730-740

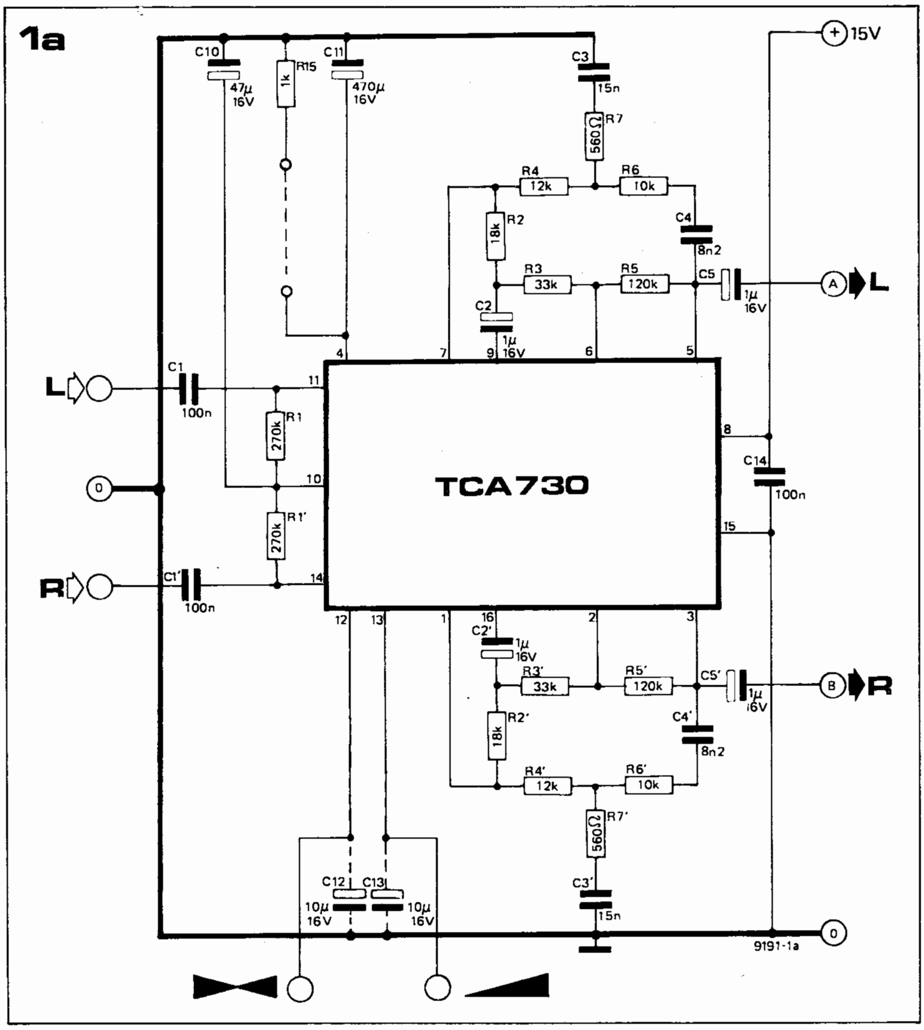
Using only two ICs, the TCA730 and TCA740, a complete stereo control amplifier can be built. An exceptional feature is that the volume, balance, and tone are all DC controlled.

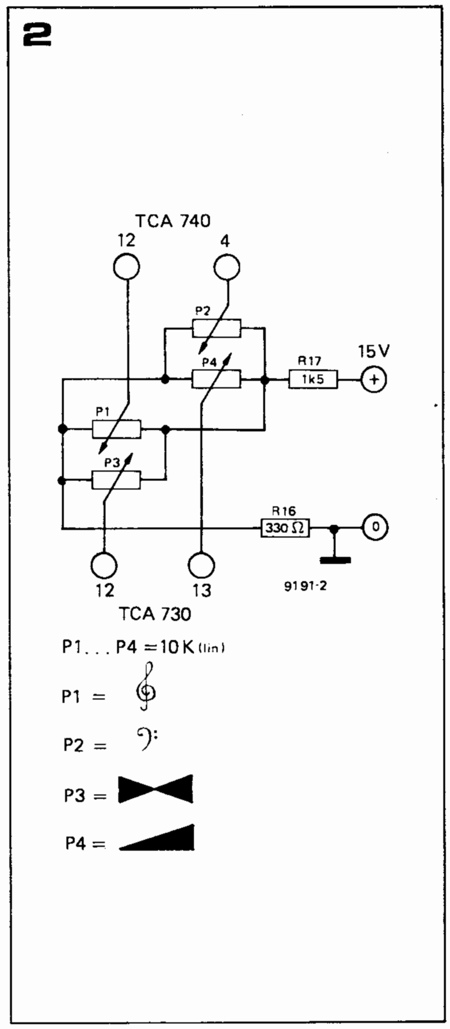
Specifications:	
Frequency response (±1 dB):	20-20,000 Hz
Signal-to-noise ratio:	57 dB
Channel separation:	60 dB
Distortion:	0.1%
Input overload level:	1 V
Input impedance:	250 k
Max. output level:	1 V
Output impedance:	4.7 k
Volume control range:	+20 - −70 dB
Max. bass lift/cut:	15 dB
Max. treble lift/cut:	15 dB

