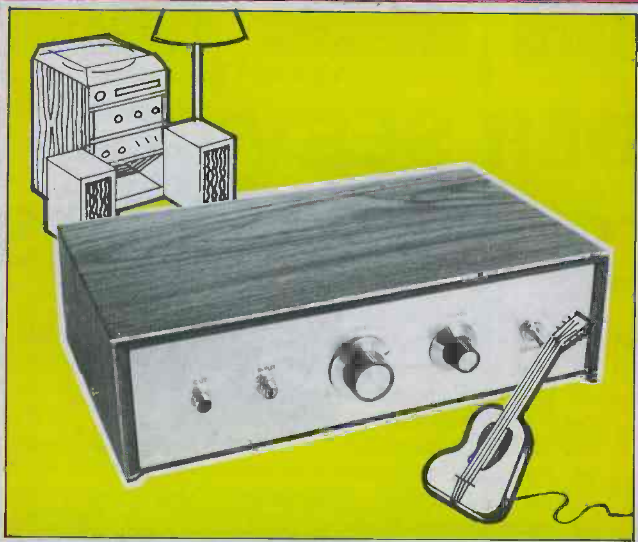
RADIO & ELECTRONICS CONSTRUCTOR

FEBRUARY 1981
60p



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HOW TO PLAY CRICKET IN COMFORT

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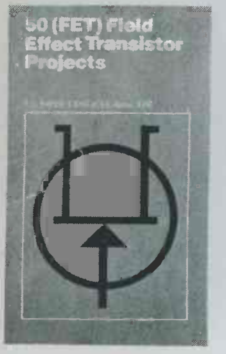

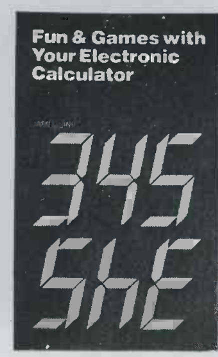

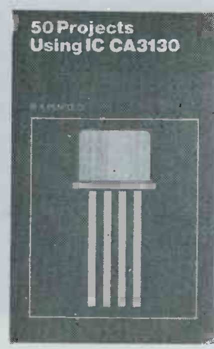

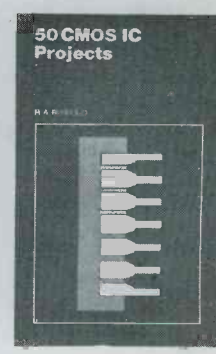

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Technical Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. We regret that queries cannot be answered over the telephone, they must be submitted in writing and accompanied by a stamped addressed envelope for reply.

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OUR NEXT ISSUE WILL BE PUBLISHED MID-FEBRUARY

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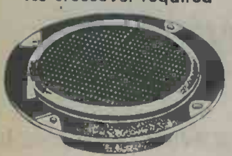

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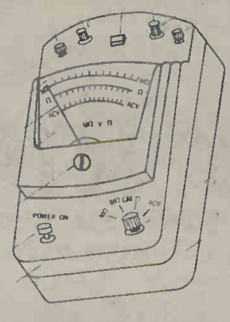

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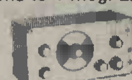

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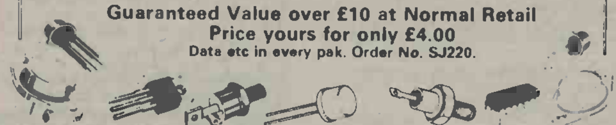

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2SA367 56p
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2SA634 80p
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2SB77 25p
2SB135 25p
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2SB156 60p
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2SB187 25p
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10MFD 9p
47MFD 22p

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0.22MFD 6p
0.47MFD 6p
3.3MFD 12p
4.7MFD 9p
6.8MFD 11p

40 VOLT
0.1MFD 10½p
0.15MFD 11½p
0.22MFD 10½p
0.33MFD 11½p
0.47MFD 11½p
0.68MFD 11½p
1MFD 11½p
1.5MFD 11½p
2.2MFD 11½p

50 VOLT
2.2MFD 11p

TRIACS

Amp	Volt		
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2.5	600	2N5757	44p
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BA116	30p	OA75	11p
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BA148	12p	OA90	4p
BA182 Varicap	6p	OA91	6p
BAX13	3p	OA95 (IN50)	6p
BAX14	2½p	OA200	2½p
BAX20	3p	IGP7	11p
BAX21 50v 120ma	3p	IGP10	11p
BAX22	3p	IN63 (OA91)	4p
BAX22 100v 120ma	4p	IN337 200v 200ma	4p
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RECTIFIERS

Type	Volt	Amp	Price
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BY127	1250	1	4p
BY212	15kv	500ma	6p
BY235	600	1½	7½p
BY236	900	1½	7½p
BY264	300	3	9p
BY265	600	3	11½p
BY266	900	3	15p
BY274	300	5	14½p
BY275	600	5	17½p
BY277	1200	5	27p
BY299	800	2	4p
BY1202	2kV	10mA	6p
BYW55	800	2 (Oxide bead)	15p
BYW56	1000	2 (Oxide bead)	18p
BYX20-200	200	25	72p
BYX22-200	300	1½	25p
BYX38 300R	300	2½	48p
BYX38 600	600	2½	52p
BYX38 900	900	2½	60p
BYX38 1200	1200	2½	65p
BYX42 300	300	10	36p
BYX42 600	600	10	46p
BYX42 900	900	10	92p
BYX42 1200	1200	10	£1.07
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BYX46 400R	400	15 Avalanche	£1.75
BYX46 500R	500	15 Avalanche	£2.00
BYX46 600	600	15 Avalanche	£2.30
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BYX48 600	600	6	60p
BYX48 900	900	6	70p
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BYX49 600	600	3	42p
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BYX72 300R	300	10	52p
BYX72 500R	500	10	65p
BYX94	1250	1	6p
E250C50	250	½	14p
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LT102	30	2	15p
M1	68	1	5p
MR856	600	3	24p
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OA210	400	5	33p
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RAS508AF	1250	1½ (Avalanche)	50p
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SR100	100	1½	9p
SR400	400	1½	10p
SR1825	100	50	75p
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IN4002	100	1	3p
IN4004	400	1	4½p
IN4005	600	1	6p
IN4006	800	1	6p
IN4007	1250	1	6p
IN5059	200	1½	10p
IN5401	100	3	10p
IN5406	600	3	15p
IS138	800	1	2½p
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3052	200	3	11p
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16492	700	1½	9½p

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½	1,600	BYX10	34p
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1	50V	WO05	27p
1	140	OSH01-200	25p
1	200V	WO2 Ex Equip	15p
1	400V	WO4	28p
1	400V	MDA104	29p
1	800V	WO8	27p
1	1000	W10	36p
1½	75V	IBIBY234	11½p
1½	150V	IBIBY235	15p
2½	100	I.R.	40p
2½	350V	9F2	53p
2½	500V	9E4	85p
3	50	KBS005	30p
3	100	KBS01	30p
3	200	KBS02	30p
3	400	KBS04	30p
3	600	KBS06	30p
3½	100	B40C 3200	39p
5	400	Texas	85p
Miniature	Meter	Type	34p

THYRISTORS

Amp	Volt		
0.8	200	2N5064	18p
1	240	BTX18-200	35p
1	240	BTX30-200	35p
1	400	BTX18-300	41p
1	700	BT 106	70p
2	400	S2710D with heatsink	40p
3	600	T3N06C00	53p
3	100	T3N1C00	36p
4	50	S107F Sensitive Gate	36p
4	50	S2060F Sensitive Gate	36p
4	400	S2061D Sensitive Gate	38p
4	500	40506 with heatsink	58p
4	600	C106M Sensitive Gate	36p
4	600	2N3228	36p
4	600	GAK	36p
5	400	S3700D	44p
5	400	S5800D/R	36p
5	600	S5800M	44p
6.5	500	BT109/SCR957	71p
7	400	S2620D	45p
7	600	S2620M	45p
8	100	S2800A	36p
8	600	S122M	54p
12	1000	CR121103-RB	£8
15	800	BTX95-800 Pulse Modulated	£1
20	600	BTW92-600RM	£3.40
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110	20	72RC2A	£3
150	1000	151RA100	£10
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BT 107		£1	

ZENER DIODES

4/500MW. BZY88, BZX97, etc. 5p
2v. 2v7. 3v. 3v3. 3v6. 3v9. 4v3. 4v7. 5v1. 5v6. 6v2. 6v8. 7v5. 8v2. 9v1. 10v. 11v. 12v. 13v. 13v5. 15v. 18v. 20v. 22v. 24v. 27v. 30v. 33v. 43v.
BZY61 Laboratory Standard 400MW 7v5. Voltage Regulator Diode 12p
1.3/1.5WT BZX61, BZY97, etc. 11p
2v4. 2v7. 3v. 3v6. 3v9. 4v3. 4v7. 5v6. 6v2. 6v8. 8v2. 10v. 11v. 12v. 15v. 18v. 20v. 27v. 33v.
2.5WT BZX70, etc. 13p
v75. 1v. 2v4. 3v6. 3v9. 5v6. 6v2. 7v. 7v5. 8v. 9v. 10v. 11v. 14v. 15v. (8p). 20v. 22v. 24v. 26v.
5WT BZV40, etc. 15p
3v3. 3v6. 3v9. 4v3. 4v7. 5v1. 5v6. 6v2. 6v8. 7v5. 8v2. 8v7. 9v1. 10v. 11v. 12v. 15v. 33v. 68v. 120v.
10WT Z5D, ZX, IS50, etc.
4v3. 4v7. 5v1. 5v6. 6v2. 6v8. 7v5. 8v2. 10v. 11v. 12v. 13v. 16v. 18v. 21v. 22v. 33v. 36v. 39v. 43v. 51v. 56v. 62v. 68v. 75v. 150v.
15WT BZV15C 12R 12volt 37p
20WT BZY93, etc. 44p
8v2. 12v. 39v.

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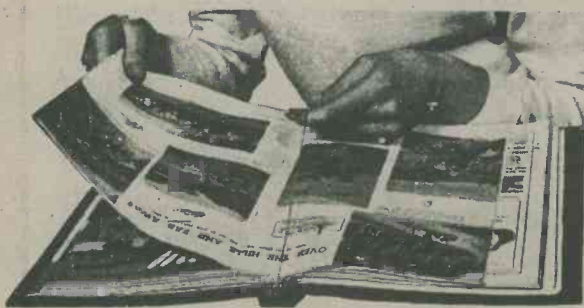

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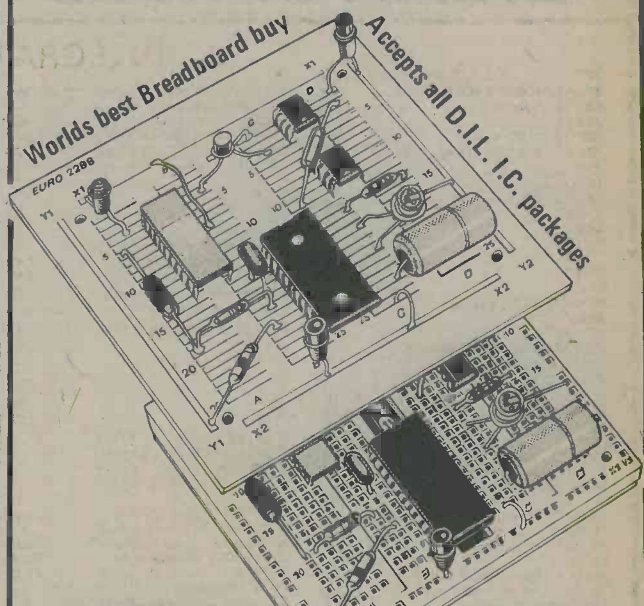

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SUGGESTED CIRCUIT

Zener Diode Analyser

By G. A. French

Many of us fall into the habit of thinking that all zener diodes have voltage-current characteristics similar to that shown in Fig. 1. As soon as a small zener current is allowed to flow, the voltage across the zener diode stays constant at zener level for all higher currents. In practice such is by no means the case, this being particularly true of the lower voltage devices which, in many instances, have to pass a relatively high current before they approach the zener level and, even then, exhibit a marked slope in their characteristics.

This article describes a zener diode analyser which can evaluate the practical performance of a zener diode at five pre-set currents ranging from 0.1mA to 10mA. It can accommodate all zener diode voltages up to about 24 volts, and voltage readings are given by a testmeter which is connected to the circuit only when required. In consequence, an expensive meter movement is not permanently tied to the unit. The analyser can check the performance of a zener diode which is to be employed in a new circuit and indicate the minimum zener current it requires for good voltage stabilising action. It can also be employed to sort out diodes which are salvaged from used equipment, and to find the zener voltage of diodes which have had their markings smudged or otherwise made illegible.

The analyser works on the simple principle of passing a known constant current through the zener diode under test and then measuring the voltage across it with a very high resistance voltmeter.

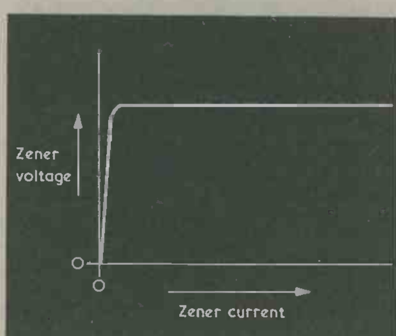


Fig. 1 A perfect zener diode voltage-current characteristic. Many practical diodes fall far short of this ideal

CIRCUIT OPERATION

The circuit of the analyser is given in Fig. 2. IC1 is an LM334Z constant current generator, and its output current flows through the test diode to the chassis rail. The three 9-volt batteries above the chassis rail give a positive supply to the i.c. of 27 volts. The constant current provided by IC1 is equal, in amps, to 0.0677 divided by the resistance, in ohms, which is connected between its pins 1 and 3. On position 5 of the range switch S1 the resistance is 6.8Ω, giving a constant current of almost exactly 0.01 amp, or 10mA. The resistance at positive 4 of the switch is 27Ω, whereupon the constant current calculates as 0.0025 amp, or 2.5mA. The current at position 3 of the switch is 1mA, at position 2 it is 0.25mA and at position 1 it is 0.1mA.

The voltage across the test diode is applied to the potential divider consisting of R6 and R7, with one-quarter of the voltage appearing across the second resistor. The current drawn by the potential divider is less than 2μA at a maximum zener voltage of 24 volts, and the low current flowing through it will have little effect on the accuracy of indications. ■

The voltage at the junction of R6 and R7 is passed to the non-inverting input of the operational amplifier, IC2. This has an input impedance of 1 million megohms and, with its output connected to its inverting input, functions as a voltage follower. Meter M1, connected between the output and the chassis rail, is a testmeter switched to a suitable d.c. volts range, and the voltage it indicates is multiplied by 4 to give the zener diode voltage. With some testmeters it may not even be necessary to carry out the multiplication. If, for instance, the testmeter has a 0-2.5 volt range and a 0-10 volt range, zener voltages below 10 volts can be measured with the meter switched to the 0-2.5 volt range, the readings being taken from the 0-10 volt scale.

The supply for IC2 is provided by BY3, the 9 volt battery immediately above the chassis rail, and by BY4, which is below the chassis rail. An offset null adjustment is given by the pre-set potentiometer VR1. Its slider is returned to the chassis rail and not to the lower negative rail, as is common with most offset null potentiometers. Because of the low voltage gain in the op-amp circuit the offset null adjustment is not critical.

On-off switching is provided by S2(a) (b) (c). Since this requires 3 poles, it is a rotary switch. S1 is also, of course, a rotary switch. The current drawn by IC2 from BY3 and BY4 is approximately 1.2mA. Also flowing in BY3, and in BY1 and BY2, is the constant current selected by S1 when a test diode is connected.

Apart from R6 and R7, the fixed resistors may all be ¼ watt 5%. R6 and R7 should preferably be 5% as well, and will then normally be available in ½ watt. VR1 is a 0.1 watt skeleton potentiometer. The four batteries can be any type, and a convenient size would be PP3. The two integrated circuits are available from Maplin Electronic Supplies. The lead-out inset for the LM334Z in Fig. 2 shows the lead-outs pointing at the reader.

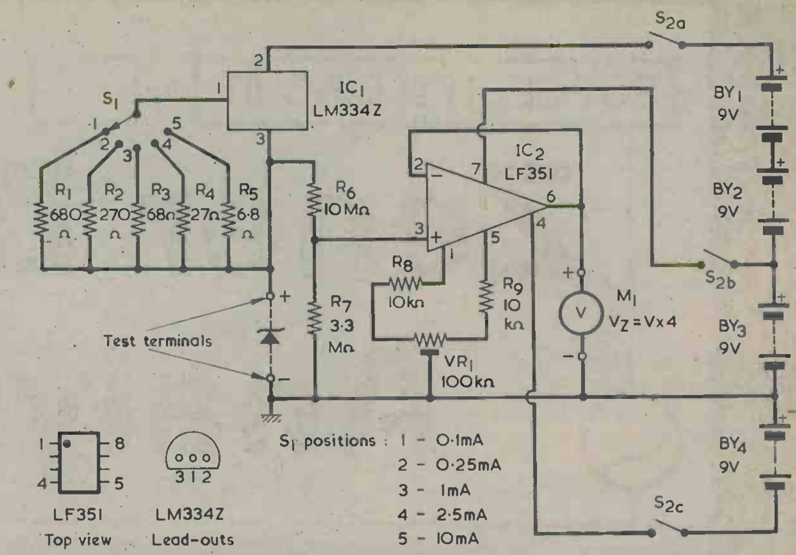


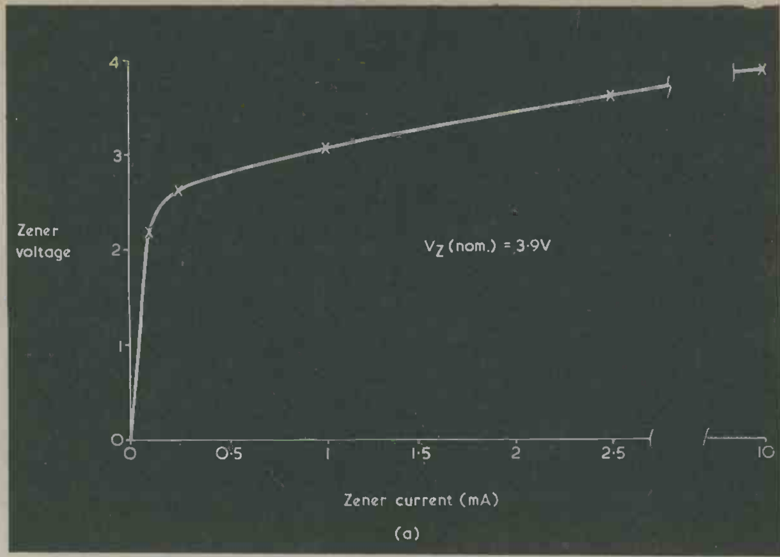
Fig. 2 The circuit of the zener diode analyser. S1 selects five different constant currents which flow through the test diode, the voltage across which is then measured.

CONSTRUCTION

The circuit can be assembled in a plastic or metal case with the two switches, the two test terminals and the two terminals for the external testmeter mounted on the front panel. When the case is metal it should be connected to the chassis supply rail. A chassis connection is not essential and if the case is all-plastic the chassis symbol in Fig. 2 can be ignored. S1 should be provided with a pointer knob and the front panel should be marked up to indicate the constant current it selects. Layout is not at all critical and the only wiring requirement is that all leads should be kept reasonably short. Ensure that pin 7 of IC2 cannot be accidentally connected to a supply potential higher than that provided by BY3.

After construction has been completed the two test terminals are connected together and the testmeter is connected up in the M1 position. VR1 is then adjusted for zero output voltage with the meter switched to a low d.c. volts range.

In use the testmeter will normally be initially switched to a range whose maximum value is greater than 6 volts. It will then read a little in excess of this voltage when no diode is connected to the test terminals. S1 should be in position 1. If a zener diode is connected to the test terminals wrong way round the output voltage will correspond to about 0.6 volt. When the zener diode is connected correctly the voltage indication will be of zener voltage at 0.1mA. If necessary, the testmeter may then be switched to a lower volts range. S1 is next advanced, one step at a time, to position 5, whereupon an indication of the minimum current at which the zener characteristic starts to flatten out will be given. With some high voltage diodes the approximate zener voltage will be given at all positions of S1, or at positions 2 to 5 inclusive. Low voltage zener diodes may show a marked change in zener voltage at the different switch settings.



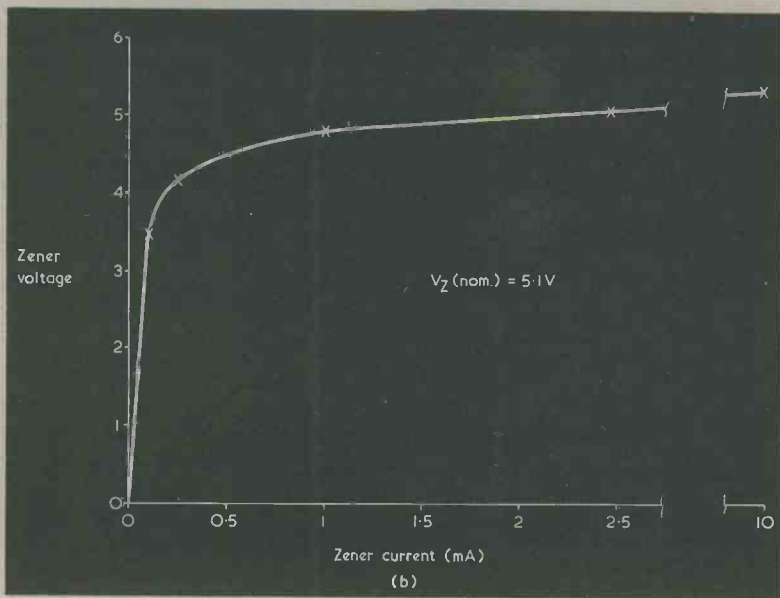


Fig. 3(a) A voltage-current characteristic, obtained with the aid of the analyser circuit, for a 3.9 volt zener diode.

(b) Another curve, given by a zener diode type BZY88C5V1

Fig. 3(a) shows the results obtained with a small 3.9 volt zener diode of unknown type and manufacture when checked with the prototype circuit. The crosses in the graph indicate the actual plotting points obtained by the analyser. A similar graph for a BZY88C5V1 is given in Fig. 3(b). As can be seen, the first diode needs a zener current of at least 2.5mA if it is to provide an adequate zener performance, whilst the second diode should pass a zener current of at least 1mA. ■

ARE YOU MISSING COPIES?

Because of last summer's printing dispute and, subsequently to it, our then printers ceasing to trade, many readers have been unable to obtain some recent issues. For the time being we are still able to supply such numbers.

RECENT PUBLICATIONS

EARLY RADIO WAVE DETECTORS. By Vivian J. Phillips, B.Sc.(Eng), Ph.D., A.C.G.I., D.I.C., C.Eng., F.I.E.E., F.I.E.R.E. 238 pages, 215 x 140mm. Published by Peter Peregrinus Ltd. Price (UK) £18.00.

