WAH-WAH FOOT PEDAL

Liven up your music with this easily operated low-cost add-on circuit

BY FRED PUCCETTI

"WAH-WAH" is one of several interesting effects used by electric guitarists to "spice up" the sounds generated by their instruments. This effect, named in imitation of its sound, is commonly employed by synthesists and electric pianists as well. It is achieved by sweeping the center frequency of a bandpass filter while the output of the instrument is fed through it. Typically, the filter is controlled by means of a foot pedal.

Presented here is a Wah-Wah pedal designed with the performing artist in mind. It employs a high-performance quad operational amplifier and a battery power source, making it well-suited to stage or studio work. Parts count is low, so the Wah-Wah Pedal is easy to build. A kit including a rugged foot-pedal mechanism is available for $55.

About the Circuit. The Wah-Wah pedal is shown schematically in Fig. 1. Signals from the instrument being played are presented to input jack *J1A*, one portion of a three-conductor, double closed-circuit, 1/4-inch (6.3-mm) phone jack. The input signals drive a second-order, two-pole active bandpass filter comprising operational amplifiers *IC1A*, *IC1B*, *IC1C*, and their associated passive components. The center frequency of this filter can be varied by means of potentiometer *R7*.

When this potentiometer is adjusted for minimum resistance, the center frequency of the filter is approximately 2500 Hz. When the potentiometer's effective resistance is increased to its maximum value of 500,000 ohms, the filter's center frequency decreases to approximately 1050 Hz. These filter responses are shown in Fig. 2, a photo of the CRT traces generated by a spectrum analyzer. The analyzer was driven by a signal generator with the project inserted in series between the generator and the analyzer, and the project's frequency-control potentiometer (*R7*) was alternately set to provide for minimum and maximum resistance.

The upper and lower limits of the range over which the active bandpass filter's center frequency can be swept are determined by the stages comprising *IC1A* and *IC1B* and their associated passive components. Inverting amplifier *IC1C* provides a slight amount of voltage gain so that signals appearing at output jack *J2* are at a suitable level. That sets this project apart from older, discrete Wah-Wah designs that did not compensate for any insertion loss introduced by the bandpass filter. An additional benefit provided by *IC1C* is buffering, which prevents the load from interacting with the filter and affecting its frequency response.

The remaining op amp, *IC1D*, is not used. In accord with good design practice, its inputs are grounded. Power for the circuit is provided by a bipolar supply consisting of two 9-volt batteries in series. Diodes *D1* and *D2* protect against the inadvertent application of reverse supply voltages. Tantalum capacitors *C3* and *C4* function as power-supply bypassing components. Note that there is no separate power switch. This is because the switching contacts of *J1B* (part of input jack *J1*) automatically connect the battery supply to the rest of the project whenever the instrument patch cord is inserted into *J1*. The only switch in the project is *S1*, a heavy-duty, push-on/push-off switch activated by the foot-pedal mechanism. It either bypasses signals around the Wah-Wah circuit or inserts it into the signal path.

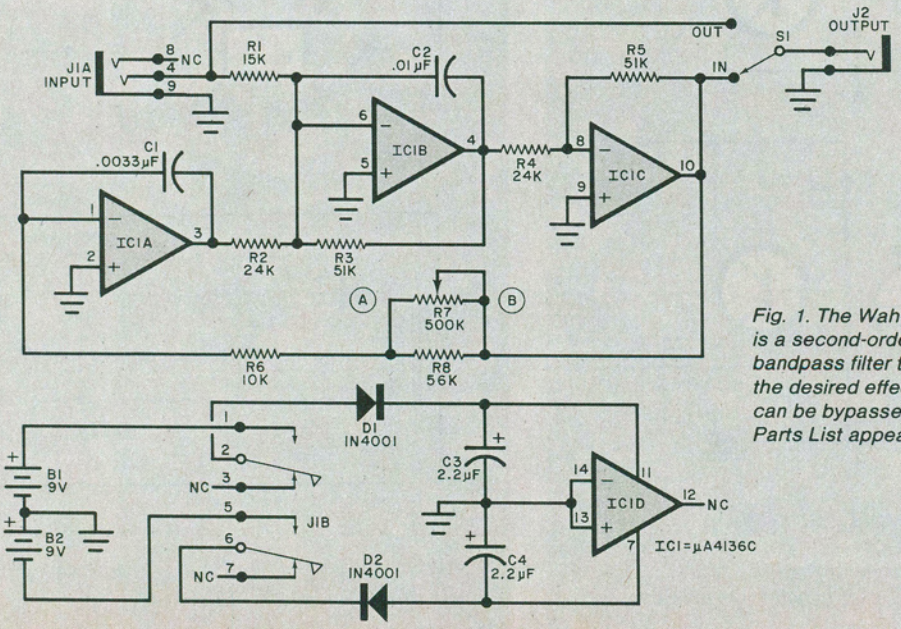


Fig. 1. The Wah-Wah Pedal circuit is a second-order, two-pole active bandpass filter that provides the desired effect. The filter can be bypassed by means of S1. Parts List appears on next page.