An alternative to the conventional potentiometer control of volume, balance and tone should be more than welcome. The problems connected with running audio signals over potentiometers are well-known: the long cables almost inevitably lead to hum and cross-talk, and 'crackly' potentiometers are notorious . . .
A solution is offered in the circuit described in this article. The Philips integrated circuits TCA730 and TCA740 have built-in 'potentiometers' that can be DC-controlled. The TCA730 contains the electronic volume and balance controls, whereas the TCA740 can be used for bass and treble control.
The necessary control voltages can be derived from a simple voltage-divider circuit incorporating several potentiometers. Since these potentiometers don't have to carry the audio signal, they can be connected to the circuit via virtually any length of cable: the hum pick-up would have to be very severe before it could cause audible modulation of the audio signal.
Another advantage of these ICs is that one (mono) potentiometer can be used to control several audio channels simultaneously, with a minimum of imbalance between the channels.
The circuit described here can be used in combination with almost any preamplifier, and the performance is definitely 'Hi-Fi'.

TCA730: volume and balance

The complete stereo control amplifier is shown in figure 1. For convenience, the circuit has been cut in two: figure 1a shows the TCA730 with associated components and figure 1b shows the TCA740. The output of 1a (connections A and B) is connected to the input of 1b.
The first section (TCA730) is the volume and balance control. In the maximum setting of the volume control the gain is x 10: 100 mV in gives 1 V out. This input sensitivity, in combination with the input impedance (250 k), means that the amplifier can be driven direct from practically any receiver, tape recorder or crystal pickup. Microphones or dynamic pickup cartridges will need a separate preamplifier, of course.
The circuit shows the complete stereo version, so that most of the components come in pairs. For instance, R1 (270 k) is the input resistor for the left channel and R1' is its twin in the right channel. The (DC) control voltages for volume and balance control are connected to pins 13 and 12, respectively; both voltages should be linearly adjustable from 1 V to 9 V. Figure 2 gives the circuit of the control potentiometers: four linear potentiometers (10 k) are connected in parallel in a voltage divider circuit that gives the correct control range. Two of these potentiometers are used for volume and balance control. Needless to say, the supply voltage for this control circuit must be well stabilised and smoothed.
If the audio input voltage is 100 mV or less, the volume control has a range from +20 to −70 dB. The balance control range depends in part on the volume setting: when the volume is set at −20 dB or less, the balance control range is +10 to −10 dB, but this range is reduced at higher volume settings.
An interesting option is offered at pin 4. If this pin is simply connected to supply common through an electrolytic (C11, 470 µ), the volume control works as normal. However, if a 1 k resistor is connected in parallel with this electrolytic (R15, dotted in figure 1a) a physiological volume control is obtained. It seems unncessary to go into this in any further detail – the effect, also known as 'contour control', is well-known by now. Suffice it to say that in the maximum setting of the volume control (control voltage: 9 V) the frequency response is flat, whereas at a much lower setting (control voltage: 3.2 V) the bass is only 40 dB down and the frequency range from 200 to 7000 Hz is already 70 dB down.





