

**T**HE fuzz effect produces a marked change in the tone of a guitar or other sound source, and may be used to add more interest to appropriate musical passages.

Various mechanical means of producing these effects are supplemented by purely electronic methods. Some of the electronic circuits are capable of introducing considerable signal gain or "volume boost" whilst others consist of diode limiters or similar devices, and do not result in an increase in volume.

Examination of the circuit diagram (Fig. 1) and other constructional diagrams, shows that the "fuzz module", which is the basis of the electronic fuzz effects described in this article, is both cheap and easy to construct. The printed circuit board is the standard P.E. "Bonanza Board" design without any link wires.

A number of effects are introduced, sometimes separately, sometimes simultaneously, according to the operating conditions. They are:

- (1) Severe amplitude distortion and harmonic generation;
- (2) Treble boost;
- (3) Frequency division by various discrete factors;
- (4) Intermodulation when fed with two or more frequencies;
- (5) Tremolo (when one or both diodes are omitted).

### BASIC PRINCIPLE

The main function of the first stage TR1 is as an impedance-matching device, as many guitars are designed for high impedance operation. Although a certain amount of distortion, and clipping of the waveform peaks, may occur here, the main effects are brought about by the circuitry of the remaining two stages.

The second stage TR2 functions as a non-linear amplifier, and although it can be biased into a linear amplifying state when quiescent or at low signal level, even here it is not used linearly, as it usually becomes overdriven in normal use.

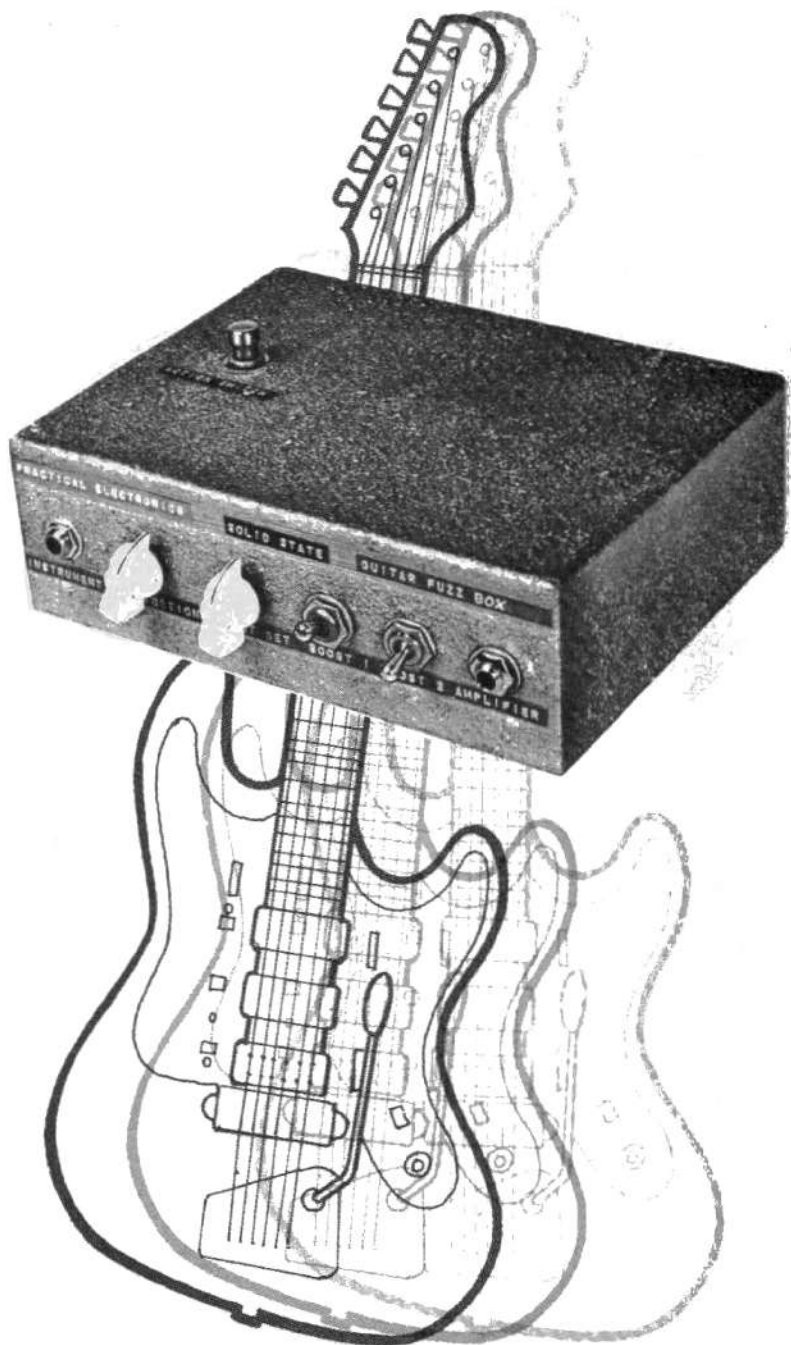
The third transistor TR3 is the output stage, and is usually overdriven, giving even more distortion. As its output voltage is quite high, and is likely to have a peak-to-peak value equal to almost the full supply voltage of about 9 volts, this stage is usually followed by an attenuator as described elsewhere in this article.

