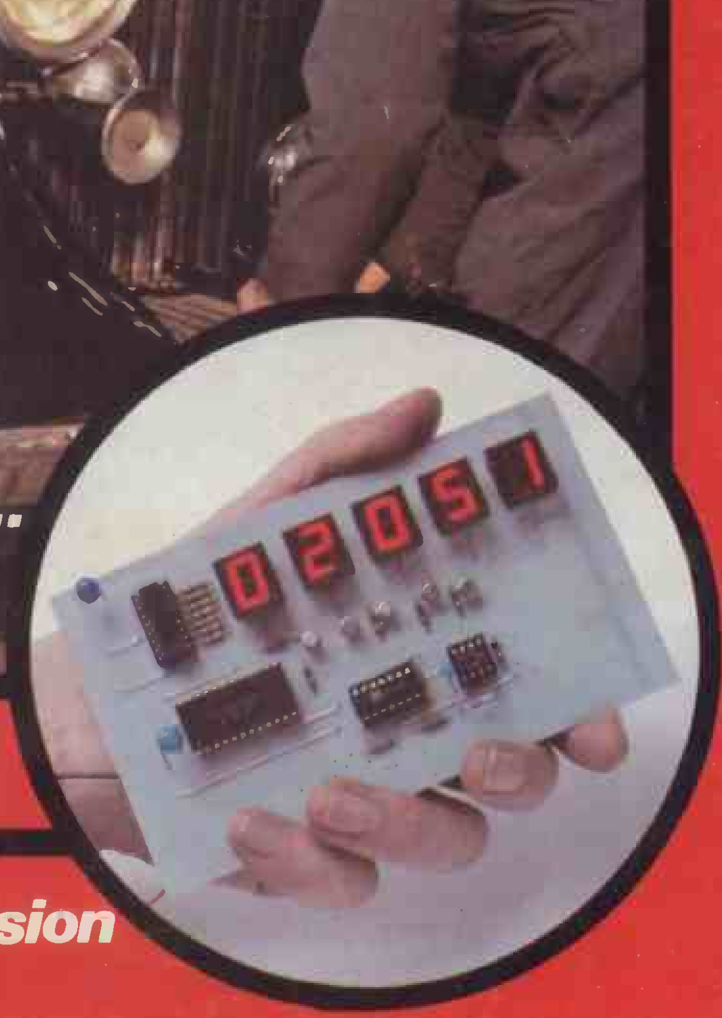
ISSN 0142-6192

Hobby Electronics

April'80
50p

TROUBLE STARTING?

Don't Keep The Lady Waiting... Build HE's Electronic Ignition



Digital Frequency Meter
You Can Count On It

Narrow Bandwidth Television
Do-It-Yourself TV

Hobbycom
Wired For Sound

RC Speed Controller
A Model Design

Solar Cells
Sunny Side Up

BEWARE! RADIO ACTIVITY

The new MK III FM tuner sitting under the Dorchester multiband AM/FM tuner

Revisions to the Mark III include a centre zero tuning indicator meter and silent preset switching

New 944378·2, the last word in stereo decoders with the KB4437/4438.

Choosing the products to advertise each month can be quite a task at AMBIT, since we tend to introduce at least one new line per week. So it is nearly impossible to say all we would like in this space - other than to bring you as far up to date as possible with current events. The major medium for finding out about what we have to offer is our unique catalogue system, and we ask that you invest in a copy of parts 1,2 & 3 since many questions we are asked can be readily answered by reference to these.
Each part costs 60p, or £1.60 for all three current editions.
We are also launching a new and greatly elongated version of our PRICE LIST, which now includes a large number of quantity listings, and many items not previously listed. The new style price list is a quick reference short form to our general catalogues - available FOC with a large (A4) SAE please.

As a result of the soaring price of oil - and the subsequent huge increases in the cost of wax for Mr Tom Jackson's famous moustache, the Post Office have increased their charges (Feb. 4th). Accordingly, our standard cover charge has been increased to 35p per order (CWO).

MODULE NEWS

We are at last able to quote for quantities of our modules, following a program of standardization and revision to speed manufacture and test. The following types are the results of the standardization program:

UM1181	5 varicap MOSFET input VHF band 2 tunerhead	£12.00 inc
911225 A	High Performance FM IF system, with switched BW	£23.95 inc
911225 B	Single BW filters, single tuned detector	£14.95 inc
91072 A	DC tuned and single pole switched MW LW tuner	£14.43 inc
91072 B	As type 'A' but with either SW1 or SW2 band	£15.90 inc
92242 A	Combined LW/MW tuner, with FM IF detector section	£29.00 inc
92242 B	As 92242A but with 5·10MHz SW section	£34.00 inc

All are supplied housed in screened metal cases 97x56x24mm, with all connections along a single edge, suitable for verticle or horizontal mounting.

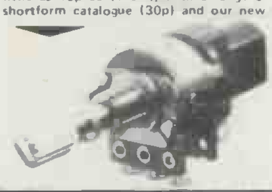
Previously advertized units are still available although there may have been some price changes in the latest edition of the Price List (Date Feb.80) A separate leaflet covering the new range of modules is available from April 80, with an A4 SAE please

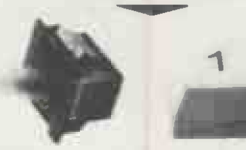
COMPONENTS

DIGITAL FREQUENCY READOUTS / SYNTHESISER SYSTEMS

Ambit has the biggest range of digital frequency readout systems for various applications in Broadcast and Communications. Prices range from £18.50 for a complete AM/FM broadcast frequency display (kit of DFM2). Most are detailed in the latest catalogue.
TUNING SYNTHESIZERS are also heavily featured, and we offer our first complete system covering MW/LW/SW2 and FM based on Hitachi parts. The unit is retrofittable to voltage tuned radio systems - and will shortly be incorporated in a complete tuner project. Cost for the synthesiser will be circa £40
A versatile communications system based on the new Mullard 2 IC system is nearing completion, together with 16 station CMOS memory and optical shaft encoder system with fast tune facility. Synthesiser circa £70, memory £50.

NEW LINE : ALPS switches and rotary potentiometers. With a general catalogue that's over 3 inches thick, we cannot begin to offer a comprehensive list of what we can offer - but we are already stocking the keyboard switches, keyswitches, pushbutton switches etc. In particular, the pushbutton switches really put all others in the shade (schadow?) when it comes to quality and price. A special new shortform is being prepared (and may be ready when you read this). All the potentiometers and switches you could ever need from a single source. Keypad switches cost as little as 15p ea (1 off), with a range of two part caps for easy ledgending. You must see the shortform catalogue (30p) and our new pricelist for full details of this huge range of components





Latest semiconductor news:

CMOS, TTL and LPSN TTL are in stock (ask for our OSTS price leaflet). Some of the very popular types are still "difficult" but we have things like 4011s, 4017s at the time of writing.
RADIO ICs - - -interesting developments here, we now have the Hitachi HA11225 and the HA12412 ultra high specification members of the CA3089E family. The PLESSEY SL1600 range now includes the SL6600 high performance PLL NBFM IF and detector.

CA3089E	2.11	HA1197	1.61	SD6000	4.31	SL1610	1,84	SL1626	2.80
CA3189E	2.53	CA3123E	1.61	TOA4420	2.59	SL1611	1.84	SL1630	1.86
HA1137W	1.95	TDA1072	3.09	MC1330P	1.38	SL1612	1.84	SL1640	2.17
HA11225	2.47	TBA651	2.53	MC1350P	1.38	SL1613	2.17	SL1641	2.17
HA12412	2.81	TDA1090	3.51	KB4412	2.24	SL1620	2.50	SL6600	4.31
KB4420	1.95	TDA1220	1.61	KB4413	2.24	SL1623	2.80	SL6640	3.16
TBA120S	1.15	TDA1083	2.24	KB4417	2.53	SL1624	3.77	SL6690	3.68
KB4406	0.80	TOA1062	2.24	MC3357P	3.16	SL1625	2.50	MC1496	1.44

TRANSISTORS : New lower prices, wider range, large stocks. Also the world's lowest noise audio devices (2SC2546E and 2SA1084E) first from AMBIT of course. Power MOSFETs & all sorts of other devices. Our 3SK51 MOSFET replaces the 408XX and 40673 families.

BC237-8-9	0.092	2SC1775	0.207	2SA1084E	0.368	BF256	0.437	BFY90	1.03
BC307-8-9	0.092	2SA872A	0.207	2SC2547E	0.391	2SK55	0.368	BF224	0.253
BC413-5	0.115	2SO666A	0.345	2SA1085E	0.391	2SK168	0.402	BF274	0.207
BD414-6	0.126	2SB646A	0.345	2SK133	6.32	3SK51	0.62	BFT95	1.138
BC546-556	0.138	2SD760	0.52	2SJ48	6.32	3SK60	0.667	VN66AF	1.092
BC550-560	0.138	2SB720	0.52	2SK135	7.29	BF960	1.426	2N4427	0.977
BC639-640	0.265	2SC2546E	0.368	2SJ50	7.29	3SK48	1.426	J176	0.747

RADIO CONTROL:- A special section for all RC fans. New and exciting stuff:
KB4445/KB4446 : complete 4 channel RX/TX dig.prop IC pair RF&control in one 4.75pr
MSL9362/MSL9363 : logic section of a four channel dig.prop link, with switch opt. 3.75pr
NE5044 : Signetics versatile 7 channel encoder, suitable for mixing etc. £2.14 ea
NE544 Signetics famous servo driver IC £2.07 MC3357P as used in RCME design £3.16 ea
AMBIT RCRX4 - RCME FM system compatible, complete RX kit with box/connector and AMBIT design screened front end with 27MHz ceramic filter £16.10 (kit)
XTALS: FM pairs £3.74 (no splits) TX is fund. ½ op frequency. RX 3rd OT- 455kHz
AM pairs £3.57 (no splits. Both 3rd OT types, again RX IF at 455kHz

AMBIT SHOP NOW OPEN

We are gradually getting our caller sales area sorted out, with displays of the products on offer and a browsers corner to sit and study data/catalogues. Call in next time you are in the area - parking outside the door.

COMPUTER CAPABILITIES

Ambit has been keeping a low profile on the subject of the MPU and its applications. Interestingly enough, the first project we offer with MPU content does rather more in the way of processing than simply playing a daft game, or looking like an enormous calculator. Our MPU facility and expertise is now for hire on a fully commercial basis. Z80, 6800, 6809, 2650 etc.

Keyboard switch
SCK41505
typ 6m ops
23p each (1-24)

NEW LINE : DC/DC+AC converters for fluorescent displays. TOKO CPS series 12v IN, -20 and 3v AC out at 65mA. Thick film design £2.34 ea Qty. prices OA

GENERAL INFORMATION

Ambit stocks the following ranges of components for ex-stock volume delivery SIGNAL COILS, CERAMIC, MECHANICAL and CRYSTAL FILTERS, RADIO ICs for AM/FM/SSB, TOROID CORES FOR RADIO and EMI FILTER CIRCUITS, INDICATING AND PANEL METERS, AUDIO ICs, RF TRANSISTORS, FETS, MOSFETS, DIODES (PIN, VARICAP, SCHOTTKY), PASSIVE DBMs (like MD108 etc), IC SOCKETS, LEDS, TRIMMER CAPS, SWITCHES, KEYBOARD SWITCHES, TUNERHEADS, IF AMPS, AM RADIO MODULES, etc etc

NEW LINE : DVM176 - the definitive ICM7106 LCD DVM module. 3½ digit £22.37 ea.

CM161: LCD 12/24hr alarm clock/day/date/backlight (eq.RS308-499) 7mm digits £11.44 each
CM174: LCD 12hr alarm clock/stopwatch/backlight with 30mm height digits £14.32 each

CATALOGUES 60p ea, all three for £1.60
PRICES SHOWN HERE INCLUDE VAT
POST/PACKAGE CHARGE NOW 35p

ambit
INTERNATIONAL

CWO PLEASE : Commercial MA terms on application
Goods are offered subject to availability, prices subject to change - so please phone and check if in doubt.

200 North Service Road, Brentwood, Essex

TELEPHONE (STD 0277) 230909 TELEX 995194 AMBIT G POSTCODE CM14 4SG

Hobby Electronics

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Editor: Steve Braidwood, G3WKE.
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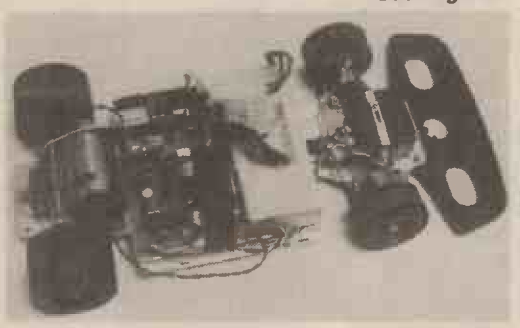
See Page 40



See Page 49

See Page 61

PROJECTS

FEATURES

NEWS & INFO

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Art Department: Diego Rincon (Art Director), Dee Camilleri, Lorraine Stout, Loraine Radmore.
Technical Artists: Paul Edwards, Tony Strakas, Joanne Barseghian.
Advertising Department: Group Advertisement Manager: Christopher Surgenor; Advertisement Representatives: Steve Rowe, Bill Delaney, Margaret Hewitt; Advertising Production Controller: Sandie Neville.
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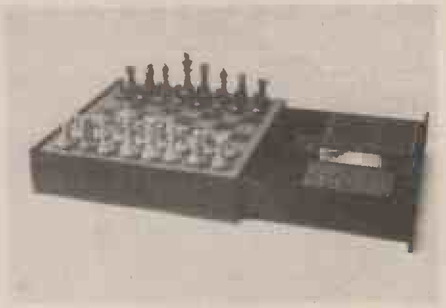
Monitor

LIQUID CHESS DEPARTMENT



Far left. The complete Chess Master system in its smart attache case.

Centre. Close up of the Chess Master board. The world's first LCD chess display.

Right. The Sargon modulator games system open for use.

If you thought that the recent flood of chessgames had finally subsided then we have some bad/good news for you. Latest contenders for the race have just arrived in this country and as far as we know, we have the only ones in the country at the moment.

In common with other recent chess-playing micros these two are just bristling with gimmicks not directly related to the game of chess. Number one is called the Chess Master Super System III. It is a modular system, expandable according to the depth of your pocket. The basic chess-playing console will set you back around £150. When your next birthday comes round you can now add to your list an impressive range of accessories designed to connect up to the Master. The most novel one, and top of our list has to be the LCD board, Chessmen are now redundant, this board will display the whole board, complete with pieces during the game. This will set you back £107. The neat little printer comes next. This gives a hard copy of every move and will print out a good graphic representation of the board at the end of every move if instructed to do so. The last couple of add-ons are a bit mundane but nevertheless worth mentioning. A plug-in memory module that will retain all the moves made during a particular game (for up to one year!) will set you back £24 and a rechargeable battery pack for portable use comes to you for just £25. By the way if you're still fluid, a smart looking attache case is available for another £43.

The second game is a little light on the gimmicks, it just claims to have the strongest chess programme ever put inside a little box. And strong it is, we can vouch for that. The other little thing to mention about the Sargon is that it can be loaded up with a variety of optional game cartridges to make it adept at Backgammon and various other board games. It comes in a rather neat little draw box which holds all the bits. The nasty little plastic men are a little disappointing, especially considering the price tag of around £260 but then it's not worth arguing, given a couple of months they'll end up like all the others and settle down to a realistic price. If you really can't wait and several hundred pounds is burning its way through your pockets then get in touch with Kramer Ltd who may be able to relieve you of some of it. Find them at 9 October Place, London NW4 (203 2473).

HEBOT ON TV

Did you see HEBOT on Nationwide last month? HEBOT has finally made its long awaited bid for stardom. In the picture we have Luke Casey (one of the Nationwide reporters) describing some of HEBOT's features. The filming was quite an ordeal, taking some three hours to complete. HEBOT actually behaved itself (much to everyone's surprise) and performed its tricks on cue (well, almost). The resultant clip of film was used to illustrate a report on robots, HE and Remcon being only one of two robot manufacturers in the UK.

You may be interested to know that one of the country's leading computer magazines is actually specifying a slightly modified version of HEBOT for the basis of a micro-processor controlled 'Mouse'. The idea is to design a mobile system that can negotiate a complex maze. The winner being the machine that covers the maze in the shortest time and making the least mistakes. HEBOT is the ideal basis for such a competition, the mechanics and drive circuitry could have been designed for the job. The only doubt we have is, why does the chassis have to be cut down for the maze, surely it would have been more sensible to increase the dimensions of the maze? We'll try and get some pix and information on the competition which we believe is due to be held around September.

