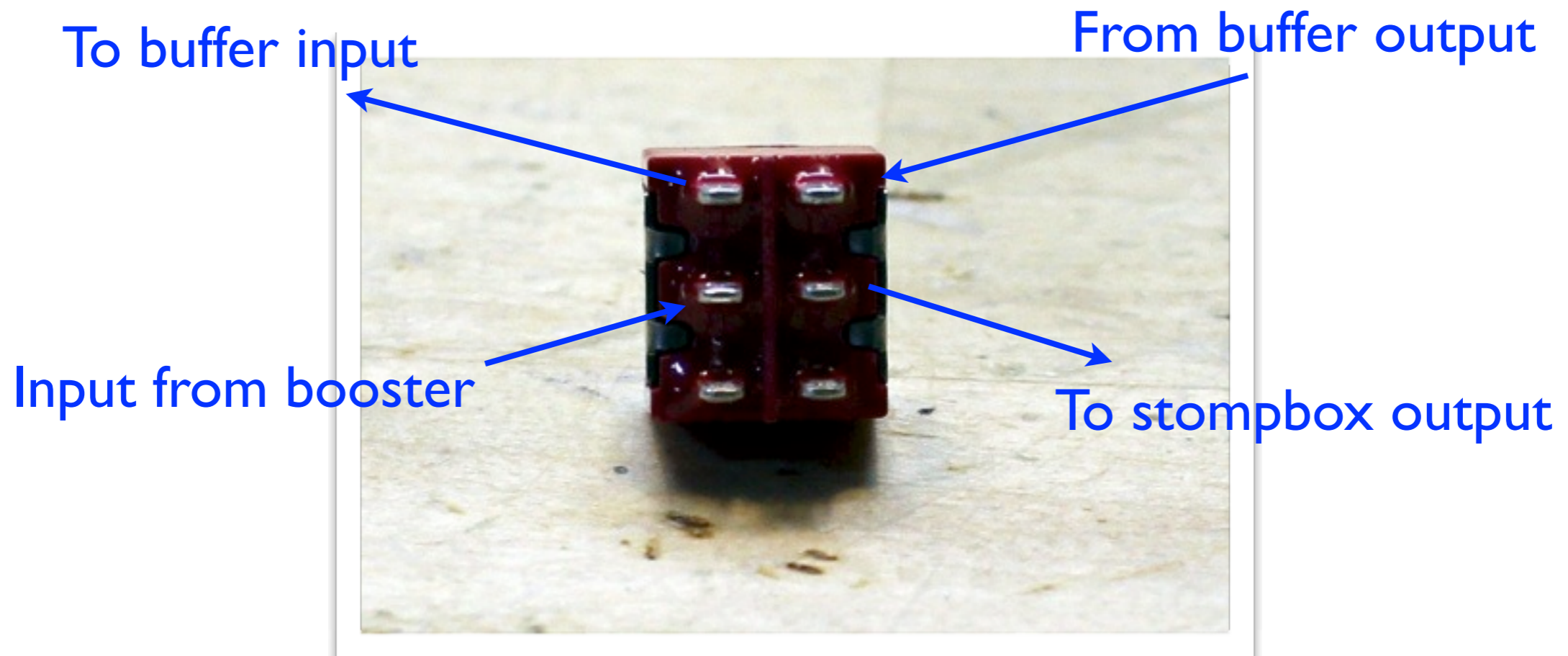
Meet the 2P2T switch



This is the underside of a 2P2T (double pole/double throw) switch. It works like the 3P2T switch we use to turn stompboxes on and off, only with—*duh*—two poles instead of three.