### AMPLITUDE DISTORTION

The fuzz module produces amplitude distortion in several ways; this originates principally in TR2. If this transistor is biased to an extent where "bottoming" occurs, it will amplify on signal peaks of one polarity only, producing a "spiked" or pulsed collector voltage waveform. Signal peaks of this same polarity may be clipped by diode D1, if of sufficient amplitude.

Peaks of the opposite polarity are clipped by the transistor itself. If the transistor is biased into a slightly less conductive region, signal peaks of one polarity will be much amplified, giving a spiky waveform, whereas the remainder of the waveform will not be amplified very much.

Further alteration of the bias is likely to result in high sensitivity, and this can be used to produce acoustic feedback. This is due to a change of the operating point of TR2 to a point of high gain. Increase of the bias to the point of "bottoming" or just beyond, results in low sensitivity, tending to suppress feedback effects. Where waveform peaks can overcome this bias, the resultant volume of the distorted sound output from the loudspeaker can be great.



# FUZZ BOX

By A. J. Bassett

## COMPONENTS . . .

## FUZZ MODULE

### Resistors

R1	4.7M $\Omega$	R4	3.3k $\Omega$
R2	10k $\Omega$	R5	470k $\Omega$
R3	10k $\Omega$	R6	22k $\Omega$

All 10%, 1/4 watt carbon

### Capacitors

C1	0.01 $\mu$ F disc ceramic 20V
C2	100 $\mu$ F elect. 15V
C3	10 $\mu$ F elect. 15V
C4	0.01 $\mu$ F disc ceramic 20V
C5	0.01 $\mu$ F disc ceramic 20V
C6	0.01 $\mu$ F disc ceramic 20V

### Transistors

TR1	MAT101
TR2	MAT101
TR3	MAT120

### Diodes

D1, D2 OA5 (2 off)