MOLTEN MONITOR

These rather gruesome looking objects are the remains (though still working) of a pair of Tann Synchronome Series 3000 Heat detectors. Why you may ask, are they in this condition. Well, they were involved in a rather suspicous fire at a popular nightclub in Chester.

The swift activation of the alarm system by the detectors prevented extensive damage. Fire damage was contained within a relatively small area and smoke damage to two thirds of the ground floor. If you would like to protect your nightclub (or any other building for that matter) with these detectors then you can find Tann at: Station Road, Westbury, Wiltshire BA13 3JT.

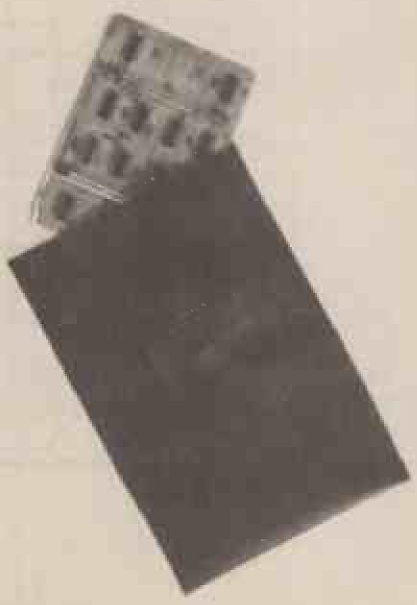
News from the Electronics World

RING MY BELL

Yes folks, these are the happy, smiling girls that put your phones together. This young lady is responsible for putting the finishing touches to one of the Post Offices latest offerings — called the Compact. As you can see these girls (at the Plessey factory) are having a whale of a time assembling these ultra-slim 'window-sill' or shelf compatible instruments with their three metres of cable making them truly mobile.

Now for the good bit. If you can think up a caption for this picture or suggest what the young lady may be saying, we'll send the best five a Tee-Shirt. Only clean(ish) suggestions please, dirty ones will not be printed (but may well win a prize if they're funny enough). Send your effort to: Caption Competition, Hobby Electronics Magazine, 145 Charing Cross Road, London WC2H 0EE. To arrive no later than April 1st.

IT'S IN THE BAG



If you're in the habit of carrying large quantities of CMOS, MOSFET or similarly delicate components around with you, then pin your ears back. Henri Picard and Frere are proud to announce the introduction of their new conductive bags. Called the 'Statfee' (isn't that better than some boring number?) they claim the strength of the new fabric used in these bags offer a 30% higher tear resistance than their old bags.

The bags are available in five sizes between 5 in by 8 in to 10 in by 18 in. Bags can also be supplied in custom sizes. If you want to keep your valuables free from the ravages of static electricity (and who doesn't) then get in touch with H P & F at: 357-359 Kennington Lane, London SE11 5HY.

BOOK REVIEW

Not much in the way of new books lately, in fact there is only one this month. It is called Electrical Drawing and comes from Firth and Lowe (they wrote it) and is published by McGraw-Hill price £3.95.

We managed to persuade our drawing office to do the review so it's over to you Joanne for your verdict.

"This book is a very simplified and readable approach to Technical Drawing, ranging from the basics of geometry and techniques to the drawing of circuit diagrams. It contains exercises and self-assessment questions, these enable the reader to learn the necessary steps to achieving a reasonable standard of electrical drawing. There is a detailed list of abbreviations and terms used so that the reader can familiarise himself (or herself) more easily with the subject matter. The drawings are not over technical and are designed to be easily understood, useful both for the amateur who has some basic knowledge and also helpful to the beginner. Altogether a worthwhile companion for the technical artist."

STAMP THIS OUT

Contrary to popular belief we are not millionaires, we are still getting loads of 'Technical Enquiry' letters without a SAE for reply. So, if you have a genuine problem concerning one of our projects (not for any other magazine please, they can sort out their own problems) then by all means write to us about it but please include an SAE. We cannot promise an immediate reply so you should allow at least three weeks before complaining.

NEGATIVE ION GENERATOR KIT

As you will see there is a distinct lack of Negative Ion Generator Kits being reviewed this month. This is not actually our fault (believe it or not). The manufacturers have informed us that due to unforeseen problems with the transformer supplied with the kit they cannot market them just yet. However, all being well they should have a new batch in a few weeks so we will be bringing you the review in the next month or so.

SHOP SHAPE

Just a quick word for those of you living around the London area and particularly in Tottenham. Just around the corner from the 'Spurs' ground you will find NIC Models little shop. If you get a chance why not drop in and have a look round. His stocks of electronic games, 'scopes, computers, models and books just has to be seen to be believed. If you talk to him nicely (Nick Nicholls that is) he may just make you a cup of his diabolical coffee. You can find him hiding in Broad Lane N15 at number 61.

CATALOGUES

Some catalogues are destined to become tatty. This is not usually a reflection of the quality of goods within, quite the opposite in fact. The West Hyde catalogue is certainly doomed, rarely have we seen so many interesting cases just crying out to have projects inside them. Apart from the cases (which must be the largest range anywhere!) they also offer a very creditable range of tools and hardware as well as testgear and components. Certainly with a range this specialised you could be excused in thinking that they would be expensive, happily this is not so. Nothing in the catalogue struck us as being overpriced, indeed many items seemed a bit too cheap to be true. Worry not though, we can vouch for West Hyde's service and have no hesitation in recommending this catalogue. After all, a really good looking case can turn a quite mundane project into a really professional piece of equipment.

West Hyde can be reached at: Unit 9, Park Street Industrial Estate, Aylesbury, Bucks HP20 1ET.

Whilst we are on the subject of catalogues, look out for our annual catalogue survey in the next month or two.

PHOTOSTATS

Due to the shortage of certain issues of HE we are now offering a photostating service for articles and projects. Each article or project will cost just 50 pence including postage (irrespective of length etc) with the exception of HEBOT which costs 75 pence (all three parts). Please specify the month, year and title of the article or project you require and address your enevelope to: Photostats, Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE.

ERRATA

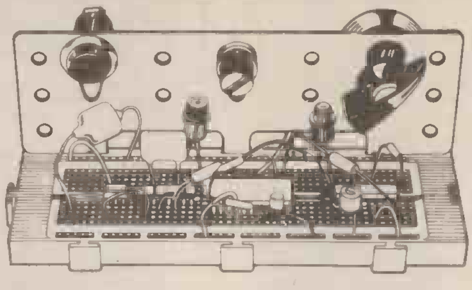
Did you spot the mystery components in last month's batch of Short Circuits? Well for those of you that missed them the answers are: Page 33 Sound Operated Switch, the unmarked resistor above C3 and C4 is R2-47 k. Page 52, the Thermostat. Capacitor C1 is 1000 µF, the resistor next to C2 is called R3 and is a 1k2 and the capacitor next to it is C3 and is 2µ2. The last mistake (courtesy of our Mr Corbett) concerns a couple of connections around IC1. Pin 9 *is* connected to the 0 V rail and pin 11 *isn't*. Sorry about that. We will all write out 100 times 'we must not make mistakes', trouble is nobody knows how to spell the long words and we can only count up to 50 anyway.

BIMBOARDS A Breadboard for every project

PERMANENT PROJECTS

NEW

NEW PC BIMBOARD. An exact printed circuit board equivalent of the BIMBOARD 1 plus 2 additional bus strips. Rows and columns of holes are numbered or lettered enabling components to be transferred one by one from a BIMBOARD 1 to the corresponding position on a PC BIMBOARD. Once soldered your project is functional, rugged, permanent. PC BIMBOARD £1.72

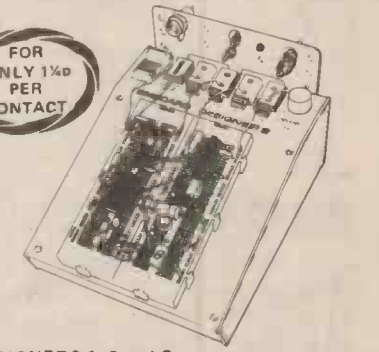


SMALL PROJECTS

BIMBOARD 1. Accepts .3" & .6" DIL IC's and MPU's plus components with .25—.85mm dia. leads. 550 double sided 1A, 10m.ohms max. nickel silver contacts on .1" matrix. Bus strips running up each side. Interlocking lugs & slots on all sides plus Component Support Bracket for Pots, Switches etc. Rows and columns of holes are numbered or lettered. BIMBOARD 1 £6.90.

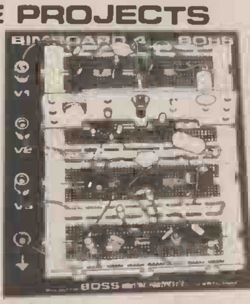
ADVANCED PROJECTS

FOR ONLY 1¼p PER CONTACT

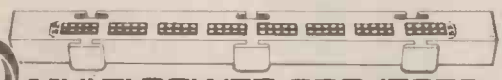


DESIGNERS 1, 2 and 3. Full prototyping units utilising 1, 2 or 3 BIMBOARD 1's mounted on a BIM 6007 BIMCONSOLE. 220/240Vac I/P via IEC plug and socket. Adjustable ±5 to ±15Vdc @ 100mA. Fixed +5V @ 1A. Fully isolated O/P's. Short circuit, fast fold-back, protection. Power rail cable clamps along top of BIMCONSOLE accept stripped wire or 4mm plug. Component Support Bracket also included. DESIGNER 1 £61.53, DESIGNER 2 £67.28, DESIGNER 3 £73.02

LARGE PROJECTS



BIMBOARDS 2, 3 and 4. Utilise 2, 3 or 4 BIMBOARD 1's on 1.5mm matt black base plate standing on 4 non-slip rubber feet. 4 screw terminals for input power lines plus 2, 3 or 4 Component Support Brackets. BIMBOARD 2 £21.17, BIMBOARD 3 £28.22, BIMBOARD 4 £36.12



NEW

MULTI-POWER PROJECTS

BIMBUSTRIP. For circuits requiring more than 2 power lines simply slot-on an extra pair of Bus Lines. BIMBUSTRIP £2.50

FUN PROJECTS

Our BIMBOOK 'Adventure in MicroElectronics' — contains 20 fun projects all designed to fit into a BIMBOARD 1. BIMBOOK £2.15

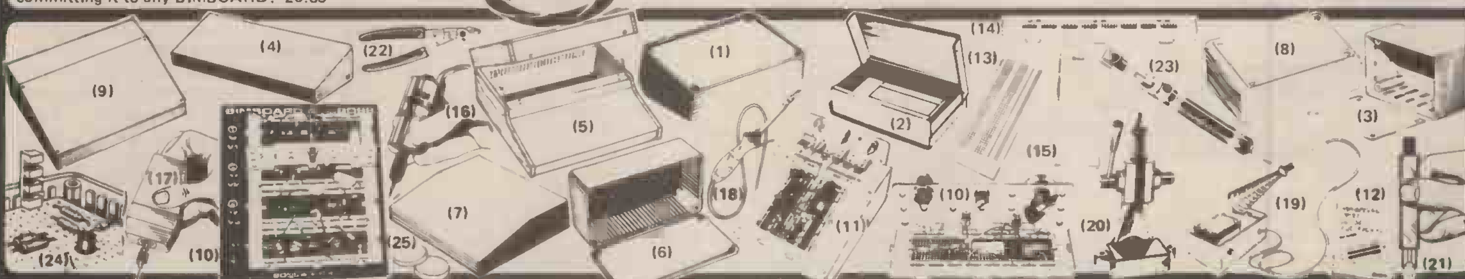
Step by step instructions show exactly which holes the various components plug into. Start with the simple projects, build up to the more intriguing ones. Full parts list given.

NEW

PLANNED PROJECTS

BIMBOARD LAYOUT PAD. Paper reprints of PC BIMBOARD let you neatly plan your layout before committing it to any BIMBOARD. £0.65

NEW



MINI DESK BIMCONSOLES (1)

BIM1005 (161 x 96 x58)	£ 2.48
BIM1006 (215 x 130 x 75)	£ 3.48

ALL METAL BIMCASE (2)

BIM 3000 (250 x 168 x 69) (Red, Orange, Grey)	£15.52

MULTI PURPOSE BIMBOXES (3)

BIM4003 (85 x 56 x 29)	£ 1.34
BIM4004 (111 x 71 x 42)	£ 1.84
BIM4005 (161 x 96 x 53)	£ 2.48

KEYBOARD BIMCONSOLES (4)

BIM7400 (355 x 178 x 102)	£19.60
BIM7401 (431 x 178 x 102)	£22.54
BIM7402 (508 x 178 x 102)	£26.25

(Black Base — Sand or Grey Top)

MPU DISPLAY BIMCONSOLES (5)

BIM7501 (250x260x112[33])	£40.37
BIM7502 (350x260x112[33])	£43.87
BIM7503 (430x260x112[33])	£47.09
BIM7504 (350x431x112[33])	£45.31
BIM7505 (430x431x112[33])	£47.98
BIM7506 (500x431x112[33])	£50.60
BIM7507 (350x431x200[33])	£77.51
BIM7508 (430x431x200[33])	£81.30
BIM7509 (500x431x200[33])	£86.82

(Width + 25 allows for wood sides) (White Top / sloping panel, Black ali or red/green/grey filter windows)

ABS & DIECAST BIMBOXES (6)

	ABS		Diecast	Hammertone	Natural
(50x50x25)	N/A		BIM5001/11	£1.54	£1.23
(100x50x25)	BIM2002/12	£1.09	BIM5002/12	£1.66	£1.32
(112x62x31)	BIM2003/13	£1.27	BIM5003/13	£2.24	£1.70
(120x65x40)	BIM2004/14	£1.51	BIM5004/14	£2.81	£2.11
(150x80x50)*	BIM2005/15	£1.72	BIM5005/15	£3.19	£2.72
(190x110x60)	BIM2006/16	£2.69	BIM5006/16	£4.94	£3.96
(112x61x31)	BIM2007/17 Grey Polystyrene £1.06				

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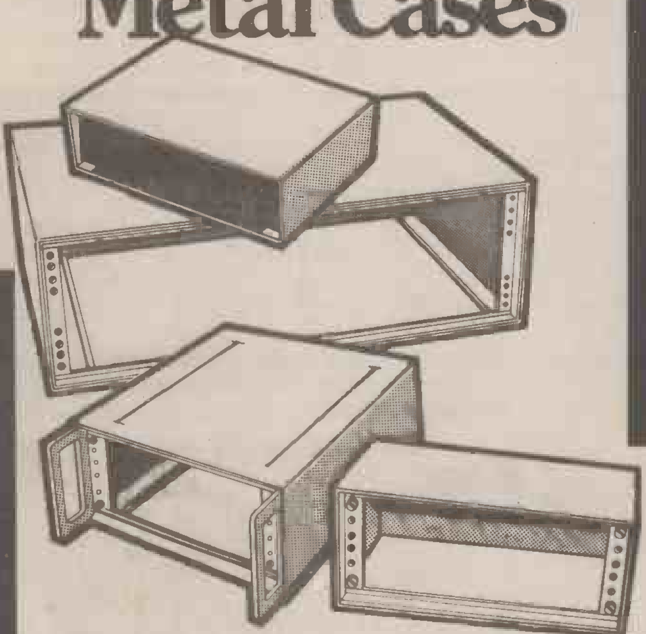

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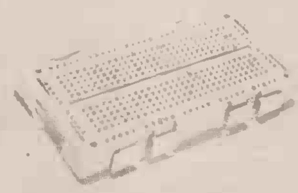

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Electronic Ignition

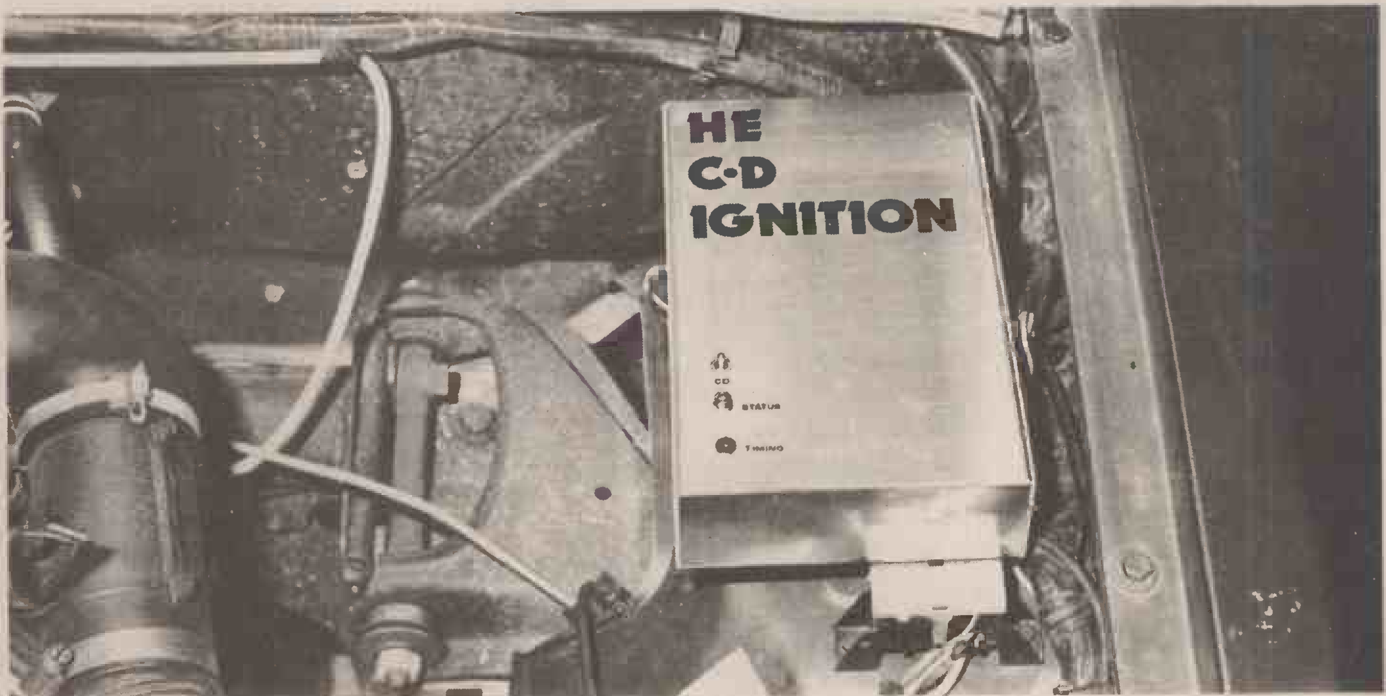
A first-class capacitor-discharge ignition unit that can be easily fitted to any 4- or 6-cylinder negative ground car engine. The unit has built-in goodies like status and timing lights, pre-settable RPM limiting, automatic fail-safe circuitry and remote change-over switching.