Nearly all of us tend to look upon the crystal and cat's whisker assembly as being probably the first radio signal detector of importance, and some of us may have heard vaguely of the coherer as preceding the crystal in this application. But there were many other types of radio detector in existence before and concurrent with the coherer, and this fascinating book describes them all in detail.

What is probably the most important detector of the pre-crystal era is nevertheless the coherer, and this worked on the principle that if a number of conductors were in loose contact with each other they exhibited a high resistance. When a radio signal was applied to them they "cohered" and offered a low resistance. Unfortunately, they did not "de-cohere" at the cessation of the radio signal and had to be tapped or agitated to return them to the high resistance state. Very many different coherers were developed and the metals could be in the form of filings, rods, balls, or virtually any other shapes which could be devised in those pioneering creative days.

They were also electrolytic detectors which offered the requisite non-linear resistance in the contact between a liquid and a metal electrode. Magnetic detectors were devised, the simplest being a very sensitive galvanometer and one of the more complicated being a rotating device incorporating 3-phase coils. Thin-film and capillary detectors were related to the coherer but took advantage of phenomena occurring in fluids. One of the more gruesome devices was the "Physiological Detector" in which electrodes were connected to the sciatic nerve of a newly killed frog, causing the frog's leg, to which were coupled a string and pointer, to twitch in response to the radio signal. The useful period of the detector came to an end when rigor mortis set in. . .

All these detectors and many more are described and illustrated in this book. It makes compulsive reading for anyone who wishes to rediscover the very early, and surprisingly successful, world of radio communication.

AUDIO CIRCUITS AND PROJECTS. By Graham Bishop. 192 pages, 215 x 125mm. Published by PAPERMAC (The Macmillan Press Ltd.) Price £4.95.

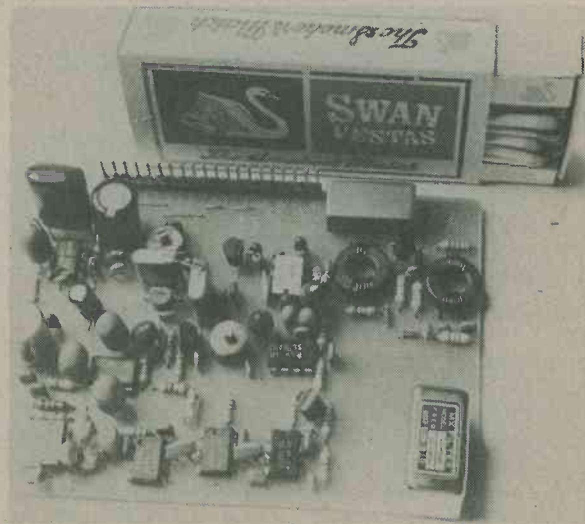
This book is the third in the PAPERMAC Electronic Projects series, and it presents nearly 100 tested circuits of amplifier and amplifier-related projects. Constructional details are given where necessary. All projects can be constructed on Veroboard, and ready-made printed circuit boards are available for designs which are better assembled in that way.

The book starts with a short treatise on human hearing, frequency range and the nature of sound, then carries on to microphones, pick-ups and speakers. Next dealt with are the basics of amplifiers. After this the main bulk of the book is devoted to working circuits. Covered first are pre-amplifiers, with attention being paid to filters, tone controls, mixers and electronic tone and attenuator control circuits. Veroboard layouts for many of the circuits are given. These are followed by power amplifier projects ranging from 1 watt to 70 watt designs. Again, Veroboard layouts are provided.

The book next turns to noise and rhythm projects, and these include attack and decay circuits, rhythm generators, envelope shapers, a reverberation unit and a peak overload detector, together once more with Veroboard assemblies. The following disco section describes sound-to-light modulators and a colour organ, and the final constructional pages deal with music circuits such as a stylus organ, organ generator and special effect oscillators. The components required for the projects, and sources of supply, are listed in two of the appendices at the end of the book.

NEWS . . . AND

10kHz to 100 MHz USB/LSB TRANSCEIVER BUILDING BLOCK



Ambit's 91600 receiver is based on an SL1600 series Plessey application design by James Bryant – modified to accept an 8-pole 10.7MHz SSB crystal filter to enable the frequency offset of the system to be used with the Ambit DFM7 LCD frequency readout module for 1kHz resolution in the HF bands.

By using the correct first mixer, the range 10kHz to 100 MHz may be spanned – although for most users, the standard 1–500MHz range is quite sufficient. The unit provides approx. 10mW of SSB in transmit mode, and a complete SSB receiver with 1W output stage.

An external local oscillator and bandpass filter// preselector is required to cover the frequency band desired – full USB/LSB switching is provided on the board.

Price around £40.00 (in kit form), the 91600 offers a versatile basis for SSB TX/RX systems for HF to UHF.

Details from Ambit International, 200 North Service Road, Brentwood, Essex CM14 4SG.

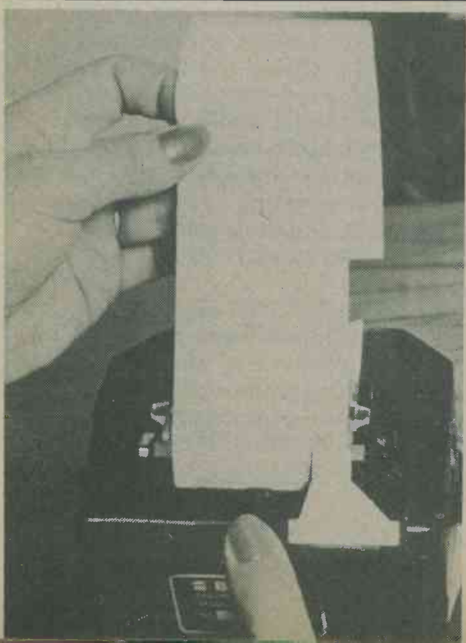
HANDY PLANE FOR DO-IT-YOURSELFERS

In addition to their portable electric planes for heavy duty industrial use, SKIL have announced the birth of a handy plane for craftsmen and do-it-yourselfers. In designing this tool, SKIL wish to meet the ever growing demand for compact, practical tools with professional qualities, prevailing amongst home users.

Apart from edging and surfacing, the new plane will also do rabetting jobs up to 7mm depth of cut. Planing jobs usually require a high degree of precision and for that reason the tool has a very high speed of 18,000 r.p.m., which also guarantees a fine, smooth finish of the workpiece. For chamfering jobs, a long V-notch has been designed in the base. A deflector removes chips away from the operator. The powerful 480-watt motor is double insulated and radio/tv suppressed according to European safety requirements. The emphasis on handling ease has been consequently extended to easy depth and bevel adjustments and safe blade change.

The tool is equipped with a pair of blades that have HSS cutting edges and that can be resharpened many times. Two adjusting screws, a device for blade adjustment, a wrench and a locking pin to block cutterhead when changing blades, are also included in the standard equipment.

Enquiries to SKIL (Great Britain) Ltd., Fairacres Industrial Estate, Dedworth, Windsor, Berkshire. SL4 1QJ.



NEW THERMAL PRINTER

Bowmar Instrument Ltd., of 43 High Street, Weybridge, Surrey, have announced details of their newly available TP 3150 Thermal Printer.

Featuring: Full alpha-numeric 64 ASCII character set; complete interface electronics; 18 characters per line; over one line per second in parallel data mode for 18 column lines; TTL compatible 7 bit ASCII inputs that accept parallel or bit serial data; low stand-by power; quiet, non-impact thermal printing on white, bond-type paper; internal 32 character FIFO buffer; and left-to-right or right-to-left printing.

The printer is ideal for microprocessor terminal interfacing, test equipment, data recording devices, communications equipment or any alpha-numeric hard copy application where quiet, intermittent printing is required.

The TP 3150 Thermal Printer's control function is implemented using a single chip microprocessor and it accepts 7-bit data in either synchronous parallel format with handshake signals or in asynchronous bit-serial format at a rate of 110 baud.

. . . COMMENT

PRESTEL FORGES AHEAD

'Prestel', the British system by which people can order goods and services through their home television sets, will shortly be available to over 60% of the population of the United Kingdom. This expansion is ahead of the schedule set by British Telecom (the new name for Post Office Telephones), and means that nearly every major city and town will have the service available, BBC World Service reported.

For Prestel, one's television set – specially designed or adapted – is also connected to the telephone. There is a push-button control unit rather like a pocket calculator. On pushing the appropriate button, the silicon chip circuits inside the set dial up a central computer over the 'phone line. This sends back signals to produce diagrams and text information on the screen of the TV set. The information capacity of the system is limited only by the capacity of the central computers.

Material available ranges from free information like transport timetables and catalogues for used cars and 'mail-order' goods, through cheap computer games and sports events to expensive specialist information about, say, trends in the stock market.

For some time now wine merchants have not only had their lists in Prestel, but also have permitted ordering, by tapping out the list numbers of the wine you want, the quantity and the number of your bank credit card. Then, within a day or two, a van turns up at your door with the wine you have ordered. There is no scope for practical jokers in this, because delivery is only to the credit card holder's address, and the system can record the identity of the 'phone line used for ordering.

The latest facility to be offered allows booking of theatre seats. The Royal Shakespeare Company's list of productions can be called up on the screen of your home or hotel TV, and by tapping the appropriate keys on the control unit, details of seats available for particular productions and days can be brought to the screen. You make your selection, give your credit card number – and the seats are booked by the computer.

So why do this, when you can book by 'phone? The answer is simple – it is much more like going to the theatre box-office in person. You can see the choice available set out on the screen in front of you at home or in your hotel bedroom and make a logical informed decision – not so easy when you are told at top speed by a busy box-office clerk on the 'phone, with others ringing in the background. And then when you get to the theatre you might find yourself behind a pillar, or that the seats have been sold twice. With the computer keeping tally, that is impossible.

BEGINNER'S BOX OF BITS

One of the snags for constructor beginners is that, unlike the old hand, they do not have a box of bits accumulated over the years. The experienced constructor can, with a bit of luck, find that he already has in his junk box, perhaps, half the components he needs for a new project – not so the beginner.

To overcome this snag for the newcomer Home Radio (Components) Ltd., P.O. Box 92, 215 London Road, Mitcham, Surrey, are now supplying a "Beginner's Constructional Hamper". Altogether the hamper contains 62 items covering 27 different components, from half-a-dozen assorted bulbs to a set of parts to make up a small chassis. Home Radio estimate the retail value of the hamper to be approximately £35 and yet it can be obtained from them for only £14, plus V.A.T.

WORLD'S SMALLEST HOME COLOUR VIDEO CAMERA

World's smallest home colour video camera, Hitachi's Model VK-C1000 incorporating a single chip MOS colour image sensor.

Using a MOS (metal oxide semiconductor) colour image sensor, Hitachi have manufactured the VK-C1000 home colour video camera, the smallest in the world. It will be marketed on the Japanese market from April 1981 at a price of around £690.

The recent improvements in functions and efficiency of home VTR equipment, together with its rising popularity has created a demand for a small lightweight and highly reliable colour video camera. The VK-C1000 has been developed by Hitachi to satisfy this demand, particularly for a video camera for outdoor use.

A single chip MOS image sensor of 2/3rds inch size has been developed using advanced VLSI (very large scale integrated circuit) technology and is used instead of a pick-up tube, and in addition the camera circuits are largely integrated. With these features, stability, long life, extremely high reliability and good picture are assured.

LOW CURRENT PILOT LAMP

By
F. L. Stephenson

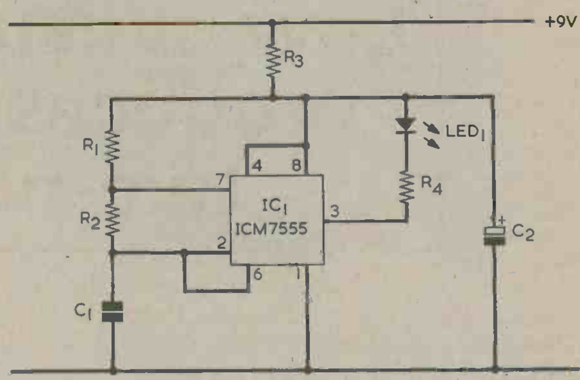
Battery-saving flashing light

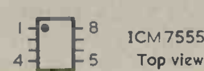
It is often desirable for battery powered equipment to have some form of pilot light to indicate when it is switched on. In the interests of battery economy the light should draw a low current only and a common approach is to have a light which flashes on for a short period at regular intervals. The average current then drawn from the supply is quite low, even when the light is brightly illuminated when it is turned on. The circuit to be described is for a flashing pilot lamp which can be added to equipment having a 9 volt battery supply.

CIRCUIT OPERATION

The circuit of the flashing pilot lamp appears in the accompanying diagram. An obvious choice for the timing device controlling the light is an ICM7555. This draws a very low supply current and can function with high value timing resistors.

The ICM7555 is employed in a standard astable oscillator configuration with capacitor C1 charging through R1 and R2, and discharging through R2 on its own. The i.c. output at pin 3 is high when the capacitor charges and is low when the capacitor discharges. The l.e.d. lights up when the output is low and a current of about 12mA flows through it, giving bright illumination.





The low current pilot lamp circuit. The l.e.d. is brightly illuminated for half a second at 5 second intervals.

COMPONENTS

Resistors
(All ¼ watt 5% unless otherwise stated)

R1 6.8MΩ 10%
R2 750kΩ
R3 100Ω
R4 470Ω (see text)

Capacitors

C1 1μF polyester
C2 100μF electrolytic, 10 V. Wkg.

Semiconductor

IC1 ICM7555

Light-Emitting Diode

LED1 red l.e.d.

Since C1 has the value of 1μF it is an easy matter to calculate the charge and discharge times. The charge time in seconds is equal to 0.685 times the sum of R1 and R2 in megohms. This calculates as 5.2 seconds to 2 significant figures. The discharge time is equal to 0.685 times the value of R2, or 0.51 second. So, the l.e.d. is lit for approximately half a second at intervals of 5 seconds.

The current drawn from the 9 volt supply when the l.e.d. is lit is almost entirely the 12mA which flows through the l.e.d. The current when the l.e.d. is extinguished is a mere 60μA. The average current drawn from the supply is therefore about one-eleventh of 12mA, or 1.1mA. This current can, of course, be reduced by increasing the value of R4, at the expense of reduced light intensity in the l.e.d. A value of 2.7kΩ in this resistor, for instance, produces an l.e.d. current of approximately 3mA, whereupon the average current drawn from the supply is a little less than 0.3mA.

R3 and C2 decouple the ICM7555 circuit from the 9 volt supply and ensure that l.e.d. current pulses are not passed along the supply rails. ■

ELECTRONIC DOOR BUZZER

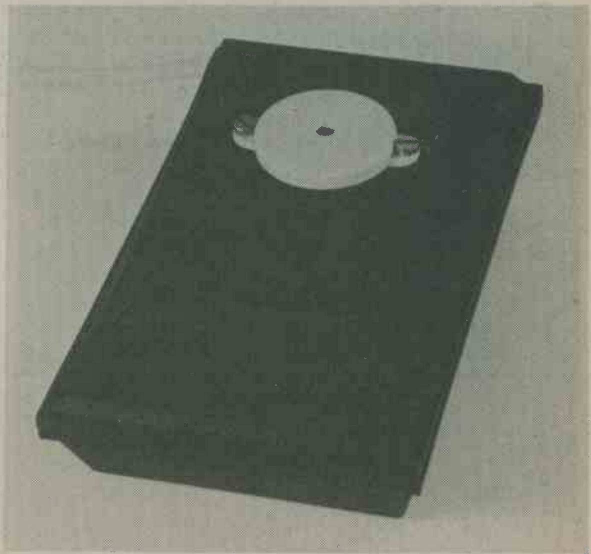
By A. P. Roberts

Low consumption unit produces distinctive two-note tone

This inexpensive door buzzer circuit produces a frequency modulated tone which is quite penetrating and attention-catching. The unit is powered by an internal 9 volt battery which is only connected into circuit when the bell-push is pressed. Even then, the current drawn from it is only 6mA and so, with normal usage, its life should be very nearly equal to its shelf life.

CERAMIC RESONATOR

The low current consumption is achieved by using a new type of component known as a "ceramic resonator". This is a piezo-electric transducer which produces an audible tone when fed with an electrical signal derived from an oscillator. Efficiency is very high and only a few mA of drive current are required to produce a loud audio tone. As the resonator is a high impedance device, the signal level should be at a fairly high voltage. The transducers are not intended to function as audio sound reproducers since they are not designed to give high quality. They are intended, instead, to be employed in alarm circuits where a flat response over the audio frequency spectrum is not required.



The ceramic transducer is mounted on the front of the case which holds the electronics

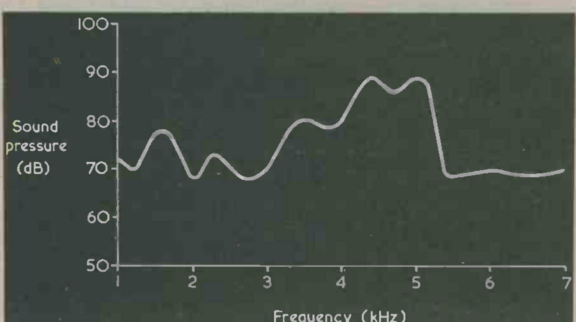


Fig. 1. The output response of the ceramic transducer type PBN-2720

The ceramic resonator used in the present project is a type PBN-2720, and is available from Ambit International. It has the frequency response shown in Fig. 1. The graph covers the range from 1kHz to 7kHz, at which the transducer has greatest efficiency. There is a pronounced peak at about 4.5 to 5kHz due to the resonant performance of the transducer, but the audible output is quite high over the entire frequency range.

DOOR BUZZER CIRCUIT

The complete door buzzer circuit is given in Fig. 2. This is based on a dual amplifier i.c. type TL082CP, which can be obtained from Watford Electronics, 33/35 Cardiff Road, Watford, Herts.

The two sections of the amplifier are used in identical oscillation configurations. One oscillator produces an audio tone to drive the ceramic transducer whilst the other runs at a much lower frequency and frequency modulates the first. The point of using frequency modulation is that this gives an audible output having more than one frequency, which is much less likely to be masked by domestic sounds. The sound is also more pleasant and less monotonous than a single frequency tone. In the present circuit a square wave modulating signal is employed, giving a "warbling" effect since the output tone is switched continuously between two pitches. The result is not unlike the ringing sound given with a Trimphone.

The lower frequency oscillator employs IC1(a) and is used in an oscillator circuit which is nowadays becoming quite common. R1, R2 and R3 all have the same value, whilst R4 and C2 control the oscillation frequency. At switch-on, C2 is discharged, whereupon the inverting input is negative of the non-inverting input, and the amplifier output goes positive. This effectively puts R3 in parallel with R1, so that the non-inverting input is at two-thirds of the supply potential. C2 commences to charge via R4 until the voltage across it reaches the same voltage as that at the non-inverting input, whereupon the amplifier output starts to go negative, causing the non-inverting input to go negative as well. There is a regenerative effect which results in the amplifier output going fully negative and causing the non-inverting input to be at one-third of supply potential. C2 now discharges via R4 until the voltage across it reaches the same potential as the non-inverting input. A reverse regenerative effect takes place, resulting in the amplifier output going positive again, the non-inverting input being taken to two-thirds of supply voltage, and the capacitor charging once more through R4. The cycles repeat in

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)

R1 33kΩ
R2 33kΩ
R3 33kΩ
R4 330kΩ
R5 68kΩ
R6 33kΩ
R7 33kΩ
R8 33kΩ
R9 47kΩ pre-set potentiometer, 0.1 watt horizontal
R10 39kΩ
R11 6.8kΩ
R12 3.9kΩ

Capacitors
C1 4.7μF electrolytic, 10V. Wkg.
C2 0.1μF polyester type C280
C3 0.01μF polyester type C280

Semiconductors
IC1 TL082CP
TR1 BC109

Switch
S1 bell-push

Transducer
X1 ceramic resonator type PBN-2720

Miscellaneous
Small plastic case
Veroboard, 0.1in. matrix
9 volt battery type PP3
Battery connector
Nuts, bolts, wire, etc.

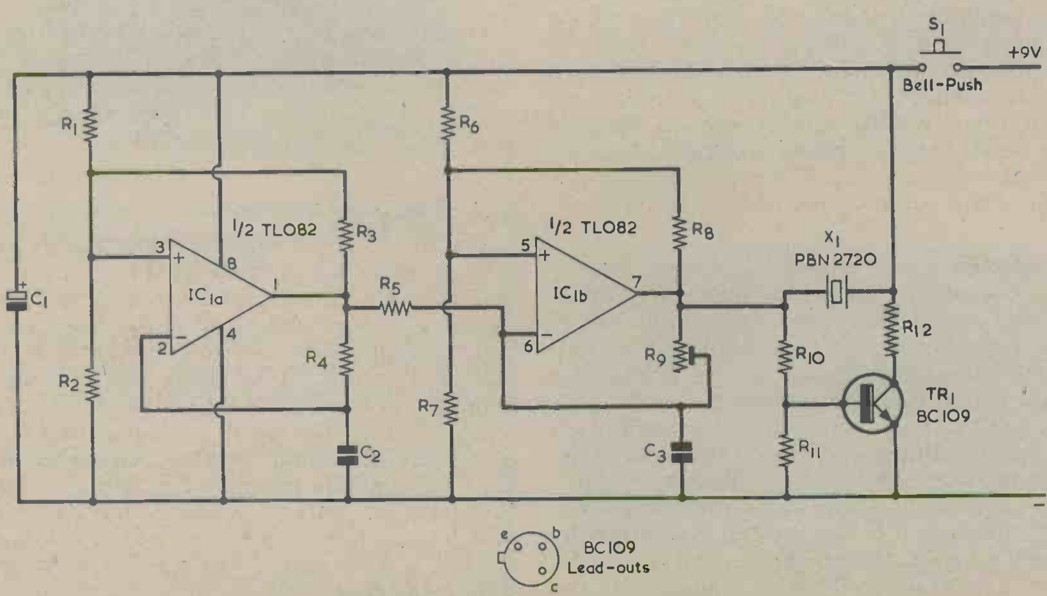
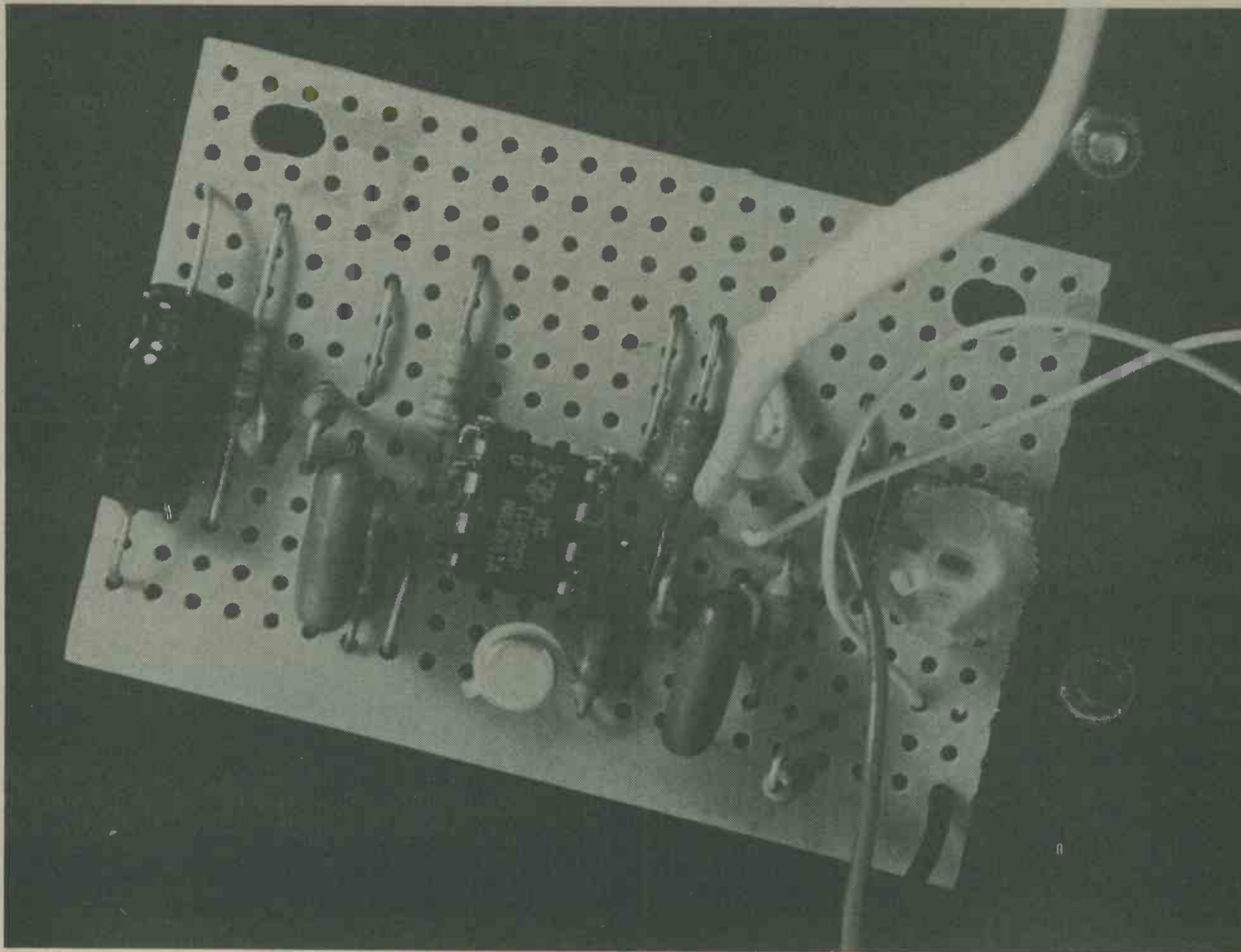


Fig. 2. The circuit of the electronic door buzzer. Low frequency oscillator IC1(a) frequency modulates the audio oscillator, IC1(b)



Close-up view of the Veroboard component panel

this manner with C2 alternately charging and discharging. A square wave is produced at the amplifier output.

