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NEWS & VIEWS

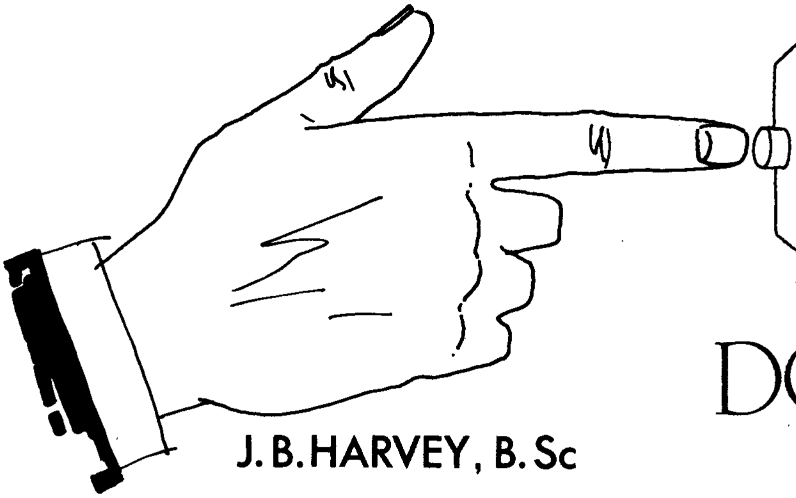
FOR OUR CONSTRUCTORS

GENERAL INTEREST

FREE THIS MONTH

'BREADBOARDS'—A special 8-page supplement reviewing commercial prototyping systems and presenting a design of our own, the PW "Experimenter"

Our January issue will be published on December 1st
(for details see page 36)



Digital DOOR CHIMES

J. B. HARVEY, B. Sc

Introduction

Being unimpressed with a simple door bell or chime the author decided to design a circuit that would generate the "Big Ben" sequence when a visitor called. Realising that one might grow tired of "Big Ben" a programmable version was developed, variations in diode linkages producing different tunes; the one in the author's home, which is described here, is currently programmed to generate the opening bars of "Colonel Bogey"!

The component cost is around £5, and the circuit is suitable for battery operation, drawing negligible current in the "standby" mode.

Circuit Description

The circuit can be considered in three sections: the sequence generator and the audio oscillators, designed around c.m.o.s. devices and linked by diodes to produce the tune required, and a simple power amplifier to drive one or more loudspeakers.

Oscillator Operation

Basic to the circuit is a two stage c.m.o.s. oscillator (see Fig. 2). This simple circuit requires only two gates, two resistors and a capacitor and operates as follows. When the waveform (1) at the output of inverter B is in a high or "1" state, capacitor C becomes positively charged. As a result the input to inverter A is high and its output is low or "0". Resistor R2 is returned to the output of inverter A to provide a path to ground for the capacitor to discharge. As long as the output of A is low, the output of B is high. As capacitor C discharges, however, the voltage at the junction of C and R2 approaches and passes through the switching point of inverter A. The output of A goes high, that of B goes low, and capacitor C charges negatively. R2 then provides a discharge path to the supply voltage, and C begins to charge to this voltage. Again the voltage at the junction of C and R2 passes through the transfer point of inverter A; at that instant the circuit again changes state, the output of A going low and of B high, and the cycle repeats.

The time to repeat one cycle is approximately 1·4CR2; the frequency can be made nearly independent of supply voltage and switching point variations by including a large resistor in series with the input to inverter A: hence R1. The oscillator may be gated on and off by using one of the inputs to gate A as a control line, taking the line high to run, low to inhibit, and this is done in the chime circuit. Since the c.m.o.s. gates used cost around 5p each, the circuit is very economical; indeed it was cheaper to use five separate oscillators in the chime circuit than one oscillator with switchable frequency.

Chime Circuit Operation

When switch S1 is closed, the RS flip-flop comprising gates A3 and A4 is set, the Q output going high and $\overline{Q}$ low (see Figs. 1 and 3). The reset line to the decade counters B & C is cleared, and the clock generator (E1 & E2) is enabled. Now the enable lines to each counter are taken to a second RS flip-flop (RS2); since one output is always high when the other is low, both counters cannot sequence at once, even though they are both clocked simultaneously. Initially, B is enabled and commences counting. On the 9th clock pulse RS2 is set, counter B is frozen and counter C takes up the count.

On the 17th clock pulse both RS flip-flops and counters are reset, and the clock is disabled.