CONVENTIONAL IGNITION SYSTEMS work by inductively storing energy in the ignition coil when the contact breaker (CB) points are closed and then releasing this energy (at a high voltage level) to the spark plug when the CB points open. These simple 'inductive discharge' systems suffer from a number of disadvantages. The available spark energy and voltage falls to low (and sometimes inadequate) levels and under cold-start conditions. The high inductor charge currents and heavy kick-back voltages cause excessive CB points burning and wear. Most important, the relatively long rise times of the ignition waveform (typically 100 uS) make the system very susceptible to total energy loss under fouled-plug and damp-weather starting conditions.

Capacitor-discharge electronic ignition systems, by contrast, work by storing energy in a capacitor (charged to 300 volts or so) between ignition cycles. This energy is then released to the spark plugs via a 100:1 step-up transformer (the existing, conventional ignition coil) each time the CB points open. The energy is released via a fast-acting silicon controlled rectifier (SCR), which in turn is triggered via the CB points at a 12 volt, 250mA level.

CD ignition systems offer several practical advantages over conventional systems. CB points burning is eliminated and wear reduced. Available spark energy and voltage do not degrade significantly under cold starting conditions, so cold-start performance is improved. Most important, the very fast rise time of the ignition waveform (about 5 uS) ensures that the spark does not degrade significantly under fouled-plug and damp-weather starting conditions. The system also gives improved ignition or 'firing' characteristics and consequently gives a slight improvement (2-5%) in fuel economy.

The HE CD ignition system described here can be used on all 4- and 6-cylinder 4-stroke engines fitted with 12 volt negative-ground electrical systems. Our unit is



The CD ignition installed and ready for use. This system has already given many thousands of miles of trouble-free motoring.

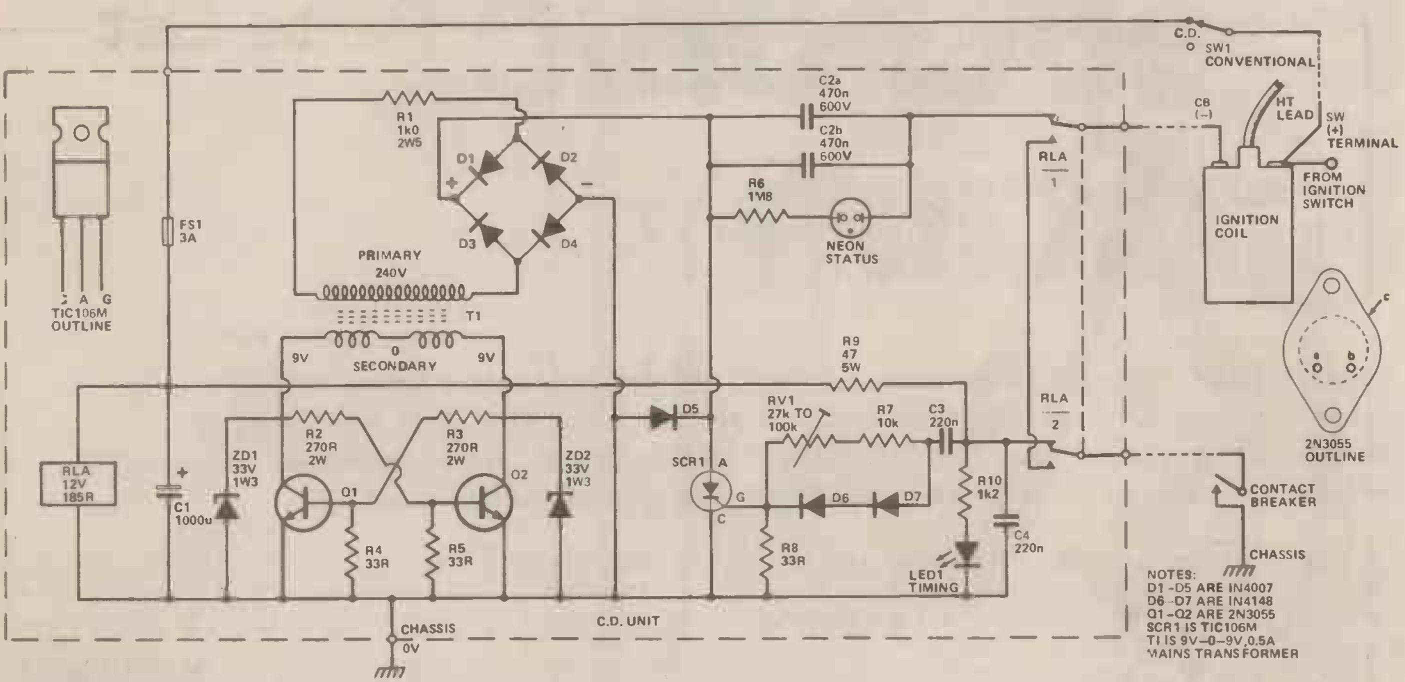


Fig. 1. Circuit diagram of the HE CD ignition system.

How it Works

The circuit can be broken down into four basic sections, a low-voltage (14 volts) to high-voltage (about 350 volts) DC-to-DC converter, an energy-storage section, a trigger/discharge section and a relay fail-safe/mode-selector section. The DC-to DC converter is used to charge the energy storage capacitor to about 250-350 volts and the trigger/discharge section is used to direct this energy to the spark plugs via the ignition coil (which is used as a simple step-up transformer) as the contact breaker (CB) points open in each cycle.

The converter section is designed around T1-Q1-Q2 and the associated components. T1 is a standard 9 V-O-9 V 0.5 amp mains transformer. Q1 and Q2 are connected to the T1 primary terminals and cross coupled via R2 and R3 so that they act as a high power astable multivibrator which feeds anti-phase square waves to TI primary. The primary circuit is powered from the vehicles battery supply (typically 14 volts under running conditions) and the astable action is such that double this voltage appears alternately on the collectors of Q1 and Q2 during the astable action. The astable waveform has considerable leading-edge overshoot and zener diodes ZD1 and ZD2 are used to limit this overshoot to safe values.

The astable voltage is stepped up to about 350 volts at D1-D4 bridge. The resulting dc is used to charge energy storage capacitors C2a-C2b, which have one side effectively taken to the battery positive line via the ignition coil. Resistor R1 and the output impedence of T1 limit the peak charging currents to safe values. The neon lamp wired across the energy storage capacitors is used to indicate their status and also to slowly discharge them when the ignition unit is switched off. Note that, because of the overshoot characteristics of the Q1-Q2 astable, the circuit is capable of producing a considerable capacitor charge even under low-voltage 'cold start' conditions.

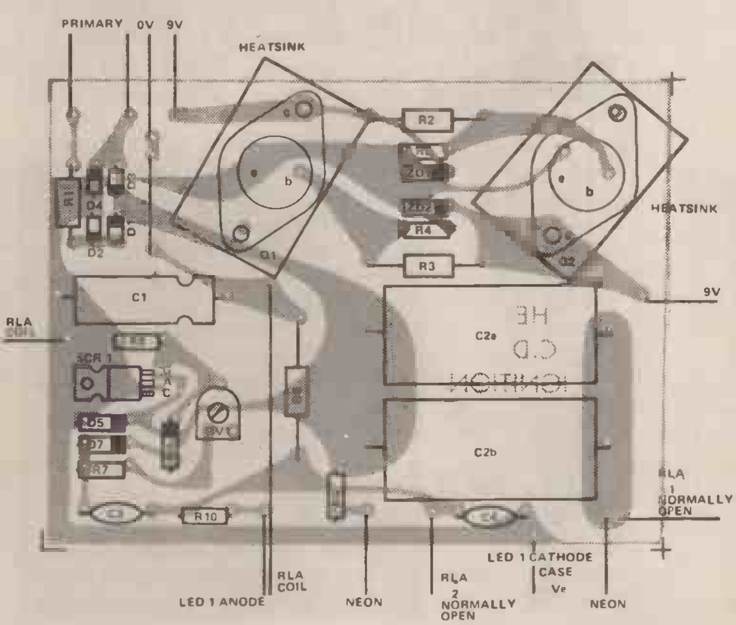
Silicon controlled rectifier SCR1 is used to discharge the storage capacitors as the CB points open. A current of about 250mA is fed through the CB points when they are closed. As the points open a brief trigger pulse is fed to the SCR gate via C3-D6-D7 and causes the SCR to turn on and discharge C2 into the ignition coil primary. Under this condition C2 and the ignition coil form a resonant circuit and the resulting backswing is 'captured' by D5 and automatically turns the SCR off after 100 uS or so, thereby completing the operating cycle: the total ignition cycle lasts for about 200 uS.

Returning to the CB 'trigger' action, assume that C3 is fully discharged just prior to the CB points opening. As the points open C3 charges rapidly via R9-D6-D7 and feeds a trigger pulse to the SCR gate. When the CB points close again C3 starts to discharge via RV1 and R7 and R8. If C3 has not discharged by the time the CB points re-open, a new trigger pulse will not be fed to the SCR gate. Thus, RV1-R7 act as a bounce-suppression network and can also be adjusted to prevent triggering beyond a certain CB operating frequency: they thus act as an RPM limiter. Light-emitting diode LED1 illuminates when the CB points are open and can thus be used as a static timing light.

Final points to note about the circuit are that it's converter section is designed to give adequate operation up to 6000RPM on a 6-cylinder (9000RPM on a 4-cylinder) 4-stroke engine and its trigger/discharge section is designed to give cold-start triggering at battery voltages down to 6 volts.

Fig. 2. Above. PCB layout for CD ignition.

Fig. 3. Below. Overlay diagram — ensure the relay is connected the right way round.



Parts List

RESISTORS:
R1, 1k0 2W5
R2, 3, 270R 2w
R4, 5, 8, 33R
R6, 1M8
R7, 10k
R9, 47R 5W
R10, 1k2

POTENTIOMETERS:
RV1, 10k horizontal preset

CAPACITORS:
C1, 1000u 25v electrolytic
C2a+b, 470n 600V dubilier
C3, 4, 220n polyester

SEMICONDUCTORS:

Q1,2,	2N3055
SCR1,	T1C106M
D1-5,	IN4007
D6-D7	IN4148
ZD1, 2	33V 1W3
Led 1	0.2" dia. red led.

MISCELLANEOUS
T1, 9-0-9 600mA
2 off heatsinks drilled for to3
Neon
SW1 SPDT toggle
FS1 3A +holder
Relay DPCO coil 185R (continental style)
Case aluminium box, size 8½" × 5½" × 2"

Buylines

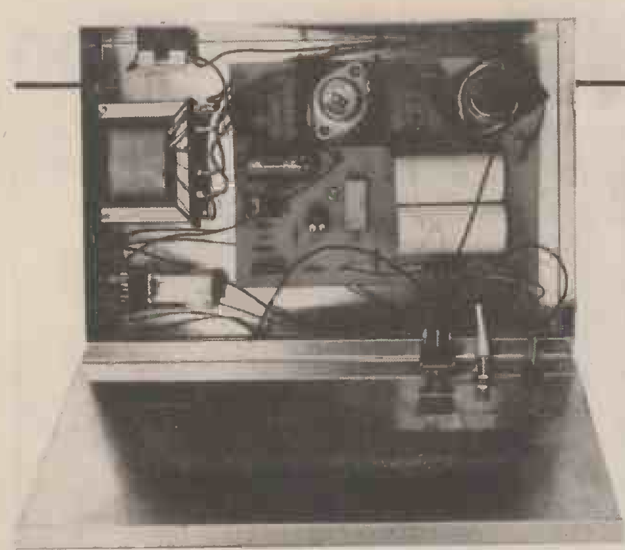
The transformer was obtained from Electrovalue, order as GP909.

A selection of aluminium boxes are available from H. L. Smith & Co. Ltd, Edgware Road. All other components are common types and should present no problems.

designed for easy fitting and uses only four external connections. The design, which has been subjected to several thousand miles of actual and simulated road testing, incorporates a number of unusual 'goodies'. It has a built-in 'status' light to indicate correct functioning and a LED indicator that can be used as an ignition timing aid (the LED illuminates when the CB points open).

Our unit also incorporates a pre-settable RPM limiter. A relay is used to change the circuit connections from 'conventional' to 'capacitor-discharge' ignition and can be activated via a remotely mounted panel switch. The CD unit is fuse-protected and the relay automatically reverts to the 'conventional ignition' mode in the event of fuse failure, thus giving fail-safe operation.

These features should ensure many thousands of trouble free miles.



We recommend that the PCB be covered in wax or varnish to reduce the vibration damage.

CONSTRUCTION AND USE

This project has been designed with ease of constructon in mind and no attempt has been made to miniaturise the unit. All components except the relay and transformer are mounted on a single PCB as shown in the overlay. Use only the specified components (see Buylines) and take care to observe the polarities of all semiconductor devices and electrolytic capacitor C1. Gives RV1 an initial value of 100k.

When the PCB construction is complete fit the PCB, relay and transformer into a suitable metal box and complete the interconnections, taking special care to see that no short circuits occur between the circuitry and the case. You can then give the unit a functional check as follows, after first settig RV1 to the minimum resistance position.

Place the unit loosely in the vehicles engine compartment, remove the existing CB-to-coil connections and then connect the unit's four output leads as shown in the diagram. One lead goes to chassis, one to the ignition coil's 'SW' or '+' terminal, one to the CB points and one to the coil's 'CB' or '—' terminal. When the connections are complete, switch on the ignition. If all is well the neon will light and the unit will emit a whistle sound. Operate the vehicles starter switch. The engine should start easily and run smoothly. Check that the ignition reverts to 'conventional' operation when the connection to the coil's 'SW' terminal is broken.

If everything is OK, bolt the unit into place in the engine compartment, as close to the coil as possible. Switch SW1, used to connect the unit to the coil's 'SW' terminal, can be mounted on the vehicle's instrument panel. If you wish to use the unit's 'RPM LIMIT' facility, raise the engine revs to the desired limit value and then adjust RV1 so that misfiring just starts to occur: if necessary, change the value of RV1 so that limiting occurs with RV1 at approximately mid value.