Amplifier IC1(b) is used in the same type of oscillator circuit, but R9 and C3 have lower values to enable the oscillator to run at an audio frequency. This frequency can be varied by adjusting the resistance inserted into circuit by R9. The output of the lower frequency oscillator is coupled to the inverting input of IC1(b) via R5 and modifies its oscillation frequency according to whether IC1(a) output is positive or negative. The required frequency modulation of the audio oscillator is thus obtained.

OUTPUT STAGE

Since the ceramic transducer requires only a low drive current it can be driven directly from the output of IC1(b). However, the signal amplitude at this output is only about 6 to 7 volts peak-to-peak and a drive voltage higher than this is desirable. The higher voltage is achieved by connecting the output of IC1(b) to the transducer and also to the base of the inverting transistor, TR1. The collector of TR1 connects to the remaining terminal of the transducer. The result is that when IC1(b) output is positive the output from TR1 collector is negative, and vice versa, resulting in a peak-to-peak drive voltage for the transducer which is well in excess of battery voltage.

Since the output voltage of IC1(b) does not go fully to negative rail potential when it goes negative, TR1 base is connected by way of the potential divider consisting of R10 and R11. The voltage drop provided by the potential divider ensures that TR1 is switched cleanly on and off, so that the voltage swing at its collector is the maximum possible.

On-off switching is provided by S1, which is of course the bell-push. C1 is a supply bypass capacitor and it is perfectly in order to use a component here which has a higher working voltage than that specified in the Components List.

ASSEMBLY

The unit can be assembled in virtually any small plastic case, since the component panel and the PP3 battery require little space. The ceramic transducer is mounted on the front panel of the case by two small bolts and nuts. The two holes required in the panel can be marked out by using the transducer as a template. A third small hole is needed to enable the two leads from the transducer to pass into the interior of the case. Two small terminals for connection to the bell-push could be positioned on one side of the case. A permanent connection was used with the prototype unit, however, and the 2-core cable which connects to the bell-push is passed through a hole drilled in the side of the case.

The component panel is a piece of Veroboard of 0.1in. matrix having 22 holes by 14 copper strips.

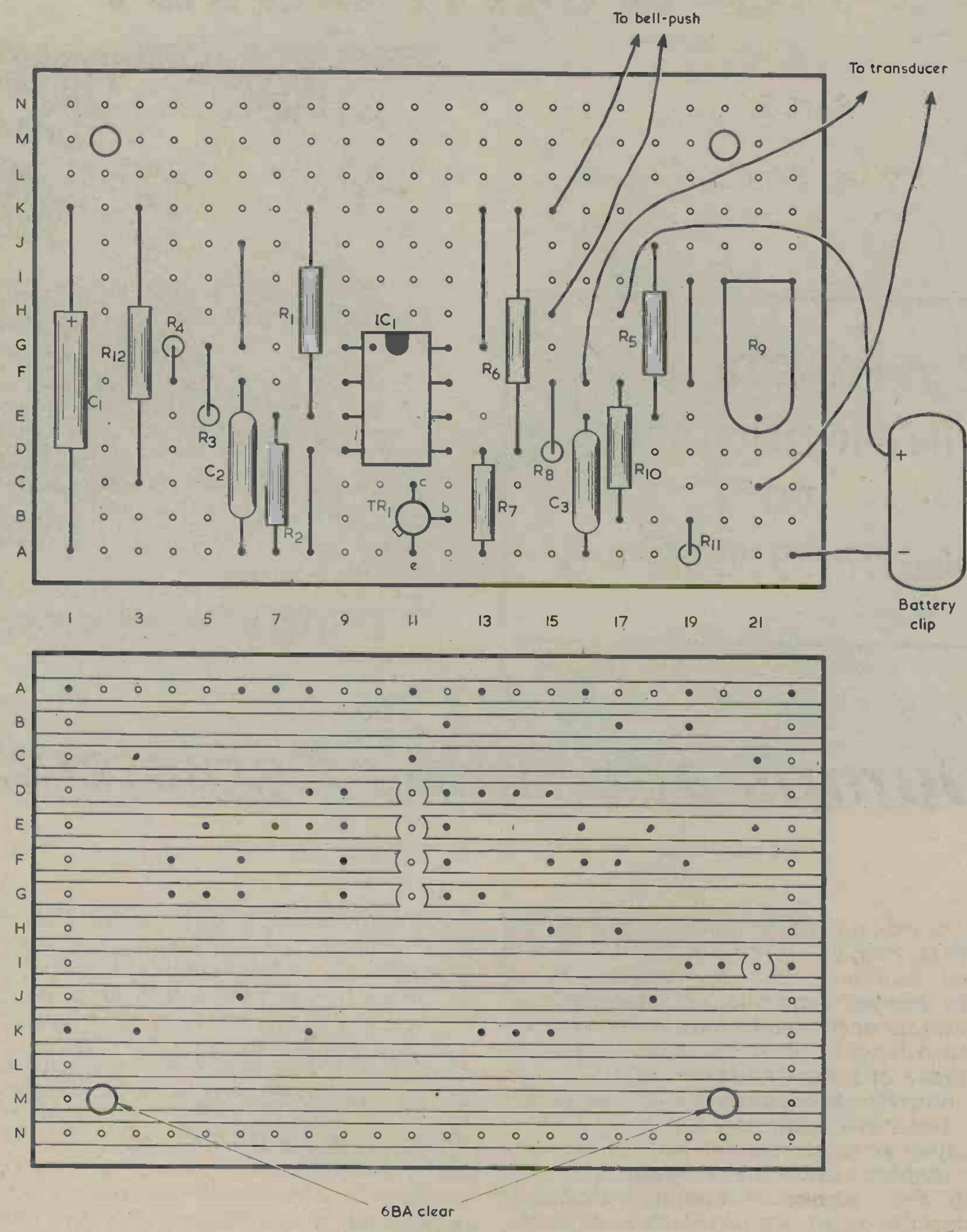


Fig. 3. Layout of components and wiring on the Veroboard panel

Details are given in Fig. 3. The board has to be cut from a larger size, after which the two mounting holes are drilled. The five breaks in the copper strips are next made, and then the components and link wires are soldered into place. Finally to be connected are the wires to the transducer, the bell-push and the battery clip. The board is secured inside the case by means of two 6BA bolts and nuts, with spacing washers to keep the board underside clear of the inside surface of the case.

ADJUSTMENT

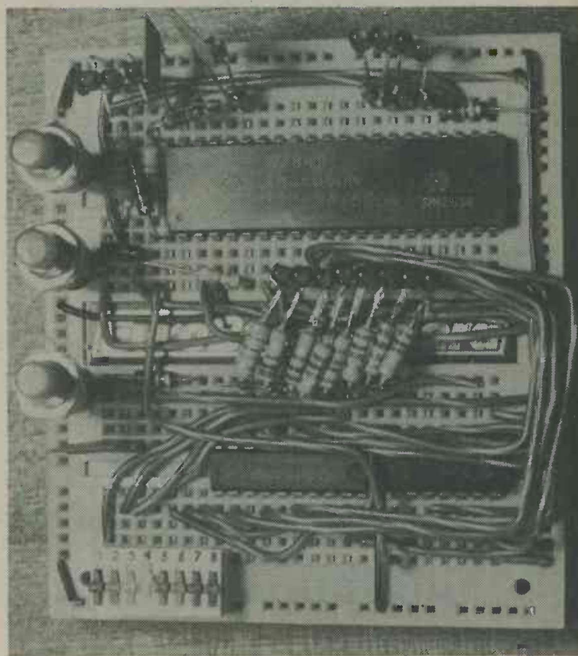
R9 is adjusted with the bell-push pressed and it provides a wide range of output pitches. If the potentiometer is adjusted backwards and forwards over this range it will be found that there are noticeable peaks in the sound output level at several settings. R9 can be given any setting which coincides with one of these peaks, the one chosen being a matter of personal preference.

■

The INStructor

Part 7

By Ian Sinclair



A PRACTICAL INTRODUCTION TO MICROPROCESSORS

Jumps and Index Registers.

The program-counter relative displacement is one way of shifting a program momentarily out of its normal sequence, but the program count returns to normal immediately afterwards. A jump is another sort of shift. A jump is not made to pick up a byte of data, it's done to shift to another piece of program. There are four jump instructions on the 8060, and we'll look at all four of them. The most basic sort of jump, JMP, is what is called an unconditional jump.

That means that when the program says JMP, you jump! Fig.1 shows an example. We use a NOP to start things off, then JMP followed by the displacement 00000011, which places the program three steps on. Now set the data switches back to NOP again and keep pressing GO. The count continues from 00000111; it doesn't return to where it was before the jump, which is an important difference between this type of instruction and the previous lot. To distinguish them, this is called a transfer function whilst the others are called memory reference instructions.

RESET		
NOP	**00001000**	**Note address**
JMP	**10010000**	**Note address**
DISP	**00000011**	**Note address**
NOP	**00001000**	**Note address**

(Remember that the data bits are not important in this example, only the addresses. The same will be true of all the examples in this Part.)

Fig. 1.

CONDITIONAL JUMPS

The JMP instruction has its uses, particularly if the 8060 is to be used at the end of a program to keep a number displayed, but the conditional jumps are even more useful. A conditional jump takes place only if some test is fulfilled. For example, the Jump-if-Zero instruction (JZ) means that the program will jump only if the byte in the accumulator is zero. Fig.2 shows examples of this, using a positive number, a negative number and then zero in the accumulator. If you keep an eye on the address l.e.d.'s you'll see that the jump occurs only when the accumulator is at zero.

The two other jumps are used to detect other conditions. The Jump-if-Positive (JP) instruction will cause a jump to take place if the byte in the accumulator has a zero in its D7 position – this means that a jump will also occur for a byte of zeros. The JNZ (Jump-if-Not-Zero) is as the name suggests – the jump will take place if there is any

RESET		
LDI	11000100	Note address at each step
01	00000001	
jz	10011000	
03	00000011	
LDI	11000100	
−1	11111111	
JZ	10011000	
03	00000011	
LDI	11000100	
00	00000000	
JZ	10011000	
03	00000011	

Fig. 2

number, positive or negative but not zero, in the accumulator. Each one of these jumps, when we use the binary codes shown in Fig. 3, is program-relative, meaning that the instruction has to be followed by a displacement byte which can be up to +127 or −128 places from the program counter address.

THE INDEX REGISTERS

The method which is used in the INS8060 to change addresses by more than 128 steps is known as indexing, and the INS8060 uses three sixteen-bit registers (in addition to the program counter) to store addresses. These registers are called pointer registers, and the program counter itself is classed as one of these registers, being referred to as PO. The others are then numbered P1, P2 and P3 respectively. So that we can specify which pointer register we want to use, these numbers are written in binary form as 00, 01, 10 and 11 and are used in this form in the instructions which make use of pointer registers.

Let's show what happens. Fig.4 shows a program which loads up pointer P1 with an address. Since the address is two bytes long and the accumulator can handle only one byte at a time, the pointer has to be loaded up in two groups of steps. We start with the number we want to load into the lower byte, in this example 00001010, and load-immediate this into the accumulator. The next instruction is a single byte instruction starting with 001100. Why "starting with" and why only six bits? The reason is that it can be completed by the two bits which specify which pointer we're using. If we finish it with 01 we shall load the byte into pointer P1, if we finish with 10 we shall load P2, and if the byte ends with 11 then P3 is loaded. This instruction is known in shortened form as XPAL – exchange the accumulator with the low byte of the pointer, and when it's used in a program we have to be careful to specify which pointer register is to be loaded. In this example, we're loading P1, so that the code is 00110001, with the final two bits indicating pointer 1. Note, by the way, that this is an **exchange**, so that if there has been a number in the pointer register, its lower byte will now be in the accumulator. Since we started by resetting, this should not cause any problems, and in any case can be cleared by loading another number into the accumulator. We do this, using load-immediate again, setting this byte to 00001111. This is shifted into the pointer register by using the single-byte instruction XPAH, binary code 00110101. This instruction exchanges the byte in the accumulator with the higher byte of the pointer and, once again, the last two bits of the code indicate the number of the pointer register. Since we've used the code 01 for the last two bits, we're transferring to pointer 1 as before.

The result of all this is that we have loaded up pointer 1 with two bytes. Now one of these is the AD11 bit and another is the AD1 bit, so that these l.e.d.'s should come on when we make the address change to the address in the pointer register, and we can use the spare l.e.d. to check for the 1's we expect to find in AD10, AD9 and AD8. The address isn't there yet, though – it's still loaded in the pointer and we have no connections to the pointer register. One way to exchange the

The JUMP instructions for jumps relative to the program counter

JMP	10010000	Unconditional jump
JP	10010100	Jump if accumulator is positive or zero
JZ	10011000	Jump if accumulator contains zero
JNZ	10011100	Jump if contents of accumulator are not zero

Fig. 3.

RESET		
LDI	11000100	
LBYT	00001010	
XPAL(1)	00110001	
LDI	11000100	
HBYT	00001111	
XPAH(1)	00110101	Note address
XPPC(1)	0111101	Note address
NOP	00001000	Note address
XPPC(1)	00111101	Note address
NOP	00001000	Note address

Fig. 4.

The pointer register codings.

Mnemonic	Code, P1	Code, P2	Code, P3
XPAL	00110001	00110010	00110011
XPAH	00110101	00110110	00110111
XPPC	00111101	00111110	00111111

Note that the last two bits of the code are used to show which pointer register is being used in each case.

Fig. 5.

The pointer-indexed jumps.

JMP	100100XX
JP	100101XX
JZ	100110XX
JNZ	100111XX

In each case XX means the pointer number 01 for P1. 10 for P2, and 11 for P3.

Fig. 6.

two is the final instruction on the list in Fig.5. This one, abbreviated to XPPC, has the effect of exchanging the bytes in the program counter (the present address) with the bytes in the pointer register. When this instruction, coded as 00111101, is set up and the GO button pressed, the result is to exchange the bytes so that the l.e.d.'s AD11 and AD1 light. The new address is actually one **more** than the address in the pointer register. The address which *was* about to appear on the l.e.d.'s (1000) is now stored in the pointer register, so that we can return to this address at any time by repeating the XPPC instruction. Try it – having exchanged, getting the AD11 and AD1 l.e.d.'s lit, and then using NOP to move the address on a bit. Then set up XPPC and, on pressing GO, you'll find the 1000 address (with l.e.d. AD11 out) back in business. This facility for hopping to a new address and then hopping back is extremely useful, and is found in all but the simplest of programs.

In this example, each of the instructions XPAL, XPAH, XPPC has referred to pointer 1, and the same instructions can be made to refer to any of the other pointer registers simply by modifying the two bits at the end of the binary code number. Fig. 5 shows these codes as they are used for each of the pointers.

INDEXED ADDRESSING

The use of indexed addressing, as this system is called, isn't confined to the XPPC instruction, and some very useful program tricks are available through the use of the pointer registers for other instructions. To take an example, Fig.6 shows the four JUMP instructions with their pointer-register variations. Once again, the binary instruction code consists of six bits, and two bits added on are used to specify which pointer register is used. When a pointer relative jump instruction is used, then, the address which is fetched is the sum of the address number stored in the pointer register plus the displacement byte which follows the jump instruction, plus 1. Fig.7 shows an example of this in use, employing pointer 2 this time. The first series of instructions load up pointer P2 with an address which will light up l.e.d. AD11, and display 1011

RESET		
LDI	11000100	
LBYT	00001000	
XPAL(2)	00110010	
LDI	11000100	
HBYT	00001000	
XPAH(2)	00110110	Note address
JMP(2)	10010010	Note address
02	00000010	Note address
NOP	00001000	Note address

Fig. 7.

List of instructions which can be indexed to a pointer. In the list, M is used to indicate the index bit, which will be set (1) for auto-indexing, reset (0) for normal pointer indexing. The XX symbols are used as in Fig. 6 to indciate the pointer number.

LD	11000MXX	Load accumulator from address
ST	11001MXX	Store contents of accumulator in address
AND	11010MXX	AND accumulator with address contents
OR	11011MXX	OR accumulator with contents of address
XOR	11100MXX	X-OR accumulator with contents of address
DAD	11101MXX	Decimal add contents of memory to accumulator
ADD	11110MXX	Binary add contents of memory to accumulator
CAD	11111MXX	Complement and add contents of memory to accumulator
ILD	101010XX	Increment memory and load to accumulator
DLD	101110XX	Decrement memory and load to accumulator

The JUMP and pointer exchange codes have been mentioned previously.

Fig. 8.

on the lower bits. The JUMP instruction uses the code relative to P2, and is followed by a displacement of two places. Run through this one, and check the address number before and after the displacement has been loaded into the microprocessor. As you might expect by this time, we can also jump to an address which is lower than the one loaded into the pointer register by using a negative displacement. Try the program again, but this time using a displacement of 11111110 (equal to decimal −2), and check the address before and after the GO switch is pushed.

Two more instructions which can make use of indexed addressing are the increment-and-load (ILD) and decrement-and-load (DLD) instructions. As usual, these consist of a basic six bits, which are completed by two bits which specify the correct pointer register. Remember that these two instructions change the data byte in the memory but not the address in the pointer register. What happens is that the GO action after the displacement byte causes the address lines to jump to an address equal to the pointer address plus the displacement. The data byte in this address is then incremented (+1) or decremented (−1) and loaded into the accumulator. The next time this byte is fetched, it will again be incremented or decremented, according to which instruction has been used. This is a convenient way of keeping a count, and the DLD instruction can, for example, be followed by a JZ, so that some new part of the program can be followed when the count is finished.

All the instructions shown in the table of Fig.8 can be used with pointer register indexing, and with yet another trick in store. Try the program in Fig. 9. This loads an easily recognisable address, into pointer P3 this time, and then, after a NOP, uses a load relative to P3, with a displacement of 1. This produces the expected address reading of 00000001, and following this with a NOP gets us

RESET		
LDI	11000100	
01	00000001	
XPAL(3)	00110011	
NOP	00001000	
LD(3)	11000111	Note address
01	00000001	Note address
NOP	00001000	Note address
LD(3)	11000111	Note address
01	00000001	Note address
NOP	00001000	Note address

For a decrement, use 11111111 after the load instruction instead of 00000001.

Fig. 9.

back to the normal address again. The next P3 relative load produces something unusual though, and when we use several more sequences of NOP and LOAD (relative P3), we can see what is happening. Each time the pointer register is used the starting address is incremented by one, so that each fetch from memory is from the address one higher than the one before. This type of system is called auto-indexing, and it's specified by an extra bit in the instruction. On all the instructions in Fig.8 the basic instruction consists of only five bits. The sixth bit is the auto index – 1 if the instruction is to be auto-indexed, 0 if not. The final two bits of the instruction are then used to specify which pointer register is to be used. Each instruction is then followed by a "displacement". When the instruction is used for the first time the displacement does ***not*** cause the address to change. The address which is fetched first time around is simply the address which is stored in the pointer register. At the end of this instruction, though, the pointer register has the "displacement" added to it, so that the next fetch from the pointer is to an address higher than before. The usual "displacement" or increment number is 1, but we could use any other number as we pleased. Now what happens if we use a negative number, such as 11111111 (decimal –1)? Try it out, using the program of Fig. 9. We load up the pointer as usual, NOP and then load, auto-indexed, relative to P3 with a – 1 displacement. What happens at each fetch?

STACK POINTER

This time, the pointer register is decremented by 1 before being fetched and used as an address. There's a very good reason for treating incrementing and decrementing in a different order. Suppose, for example, we want to preserve some constants, the numbers in various registers, while the microprocessor gets on with something different. We can load a number into the accumulator, store it with auto-indexing (using +1 for incrementing) and repeat this set of steps for each number we have to preserve. The result will be that each number is stored in order somewhere in the read/write memory. Now how do we get them back? At the end of the loading operation, the address in the pointer register will be one higher than the address which was used to store the last byte. This is because the address is incremented ***after*** the address has been used. If the same system were used when the index is decremented, then the first address fetched back would be empty or, worse still, nonsense, since we haven't written anything in that memory space. The system of decrementing the address before fetching ensures that we can fetch back the bytes in exactly the opposite order from that in which they were stored – first in, last out. This is the action of a "stack", and the register which is used in this way is often called the "stack pointer".

