PROTO-PEDAL SOLUTION

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ABSTRACT

Many musicians that cannot afford to purchase expensive effects pedals will turn to creating their own. Though this is a fantastic learning experience that can be shared by almost anyone, the process itself is taxing and time consuming. The Proto-pedal aims to make the process of designing and testing a pedal circuit easier and hassle free. The Proto-pedal provides a plug and play platform for audio circuits that allows for solderless connections between components and real time audio testing.

1. INTRODUCTION

Audio signal effects have been around since the dawn of the Rock 'n Roll revolution of the 1950's. The first guitar effects pedals were introduced as early as the 40's with DeArmond creating the first stand-alone effect, the tremolo. [1] In 2017, a quick search at musiciansfriend.com returns 1275 different effects pedals for guitars alone. [2] These pedals were driven by the inspiration to create new sounds and innovate the music industry. Most like to think that innovation is left to big company's now, but a growing popularity for "boutique" pedals shows that innovation lies in passionate individuals. The problem with this right now is that there is no standard way to test a pedal circuit without wiring everything up, soldering it, and plugging it in to an amplifier. The solution to this problem is to create a standard prototyping pedal that allows for multiple effects circuits to be tested and proven before permanent connections are made. This product should be able to plug into an effects chain and perform as a complete pedal, while retaining the ability to be quickly modified.

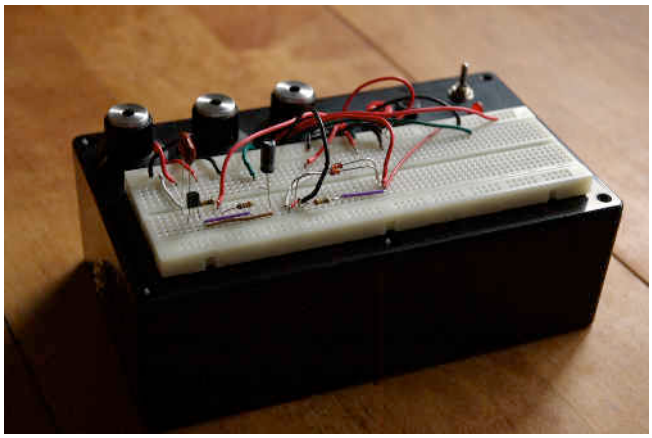

Figure 1 Assembled Proto-Pedal.

2. NOMENCLATURE

POT	Potentiometer
LED	Light Emitting Diode
DMM	Digital Multimeter
DC	Direct Current

3. METHODS

Enclosure construction

The enclosure chosen was to be a XxX plastic project enclosure. This was chosen to allow for easy construction using household power tools. The enclosure only needed to serve as a place to mount the controls and inputs needed for the device. On this enclosure, holes would be drilled for two ¼" input jacks, one DC input jack, three potentiometers, two bolt on binding posts, an LED, a switch, and three holes for wire management. The tools needed for the box alone included a 30W soldering Iron and its necessary components, a handheld drill with multiple drill bits, and a DMM.

Figure 2 DMM Used in Experiment.

The method of constructing the holes for the enclosure included fitting the drill bit size to the shaft of the desired component, drilling a pilot hole at the specified location, and drilling the hole. The breadboard was fastened to the enclosure using the sticky tape located on the underside of the breadboard.

Wiring of the proto-pedal included wiring input and output jacks, potentiometers, lights, and switches as well as power inputs. For the input and output jacks, the red and black wire was used to connect the signal and the shield respectively. This can be seen in the following diagram.

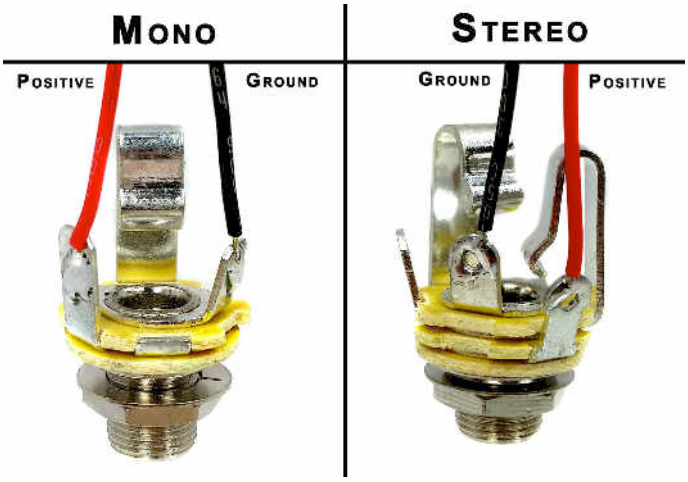

Figure 3 Mono Jack Connection Diagram [3]