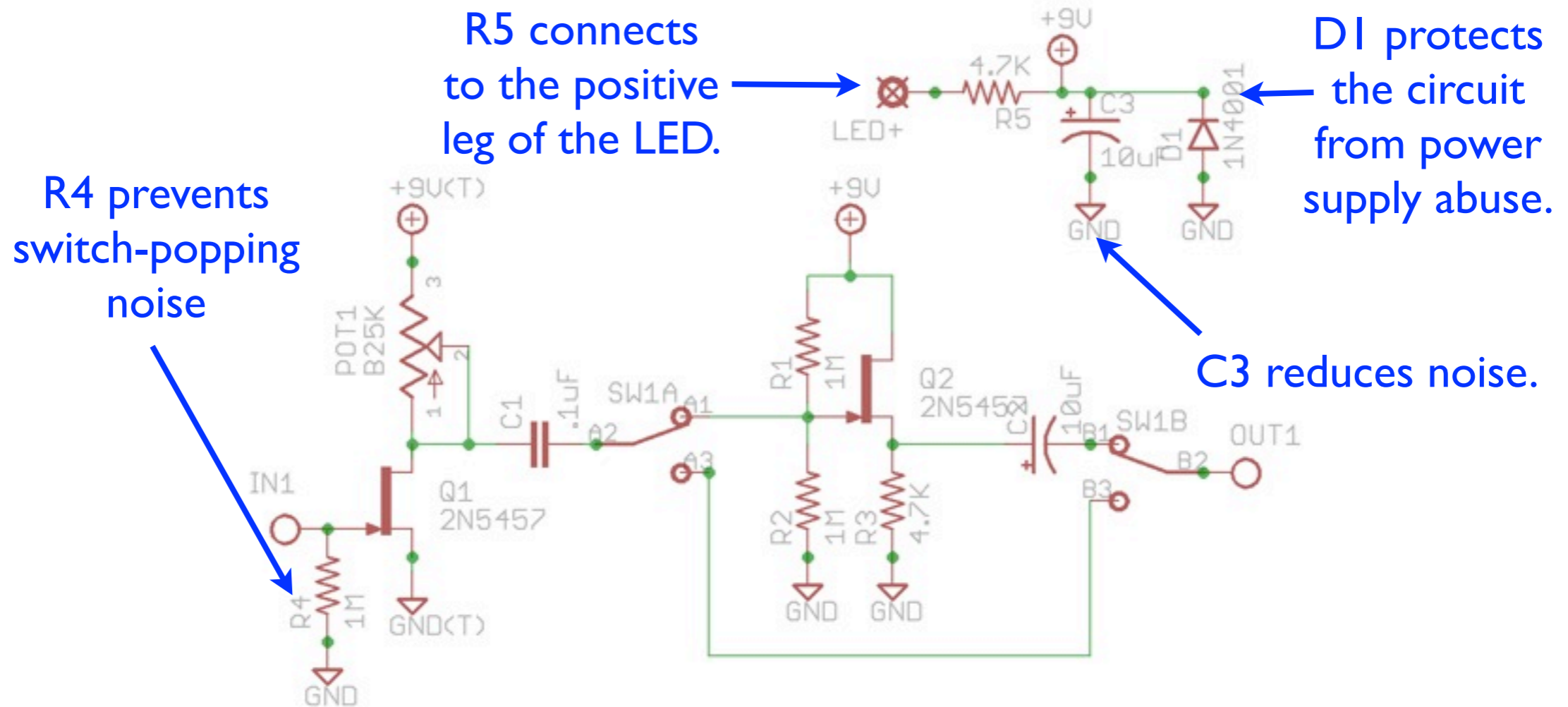
With the switch in bypassed position, the signal enters from the booster, and proceeds directly to the output via the jumper wire.

Meet the 2P2T switch



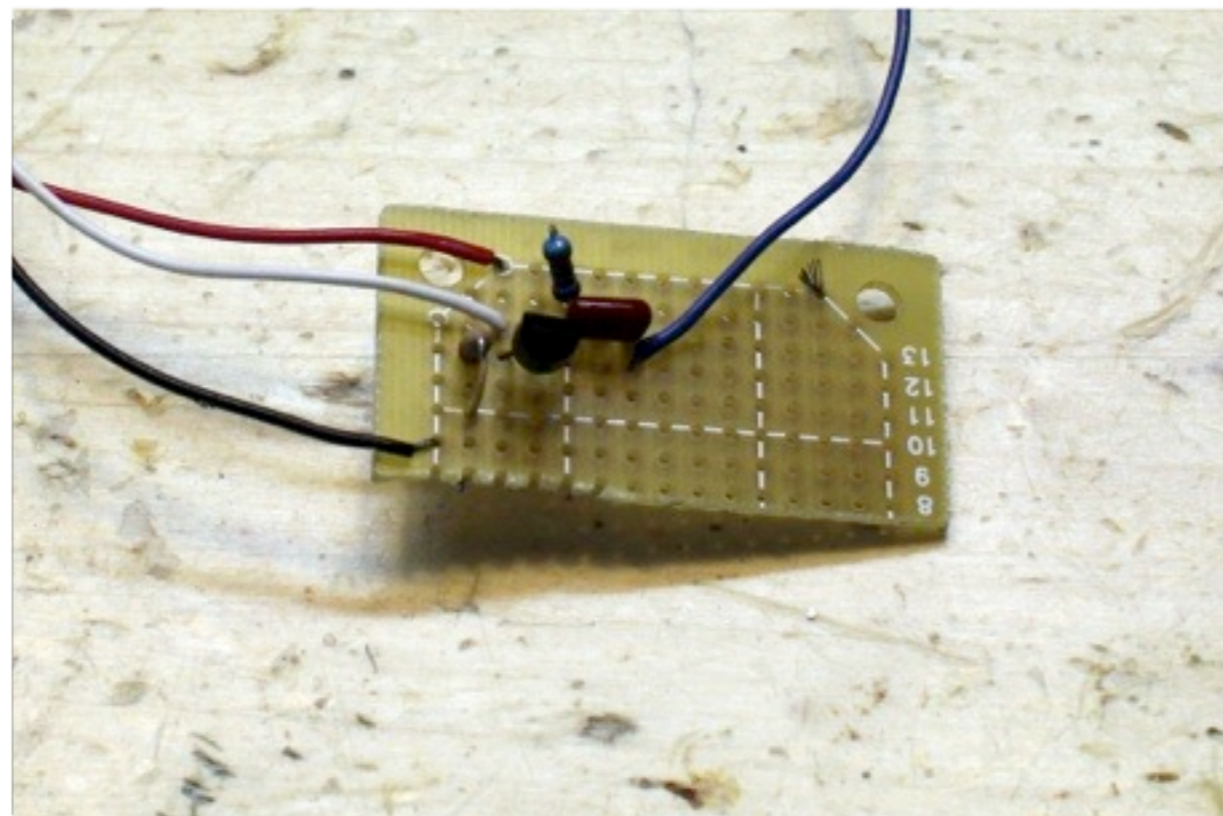
In the other switch position, the signal is routed through the buffer circuit before proceeding to the stompbox output.