There are still a few secrets left. One is that in any memory – reference instruction (any in the table of Fig.8), the value 10000000 used as a displacement produces rather odd results, whether the instruction is PC relative, indexed or auto-indexed. The program of Fig.10 shows an example. The extension register is loaded with the byte

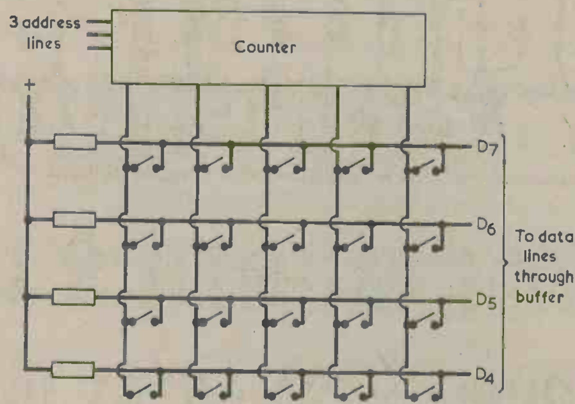
RESET		
LDI	**11000100**	
BYT	**11111110**	
XAE	**00000001**	
NOP	**00001000**	
LD(P1)	**11000000**	**Note address**
– 128	**10000000**	**Note address**
NOP	**00001000**	**Note address**

Fig. 10.

11111110 (decimal –2), and after a NOP, the load-from-memory instruction is followed by the displacement 10000000, program relative. This number is decimal –128, but the program doesn't move 128 steps back, but only from 0110 to 0100. What has happened is that the number in the extension register has been used as a displacement relative to P1, which was reset to zero. Unless you've done some programming, it's difficult to appreciate the value of this, but one example may give you a glimmering. Usually, when we have a displacement, we have to specify it in the program, but this lets us use a displacement which isn't programmed! The outstanding example of this is a scanned keyboard.

There are two main ways of using a keyboard to input information to a microprocessor. One is to connect the keyboard to a digital circuit which will convert each key press into its appropriate digital circuit which will convert each key press into its appropriate digital code – that's a hardware solution. This type of method succeeds when each keyboard switch is separate. The other method uses a matrixed keyboard, where the keys are arranged in connected rows and columns. The action of a key is simply to short out one row to one column. With a system like this, converting the key-push into a digital code is not nearly so easy, and a method called "software scanning" is used, which is made much easier by the use of the extension register as we've described. Using the 5 x 4 matrix of Fig. 11 as an example, a counter is used to convert a few digits of an address into a logic 0, which is applied to one column of keys. If a key in this column is depressed, one data line is taken to logic 0. Note that only four data lines are affected – in this example the upper lines. This gives a number on the data line which can be loaded into the extension register. The number can then be used as a displacement in a load-from-memory, so reaching a memory address where the correct binary code for the number is stored. The beauty of this system is that the key action doesn't have to generate the correct binary number, simply ***any*** binary number, provided no two keys give the same number. If no key on the first column is pressed, the address increments, the lower four data lines are also incremented,

An example of a matrixed keyboard.



Programming: the keyboard program consists of putting out the keyboard addresses in sequence. If, when an address is put out, a zero is detected on the upper data lines, the byte is shifted into the extension register. If the data byte is still 1111XXXX, then the next address is put out, and so on until all the keyboard lines have been scanned. The program usually provides for "software debounce" – if a byte is returned on the data lines, the same address is scanned again a few milliseconds later to confirm the presence of a key pressed.

Fig. 11.

and the second column is activated. Even if the key which is now pressed is in the same row, the new number on the lower lines ensures that a different byte is loaded into the extension register.

NEXT MONTH

In next month's issue we shall look at the interrupt system, flags and sensing.

(To be concluded)

TRADE NOTE

ULTRASONIC TRANSDUCERS

Impectron Limited, of Foundry Lane, Horsham, W. Sussex, RH13 5PX, are now producing two new low cost matched ultrasonic transducers. These are small, light and highly sensitive, and they offer an excellent performance for applications such as industrial control and intruder detection systems.

The EFR-OCB25K5 and EFR-RCB25K5 are transmitter and receiver respectively, with a nominal centre frequency of 25kHz. The sensitivity is around −65dB per volt per microbar with a minimum bandwidth of 3kHz. Overall dimensions are 1 inch long (body length being 0.37 inch) by 0.95 inch diameter for both receiver and transmitter. The internal construction of the transducers incorporates a compound vibrator consisting of a ceramic chip and conical aluminium resonator. This assembly provides sensitivity and wide bandwidth, whilst the choice of body material and production methods ensure a long life in demanding environments.

Delivery is ex-stock, and application notes are available by return from Impectron to help circuit designers.

RADIO & ELECTRONICS CONSTRUCTOR

MARCH 1981

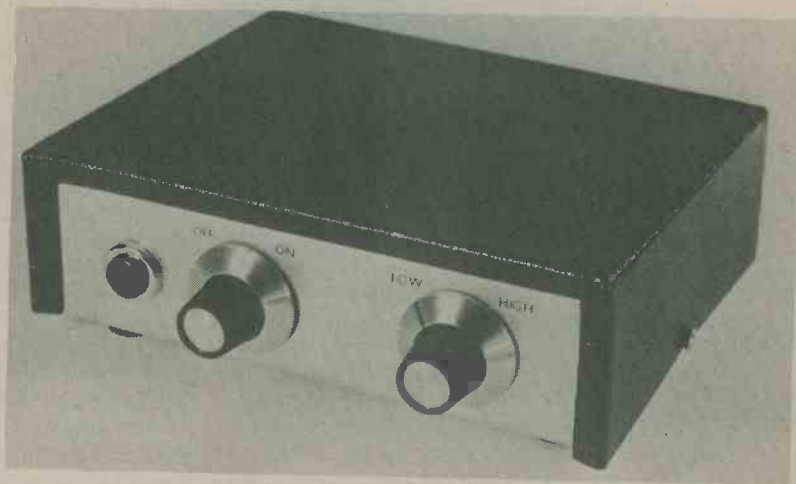
IN NEXT MONTH'S ISSUE

ROOM THERMOSTAT UNIT

Uncomplicated robust circuitry

Temperature control from 10 to 30°C

Switches currents up to 8 amps



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★ Low cost design

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Reverbera

Self-contained self-powered unit

By R. A. Pe

Switching reverbera

Natural reverberation of sound occurs in any room to some degree, but in rooms of normal domestic proportions and fitted with modern furnishings the reverberation time is usually only a small fraction of a second and is barely noticeable. Reverberation is caused by sounds being reflected around a room before they become attenuated to an inaudible level. Large halls usually have quite lengthy reverberation times, these often being as long as several seconds. When certain types of music are produced this reverberation results in a very rich sound.

There are a number of ways in which artificial reverberation can be added to an electrical audio signal in order to give a "big hall" sound to home produced music and recordings. One of the most simple, inexpensive and popular methods is to use a system based on a spring-line reverberation unit. Such a unit has input and output transducers with one or more springs under low tension between them. An electrical signal applied to the input transducer produces an acoustical signal at one end of the springs, which then travels relatively slowly down the springs until it reaches the output transducer, whereupon it is re-converted to an electrical signal. The acoustical signal is not entirely absorbed by the output transducer and it is reflected back to the input end of the springs where it undergoes a further reflection. This process is repeated a number of times until the initial signal dies away to an insignificant level, and the effect is analogous with the reverberation of sounds in a large hall. The signal from the output transducer is mixed with the original signal to give the required amount of reverberation.

The reverberation unit described in this article employs a commercially manufactured spring-line unit and the only active component used is an integrated circuit. The unit is powered by a PP6 size 9 volt battery and is intended to operate with an input signal level of between 100mV and 1 volt r.m.s., although it can still be used effectively with signals somewhat outside these levels.

The completed reverberation unit is housed in an attractive ready-made metal case

ation Unit

y

enfold

Reverberation amplitude control

option for ation only

THE CIRCUIT

The complete circuit of the reverberation unit is given in Fig. 1. In this the integrated circuit is an LM389 which contains a small Class B audio power amplifier, with an output at pin 1, and three separate transistors. These are TR1 to TR3 and the numbers alongside them in the diagram are the i.c. pin numbers. The power amplifier section is used to drive the input transducer in the spring-line unit. This transducer requires a fairly strong signal as losses in the springs are high and a low input signal would produce a poor signal-to-noise ratio as well as an inadequate reverberation effect.

The inverting input of the amplifier, at pin 5, is connected to the negative rail, and the input signal is applied, via C2 and volume control VR1, to the non-inverting input at pin 16. There is no polarising voltage for C2, but this capacitor still functions satisfactorily as a d.c. blocking component. C4 decouples the supply to an internal pre-amplifier inside the i.c. and prevents possible instability due to feedback along the supply rails. The amplifier output is coupled to the spring-line input transducer through R1 and C5. R1 is included to ensure that the amplifier cannot be driven to a level where current consumption is excessive.

The spring-line output transducer couples through C6 to the base of TR1 which, due to its unbypassed emitter resistor, has a voltage gain of about 12 times. The signal at its collector is passed via C7 and R5 to the base of TR2. Also coupled to this base, via C3, S2 and R6, is the original input signal. R6 has the same value as R5 and they provide a simple mixing circuit in which the original signal and the reverberation are

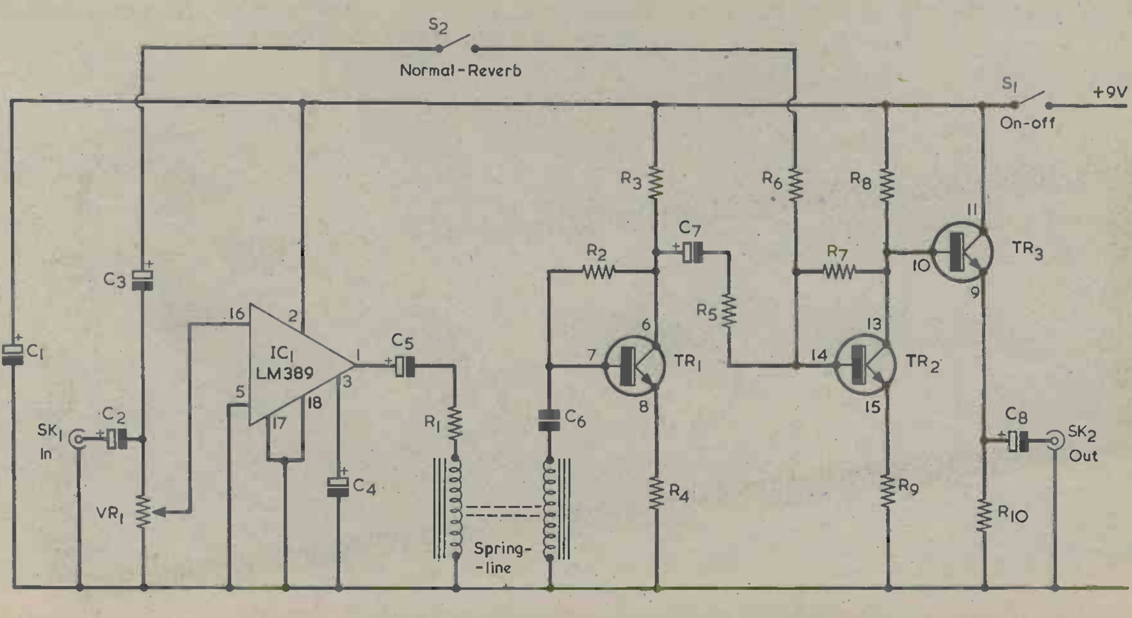
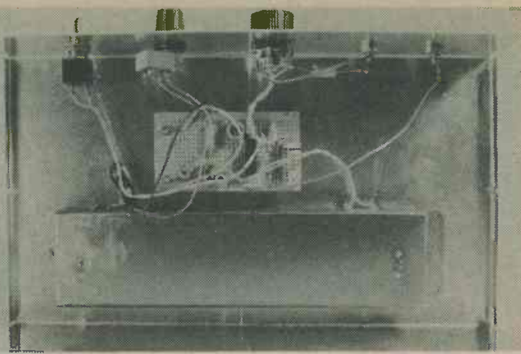


Fig. 1. The circuit of the reverberation unit. The power amplifier and the three transistors are all contained in a single i.c.

The spring-line unit is mounted near the rear of the case. The Veroboard panel lies between the spring-line unit and the front panel components



mixed together. TR2 offers a small amount of gain and a high input impedance for the mixing circuit, and its output couples to the emitter follower, TR3. This last transistor gives the unit a low output impedance.

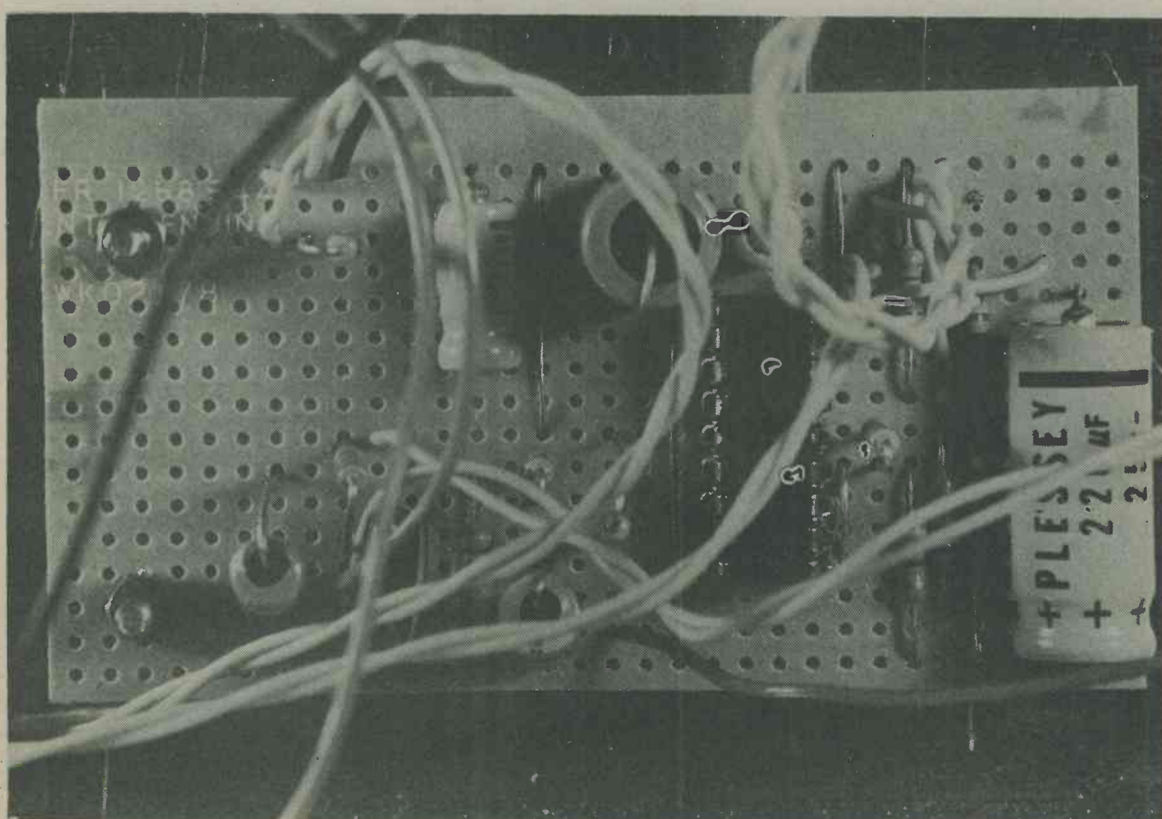
A wide range of control is provided by VR1 and S2. With S2 closed the amount of added reverberation is varied by VR1. With S2 open the original signal is switched out and only the reverberation signal is passed to the output of the unit.

S1 is the on-off switch and C1 the main supply bypass capacitor. The quiescent current consumption from the 9 volt battery is typically about 9 to 10mA, but the consumption rises to about two or three times this level when IC1 is driven hard.

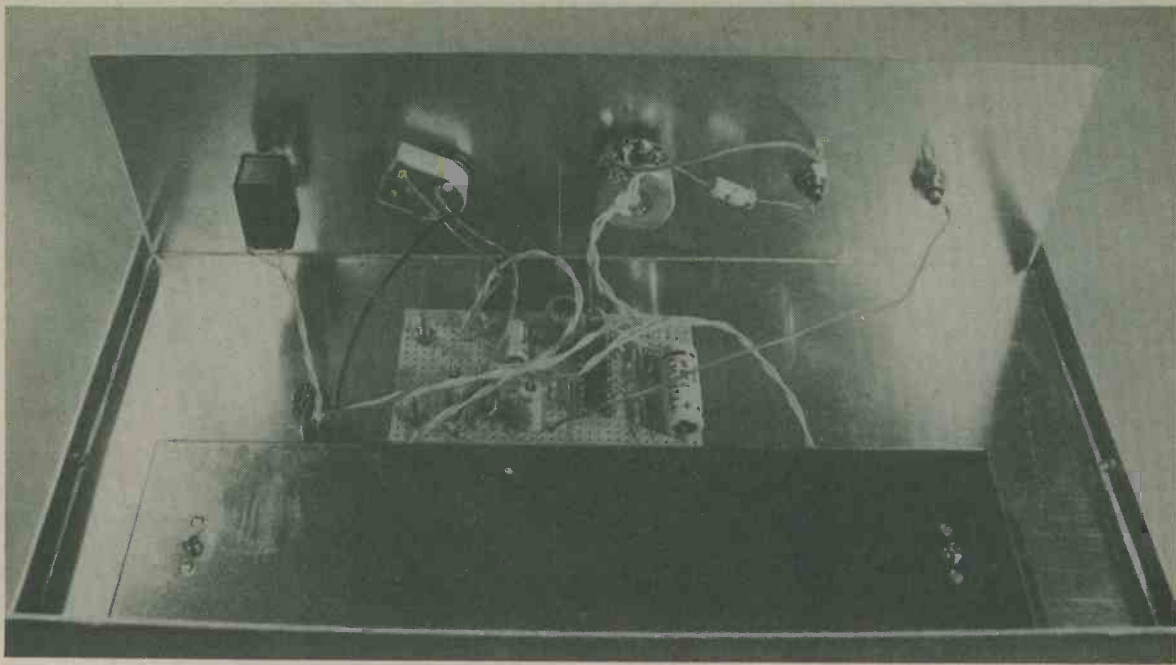
COMPONENTS

The spring-line unit is available from Maplin Electronic Supplies, and is described in their catalogue as a "short spring-line unit". The LM 389 i.c. is also available from this source. The case used for the prototype unit was, again, obtained from Maplin Electronic Supplies. This is an aluminium case, type TP5, having a wood-grain finish on its cover and dimensions of approximately 279 by 159 by 76mm.

The electrolytic capacitors are all specified as having working voltages of 10 volts. In practice it may be found very difficult to obtain 1μF capacitors with a working voltage as low as this and it will be perfectly in order to use 1μF components for C3 and C7 which



Close-up view of the Veroboard module



Rear view, illustrating the wiring to the components on the front panel

COMPONENTS

Resistors
(All fixed values ¼ watt 5% unless otherwise stated)

R1 33Ω
R2 1.2MΩ 10%
R3 4.7kΩ
R4 390Ω
R5 56kΩ
R6 56kΩ
R7 1.2MΩ 10%
R8 4.7kΩ
R9 1.5kΩ
R10 2.7kΩ
VR1 10kΩ potentiometer, log

Switches
S1 s.p.s.t. rotary toggle
S2 s.p.s.t. toggle

Sockets
SK1 phono socket (see text)
SK2 phono socket (see text)

Semiconductor
IC1 LM389

Capacitors
C1 220μF electrolytic, 10V. Wkg.
C2 10μF electrolytic, 10V. Wkg.
C3 1μF electrolytic, 10V. Wkg.
C4 10μF electrolytic, 10V. Wkg.
C5 100μF electrolytic, 10V. Wkg.
C6 0.1μF polyester, type C280
C7 1μF electrolytic, 10V. Wkg.
C8 10μF electrolytic, 10V. Wkg.

Miscellaneous
Spring-line unit (see text)
Metal case (see text)
9-volt battery type PP6 (see text)
Battery connector
2 control knobs
Veroboard, 0.1in. matrix
Nuts, bolts, wire, etc.

have working voltages as high as 100 volts. Similarly, the 10μF capacitors can have working voltages up to some 25 volts.

CONSTRUCTION

The photographs show the general layout of the unit. From left to right on the front panel are the output socket, VR1, S1 and S2. The author used phono sockets for input and output, but alternative types can be used if these are more convenient. The spring-line unit is mounted on the base panel of the case, well towards the rear and with the input and output terminals facing forwards so that they are readily accessible. The unit can be used as a template for marking out the two mounting holes required in the base panel, and it is secured by means of M3 bolts and nuts.