The next step was to solder the DC Input. Here, the Proto-pedal proves its versatility in its ability to be run from 9V DC power from the wall or from a 9V Battery. The wires connected to this jack are not soldered at the other end. This means that under no circumstances are the wires connected to this jack to be moved while connected to the wall. However, 9V DC power is relatively harmless. This connection was made using the wiring diagram below.

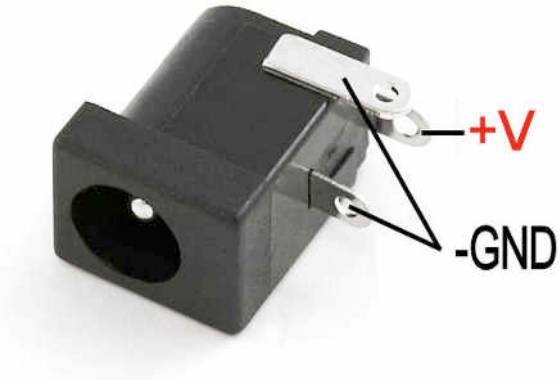

Figure 4 DC Jack Connection Diagram [4]

The next important component to solder together was the potentiometer. For the purposes of this project, 3 100kOhm potentiometers were used. These were wired as shown below.

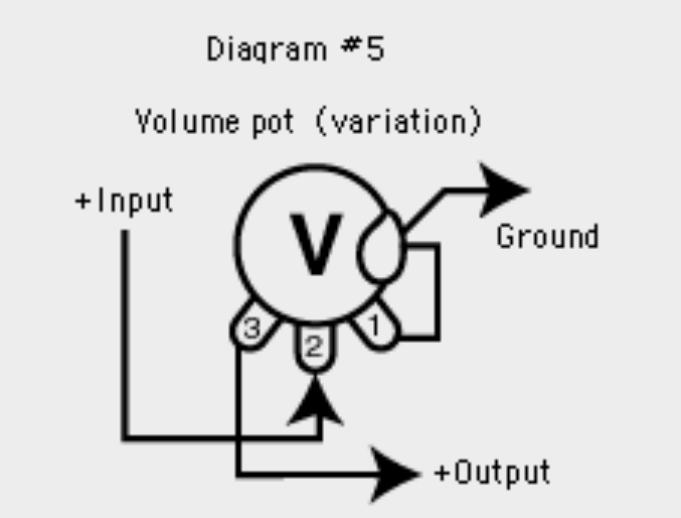

Figure 5 Potentiometer Connection Diagram [5]

Potentiometers are configured in such a way that the wiring would work if you reversed the order of terminals 1, 2, and 3. Reversing the terminals would mean reversing the position of the maximum level on the rotating dial. The potentiometers were wired such that terminals 1, 2, and 3 connected to black, red, and green wires respectively.

After the connections to the terminals were made, the only thing left to do was to tin the ends of the wire to allow for insertion into the breadboard, and feed the wires through the holes in the enclosure to reach the breadboard on top.

Circuit

The scope of this project did not include creation of a circuit, but of a prototyping medium for which to create an audio circuit. For this reason, the circuit diagram along with a list of materials used to create this circuit is presented, but the design of this circuit belongs to user "mikehayworth" from instructables.com below is a schematic of the circuit assembled on the proto-pedal.