Schematic version 3



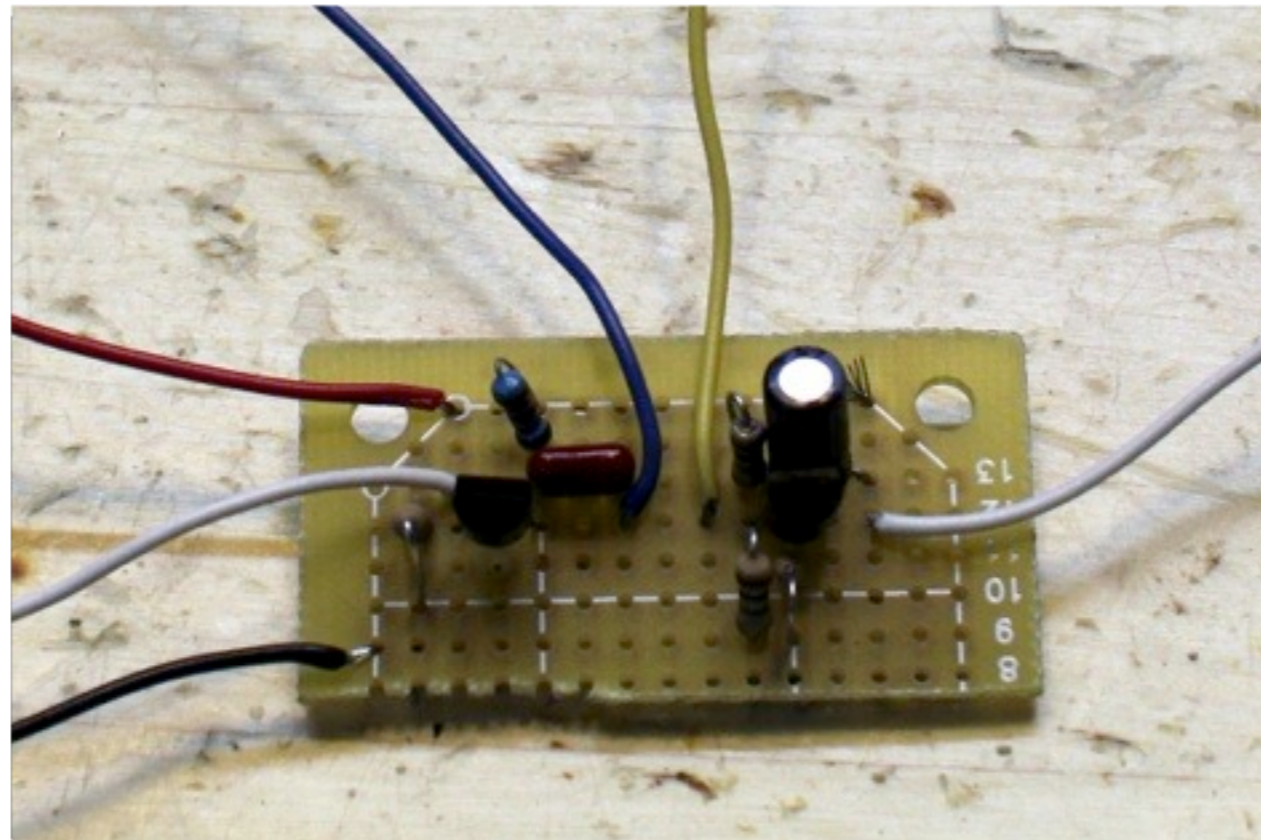
Here's the version we're actually going to build. It features the same noise-reduction and circuit-protection components we used in our first two projects.

