

CHORUS MACHINE



THE BLACK HOLE

Tim Orr, the prolific producer of music machines, presents the Black Hole Chorus Machine. Choose chorus effect or vibrato and control it all by footswitch.

The black hole is a musical effects device for processing natural and synthetic sounds. It has two modes of operation, chorus and vibrato. In the chorus mode the input signal is delayed (12 mS) by an analogue delay line. It is then mixed back with the original signal. This delay time is not long enough for a distinct second image to be heard, but it is noticeable, particularly as the time delay is slowly modulated. The sound produced by this process has a sort of 'spacey' feel to it as though the input signal was being accompanied by a faint chorus. What is, in fact, happening is that a comb filter has been produced (Fig. 1) with notches spaced at about every 90 Hz. As the delay time is modulated these notches move up and down in frequency producing a colouration of the sound similar to phasing. This, coupled with the short time delay, produces the 'spacey' colouration known as a chorus effect. A manual speed control allows the user to vary the modulation speed. A slow modulation is best suited for guitar and keyboard instruments, whereas a faster speed, which introduces a noticeable pitch modulation, works well on vocals. Another chorus mode is available to switch in a second delay line modulated in antiphase.

The vibrato mode is essentially the same as the chorus; the only things that change are the modulation waveform (triangular sweeps for the chorus sinusoidal sweeps for the vibrato) and the frequency range. As this is 2 to 13 Hz, a definite pitch modulation is produced. The controls that effect the vibrato are speed and modulation depth. The vibrato is not just pure frequency modulation, there is also amplitude modulation which produces a slightly more interesting effect.

The vibrato/chorus selection is made with a footswitch. Two LEDs indicate which effect has been selected and also the modulation speed. The input amplifier has a manual level control plus a high impedance-high level/low impedance-low level selector switch, thus enabling a wide range of input levels to be accommodated. The largest input level is 4V5 rms, and the smallest level for overload is 5 mV rms; a range of nearly 60 dB. An overload LED indicates the onset of distortion.

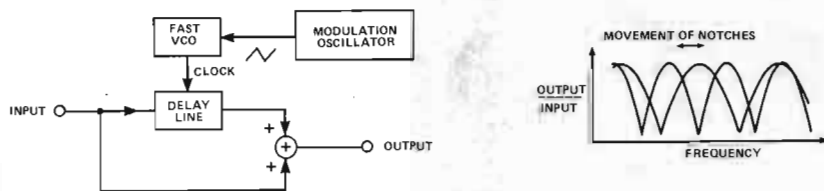


Fig.1. Block diagram of a comb filter.

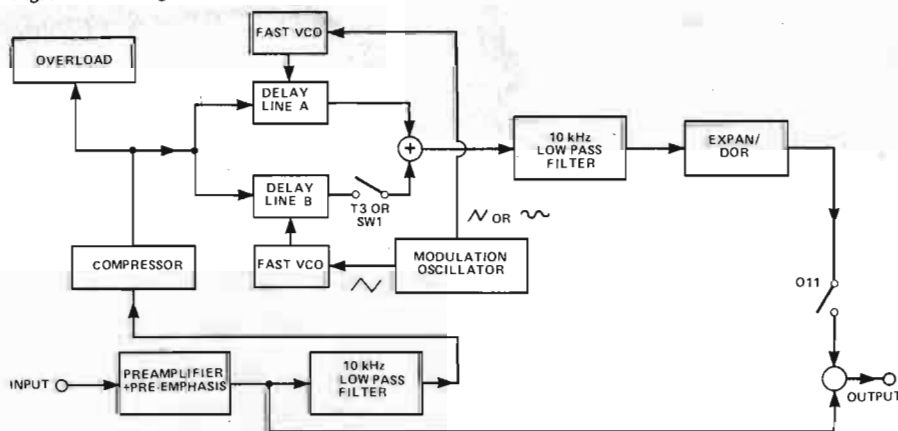


Fig.2. Block diagram of the Black Hole choraliser system.