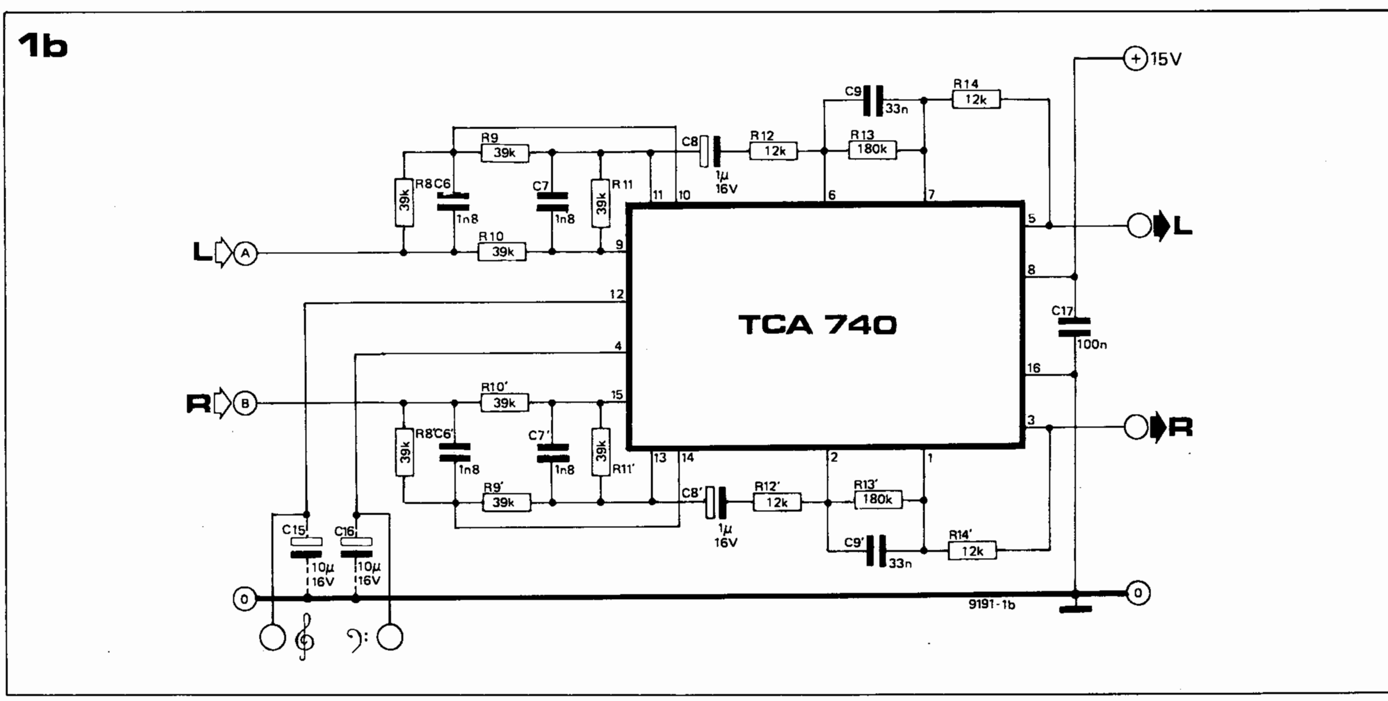


Figure 1. A complete stereo control amplifier using only two ICs. Points A and B in figure 1a are connected to the corresponding points in figure 1b. The dotted connection is used for the 'contour' option (see text). The control inputs are connected to the corresponding potentiometers in figure 2.

Figure 2. The circuit for the control potentiometers (treble, bass, balance and volume respectively). These components are not mounted on the p.c.b.

TCA740: tone

As explained above, the TCA740 controls bass and treble in the same way that the TCA730 controls balance, volume and contour. The TCA740 has unity gain in the 'flat' position of the controls; the maximum signal level at input and output is 1 V.

As with the TCA730, most of the components come in pairs for the stereo version. The control voltages for treble and bass control are connected to pins 12 and 4, respectively. These voltages are derived from two of the potentiometers in figure 2.