Perfboard the Booster



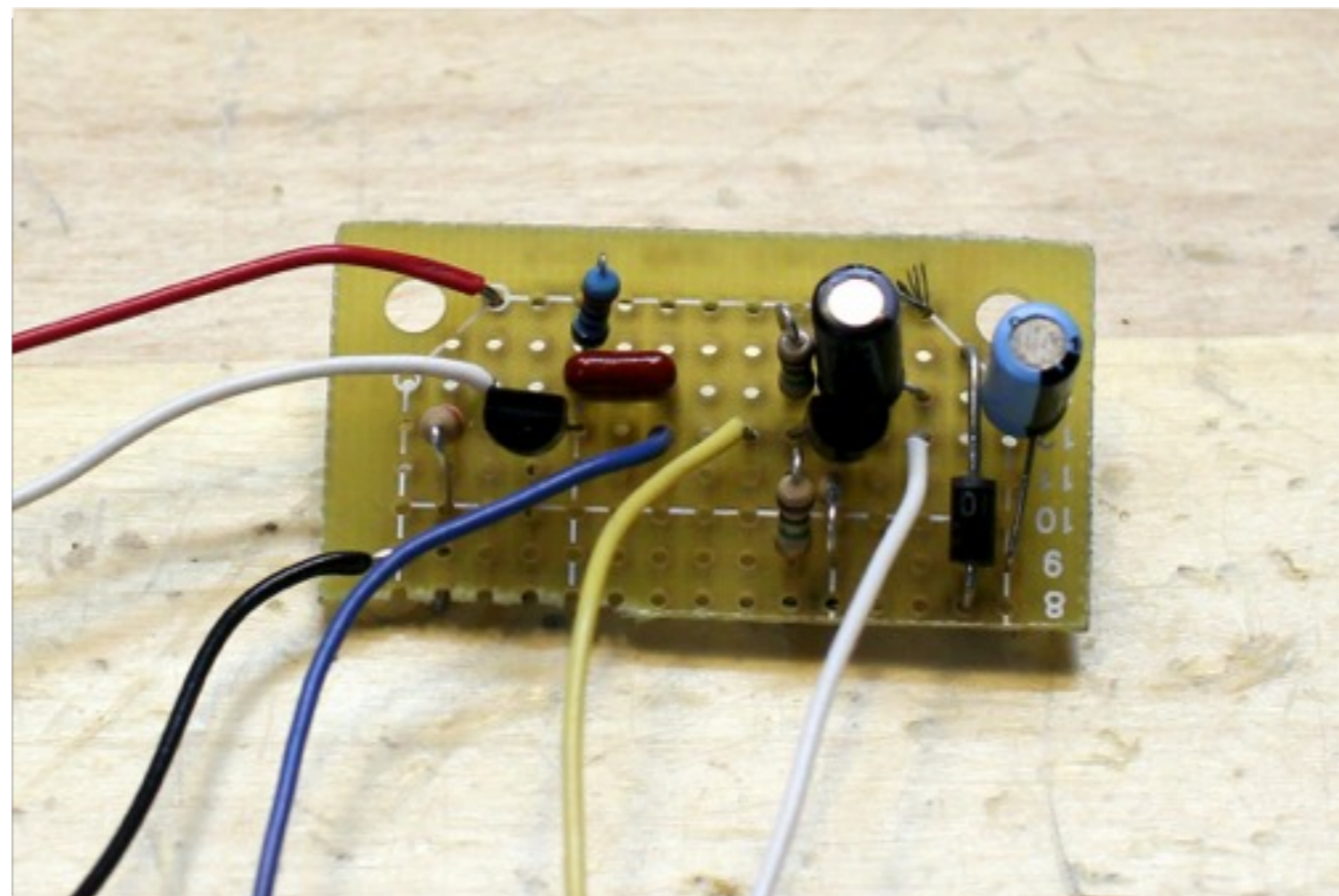
Here's how the booster looks when perfboarded. (For perfboarding techniques, see projects 1 and 2.)