If your vehicle is fitted with a CB-activated tachometer, the tacho will probably work perfectly well with the CD unit. If you have a Smiths or similar 'impulse' tacho, you may have to wind a few turns of wire around the ignition HT lead to form a suitable impulse pick-up point. One side of this pick-up goes to ground and the other to the tacho input. **HE**

Clever Dick

Thanks for all the translations, we continue in this foreign theme with a query on Russian transistors. Plus some more comments on 'medical' circuits

WE RECEIVED literally dozens of replies to our request for a translation of the article we printed last month. As promised the first reply (from Holger Hasenstrauch, surprise, surprise) has won a genuine HE Binder. The standard was extremely high, this we determined by the similarity between different submissions. Now for the bad news, the article was so boring that we are both to waste space in printing the correct translation. Suffice to say that according to the 'Luxemburger Wort' Negative Ions are actually dangerous, to the extent of causing certain bronchial ailments. The article goes on to quote a couple of impressive sounding sources and leaves little doubt as to the nature of Negative Ions. Who do we believe? Ah well, thanks to everyone who took the trouble to write in, we'll try and find something a bit more interesting next time.

Now back to more pressing matters.

A couple of months ago Dr R N C Douglas wrote to us about the possibility of publishing some 'medically' orientated circuits. If you can remember back that far you may recall our doubts regarding the legality of these circuits. Well, to cut a long story short we're still no wiser. However, it was apparent from the letters we received that circuits in this vein would be most welcome. Here are a couple of extracts from these letters. The first is from Richard Marengo.

Dear Dick,

I share Dr R N C Douglas's interest in physiological measurement but not your concern for safety. According to a text book on psychophysiology (Masset J, a Primer of Psycophysiology, San Francisco, W M Freeman and Co, 1978), which my class was recommended at undergraduate level, there is an enormous change in voltage (≃1mV) from one side of the body to the other on each beat of the heart. It would not be at all dangerous to measure this change at any two of the three points on 'Einhovens Triangle! . . .

Richard Marengo
Birmingham

Richard does go on to explain a couple of other interesting phenomena but space is sadly limited. From what he says though this Masset book looks like required reading, we'll try and get hold of a copy.

By the way Richard does explain Einhovens Triangle, it is an imaginary triangle drawn across the body from wrist to wrist and meeting at one of the two legs. These are the optimum positions for such measurements.

Our second letter comes from Brian Audley, he writes:

Dear Dick,

How about producing a pulse rate monitor. There are so many people these days to keep fit by various methods, many of which require one keeping an eye on one's pulse rate. I'm sure such a circuit would create a lot of interest.

Brian Audley
Portstewart
Northern Ireland

These two letters, and the many others we received all agreed, circuits that monitor bodily functions *are* popular. We are forced to conclude that a design or two along these lines would not come amiss. Look out for them in the coming months.

Now to more down-to-earth matters. Peter Boyle has had some problems with transistors.

Dear Dick,

I have a Russian Radio (''Astrad'' model) which is unserviceable due to some faulty transistors. They are marked ┌ T 322A 3 71 (equivalent to GT 322A 3 71).

I have asked many people — including exhibitors at the recent Breadboard Exhibition — what the present day equivalent transistor is and where it might be obtained, without success.

I would be grateful if your experts could help with any information.

Peter Boyle
Windsor

This one did cause a little bit of trouble. None of our reference books could shed any light (although we did get close to it and have a good idea of the specs). Our second recourse was to try the Russian Embassy. They referred us to their Trade Legation who referred us to a very helpful lady at a company called Technical and Optical. It appears that they carry large stocks of spare parts for Russian equipment and are only too happy to help anyone out with this sort of problem. Although we were still unable to sort out a direct European or American equivalent for this transistor they did tell us that they stock a Russian equivalent at their shop, this is the RT322B. Technical and Optical can be found at Zenith House, The Hyde, Edgware Road, in London. Don't all go russian over there at once, you can give them a tinkle on 01-200 6505.

Jon Thompson writes to us after having an unfortunate experience with his car and some light fingered gentlemen.

Dear Clever Dick,

After having an expensive radio and large portion of the *dashboard ripped from my car I have just finished constructing and installing an incredibly devious, totally unbeatable (I hope) alarm system. However, the 100,000 dB siren that I invested in is somewhat inaudible above the din of the juke-box in my local Ale-house.*

I would like to add on to the alarm system a radio with pocket receiver of the type currently being advertised for the extortionate price of £70-£80. Can you provide constructional details of a simple R/C transmitter and receiver, I know I need a licence.

Jon Thompson,
South Yorkshire.

Some time ago we were approached by a gentleman with a similar idea. He had even gone to the Home Office with his prototype to enquire if there would be any problems licensing his system. He was using the 27 MHz R/C band so there should have been no problems on that score, or so he thought! It turned out that his idea was fine, trouble was, as he was using the radio control band, the TX/RX combination may not be used for the transmission of messages, only the control of models. The helpful gentleman at the Home Office did have one suggestion to get round the regs. His modification to the receiver included a small motor with a miniature aircraft attached to a little wire. If the thief activated the alarm the little aeroplane would start to whizz around on top of the receiver. This had another bonus, the thief probably wouldn't have a R/C licence and they could 'do' him for unauthorised transmitting as well as car theft.

But that doesn't help you, all we can say is have a look at our R/C system that will be making an appearance (hopefully in the June issue), maybe you could modify that.

Last but not least we have a request from Shaun Donelly for a speedometer design. Can we help? Of course we can!

Dear Dick,

I am now studying for my 'O' level course in Technology. I am designing an electronic speedometer for a bicycle. Do you think you could give me the address of any firms that manufacture such devices?

Shaun Donelly,
Bedford.

CD to the rescue. We have a couple of ideas for you. Why not modify the LED Tachometer in the August '79 issue? You will need to employ a sensor system on one of the wheels to act as a trigger input. The only real problem is likely to be calibration. You will need to know how far you travel for each revolution of the wheel and adjust the timing period of the range capacitors C2 and C3 accordingly. If you despair why not have a word with the British Cycling Bureau who organised a 'Bike of the Future' competition last year. The winning entry was an electronic speedometer. By the way, the August issue is now unavailable but the LED Tacho, along with 24 of our best projects are now available in the new Hobby Electronics Projects Special. See the ad in this issue for more details.

We've run out of space and time again so, keep the letters coming (and please try to keep them short). See you next month. **HE**

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HE proudly presents HOBBYCOM, a multiple station, two-wire intercom with call facility — a project to talk yourself into.

THE BASIC HOBBYCOM is a master station intercom which is a completely self-contained mains powered unit. This saves the necessary and costly replacement of batteries which seems to come round with sickening regularity in battery powered equipment.

Hobbycom is a four sub-station intercom although constructional hints are given later to adapt the intercom system to more than four channel ie. 8, 12 or more. Each sub-station consists only of one loudspeaker, one push-button switch and one capacitor and is connected by cable to the master unit.

In our efforts to keep down the cost of the intercom we hit upon a design which allows the use of two-wire connections. A lot of other designs use three wire (mains cable) connecting wire but as the price of such cable is more than three times the price of the two-wire variety, our Hobbycom is obviously superior to these designs, remembering that in a typical installation of Hobbycom about 100 metres of wire will probably be used.

The call facility allows the user of any one of the substations to call the master station user, or vice versa, quite a useful addition to the plain intercom.

CONSTRUCTION

Construction is, as usual in HE, straightforward if our PCB designs are used. There are of course, two boards — one for the main circuit and one for the switch circuitry (shown inside the broken lines on the circuit diagram). Neither should present problems.

Ensure that all semiconductors are inserted correctly. It is perhaps advisable to use IC sockets for the DIL integrated circuits. Electrolytic capacitors should also be checked for correct insertion before switch on.

Always, when dealing with mains powered equipment be extra careful. It only takes one mistake! You might not live to make another.

If you follow the overlay diagrams when wiring up the two boards no difficulties should arise as all connections are adequately shown. Connections to the remote stations can be made using any suitable plug and socket arrangement eg. banana type, or possibly the clip-on-type speaker connections which are available. As the lead to the remote station does have to be polarised then

Our receptionist Tracy Cambell using the Hobbycom. Will it ever replace the telephone?

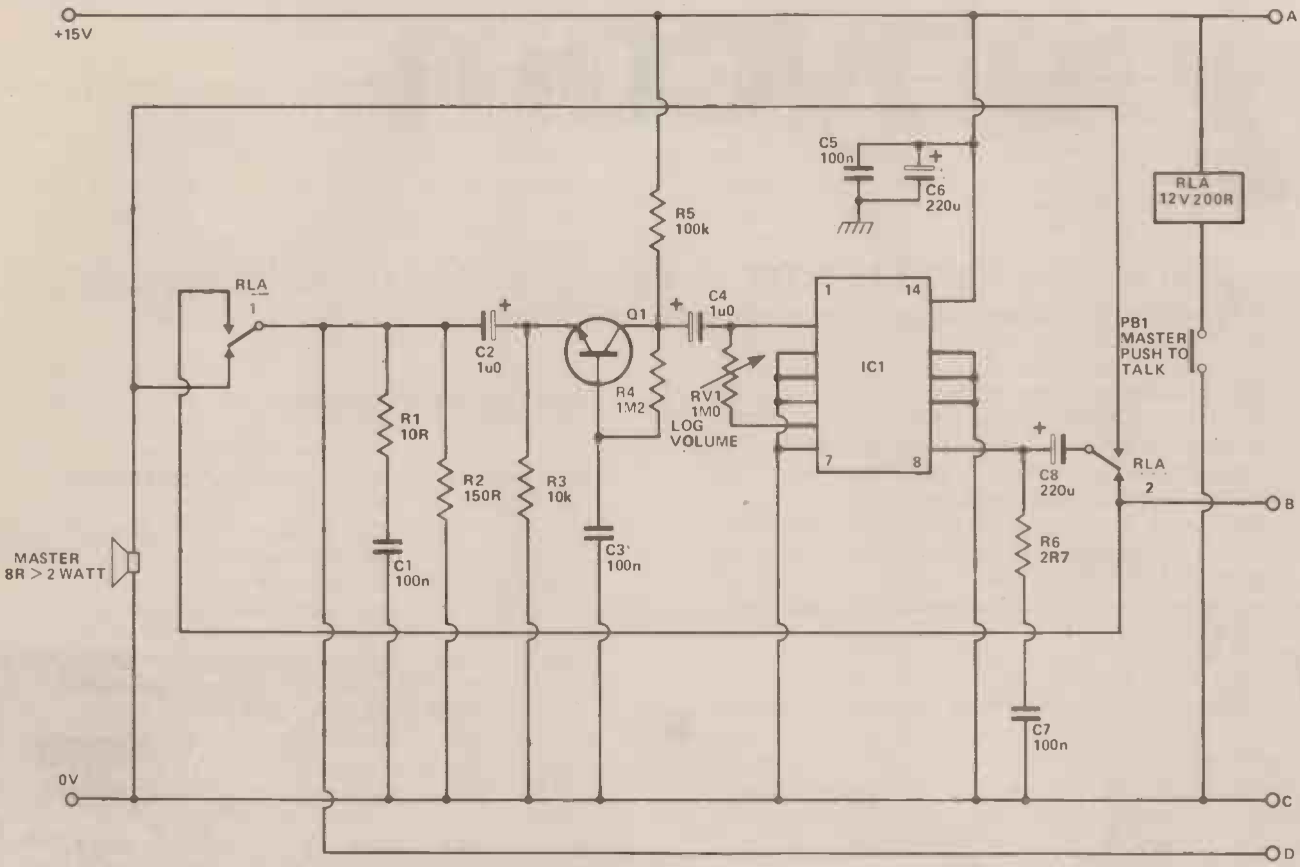
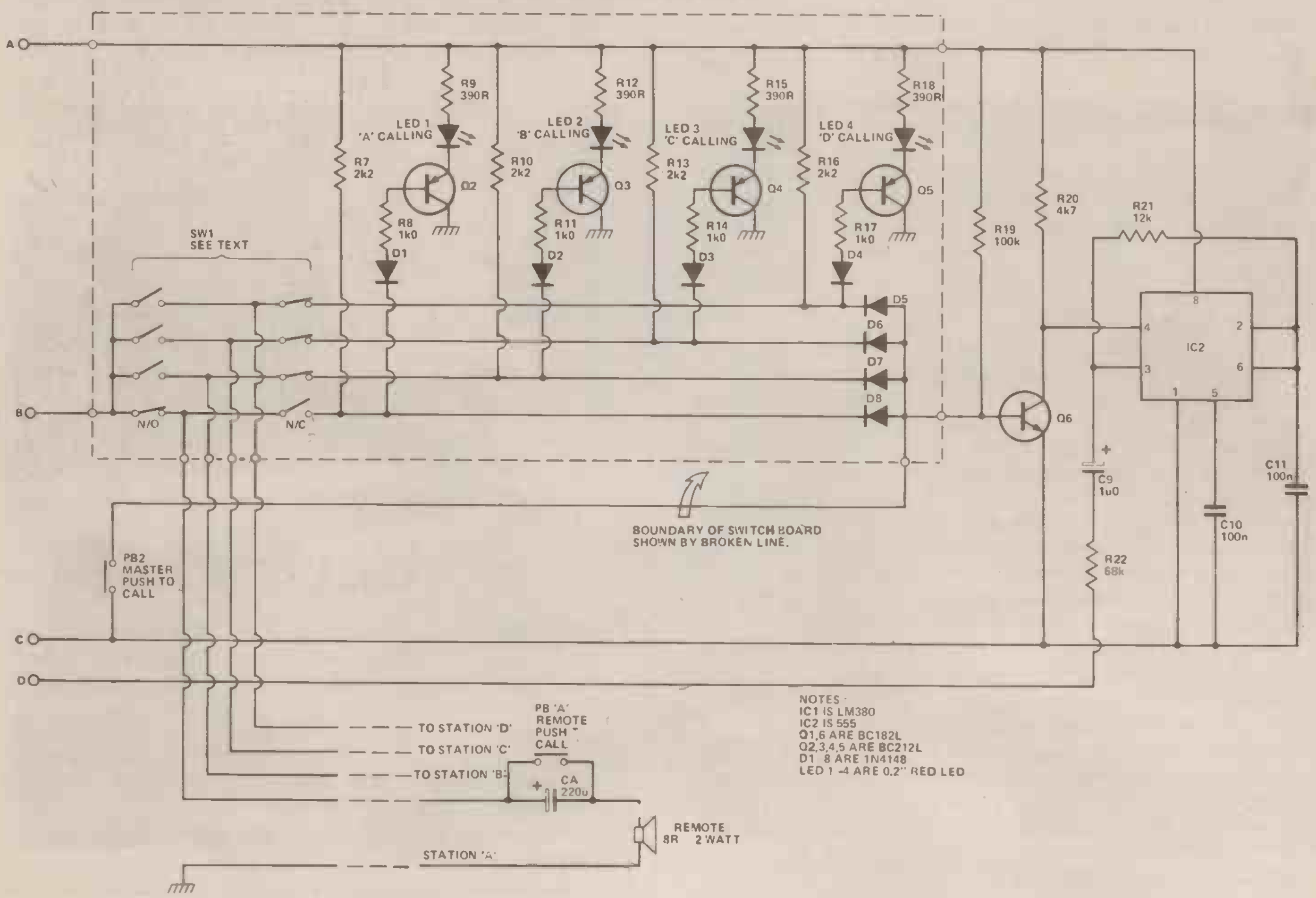


Fig. 1. Circuit diagram of the Hobbycom. Don't forget to join points ABC and D



How it Works

The amplifier is formed around a standard LM380 two watt power amp IC. This device should be easily recognisable to our regular readers. A speaker of the type used in this circuit has a low O/P whilst the I/P to the IC needs to be quite high. To match the two the circuitry around Q1 is needed.

Relay RLA is in the circuit simply to alleviate the normal wiring problems encountered with changeover between I/P and O/P speakers. All of the complicated interwiring is on the copper track of the circuit board and changeover is now performed by activating the relay with the use of a simple push button switch PB1.

The bank of switches which make up SW1 connect the master station to one of four remote sub-stations. Simultaneously, SW1 also connects the remaining three sub-stations to the corresponding three remaining I/Ps of the LED generator formed around Q2 — 6 and circuitry. These I/Ps are also paralleled to the I/P of the call generator. At any time, these two parts of the circuit allow a sub-station to call the master by means of a push-button switch. In the diagram, station A is shown connected to the intercom whilst stations B, C and D are not. If sub-stations B, C or D contact the master by pushing one of the switches PBB, PBC or PBD then the call generator is enabled, emitting a tone to the master thus attracting his attention. The corresponding LED 2, 3 or 4 will also light, telling the master which sub-station is calling. The LED will stay lit for a few seconds before going out.

The power supply is mains to DC and makes use of a 15 V voltage regulator IC to give a steady voltage to the rest of the circuit.