### Miscellaneous

Printed circuit board kit

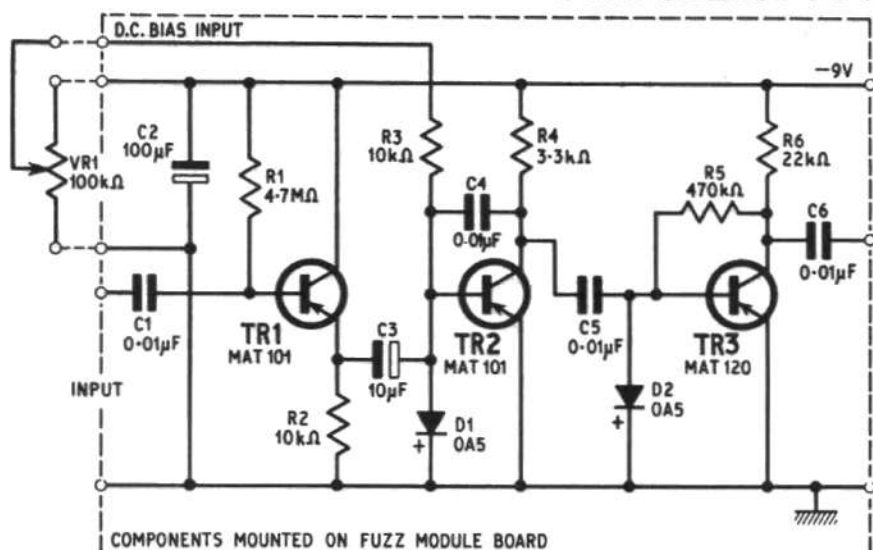


Fig. 1. Circuit diagram of the basic fuzz module

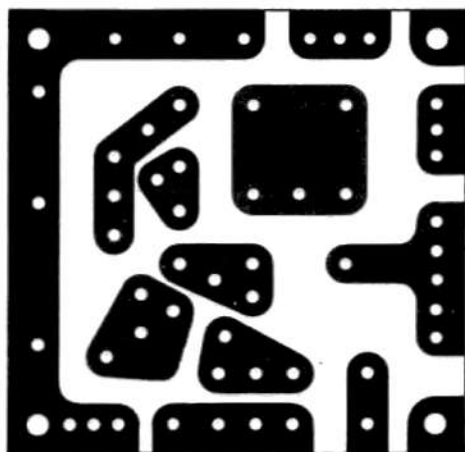
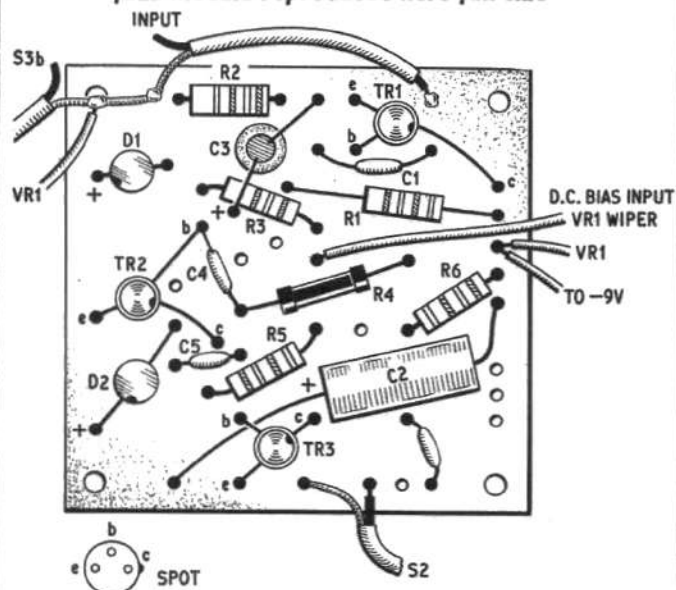


Fig. 2. Printed circuit pattern for the fuzz module reproduced here full size



TRANSISTOR CONNECTIONS  
LOOKING AT WIRES

Fig. 3. Layout of components on the printed circuit board

Amplitude distortion and waveform clipping generate plenty of harmonics, which gives the fuzz sounds such a rasping quality.

### TREBLE BOOST

The coupling capacitors are of low value to give some treble boost. The effect may be boosted further by the removal, or reduction in values, of the negative feedback capacitor C4, at a slight risk that stray capacitances may cause the circuit to produce unwanted high frequency oscillation. The treble boost is also more evident when TR2 is biased to give a high gain.

### FREQUENCY DIVISION

Frequency division occurs mostly when TR2 is "bottomed", or nearly so. Not all the peaks of the incoming waveform will then transfer the transistor over to an amplifying state. This happens only at intervals, but must bear a definite relation to the input frequency. The output is then at a frequency lower than that of the input, and known as a "sub-harmonic".

Since the division may be by a ratio of two or some higher number, the "sub-harmonic" frequency is often quite low. Hence the fuzz module is capable of introducing more bass as well as more treble frequencies into the output, thus reproducing the guitar sound over a wider portion of the audio spectrum. (Might not the popularity of this "frequency range expansion" be related to what is known in some circles as "consciousness expansion"?)

### INTERMODULATION

When two or more strings are played simultaneously, intermodulation is almost certain to occur. This is a well known phenomenon which results in the production of additional tones, which are not harmonically related to the notes played. The result is often not musical, though with skill in use, the effect can be made musically useful.