wah-wah pedal

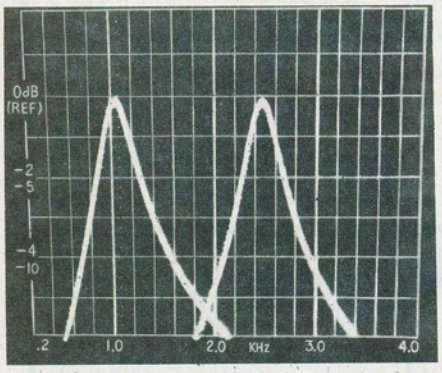


Fig. 2. Bandpass filter's frequency response when the foot pedal is fully up (left) and down (right).

PARTS LIST

B1, B2—9-volt transistor battery
C1—0.0033-μF, 5%-tolerance polystyrene
C2—0.01-μF, 5%-tolerance polystyrene
C3,C4—2.2-μF, 16-volt tantalum
D1,D2—1N4001
IC1—μA4136C quad operational amplifier or equivalent
J1—Three-conductor, double closed-circuit 1/4-inch (6.3-mm) phone jack (Radio Shack No. 274-277 or equivalent)
J2—Monaural, open-circuit 1/4-inch (6.3-mm) phone jack
The following are 1/4-watt, 5%-tolerance, fixed carbon-composition resistors, unless specified otherwise.
R1—15,000 ohms
R2,R4—24,000 ohms
R3,R5—51,000 ohms
R6—10,000 ohms
R7—500,000-ohm, linear-taper potentiometer (see text and note below)
R8—56,000 ohms (see text)
S1—Spdt, heavy-duty, push-on/push-off switch (Alcoswitch MPG-106D or equiv.)
Misc.—Foot-pedal potentiometer drive mechanism and enclosure (DeArmond Model 1600 or equivalent), printed-circuit or perforated board, IC socket or Molex Soldercons (if desired), battery holder, battery clips, hookup wire, solder, hardware, etc.

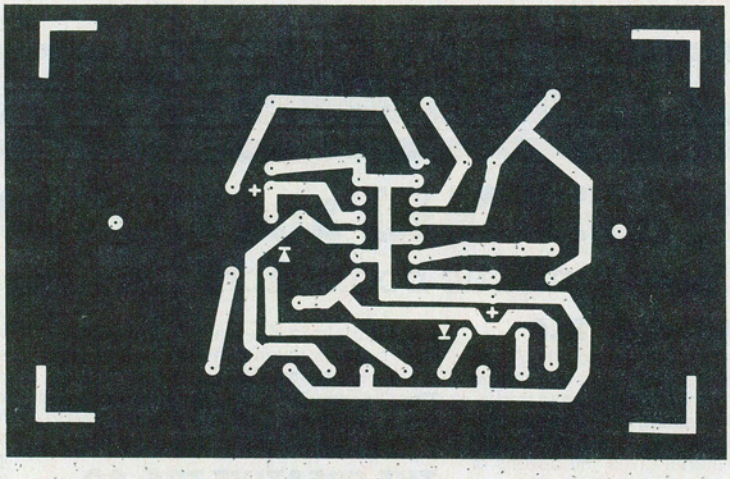
NOTE-*The following is available from PAIA Electronics, Inc., Box 14359, Oklahoma City, OK 73114: DeArmond Model 1600 foot pedal No. 1230PED (includes 500,000-ohm potentiometer R7) for $39.95 plus $3.00 postage and handling (U.S.); etched and drilled printed-circuit board No. 1230PCB for $9.95 postpaid (U.S.). Oklahoma residents, add sales tax.*

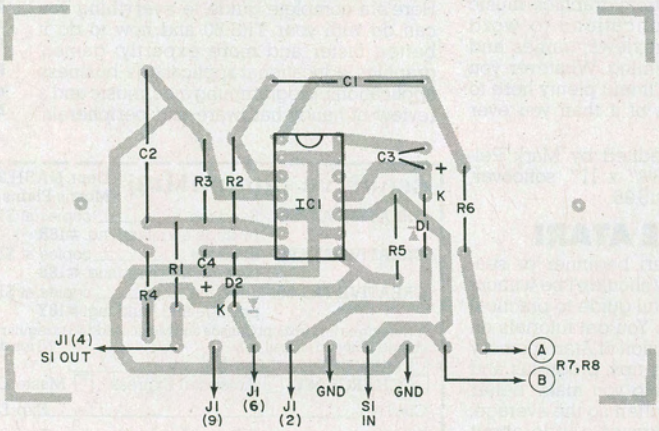
Construction. The Wah-Wah circuit is simple, so either printed-circuit or point-to-point wiring techniques can be employed to reproduce it. The full-size etching and drilling guide for a suitable printed-circuit board appears in Fig. 3 together with the corresponding full size component placement guide.