Situated between the spring-line unit and the front panel components is the Veroboard module, the component and copper sides of which are shown in

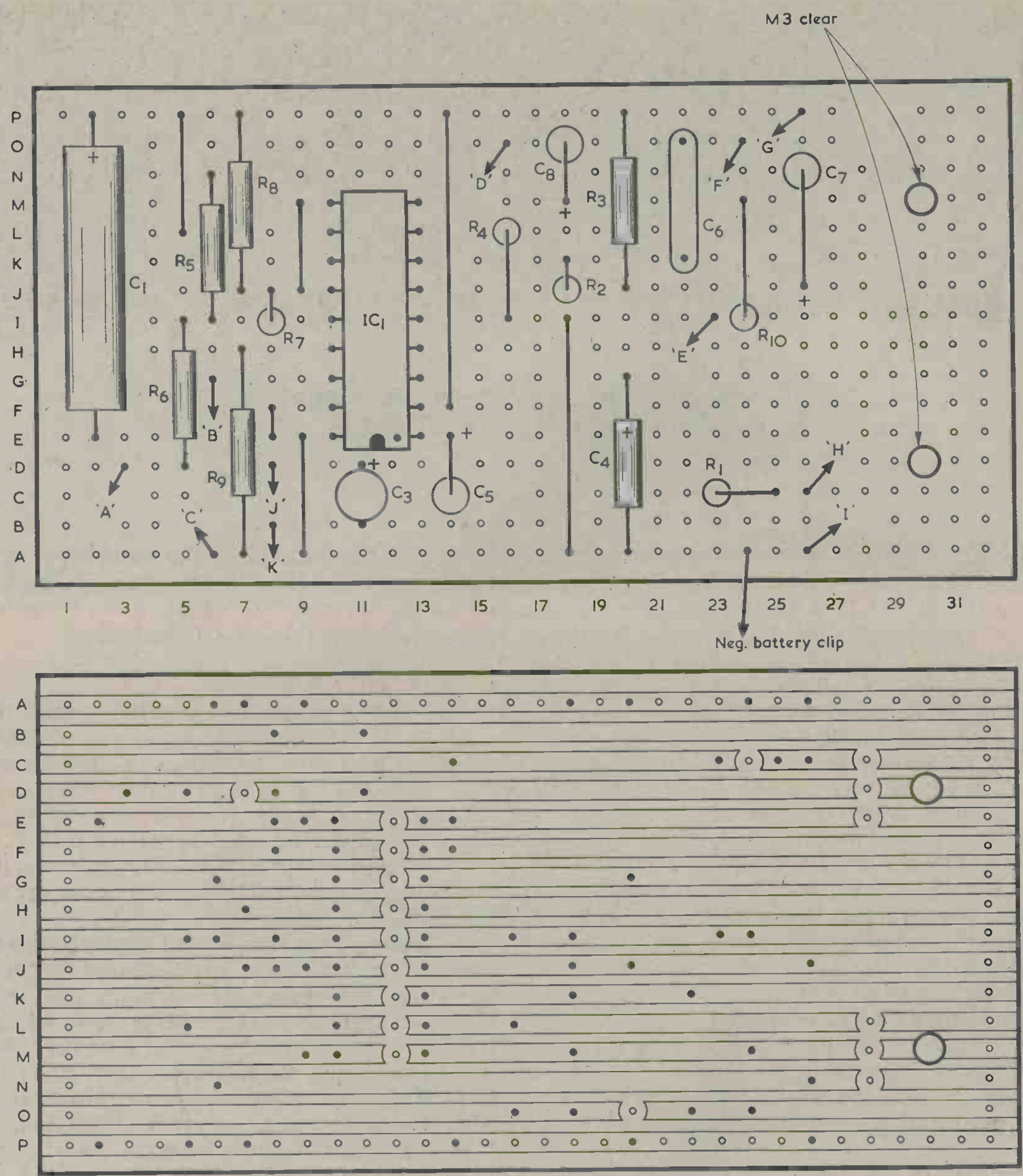
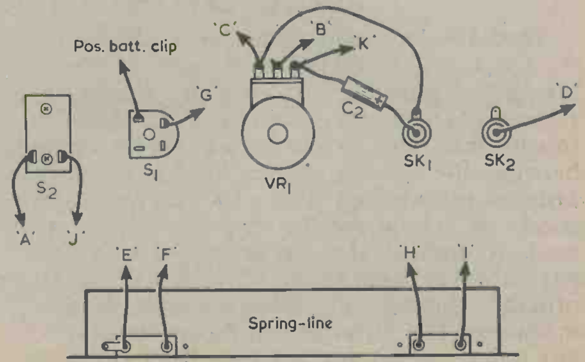
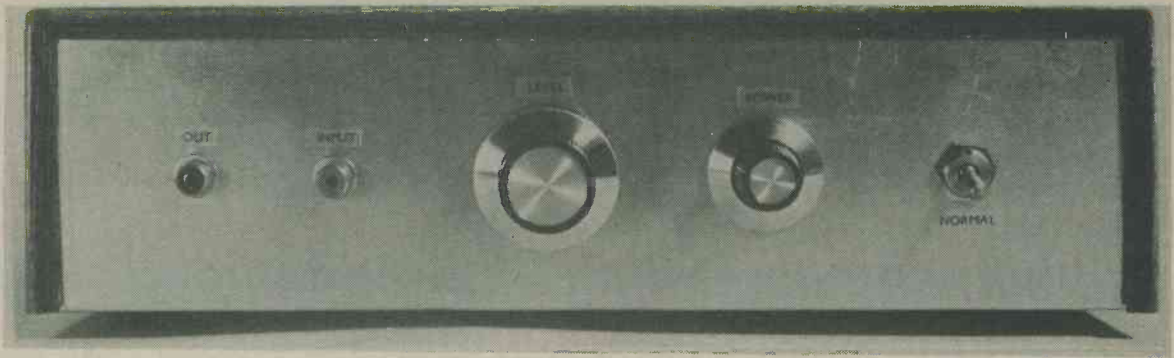


Fig. 2. Nearly all the small components are assembled on a Veroboard of 0.1in. matrix. Component positioning and layout are shown here

Fig. 3. Connections to the front panel components and to the spring-unit





On the front panel, from left to right, are SK2, SK1, VR1, S1 and S2

Fig. 2. The Veroboard panel has 16 copper strips by 32 holes and has to be cut down from a larger piece. After filing the sawn edges to give a neat finish, the two mounting holes are drilled and the 18 breaks in the strips are made. The components and the 6 link wires are then soldered in place, taking care to ensure that IC1 and the electrolytic capacitors are fitted to the board right way round.

Flexible p.v.c. covered leads identified in Fig. 2 by the letters "A" to "K", are also soldered to the board. These leads can be longer than will finally be required and they can be cut to the correct length when the free ends are connected later. The board is secured to the base of the case by two M3 nuts and bolts, with spacing washers on the bolts to ensure that the underside of the board is well clear of the metal base panel surface. The board is oriented so that C3 and C5 are nearer the front panel.

The remaining wiring is illustrated in Fig. 3, where connections to the Veroboard are identified by the letters "A" to "K", which correspond with the same letters in Fig. 2. As can be seen, C2 is not mounted on the Veroboard and is positioned between SK1 and VR1.

There is plenty of space for the PP6 battery. Indeed, a larger PP9 type could be used, if desired, and this would probably give lower running costs if the reverberation unit is to be frequently employed over long periods. With the prototype, a piece of foam plastic was glued to the underside of the case lid and this was quite sufficient to hold the battery in place when the lid was screwed on.

USING THE UNIT

The unit is simply connected between the signal source and the amplifier, employing screened leads. As described here, the unit can only be used with mono signals, but it is of course only necessary to construct two units for stereo, with each unit processing one channel. The voltage gain through the unit is roughly unity and it is therefore unlikely that any problems will occur when it is connected into a system.

As already mentioned, VR1 controls the amount of reverberation which is added to the original signal. Care must be taken when adjusting this component. Unless the input signal level is quite small, the power amplifier in IC1 will be driven to the point where the output becomes clipped well before VR1 is turned fully clockwise. Overdriving the power amplifier is undesirable because it gives distortion, reduced battery life and, in any case, an unrealistic amount of reverberation. VR1 must therefore be adjusted carefully and sensibly to give a good effect, and not simply set at maximum.

■

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies = kHz*

● **AFGHANISTAN**
Kabul on a measured **6231** at 1447, OM announcer, songs and music in the Urdu programme for nearby countries in the Domestic Service 2nd Programme. The Urdu transmission is scheduled from 1330 to 1530.

● **NEW ZEALAND**
Wellington on **15485** at 0538, OM and YL with a programme about New Zealand internal affairs in an English transmission for the Pacific area. At 0545 local sporting events and results were featured. (OM = Old Man = Male; YL = Young Lady = female).

● **PAKISTAN**
Islamabad on **21655** at 1040, YL announcer with local music and song programme in the Urdu service for Europe, scheduled from 0715 to 1100 on this particular channel.

● **NORWAY**
Oslo on **21730** at 1210, YL with station identification then OM and YL alternate with news items in the English programmed 'Norway this Week' radiated to Europe, the Far East, Pacific, South and South East Asia. This particular programme featured on Sundays only.

● **AUSTRALIA**
VLH9 Lyndhurst on **9680** at 1245, classical piano music, at 1250 OM announcer then choir and a religious programme, all for local consumption.

Melbourne on **11740** at 0745, OM with listeners letters in the English programme to Europe entitled 'Mailbag' (although some Pacific and Asian addresses were mentioned) scheduled from 0700 to 0800 on this channel and in parallel on **21680**, also logged.

Melbourne on **21570** at 0753, musical box version of 'Waltzing Matilda', the tuning and interval signal. At 0758 OM with details of frequencies and times, 0800 time-check pips then into a newscast of world events. Also logged in parallel on **15115**.

● **UNITED ARAB EMIRATES**
Dubai on **21700** at 0633, OM's and YL's with a drama in Arabic.

● **SOUTH AFRICA**
RSA (Radio South Africa) Johannesburg on **21535** at 0640, OM's with a newscast in English in the programme 'Looking into Africa', directed to Europe and West Africa from 0600 to 0700. All about African internal affairs – quite instructive.

● **INDIA**
AIR (All India Radio) Delhi on **3255** at 1549, OM with an English programme all about nuclear power in India. This is the Home Service, scheduled from 1400 to 1600.

AIR Lucknow on **3205** at 1534, YL with a newscast in English, a moderate signal but with some co-channel QRM (interference). This is the B Programme scheduled here from 1130 to 1740. The power is 10kW.

Radio Kashmir on a measured **3277** at 1535, YL with a newscast in English. At 1536, identification as AIR. Good clear signal. Scheduled from 1130 to 1740, the power being 7.5kW.

AIR Kurseong on **3355** at 1542, YL with news comment in English, a good clear signal on a clear channel. The schedule is from 1130 to 1700 and the power is 20kW.

AIR Delhi on **3365** at 1544, same programme as above in parallel. The schedule here is from 0025 to 00230 and from 1330 to 1830. The power is 10kW.

AIR Gahauti on **3375** at 1545, again the same programme as above but a weak signal although clear of QRM. Gahauti is scheduled from 1145 to 1740, the power is 10kW and the programmes are mostly in Assamese but with English newscasts at 1530 and 1730.

● **NEPAL**
Kathmandu (transmitter at Khumaltar) on **3425** at 1550, OM announcer in Nepalese, YL with local songs. The schedule is from 0020 to 0350 (Sundays to 0450), 0720 to 0950 and from 1150 to 1720. English programmes are radiated from 0220 to 0230 and from 1435 to 1520. The power is 100kW.

● **CHINA**
Radio Peking on **6430** at 1207, OM with the Mongolian programme in the Minority Language Service, scheduled from 1200 to 1255 on this channel.

Radio Peking on **11000** at 1135, local songs and music in the Tibetan programme in the Minority Language Service, scheduled on this channel in Tibetan from 1100 to 1155.

Radio Peking on **11375** at 1412, YL with the programme in Kazakh, scheduled from 1400 to 1455, in the Minority Language Service. Also logged in parallel on **11040**.

Radio Peking on **11650** at 1423, YL and OM with the English programme directed to South Asia and scheduled from 1400 to 1500 on this frequency.

Wulumqi, Xinjiang, on **5060** at 0055, Chinese music, YL with songs. A good signal when receiver on USB to escape utility QRM LF of channel. This one radiates both local programmes and those from R. Peking in Mongolian. This logging was made during the 2330 to 0555 schedule (February to September from 2400 or, to be correct, 0000 GMT). Wulumqi is also on the air from 1100 to 1625.

Nanning, Guangxi, on **4915 at** 2138, YL in Chinese – the usual programming but signal somewhat muffled under co-channel heterodyne. This is Guangxi 1 which is on the air from 2105 to 0005 and from 0840 to 1600 relaying the Peking Domestic Service 1.

Kunming, Yunnan, on **2310** at 2319, YL with a talk in dialect. Yunnan 2A features programmes in Minority languages and is on the air from 2200 to 2400 and from 1225 to 1430.

Kunming, Yunnan, on **2460** at 2321, OM and YL alternate in Chinese. This is Yunnan 1, radiating in Chinese from 2150 to 1620. Can also be heard in parallel on **4760.**

● INDONESIA

RRI (Radio Republik Indonesia) Bukittinggi, on a measured **4828** at 1522, OM in Indonesian, short musical interludes local-style. This one is scheduled from 2300 to 0300, from 0500 to 0715 and from 0930 to 1600. The power is 1kW and is listed on **4827.**

RRI Yogyakarta on **5046** at 1536, slow rythmic local music between acts of a drama, much clanging of cymbals. Good signal when tuned on a 1.2kHz bandwidth. The schedule is from 0100 to 0300, from 0455 to 0800 and from 0955 to 1700 and the power is 5kW. Yogyakarta is in Java (Indonesian = Jawa).

RRI Padang on a measured **4002** at 1542, 'When the Saints go Marching In' in local style! OM announcer, fair signal on a clear channel at this time. The schedule is from 2230 to 0100 and from 1000 to 1600, closing time variable. The power is 10kW and Padang is in Sumatra.

RRI Bukittinggi on **3232** at 1546, OM in Indonesian, religious chants at 1552. A poor signal but a clear channel. The schedule is from 1100 to 1600 (Saturdays until 1700); the power is 10kW and Bukittinggi is in Sumatra.

● MALAYSIA

Kuala Lumpur on **4845** at 1525, OM and YL with Indian songs and music, a good signal on USB. The schedule here is from 2130 to 0130 and from 0545 to 1530 Monday to Friday; from 2130 to 0330 and from 0545 to 1530 on Saturdays and from 2130 to 1530 continuous on Sundays. The power is 50kW.

● SINGAPORE

Radio Singapore on **5052** at 1534, OM with a newscast in English, both local and world events. All programmes are in English and they are timed from 2230 to 1630, Sundays until 1700. The power is 20kW and may also be heard in parallel on **5010.** Experience shows however that it is often possible to hear them on one channel whilst the other is silent.

● BURMA

Rangoon on **5040** at 1539, local style music on records. A fair signal under co-channel hetro. Rangoon is timed from 0930 to 1430 in Burmese and from 1430 to 1600 in English. A piano solo in European style was featured from 1542. The power is 50kW.

● SRI LANKA

Colombo on **4870** at 1605, OM and YL in the Sinhala programme in the Home Service 2. The schedule is from 0000 to 0300 and from 1030 to 1730. The power is 10kW.

● SOCIETY ISLANDS

Papeete, Tahiti, on **15170** at 0517, OM with Polynesian songs, OM announcer in Tahitian. This is the Home Service scheduled from 1600 to 0730 and the power is 20kW. Tahiti is in France Regions 3.

● TAIWAN

Taipei on **9610** at 2130, OM with a newscast of local affairs in the English programme intended for Africa, the Middle East and Europe and scheduled from 2130 to 2230 on this frequency.

● PHILIPPINES

Tinang VOA (Voice of America) on **15410** at 1440, YL in Asian dialect, 'Yankee-Doodle' interval signal at 1500. Signal subject to interference from R. Moscow, co-channel.

Tinang VOA on **9630** at 1350, YL in Khmer to South Asia, scheduled from 1330 to 1400 when into the Burmese programme – at least according to the schedule!

Radio Veritas, Manila, on **11955** at 1517, OM and YL with the programme in Vietnamese to Vietnam, scheduled from 1500 to 1530.

● LESOTHO

Maseru on **4800** at 1744, OM and chorus with African songs and chants, YL announcer. This is the recently installed 50kW transmitter, a gift from the British Government. The schedule is irregularly from 0400 to 2030.

● BRAZIL

Radio Difusora Taubate, Taubate, on **4925** at 0220, YL with songs in Portuguese, OM announcer with announcements and commercials. The schedule is from 0830 to 0300 and the power is just 1kW.

Radio Tabajara, Joao Pessoa, on a measured **4796.8** at 0104, OM with sports commentary in Portuguese, a fair signal on USB to clear hetro. The schedule is from 0730 through to 0400 and the power is 2kW. Listed on **4797** but subject to slight variations at times.

Radio Capixaba, Vitoria, on **4935** at 2150, OM with commentary in Portuguese. The schedule is from 0730 to 0100 (Sundays until 2230 but reported to vary from 2200 to 0200). The power is 1kW.

● VENEZUELA

La Voz de Carabobo, Valencia, on **4780** at 0110, OM with an excited commentary on a local sporting event. The schedule of this one is from 1000 to 0400 and the power is 1kW.

"Quick Dad look – that car's got Radio one and two!"

OWIZZEE!!

By

David Arts

How to play cricket in comfort

The prototype OWIZZEE! game is housed in a small plastic case with legends on the front panel indicating push-button and l.e.d. functions

OWIZZEE is an electronic game designed to simulate a game of cricket, albeit in a simple manner. The game has provided hours of amusement and can be extremely exciting, especially for the youngsters.

Four integrated circuits are used in the design, these being a 555, two 4017 decade counters and a 4013 type "D" dual flip flop.

CIRCUIT OPERATION

The circuit of the game is shown in Fig. 1. IC1 is the 555 connected as a table multivibrator having a frequency of around 550Hz. When the "Bat" push-button is depressed the 555 output is applied to the clock input of the decade counter, IC2, the ten outputs of which go high in turn with each clock pulse. When the push-button is released the counter stops with one of its outputs high and the remainder all low. No connections are made to four of the outputs and if the counter stops with any of these high the 7-segment display is not illuminated and no runs are scored. The remaining six outputs are fed via steering diodes and current limiting resistors to the display to indicate runs scored. Out of the six chances of making a score there are two chances of a single run, two chances of 2 runs, one chance of a 4 and one chance of a 6. This combination was found to be the most realistic after much experiment.

The bowling circuit operates on similar lines to the batting circuit. On depressing the "Bowl" push-button, clock pulses are fed into IC3, whose outputs similarly go high in turn. However, this time use is also made of the carry-out function on pin 12 which goes positive at the end of each decade count. This is used to clock one of the flip-flops in IC4, which is made to operate as a divide-by-two counter by coupling its not-Q output back to its data input. Each carry-out pulse then changes the state of the Q and not-Q outputs on alternate decades, with each output going high and low in turn.

Four of the IC3 outputs are used in conjunction with the Q and not-Q outputs of IC4 to light one of four l.e.d.'s. LED1 will light if IC3 pin 4 is high and IC4 pin 1 is low, LED2 will light if IC3 pin 5 is high and IC4 pin 1 is low. The other two l.e.d.'s will light when IC4 pin 2 is low. It can be seen that there are 4 chances in 20 of one of the l.e.d.'s lighting up when the "Bat" push-button is depressed and released. Three

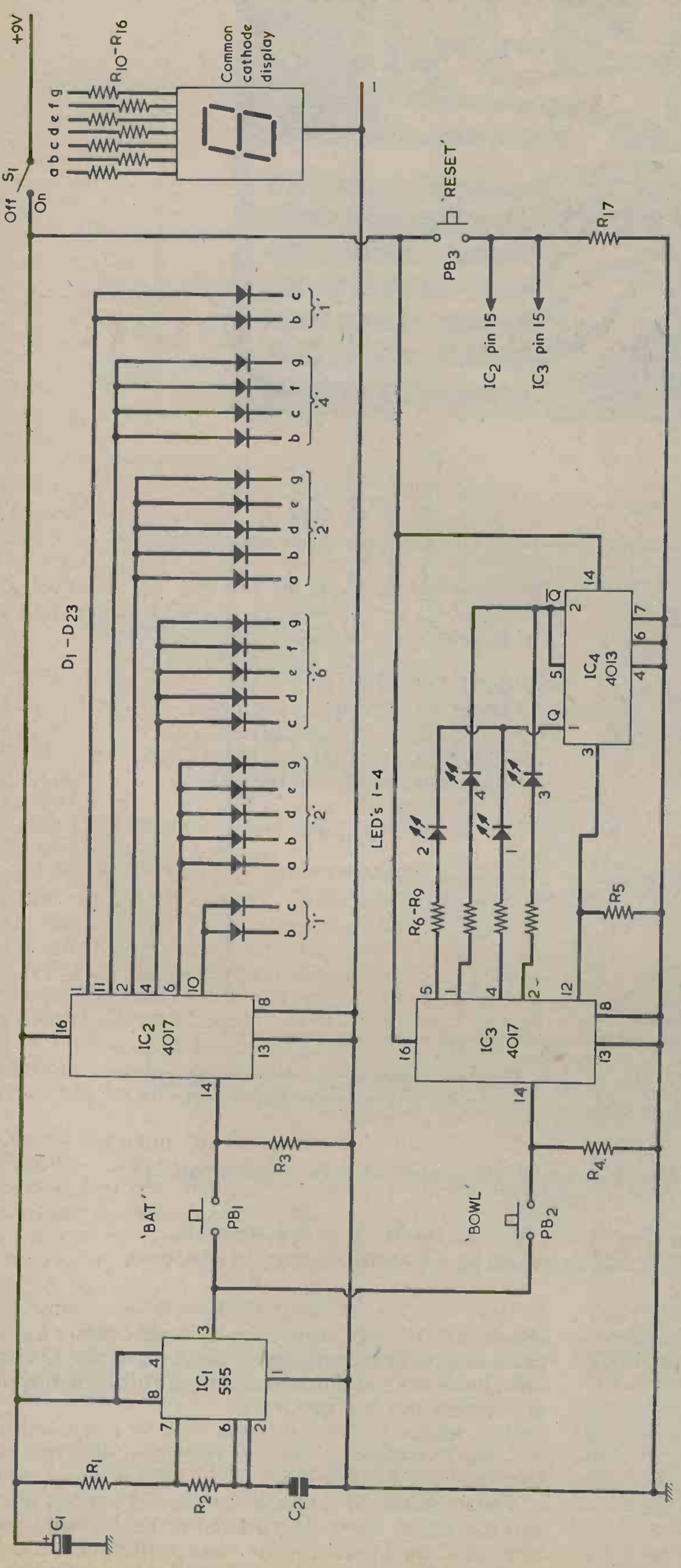


Fig. 1. The circuit of OWIZZEE! Batting scores are indicated by the 7-segment display and wickets, or wides, by LED1 to LED 4

COMPONENTS

Resistors
(All ¼ watt 5%)
R1 8.2kΩ
R2 56kΩ
R3-R5 22kΩ
R6-R16 680Ω
R17 22kΩ

Capacitors
C1 100μ F electrolytic, 10V. Wkg.
C2 0.022μ F

Semiconductors
IC1 555
IC2 4017
IC3 4017
IC4 4013
D1-D23 1N4148

Light-Emitting Diodes
LED1 green l.e.d., 0.2in. dia.
LED2-4 red l.e.d., 0.2in. dia.
Common cathode 7-segment display (see text)

Switches
S1 s.p.s.t. miniature toggle
PB1-PB3 push-button, push to make

Miscellaneous
Plastic case (see text)
9 volt battery type PP3
Battery connector
Printed circuit board
Veroboard, 0.1in. matrix
Wire, etc.