The frequency characteristics in 'maximum', 'flat' and 'minimum' positions of the tone controls are plotted in figure 3. Maximum cut and boost is a good 15 dB, both for treble and for bass. The 'flat' response, as measured for our lab-

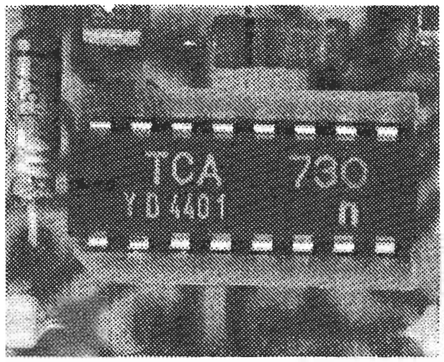
oratory prototype, is definitely flat: −1 dB at 20 Hz and 100 kHz!
The output signal (left channel: pin 5, and right channel: pin 3) can drive almost any power amplifier – the maximum level is 1 V.

Construction

The complete control amplifier, with the exception of the potentiometer circuit shown in figure 2, can be built on one small printed circuit board. All connections to the potentiometers are along one edge of the board.
If physiological volume control is required, pin 4 of the TCA730 must be connected to R15 through a wire link (dotted on the component layout). Alternatively, a switch can be connected at this point so that the 'contour' control can be switched on or off as required.
The electrolytics C12, C13, C15 and C16 are not strictly necessary, and can usually be omitted. However, if long leads are run from the control potentiometers to the boards, or if the supply to the control potentiometers is not adequately smoothed, it can be advisable to add these capacitors. The original reason for putting them on the board was that it makes it possible to use a digital control unit instead of the potentiometers . . . however, that is still in the pre-prototype stage!

A final word

There should be no further need to discuss the technical merits of this control amplifier; the specifications tell the story. For those who are perhaps not so familiar with the technical terminology, however, we can safely state that the performance of this amplifier should be quite satisfactory as part of most high fidelity systems.



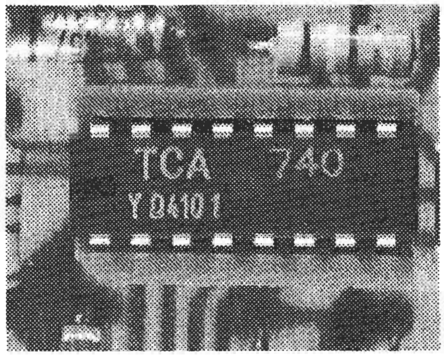


Figure 3. Frequency response curves in the 'maximum', 'flat' and 'minimum' positions of the tone controls.

Figure 4. Printed circuit board and component layout for the complete stereo control amplifier.

A final word on the power supply: the supply voltage given in the circuit (15 V) must be adhered to. A higher voltage can destroy the ICs, and a lower voltage will lead to inferior performance. For this reason it is advisable to use a stabilised supply; it should also be adequately smoothed. The current consumption is approximately 60 mA. Considering the fact that the power amplifiers will almost certainly be running on a higher supply voltage and will have sufficient current to spare, the simplest solution for the supply to the control amplifier will be to use a stabiliser IC. A suitable type would be the LM131. Of course, a simple zener stabilisation with adequate smoothing would do instead.

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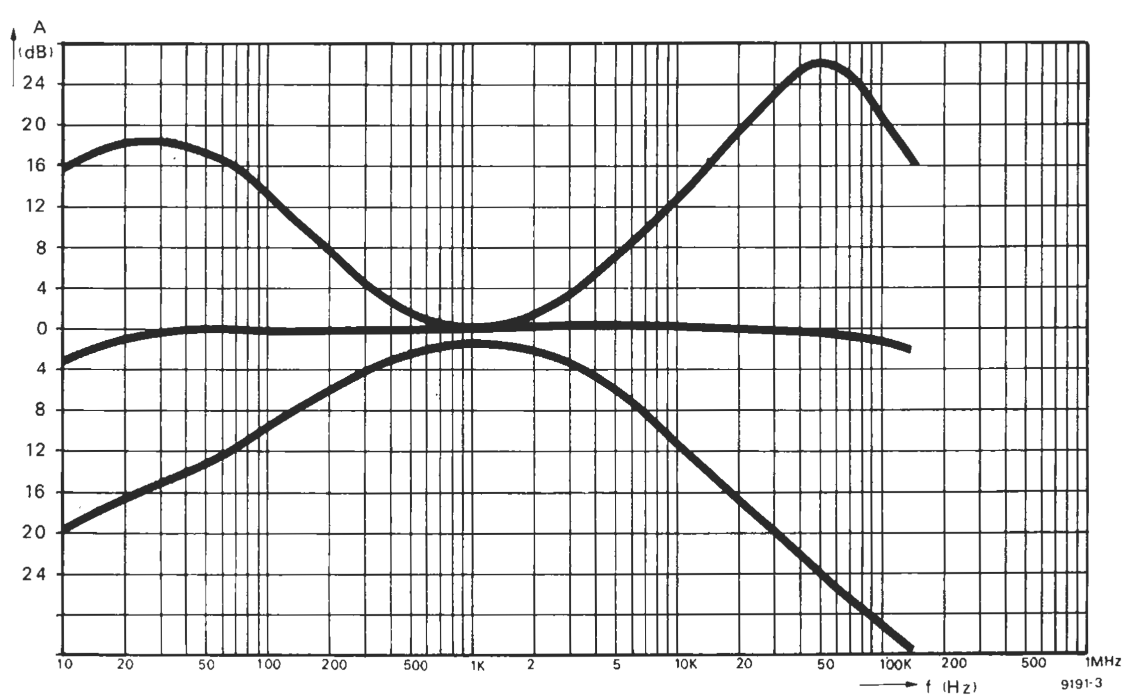