### TREMOLO

If one or both diodes are omitted from the circuit, a tremolo effect may be produced, dependent upon periodic (but not always regular) blocking of TR3. If this effect is required, a switch may be included in

series with D2, and mounted on the chassis. If an increase in the duration of the blocking action is required, a larger value of capacitor may be placed in parallel with C5, which couples the signal from TR2 to the base of TR3. Values tried may be up to several microfarads and these higher values may be either paper or electrolytic as convenient.

## WAVEFORM JITTER

Waveform jitter is an effect deliberately produced in mechanical fuzz units. A small amount of "jitter" is produced in this electronic fuzz module and originates in slight irregularities in the incoming signal. Some of these irregularities are amplified and intensified to a certain degree, giving rise to random effects. The result is a slight waveform "jitter" which can be observed with an oscilloscope and, if intensified, gives rise to some interesting effects.

## BUILD THE MODULE

Using components in the parts list (see Fig. 1), construct the fuzz module on the basic printed circuit pattern shown in Fig. 2. This particular pattern is, in fact, the P.E. Bonanza Board design, but a new one can be made by using one of several printed circuit kits now on the amateur market. The pattern in Fig. 2 is printed full size so that it can be used as a template.

There should be no difficulty in mounting the components on the other side of the board, provided the usual precautions are taken when soldering. Fig. 3 should be followed to help obtain a neat finished result.

Before testing the module, check that your construction is correct, and agrees with the circuit diagram. C4 may be omitted unless there are signs of h.f. instability.

Before incorporating the module in the chassis, read the following notes on applications, then decide what effects are required and construct the chassis accordingly. Placement of components in the chassis for both versions A and B is given as a rough guide, but there is plenty of room to alter the layout if required.

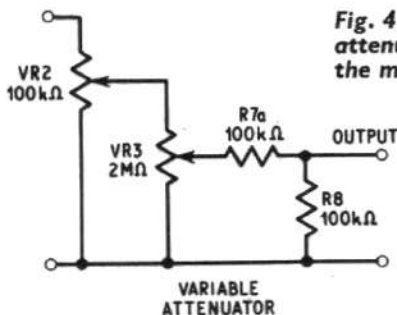


Fig. 4 (left). Simple variable attenuator used when testing the module

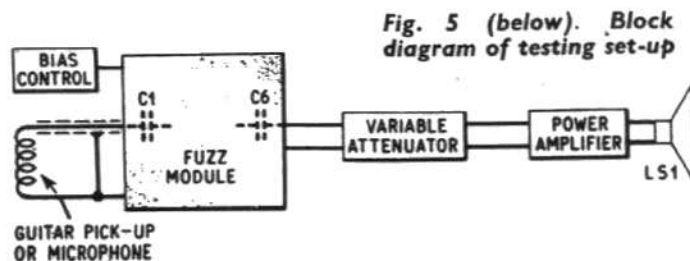


Fig. 5 (below). Block diagram of testing set-up



Simple version—Fuzz Box A

## TEST THE MODULE

To test the fuzz module the following will be required: an audio amplifier with loudspeaker, an electric guitar or a microphone (most microphones are suitable, but one of medium impedance between 500 ohms and 100 kilohms is advised), a 9 volt battery, a 100 kilohm potentiometer, and an attenuator to prevent overloading of the amplifier input.

A simple variable attenuator circuit (shown in Fig. 4) is connected to the output of the module, with the attenuator output wired to the input of the power amplifier. The circuit for testing the module is shown in Fig. 5, and may be temporarily set up for this purpose before the module is used in a more advanced project such as a fuzz box or other effects unit.

All volume controls should be set to a low level, and a sound signal injected into the system from the guitar or microphone. Adjust the controls so that the sound comes through at a reasonable level, and carefully vary VR1 to give different levels of distortion and gain. This may result in acoustic feedback at certain points, with lower volume at both top and bottom settings. Set VR1, in conjunction with the volume controls, for best results, giving a rasping tone to the signal.

## NOISE LEVEL

At some settings of the controls, the circuit can be quite noisy, but careful adjustment can reduce this to a lower level. Signal-to-noise ratio is also better with some instruments than with others, and may depend upon the settings of the controls on the guitar itself.