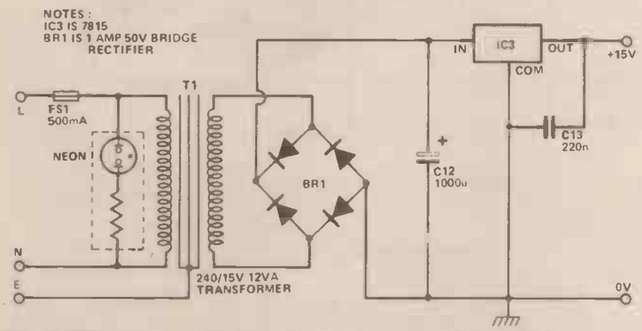


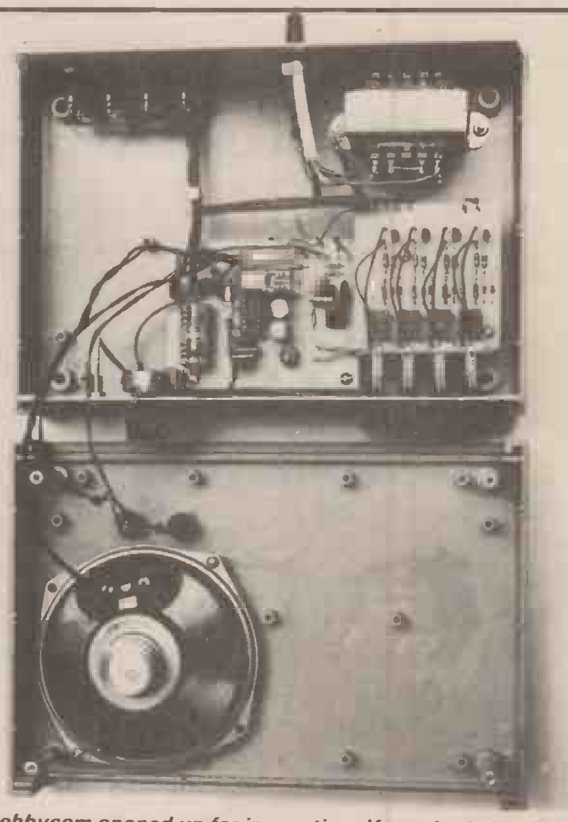
Fig. 2. PSU circuit diagram for the Hobbycom. Battery operation is not advisable.

whatever connecting arrangement you use will need to be coloured to differentiate between the two leads.

When you are ready to test, do so without IC1 and 2 in place. The only reason for this is their cost of replacement if you have a serious fault. Turn on the power and carefully measure the voltage between the power supply output pins from the main board, it should be 15 V DC ± 0.5 V. If you find anything else then check the circuit again. If all is well, however, then insert the remaining parts and test the whole circuit. Remember that with both master and a remote station in the same room you will almost certainly get loud feedback. The only way to eliminate this is to separate them completely.

Some of our quicker readers will no doubt have noticed that as the I/Ps and O/Ps to and from the switches on the switch board are paralleled then more than one switch board can be used. ie. two switch boards give eight stations, three give twelve etc. This is perfectly true and more than one can be used, with one constraint. The banks of switches between separate switch boards will not be interlocking, meaning that the master can be connected to more than one remote station simultaneously. Apart from heavily loading the amplifier this also means that a supposedly private conversation between master and a particular sub-station may not be quite as private as you thought.

Alternatively, the Hobbycom can be adapted to a 1, 2 or 3 sub-station intercom by omitting 3, 2 or 1 of the switches on the switch board.



The Hobbycom opened up for inspection. If required a small box could easily be used.

Buylines

We obtained our relay and bank of switches SW1, from Watford Electronics, but no doubt readers will probably be able to find alternative suppliers if they wish.

The case we used for the master station is type CTB 1, which is available from Continental Specialties. Our sub-station cases were also from Continental Specialties, type DMC-2.

All other components should be easily found at your local stockist.

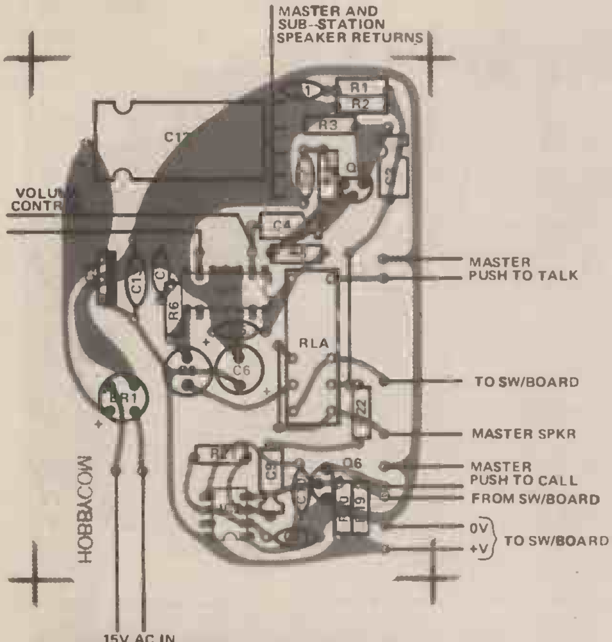


Fig. 3. Overlay for main board.

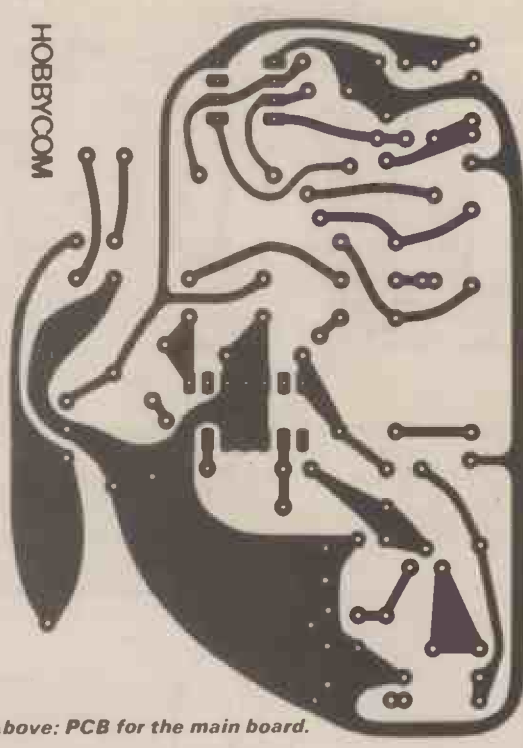


Fig. 4. Above: PCB for the main board.

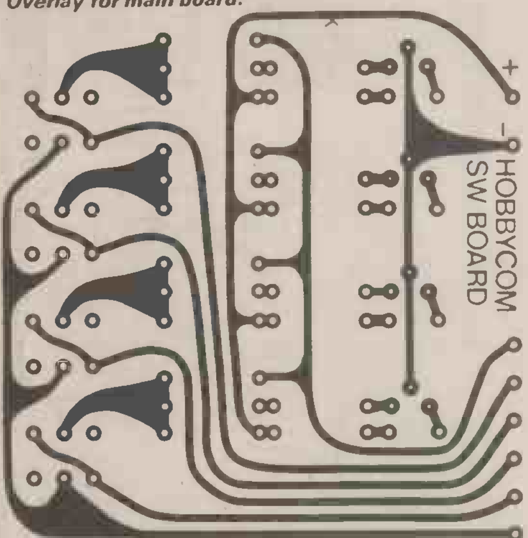
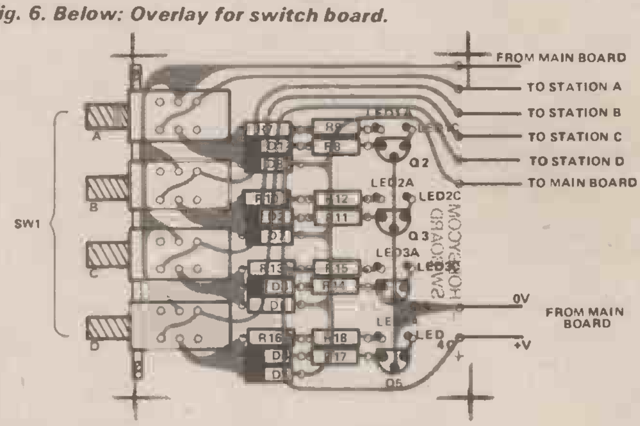


Fig. 4. PCB for the switch board.

Fig. 6. Below: Overlay for switch board.

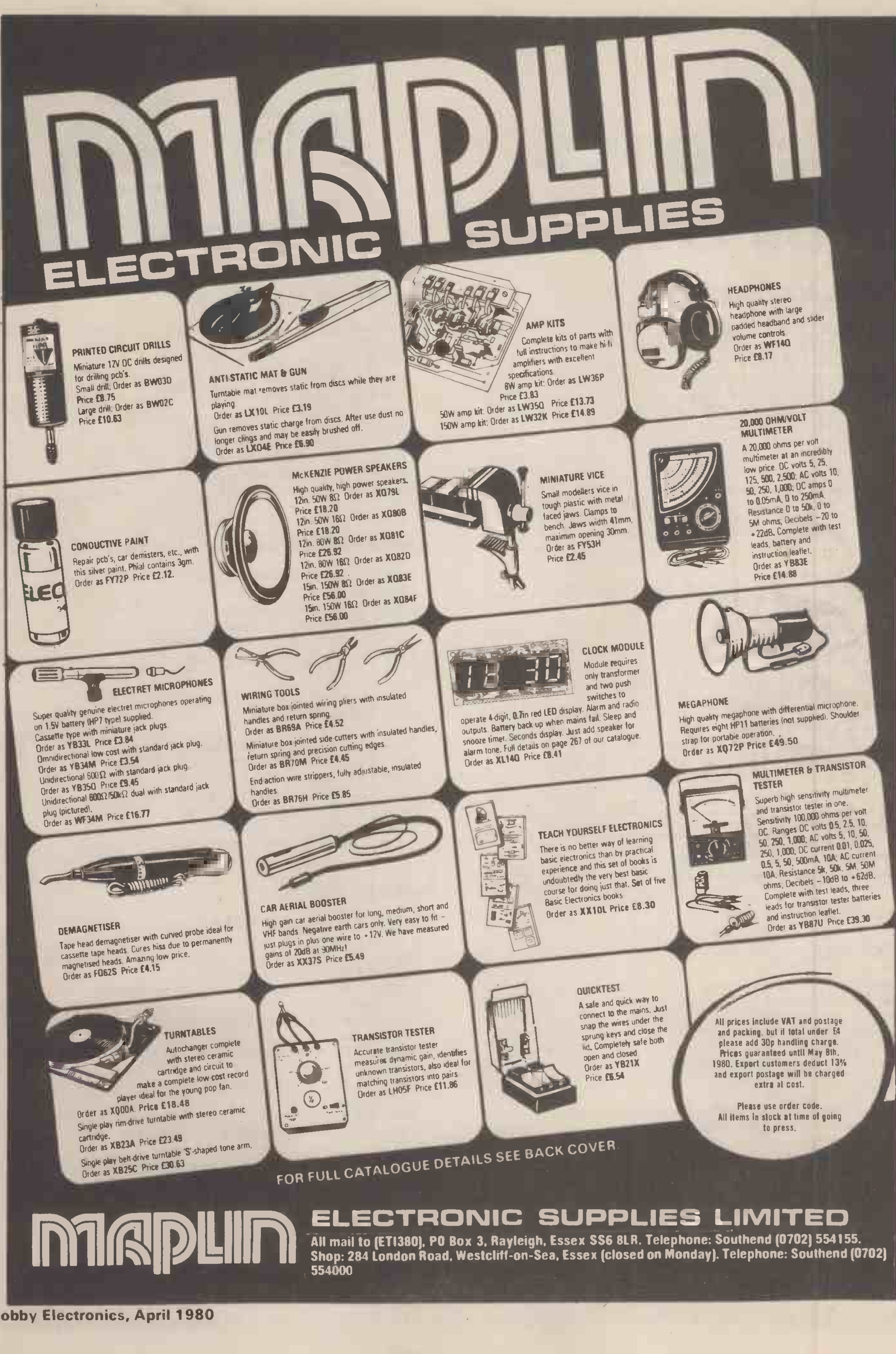


Parts List

RESISTORS (All ¼ Watt, 5%)	
R1	10R
R2	150R
R3	10k
R4	1M2
R5, 19	100k
R6	2R7
R7, 10, 13, 16	2k2
R8, 11, 14, 17	1k
R9, 12, 15, 18	390R
R20	4k7
R21	12k
R22	68k
CAPACITORS	
C1, 3, 5, 7, 10, 11	100n Polyester
C2, 4, 9	1u 16 V Elect.
C6, 8	220u 16 V PCB Elect
C12	1000u 25 V Elect.
C13	220n Polyester
C A, B, C, D	220u 16 V Elect.

POTENTIOMETERS	
RV1	1M Log
SEMICONDUCTORS	
IC1	LM380
IC2	555
IC3	7815
Q1, 6	BC182L
Q2, 3, 4, 5	BC212L
D1-8	1N4148
BR1	1A 50 V Bridge Rectifier

MISCELLANEOUS
2 × 8R greater than 2 watt speakers
RLA 12 V 200R P.C. mounting relay
PB1, 2, A, B, C, D momentary action push button
SW1 bank of four, interlocking, 2 pole C(O signal switches + knobs
T1 Mains to 15 V 12 VA transformer
FSI + panel mounting holder
Neon, case and knob to suite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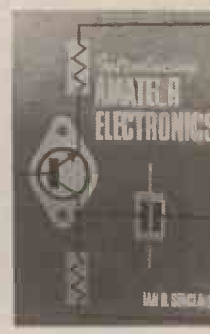

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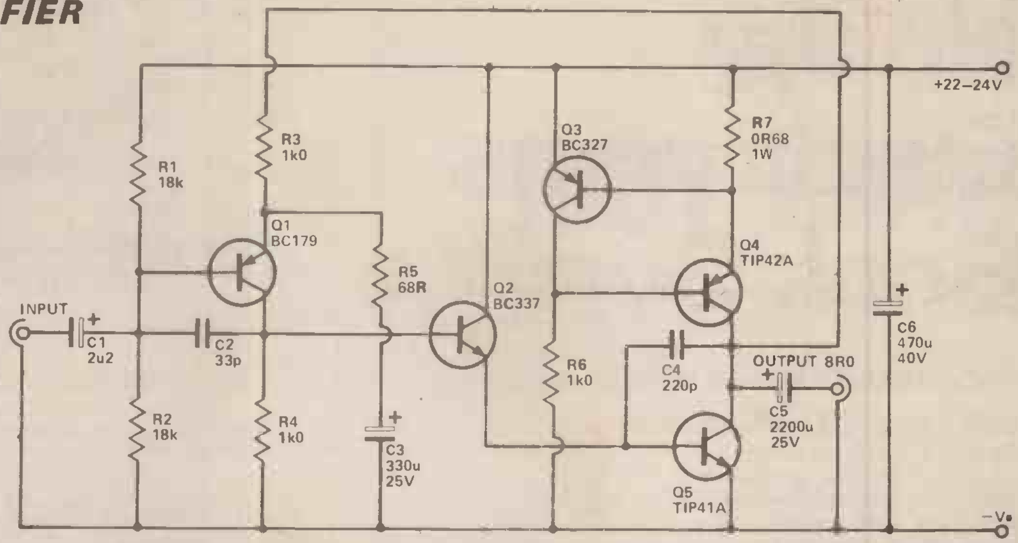
Short Circuits

CLASS A AMPLIFIER

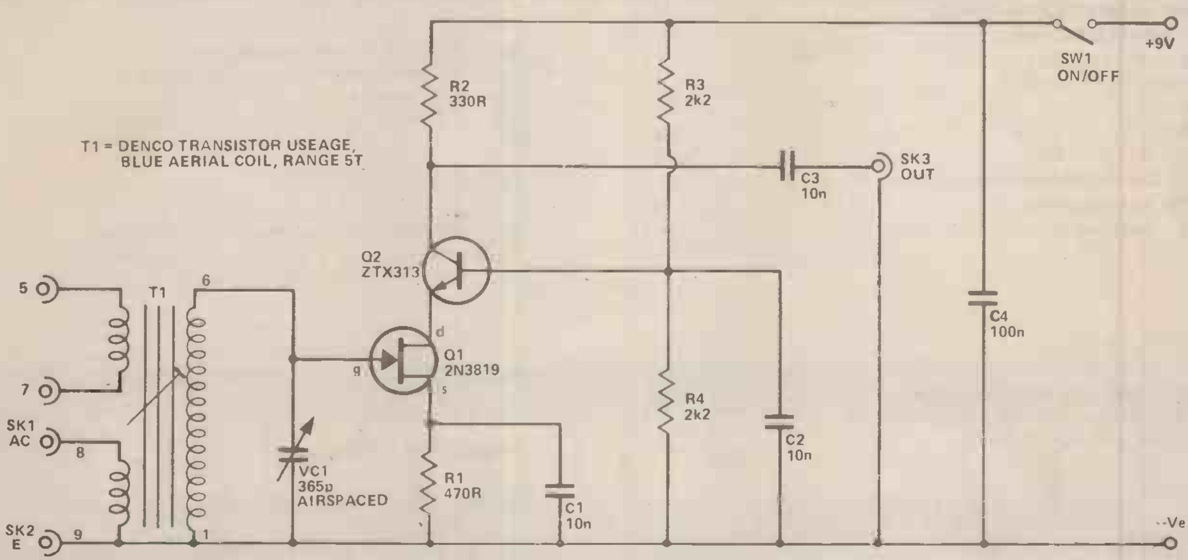


One problem with conventional (class B) audio power amplifiers is that they produce increased distortion at low output powers. The type of distortion produced is a particularly noticeable type known as crossover distortion. One way of totally overcoming this problem is to use a class A amplifier, and designs of this type produce no crossover distortion whatever. Unfortunately, the efficiency of Class A designs is considerably less than that of Class B designs, which is probably the main reason that Class A designs are a rarity these days. This design gives an output power of about 4.1 watts RMS into an 8 ohm load, but requires a supply of about 22 to 24 volts at 1 amp. (some 22 to 24 watts). This gives an efficiency of only about 19% at best, which is less than a third of the efficiency of many Class B designs.