	LOW	HIGH
MAXIMUM INPUT LEVEL	1.25V _{pp}	13V _{pp}
MAXIMUM INPUT LEVEL SENSITIVITY	15mV _{pp}	150mV _{pp}
INPUT IMPEDANCE	10k	110k
SIGNAL TO NOISE RATIO	68dB	74dB

MAXIMUM OUTPUT LEVEL	1V _{pp}
OUTPUT IMPEDANCE	600ohms
VIBRATO SPEED	2 - 13 Hz
CHORUS SPEED	0.3 - 3.3 Hz

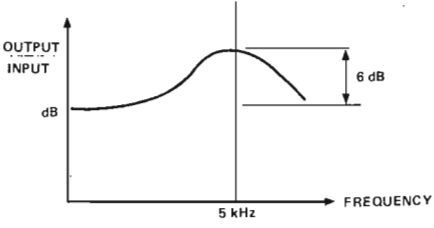
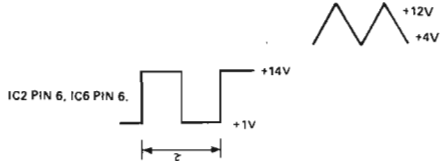
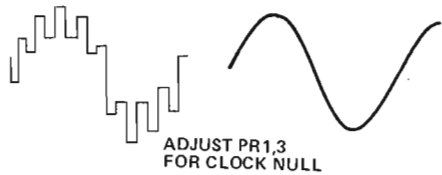


Fig.3. (top) Performance specification.

Fig.4. (above) Frequency response of pre-emphasis, IC11 pins 5, 6, 7.

- REMOVE ALL ICs. TEST FOR ±15V AT IC9,10. THE UNREGULATED RAILS WILL BE APPROXIMATELY ±22V. REPLACE ALL ICs AND RECHECK PSU.
- IC11 PIN 1,7 AND IC12 PIN 1,7, WILL HAVE THE AUDIO INPUT SIGNAL WITHOUT ANY DC BIAS.
- COMPRESSOR OUTPUT, IC13 PIN 10, HAS A DC BIAS OF APPROX. +7V PLUS THE AUDIO INPUT SIGNAL.
- FAST VCO. IC1 PIN 6 AND IC4 PIN 6



z VARIES FROM ABOUT 22μs TO 28μs, IT BEING SWEEPED BY THE MODULATION OSCILLATOR IC7.

* DELAY LINE OUTPUT
VIEW PR1 WIPER

INJECT A 1 kHz SINWAVE. VARY ITS AMPLITUDE SO THAT IT IS 2V_{pp} AT THE VIEWING POINT. ADJUST PR2 SO THAT THE WAVEFORM IS SYMMETRICALLY BIASED BETWEEN THE TWO CLIPPING LEVELS. NEXT ADJUST PR1 SO THAT THE CLOCK SIGNAL IS NULLED. REPEAT FOR DELAY LINE B, USING PR3,4, VIEWING PR3 WIPER.

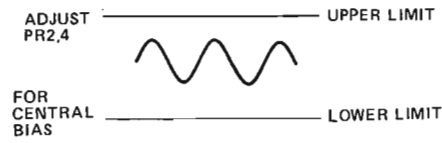


Fig.5. (above and above left) Alignment notes.

- POST FILTER, IC15 PIN 7. RECOVERED AUDIO SIGNAL WITH NO DC BIAS.
- EXPANDER, IC13 PIN 7. RECOVERED AUDIO SIGNAL WITH +5V DC BIAS.
- OUTPUT SIGNAL, IC15 PIN 1. INJECT A 500 Hz SINWAVE INTO THE UNIT. A MODULATED OUTPUT SIGNAL WILL BE SEEN.

