FUZZ BOX

By C.F. TERRELL

An effects unit designed for use with electric musical instruments.

Still one of the most used effects units in the world of "pop music" is the fuzz box. Although this "effect" was one of the first used, its popularity has not waned.

The fuzz box is used most by the lead guitarist but has on occasion been found useful for the bass guitar and organ to produce an exciting and dramatic sound.

The Fuzz Box to be described in this article is simple to build, is inexpensive (compared with commercially available units) and incorporates a footswitch that enables "fuzz" or "straight-through" operation. It is powered by a single PP3 9 volt battery, and since current drain is in the order of 1 milliamp, the battery should last a long time.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Fuzz Box is shown in Fig. 1, and is seen to be a simple two-stage amplifier incorporating negative feedback between the stages.

Transistors TR1 and TR2 are wired in a d.c. feedback pair configuration giving high gain which is virtually independent of individual transistor gains. Base bias for TR1 is derived from the emitter of TR2 via feedback resistor R2. The biasing has been arranged such that TR1 is biased close to saturation level.

Input is via coupling capacitor C1. For ease of explanation it will be assumed that a small sinusoidal signal of peak amplitude greater than about 10 millivolts is being inputted, see Fig. 2(a).

The positive half cycles of the input waveform cause the transistor TR1 to move further towards saturation and to become saturated on the peaks. The point at which saturation is reached is determined by the amplitude of the input and the setting of the fuzz control—but more about this later. The result of this is to produce severely clipped sine wave as seen in Fig. 2(b).

The negative excursions of the input waveform may also produce a clipped output if the input signal is of sufficient amplitude, in which case a waveform of that shown in Fig. 2(c) would be obtained.

Note that the signal appears inverted. This is due to the property of a single-stage common emitter amplifier producing a phase shift of 180 degrees.

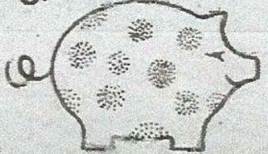
The single or double-clipped waveform is then directly coupled to the base of TR2 where it is further amplified to produce a double-clipped waveform with very short rise time. The output is approximately a square wave, Fig. 2(d).

The output at the collector of TR2 swings by 9 volts, peak-to-peak. This is too high to be inputted into an amplifier and is attenuated by using a split collector load and taking the output from the junction of R3 and R4. This arrangement attenuates by a factor R3/(R3+R4) to give a peak-to-peak swing of approximately 600 millivolts which is coupled to the volume control VR2 by C2, functioning as a d.c. blocking capacitor.

The circuit formed by C2 and VR2 is that of a differentiator whose time constant has been designed to produce "spiking" at low frequencies. This enhances the sharpness of the fuzz effect at low frequencies.

FOR GUIDANCE ONLY

ESTIMATED COST* OF COMPONENTS
including V.A.T.



£3.00
including case

*Based on prices prevailing at time of going to press

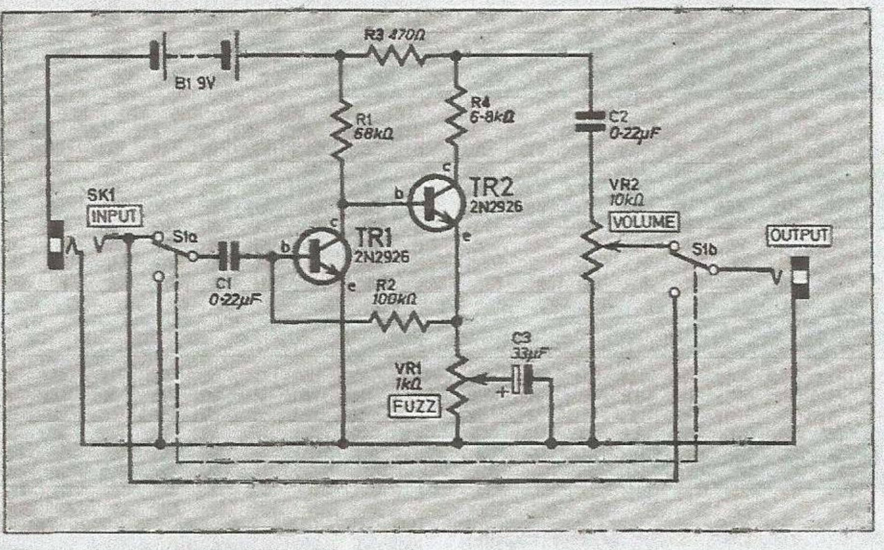


Fig. 1. The complete circuit diagram of the Fuzz Box with built-in footswitch.