However, this circuit does give good quality despite its simplicity, and is an interesting design for those who like to experiment with unusual circuits. Q1 is used in the common emitter input stage, and it is direct coupled to the output stage via emitter follower buffer transistor, Q2. The latter is needed because of the fairly high drive current required by the output stage. Q5 is the output transistor, and it is employed in the common emitter mode. It has a constant current source as its collector load, and this is formed by Q3, Q4, and R7. The latter sets the output current of the circuit at nominally just under 1 amp. The constant current generator load gives better efficiency than simply using a load resistor, and also gives good linearity.

R3 gives virtually 100% negative feedback over the amplifier at DC, giving unity voltage gain. By biasing the input to half the supply voltage using R1 and R2, the output is also biased to the required level of half the supply voltage. R5 and C3 decouple some of the feedback at audio frequencies, giving the circuit a sensitivity of about 380 mA. RMS for maximum output. C2 and C4 aid stability, while C1 and C5 provide DC blocking at the input and output respectively.

Q4 and Q5 must be mounted on a substantial heatsink.



10 TO 30MHz PRESELECTOR

Many older or less expensive SW receivers give a relatively poor level of performance on the high frequency bands where their sensitivity falls away somewhat. One way of improving the high frequency performance of such a set is to add a preselector at the input. A preselector is a tuned RF amplifier which boosts the aerial signal before it is fed to the receiver. Apart from giving improved sensitivity, the decreased RF bandwidth provided by the unit also helps to attenuate any spurious responses of the receiver.

The aerial signal is taken to the low impedance primary winding of T1, and from here it is induced into the main, tuned winding. VC1 can be used to resonate the tuned circuit at any frequency between about 10 and 30MHz, and all the HF bands fall within the coverage of the unit. Of course, in practice VC1 is simply adjusted to peak received signals, and is the tuning control of the unit.

Q1 is a JFET which is used in the common source mode, and has R1 and C1 as its source bias resistor and bypass capacitor respectively. It directly drives the input of Q2, which is an ordinary bipolar device which is used in the common base mode. This has R2 as its collector load, R3 and R4 to provide base biasing, and C2 as the base decoupling capacitor. This two stage amplifier is a form of "cascode" circuit, and gives good performance at the fairly high frequencies involved here. The voltage gain of the circuit is well over 20dB. C3 provides DC blocking at the output of the unit.

Construction of the unit is not critical, but try to keep all the wiring reasonably short. As supplied, the core of T1 is fully screwed into the former, and in order to obtain the correct frequency coverage the core must be unscrewed so that approximately 10 mm of metal screwthread protrudes from the top of the coil. T1 can be mounted in a B9A valveholder incidentally. The twin lead connecting the output of the preselector to the aerial and earth sockets of the receiver should be reasonably short (no more than about 1 metre) in order to minimise losses.

The current consumption of the circuit is approximately 5 mA.

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4002	20p	4027	45p	4071	20p
4007	20p	4028	85p	4072	20p
4009	40p	4029	85p	4081	20p
4011	20p	4040	110p	4093	50p
4012	20p	4041	85p	4510	80p
4013	35p	4042	80p	4511	90p
4015	80p	4043	95p	4518	80p
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7404	12p	7486	20p	74157	40p
7408	12p	7490	25p	74164	55p
7410	10p	7492	30p	74165	55p
7413	22p	7493	25p	74174	55p
7414	39p	7496	45p	74177	50p
7420	12p	74121	25p	74190	50p
7430	12p	74123	38p	74191	50p
7432	18p	74125	35p	74192	50p
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DL707	0.3 in CA	130p	120p
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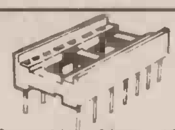

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8pin	8p	18pin	14p	24pin	18p
14pin	10p	20pin	16p	28pin	22p
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3 lead T018 or T05 socket. 10p each
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2.5 x 3.75	45p	45p	
2.5 x 5	54p	54p	Pin insertion
3.75 x 5	64p	64p	tool 108p
3.75 x 17	205p	185p	
Single sided pins per 100	40p	40p	

Top quality fibre glass copper board Single sided. Size 203 x 95mm 60p each
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Carbon film resistors. High stability, low noise 5%
E12 series 4.7 ohms to 10M. Any mix

	each	100+	1000+
0.25W	1p	0.9p	0.8p
0.5W	1.5p	1.2p	1p

Special development packs consisting of 10 of each value from 4.7 ohms to 1 Megohm (650 res) 0.5W £7.50 0.25W £5.70.

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0.25W	4p	3.5	3.2

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		LM324	45p	NE555	23p
		LM339	45p	NE556	60p
		LM348	90p	NE567	100p
		LM377	170p	RC4136	100p
709	35p	LM378	230p	SN76477	230p
741	16p	LM380	75p	TBA800	70p
747	45p	LM381	150p	TBA810S	100p
748	30p	LM382	120p	TBA1022	620p
7106	850p	LM3900	50p	TL081	45p
CA3046	55p	LM1458	35p	TL084	125p
CA3080	70p	LM3909	65p	ZN414	80p
LF356	80p	LM3911	100p	ZN425E	390p
LM301AN	26p	MM57160	590p	ZN1034E	200p

TRANSISTORS

				TIP32C	80p
				TIP2955	65p
				TIP3055	55p
		BC548	10p	ZTX107	14p
AC127	17p	BCY71	14p	ZTX108	14p
AC128	16p	BCY72	14p	ZTX300	16p
AC176	18p	BD131	35p	ZTX500	16p
AD161	38p	BD132	35p	2N3053	18p
AD162	38p	BD139	35p	2N3054	50p
BC107	8p	BD140	35p	2N3055	50p
BC108	8p	BFY50	15p	2N3442	135p
BC108C	10p	BFY51	15p	2N3702	8p
BC109	8p	BFY52	15p	2N3704	8p
BC109C	10p	MJ2955	98p	2N3706	9p
BC147	7p	MPSA06	20p	2N3819	15p
BC148	7p	MPSA56	20p	2N3905	8p
BC177	14p	TIP29C	60p	2N3906	8p
BC178	14p	TIP30C	70p	2N5459	32p
BC182	10p	TIP31C	65p	2N5777	50p
BC182L	10p				
BC184	10p				
BC184L	10p				
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TANTALUM BEAD ... each
0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1 & 2.2uF @ 35V ... 8p
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0.15, 0.22 ... 7p
0.33, 0.47 ... 10p
0.68 ... 14p
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63V	0.47	1.0	2.2	4.7	10	5p
			22	33	47	7p
	100					13p
			220			20p
25V	10	22	33	47		5p
	100					8p
		220				10p
				470		15p
	1000					23p

CONNECTORS

JACK PLUGS AND SOCKETS

	unscreened	screened	socket
2.5mm	9p	13p	7p
3.5mm	9p	14p	8p
Standard	16p	30p	15p
Stereo	23p	36p	18p

DIN PLUGS AND SOCKETS

	plug	chassis socket	line socket
2pin	7p	7p	7p
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5pin 180°	11p	10p	14p
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Suitable for low voltage circuits. Red & black.
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Available in blue, black, green, brown, red, white and yellow. Plugs 11p each Sockets 12p each

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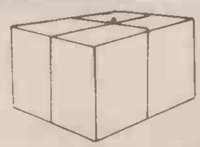
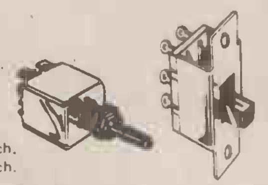
Screened plug ... 13p
Single socket 7p Double socket ... 10p

SPRING SPECIALS



Set of 4 AA (HP7) Rechargeable Cells	~~500p~~	450p
PP3 Rechargeable cell	~~450p~~	410p
Pack of 10 miniature slide switches	~~150p~~	120p
Pack of 10 push to make switches	~~150p~~	120p
Pack of 10 push to break switches	~~200p~~	150p
Murata Ultrasonic Transducers, per pair	~~350p~~	300p
Resistor Development packs.		
10 off, each value from 4.7 ohm to 1M ¼w	~~570p~~	500p
½w	~~750p~~	650p
Polyester Development packs.		
5 off, each value from 0.01 to 3u2	~~620p~~	520p
Preset Potentiometer pack		
5 off, each value 100 ohm to 1M, 65 presets	~~395p~~	305p
Ceramic Development pack		
10 off, each value 22pF to 0.1uF, 310 caps.	~~595p~~	525p
LED pack, 10 off,		
each type 0.2 Red, green, yellow	~~350p~~	300p
Pack of 10 CA3080 Transconductance amps.	~~700p~~	620p
Pack of 10 LM301AN Op. amp.	~~260p~~	230p
Pack of 10 LM380N 2W Audio Amp	~~750p~~	620p
LM380 + LM381 and data	~~235p~~	180p
Pack of 3 LM3909 LED flasher	~~185p~~	150p
Pack of 10 TL081 Jfet Op. amp.	~~450p~~	320p
MM57160 Stac. Timer + data	~~600p~~	550p
SN76477 Sound generator + data	~~240p~~	200p
Pack of 2 ZN414 AM chips	~~160p~~	130p
SS-2 Breadboard	~~1085p~~	990p
Expo Reliant Drill	~~665p~~	570p
Expo Titan Drill	~~1030p~~	920p
Drill stand for above	~~1200p~~	1100p
Pack of 8 2708 Eprom	~~4720p~~	4500p
Pack of 8 2114 Ram LP 300ns	~~3125p~~	3000p
Pack of 8 4116.	~~4560p~~	4300p

SWITCHES



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Subminiature toggle. Rated at 2A.
SPST 52p. SPDT 62p. DPDT 69p.
Standard type. Rated at 1.5A.
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Miniature DPDT 15p each.
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Available in 4 pole 3 way, 3 pole 4 way, 2 pole 6 way, 1 pole 12 way ... 43p each
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Miniature push to make ... 15p each
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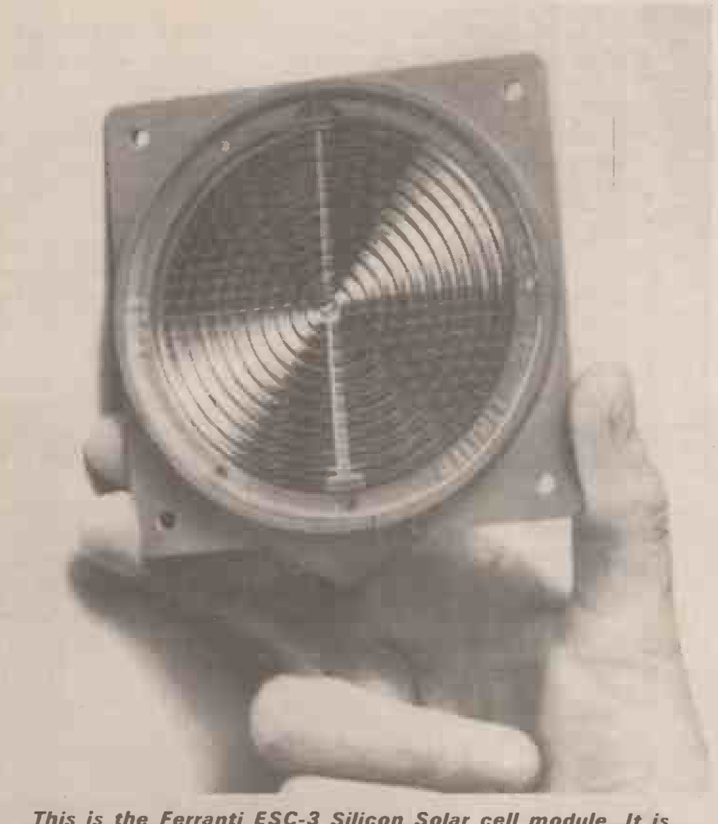
Sunny Side Up

Rick Maybury has some bright ideas and illuminating facts on solar cells. They may be just the thing to give this energy-starved world a sunnier outlook.

FREE ELECTRICITY! Have you just received a large electricity bill? Then read on because we are about to tell you know, for just a few thousand pounds, you can 'cock your snoot' at your local purveyor of electricity.

On a sunny day (even in this country) the old 'currant bun' up in the sky, deposits something like 1 kilowatt of energy on every square metre of ground. Given that a pretty average Solar Cell is about 10% efficient you could expect to collect something like 4.5kW of electricity from a surface area of just 80 square metres, even on a cloudy day. (That is roughly the roof area of a smallish house.) Providing you have some sort of storage system for those dark nights, Lead-acid accumulators would do nicely, you might never receive another electricity bill.

It all sounds so simple doesn't it? Actually it can be, trouble is you would need to have an income approaching the average oil Sheik to afford it. It seems ironic that most solar cells are made from Silicon, one of the Earth's most abundant elements. Unfortunately, to be of any use in solar cells it must be incredibly pure. And that costs money.



This is the Ferranti ESC-3 Silicon Solar cell module. It is primarily intended for experimental use and will deliver 0.5 V at 0.8 A in bright sunlight

RISE AND SHINE

Solar Cells, or to be more precise, Photovoltaic Cells have been around for quite a few years now. The first successful cells were developed in the early 1800s. The material used was based on an element called Selenium, conversion efficiency in those days was pretty dire, in the order of 0.025% on a very sunny day.

Since then things have improved dramatically. Modern cells have managed something like 25% efficiency although they are seldom seen outside research labs at the moment. Most commercial cells can convert at about 15% efficiency and this figure is unlikely to change for a few years, or at least, if they do improve they are going to be horribly expensive.

LIGHT WORK

Extracting your 15% of free energy is quite a complicated process. Without going too deeply into the details, (you don't really want to read a long boring story all about minority carriers and other molecular phenomenon do you?) the silicon solar cell is best described as a kind of semiconductor diode.

The cell is made up from two semiconductor layers. If you've been paying attention over the last few months you may recall that these semiconductor materials are made by 'doping' or adding certain impurities to the purified silicon. (This applies to other semiconductor materials too, like Germanium, selenium and Gallium Arsenide. These can be used for making Solar cells but are even less efficient!) According to the impurities added the silicon will be called either N type or P type. N type means that the Silicon now has an abundance of electrons within it's structure. The P type is the exact opposite, it has a distinct lack of electrons, in fact lots of little 'holes' where they used to be. If you take two thin slices of P type and N type silicon and put one on top of the other the point at which they meet exhibits some very unusual properties. This area is called the junction and forms a region called the 'depletion layer.' Should a photon (a particle of light) enter this layer it will break down the bond that exists between the molecules and send an electron scuttling towards the N type layer and a 'hole' to the P layer. If the two slices are connected to an external load a circuit will exist and a current will flow.

In practice one layer has to be transparent. This is achieved by either depositing a very thin P type layer on a much thicker N type substrate or a thin N type on a P type substrate.