For the sequence to repeat correctly the next time S1 is pressed it is necessary for RS2 to reset before RS1, since the reset drive pulse is taken from counter C, and this disappears when RS1, and hence the counters, are reset. Since both flip-flops are reset by the same drive pulse a race hazard situation exists; this is resolved by including a resistor R3 in the reset line to RS1. R3 in conjunction with the input capacitance of gate A3 gives rise to a small time constant, sufficient to delay the reset of RS1 by the required number of nanoseconds. Should the delay prove insufficient a small capacitor (10-100pF.) can be fitted (C2).

This reset pulse, and consequently the 17th clock pulse, are of short duration, comparable with the propagation delay of a c.m.o.s. gate (typically 25 nS), since in resetting everything in sight the reset pulse is itself eliminated.

Inspection of Fig. 3 shows that a sequence of sixteen discrete pulse outputs is available, each output being one clock pulse in duration; the other outputs of the decade counters are of longer or shorter duration, and so are unsuitable for the present purpose. These sixteen pulses are connected by programming diodes to the enable lines of five audio oscillators, and it is the positioning of these diodes that determines the note sequence that will be generated. These oscillators are set to operate at suitable audio frequencies, adjustment being provided by VR1-5. The five outputs are isolated from each other by D1-5, and are taken to the input of a simple power amplifier.

Power Amplifier

This amplifier operates in the class D mode, the output being switched between supply and ground at a rate determined by the incoming signal. This has several advantages: there is no quiescent current, the load may be driven directly without the need for a large coupling capacitor, and large amounts of power may be switched into the load with little dissipation in the output transistors Tr2 and Tr3, limited only by the maximum collector current of these transistors (for BC140/BC160 $I_c$max is 1A); consequently no heatsinking is required and therefore the amplifier is very economical.

Other transistors may be used if BC140/BC160 are not readily available, provided that they have reasonable gain and current handling capability. The astute reader will realise that with the load coupled to the amplifier as shown, Tr3 does most of the work; Tr2 would be unnecessary for a purely resistive load, but for an inductive load such as a loudspeaker Tr2 provides an active pull-up and serves to square off the output waveform. D7 and D8 are included to restrict the possibility of breakdown in the output transistors when driving an inductive load.

Construction

The digital door chime may be assembled on veroboard, no special care in layout being necessary; however, a purpose-made printed circuit board is undoubtedly neater, and a suitable layout is shown in Fig. 4; Fig. 5 gives the component locations. If S1 were connected to the circuit via a very long length of wire, spurious pick-up could set off the chimes (although this has not happened on any of the units