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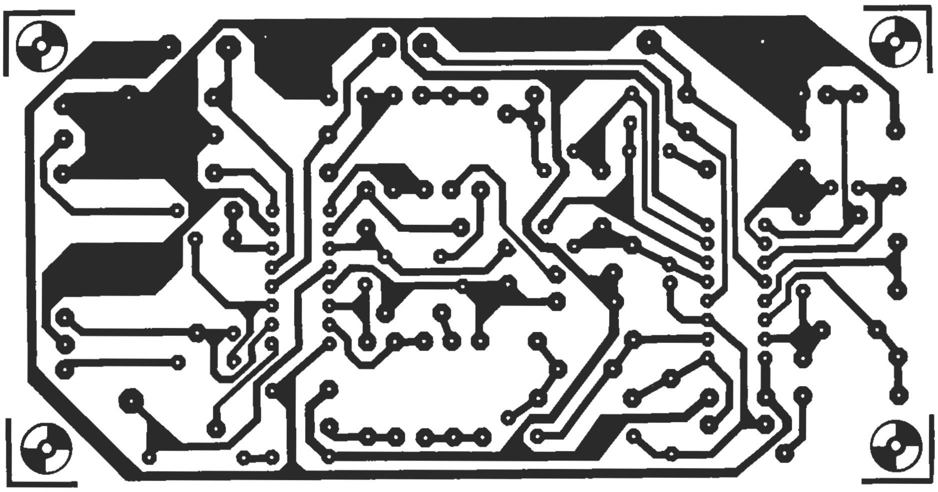
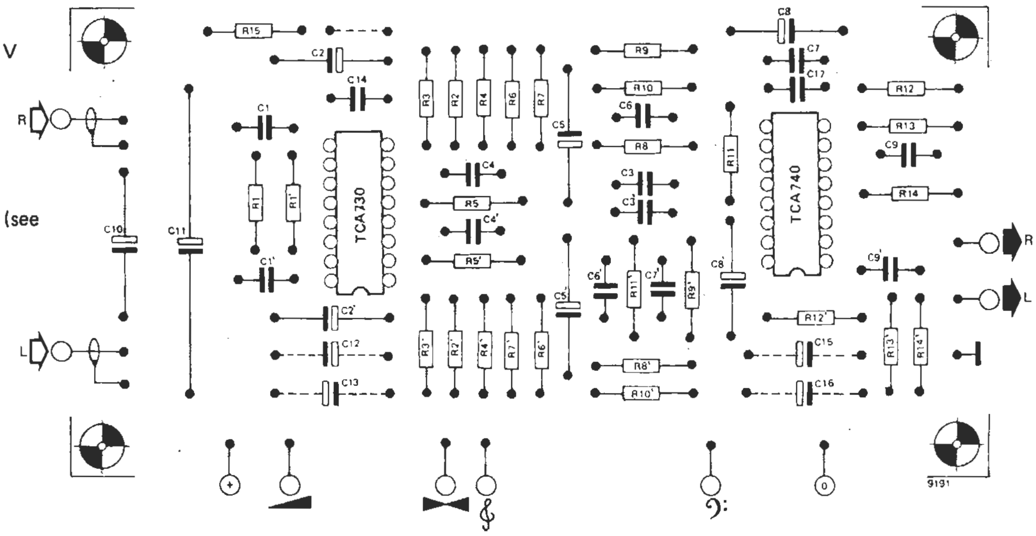