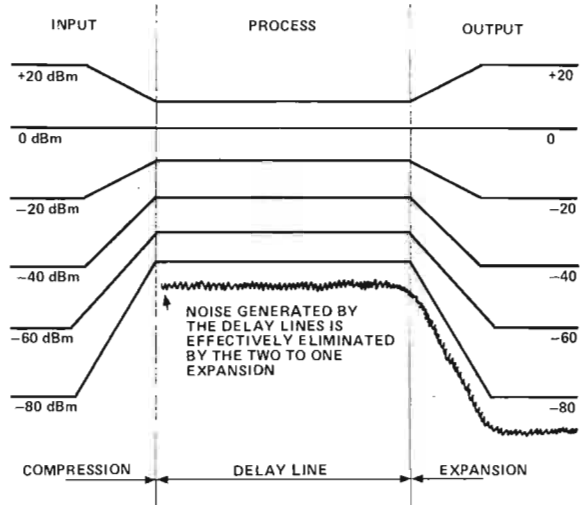
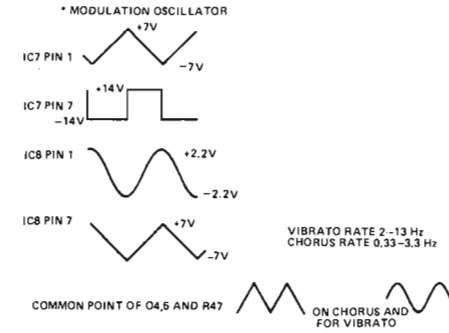
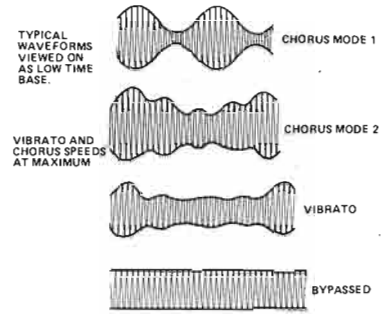
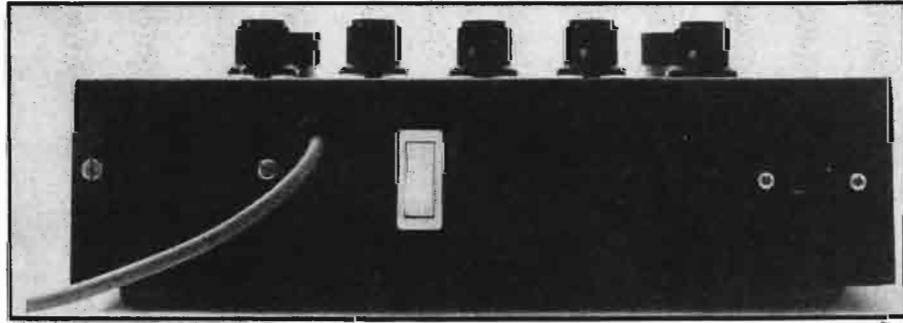


Fig.6. (left) Using a compander system to remove delay line noise.



You don't want to have to fumble for a lot of controls on the rear panel, so it's plain and simple - power on/off. No chance of accidentally hitting the power switch when you're operating Black Hole by footswitch.

