

Build an All-Tube Fuzz/Wah Pedal

by Eric Barbour and Peter Belov

In spite of more than 30 years of development and marketing, to this day all commercial guitar "wah" pedals have been solid-state and have followed a limited product design philosophy. Typically they use a twin-T or RL bandpass filter based on discrete transistors or low-cost ICs, swept with a potentiometer or optical interrupter geared to the pedal mechanism. The result often is a "solid-state" distortion sound, especially if the wah is preceded by a distortion pedal. And the sweep mechanism can be unreliable, due to a noisy pot or dirt in the optical pickup.

The wah pedal presented here is totally based on vacuum tubes. Svetlana EF86s are ideal for the purpose, as they are low in noise and hum and high in gain when connected as pentodes. The result is a minimal design, giving easily-controlled clipping distortion which accentuates the "wah" sound effect while using only 2 tubes.

The bandpass filter is unique, in that it uses an LC feedback filter. A large variable capacitor, of a type commonly used in radio equipment, is geared to the pedal. This construction has no optical devices and no moving or sliding electrical contacts, thereby minimizing reliability issues. This design is simple enough for the moderately experienced DIYer to construct at home, using only basic hand tools (with some help from a machine shop, if cutting the hole in the volume pedal proves to be too difficult). Readers who don't feel qualified to construct this pedal themselves should consult with a local amplifier service technician for custom construction.

As shown in the schematic, the guitar signal enters the input jack, which is loaded by only a 1-megohm resistor. It enters the first stage, an EF86 in pentode connection. This gives a voltage gain of about 150, ample for any guitar pickup. The signal passes through a drive volume control to the second stage, another EF86 connected as a triode and having a simple LC parallel-resonant filter in feedback connection. The inductor is a small iron core choke, of a type commonly used in audio filtering circuits. A suitable inductor is the Hammond 155C. Although an unusual type, it is readily available from the sources listed below. The variable tuning capacitor is also a very common part; it is used in many RF power linear amplifiers as the antenna loading adjustment. Availability of this part is excellent (Antique Electronic Supply C-V500-X3 or RF Parts X764).

Selection of the wah effect or only the first-stage preamp is effected with the footswitch. If no gain is desired when the pedal is bypassed, the "Gain Only" terminal may be connected to the guitar input jack instead. The power supply is a simple one based on a low-cost filament transformer available from distributors such as Mouser Electronics. One primary is used to accept 120v AC power; the other primary is rectified and filtered to produce about +140v DC for the tube plate supply. The secondaries are connected, rectified and filtered to produce clean +6v DC to run the tube heaters. All components shown here are conservatively rated. PC boards may be fabricated to accept all of the components shown, including the choke, tuning capacitor, jacks and footswitch. The power transformer (which is a low-profile PC-mount type) and other power-supply components should be mounted well away from the audio circuits. A separate cabinet is strongly recommended, to minimize hum.

The photos show construction of the prototype. An Ernie Ball volume pedal was chosen for its

rugged construction. The pot was removed and a large hole was cut in the right side of the pedal base. (This can be done with a "Unibit" stepped drill bit and a 3/8" electric drill. If you don't feel qualified to do this, take the pedal to a machine shop and have them cut the hole.) A matching hole was cut in the side of an LMB slope-front cabinet, then the cabinet was attached to the pedal base so that the large holes lined up. The tuning capacitor was then mounted in the cabinet so that its shaft protruded into the volume pedal's base as far as possible without touching the sheet metal. Note: one connection to this capacitor is made to its frame, so it must be mounted using nylon hardware to insulate it from the cabinet.

Mechanical parts to drive the capacitor are obtained from Small Parts Inc. The two plastic gears are drilled and tapped to accept 6-32 setscrews. A Small Parts GD-3244 gear is mounted on the shaft of the tuning capacitor. A 1 7/16" piece of Small Parts O-CGSX-4 shaft stock is cut, and the pulley from the pedal's potentiometer is mounted to one end. The block on which the pot mounted has a 3/8" hole which requires a bearing for the 1/4" shaft. Remove the block from the pedal and use a bench press or vise to press a Small Parts O-FBB-4/6 bronze bearing into the block. (It should be a tight press-fit. If not, use epoxy to mount the bearing in the block.)