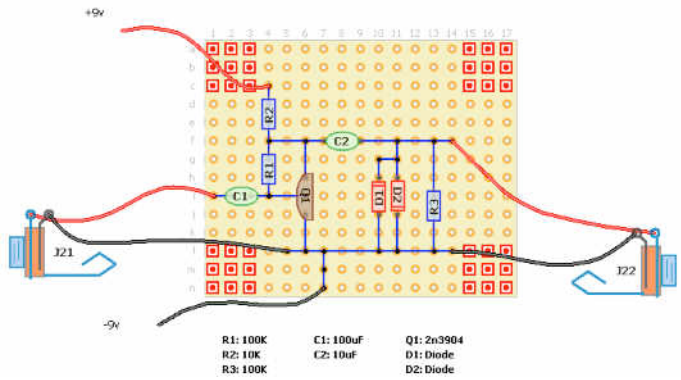

Figure 6 Distortion Circuit Schematic [6]

4. RESULTS

After constructing the proto-pedal, it was found that trouble shooting needed to be done on the circuit itself, however, the proto-pedal performed as expected. To test the effectiveness of the pedal, one of the 100k POT's was wired directly between the input and output. This created one of the simplest circuits in audio signal processing, known as a volume control. The level of noise that came with the circuit was insignificant when measured against industry standard pedals in bypass mode. It was found that the continuity was achieved between both the shield and the signal wires between the input and outputs. Below is a photo of the undercarriage of the proto-pedal.

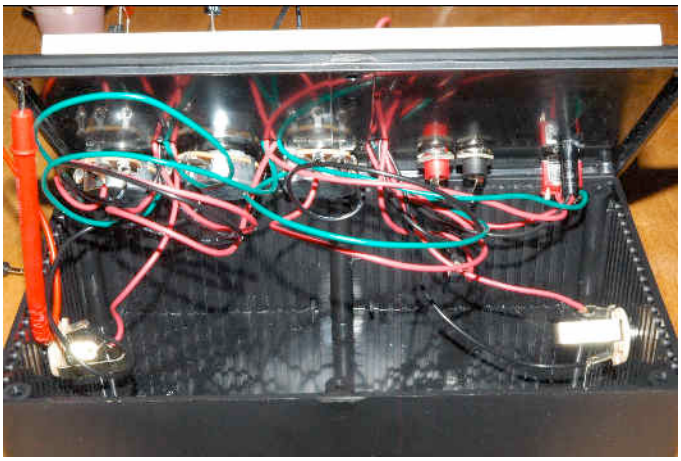

Figure 7 Inside the Proto-Pedal.

The results of the circuit testing for the distortion circuit were that there was a decrease in output level when power was connected, and the distortion of the signal was minimal.

5. DISCUSSION

Test results show that the proto-pedal fulfilled the desired criteria for successfully creating a medium by which an audio effects signal can be tested. During the testing in fact, the proto-pedal saved time by proving that the schematic found online either was not interpreted correctly when built, or does not function as it should.

The Continuity tests showed that what is called true bypass was operational on the circuit. This means that when the circuit is wired correctly, the signal is allowed to pass through the input and to the output with minimal signal loss. Furthermore, the functionality of the breadboard circuit was found to be faulty. This could have been any one of three major reasons. The most probable cause is that there was an operator error in the construction of the circuit on the breadboard. This could be mitigated by simply pulling out the components and rewiring them in the breadboard. The alternative approach in troubleshooting this problem without a proto-pedal would be to

solder the entire circuit, test the circuit, and when it does not work, de-solder the components. This alternative takes much longer than with the proto-pedal.

The second reason for circuit failure could be within the selection of components for the circuit. This circuit creates what is known as “diode clipping distortion.” This is when a diode is used to clip the range of a signal. The diodes used in this build were Zener diodes, but they could be switched out for something as simple as LED’s to perform the same function, however, their threshold voltage could be different and thus, the output would sound different.

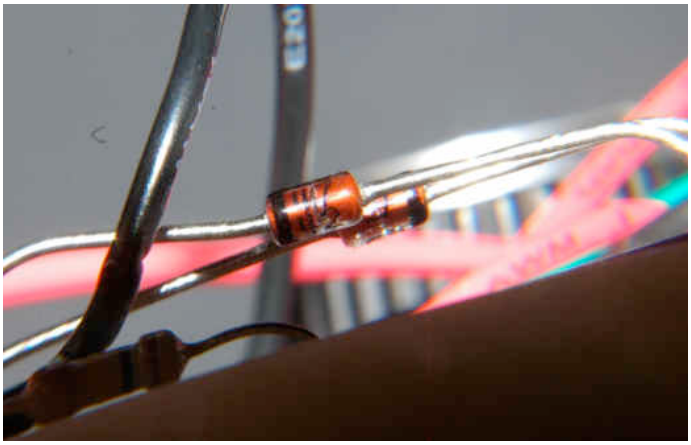

Figure 8 Zener Diode used in the circuit.