In order to extract the maximum amount of power possible from the cell certain construction techniques have been evolved. Connections to the substrate are relatively easy, this is usually made on the underside of the cell. The topside is a little more difficult. One method is to deposit a thin conductive layer onto the rim of the cell. A great deal of care has to be taken to ensure that this does not form a semiconductor junction (remember the solar cell is basically a diode) otherwise the cell could be reverse biased. This connection has to be as small as possible as it will reduce the effective area of the cell. The second method works by depositing a thin grid of

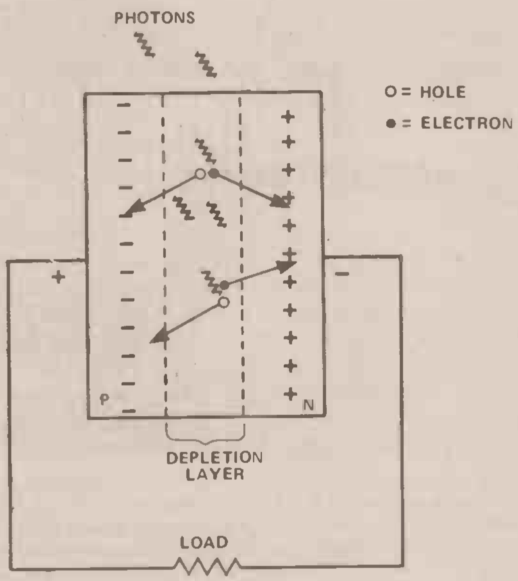


Fig. 1. General construction of a photovoltaic cell

conductive fingers on the topside, again precautions are taken to prevent any undue 'masking' or undersirable reverse bias.

As it stands the cell would be physically fragile so they are usually mounted on some kind of rigid base. In the case of a large array of cells this can be an aluminium sheet. This also helps in dissipating the other 80 or so percent of lost energy as heat.

As with batteries cells connected in series will produce a voltage equal to the sum of the voltage of all the

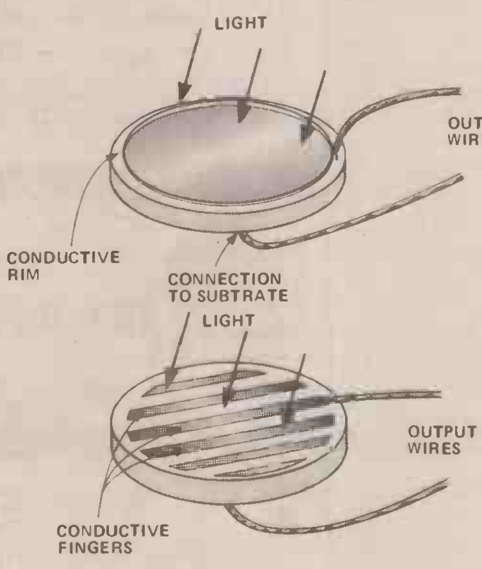


Fig. 2. (A) connection by conductive rim. (B) connection by conductive fingers.

individual cells. Parallel connections will yield current in a similar proportion.

That of course is an almost wickedly simplistic explanation of solar cells but as you will doubtless appreciate several books have been written on the subject. To explain it in just a couple of paragraphs is a hopeless task. If you really want to know how they work then take a trip down your local library, but don't forget your degree in molecular physics — you'll need it.

BRIGHT IDEAS

But now, back to the land of the living and a few ideas on how solar cells can improve your life.

The most publicised use for solar cells has got to be in powering satellites. Unfettered by the Earth's atmosphere, gravity (and lack of money) they can provide a reliable source of electricity. The cells are usually arranged on 'winged' arrays that deploy from the satellite once it has reached its orbit. Under these fairly harsh conditions the cells should supply power to the satellite for a good few years. If you can remember back to our August 79 issue you may recall our feature on 'Satellite Power'. Vast arrays of solar cells on orbiting 'solar power stations' would collect sunlight, convert it into high intensity microwaves and beam it to Earth. This would then be re-converted back into electricity, suitable for connection to a grid supply.

This idea is receiving some serious investigation at the moment but any practical development would take many years to come to fruition, so lets look at how solar cells are getting on down here, today.

MOONSHINE

Many of you will have a solar cell or two hiding in bits of equipment around the house. Some older light meters used for photography sported solar cells. It's easy to identify them, they don't need batteries! Several older types of cameras had solar cells built in. This is an extremely elegant way of measuring light intensity. Most cells exhibit a fairly linear voltage output under a constant load. Coupled up to a moving coil microammeter with an appropriately calibrated scale it will never wear out. The only problem is that, because the currents involved are extremely small, (especially in near-dark conditions) the meter movement has to be extremely sensitive. Consequently, they are extremely fragile, both mechanically and electrically. Today they have been largely superceded by the photoconductive cell or LDR (Light Dependant Resistor) type lightmeter which, although it needs a battery is considerably cheaper and much more robust.

In the past year or so solar cells have been turning up on digital watches. Most, if not all of the current batch use the cell to 'back up' a conventional mercury cell. Exposing the cell to a bright light stretches the life of the internal battery. Some manufacturers are making some rather dubious claims for longevity, we would suspect that doubling the life from one to two years is not unreasonable. As with any kind of LCD watch the battery life usually depends on how much use the backlight gets, or in the case of an alarm model, how long you let it sound. At the moment these solar cells are a bit of a gimmick but given the current trends in lower current consumption etc we can see no reason why they should not be worthwhile in a year or two as a primary power source.

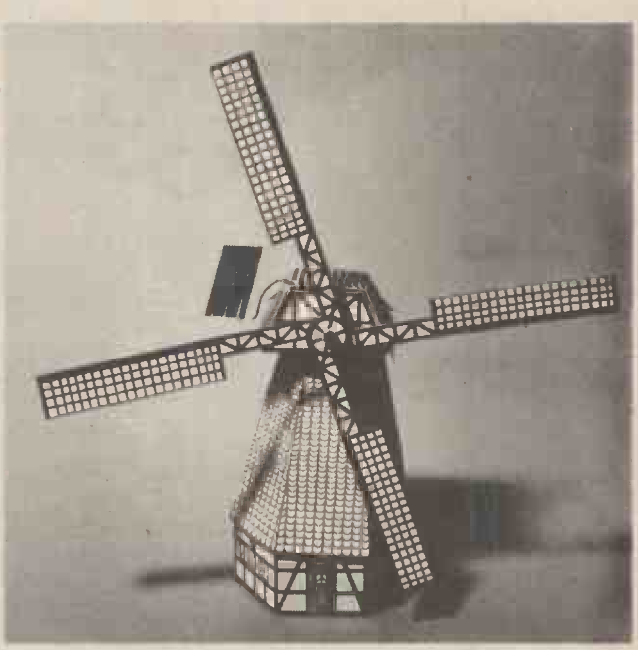
LIGHTING THE WAY

So much for domestic applications. In the big, wide world solar cells are finding themselves in all sorts of places. Remote, emergency radio telephones are already in use in osilated areas. Buoys at sea are using solar cells to power lights and audible warning devices. One enterprising gentleman in America actually powered his car with a solar panel. Truth be told though, he could only get up to about five miles an hour in very bright sunlight and weight being at a premium he couldn't carry any batteries. What is even more surprising is that this was some seventy years ago. There really is nothing new under the sun!

A SUNNY OUTLOOK?

Doubtless, improvements in production techniques and development of new materials will result in an even greater efficiency. We can expect to see solar cells popping up all over the place in the coming years. But will they ever be cheap/efficient enough to really solve our current or future energy problem? We would like to think so, solar electricity is clean enough not to upset anyone. However, one intriguing problem remains. If you consider how much energy is required to manufacture a solar cell, will we have enough energy left in the ground to develop a new power source? The energy needed to create the ultra-pure crystals for one single solar cell a couple of inches across is more than one person would normally use in a whole lifetime. Cheap they are not!

HE



A mixture of alternative technologies. This cardboard windmill is proving very popular in Germany at the moment. It conceals a small electric motor that is powered by a small solar panel. (between the two sails on the left hand side). In Germany (and many other European countries) this kind of solar powered toy symbolises the strong anti-nuclear movement. In almost every shop they have some kind of animated display powered by a solar panel. We wonder if they realise how much energy (much of it nuclear) went into producing the solar cells.

Next Month

Hobby Electronics

RADIO CONTROL MODEL SURVEY

It's been quite some time since we had a 'toy' feature, so we thought it was a good excuse to look at the latest crop of remote control cars, tanks, boats and other vehicles that have been flooding into the toy shops in the last few months.

Many of these so-called 'toys' are quite sophisticated, in fact a couple of them are far too good for youngsters. We reckon any kid getting one of these for a present hasn't a chance of playing with it if there is an adult around. This was more than bourne out by the HE staff, literally queueing up to play with them. Find out how we got on in next month's exciting feature (providing we can tear them away from tearful office staff).

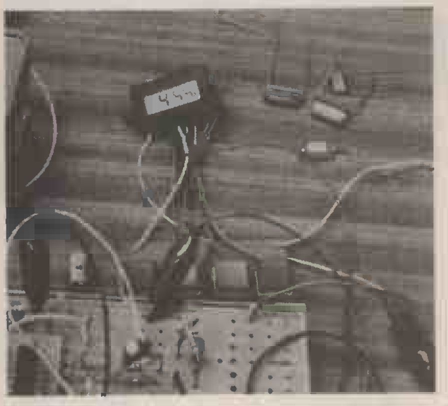
CONTEST

Yes, another of our famous devil-may-care contests. Prizes galore, instant stardom, just some of the things that happen in our competitions. We can't reveal the details yet (we're not too sure of them ourselves). What we can say is that the first prize will be a superb Heathkit type build-it-yourself goodie and that if you miss it you will never forgive yourself.

CROSSOVERS

Now for the first time anywhere. The complicated bits in loudspeakers, the Crossover Networks, will be explained as never before. Learn the intimate secrets of these cunning little circuits. Now you will be able to look any 'Audiophile' in the eye and know what he's talking about, you may even be able to tell him a thing or two.

MINICLOCK

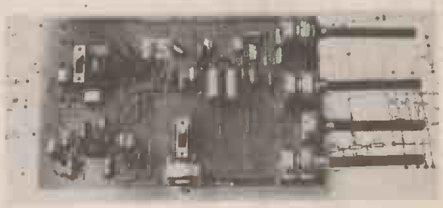


Time for a really alarming project. We promise no 'wind-ups' with this crystal controlled, battery powered, LCD display travelling alarm. It will fit snugly into the palm of your hand. Ideal for the 'travelling man', this neat little timepiece will reliably inform you of the correct time anywhere in the world. (Yes folks, a truly international clock, we absolutely guarantee it will work anywhere in the world.)

The built-in alarm will remind you of that all-important business lunch or just tell you it's time to get up. Never be late again, never be at a loss at parties, impress your friends . . . .

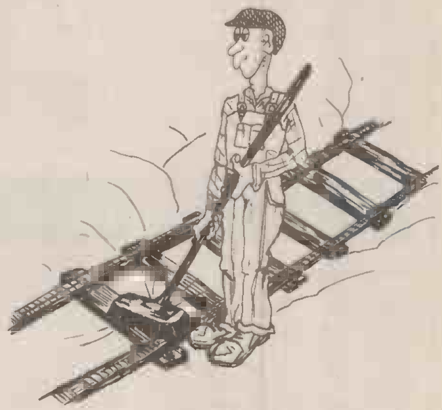
The copywriter for this project has just been retired due to an overdose of corny cliches. Seriously though, don't miss next month's HE, or you'll live to regret it.

SYSTEM 5080



To conclude the fabulously popular 5080 modular Hi-Fi system we are presenting the last word in Pre-Amplifier designs PLUS an amazing speaker system that will really complement the PA and PSU modules. For less than the price of a half decent ready built amplifier the 5080 system will bring the world of true Hi-Fi into your living room. (And if that sounds a bit schmaltzy just wait till your hear the amp at full tilt . . . .)

TRACK CLEANER



Troubled by tarnished tracks? Confounded by corroded connections? HE to the rescue, our supersonic, high-voltage grime-beater will get rid of those bits that clog your contacts and leave your model railway running so smoothly you'll wonder how you ever shunted your steamer without it.

The May issue will be on sale April 11th

The items mentioned here are those planned but circumstances may affect the actual contents

BI-PAK

SEMICONDUCTORS SEND YOUR ORDERS TO
DEPT. HE4, PO BOX 6, WARE, HERTS.
VISIT OUR SHOP AT: 3 BALDOCK ST., WARE, HERTS.
TEL: 0920 3182. TELEX: 817861

TRANSISTORS

AC126	£0.21	BC148	£0.08	BC549	£0.12	BU105	£1.84	ZTX109	£0.11
AC127	£0.21	DC149	£0.08	BC550	£0.16	BU105/02	£2.24	ZTX300	£0.13
AC128	£0.18	BC157	£0.12	BC556	£0.16	BU204	£1.61	ZTX500	£0.14
AC128K	£0.30	BC158	£0.12	BC557	£0.15	BU205	£1.61	2N1613	£0.23
AC132	£0.23	BC159	£0.12	BC558	£0.14	BU208/02	£2.58	2N1711	£0.23
AC134	£0.23	BC167	£0.14	BC559	£0.16	MJE2955	£1.04	2N1889	£0.23
AC137	£0.23	BC168	£0.14	BD115	£0.58	MJE3055	£0.69	2N1890	£0.51
AC141	£0.25	BC169	£0.10	BD116	£0.92	MJE3440	£0.60	2N1893	£0.35
AC141K	£0.35	BC169C	£0.12	BD121	£0.75	MPF102	£0.32	2N2147	£0.86
AC142	£0.23	BC170	£0.10	BD124	£0.81	MPF104	£0.40	2N2148	£0.81
AC176	£0.21	BC171	£0.10	BD131	£0.40	MPF105	£0.40	2N2160	£1.15
AC176K	£0.30	BC172	£0.10	BD132	£0.40	MPSA05	£0.23	2N2192	£0.44
AC178	£0.29	BC173	£0.10	BD133	£0.46	MPSA06	£0.23	2N2193	£0.44
AC179	£0.28	BC177	£0.18	BD135	£0.44	MPSA55	£0.23	2N2194	£0.44
AC180	£0.23	BC178	£0.16	BD136	£0.40	MPSA56	£0.23	2N2217	£0.25
AC180K	£0.32	BC179	£0.18	BD137	£0.40	OC22	£1.73	2N2218	£0.25
AC181	£0.23	BC180	£0.29	BD138	£0.41	OC23	£1.73	2N2218A	£0.25
AC181K	£0.32	BC181	£0.10	BD138	£0.41	OC24	£1.55	2N2219	£0.23
AC187	£0.21	BC182L	£0.10	BD140	£0.41	OC25	£1.15	2N2219A	£0.25
AC187K	£0.32	BC183	£0.10	BD155	£0.92	OC26	£1.15	2N2904	£0.23
AC188	£0.21	BC183L	£0.10	BD175	£0.69	OC28	£0.92	2N¼&7½A	£0.24
AC188K	£0.32	BC184	£0.10	BD176	£0.69	OC29	£1.09	2N2905	£0.23
AD140	£0.69	BC207	£0.13	BD177	£0.78	OC35	£1.03	2N2905A	£0.23
AD142	£0.98	BC208	£0.13	BD178	£0.78	OC36	£1.03	2N2906	£0.18
AD143	£0.86	BC209	£0.14	BD179	£0.86	OC70	£0.27	2N2906A	£0.21
AD149	£0.69	BC212	£0.10	BD203	£0.92	OC71	£0.17	2N2907	£0.23
AD161	£0.40	BC212L	£0.10	BD204	£0.92	TIC44	£0.33	2N2907A	£0.25
AD162	£0.40	BC213	£0.10	BDY20	£0.92	TIC45	£0.40	2N2926G	£0.10
AD161		BC213L	£0.10	BF457	£0.43	TIP29A	£0.46	2N2926Y	£0.09
162MP	£0.81	BC214	£0.10	BF458	£0.43	TIP29B	£0.48	2N29260	£0.09
AF124	£0.35	BC214L	£0.10	BF459	£0.44	TIP29C	£0.51	2N2926R	£0.09
AF125	£0.35	BC227	£0.18	BF594	£0.35	TIP30A	£0.46	2N2926B	£0.09
AF126	£0.35	BC238	£0.18	BF596	£0.32	TIP30B	£0.48	2N3053	£0.20
AF127	£0.37	BC251	£0.17	BFR39	£0.28	TIP30C	£0.50	2N3054	£0.46
AF139	£0.40	BC251A	£10.18	BFR40	£0.29	TIP31A	£0.46	2N3055	£0.46
AF186	£0.58	BC301	£0.32	BRR79	£0.32	TIP31B	£0.48	2N3614	£1.15
AF239	£0.47	BC302	£0.33	BFR80	£0.32	TIP31C	£0.50	2N3615	£1.21
AL102	£1.38	BC303	£0.32	BFX29	£0.25	TIP32A	£0.46	2N3616	£1.21
AL103	£1.36	BC304	£0.44	BFX30	£0.25	TIP32B	£0.48	2N3646	£0.10
AU104	£1.61	BC327	£0.18	BFX84	£0.25	TIP32C	£0.50	2N3702	£0.09
AU110	£1.61	BC328	£0.17	BFX85	£0.28	TIP41A	£0.50	2N3703	£0.09
AU113	£1.61	BC337	£0.17	BFX86	£0.29	TIP41B	£0.52	2N3704	£0.08
BC107A	£0.09	BC338	£0.17	BFX87	£0.25	TIP41C	£0.55	2N3705	£0.08
BC107B	£0.10	BC440	£0.35	BFX88	£0.25	TIP42A	£0.50	2N3706	£0.09
BC107C	£0.12	BC441	£0.35	BFY50	£0.20	TIP42B	£0.52	2N3707	£0.09
BC108A	£0.09	BC460	£0.44	BFY51	£0.20	TIP42C	£0.55	2N3708	£0.08
BC108B	£0.11	BC461	£0.44	BFY52	£0.20	TIP2955	£0.69	2N3709	£0.08
BC108C	£0.12	BC477	£0.23	BIP19	£0.44	TIS43	£0.25	2N3710	£0.08
BC109A	£0.09	BC478	£0.23	BIP20	£0.44	TIS90	£0.20	2N3711	£0.08
BC109B	£0.10	BC479	£0.23	BIP19		UT46	£0.23	2N3819	£0.21
BC109C	£0.12	BC547	£0.12	20MP	£0.92	ZTX107	£0.11	2N3820	£0.40
BC147	£0.08	BC548	£0.12	BRY39	£0.51	ZTX108	£0.11		