Perfboard the Buffer



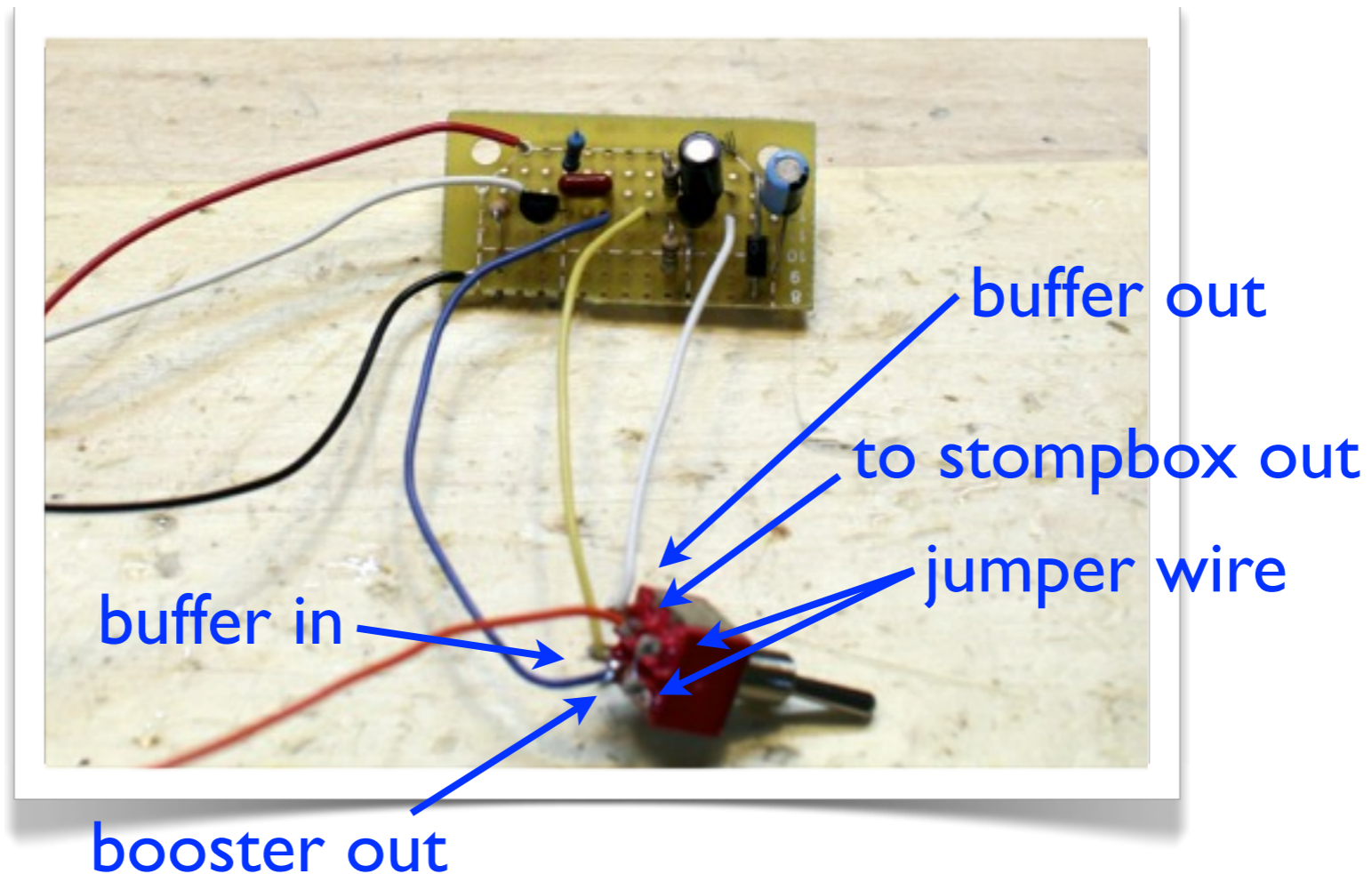
Here I've added the buffer. Both circuits connect to the same +9v and ground busses. The booster output (the blue wire here) and the buffer input (the yellow wire) aren't yet connected—we'll use the switch for that.

Add the other stuff



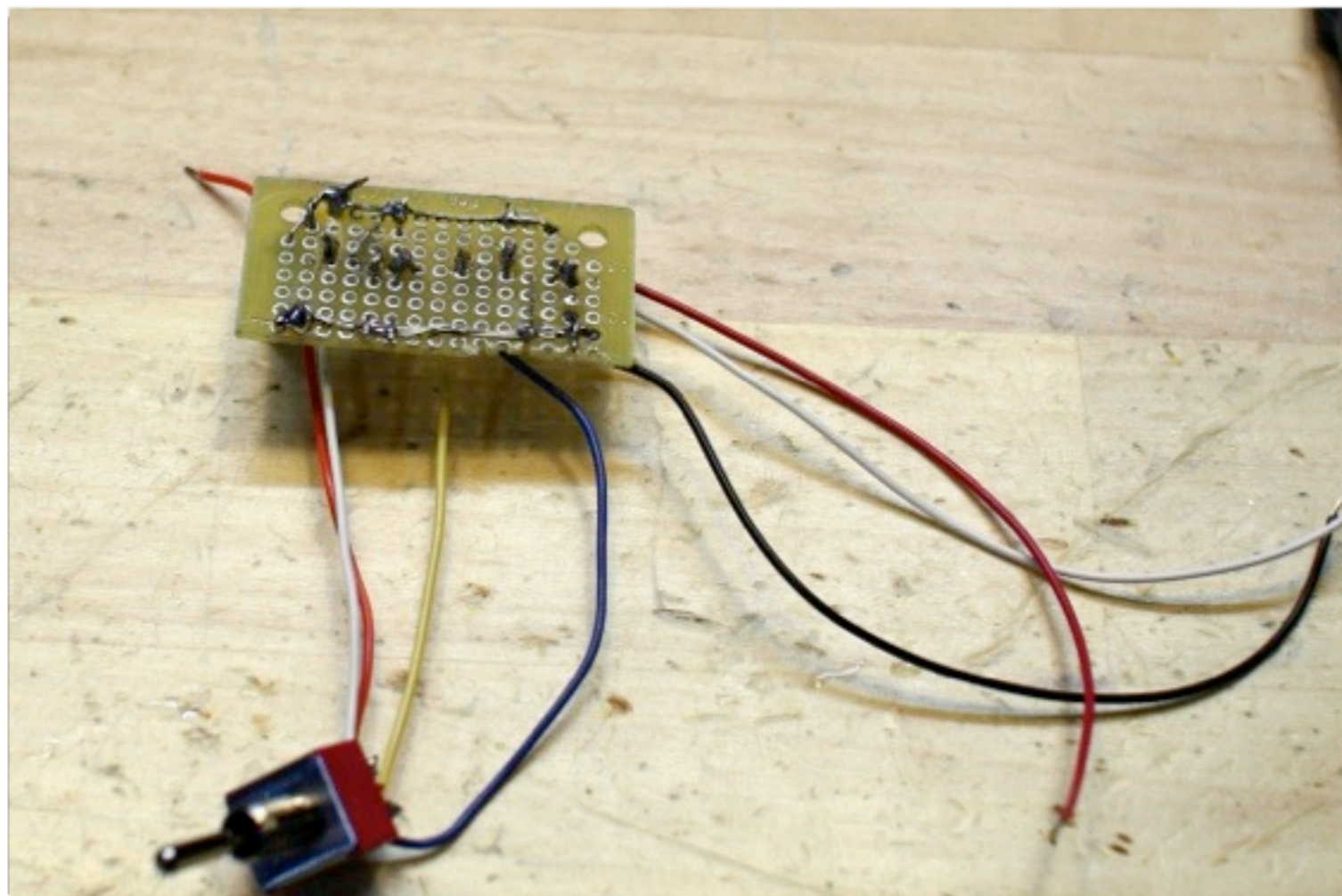
Here's how it looked after I added the noise-reduction and circuit protection components from schematic version 3. (I haven't yet added the 4.7K resistor that connects the +9v bus to the positive leg of the LED. There's a nice spot for it above the yellow wire.)