Again, this process of switching out diodes is made much easier with the proto-pedal because instead of de-soldering the components, all that is required to complete the switch is to pull the Zener diodes out of the breadboard, and stick a LED’s in their place.

The third possible reason for the circuit failure could lie in the failure of one of the components due to an error in the previous steps. The transistor used in this circuit can be blown easily by improperly wiring the circuit. If this is the case, then a new transistor is needed to replace the existing one.

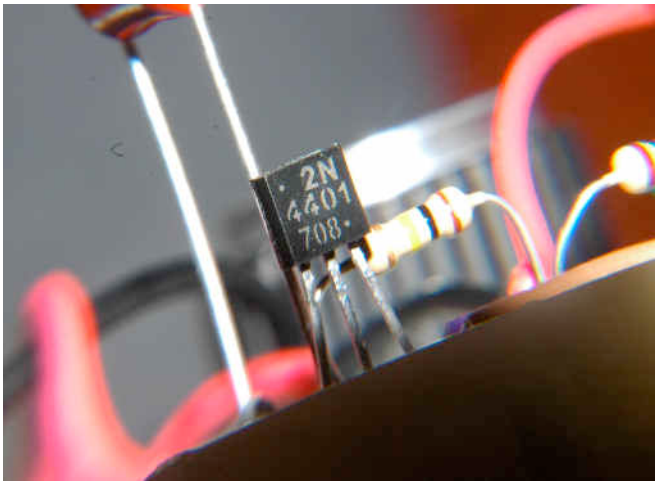

Figure 9 Transistor used in the circuit.

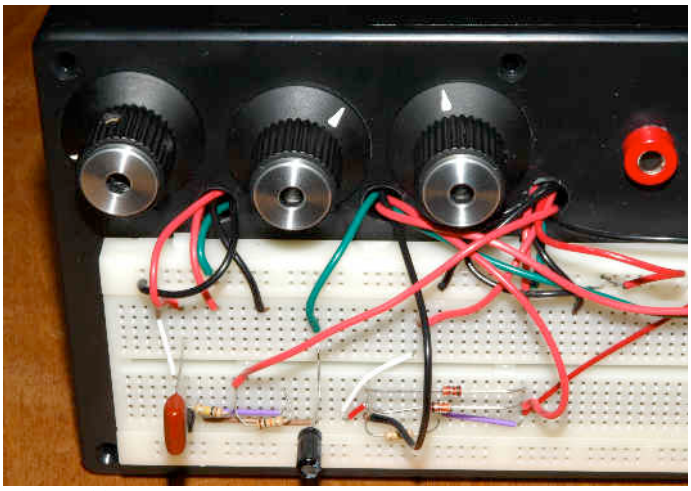

Figure 10 Top View of Proto-Pedal.

The limitations of this approach to prototyping for pedal circuits is that there are only three potentiometer holes on the enclosure. There are a few schematics out there that call for more than three POT’s to be used. While it is possible to wire more than three POT’s to this pedal, the result would not be movable, or as secure as originally intended. Another limitation of this approach is the size of the breadboard. Currently, there are 128 nodes on this device. Theoretically that allows for an enormous amount of connections. However, the limiting factor would be the size of the electrical components located in the circuits. A standard resistor body covers up at least three terminals.

6. CONCLUSION AND FUTURE WORK

In conclusion, the biggest problem to a hobbyist that wants to build an effects pedal, but does not completely understand signal processing needs a way to test the circuits of prototype pedals. The proto-pedal accomplishes that goal with a platform readily available to introduce a beginner into the world of signal processing without needed to de-solder the components every time something does not work.

Future work and improvements to the design include the addition of breadboard to the underside of the lid of the enclosure. This addition will allow a circuit to be created and then closed off inside the enclosure so as to further protect the components from being dislodged or altered in some way.

ACKNOWLEDGMENTS

Dr. Pranav Bhounsule for approving this project.

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