Apply a small amount of light grease to the shaft. Slip the shaft into the bearing so that the pulley will be in its original position. On the opposite end of the shaft, slip a Small Parts O-SX-4 collar until there is less than 1/16" of axial play in the shaft. Then tighten the collar's setscrew. Slip the GD-3232 gear onto the shaft, then reinstall the block into the pedal body. Adjust the GD-3232 gear until it mates with the gear on the capacitor, then tighten its setscrew. Moving the pulley by hand should cause the tuning capacitor to move through its full 180 degree rotation.

Once the capacitor is controlled by the pulley, wrap the pedal string onto the pulley in the OPPOSITE direction it was originally wrapped. When done, operating the pedal by pressing its toe end should cause the capacitor's plates to rotate OUT, for less capacitance. The normal convention for wah pedals is that pushing on the toe end causes an increase in center frequency. If the string is wrapped onto the pulley in the wrong direction, the pedal will work backwards from the convention. The spring in the drive string will take up any slack if the string is properly installed. And the capacitor will not be damaged if its rotation range is exceeded by the pedal, since the pulley will allow the string to slip. Use a small amount of light grease on the gears, to prevent binding.

The tubes are encased within the LMB box, using surplus right-angle mount sockets (Antique Electronic Supply P-ST9-264). Wiring was done point-to-point on two terminal strips. The inductor L1 resembles a small filament transformer, and can be mounted anywhere convenient. The LMB box was mounted to the volume pedal's channel base with 8-32 hardware. Circuit layout is not critical, except that connections to the grids of the EF86s (pin 9) should be kept short. As said before, the capacitor C7 MUST be mounted with nylon hardware to insulate its frame from the box. Three 6-32 nylon screws and #6 nylon washers should be adequate. The mounting holes in the base of the capacitor are already threaded, so no hexnuts or other fasteners are needed.

To keep hum down, the power supply is built into a separate plastic case and connected to the wah chassis with a 3-wire cable. The power transformer is a Magnetek VPP12-4400 or similar, available from Mouser. It is a PC mount type, so it will need to be mounted in the case with standoffs and long 6-32 screws through the holes in its frame. This supply is very conservative,

so it could be used to run a few other small-signal tube circuits.

One side of the capacitor consists of its frame. A wire can be soldered to the tin-plated dividers between the three main sections. (Be sure to use thin wire and a minimum of solder, as it is possible for the connection to rub against the moving plates if it is too physically large.) The other connection requires soldering wires to all three of the stator sections, then connecting them together. There are solder lugs on each side of each stator section for this purpose.

Once the mounting and wiring of parts is done, power can be applied. You should use a voltmeter to measure the unit voltages, to insure that all is working properly. If you see any smoke or smell anything burning after one minute warmup time, unplug the unit immediately and check for improper wiring or bad components.

The plate supply should be around 140v to 160v--its variation is due to AC line-voltage variations and transformer variations, and is quite normal--the circuit is very non-critical of operating voltages. The heater voltage should be about 6.0 to 6.5 volts DC. Again, this is not critical in this particular circuit. Measure the voltage on the plate pin of each EF86 tube (pin 6). After the tubes warm up, you should see about +35 to +50 volts on the plates.

Then put the cover on the enclosure and connect it up to your amp and guitar. Power up, wait for warmup, and set the volume for just the desired amount of distortion (more distortion will give a more pronounced "wah" effect). Then wail away! It sounds totally UNLIKE any wah pedal you may have experienced in the past- -thick, rich, and buttery.

USA suppliers of parts used in this pedal:

Antique Electronic Supply
PO Box 27468
Tempe AZ 85285
phone (602) 820-5411
fax (602) 820-4643
(capacitor, tubes etc.)