## USING THE MODULE

For those with economy in mind, the module may be simply installed in a screened metal box along with standard audio input and output sockets, battery, and on/off switch. A small carbon resistor may be connected from the "bias input" to the negative supply, the value chosen to give the degree of distortion required. A suggested value is 1 megohm.

If the attenuator network is omitted, it is best to connect a 4-7 megohm resistor in series with the output, to cut down the output signal and avoid overload to the main amplifier. The complete chassis using this simple arrangement is shown in Fig. 6. The fixed resistor R7b can be switched in by S2.

An arrangement which is in general more satisfactory as a "fuzz box" is shown in the circuit diagram of Fig. 7, and the layout is shown in Fig. 8. This circuit uses the variable attenuator with two boost switches S1 and S2. In both designs the battery is switched into circuit by the insertion of a "tip-sleeve" jack plug into JK2. The connection is made between the jack

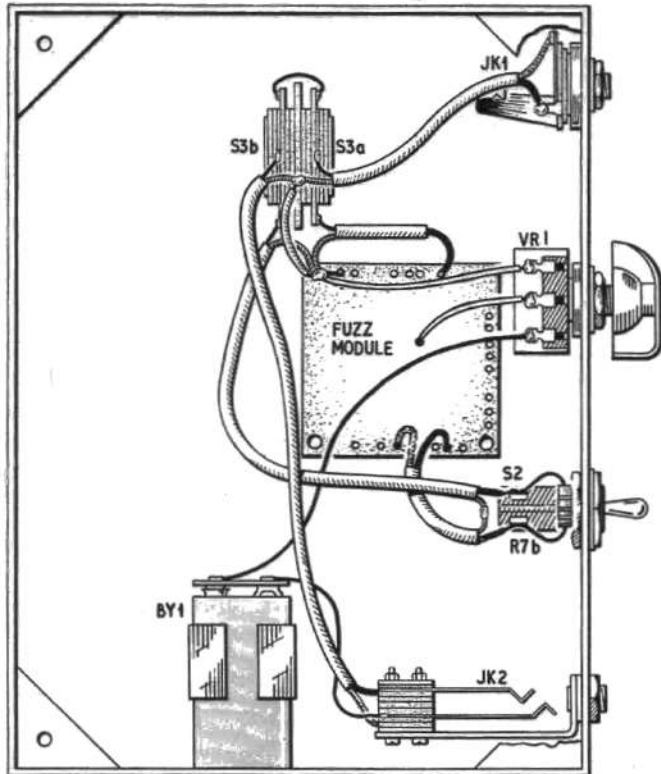
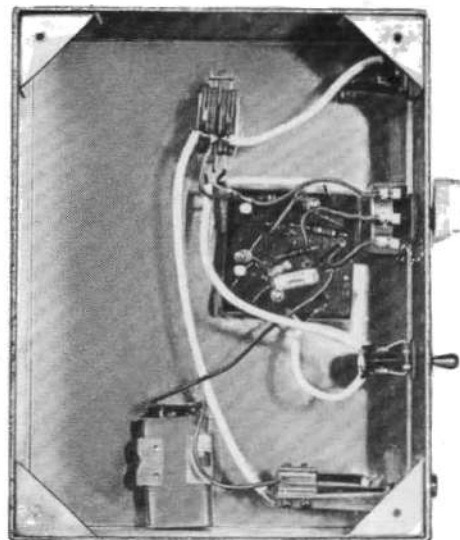


Fig. 6. Layout of components in the chassis for the simple version of the fuzz box

The photograph (right) shows the interior of the simple Fuzz Box A



## COMPONENTS . . .

### FUZZ BOX 'A' COMPLETE

(Simple version Fig. 6)

In addition to the Fuzz Module:

- VR1 100k $\Omega$  linear carbon potentiometer
  - R7b 4.7M $\Omega$  10%,  $\frac{1}{4}$ W carbon resistor
  - S2 Single pole, on/off, toggle switch
  - JK1 Jack socket, tip and sleeve, with plug
  - JK2 Jack socket, tip and sleeve insulated from mounting (Bulgin type J16 with plug)
  - S2 Push-to-make, push-to-break, double-pole, double-throw switch (Bulgin type SR 270)
  - BY1 Battery 9V
- Chassis, aluminium 8in  $\times$  6in  $\times$  2 $\frac{1}{2}$ in  
Single core screened wire  
Battery connector and knob