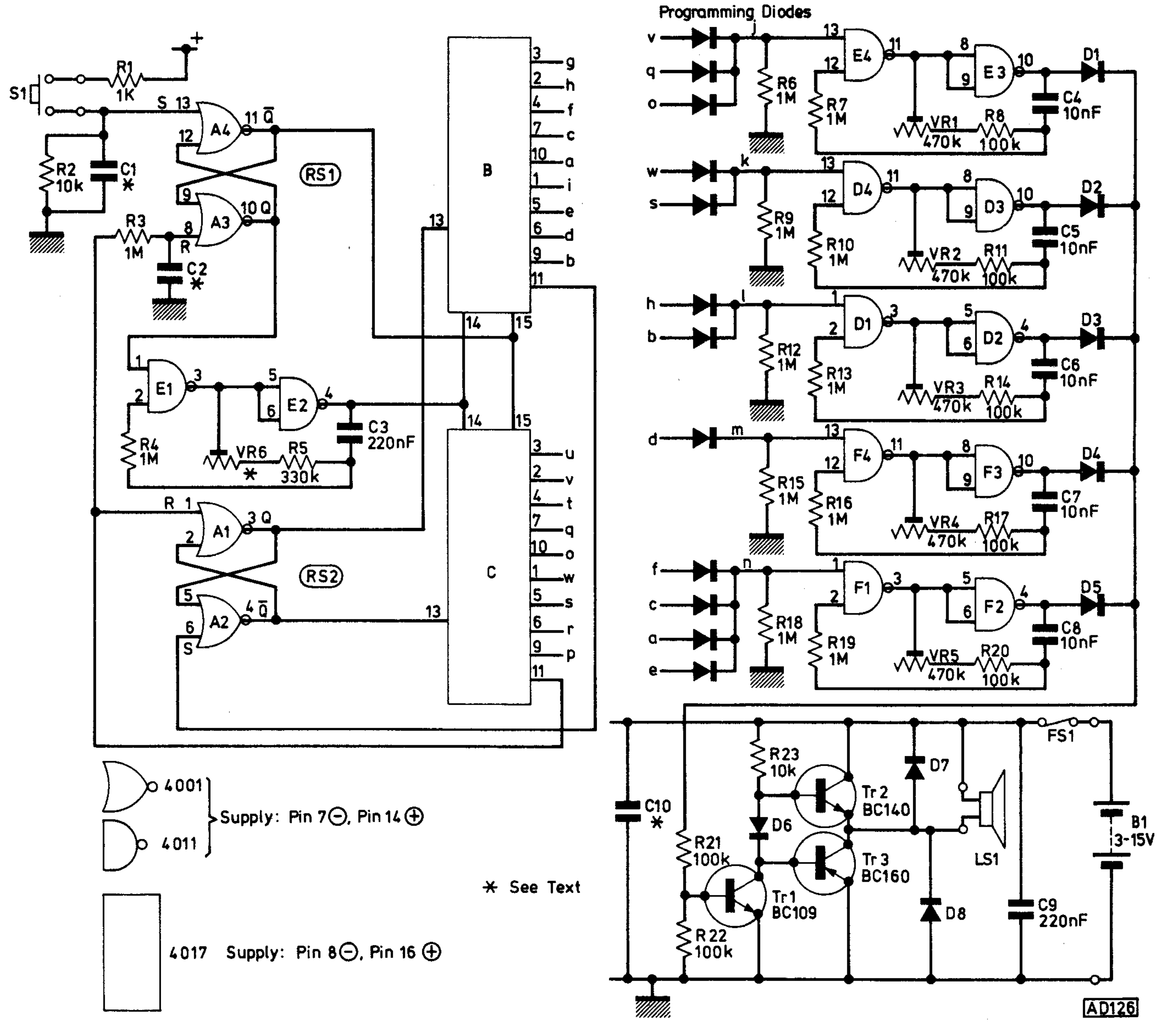


Fig. 1: The circuit diagram is easily divided into three separate sections, the sequence generator on the left, the audio oscillators and the audio amplifier

so far built); a 10nF capacitor (C1) across R2 will eliminate this hazard. C10 may be added for extra supply decoupling, although no problems have been experienced with the prototypes. VR6 may be added to vary the clock rate, and hence the speed at which the tune is played; if this facility is not required then the VR6 position should be linked across on the p.c.b. Finally a fuse has been included in the supply line to protect the power source in the event of a component failure.

Handling C.M.O.S.

Whatever method of construction is used it is necessary to handle the c.m.o.s. devices with care, to avoid damage by static discharge. Unless the constructor is experienced in the handling and soldering of these devices it is advisable to assemble the circuits using i.c. sockets, leaving the fitting of the devices until last. The chips are supplied either in a metal tube or mounted on conductive foam to prevent damage during transit, and they should be left there until they are transferred to the circuit. When handling the i.c.s, avoid working in a very dry atmosphere, wearing a nylon shirt or doing anything else likely to produce a build-up of static. It is a good idea to cover the working surface with a sheet of earthed aluminium foil and keep everything on that. Once in circuit, of course, the i.c.s are safe from further damage by static.

Operation

Unlike t.t.l., c.m.o.s. will operate from any supply in the range 3-15V; in addition the current drawn by c.m.o.s. when powered up but not switching is negligible. Since the power amplifier draws no quiescent current either, the digital door chime may be run off a small dry battery (e.g. PP9), the life of the battery approaching its shelf life, since current is only drawn when the chime is operating. (If you find this difficult to believe, connect a $50\mu A$ meter in the supply lead—there is no deflection on "stand-by").

The current drawn when the unit is running depends almost entirely on the load, the circuit itself drawing around 1mA. The only limitation on load impedance is that the $I_c$max of the output transistors is not exceeded; e.g. if a 15V supply and a 15 ohm load is used, the peak load current will be 1A, and the r.m.s. power delivered to the load will be 3·75W,

