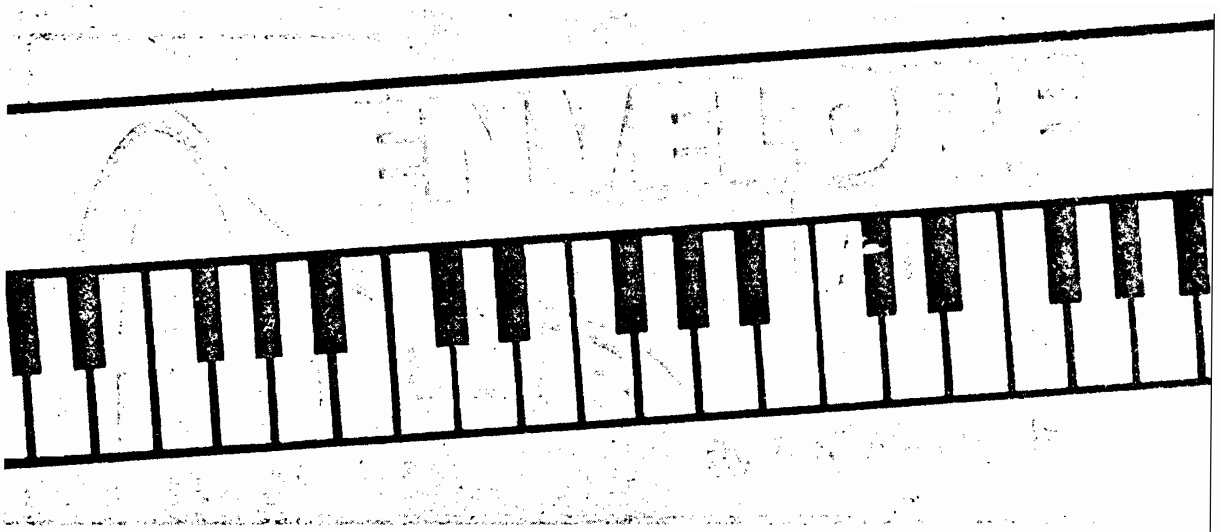

THE unit described here has been designed to fulfil the need for a more acurate synthesis of the amplitude envelope of musical instruments, particularly stringed, when used in conjunction with a music synthesiser and a keyboard.

The circuit achieves this in a very simple manner and the use of linear integrated circuits makes construction easy and keeps the cost low. In fact this unit costs little more to build than a standard envelope shaper.

PRINCIPLE OF OPERATION

Most envelope shapers have two variables: attack time and decay time, as shown in Fig. 1a. Fig. 1b, however, shows that stringed instruments in particular have a much more complex amplitude envelope. Fig. 1c shows that a more accurate synthesis is obtained by splitting the decay slope of Fig. 1a into two parts and introducing a sustain level, the duration of which is governed by the point at which the effective key is released. Four variables are thus required: Attack time, Decay time, Sustain level and Release time (release time being the second half of the decay slope). Hence the abbreviation A.D.S.R.

THE CIRCUIT

The complete circuit diagram of the envelope shaper is shown in Fig. 2. When the keyboard contacts are closed by the depression of a key, the positive-going voltage is differentiated by C1 and applied to the base of TR2 which along with TR1 forms a bistable.

TR1 is turned off and its positive-going collector voltage causes C2 to charge via D6, R13 and VR2 (ATTACK) until the voltage set at the potential divider, R16/R17 is reached—in this case, about five volts.

At this point, the output of the comparator, IC1 will go very rapidly positive, causing the bistable to reset via C3, when TR1 again conducts.

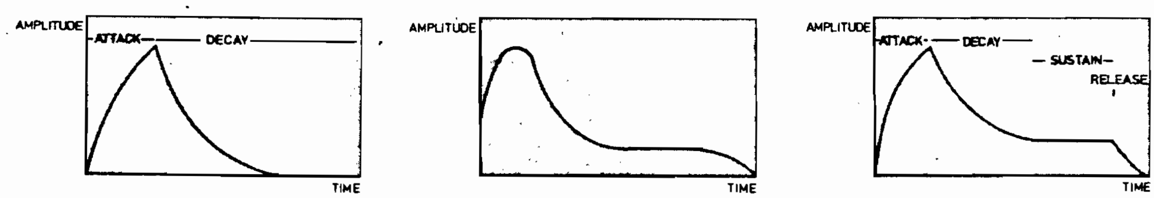

Fig. 1. Amplitude envelopes of (a) a standard envelope shaper, (b) a typical stringed instrument and (c) an A.S.D.R. envelope shaper