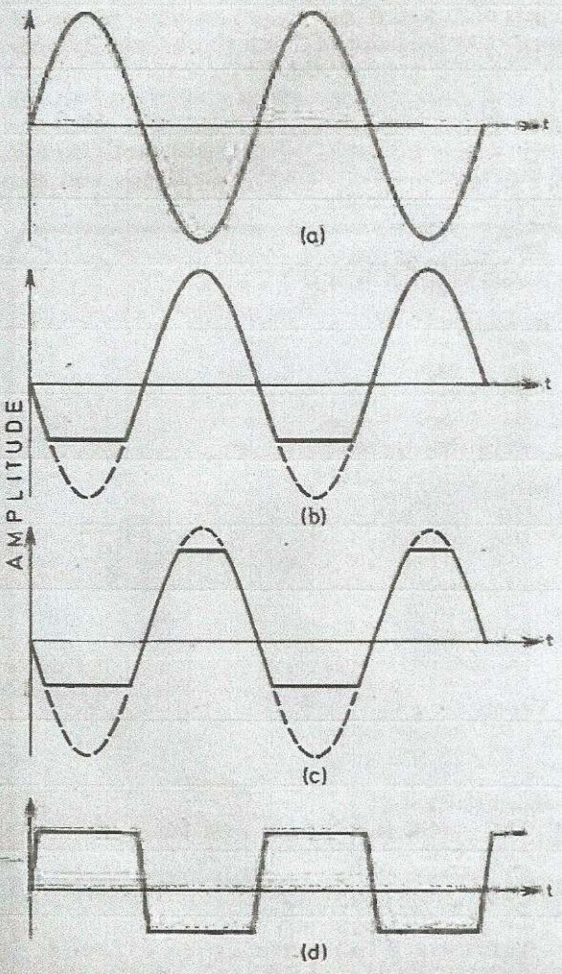


Fig. 2. (a) The input waveform; (b) waveform at collector of TR1; (c) at collector of TR1 if input signal amplitude is increased; (d) output waveform at collector of TR2.

FUZZ CONTROL

A control over the "quality" or "quantity" of fuzz is afforded by VR1.

Now the a.c. gain of the feedback pair is dependent on the ratio of feedback resistor R2 to the a.c. resistance (impedance) in the emitter leg of TR2.

It can be easily verified that the reactance of C3 is approximately equal to $5000/f$ ohms where f is frequency of the input signal.

For $f = 100$Hz and 10kHz, the reactance of C3 is approximately 50 ohms and 0·5 ohm respectively. Therefore, the effect of shunting VR1 or portion of VR1 can dramatically affect the gain of the amplifier. It can also be seen that the higher the frequency, the higher the gain for the same setting of VR1.

As VR1 is turned up, so as more of VR1 is shunted by C3, it has been shown that the gain of the two-stage amplifier is increased, but since limiting (clipping) is evident from the beginning of turning VR1, it is difficult to see how this control further affects the tone of the fuzz. So how does it work?

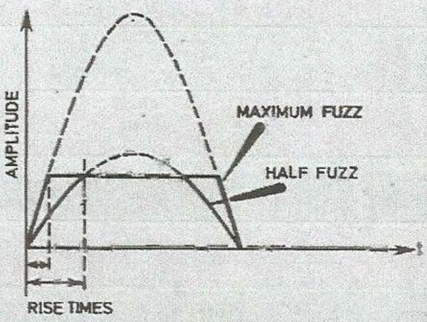


Fig. 3. Shows how the gain of the amplifier pair is proportional to the harmonic content.