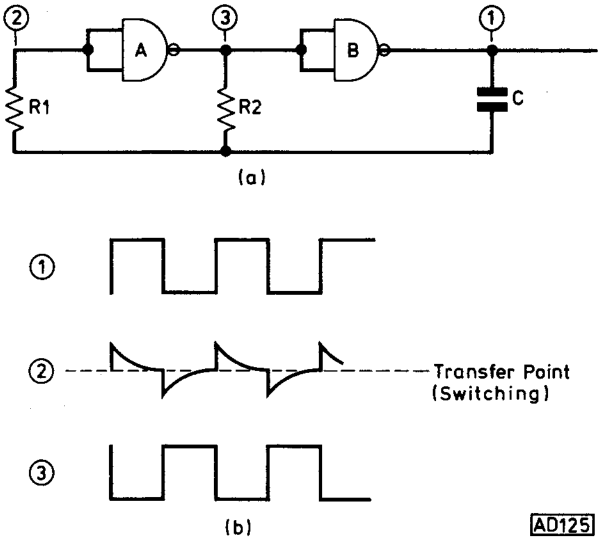


Fig. 2: The basic two stage c.m.o.s. oscillator

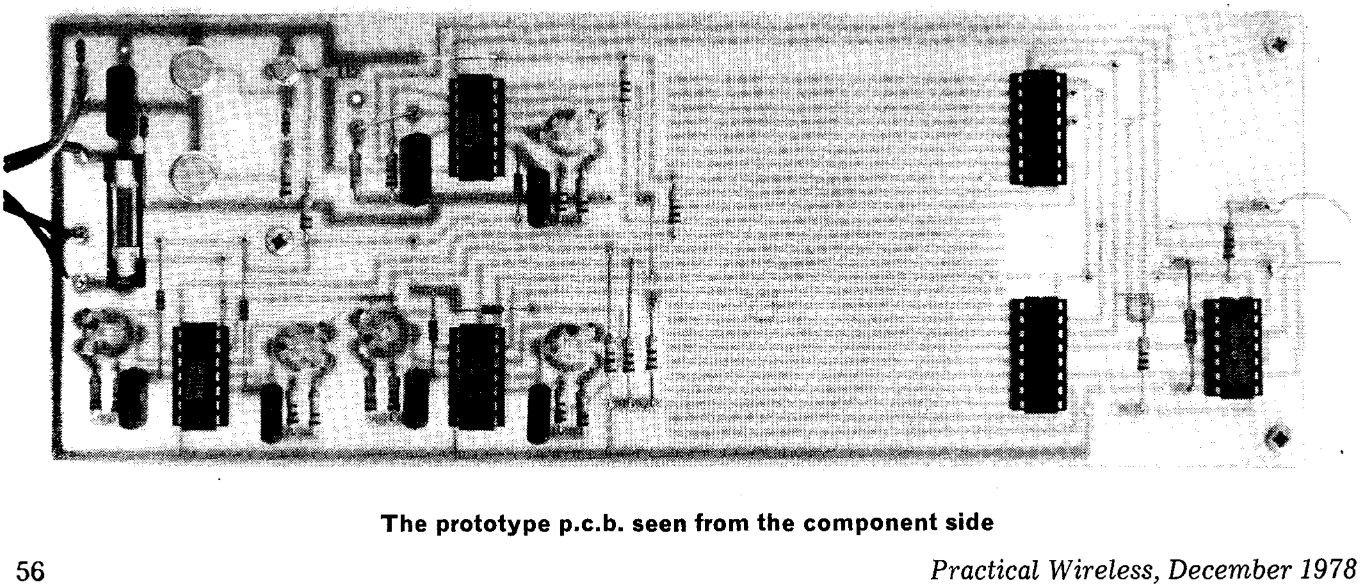
assuming a 1:1 mark-space ratio. Being driven by a square wave the loudspeaker signal is rich in harmonics, the note produced having a penetrating quality that is well suited to its application.

Setting Up

Plug in all the i.c.s and connect the unit to a power supply, with a current meter in the positive lead. There should be negligible current drawn when the circuit is not operating: any permanent quiescent current should be investigated. The five notes may be set up easily by pulling up each enable line (j-n) in turn to give a continuous tone and adjusting the associated preset.

To adjust	Link positive rail to
VR1	I.C.E Pin 13
VR2	I.C.D Pin 13
VR3	I.C.D Pin 1
VR4	I.C.F Pin 13
VR5	I.C.F Pin 1

Finally, close S1 to verify the operation of the entire circuit. The speed at which the tune is played may be adjusted by altering the value of R5 (or tweaking VR6 if fitted).



