

## A NEW MUSICAL EFFECTS UNIT



# AUTOWAH

BY P. J. GOODWIN

**T**HIS unit contains a novel guitar effects circuit which uses an operational amplifier as a filter and attenuator, to automatically generate either a wah-pedal, or swell-pedal sound. The wah-pedal mode makes use of the Voltage Controlled Filter (v.c.f.), and the swell-pedal makes use of the Voltage Controlled Attenuator (v.c.a.); the effect being triggered by the start of each new note played through the unit. This leaves the guitarist's foot free to operate other effects pedals and switches, and also, especially when used in the attenuation mode, produces an effect not easy to achieve by conventional means.

### PRINCIPLE OF OPERATION

Referring to the block diagram in Fig. 1 it can be seen that the input signal is buffered by an amplifier, and fed to a rectification and pulse generator circuit. This fires a pulse to the ramp generator at the start of each note. The pulse has the effect of resetting the ramp (which normally rests high), then allowing the output voltage to climb back up to the high end again, at a

rate set by the time control. This ramp voltage is fed to the signal processing circuit, which can be switched into either a v.c.f. or v.c.a. mode of operation. Thus each note produced by the guitar will initiate its own ramp, and consequently its own "wah" or "swell".

A switch is also fitted to connect the input directly to the output, and so allow the signal to pass unchanged.

### THE CIRCUIT

The v.c.f./v.c.a. is formed by IC1 and its associated components as illustrated in Fig. 2. Capacitors C1 and C2, and the field effect transistor TR1 form a "T" filter in the feedback path of IC1 when operating as a v.c.f., whilst for v.c.a. mode the f.e.t. becomes part of a purely resistive feedback path.

Amplification of the raw signal is required for the rectifier stage, and this is achieved through IC2. The gain of this pre-amp is set by R5 and R7, and the output is a.c. coupled (C4) to allow for the level shift generated by the diode pump rectifier, giving greater sensitivity. The components D1, D2 and C5 form the rectifier and smoothing circuit, with R8 providing a discharge path for C5. D3 provides a discharge path for C6. A d.c. voltage will appear across C5 throughout the duration of a note from the guitar, and due to the differentiating capacitor (C6), a pulse will be delivered to the base of TR2 at the onset of each note. Now C7 will be reset by TR2 and TR3, but because the pulse is very short, C7 will start to recharge almost instantly, at a rate set by VR2. It is this ramp, starting at the onset of each new note, that is used to control the v.c.f./v.c.a. via the gate of TR1.

Stereo jack sockets are used for input and output connections, to allow automatic connection of the batteries when the plugs are inserted.