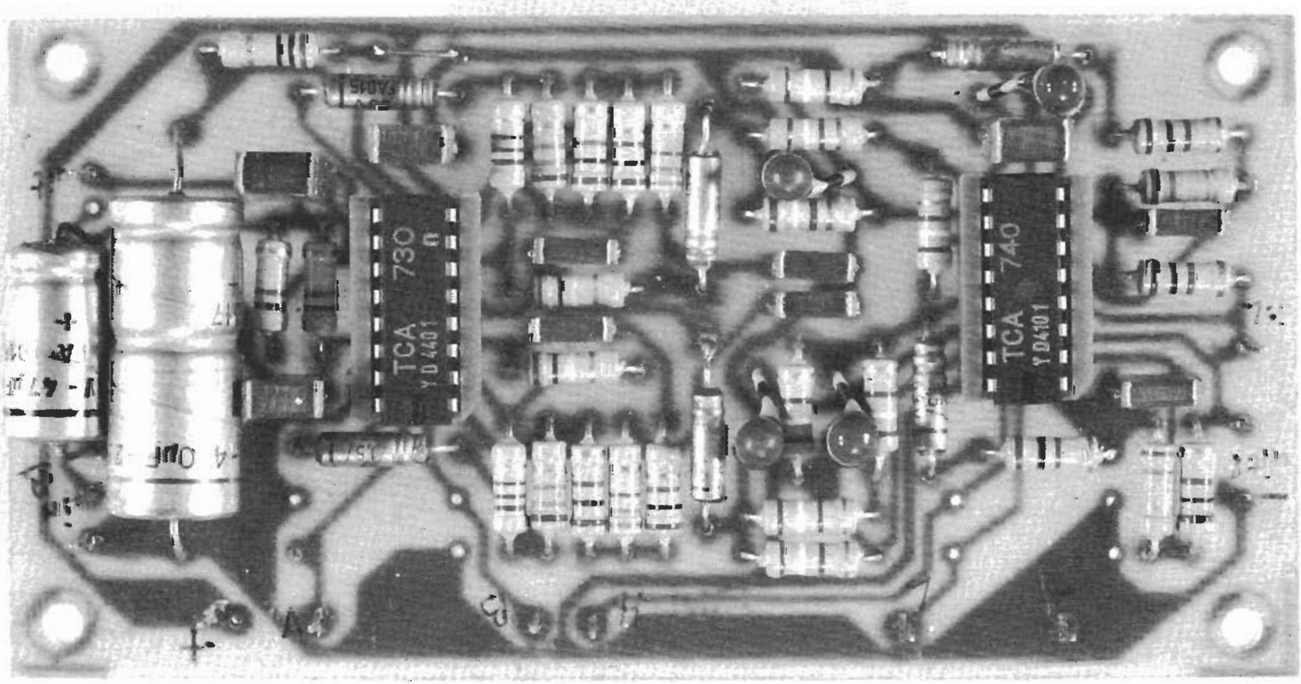
Parts list

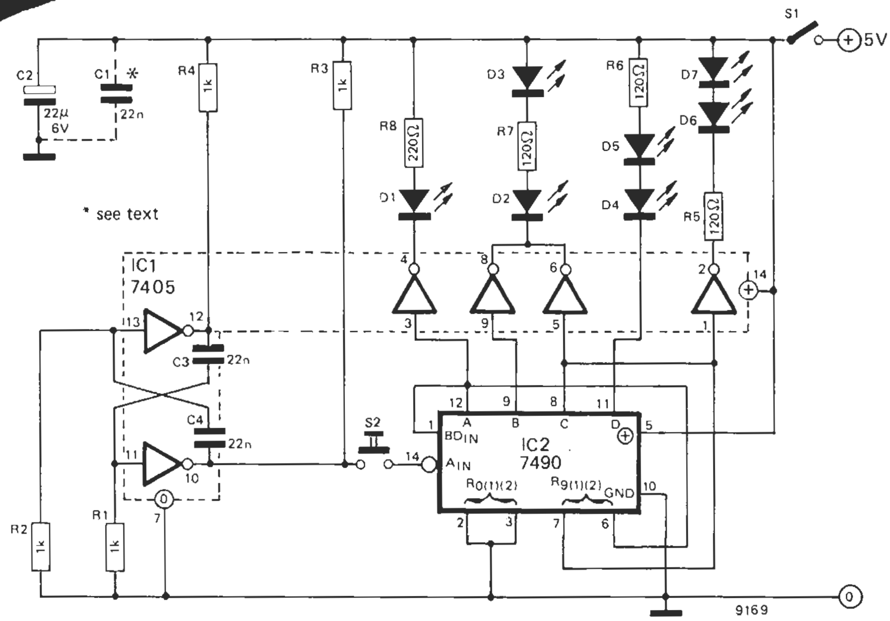
Resistors:
R1,R1' = 270 k
R2,R2' = 18 k
R3,R3' = 33 k
R4,R4',R12,R12',R14,R14' = 12 k
R5,R5' = 120 k
R6,R6' = 10 k
R7,R7' = 560 Ω
R8,R8',R9,R9',R10,R10',R11,R11' = 39 k
R13,R13' = 180 k
R15 = 1 k
R16 = 330 Ω
R17 = 1k5
P1,P2,P3,P4 = 10 k, lin

Capacitors:
C1,C1',C14,C17 = 100 n
C2,C2',C5,C5',C8,C8' = 1 μ/16 V
C3,C3' = 15 n
C4,C4' = 8n2
C6,C6',C7,C7' = 1n8
C9,C9' = 33 n
C10 = 47 μ/16 V
C11 = 470 μ/16 V
C12,C13,C15,C16 = 10 μ/16 V (see text)