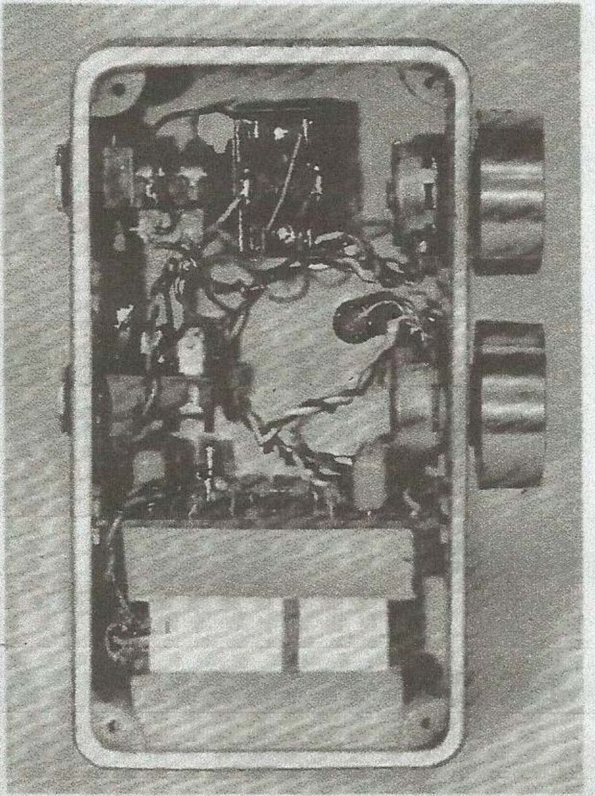
Well, when the control VR1 is set for maximum effect, (total shunt), the onset of clipping occurs at a much shorter time (measured from when the signal starts to rise or fall) than when the control is set, say halfway, see Fig. 3. The important observation is that the waveform at the collector of TR2 is much more "square" than when set at say, the halfway position, indicating the presence of higher order harmonics (see *Help E.E. Feb. 74)*. It is the latter that determines the harshness of the fuzz effect.

CONSTRUCTION

The prototype Fuzz Box used a piece of 0·15in matrix Veroboard size 7 strips by 17 holes to secure the smaller components. The layout of the components on the topside of the board, and the breaks on the underside of the board are shown in Fig. 4.

In the prototype, no component board fixing holes were needed, since the commercially available fibreglass case used had slots to accommodate the board. If this type of fixing is not available, the board should be extended to allow a fixing hole to be made.

Begin by making the necessary breaks along the copper strips and then position and solder the resistors and capacitors according to Fig. 4. The transistors should be mounted last of all and a heatshunt used to avoid thermal damage.



Photograph of the inside of the completed prototype Fuzz Box.

Now attach the five flying leads using adequate lengths to reach the other components.

It is now necessary to prepare the case to mount SK1, SK2, VR1, VR2 and S1. Secure these components to the case and wire up to each other and the component board as in Fig. 4.

Note that there is no battery on/off switch; the battery circuit is made on the negative side by use of an extra earth tag on the input jack socket SK1, the connection between the two earth contacts being made by the earth shank on the jack plug. It is therefore, essential to remove the input jack plug when the unit is not in use so as to prolong the life of the battery.

If the type used in the prototype is not available, a stereo jack socket can be used. In this case, the two rear contacts should be used so that the input jack plug earth shank connects these two contacts and completes the battery circuit on the negative side. Alternatively, an on/off switch can be wired in series with the battery.

The battery is held in position behind the component board by means of two pieces of sponge foam as shown. With the battery in position the bottom panel should be secured in place.

It is a good idea to attach rubber feet to the underside to prevent the unit slipping when the footswitch is operated. The rubber feet also add to the appearance. Attach two knobs and the unit is ready for testing.

Components....

Resistors
R1 68kΩ
R2 100kΩ
R3 470Ω
R4 6·8kΩ
All ¼ watt carbon ± 10%

Potentiometers
VR1 1kΩ lin. carbon
VR2 10kΩ log. carbon

SEE
SHOP TALK

Capacitors
C1 0·22µF
C2 0·22µF
C3 33µF 10V elect.

Transistors
TR1 2N2926 silicon *npn*
TR2 2N2926 silicon *npn*

Miscellaneous
SK1 mono jack socket type R26/1 (Re-An Products) or standard stereo type
B1 9V PP3
SK2 mono jack socket
S1 d.p.d.t. foot switch
Veroboard: 0·15in. matrix 7 strips x 17 holes; battery clips to suit B1; knobs (2 off); case (type FB1 E. R. Nicholls); rubber feet (4 off); foam sponge; connecting wire.