The prototype p.c.b. seen from the component side

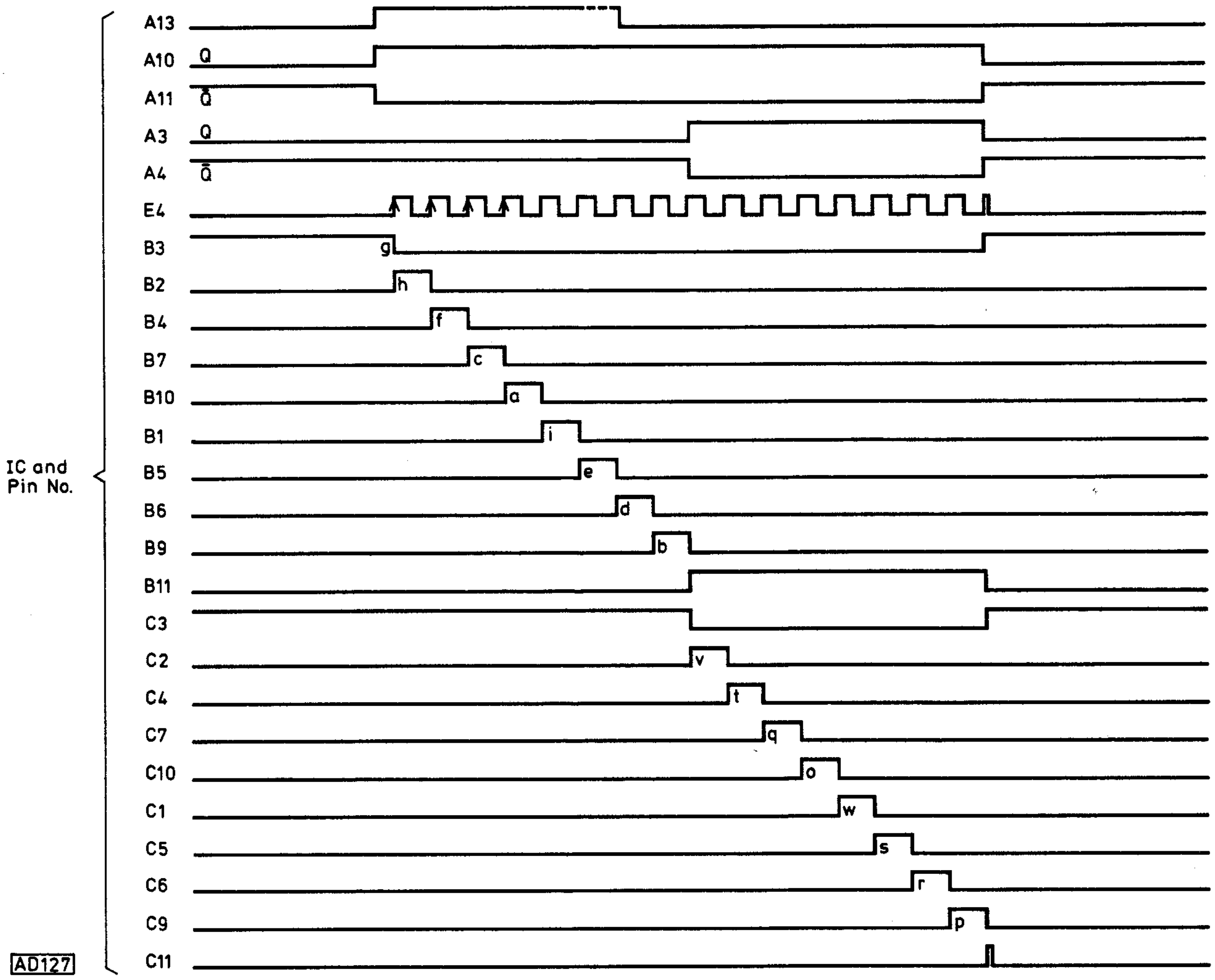
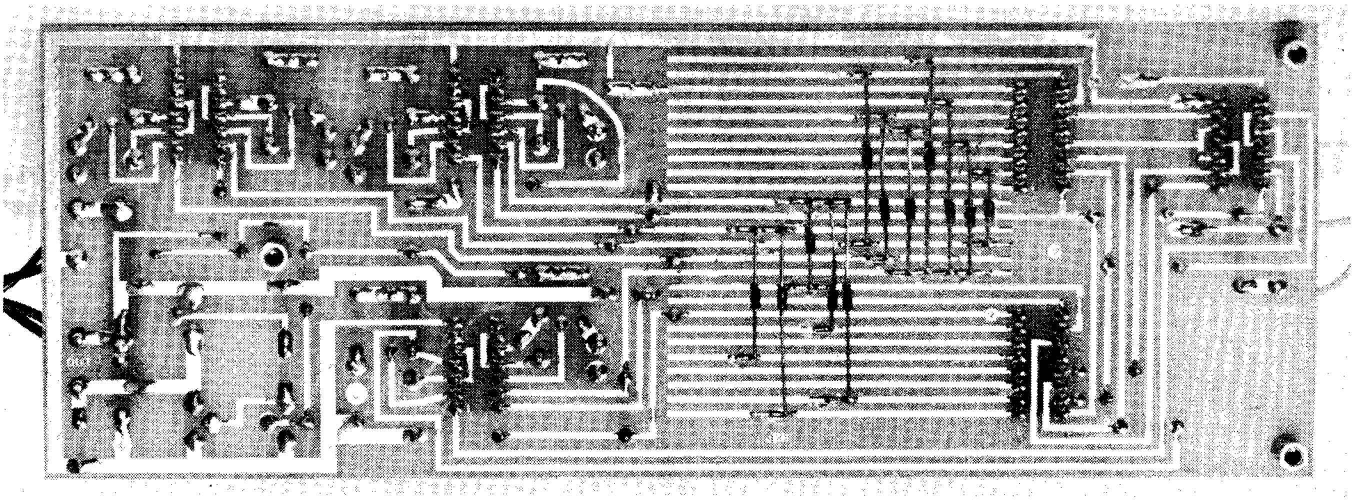