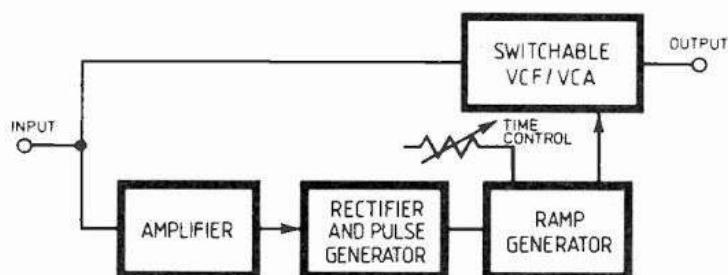
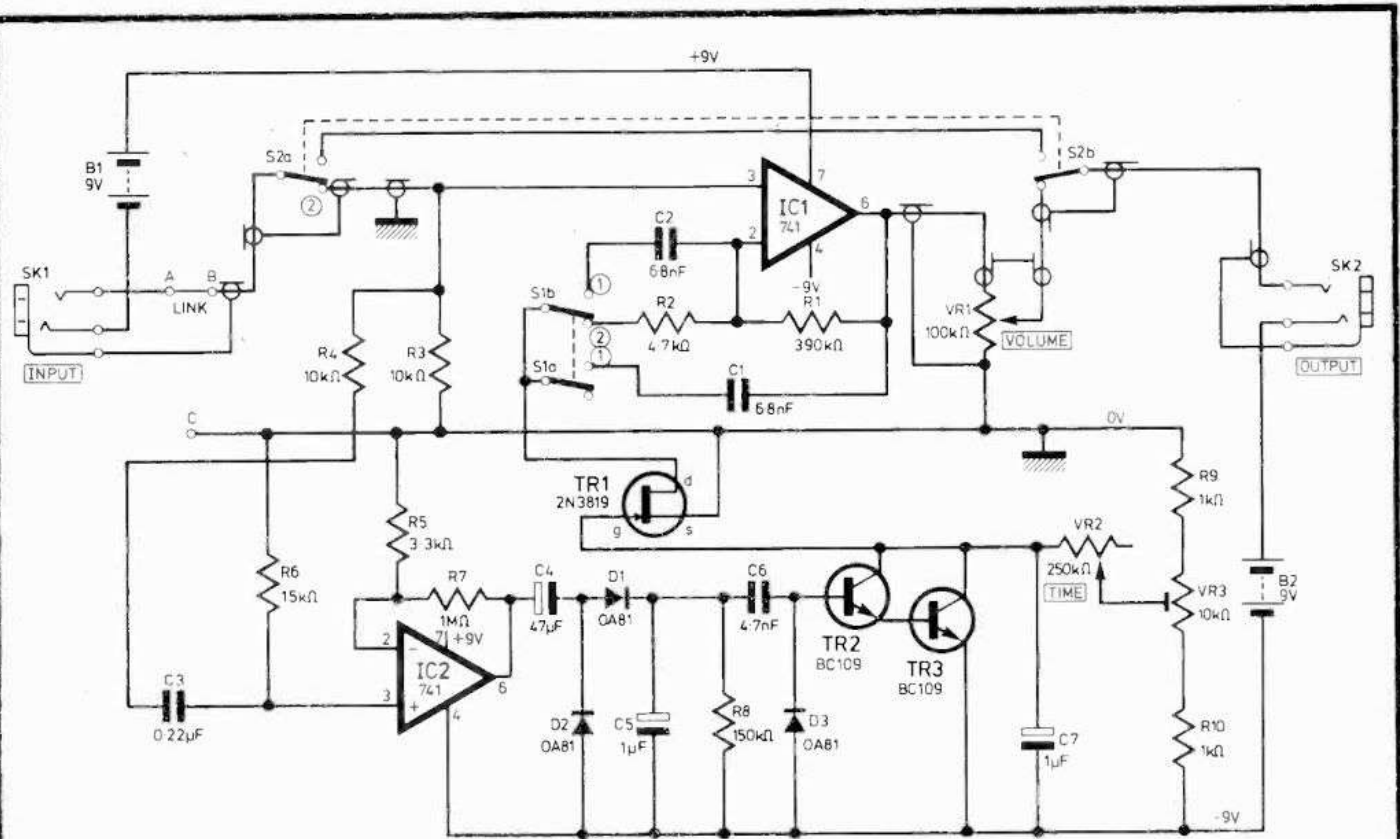


Fig. 1. Autowah block diagram



## COMPONENTS . . .

Fig. 2. Circuit diagram. All input and output leads to the jack sockets are screened, the screening providing an earth path

### Resistors

R1	390kΩ	R6	15kΩ
R2	4.7kΩ	R7	1MΩ
R3	10kΩ	R8	150kΩ
R4	10kΩ	R9	1kΩ
R5	3.3kΩ	R10	1kΩ

All  $\frac{1}{4}$  W 10% carbon

### Potentiometers

VR1	100kΩ log
VR2	250kΩ log
VR3	10kΩ preset

### Capacitors

C1	6.8nF
C2	6.8nF
C3	0.22μF
C4	47μF 25V elect
C5	1μF 10V elect
C6	4.7nF
C7	1μF 16V elect

### Integrated Circuits

IC1	741
IC2	741

### Semiconductors

TR1	2N3819 f.e.t.
TR2	BC109C
TR3	BC109C
D1	OA81
D2	OA81
D3	OA81

### Miscellaneous

4BA+6BA nuts and bolts. Two-pole c/o switches (2 off). Knobs, and a plastic or metal case. Two stereo jack sockets. 0.1 inch matrix Veroboard, 90×100mm approx. Battery connectors (2 off), and wire.