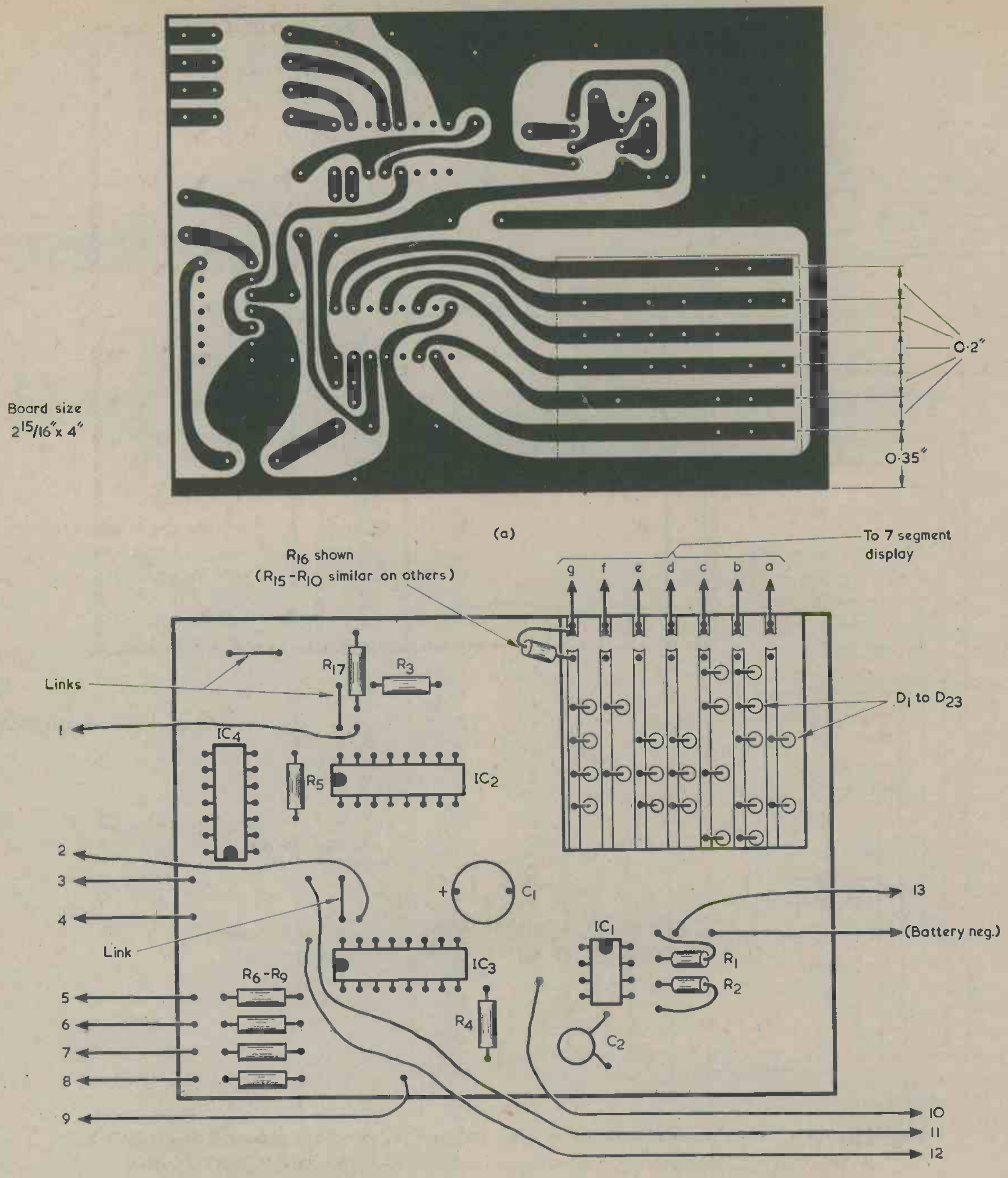


Fig. 2.(a). The copper side of the printed circuit board. This is reproduced full size

(b). The component side of the board. First to be fitted is the specially prepared Veroboard item of (c), which has to be correctly aligned in position

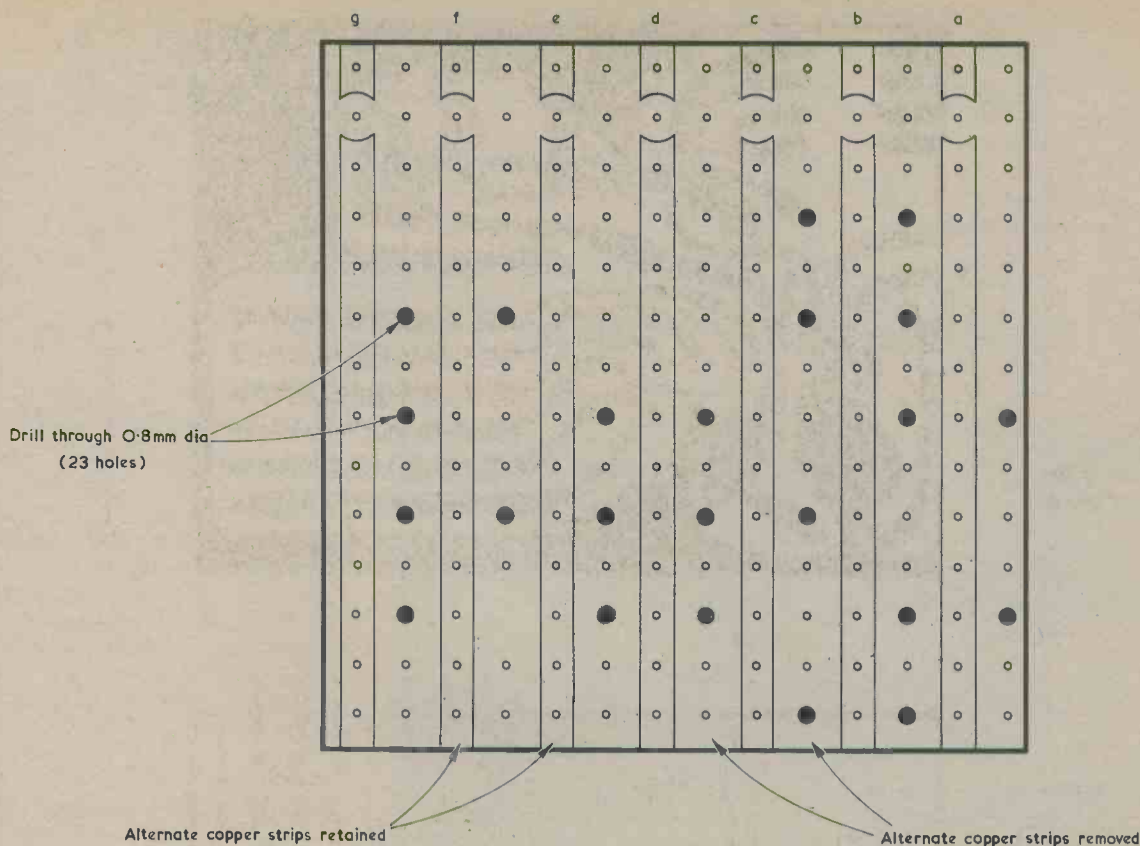
of the l.e.d.'s are labelled to indicate a wicket – "Bowled", "Caught" or "L.B.W". The fourth l.e.d. indicates a "Wide".

The game is provided with a Reset push-button which, when depressed, connects pins 15 of IC2 and IC3 to the positive rail. This returns both i.c.'s to the zero output condition. Since no connections are made to either of the zero output pins, both displays are thus cancelled.

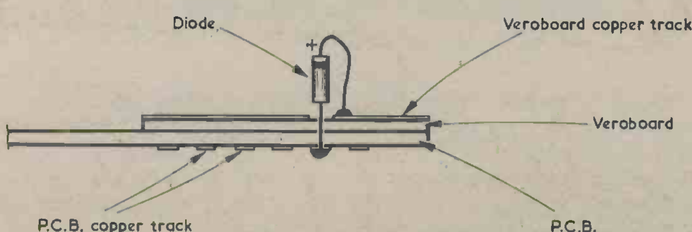
No connections are made to the unused flip-flop in IC4, and this arrangement functions satifactorily in practice. The current drawn from the 9 volt battery is about 6mA with the display and the l.e.d.'s extinguished. It rises to about 20mA when the display indicates a score and to approximately 10mA if one of the four l.e.d.'s is alight.

CONSTRUCTION

The majority of components are assembled on a printed board, the copper side of which is shown full size in Fig. 2 (a). Before any components are mounted, however, it is necessary to fix, on the plain side of the board, the 0.1in. Veroboard item shown in



(c)



(d)

Fig. 2(c). How the Veroboard item is prepared. The holes are not drilled until after the Veroboard has been secured to the printed circuit board

(d). A side view of the Veroboard and printed circuit board assembly

Fig. 2 (c). Alternate copper strips are removed from the Veroboard, and this process can be carried out quite easily by using a sharp knife and carefully peeling back the copper. The 7 breaks in the copper strips are next made. The board is then glued on the plain side of the printed board, copper strips uppermost, to take up the position shown in Fig. 2 (b). Bostik or a similar adhesive may be used. After the glue has set, the holes illustrated in Fig. (2) (c) are next drilled, these being in the Veroboard areas from which the copper has been removed. If the Veroboard and printed board have been aligned accurately, the holes will pass through the printed board in the positions shown in Fig. 2 (a). The diodes in the diode matrix can now be carefully soldered in place as illustrated in Fig. 2 (b). Each diode anode connects to the copper print, and each diode cathode connects to a Veroboard copper strip. Also soldered into place are the series resistors R10 to R16. These are soldered to the Veroboard copper strips. Fig. 2 (d) gives a side view of the Veroboard and printed board assembly. Wires from the end of the Veroboard connect to the 7-segment display.

The remaining components on the printed board can now be soldered in position. The prototype game was housed in a plastic case measuring about 6 by

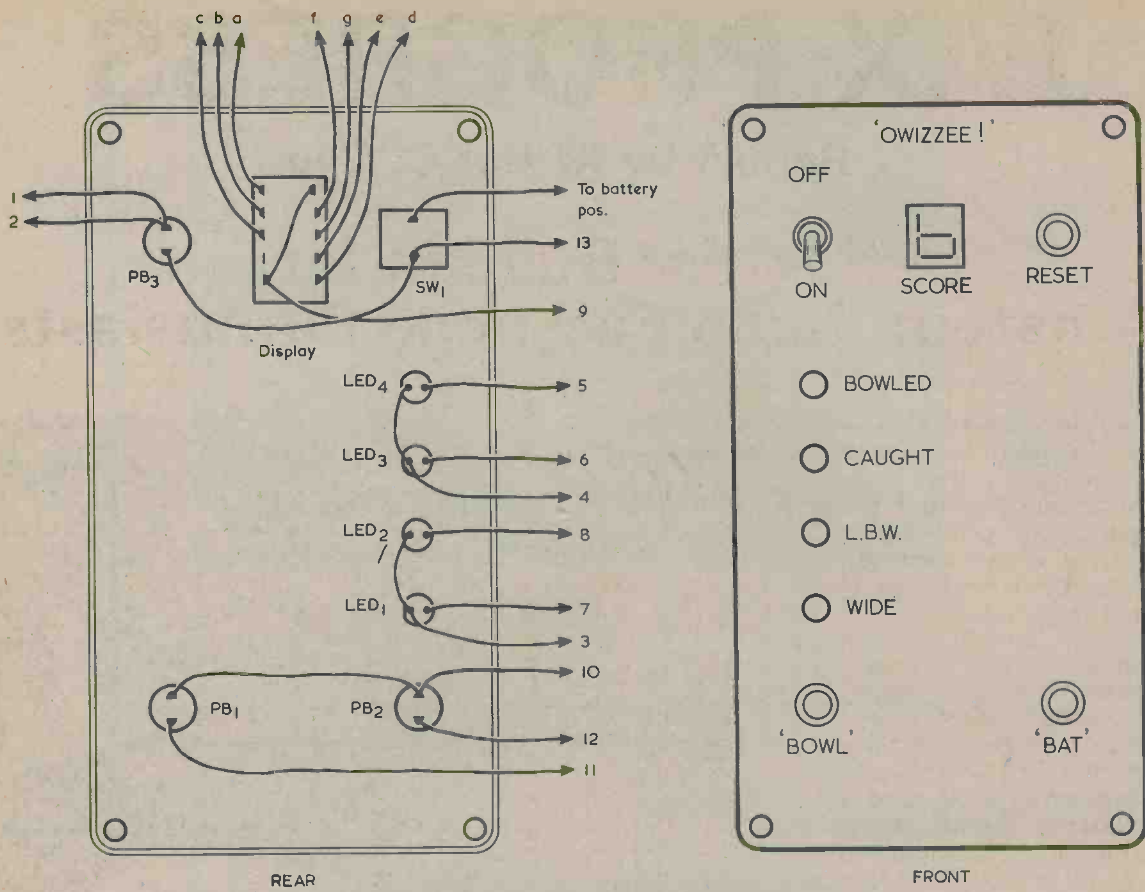


Fig. 3. The wiring and components on the front panel. The numbers from 1 to 13 correspond with those in Fig. 2(b)

3⅛in. and about 2in. deep. Any small plastic case capable of taking the components and battery can of course be used. The printed board was secured to the base of the case with thin flexible leads coupling it to the front panel components, the leads being long enough to allow the front panel to be removed. The front panel is cut out and wired as shown in Fig. 3. The display was glued in place after having first glued a piece of red Cellophane over the aperture from the rear. The display used was an Archer type 276-062, and this should be available at Tandy dealers. An alternative display is the FND500, which is available

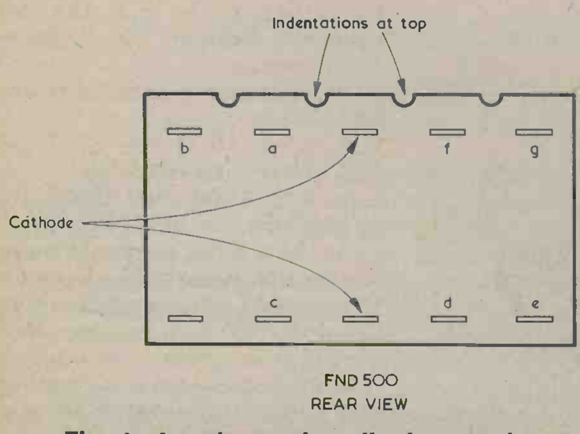


Fig. 4. An alternative display to that used in the prototype is the FND500. This has the pinning shown here

from a number of suppliers. The FND500 has the pin layout shown in Fig. 4.

The panel lettering should be carried out before mounting the panel components. In the prototype, the l.e.d.'s were push fits into the holes in the panel, but panel mounting bushes could be used if desired. Obviously, constructors will have their own ideas on layout and presentation.

THE PLAYING RULES

The author has drawn up a set of playing rules as "standard" but any variation can be played as a matter of personal choice. In the standard game each player has five wickets; this makes the game lively and interesting with players having a reasonably short turn-round time. The game can of course be played on more conventional lines with ten wickets per player, but it can then become rather frustrating for the bowler when for a long time he goes without taking a wicket and sees the cheery face of the batsman piling on the runs.

The bowler starts by depressing the "Bowl" push-button and if he fails to get a wicket the batsman presses the "Bat" button. The score, if any, is noted on a pad, and it is best to keep a running score as the game proceeds. The bowler then tries again and play alternates until the bowler takes a wicket or bowls a wide, in which case he bowls again. In the case of a wide, however, the batsman is credited with one run! When the fifth wicket has fallen the bowler takes his turn to bat and tries to beat the score. The game can be played over two innings, if preferred. ■

FAX PROGRESS

Report by Arthur C. Gee

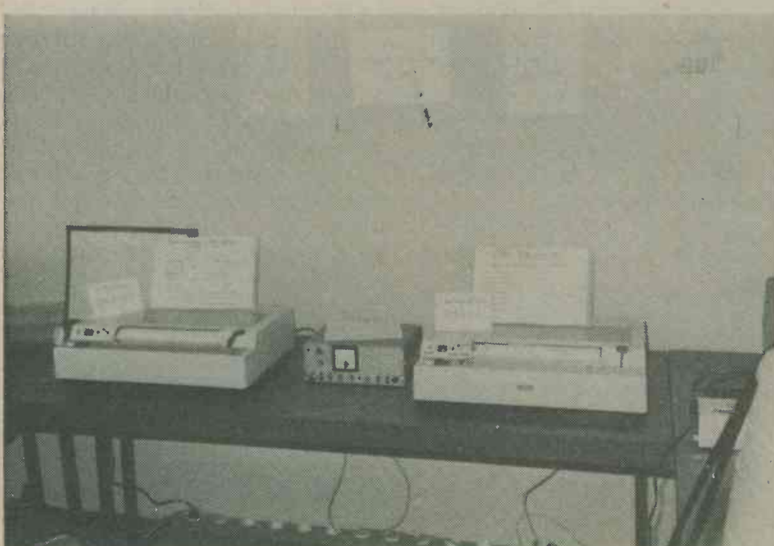
Regular Bulletin for Amateur Radio Facsimile Enthusiasts

Hans J. Schalk in his shack.

Facsimile transmission and reception is gradually catching on amongst the more experimentally minded radio amateurs, but progress has been slow since permission was granted recently to use this mode.

One step which may well help to encourage interest, is the establishment by Hans J. Schalk, DJ8BT, of Frankfurt, of a regular FAX Bulletin, transmitted on Saturdays and Sundays on the 80 and 20 metre amateur bands. Hans is reproducing in facsimile form the regular DARC News Bulletin, "DL-Rundspruch", so that those with FAX equipment, or those interested enough in this mode to be contemplating getting suitable equipment, have something to receive regularly, of an amateur radio interest.

The equipment used is a HELL HF 146 FAX Transceiver, which is a relatively modern and transistorised unit. The drum speed however, is a fixed one of 180 r.p.m., so that, to make it more versatile, Hans built a frequency divider and mixer unit, which now enables him to use all commercial drum speeds, viz., 60, 90, 120, 180 and 240 r.p.m. For his bulletins, a speed of 120 r.p.m. is used, but other drum speeds will be used if requested. The transmission time for one A4 sized page takes about ten minutes and the "DL-Rundspruch", which usually runs to two pages or so, takes about 25 minutes. A CQ and Test Chart transmission is run for ten minutes before the Bulletin transmission.



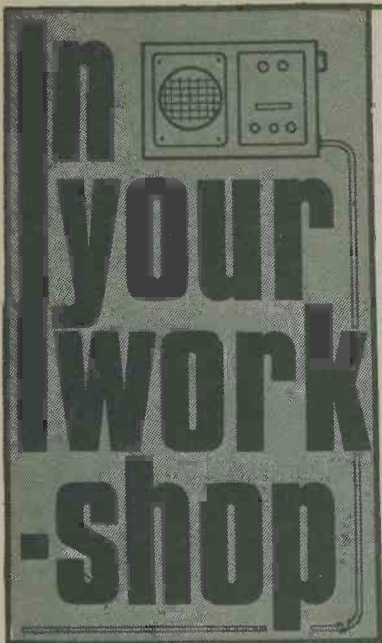
The equipment used at a FAX demonstration at "HAM RADIO 80" held at Fridrickshafen/Badensee.

Transmission schedules are as follows:

Saturdays 1800 hrs GMT on 3605 MHz – F4/800 Hz.

Sundays 1000 hrs GMT on 14105 MHz – F4/800 Hz.

As Hans says, now that there is a regular weekly FAX Bulletin this should encourage activity in this mode, as all FAX machine owners will have a weekly opportunity of testing out their equipment. Maybe this new service will give new life to some "long forgotten and dusty" FAX machines. ■



FIXING AN F.M. RADIO

Contentedly, Smithy watched his assistant as, leisurely, Dick brought the small f.m.-a.m. radio over to the bench. Yet another highly successful day could be chalked up in the favour of Dick and Smithy, and there were now at least two hours to go before they officially closed up shop for the day. The "Repaired" rack groaned under the weight of sets made serviceable by the indefatigable efforts of our talented pair. For most of the time they had proceeded along their own separate paths but on several occasions Dick had had to call in the aid of Smithy, who had instituted schemes of fault diagnosis and trouble-shooting which led to the successful location of Dick's snags. After this followed the triumphant installation, with impeccable solder joints on the part of Dick, of the replacement part which was needed to bring the set concerned back to its fully functional level. Dick would be the first to state that, whilst he might not be too hot on theory, he wielded a mean soldering iron.

F.M.-A.M. RADIO

Thus it was that the pair elected to work together on the very last set awaiting repair: the little f.m.-a.m. radio which Dick was now placing on the surface of Smithy's bench. Dick settled himself comfortably on the stool he had brought over from his own bench and operated the volume control of the radio to switch it on. The sound of a punk rock group filled the Workshop. Dick adjusted the tuning control and was able to receive both Radio 2 and Radio 3. He had patently been tuned to Radio 1 when he first turned on the set and the tuning performance of the radio showed that it was switched to a.m., whereupon it was covering the medium wave band with no access to Radio 4. Dick looked at the back of the set, to find a small 2-way slide switch with its positions marked "AM" and "FM". With a.m. selected the receiver was limited to the medium wave band only, but it showed no signs of covering this band other than with a perfectly acceptable efficiency.

"It's okay on a.m., Smithy." he announced. "I'll try it on f.m. now."

He moved the slide switch to the "FM" position, pulled out the telescopic aerial and tuned across the band. The set was silent.

"Well there's our snag," pronounced Smithy. "The set isn't working on f.m. I suppose we'd better do the obvious thing first and check battery voltage."

Dick removed the battery cover, to reveal four HP7 cells. He was able to get his test prods to the end spring contacts for the cells and the meter on Smithy's bench indicated about 5.75 volts with the set switched on at a low volume setting and with either f.m. or a.m. selected.

"We can," said Smithy cheerfully, "take our time over this. The f.m. section in these sets is usually the first to stop working properly when the battery voltage falls, but it shouldn't go completely dead when the battery voltage is only a little below 6 volts. The fact that the same voltage was given with both a.m. and f.m. selected means that the loading on the battery is probably the same on both bands so that, at least, there isn't excessive battery current drawn when f.m. is selected. Get the back off, Dick, and I'll see if I can find the service sheet."

Some minutes later, Smithy returned to his bench with a service manual, to find Dick carefully examining the receiver printed board for obvious visible faults.

"Everything looks all right," stated Dick.

"Fair enough,' responded Smithy, looking at the receiver circuit diagram. "This set has got two transistor amplifying stages which are common to both the a.m. intermediate

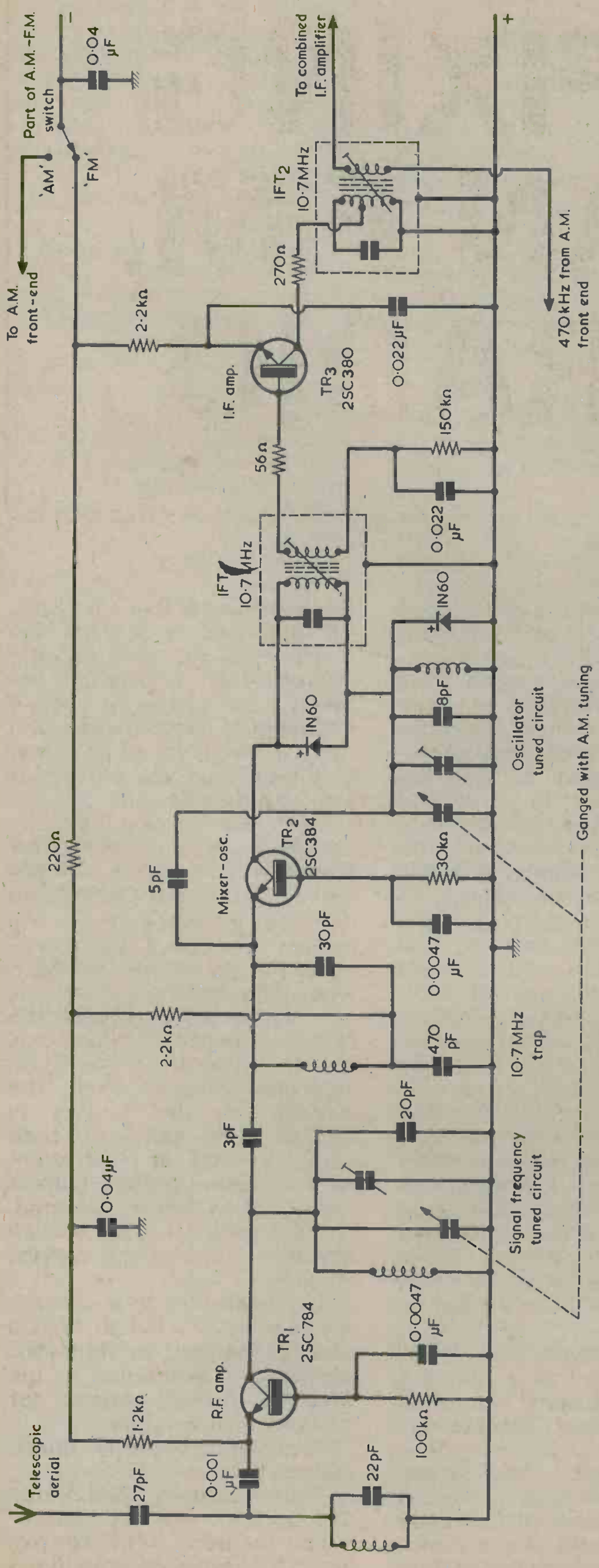


Fig. 1. The circuit of the r.f. amplifier, mixer-oscillator and first 10.7MHz i.f. amplifier in the f.m.-a.m. radio serviced by Dick and Smithy. This represents standard commercial practice and is a slightly simplified version of the circuit employed in the Ferguson portable radio model 3189.

frequency of 470kHz, and the f.m. i.f. of 10.7MHz. We're not in any hurry, so let's take things easy and just assume that, since these two stages are okay on a.m., they should also be okay on f.m. Which means that we might as well turn our attention first to the section of the radio which takes in the f.m. front-end and the f.m. first i.f. transistor."