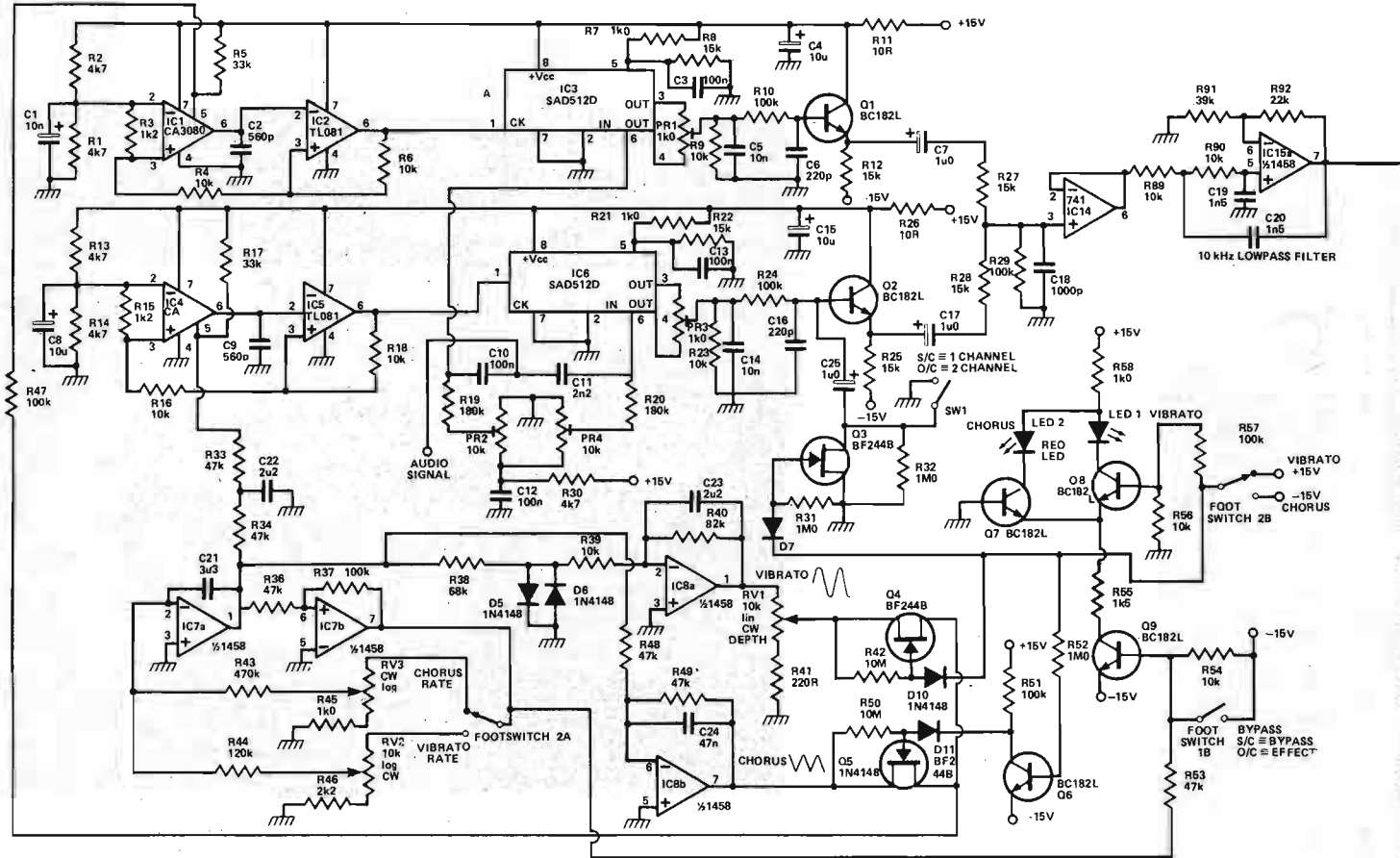


Fig. 7. Circuit diagram. This circuit includes the footswitch controls for bypass, chorus, vibrato and chorus and vibrato rate.