FUZZ BOX

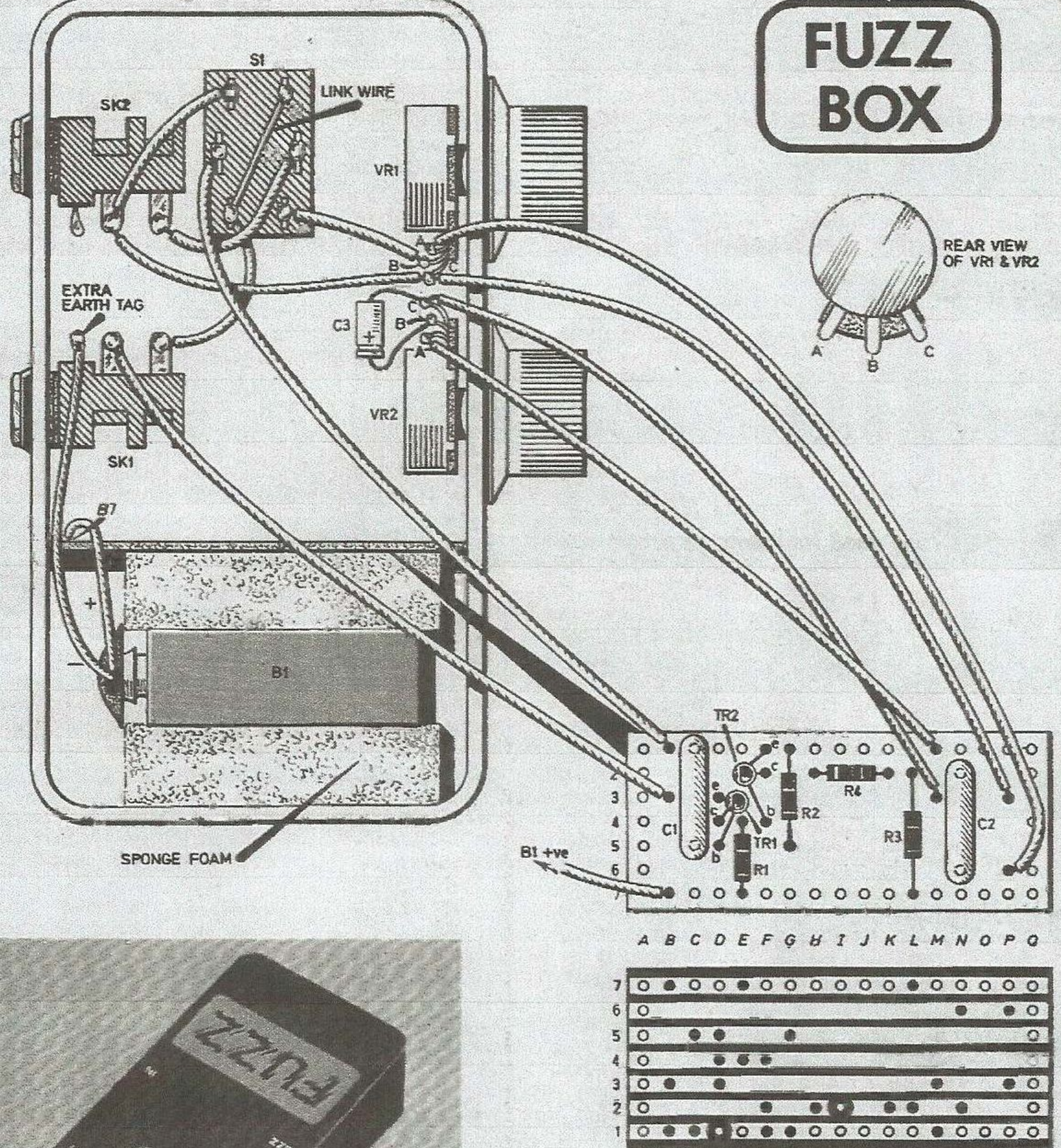
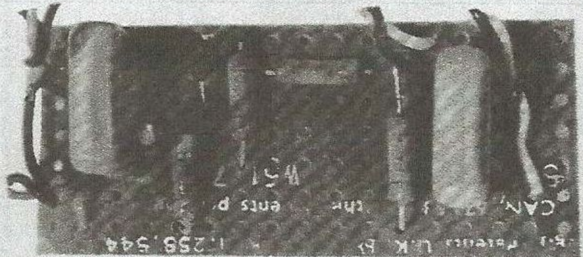


Fig. 4 (above). The layout of the components on the Veroboard and wiring up details to case mounted components.