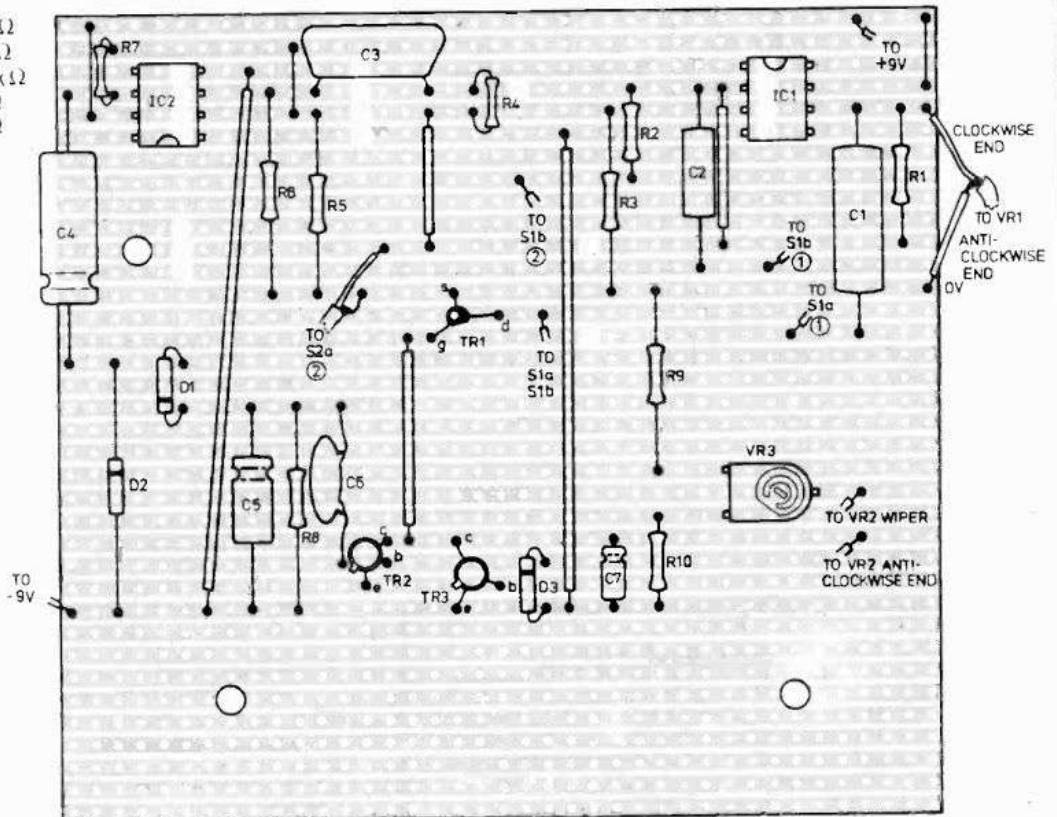
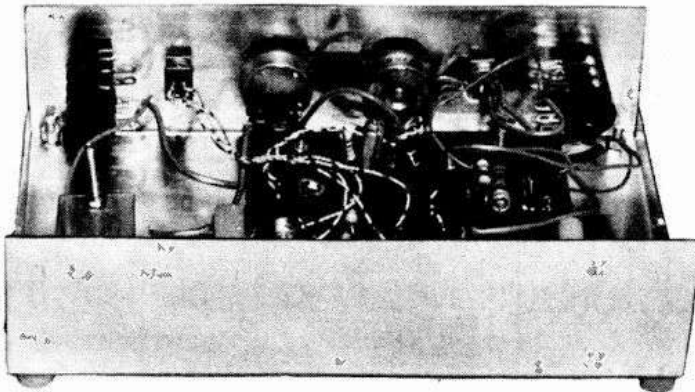


Fig. 3. Component layout. Switch positions are numbered to simplify wiring. Note: C4 is shown with incorrect polarity and should be reversed



Rear view showing wiring to front panel controls

## CONSTRUCTION

The unit was constructed on 0.1in Veroboard as shown in the layout diagram (Fig. 3). The gate of TR1 may be left unconnected at the circuit board construction stage, to allow for a simple test later on.