Smithy pointed to the appropriate section of the receiver circuit. (Fig. 1.)

"Dear, oh dear." sighed Dick. "This is another of those circuits where the positive rail is common to chassis and the negative rail is at the top of the diagram. And we've got transistors with those Japanese type numbers, too."

"Look them up in **Towers**."

"Okeydoke," said Dick, as he stood up, reached to the shelf above Smithy's bench and took down the Workshop copy of **Towers' International Transistor Selector, Up-Date 2**. He turned through the pages and then found the transistor types which were employed in the circuit.

"All three transistors are n.p.n. silicon," he said. "TR1 and TR2 are v.h.f. amplifiers and TR3 is a general purpose type."

"Very good," said Smithy, "Well, the i.f. transistor, TR3, is obviously connected as a common emitter amplifier."

Dick looked at the circuit dubiously.

"If you say so."

"I do say so." Smithy pulled his note-pad towards him and picked up a ball-point pen. "If I redraw the circuit with the positive rail at the top, you can see that it's a very straightforward common emitter stage."

Smithy busied himself with his pen, then showed the circuit he had sketched out to Dick. (Fig. 2.)

"That 0.022μF emitter bypass capacitor," objected Dick, "doesn't go to the negative rail, it goes to the positive rail."

"So what? Both rails are coupled together by a 0.04μF capacitor at the arm of the a.m.-f.m. switch, so that the emitter bypass capacitor can be returned to either."

"What about the 56Ω resistor

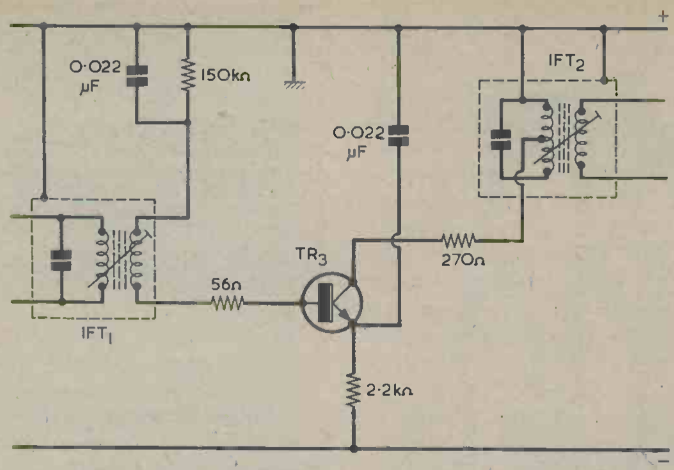


Fig. 2. TR3 is employed in the common emitter mode, as can be clearly seen if the circuit around it is redrawn with the positive supply rail at the top.

in the base circuit and the 270Ω resistor in the collector circuit?"

"You get these in f.m. i.f. stages," explained Smithy. "They help to reduce the effects of impulsive interference."

COMMON BASE AMPLIFIER

"Humph," grunted Dick. He turned his attention to the first stage in the front end. "Hey, what about TR1? Don't tell me that that's in a common emitter circuit as well."

"No, it isn't. It's in a common base circuit. Let me show you the basic common base configuration."

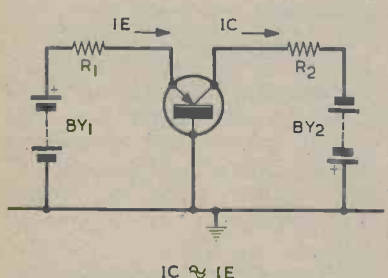


Fig. 3. The basic common base transistor configuration. Input and output signals may be applied to and obtained from the emitter and collector respectively via coupling capacitors. Current is assumed to flow from positive to negative. With an n.p.n. transistor, battery polarities and current directions are reversed.

Again, Smithy's pen passed quickly over the top sheet of his note-pad. (Fig. 3.)

"This is a common base amplifier," he went on. "I've used a p.n.p. transistor instead of an n.p.n. one because this makes it easier to visualise the currents which flow. The base is connected to a common rail which we can conveniently refer to as 'earth'. Battery BY1 and resistor R1 cause a forward current to flow in the emitter-base junction of the transistor. A collector current flows in resistor R2, which is supplied by battery BY2. As you can see, I've put in two little arrows and called the currents IE and IC."

"What's the relationship between these two currents?"

"They're virtually the same."

"The same?" repeated Dick incredulously. "Come on Smithy, you're having me on!"

"No, I'm not," replied Smithy. "Provided R2 is not too high in value, the current which flows in it is almost exactly the same as the current which flows in R1."

"But that **can't** be true," protested Dick. "You've got two separate circuits here. One circuit is given with BY1 and R1, and the other circuit is given with BY2 and R2. Are you telling me that if R1 has a value which causes 1mA to flow in it, there will be 1mA flowing in R2?"

"I am," said Smithy. "Or at least there will be very nearly 1mA in R2. If I reduced the value of R1 so that it passed 5mA, there'd be almost exactly 5mA in R2 as well. Similarly, if I increased R1 so that only 0.2mA flowed in it, then the current in R2 would also be virtually 0.2mA."

"Whatever," queried Dick "the value of R2?"

"Regardless of the value of R2," confirmed Smithy, "provided that it's low enough to allow the collector current to pass."

"Would that 0.2mA flow, even if R2 had as low a value as, say, 10Ω?"

"It would flow," Smithy assured him gravely, "if R2 were a short-circuit!"

Dick gazed at Smithy's circuit.

"I don't believe it!"

Smithy glanced at Dick's perplexed face.

"I suppose it does take a little imagination to see the effect," he said. "Let me see if I can show it you in a way you'll understand more easily."

He scratched his head thoughtfully, then picked up his pen as a thought occurred to him.

"Let me re-draw that common base circuit," he said slowly, "so that battery BY1 is above battery BY2."

He drew out a new circuit diagram and then showed it to Dick. (Fig. 4(a).)

"Does that," he asked, "make it clearer?"

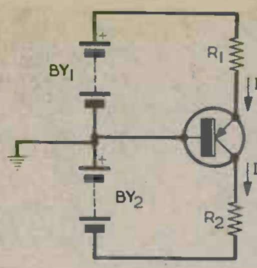
Dick scowled down at the re-arrangement of the circuit symbols.

"I'm afraid not, Smithy. All you've done is move the batteries and resistors about a bit. I'm still baffled!"

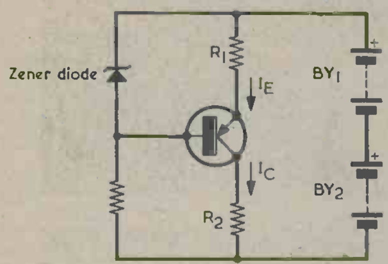
"All right," said Smithy equably, "I'll now make another change. I'll keep BY1 and BY2 in series to give the same overall supply voltage that we had before. But I won't connect the junction of the two batteries to the transistor base. Instead, I'll feed that base by the steady voltage dropped across a zener diode having the same voltage as BY1. Here's the idea."

Smithy sketched out his new circuit then looked expectantly at his assistant. (Fig. 4(b).)

"That," said Dick frowning,



(a)



(b)

Fig. 4(a). Redrawing the circuit of Fig. 3 with battery BY1 above BY2. (b). Here, the connection between the batteries and the transistor base is removed and a zener diode added. The voltage across the diode is the same as that previously provided by BY1.

"looks very familiar to me."

"Think about it."

"Why, of course," exclaimed Dick. "It's the circuit of a constant current generator! The transistor base is held at a fixed potential by the zener diode, and the voltage across the diode, minus about 0.6 volt dropped in the transistor base-emitter junction, appears across R1. Since the voltage across R1 is fixed, the current which flows in it must also be fixed. The collector current is the same as the emitter current and so a constant current is given in R2 regardless of its value."

"Provided," stated Smithy, "that R2 has a value which is not too high to allow the current to flow. You should also have mentioned that the current in R2 is not precisely the same as that in R1, because the current in R1 is the collector current plus the very small base current which allows the collector current to flow. If the transistor has a high current gain, though, the emitter and collector currents are nearly identical."

"I've got all that," said Dick quickly. "Let's go back to the circuit you drew just before. That's the first one where you put BY1 over BY2. I can see now how this gives the same sort of constant current performance as the circuit with the zener diode. The current which flows in R2 **must** be the same current, less the much smaller base current, as that which flows in R1. Gosh, it takes a bit of thinking about, though!"

"What you have to remember," said Smithy, "is that, with a common base amplifier stage, the actual supply voltage is given by BY1 and BY2 in series. The current which BY1 supplies is then virtually the same as that which BY2 supplies. We tend to think of bias current as being much smaller than collector current because we're so used to the common emitter circuit. But in the common base circuit the bias current to the emitter, provided by BY1 in our example, is actually a little higher than the collector current."

INPUT TRANSISTOR

"That's really cleared up this common base business for me," said Dick enthusiastically. "Wait a minute, though!"

"What's up now?"

"You said that the first transistor in this f.m. front-end was connected as a common base amplifier. But there's no BY1 and BY2 in the receiver circuit – there are just negative and positive supply rails."

Smithy busied himself once more with his pen. After some moments he showed a further circuit to his assistant. (Fig. 5.)

"Here's that r.f. amplifier transistor," he said. "An input from the aerial goes to its emitter, and an output from the collector goes to the signal frequency tuned circuit. A current is applied to the base via the 100kΩ resistor, with the result that virtually the same current flows through the 1.2kΩ emitter resistor and the coil in the collector tuned circuit. The important bit here is that the base is bypassed to

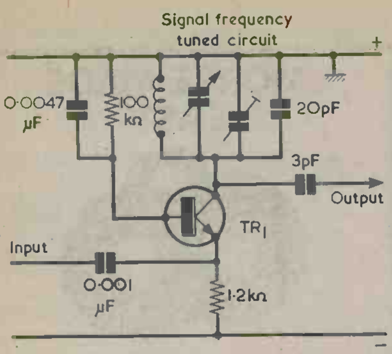


Fig. 5. TR1 in the receiver circuit functions as a common base amplifier at r.f. because of the 0.0047μF capacitor coupling its base to chassis.

chassis via a 0.0047μF capacitor. This means that so far as r.f. is concerned, that base is as common with chassis as it would be if there was a direct connection. Got it?"

"Blimey, yes. But there's something else I've thought of!"

"Go on."

"If the standing emitter and collector currents are virtually equal, an r.f. current in the base circuit will produce the same r.f. current in the collector circuit. What's the use of a transistor which provides no current gain?"

"The r.f. current gain the transistor provides," said Smithy, "is, as you rightly point out, just about unity. In fact, it's very slightly less than unity. On the other hand, the input impedance at the transistor emitter is low and the output impedance at the collector is very high. So, whilst the transistor may not offer any current gain it can, given the right components in the emitter and collector circuits, provide a considerable degree of **voltage** gain. As you can see, the collector of the transistor goes straight into the whole signal frequency tuned circuit. It doesn't go into a tap in the coil as would normally occur with a common emitter amplifier. There's another thing, too. When a transistor is connected in common base it maintains its amplification up to frequencies which are very much higher than would be given when it is in common emitter. That's why common base transistors are so frequently found in the r.f. amplifier and mixer-oscillator stages of f.m. receiver front-ends."

Dick turned his attention to the receiver service manual.

"That mixer-oscillator transistor has to be in common base, too," he said. "Its base is bypassed to chassis by another 0.0047μF capacitor."

"That's right," confirmed Smithy. "Now, another feature of transistors in the common base configuration is that, voltage-wise, the emitter and collector are in phase. If the emitter is taken negative of the base, the effect on collector current is the same as if, with a common emitter transistor, the base is taken positive of the emitter. In other words, taking the emitter of a common base transistor negative causes the collector to go negative, too. In the same way, taking the emitter positive causes the collector to go positive as well. So far as the mixer-oscillator transistor is concerned this means that a simple capacitive coupling from the collector back to the emitter is all that is required to make it oscillate. If you look at the service manual circuit again you'll see that the mixer-oscillator collector connects through the primary of the first 10.7MHz i.f. transformer to the top end of the oscillator tuned circuit. And the top end of that tuned circuit couples back to the emitter through a 5pF capacitor."

"Well," grinned Dick, "you couldn't have things much simpler than that. There's a 1N60 diode across the i.f. transformer primary. What's that for?"

"It's another component to reduce the effects of impulsive interference," replied Smithy. "The 1N60 is a germanium diode which is primarily intended as a video detector. In this circuit it turns on and damps the i.f. tuned circuit if there are any interference signal spikes. It also prevents excessively high signal levels getting into the i.f. amplifier."

"There's another 1N60 diode across the oscillator tuned circuit."

"That one does much the same sort of thing. It limits oscillator frequency amplitude to about the same level over the tuning range. Any more questions?"

"Nope."

"Good," pronounced Smithy. "Let's get down to some servicing then."

"You said earlier," commented Dick, "that the common i.f. amplifier stages should be all right."

"I only said that we'd start of by **assuming** they're all right. It's quite possible that the snag is in that common amplifier. But, as we're taking it easy, let's keep on playing hunches. If we continue with the assumption that it's the f.m. front-end which is at fault then a few unhurried voltage checks won't do any harm at all. Let's first check that the f.m.-a.m. switch is doing its job properly and is allowing power to get to the front-end. Perhaps you could keep an eye on the needle of my testmeter while I see what voltages are available."

Smithy turned to the printed circuit layout diagram in the service manual, and noted that his trusty analogue testmeter was switched to 0-10 volts d.c., as it had been when Dick used it to measure the battery voltage. He turned on the receiver, ensured that it was switched to f.m. and rested his positive test prod on the first i.f. transformer can to obtain a positive supply connection. After some scrutiny he applied the negative prod to the negative supply for the first transistor in the front-end. (Fig. 6(a).)

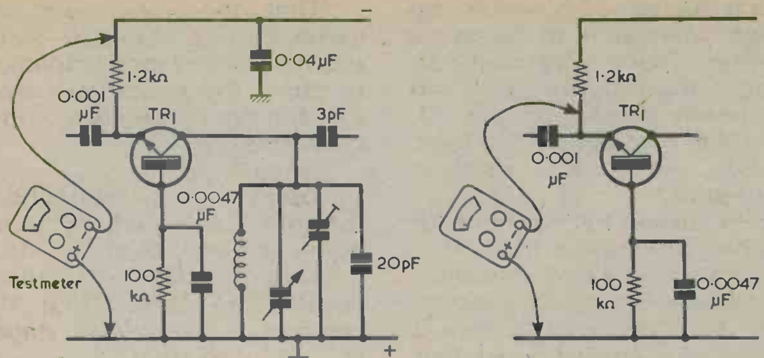
"Any reading?"

"Are you checking the supply rail voltage?"

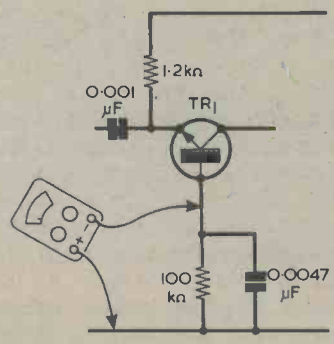
"I am."

"Well," said Dick, "you're getting a reading of about 5 volts. Shouldn't it be the same as the battery voltage we measured earlier?"

"It will be lower that that," said Smithy. "There are several series decoupling resistors in the negative rail between the negative battery terminal and the point I'm checking now. I'll check the emitter of the first transistor next. Now, where is that on the board? Ah, here it is!"



(a) (b)



(c)

Fig. 6(a). Smithy first checked to ensure that a supply voltage was being passed to the f.m. front-end.

(b). He next measured the voltage at TR1 emitter.

(c). Finally, he applied his testmeter across the 100kΩ base resistor, with rather surprising results.

Smithy applied his test prod to the transistor emitter. (Fig. 6(b).)

"The meter's giving pretty well the same reading," stated Dick. "Just about 5 volts."

Smithy raised an eyebrow.

"Is it now?" he remarked. "Don't tell me that I'm already on to something. I'll check the base of that first transistor next. Here we go!" (Fig. 6(c).)

Smithy placed the test prod end against the transistor base. There was a noticeable crackle from the receiver loudspeaker which then, to Dick's utter amazement, proceeded to give a distorted musical output.

"Blimey, Smithy, what did you do there?"

But Smithy was not yet ready to explain the phenomenon.

"See if you can tune in that station properly."

As Smithy kept the test prods in place, Dick adjusted the receiver tuning. This soon allowed the received signal to be heard clearly. Smithy removed his negative test prod and the music ceased. He re-applied the prod and the music once more became audible.

"Come on, Smithy! What the heck is happening there?"

"I've bridged the 100kΩ base resistor for the first transistor with the resistance of my testmeter," said Smithy cheerfully. "My testmeter's got a resistance of 20,00 ohms per volt and so I'm putting 200kΩ across what is bound to be an open-circuit 100kΩ resistor. The meter resistance is enough to turn the transistor on, although it won't be passing the full current it ought to. The long testmeter leads won't upset matters, incidentally, because they're bypassed by the 0.0047µF capacitor between the base and chassis. So it looks as though all we need to do is to fit a new 100kΩ resistor in this set."

TAKING IT EASY

Contentedly, Smithy watched his assistantas, leisurely, Dick proceeded to remove the faulty open-circuit 100kΩ resistor from the receiver printed board. The chalking up in their favour on this highly successful day had been further augmented by this final felicitous adventure in fault finding. Dick soldered in a replacement resistor, and they listened to the radio as it now gave a faultless performance on its f.m. range. Unhurriedly, Dick refitted the printed board in the cabinet, screwed on the back, gave the set a last check to make certain that all was well and carried it over to the "Repaired" rack.

SINGLE I.C. SIGNAL TRACER

By

M. V. Hastings

Inexpensive design with low component count

•

Traces a.f. and modulated r.f. signals

•

Two gain levels

This simple test instrument is suitable for tracing both audio frequency and amplitude modulated radio frequency signals, and is therefore suitable for fault-finding on audio and a.m. radio equipment. The unit is inexpensive since it incorporates only a single integrated circuit and a few passive components. The circuit is powered by a 9 volt battery and the output is applied to a crystal earphone. Two levels of voltage gain are available, one being 20dB (10 times) and the other 60dB (1,000 times). The tracer can in consequence detect very low level signals but need not be overloaded by higher level signals.

CIRCUIT OPERATION

Fig. 1 shows the circuit and, as will be apparent to many readers, the tracer is basically an operational amplifier used in the inverting mode. The LF351 has a very high resistance Jfet input and, in consequence, has a low noise level. This last factor is very important because weak signals must not be masked by noise generated in the amplifier.

To avoid the need for dual supply rails, the equal value resistors R3 and R4 bias the non-inverting input of the LF351 to a mid-supply voltage. There is 100% negative feedback at d.c. via R5 which causes the quiescent output voltage to be at the same level as the non-inverting input. This enables the output to have what is virtually the maximum possible voltage output swing before clipping and serious distortion occur.

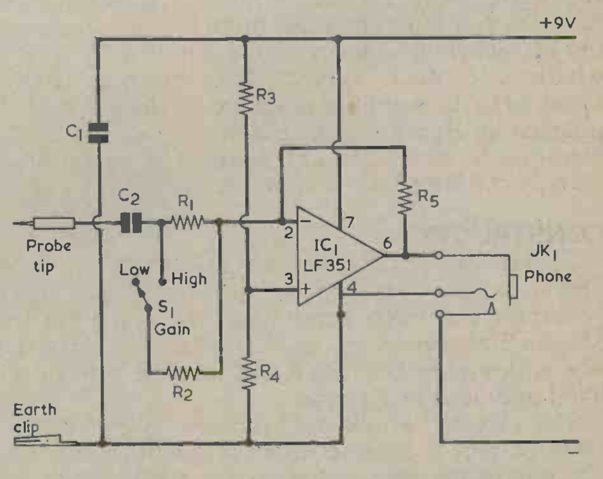
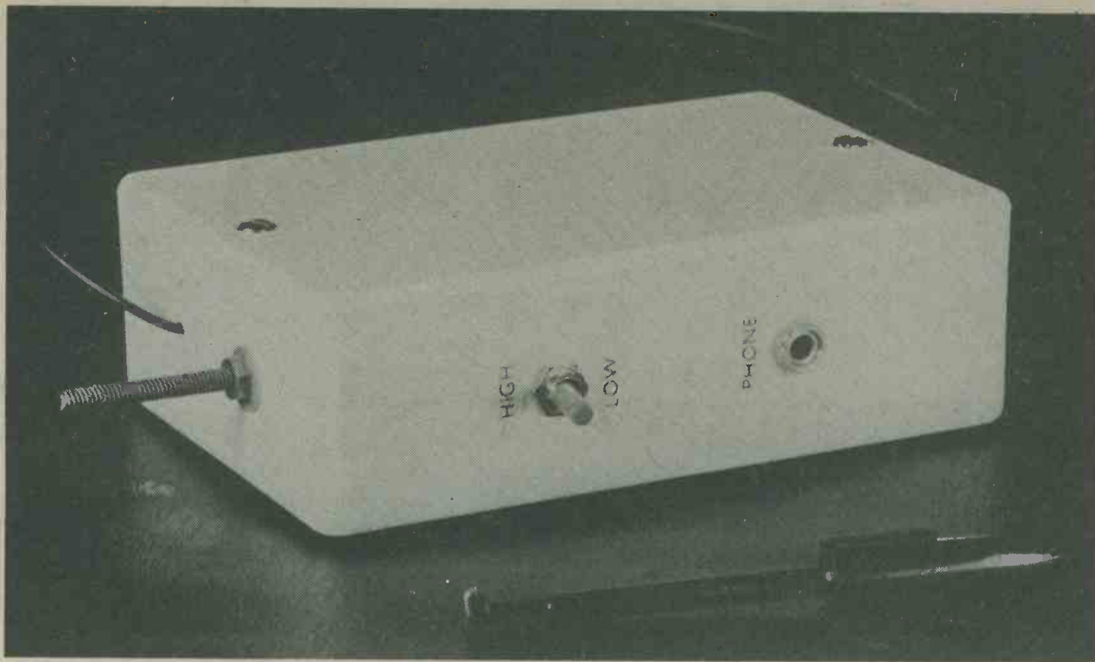


Fig. 1. The circuit of the signal tracer. This is switched on when the earphone plug is inserted into socket JK1.