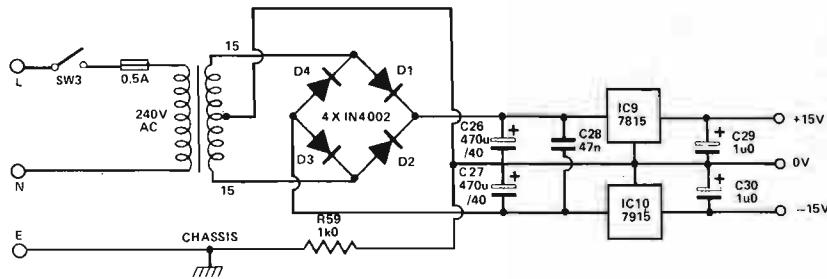
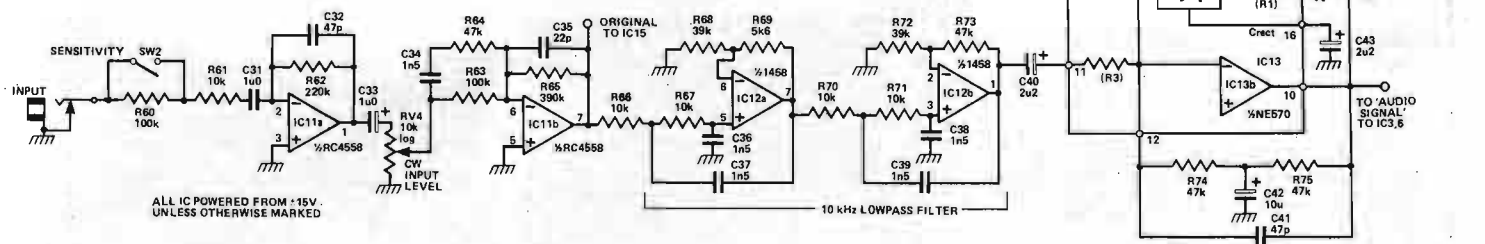
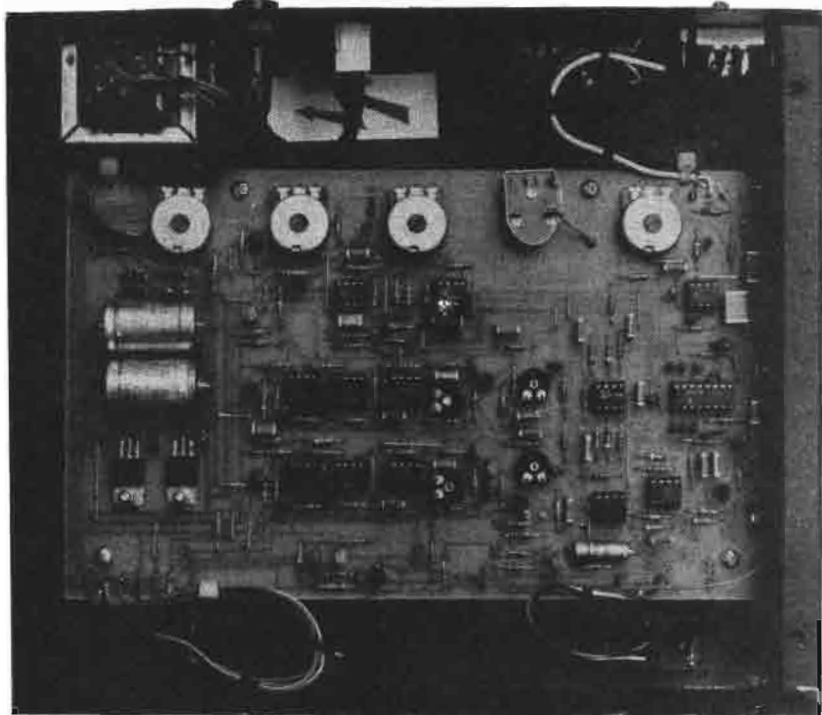
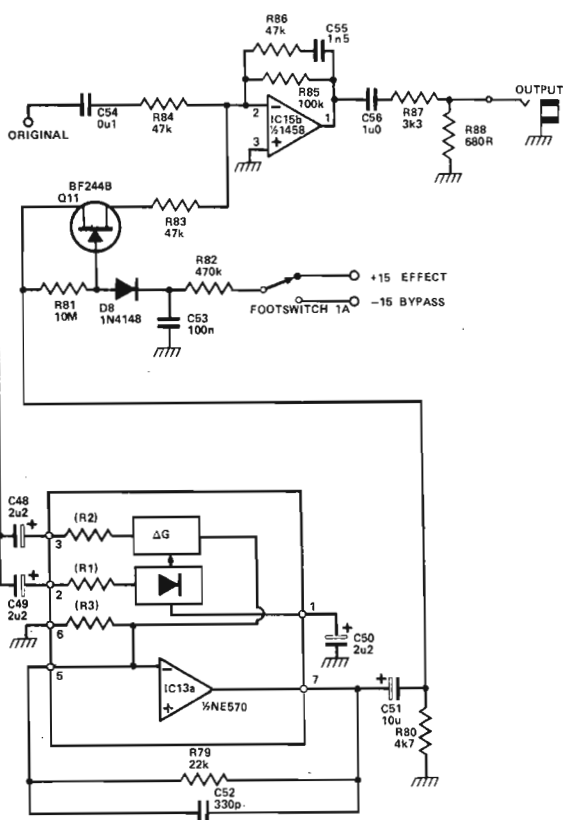