Connecting the switch



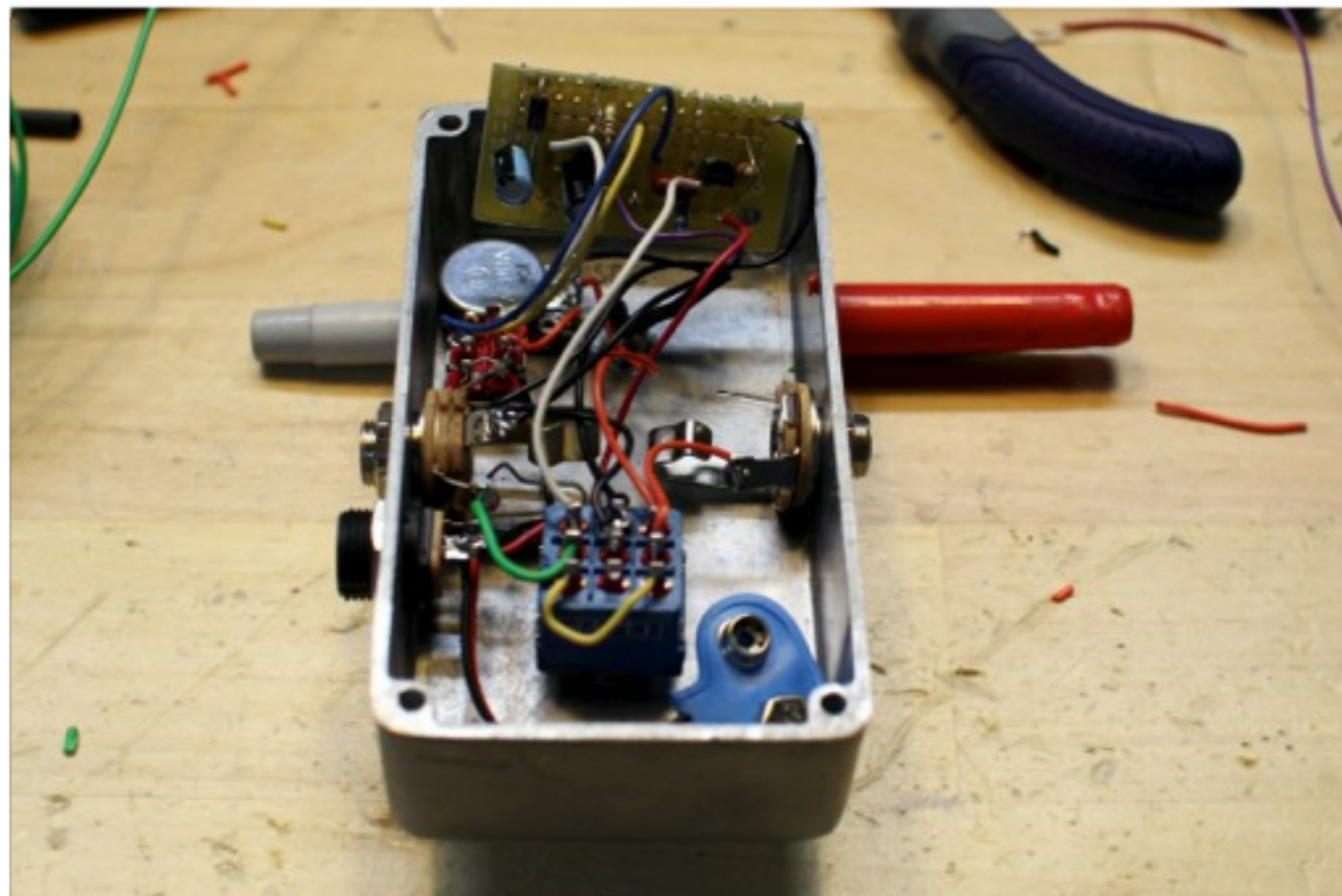
Here's how it looks with the switch wired up. Don't make the wires too long—just lengthy enough to tuck beneath the perfboard, where the switch will reside.