Use of a socket or Molex Soldercons with *IC1* will simplify replacement of that component should it later become defective. Be sure to observe polarities and pin basing when mounting the IC, diodes, and tantalum capacitors on the circuit board. Employ the minimum amount of heat and solder consistent with the formation of good connections. When all components have been mounted on the board, examine your work for solder bridges, cold solder joints, etc.

A number of components (*B1, B2, J1, J2, R7* and *S1*) are not mounted on the circuit board. Rather, they are secured to the enclosure associated with the foot-pedal mechanism that drives potentiometer *R7*. This makes for a compact, convenient package. You can either construct an enclosure and foot-pedal mechanism from scratch or use a commercial product that has been specially designed for musical applications. The author recommends the DeArmond Model 1600 foot-pedal assembly, which contains a 500,000-ohm potentiometer and a worm-gear mechanism to drive the potentiometer. This is the foot pedal that he used in the construction of his prototype.

Figure 4 is a bottom view of the prototype with its bottom cover removed to show the worm-gear drive, the potentiometer, circuit board and other components mounted in the foot-pedal enclosure. A hole has been drilled along the long axis of the enclosure near the top below the pedal to accommodate bypass switch *S1*. This heavy-duty, push-on/push-off switch required a large mounting hole. Extreme care was taken when drilling this hole so that the rubber-topped metal pedal plate was not damaged by the drill bit. Figure 5 is a side view showing how *S1* was mounted so





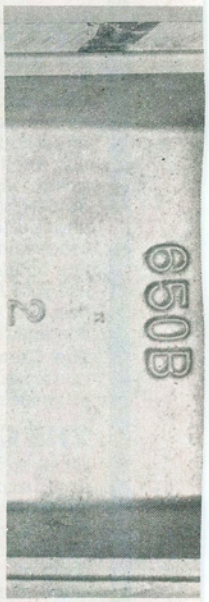


Fig. 3. Full-size etching and drilling guide (above) with corresponding parts placement guide below.

that it could be actuated by a full depression of the foot pedal.

The DeArmond Model 1600 foot pedal includes two monaural, open-circuit phone jacks. Its output jack (labelled AMPLIFIER) can be used as *J2*, but the input jack (INSTRUMENT) should be removed and replaced with a three-conductor, double closed-circuit 1/4-inch (6.3-mm) phone jack. This jack will fit in the space formerly occupied by the monaural, open-circuit input jack and will function as *J1*.

To mount the circuit board in the foot-pedal enclosure, a hole must be drilled in each of the mounting studs on the underside of the enclosure. Drill these holes 3/16" (4.8 mm) deep, taking care not to penetrate all the way through the enclosure. If a tap-set drill is available, it can be used to tap out the holes to the appropriate tap size. In the prototype, 10-32 tap-set holes were drilled and tapped to accommodate the screws that were used to hold the printed-circuit board in place. Spacers were inserted between the circuit board and the mounting studs to ensure that there is sufficient clearance for the board. If a tap-set drill is not available, holes should be drilled 3/16" (4.8 mm) deep using a No. 35 drill, and the board secured to the mounting studs using 6-32 self-tapping screws and circuit board standoffs.

Figure 4 shows how the battery holder that retains the two 9-volt batteries is mounted in the foot-pedal enclosure. It is secured in place using one of the two retaining screws of the worm-gear assembly. The photograph also shows how the circuit board, switch, jacks, batteries, and potentiometer are interconnected using battery clips and hookup wire. A close inspection of the photo reveals the installation of a fixed resistor (*R8*) across the 500,000-ohm potentiometer. It is placed in parallel with potentiometer *R7* to reduce the maximum effective resistance of the potentiometer, which is built into the DeArmond Model 1600 foot pedal, to 50,000 ohms. If a home-brew or some other foot pedal is used, *R8* can be omitted and a 50,000-ohm linear-taper potentiometer installed as *R7*. Note that the center lug (the wiper) of the potentiometer and the lug furthest away from the input and output jacks should be connected together.

Checkout and Use. Install fresh 9-volt transistor batteries in the holder and attach the battery clips to them. Then plug one end of a patch cord into the output jack of an electric guitar or similar signal source and the other end into jack *J1*. Use a second patch cord to route signals from output jack *J2* to the input jack of an instrument amplifier. Strike a note or chord and listen to the output of the amplifier while you pump the foot pedal up and down. If you hear no variation in timbre, depress the foot pedal fully until you hear the click of *S1*. Then repeat the process by striking a note or chord and rapidly pumping the foot pedal up and down. You should then hear the output of the guitar modified by the "wah-wah" sound.