The signal tracer is housed in a small plastic case which can be held in the hand. The probe tip at the end is then applied to the test points in the equipment being checked.

Assuming a relatively low impedance at the point to which the signal tracer connects, the voltage gain is equal to the value of the feedback resistor divided by the value of the resistor in series with the inverting input. When S1 is in the "Low" position these two resistor values are 10mΩ (R5) and 1MΩ (R1) respectively and the voltage gain is therefore 10 times. Setting S1 to the "High" position connects the 10kΩ resistor R2 across R1, so that the series input resistance is effectively 10kΩ and the voltage gain is 1,000 times.

D.C. blocking is provided at the input by C2. No d.c. blocking is required at the output because a crystal earphone imposes no significant d.c. loading. It is quite in order, also, for the crystal earphone to have the amplifier quiescent output voltage across it. On-off switching is given at the output jack socket, where a contact connects the negative battery terminal to the amplifier when the crystal earphone is plugged in. Removing the earphone plug causes the amplifier to be switched off again. The circuit has a current consumption of approximately 2mA only.

CONSTRUCTION

A white plastic case measuring about 114 by 76 by 38mm is used to house the prototype signal generator, and this is a case type PB1, available from Maplin Electronic Supplies. A small case of about this size is desirable because it can then be held in the hand and used as a probe.

The layout employed can be seen in the photographs. A long 4BA or M4 bolt is mounted at one end of the case and is used as the probe tip. If desired, its end can be filed to a point. A solder tag is fitted under the bolt head inside the case to allow connection to be made to the bolt. A plain washer should be fitted outside the case under the securing nut. A small hole about 2mm in diameter is drilled at

COMPONENTS

Resistors
(All ¼ watt 5% unless otherwise stated)
- R1 1MΩ
- R2 10kΩ
- R3 15kΩ
- R4 15kΩ
- R5 10MΩ 10%

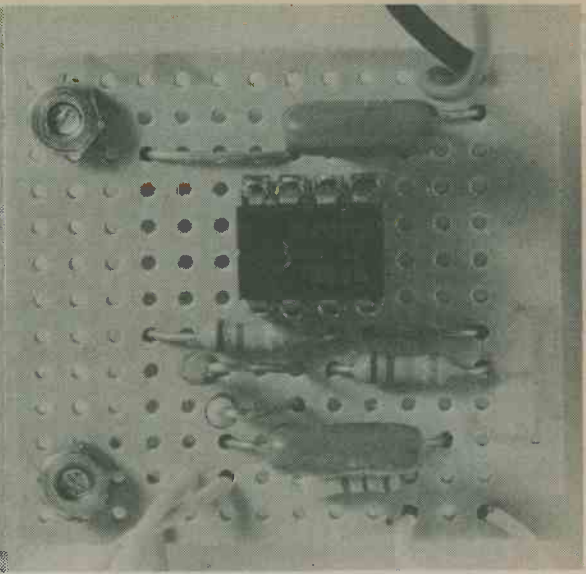
Capacitors
- C1 0.1μF polyester type C280
- C2 0.1μF polyester type C280

Integrated Circuit
- IC1 LF351

Switch
- S1 s.p.s.t. sub-miniature toggle

Socket
- JK1 3.5mm jack socket, modified (see text)

Miscellaneous
- Small plastic case (see text)
- 9 volt battery type PP3
- Battery connector
- Crystal earphone with 3.5mm jack plug
- Veroboard, 0.1in matrix
- Earth test clip (see text)
- Nuts, bolts, wire, etc.



The Veroboard assembly. This accommodates the single i.c. used in the tracer together with a small number of resistors and capacitors.

the same end of the plastic case, and this will eventually take the lead which connects to the earth clip. This can be a crocodile clip or any other convenient form of test clip. Switch S1 and socket JK1 are mounted on one side of the case, with the switch closer to the probe tip.

JK1 is an ordinary 3.5mm jack socket of open construction, normally having a contact which breaks when a plug is inserted. The socket is modified so that the contact makes with insertion of the plug. The unmodified socket has a contact set consisting of two pieces of metal, one fixed and the other springy so that it moves away from the fixed piece when the plug is inserted. The fixed piece is carefully bent downwards under the springy section so that the two are not normally in contact and only come together when the plug is fitted. The modified socket should have the appearance illustrated in Fig. 2. Make quite sure that the two parts of the contact set are not touching when the plug is not in the socket, as the unit will be permanently switched on if this should be allowed to happen.

COMPONENT PANEL

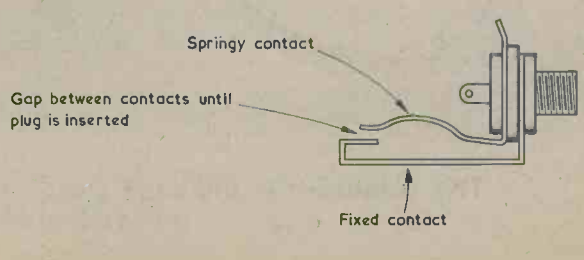
Most of the circuitry is assembled on a piece of 0.1in Veroboard having 13 holes by 13 copper strips. Fig. 3 gives details.

The board has first to be cut out from a larger piece, after which the two mounting holes are drilled. These can be clearance size for 6BA or M3 bolts. The 4 breaks in the copper strips are next made, using the special Vero tool or a small drill bit held in the hand. The components and link wires are next soldered in place, these being followed by the leads which connect to the components external to the board. The external wiring is finally completed, after which the Veroboard panel is mounted inside the case by two 6BA or M3 bolts with nuts. It takes up the position shown in the photograph of the case interior. Spacing washers should be fitted over the bolts to keep the panel underside clear of the inside surface of the case. The flexible lead which connect to the earth test clip can be about 18in long. A blob of glue can be used to secure it at the Veroboard hole at which it connects in order to reduce strain on the copper strip at the soldered joint. There is plenty of space for the PP3 battery. If a piece of sponge plastic is placed over the battery it will be held in position when the case lid is screwed on.

USING THE UNIT

There must, of course, be a signal fed into the input of the equipment being tested when the signal tracer is in use. This signal can be provided by a signal generator, but the normal signal source of the equipment is just as good. The earthing clip of the tracer is connected to the chassis of the equipment being checked and the probe tip is then applied to various points, starting at the input and working towards the output.

Fig. 2. Socket JK1 after modification. The fixed contact is carefully bent so that its end is below the springy contact instead of above it. The contacts should touch each other only when a jack plug is inserted.



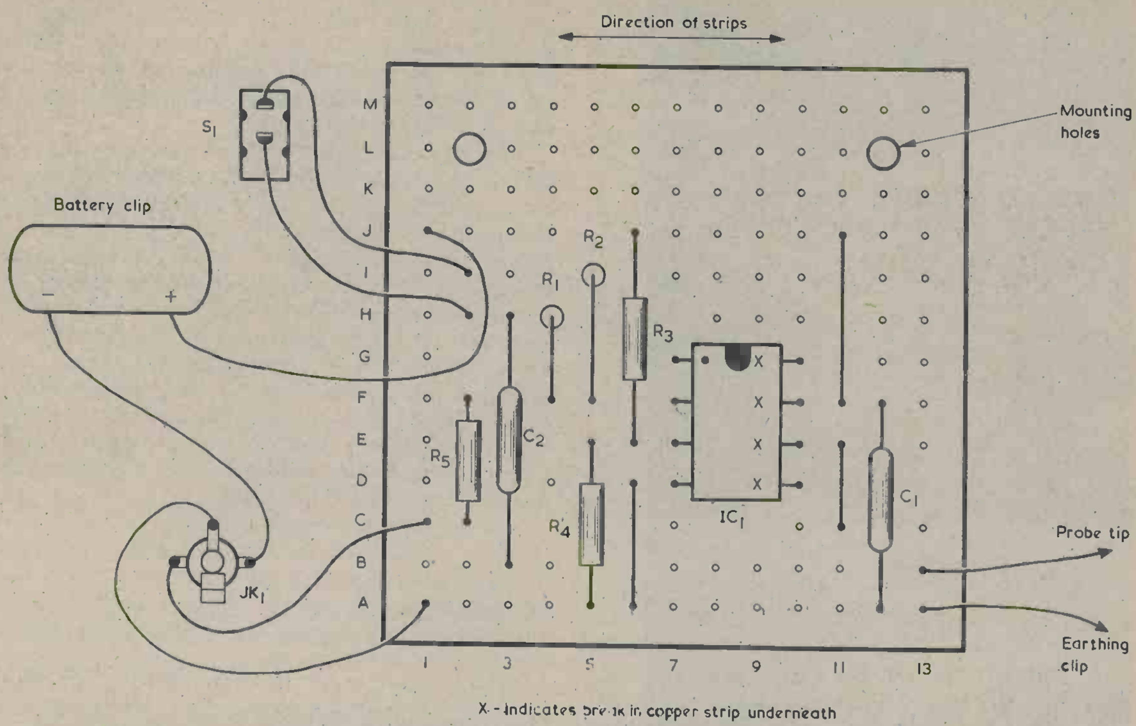
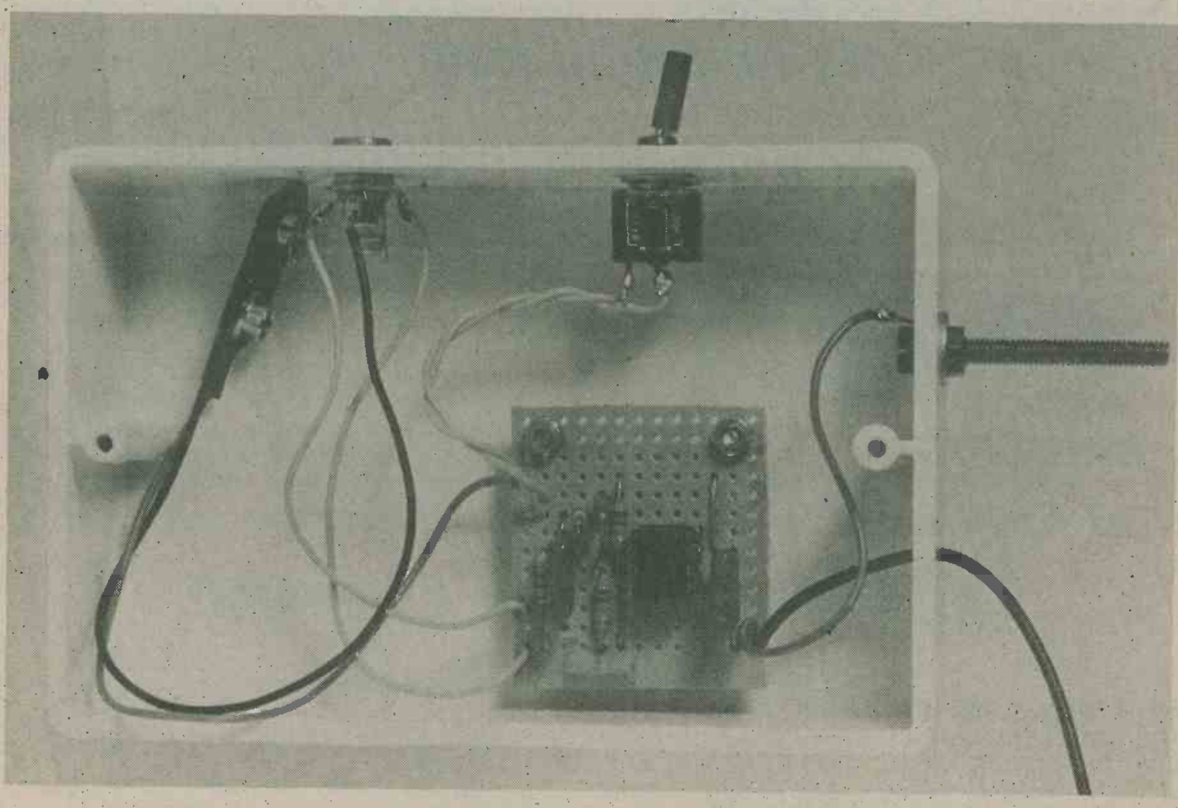


Fig. 3. Layout and wiring on the Veroboard panel. Also shown are the connections external to the panel.



The Veroboard is mounted inside the case near the probe tip. Note its orientation and positioning.

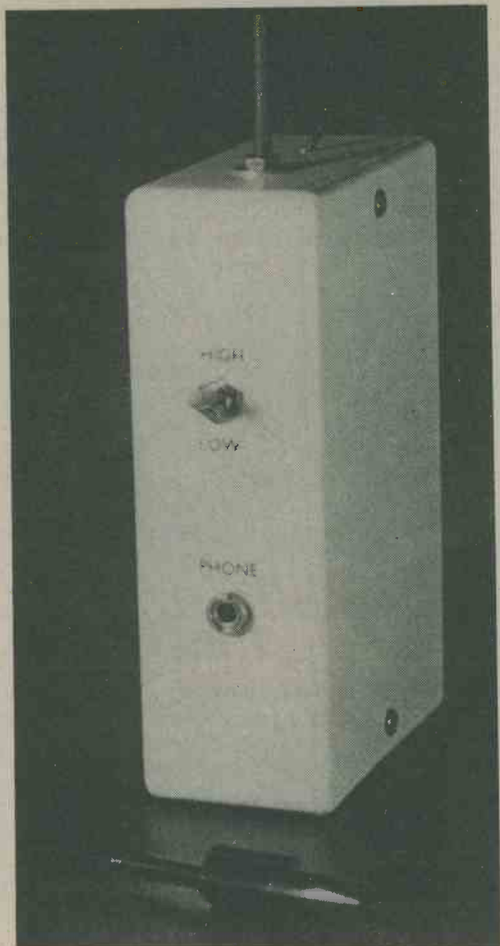
Note that if the equipment is mains operated, the signal tracer may only be used when the equipment chassis is fully isolated from the mains supply by a double-wound mains power transformer. **The tracer must not be used with equipment having a direct connection between chassis and mains because of the risk of a dangerous shock.**

The person employing the signal tracer uses his own initiative in selecting test points. In general, the first test is made at the base of the input transistor, the second at its collector, the third at the base of the following transistor, and so on. If, say, there is a satisfactory signal at the base of a transistor and the signal is absent or is seriously distorted at its collector, then the fault obviously lies in the transistor or its associated circuitry. The transistor itself may be faulty or the collector load could, for example, have gone open or short-circuit. The primary function of a signal tracer is to find the area in which a fault lies. Component checks and/or voltage tests are then used to finally pin-point the fault.

Another use for the signal tracer is to check emitter bypass capacitors in circuits where a transistor emitter has a bias resistor connecting to chassis. If a significant signal level is present across the bypass capacitor this indicates that the bypass capacitor is not functioning correctly.

When tracing very low signal levels, as in the early i.f. stages of an a.m. radio receiver or the microphone input of a tape recorder, it will almost certainly be necessary to set S1 to the "High" position to obtain adequate sensitivity. However, for most tests the tracer will be overloaded unless S1 is switched to "Low". It is a good plan to use the signal tracer on serviceable equipment to obtain an idea of the signal level performance given at different stages.

On the face of it the unit is not suitable for r.f. signal tracing as there is no demodulation circuitry at the input. It is found in practice, however, that demodulation occurs within IC1, whereupon the unit is perfectly suitable for signal tracing in the i.f. stages of a.m. receivers. ■



In this view the gain switch S1 is uppermost, with the jack socket below it.

Circular Hole Jig

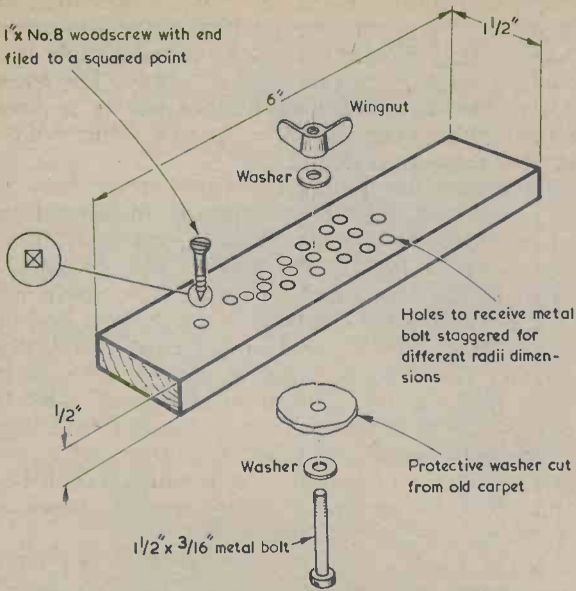
by D. M. Pitkin

Home-made jig cuts out large clean holes

Quite often an electronics project demands that fairly large circular holes need to be cut in a plastic panel to provide speaker apertures or to take meters or similar items. Faced with this problem recently, I discovered that a conventional hole saw produced sizes too small or too large for the particular item to be mounted.

WOODEN JIG

The problem was solved quite simply by making up the jig shown in the diagram. The main section is a short length of scrap timber measuring about 6in. long, 1½in. wide and ½in. thick. Also required are a 1in. woodscrew, a 1½in. metal bolt of 3/16in. diameter, two 3/16in. plain metal washers, a protective washer cut



The home-made jig uses readily available parts and can be used to cut clean circular holes in plastic panels.

out from an old carpet and a wing nut which fits on the 1½in. bolt.

The end of the 1in. woodscrew is filed to a squared point, and this point will cut cleanly through the plastic. Mark a centre line on the piece of wood and prick it about 1in. from one end to receive the woodscrew. From this point mark out with a pair of dividers the required radius. Quite a number of radii can be accommodated on the single piece of wood to suit varying components by staggering the holes to be drilled.

When the marking out is complete, drill a threading hole for the woodscrew and an 3/16in. hole at the radius point to be used. Fit the woodscrew, allowing the point to project through the timber a little more than the thickness of the plastic to be cut, and the jig is then ready for use.

To cut the circular hole in the plastic, locate and drill a 3/16in. hole at its centre. Fit a plain washer over the 1½in. bolt and pass it through this hole from the underside. On the top of the plastic fit the protective washer, the wooden jig, a second plain washer and the wing nut. Tighten the wing nut with moderate pressure and turn the jig in a clockwise direction. The pointed woodscrew end will then cut through the plastic. Extra thick plastic can be tackled by reversing the jig and cutting from each side. Turning the jig in a clockwise direction maintains pressure on the cutting point. ■

RECIPROCAL WORKING

We regret that two obvious errors appeared in the article "Reciprocal Working", published in the December issue. The final term in the key sequence on page 210 should, of course, be 0.047. Also, the frequency in the last calculation on page 211 should be 2.36Hz.

BOOK REVIEW

RADIO CONTROL FOR BEGINNERS. By F. G. Rayer, T.Eng. (C.E.I.), Assoc.I.E.R.E. 96 pages, 180 x 105mm. Published by Bernard Babani (Publishing) Ltd. Price £1.75.

The purpose of this book is to provide an introduction to radio control of models for beginners in this popular hobby. It commences by discussing the principles of radio control in various systems, including single and multi-channel, and then deals with licence conditions. Next to be described is a typical transmitter, with constructional notes, and a tone modulator. A mini transmitter is next dealt with as also is the question of transmitter aerials.

The book next proceeds to receiver aerials and takes in a super-regenerative receiver and a superhet receiver, again with constructional information. After this, relays and actuators are covered, together with other mechanical details and transistor switching of controlled devices. The book concludes with a consideration of the controlled model, which may be aircraft, boat or car.

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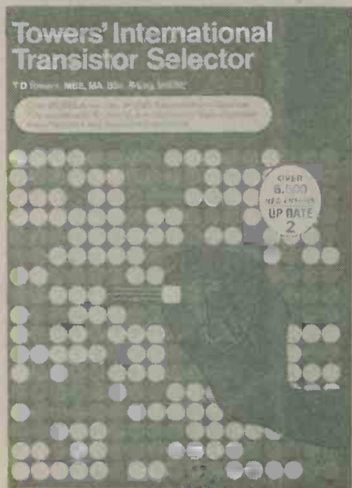
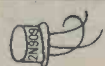
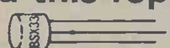


This is dead!



Would this replace it?



If it takes you longer than 1 minute to find out all about these transistors then you need a copy of TOWER'S INTERNATIONAL TRANSISTOR SELECTOR. It's one of the most useful working books you will be offered this year. And probably the cheapest!

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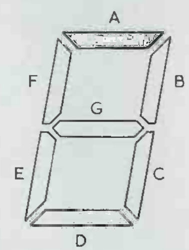
SEVEN SEGMENT DISPLAYS

A seven segment numeric display is formed in the manner illustrated in (a), and the way in which the numbers 1 through to 0 are presented is shown in (b). 1 is given by segments B and C, 2 by segments A, B, D, E and G, 3 by segments A, B, C, D, 4 by segments B, C, F and G, and 5 by segments A, C, D, F and G. The number 6 is displayed with segments C, D, E, F and G, 7 with segments A, B and C, 8 by all seven segments, and 9 by segments A, B, C, F and G. Finally, 0 is represented by segments A, B, C, D, E and F.

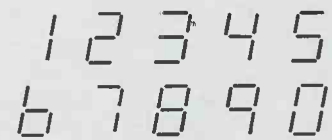
Two alternative presentations for 6 and 9 appear in (c). Both have added "tails", the number 6 tail being given by segment A and the number 9 tail by segment D. Further provided in the display may be a decimal point segment. Plus and minus signs, colons, etc., can also be included.

Light-emitting diode displays, in which each segment is an l.e.d., are either common cathode or common anode types. With the first type the segment cathodes are made common and connect to one (or more) of the display terminals. The display is then driven as in (d), with a current limiting resistor in series with each anode. A common anode display is connected as in (e), with current limiting resistors in series with the seven segment cathodes. The decorder-driver i.c. may be either t.t.l. or CMOS (with which the current limiting resistors are sometimes omitted).

Liquid crystal displays are also very widely encountered, and are typified by requiring extremely low drive currents. This makes their use attractive in digital watches and other battery driven items.

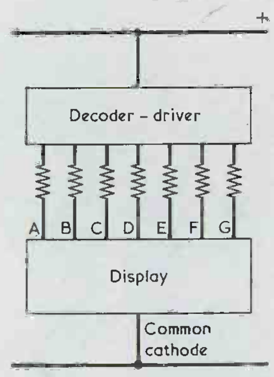


(a)

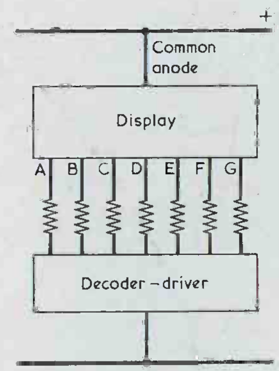


(b)

(c)



(d)



(e)