Fig. 3: Timing diagram showing the relationships of the various pulses

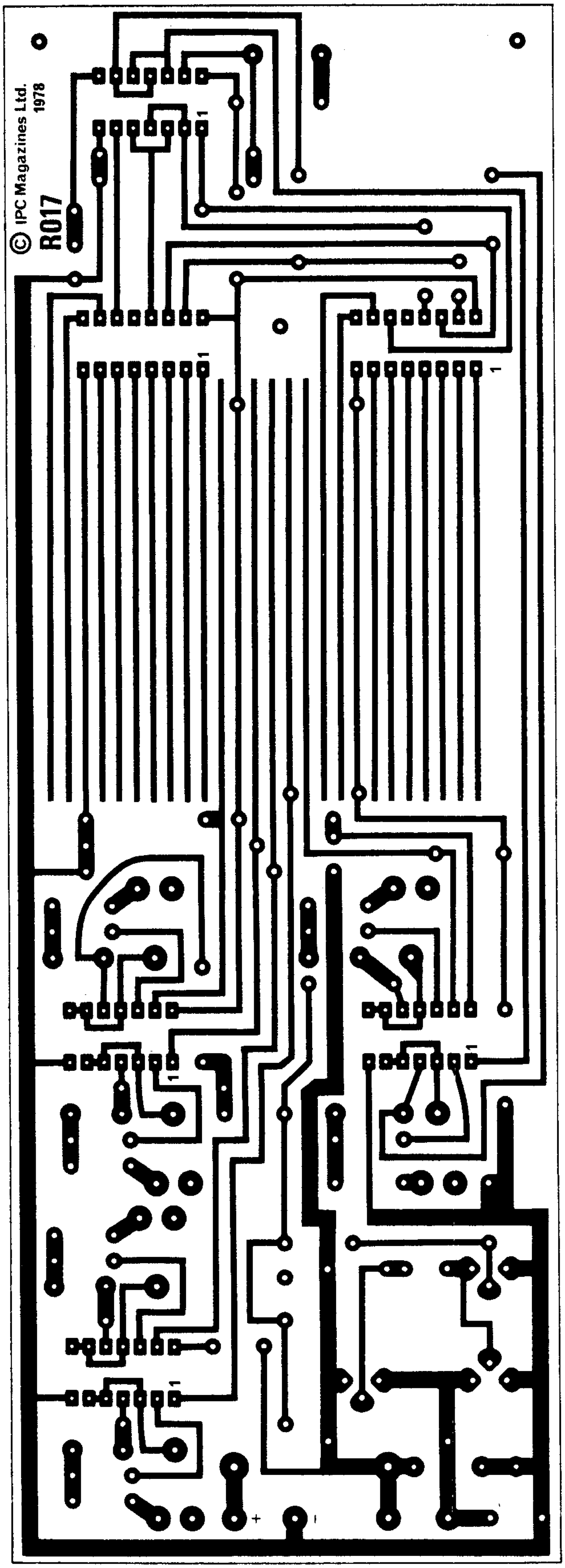
Faultfinding (e.g. decoding errors, wrong or missing notes) may be simplified by bridging C3 with a 2·2μF capacitor; this will slow down the clock to 1Hz and allow the circuit operation to be checked at leisure against the timing diagram (Fig. 3) with a meter.

Touch Control

Advantage may be taken of the very high input impedance of c.m.o.s. devices to operate the chimes by touch control instead of a switch. Simply increase R1 to 100k and R2 to 10M, and replace S1 with a pair of touch contacts.