The ugly side



Here's the ugly underside. Yours will look ugly too, in its own special way. ;)

Box 'er up!



The boxing technique is exactly the same as in projects 1 and 2. Here's how mine looked. It isn't pretty, but it sounds great. Once you've verified that yours is working, you may want to use little cable ties to neaten things up.

Drill your own?

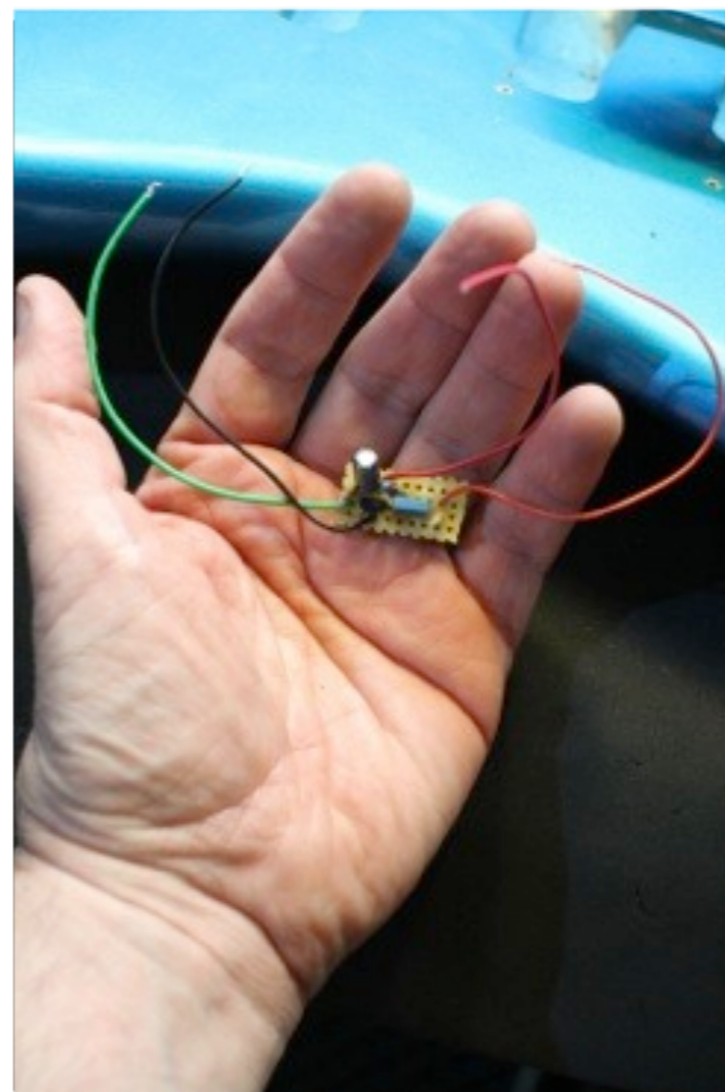


I wanted my knobs and LED in an unusual configuration, so I drilled my own 1590B-sized enclosure. But you can use any box pre-drilled for two switches plus LED (the switch fits into one of the knob holes).