Photograph of the completed unit.

Shown right is a photograph of the component board.



IN USE

The electric guitar or other instrument should be plugged in at SK1 and with the gain and fuzz controls turned low; the fuzz output, SK2, should be plugged into an amplifier using a length of screened cable, both ends terminated with a jack plug.

Turn up the gain control slightly, and on playing the guitar a slight fuzz sound, or the unaffected guitar sound should be heard. Depressing the foot switch should change from one state to the other.

With S1 set for fuzz, the fuzz control, VR2, should be turned clockwise, resulting in a more harsh fuzz.

With VR2 set for the required fuzz tone, the gain control should be set so that the required balance between "straight-through" and "fuzz" is obtained.

When the prototype unit was thoroughly tested to satisfaction, the component assembly was removed from the case and the case cleaned and sprayed with a matt black aerosol paint. The controls and jack sockets were then labelled using Letraset, as shown, to give a neat, professional finish. ▣

Speaker impedance

I have been given a record deck and I have a suitable amplifier which uses two 16 ohm loudspeakers. I only have two 8 ohm loudspeakers. Is there any way of coupling these to the amplifier without causing damage.

Although not an ideal solution you can put each loudspeaker in series with an 8 ohm resistor of suitable power rating to increase their effective impedance. The problem with this approach is that you will half the effective power output into the loudspeaker. Nevertheless if your amplifier provides an output in the range of 5 to 10 watts this should present no major problem for domestic applications.

The resistors you use should have a power rating approximately equal to the channel output power that is quoted for your amplifier and you should remember that they might get warm.

'Scope

I am contemplating buying a cheap oscilloscope — possibly secondhand or surplus. Could you advise me as to what would be the minimum features I should look for if it was to be used on projects similar to those published in your magazine?

Advising someone on what is desirable in an oscilloscope is rather like trying to advise a woman about a dress! Everyone has his own opinions. However if one is limited in price (we assume the range £25 to £40) we can be of some help. Invariably you will find that the older type of 'scope is cheaper—the type with circular screen format as opposed to the more modern rectangular shape. Quite honestly the appearance of the unit is irrelevant and screen shape is unimportant for simple applications.

One might be tempted to go for an impressive looking machine with dozens of knobs on the front panel; these are fine if you know what you are doing but can be very confusing to operate unless you have some previous experience. We would suggest you look for a simple unit which has sophistication built into its electronics rather than into its appearance—apart from being easier to use it will probably be more reliable.

Considering the self imposed price restriction we must talk in terms of a SINGLE BEAM 'scope; it should be of medium persistance and should have controls for beam brightness and focus (some surplus types may offer an astigmatism control which is an extension of the focus to get a really sharp spot). The two most important parameters to select on are the range of X-timebase speeds or frequencies and the sensitivity of the Y-amplifier. A good general purpose instrument will have X-timebase speeds ranging from 100mS per cm to about 1µS per cm with a five or six position range switch and a fine speed control which makes the switched ranges overlap. Such an instrument will cover most circumstances that involve frequencies up to about 1MHz.

The timebase ought to be triggerable. Cheaper instruments will have automatic trigger control but we feel that an overriding manual trigger level control is a very useful feature—even though it makes the unit a little more complex to operate. Having an option for external triggering is a bit of a luxury and is seldom needed in simple applications.

The Y-amplifier should ideally be switchable between a.c. coupling and d.c. coupling, however, having the facility to measure d.c. voltages on an oscilloscope usually puts its price up. Whatever you decide on the latter point you should aim to go for as high an input impedance as possible (greater than 1 megohm) and its sensitivity should give you vertical beam deflections of from 10mV per cm to about 5V per cm at its least sensitive end.

There should be a fine control on this sensitivity which can be switched to a calibrated position —so that you know where you stand. In the absence of a calibrated amplifier there should be an internally generated calibration signal available on the front panel for checking purposes. There should also be vertical and horizontal beam shift controls. The above points are usually embodied in most instruments called "service scopes" as well as many other niceties but we suggest that you consider the above as being MINIMUM requirements — your pocket sets the MAXIMUM!