Copper track side of the p.c.b. showing positioning of the diodes



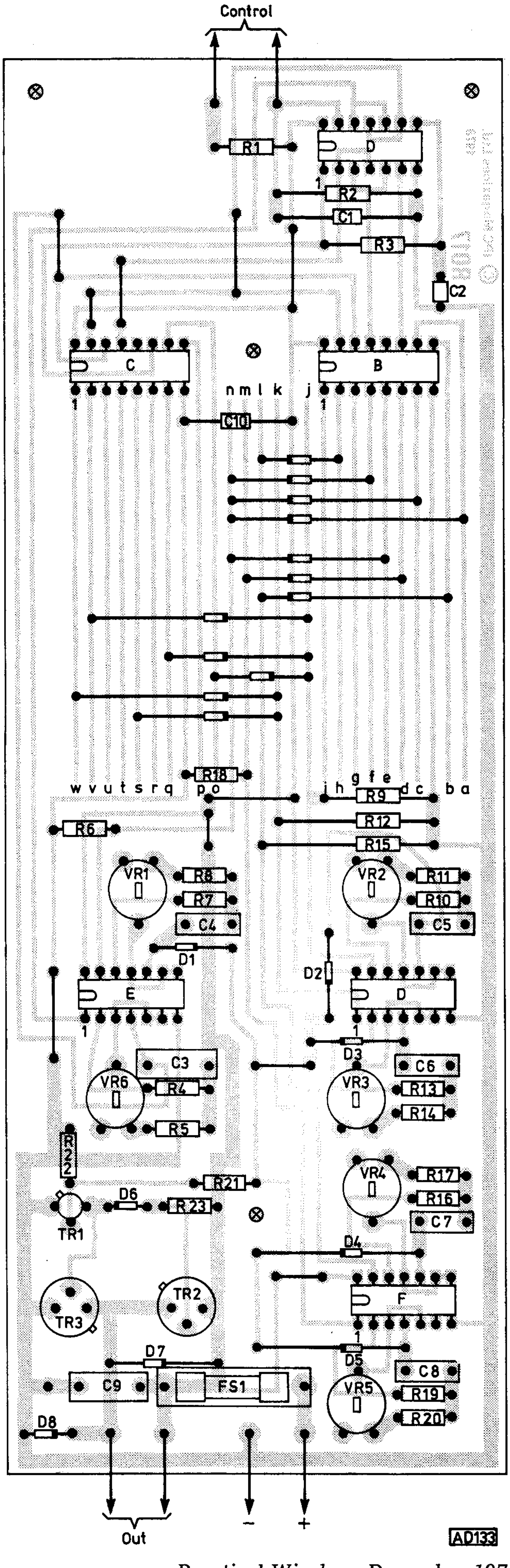


Fig. 4: Above, copper track layout of the p.c.b. (shown full size)
Fig. 5: Right, component layout

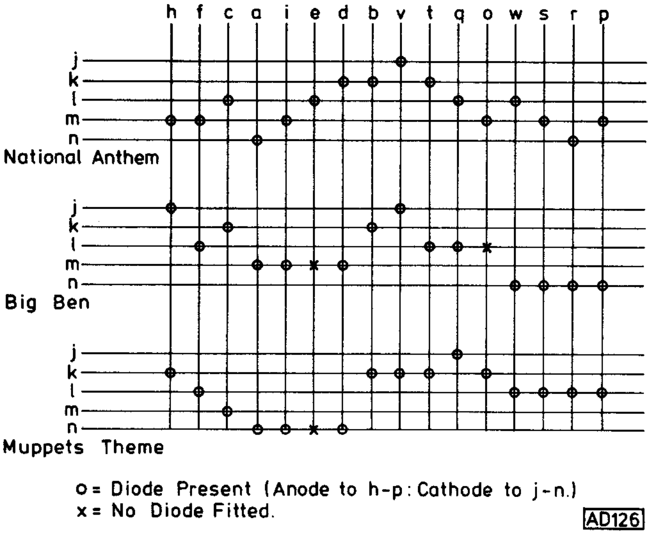


Fig. 6: Programming for three sample tunes. This shows the positioning of the diodes on the matrix part of the p.c.b.