Fig. 8. (left) Circuit diagram of the Black Hole's power supply.

Fig. 9. (below) This part of the circuit, the input amplifier, includes a 10 kHz low pass filter section built around IC12.





The inside story. Here the PCB has been built and installed in the case with the power supply. Just screw on the base-plate and it's ready to go.

HOW IT WORKS

The input amplifier (Fig.9) is a low noise Op Amp device, the RC4358 (IC11, pins 1,2,3). With SW2 closed the input impedance is 10 k and the first stage gain is +25 dB. With SW2 open circuit, the input impedance is 110 k and the gain is +6 dB. IC13, pins 5,6,7 forms a pre-emphasis circuit that is used to enhance the higher frequencies of the input signal (Fig.4). A de-emphasis circuit (IC15, pins 1,2,3) corrects the frequency response at the output and in doing so attenuates unwanted high frequency noise generated by the delay line and the compander. After pre-emphasis the signal is filtered by a 10 kHz 4 pole lowpass filter (IC12) to eliminate aliasing effects that can be caused by the delay line. A compander (compressor/expander) system has been employed to improve the overall noise performance (Fig.5). This ensures that the delay lines are always driven with a relatively large signal and that when there is no input signal, the output noise from the delay lines is expanded downwards thus rendering it inaudible. A simple overload detector circuit (Q10) is used to indicate the onset of distortion.

The delay lines are clocked by high frequency VCOs, IC1,2 and IC4,5. The VCO is a simple triangle/square wave relaxation oscillator running at about 45 kHz. The current into pin 5 of the CA3080 determines the oscillation frequency and this current is modulated by the slow oscillator

IC7. Audio signals are fed into the analogue delay lines (IC3,6), the delay time being determined by the relationship,