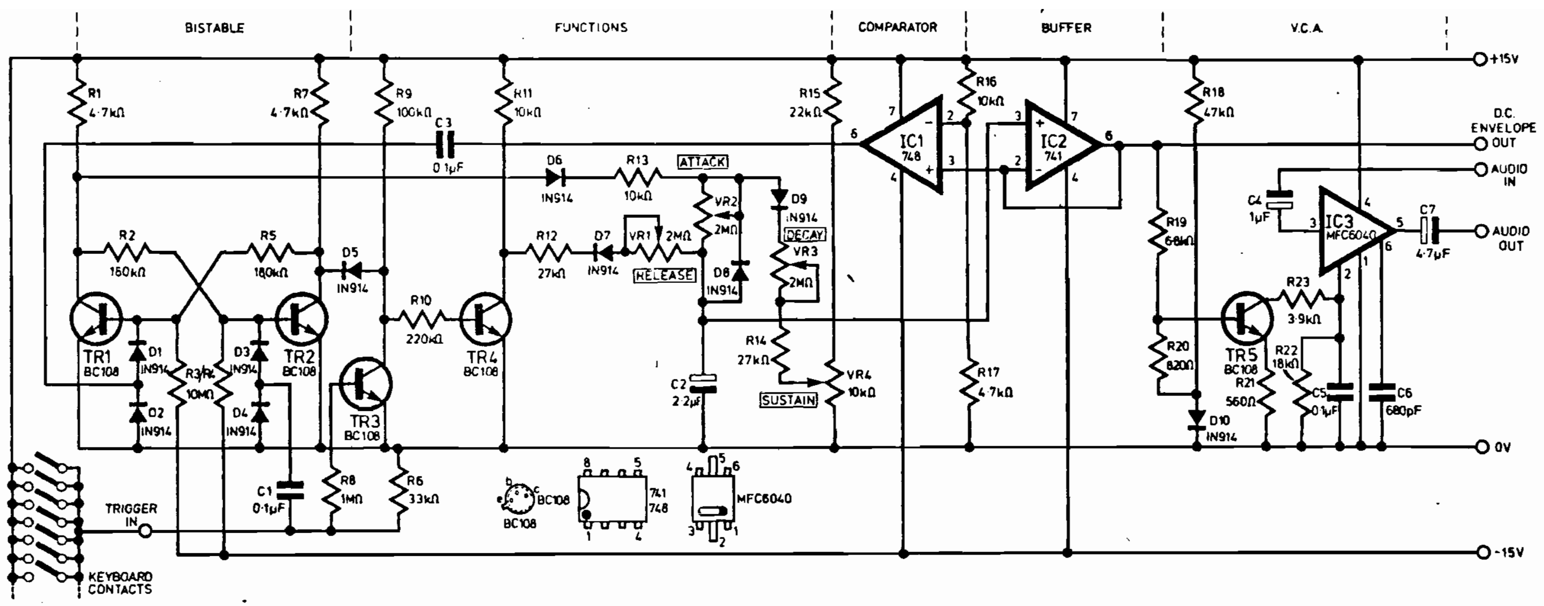

Fig. 2. Complete circuit diagram of the Envelope Shaper

COMPONENTS . . .

Resistors

R1	4·7kΩ
R2	180kΩ
R3	10MΩ
R4	10MΩ
R5	180kΩ
R6	33kΩ
R7	4·7kΩ
R8	1MΩ
R9	100kΩ
R10	220kΩ
R11	10kΩ
R12	27kΩ
R13	10kΩ
R14	27kΩ
R15	22kΩ
R16	10kΩ
R17	4·7kΩ
R18	47kΩ } see text
R19	6·8kΩ } see text
R20	820Ω
R21	560Ω
R22	18kΩ
R23	3·9kΩ

All ±5% ¼W carbon

Potentiometers

VR1–VR3	2MΩ linear (3 off)
VR4	10kΩ logarithmic

Capacitors

C1	0·1μF polyester
C2	2·2μF 16V elect.
C3	0·1μF polyester
C4	1μF 16V elect.
C5	0·1μF polyester
C6	680pF polystyrene
C7	4·7μF 16V elect.

Semiconductors

TR1–TR5	BC108 (5 off)
D1–D10	1N914 (10 off)
IC1	Type 748
IC2	Type 741
IC3	MFC6040

Miscellaneous

0·1in matrix Veroboard 102 × 64mm (4in × 2½in)