A ready-made aluminium and steel box, 203 × 140 × 51mm, was used for the prototype, but any convenient case will do, although metal is preferable for both screening and robustness.

Although a miniature two-pole changeover toggle-switch was used as the BYPASS switch on the prototype, a footswitch could be used and mounted in the lid of the box. However, suitable two-pole changeover footswitches do seem to be both expensive and difficult to obtain from electronic parts retailers.

Current consumption is around 4mA (measured in each supply rail), so PP3 or PP6 batteries can be used. The batteries were clamped into the prototype by an aluminium strip held by two long 6BA bolts.

The Veroboard was mounted on two 25mm × 4BA bolts using short lengths of plastic tube as spacers, and with additional support from a block of foam rubber glued to the floor of the box.

Letraset and Letrafilm were used on the front panel, and sprayed with Letracote gloss. This finish tends to be rather brittle, and so a coat of polyurethane varnish would give a more resilient finish.

## TEST

A simple test can be carried out at this point to check the operation of the v.c.f./v.c.a. A fingertip brought close to the gate of TR1 should cause heavy 50Hz mains hum modulation of any note fed through the unit to an amplifier. There should be a clearly audible difference between the v.c.f. mode and the v.c.a. mode. After this check, the gate of TR1 can be connected to the circuit. The unit is sensitive enough to respond to most guitar pick-ups, although some low output guitars may give unreliable triggering.

## ADDITIONAL PRE-AMPLIFIER

Should a low output guitar be used, the additional pre-amp shown in Fig. 4 can be employed to boost the low level signals. It may be fitted inside the Autowah Unit, or built as a separate item with its own case and batteries, so as to be a useful general purpose pre-amp. When used with normal guitar pick-ups, the pre-amp will cause a certain amount of clipping and distortion; but this does give the v.c.f. more harmonics to work on, and results in a stronger more aggressive sound, possibly preferred by some rock guitarists.

## USING THE AUTOWAH

Since the trigger circuit responds to increases in the input level, it is not normally necessary to leave spaces between notes as with some circuits, and quite fast, fluid runs can be played after only limited experience with the unit. However, should the circuit not seem to respond quickly enough to successive notes, R8 may be slightly reduced in value.

For best results, some experimentation with the input levels may be necessary, compensating for any adjustments by a corresponding adjustment to the amplifier volume control.

The output volume of the Autowah is normally set to give no change in volume with the unit switched out of circuit. With the unit in circuit and switched to v.c.f. mode, the time control will vary the length of the "wah", from an extremely short "click" to something over one second. In the v.c.a. mode, most effective results are obtained when the time control is adjusted to just remove the sharp peak at the start of the guitar envelope, which changes the sound to a surprising extent. This produces something like a violin sound; or with fuzz, using the additional pre-amp, a harmonium sound is produced.

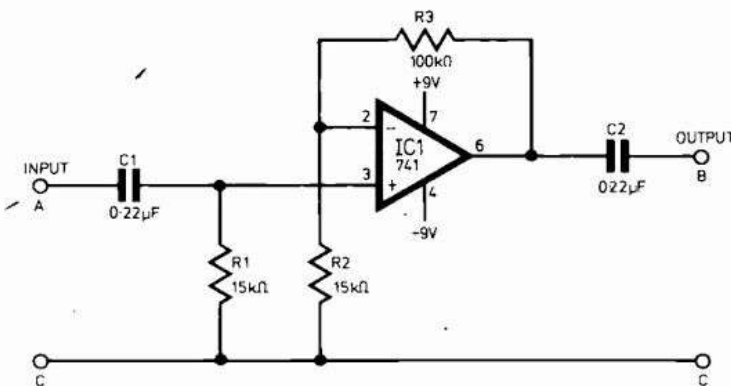


Fig. 4. Additional pre-amplifier for use with low output guitars

## COMPONENTS . . .

### OPTIONAL PRE-AMP

#### Resistors

- R1 15kΩ
- R2 15kΩ
- R3 100kΩ
- All ¼W 10% carbon

#### Capacitors

- C1 0.22µF
- C2 0.22µF

#### Integrated Circuits

- IC1 741