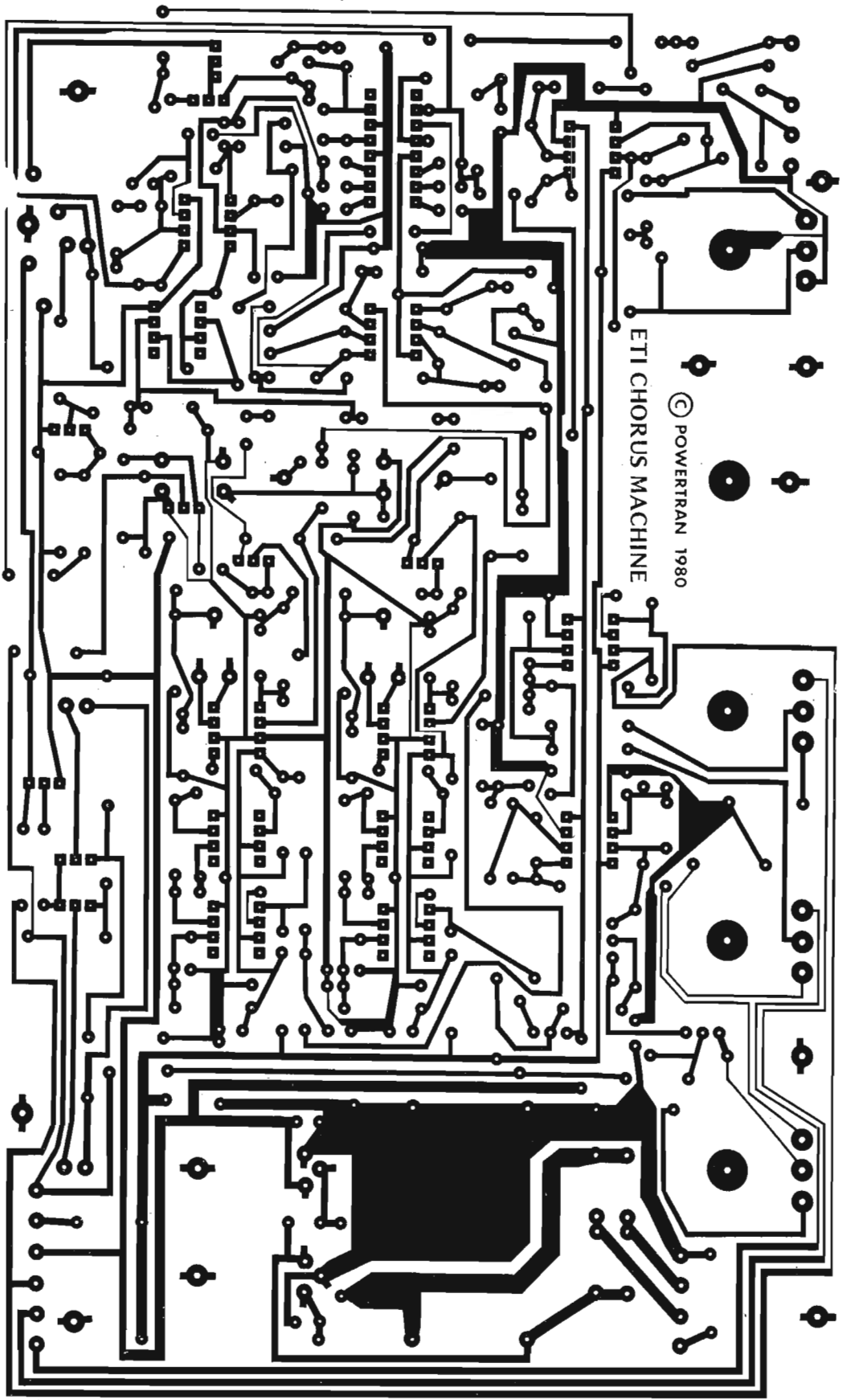
$$\text{Delay time} = 312 / \text{clock frequency},$$

which in this case is about 12 nS. The outputs of the two delay lines are prefiltered by R10,C5 and R24,C16, then mixed together and filtered by a 10 kHz lowpass filter, IC15, pins 5,6,7. The signal is then expanded by the NE570 chip after which it is mixed with the original signal at IC15, pins 1,2,3, having first passed through a 'silent' analogue switch (Q11) which is ON when the effect is selected and OFF when bypassed. The modulation oscillator operates over two frequency ranges, one selected by the chorus speed control, the other by the vibrato speed control. IC7 is a low frequency triangle/squarewave relaxation oscillator. When the chorus mode has been selected the modulation waveform is a sine wave, being generated by IC6, pins 1,2,3. This signal is routed via switch Q4 to the high frequency VCO driving delay line A, whilst delay line B is disabled by Q3 which shunts the audio signal to ground. A simple LED control circuit Q7,8,9 indicates whether the unit is bypassed or in either the chorus or vibrato mode as well as indicating the modulation speed.

A standard two rail power supply provides a regulated +15 V at 70 mA and -15 V at 30 mA from two voltage regulators IC9,10.

BUYLINES

A complete kit of parts for the Black Hole Choraliser is available from Powertran Electronics. A single delay machine costs £57.30 and a dual delay machine £68.80 (prices include VAT and post). See Powertran's advert elsewhere in this issue for their full address.



ETI CHORUS MACHINE

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