Back the pedal off to its fully up position by pressing down with your heel and strike a chord. Bass notes should predominate over treble notes in the output of the amplifier. Next, move the pedal to its (almost) fully down position by applying pressure with your toes. Do not press the pedal with so much force that *S1* latches into its OUT position. Then strike the same chord that was struck previously and monitor the ouput of the amplifier. You should hear a predominance of treble notes over bass notes. If the opposite response is heard, potentiometer *R7* has been reverse-wired and the leads running to it from the circuit board should be transposed.

You can combine the Wah-Wah pedal with other signal processors, such as a fuzz-box, sustain, and a flanger, to create your own special sounds. Experiment with each of the signal processors you have to determine how much of any one effect should be added to the sound of your instrument at any given time. Keep in mind that too much of any sound effect can disturb your audience and that too little of it can bore them. The best bet is to apply judicious amounts of the sound effects available to you in a sequence dictated by your interpretation of the music you are going to play. This will not only entertain your audience, but also leave in their minds the impression that you are truly a creative musician. ◇

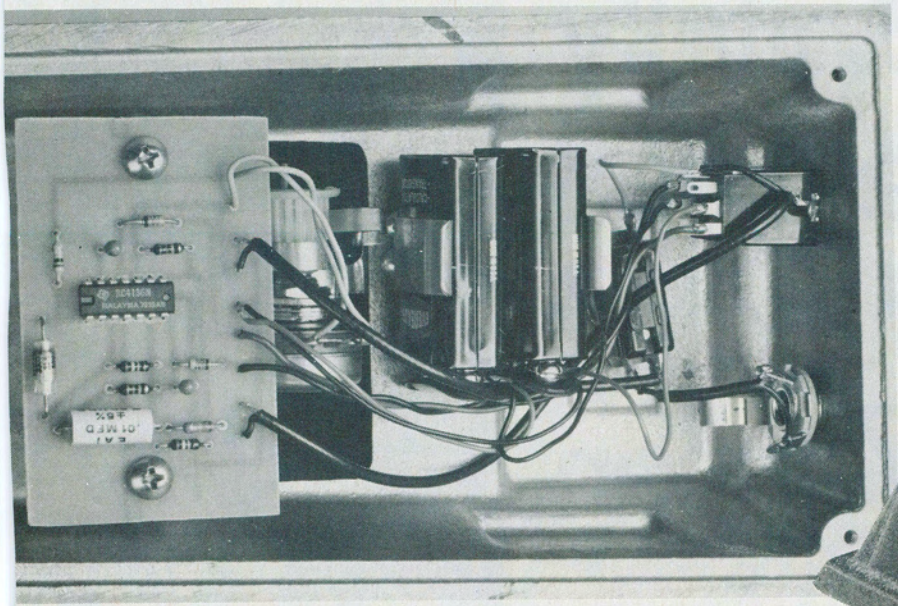


Fig. 4. Bottom view of prototype shows how the pc board and other components fit inside the foot-pedal enclosure.

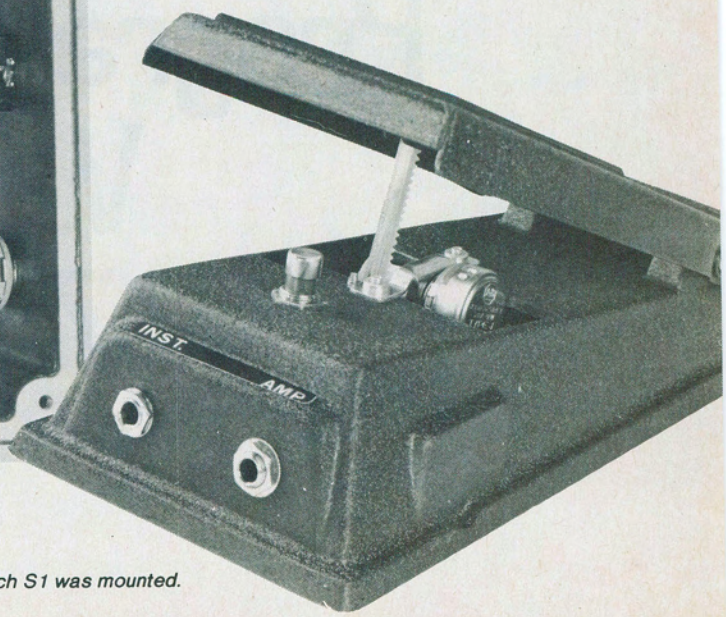


Fig. 5. View of pedal showing how switch S1 was mounted.