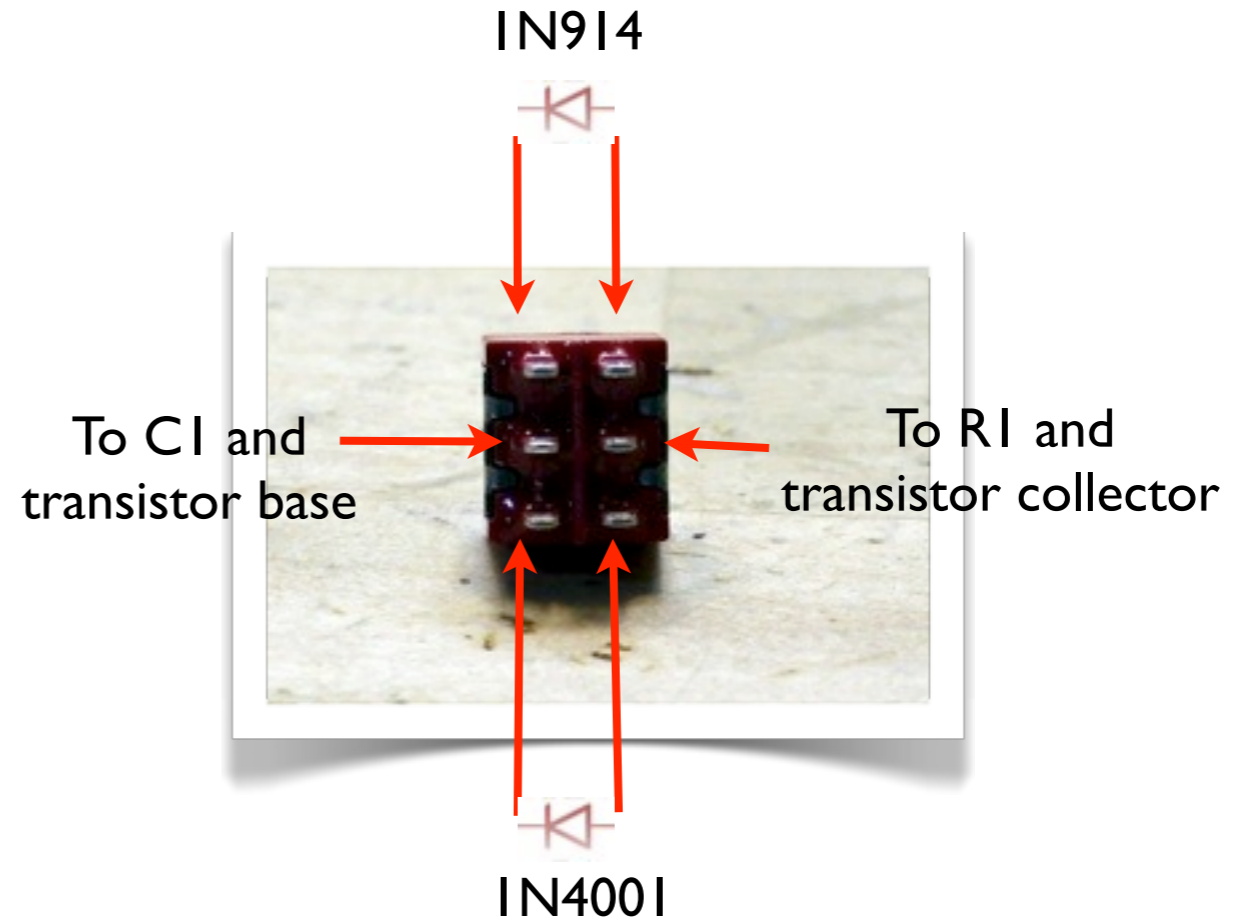
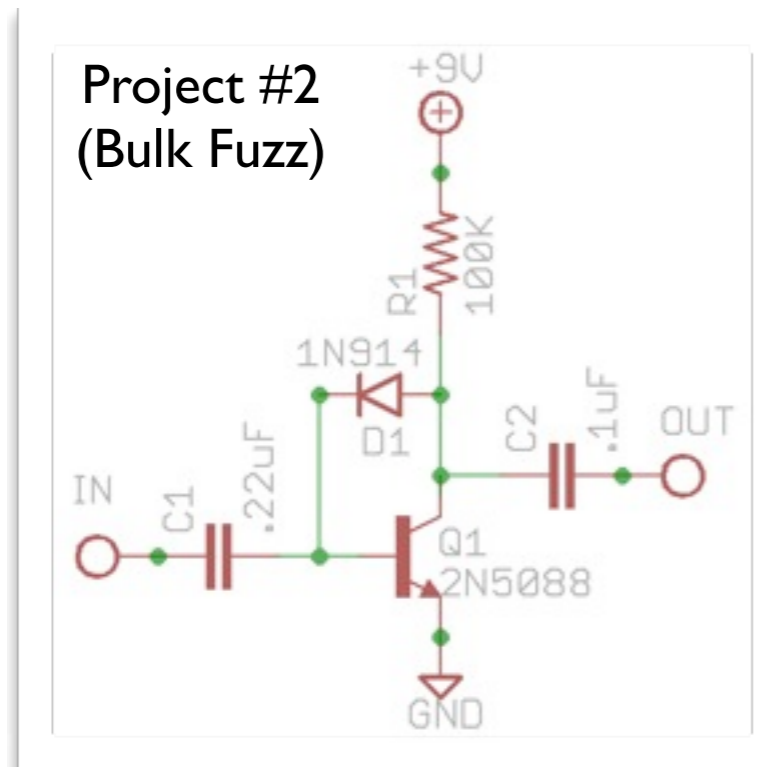
Another option:

You don't necessarily have to build this into a stompbox enclosure. The booster is so small, you can fit it inside a guitar or bass, provided there's also enough room in the cavity to accommodate a 9v battery.

We'll look at optimizing and installing onboard effects in an upcoming installment.



Food for thought . . .



Whether or not you complete this project, please note how using switches can expand your options. Anytime you can't decide which of two component types or values you like best, you can use a switch and have both.

For example, say you couldn't decide whether you preferred the sound of the 1N914 diode shown in the project #2 schematic, or, say, an 1N4001 diode. Wiring the switch as shown would allow both options. You can apply the same technique to caps, resistors, and transistors.

What could possibly go wrong?



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