Semiconductors:
IC1 = TCA730
IC2 = TCA740







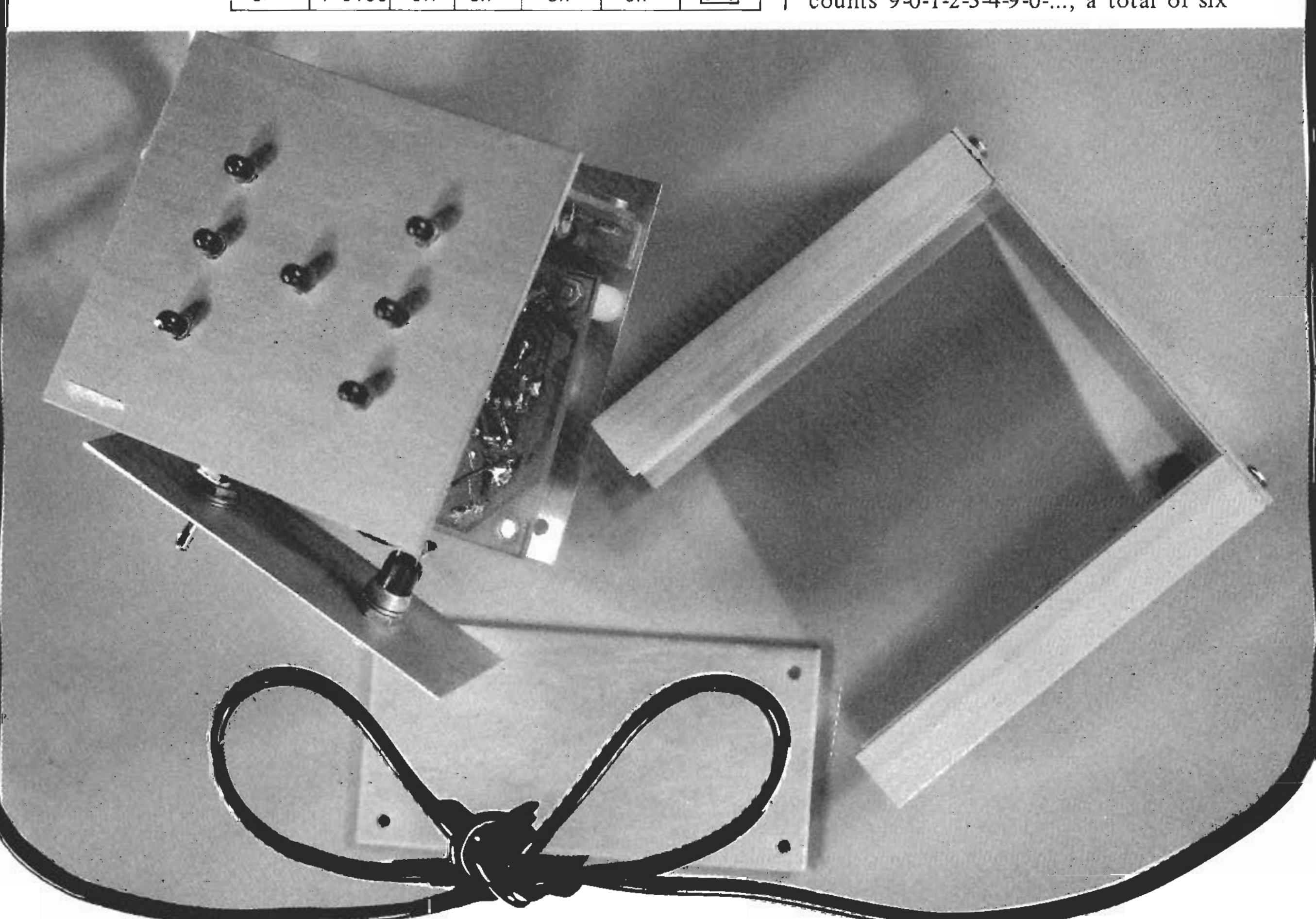
M.G. Fishel

die

Table.						
throw	7490 count	D1	D4,D5	D2,D3	D6,D7	display
1	9=1001	on	off	off	off	
2	0=0000	off	on	off	off	
3	1=0001	on	on	off	off	
4	2=0010	off	on	on	off	
5	3=0011	on	on	on	off	
6	4=0100	off	on	on	on	

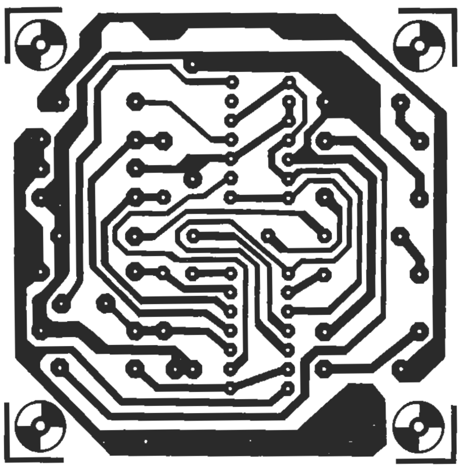
In this simple electronic die only two ICs are used for the oscillator, 6-counter, decoder and display-drivers.

Four basic display patterns are used to create the six displays required for a die (see table). The LEDs D1 - D7 are driven from a simple decoder circuit consisting of 4 inverters (2/3 IC1), which in turn is driven by a 7490 (IC2) wired as 6-counter. A slightly different circuit from the usual is used to achieve the count of six: the A and C outputs are connected to the reset-9 inputs, so that as soon as a count of five (0101) is reached the 7490 is reset to 9. It now counts 9-0-1-2-3-4-9-0-..., a total of six



counts per cycle.
The 7405 contains 6 inverters, of which only four are used for the decoding circuit. The remaining two can therefore be used to construct a simple multivibrator for driving the counter. The multivibrator is free-running; it can be connected to the counter via push-button S2 for each throw of the die.
The LEDs (D1 - D7) are arranged on the printed circuit board in the correct pattern. They can be mounted either on the component side or on the copper side; this second alternative will probably prove the most practical when mounting the die in a small box.

Capacitor C1 (dotted in the circuit) is not mounted on the p.c.b., because it did not prove essential in practice. However, a good power supply (preferably stabilized) is advisable. If batteries are used C1 should be mounted on the board in place of C2, the leads from the battery must be short, and a larger electrolytic (220 µ - 470 µ) must be mounted across the supply connections to the board.



Parts list:

Resistors:
R1 - R4 = 1 k
R5 - R7 = 120 Ω
R8 = 220 Ω

Capacitors:
C1*, C3, C4 = 22 n
C2* = 22 µ/6 V

Semiconductors:
IC1 = 7405
IC2 = 7490
D1 - D7 = LED

* = see text