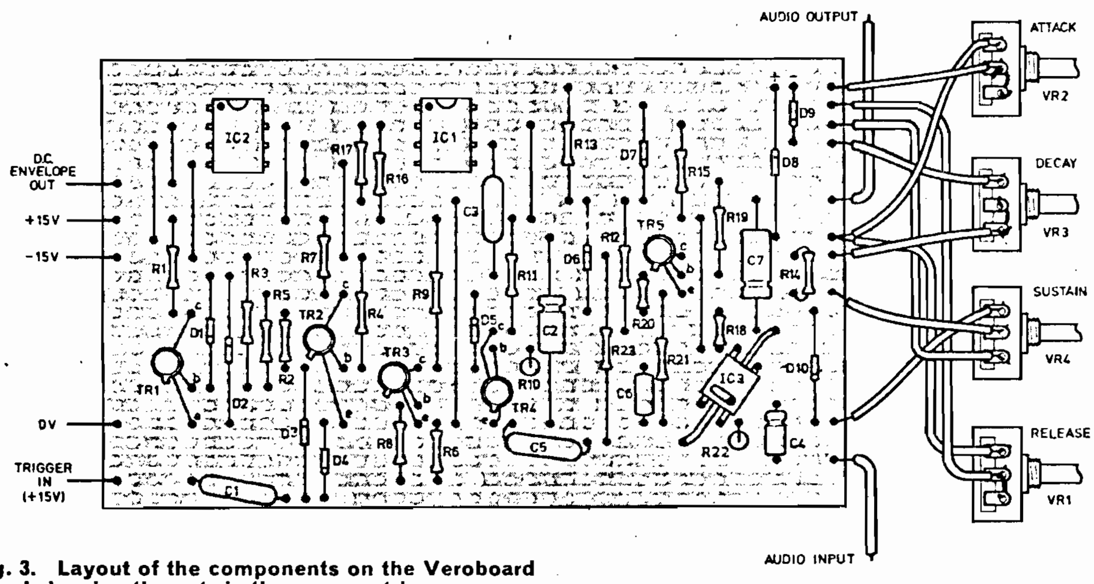

Fig. 3. Layout of the components on the Veroboard panel showing the cuts in the copper strips

Since there is no potential to charge C2, it discharges to the potential set at the wiper of VR4 (SUSTAIN). While this sequence is in progress, TR3 is biased on by the positive voltage from the keyboard contacts via R8 and will remain so until the key is released, when TR3 switches off, switching TR4 on. C2 is then discharged completely via D7 and VR1 (RELEASE), completing the A.D.S.R. sequence.

Diode D8 ensures that the full attack period is completed even if the key is released during attack. It does this by holding TR4 off while the bistable is "set", i.e. during attack.

The voltage on the positive plate of C2 is followed and buffered by IC2 to give 0 to 5 volts positive at the d.c. envelope output. This voltage is fed to TR5 which drives the voltage-controlled attenuator, IC3.

Because of the possible gain spread of TR5, the value of R19 and/or R18 may need adjusting so that the voltage at pin 2 of IC3 varies between 3·5 volts and 5·6 volts as measured with a high impedance voltmeter. This will give an attenuation range of 65dB, which was found to be adequate in the prototype. This range could be increased to about 80dB by increasing the value of R22 to 33kΩ but propagation delay might then be experienced due to the time taken to charge C2 to a voltage where the note has reached an amplitude that is audible.

CONSTRUCTION

The prototype was constructed on a small piece of 0·1in Veroboard prepared as shown in Fig. 3. Miniature resistors were used to make the unit neat and compact, but if standard resistors are used, R2 and R6 should be mounted vertically. Diode and capacitor orientation should be checked with Fig. 3.

The leads of TR1, 2 and 4 span a distance of half an inch or so and it should be checked that they do not short to the cases of the transistors. IC1 and 2 were soldered directly into the board since i.c. sockets were considered an unnecessary expense using today's robust integrated circuits and a little care. The two longest pins of IC3 should be bent halfway along their length 10 degrees to the left, as viewed from their respective ends. This will ease insertion into the board. Thin insulated wire should be used for the nine inter-track links.

The four potentiometers are connected to the board by five wires which could be quite long allowing the circuit board to be located remote from the control panel if necessary. R14, D8 and D9 are mounted on these potentiometers.

USING THE CIRCUIT

The trigger input should be connected to one of the keyboard busbars so that when any key is depressed, 15 volts will be applied.

The audio input need not be screened unless spikes are found to be induced, when it can be screened to the 0V line. The input voltage should not exceed 500mV r.m.s. if distortion is to be avoided. The maximum gain of the electronic attenuator is 13dB; hence the output voltage could reach 2·2V r.m.s.

The d.c. envelope output could be used to control a voltage-controlled filter or even another voltage-controlled attenuator to provide a separate channel for stereo effects.

It will be found by experimentation the settings of the controls required to give an accurate synthesis of a particular instrument, but as a guide strings, for example, have a very rapid attack followed by a fairly long decay and a low sustain level. The release time varies from instrument to instrument. For example, it will be short for a piano but long for a guitar.

Special effects can also be generated. An example of this is given by adjusting all controls to minimum. The resultant sound will be a short "pop" of the note every time a key is depressed. If the DECAY control is advanced slightly, the "pop" will become a "blip". ★