★ components

Resistors

All ¼ watt 5%

R1	1k	R10	1M	R19	1M
R2	10k	R11	100k	R20	100k
R3	1M	R12	1M	R21	100k
R4	1M	R13	1M	R22	100k
R5	330k	R14	100k		
R6	1M	R15	1M		
R7	1M	R16	1M		
R8	100k	R17	100k		
R9	1M	R18	1M		

VR1-5 all 470k lin. preset

Capacitors

C1	see text	C6	10nF 100V polyester
C2	see text	C7	10nF 100V polyester
C3	220nf 100V polyester	C8	10nF 100V polyester
C4	10nF 100V polyester	C9	220nF 100V polyester
C5	10nF 100V polyester	C10	see text

Semiconductors

Tr1	BC109	IC A	4001	IC D	4011
Tr2	BC140	IC B	4017	IC E	4011
Tr3	BC160	IC C	4017	IC F	4011

All diodes 1N4148

Miscellaneous

Fuseholder, 1A fuse, loudspeaker, battery and connector, 14 way i.c. sockets (4 off), 16 way i.c. sockets (2 off), door bell switch or touch contacts.

Alternative tunes

The circuit as it stands provides sixteen time intervals and five notes, conveniently enabling the first four bars of any number of tunes to be programmed; several examples are shown in Fig. 6. Extra notes may be provided by adding further audio oscillators to the circuit (most economically added in pairs, since there are four Nand gates in each i.c.) and programming them as required; the outputs would be taken via isolating diodes to R21. Finally, really keen constructors can work out for themselves how to add further decade counters to extend the length of the chimes. ●

RECEIVER ADD-ON ACCESSORIES

Continued from page 25

In use, the object is to find the right amount of inductance, by changing the tapping point on the coil, and the correct amount of capacitance, the point of resonance being indicated by a sharp increase in signal strength. There will be many points at which the signal will peak but there will be a particular ratio of inductance and capacitance giving the maximum signal. Make a note of the tapping point on the coil and the tuning capacitor/s settings for future reference. Do this at the centre of each band of interest. It is worth while taking a little time to find the correct settings, so do not settle for the first peak found.

Stephen-James Ltd, 47 Warrington Road, Leigh, Lancs.
Multi Tuners, Mk1 1·8 to 30MHz, five aerial configurations. Mk2, similar plus m.w. band. **Crystal Calibrator**, 1MHz, 500kHz, 100kHz, 50kHz, 10kHz, 5kHz and 1kHz. **Audio Bandpass Filter**, eight switched bandwidths 80Hz to 2·5kHz. Peak and Notch Filter, between receiver and speaker/phones. Preselectors.

Amtest, 55 Vauxhall Street, Rainbow Hill, Worcester WR3 8PA.
Aerial Tuner AT2, 1·5 to 30MHz for end-fed aerials. **RF Preselector** PRS1, same range, up to 30dB gain. **PRM** for m.w. coverage to 1·6MHz. **PRM Adaptor Unit**, for coupling external aerials to internal ferrite rod aerial of receiver.

Cambridge Kits, 45(P) Old School Lane, Milton, Cambridge CB4 4BS.
LF Converter, 100/600kHz converted to 80m band. **Tunable Audio Notch Filter**, between speaker and receiver, 350 to 6000Hz. **Crystal Calibrator** 1MHz, 100kHz, 25kHz. All are kits.

G2DYM Aerials and Projects, Whiteball, Wellington, Somerset.
Aerial Matching Unit, designed to combat TV timebase QRM, untuned, wideband for 50Ω to balanced feeder from multi- or single-band dipole. Switch for Marconi T operation on 160m and broadcast band.

Partridge Electronics Ltd, Broadstairs, Kent.
ATU's 111B and LO-Z500 for use with Joystick aerial. **Joymatch Triple purpose ATU**, s.w. and m.w. coverage, in kit form.

Lowe Electronics Ltd, 119 Cavendish Road, Matlock, Derbyshire.
ATU, Daiwa CL22 1·8 to 30MHz for SWL. **Converters** by Microwave Modules, various for 4m, 2m, 70cm and 23cm to h.f. receiver.

Rocquaine Electronics, Aldebaran, Le Coudre, St. Pierre-du-Bois, Guernsey, Channel Isles.
Crystal Calibrator RQ1, 1MHz, 100kHz and 10kHz, c.w. or modulated output, kit form. **Frequency Counter** RQ3, up to 40MHz, 4-digit l.e.d. display of frequency or period or wavelength, kit form.

Datong Electronics Ltd, Spence Mills, Mill Lane, Bramley, Leeds LS13 3HE.
Active Antenna AD170, indoor aerial system 60kHz to 70MHz, 3m long dipole plus amplifier, output 50Ω. **Up-Converter UC/1**, synthesised receiving adapter plus 2m converter for receivers tuning 28-29MHz or 144-145MHz, range 90kHz to 30MHz. **Audio Filter FL1**, automatic suppression of heterodynes in range 280-3000Hz, variable width notch 25-1000Hz. ●