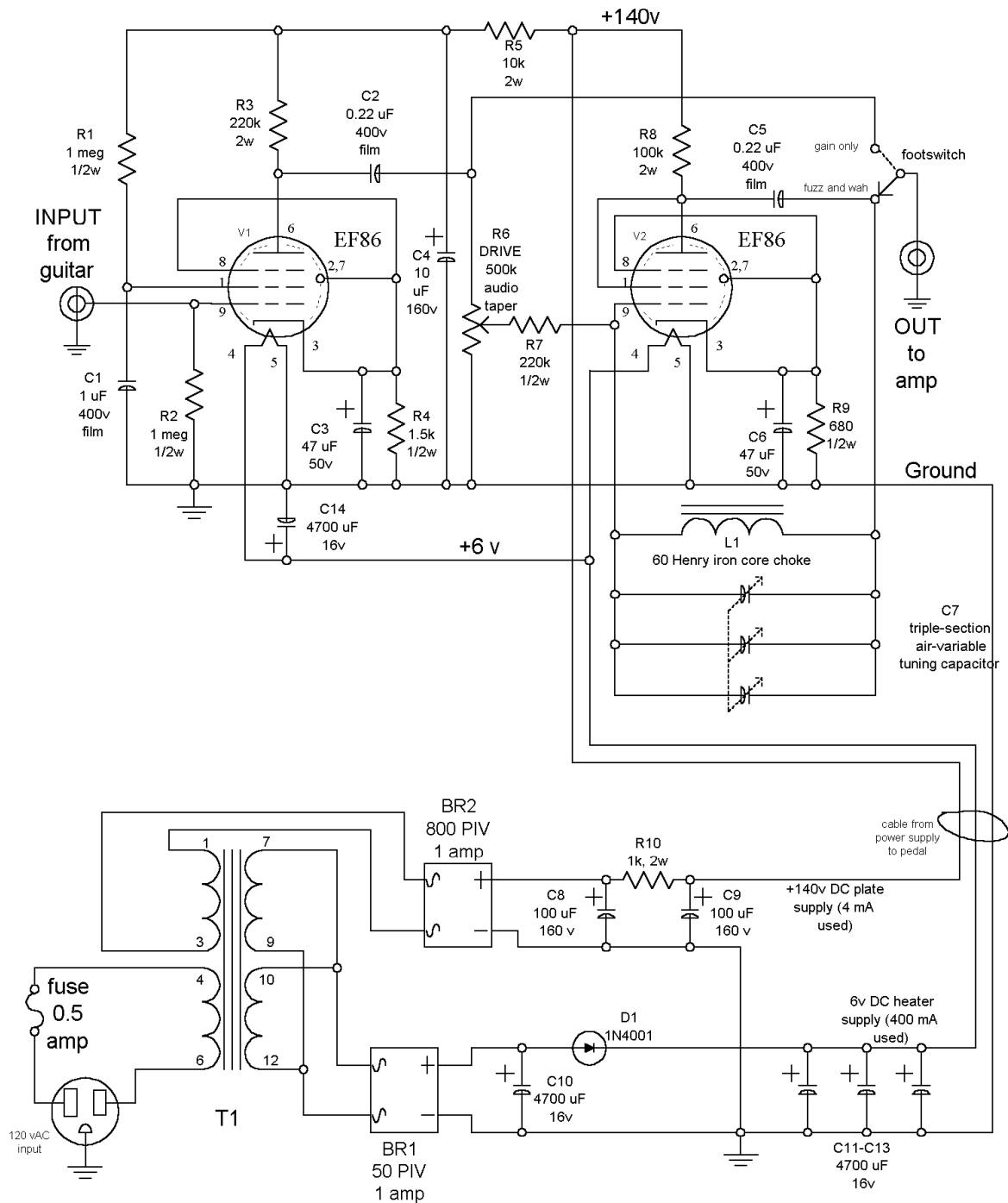
Small Parts Inc.
PO Box 4650
Miami Lakes FL 33014
phone (305) 557-8222
fax (305) 558-0509
(mechanical parts)

Mouser Electronics
958 N. Main St.
Mansfield TX 76063
phone (817) 483-6828
fax (817) 483-0931
(transformer, other parts)

RF Parts Co.
435 S. Pacific
San Marcos CA 92069
phone (619) 744-0700
fax (619) 744-1943

(tuning capacitor, etc.)

Schematic of all-tube "fuzz-wah" pedal using EF86s.



DISCLAIMER:

This circuit design uses high voltages which can be hazardous. The user assumes all responsibility for the correct and safe operation of these circuits. The authors and Svetlana Electron Devices do not guarantee or certify that these circuit designs will satisfy the user's requirements.