## COMPONENTS . . .

### FUZZ BOX 'B' COMPLETE

(Advanced version Fig. 8)

In addition to the Fuzz Module and all components for the simple version:

- VR2 100k $\Omega$  log. carbon potentiometer
- S1 Single pole, on/off, toggle switch

Note: When testing the module the following are also required for the attenuator (see Fig. 4):

- VR3 2M $\Omega$  log. carbon potentiometer
- R7a 100k $\Omega$
- R8 100k $\Omega$  } 10%,  $\frac{1}{4}$ W carbon resistors

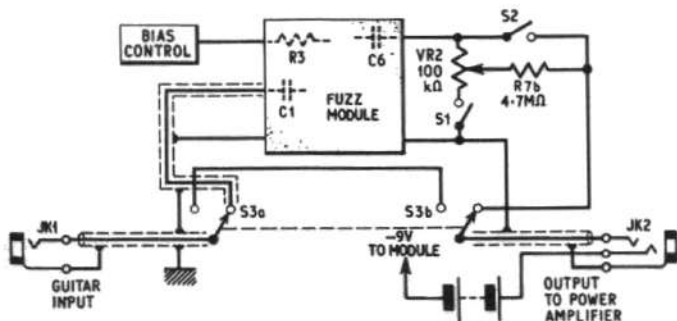


Fig. 7. Circuit diagram of the advanced fuzz box

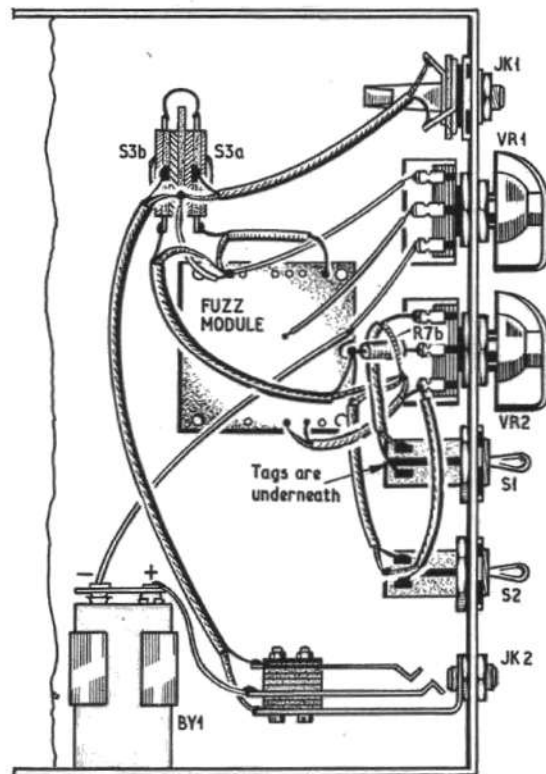


Fig. 8. Component layout for the advanced fuzz box

mounting nut (chassis) and the plug sleeve connected to battery positive.

Although the circuit can be built in a much smaller box than that shown, and will fit with ease in a box only 6in x 3in x 2½in, the larger size is more convenient for use on stage, particularly when operated by a foot on the push button "action" switch S3.

One advantage of this arrangement is that, in the straight-through or "non-fuzz" position of the "action switch" S3, the guitar signal passes straight through the unit absolutely unchanged. In some commercial and amateur designs, this is not the case; the signal may be attenuated or interfered with in some other way.

### MAKING YOUR GUITAR HOWL

The boost switches S1 and S2, which are used in the better design (Figs. 7 and 8), can be used singly or in combination to produce a very strong fuzz signal, which usually results in acoustic feedback or howl.

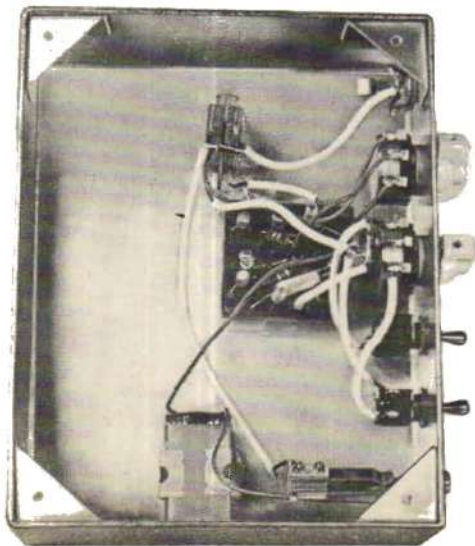
Your loudspeakers and amplifier should be able to handle the extra volume without damage. (Some manufacturers guarantee that certain of their amplifier and loudspeaker equipment is built to withstand operation under continuous overload conditions. Others do not, and in some cases the equipment might fail. It is a wise precaution to check on this point first.) Here is an opportunity to make simultaneous use of the vibrato arm, or a "bottleneck".

### OTHER USES

The fuzz module may be used in theatrical production to disguise the voice. In this connection, and also for guitar use, simultaneous introduction of other effects such as echo, reverberation, tremolo, treble or bass boost, or filters as used in electronic organs can add greatly to the tonal interest. These other effects should be added between the fuzz module and the power amplifier in order to modify the output waveform of the fuzz module.

### ANTI-HOWLROUND

For some purposes it may be desirable to use high volume without acoustic feedback. This can be done by turning VR1 carefully clockwise—towards the negative supply. At first, feedback will be intense, but a point can be found where the feedback will subside, yet ample volume will be available from the unit, often considerably higher than can be obtained with the instrument connected straight to the amplifier.



Interior view of advanced Fuzz Box B

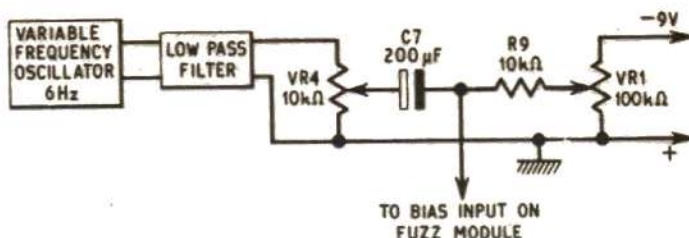


Fig. 9. Using an i.f. oscillator and low pass filter, add VR4, C7, and R9 to the bias control VR1 for rhythmic fuzz

### RHYTHMIC FUZZ

The behaviour of the module is greatly influenced by the amount of negative bias fed to the bias input. Also a small amount of positive bias will switch off TR2, and effectively block the signal path altogether. The experimenter may take advantage of these features for various purposes including remote or automatic control over the module.

One suggestion here is to connect the bias input to a low frequency oscillator (as used in tremolo units) according to the circuit in Fig. 9, when the fuzz output quality and amplitude will be controlled by the oscillator to give a rhythmic fuzz effect. The oscillator may be run at around 6Hz for most purposes. ★

## Meetings . . .

### SOCIETY OF ELECTRONIC AND RADIO TECHNICIANS

#### COVENTRY

Date: October 19  
 Title: Thyristors  
 Time: 7.30 p.m.  
 Address: Herbert Art Gallery and Museum, Earl Street, Coventry.

#### NORTHAMPTON

Date: October 26  
 Title: Record Playing Units  
 E. Mortimer  
 Time: 7.0 p.m.  
 Address: Northampton College of Technology, St. George's Avenue, Northampton.

### INSTITUTION OF ELECTRICAL ENGINEERS

#### LONDON

Date: October 20  
 Title: Testing and Specification of Integrated Circuits  
 Time: 5.30 p.m.  
 Address: Savoy Place, London, W.C.2.

### INSTITUTION OF ELECTRONIC AND RADIO ENGINEERS

#### COLCHESTER

Date: October 24  
 Title: The Future of Electronic Telephone Exchanges  
 V. E. Mann  
 Time: 7.0 p.m.  
 Address: University of Essex, Wivenhoe Park, Colchester.

#### NOTTINGHAM

Date: October 18  
 Title: Microcircuitry, Dr. I. C. Walker  
 Time: 6.30 p.m.  
 Address: Nottingham University, University Park.