74 SERIES TTL

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	£0.10	7427	£0.27	7472	£0.23	74105	£0.43	74163	£0.71
7401	£0.12	7428	£0.29	7473	£0.28	74107	£0.27	74164	£0.78
7402	£0.12	7430	£0.12	7474	£0.28	74110	£0.41	74165	£0.78
7403	£0.12	7432	£0.25	7475	£0.33	74111	£0.66	74166	£0.89
7404	£0.12	7433	£0.34	7476	£0.28	74118	£0.92	74174	£0.74
7405	£0.12	7437	£0.25	7480	£0.50	74119	£1.35	74175	£0.71
7406	£0.25	7438	£0.24	7481	£0.97	74121	£0.27	74176	£0.66
7407	£0.25	7440	£0.13	7482	£0.78	74122	£0.44	74177	£0.66
7408	£0.14	7441	£0.57	7483	£0.66	74123	£0.46	74180	£1.72
7409	£0.14	7442	£0.46	7484	£1.01	74136	£0.59	74181	£0.66
7410	£0.12	7443	£0.80	7485	£0.78	74141	£0.63	74182	£0.80
7411	£0.19	7444	£0.80	7486	£0.25	74145	£0.63	74184	£0.80
7412	£0.17	7445	£0.74	7489	£1.95	74150	£0.78	74190	£0.78
7413	£0.27	7446	£0.69	7490	£0.36	74151	£0.65	74191	£0.71
7414	£0.57	7447	£0.55	7491	£0.73	74153	£0.55	74192	£0.69
7416	£0.26	7448	£0.64	7492	£0.40	74154	£0.94	74193	£0.66
7417	£0.26	7450	£0.12	7493	£0.34	74155	£0.67	74194	£0.71
7420	£0.12	7451	£0.12	7494	£0.86	74156	£0.57	74195	£0.69
7421	£0.23	7453	£0.12	7495	£0.57	74157	£0.57	74196	£1.20
7422	£0.18	7454	£0.12	7496	£0.57	74160	£0.66	74197	£1.20
7423	£0.24	7460	£0.12	74100	£0.97	74161	£0.71	74198	£2.12
7425	£0.21	7470	£0.28	74104	£0.44	74162	£0.71	74199	£2.12
7426	£0.26								

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0.16	CD4015	£0.87	CD4026	£1.38	CD4043	£1.01	CD4070	£0.19
CD4001	£0.22	CD4016	£0.48	CD4027	£0.57	CD4044	£0.94	CD4071	£0.19
CD4002	£0.18	CD4017	£0.86	CD4028	£0.78	CD4045	£1.61	CD4072	£0.19
CD4006	£1.05	CD4018	£0.97	CD4029	£0.97	CD4046	£1.49	CD4081	£0.19
CD4007	£0.19	CD4019	£0.48	CD4030	£0.55	CD4047	£1.00	CD4082	£0.20
CD4008	£1.05	CD4020	£1.03	CD4031	£2.30	CD4049	£0.48	CD4510	£1.13
CD4009	£0.51	CD4021	£0.94	CD4035	£1.15	CD4050	£0.48	CD4511	£1.09
CD4010	£0.55	CD4022	£0.94	CD4037	£1.09	CD4054	£1.26	CD4516	£1.15
CD4011	£0.22	CD4023	£0.17	CD4040	£1.01	CD4055	£1.15	CD4518	£1.15
CD4012	£0.18	CD4024	£0.74	CD4041	£0.87	CD4056	£1.55	CD4520	£1.15
CD4013	£0.48	CD4025	£0.17	CD4042	£0.82	CD4069	£0.19	CD4014	£0.92

LINEAR

Type	Price			Type	Price	Type	Price	Type	Price
CA3011	£0.92	CA3130	£1.06	MC1350	£1.38	UA710C	£0.46	SN76115	£218
CD3014	£1.55	CA3140	£0.80	MC1352	£1.61	72710	£0.34	SN76660	£0.86
CA3018	£0.74	LM301	£0.33	MC1469	£3.59	UA711C	£0.36	SL414A	£2.24
CA3020	£1.95	LM304	£1.84	MC1496	£1.03	72711	£0.36	TAA5508	£0.40
CA3028	£0.92	LM308	£1.15	NE536	£3.05	UA723C	£0.52	TAA621A	£2.30
CA3035	£1.61	LM309	£1.72	NE550	£1.09	72723	£0.52	TAA621B	£2.87
CA3036	£1.15	LM320-5V	£1.72	NE555	£0.27	UA741C	£0.27	TAA661	£1.72
CA3042	£1.72	LM320-12V	£1.72	NE556	£0.69	72741	£0.27	TAD100	£1.49
CA3043	£2.12	LM320-15V	£1.72	NE565	£1.38	741P	£0.23	TBA540	£2.41
CA3046	£0.80	LM320-24V	£1.72	NE566	£1.38	UA747C	£0.69	TBA810S	£0.86
CA3052	£1.84	LM380	£0.97	NE567	£1.95	72747	£0.69	TBA810	£1.12
CA3054	£1.26	LM381	£1.66	UA702C	£0.52	UA748	£0.40	TBA820	£0.80
CA3075	£1.72	LM3900	£0.66	72702	£0.52	72748	£0.40	TBA9200	£2.87
CA3081	£1.72	MC1303L	£0.97	UA703	£0.28	748P	£0.40	TCA270S	£2.30
CA3089	£2.30	MC1304	£2.18	UA709	£0.28	SN76013N	£2.01	TBA800	£0.92
CA3090	£4.14	MC1310	£1.09	72709	£0.52	SN76023	£2.01		
CA3123	£2.18	MC1312	£2.18	709P	£0.28	SN76110	£1.72		

THYRISTORS

Volts No	Price	Volts No	Price
50 THY1A/50	£0.29	50 THY7A/50	£0.55
100 THY1A/100	£0.32	100 THY7A/100	£0.58
200 THY1A/200	£0.36	200 THY7A/200	£0.65
400 THY1A/400	£0.43	400 THY7A/400	£0.71
600 THY1A/600	£0.51	600 THY7A/600	£0.89
800 THY1A/800	£0.66	800 THY7A/800	£1.05
Volts No	**Price**	**Volts No**	**Price**
50 THY3A/50	£0.32	50 THY10A/50	£0.58
100 THY3A/100	£0.34	100 THY10A/100	£0.65
200 THY3A/200	£0.37	200 THY10A/200	£0.71
400 THY3A/400	£0.48	400 THY10A/400	£0.80
600 THY3A/600	£0.57	600 THY10A/600	£1.13
800 THY3A/800	£0.74	800 THY10A/800	£1.40
Volts No	**Price**	**Volts No**	**Price**
50 THY5A/50	£0.41	50 THY16A/50	£0.62
100 THY5A/100	£0.51	100 THY16A/100	£0.66
200 THY5A/200	£0.57	200 THY16A/200	£0.71
400 THY5A/400	£0.65	400 THY16A/400	£0.88
600 THY5A/600	£0.79	600 THY16A/600	£1.03
800 THY5A/800	£0.93	800 THY16A/800	£1.59

SILICON RECTIFIERS

200MA		**10 Amp**	
IS920 50v	£0.07	IS10/50 50v	£0.21
IS921 100v	£0.08	IS10/100 100v	£0.24
IS922 150v	£0.09	IS10/200 200v	£0.26
IS923 200v	£0.10	IS10/400 400v	£0.40
IS924 300v	£0.11	IS10/600 600v	£0.48
1 Amp		IS10/800 800v	£0.58
IN4001 50v	£0.05	IS10/1000 1000v	£0.69
IN4002 100v	£0.05	IS10/1200 1200v	£0.79
IN4003 200v	£0.07	**30 Amp**	
IN4004 400v	£0.08	IS30/50 50v	£0.64
IN4005 600v	£0.09	IS30/100 100v	£0.79
IN4006 800v	£0.10	IS30/200 200v	£1.06
IN4007 1000v	£0.11	IS30/400 400v	£1.43
1.5 Amp		IS30/600 600v	£2.02
IS015 50v	£0.10	IS30/800 800v	£2.23
IS020 100v	£0.11	IS30/1000 1000v	£2.65
IS021 200v	£0.12	IS30/1200 1200v	£3.31
IS023 400v	£0.14	**60 Amp**	
IS025 600v	£0.16	IS70/50 50v	£0.86
IS027 800v	£0.18	IS70/100 100v	£0.96
IS029 1000v	£0.23	IS70/200 200v	£1.38
IS031 1200v	£0.28	IS70/400 400v	£2.01
3 Amp		IS70/600 600v	£2.58
IN5400 50v	£0.16	IS70/800 800v	£2.87
IN5401 100v	£0.17	IS70/1000 1000v	£3.45
IN5402 200v	£0.18		
IN5404 400v	£0.19		
IN5406 600v	£0.24		
IN5407 800v	£0.28		
IN5408 1000v	£0.34		

LEDs

O/no	Size	Colour	Price
1501	125	RED	£0.10
1502	125	GREEN	£0.16
1503	125	YELLOW	£0.16
1504	2	RED	£0.10
1505	2	GREEN	£0.16
1506	2	YELLOW	£0.16
1509	2	CLEAR (Ill Red)	£0.12
SUPER 'Hi'Brite' Type			
1521	125	RED	£0.11
1522	2	RED	£0.11
1514	ORP 12 Light dependent resistor		£0.70
1520	OCP71 Photo transistor		£0.40

CLIPS

1508/125	pack of 5	125 clips	£0.17
1508/2	pack of 5	2 clips	£0.20

DISPLAYS

DL703. 7 segment D.P. left (30" height) common anode single digit O/NO 1523 £0.80

DL707 RED 7 segment D P left (0 3" height) common anode single digit O/NO 1510 £0.92

DL527 RED 7 segment D P left (50" height) common anode Two-digit reflector o/NO 1524 £1.95

DL727 RED 7 segment D P right (510" height) common anode Two-digit light pipe O/NO 1521 £2.53

DL747 RED 7 segment D P left (630" height) common anode Single-digit light pipe O/NO 1511 £1.72

OPTO-ISOLATORS

Isolation Breakdown — Voltage 1500 — continuous fwd current 100mA

CIL74 Single-channel 6 pin DIP standard type — optically coupled pair with infra-red LED emitter and NPN silicon photo transistor O/NO 1497 £0.57

CILD74 Multi-channel 8 pin DIP two isolated channels O/NO 1498 £1.15

CILQ74 Multi-channel 16 pin DIP four isolated channels O/NO 1499 £2.53

SECOND GRADE LED PACK

A pack of 10 standard sizes and colours which fail to perform to their rigid specification but which are ideal for amateurs who do not require the full spec.
O/NO 1507 £1.04

AUDIO MODULES

AMPLIFIERS

AL10	3 watt Audio Amplifier Module 23-32v supply	£3.63
AL20	5 watt Audio Amplifier Module 22-32v supply	£4.73
AL30A	7-10 watt Audio Amplifier Module 22-32v supply	£5.51
AL60	15-25 watt Audio Amplifier Module 30-50v supply	£6.81
AL80	35 watt Audio Amplifier Module 40-60v supply	£10.67
AL120	50 watt Audio Amplifier Module 50-70v supply	£17.38
AL250	25 watt Audio Amplifier Module 50-80v supply	£25.91

STEREO PRE-AMPLIFIERS

PA12	Supply voltage 22-32 input sensitivity 300mv suit AL 10/AL20/AL30	£9.63
PA100	Supply voltage 24-36v inputs:—Tape, Tuner, Mag. P.U. Suit AL60/AL80	£20.30
PA200	Supply voltage 35-70v Inputs:—Tape, Tuner Mag. Suit AL80/AL120/250	£20.98

MONO PRE-AMPLIFIERS

MM100	Supply voltage 40-65v inputs. Mag. P.U. Tape Microphone Max. output 500mv	£14.29
MM100G	Supply voltage 40-65v inputs: 2 Guitars Microphones Max output 500ma	£14.29

POWER SUPPLIES

PS12	24v Supply suit 2/AL10, 1-AL20 2-AL30 & PA12/S 450	£1.90
SPM80	33v Stabilised supply—suit 2 - AL60 PA100 to 15 watts	£5.57
SPM120-45	45v Stabilised supply—suit 2-AL60. PA100 to 25 watts	£7.34
SPM120/55	55v Stabilised supply—suit 2 - AL80 PA200	£7.34
SPM120/65	65v Stabilised supp uit 2 - AL120, PA200, 1 - AL250, PA200	£7.34
SG30	15-0-15 Stabilised power supply for 2 - GE 100MKII	£4.37

MISCELLANEOUS

MPA30	Stereo Magnet, Cartridge Pre-Amplifier-input 3.5uv output 100mv	£3.76
S 450	Stereo FM Tuner Supply Voltage 20-30v-Varicap tuned	£29.39
STEREO30	Complete 2 watt per Channel Stereo Amplifier Board—includes amps, pre-amp power supply front panek knobs etc — requires 2050 Transformer	£24.25
BP124	5 watt 12v max — Siren Alarm Module	£4.43
GE100MKII	10 Channel mono-graphic equaliser complete with sliders and knobs	£26.45
VPS30	Variable regulated stabilised power supply 2-30v 0-2 amps	£8.74

SOCKETS

1611	8 pin DIL	£0.09
1612	14 pin DIL	£0.11
1613	16 pin DIL	£0.12
1720	18 pin DIL	£0.18
1721	20 pin DIL	£0.20
1722	22 pin DIL	£0.22
1614	24 pin DIL	£0.24
1615	28 pin DIL	£0.26
1723	40 pin DIL	£0.34
1616	TO18 transistor	£0.13
1617	TO3 transistor	£0.37
16117	TO5 transistor	£0.13
1724	14 pin DIL Wire wrap gold plated Cambion	£0.25

G.P. SWITCHING TRANSISTORS

TO18sim to 2N706 8 BSY27 28 95A ALL usuable devices no open and shorts. ALSO available in PNP sim to 2N290 BCY70
20 for **57p**; 50 for **£1.15**; 100 for **£2.07**; 500 for **£9.20**; 1 000 for **£16.10**; when ordering state NPN, PNP

G.P. SILICON DIODES

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Digital Frequency Meter

Living by numbers? . . . do it digitally with this easy to build DFM.

WITH JUST A COUPLE of simple-to-operate controls, this project will enable you to measure and display frequencies from 20 Hz to about 2 MHz. The upper frequency limit is determined by the waveform of the input signal, the input amplifier and the performance of the particular chip used for IC3. As the CMOS chips used in this design have a better high-frequency performance with increasing supply voltage, a twelve volt supply was chosen and this can be simply provided with eight AA size cells; HP7s for example.

99999 = 1

Even a few years ago, a DFM like this unit would have been mains-powered with numerous boards and innumerable interconnections. Large scale integration, the same technology that has put microprocessors in almost everything, has changed all that and this project features a five digit readout with input amplifier, logic gating and counter all on one board. This saves you from having to worry about connecting displays and cascading discrete counter chips.

Most of the work is done by one chip which counts the input pulses and organises the display. Another chip takes the display data and drives the light-emitting-diode display while the remaining ICs provide an accurate counter "window" and gate the input signal.

The advantage of CMOS over conventional bipolar technology is low current drain and the whole unit uses less power than an ordinary torch bulb. Many more

The HE Digital Frequency Meter hooked up to our workshop signal generator and oscilloscope for calibration

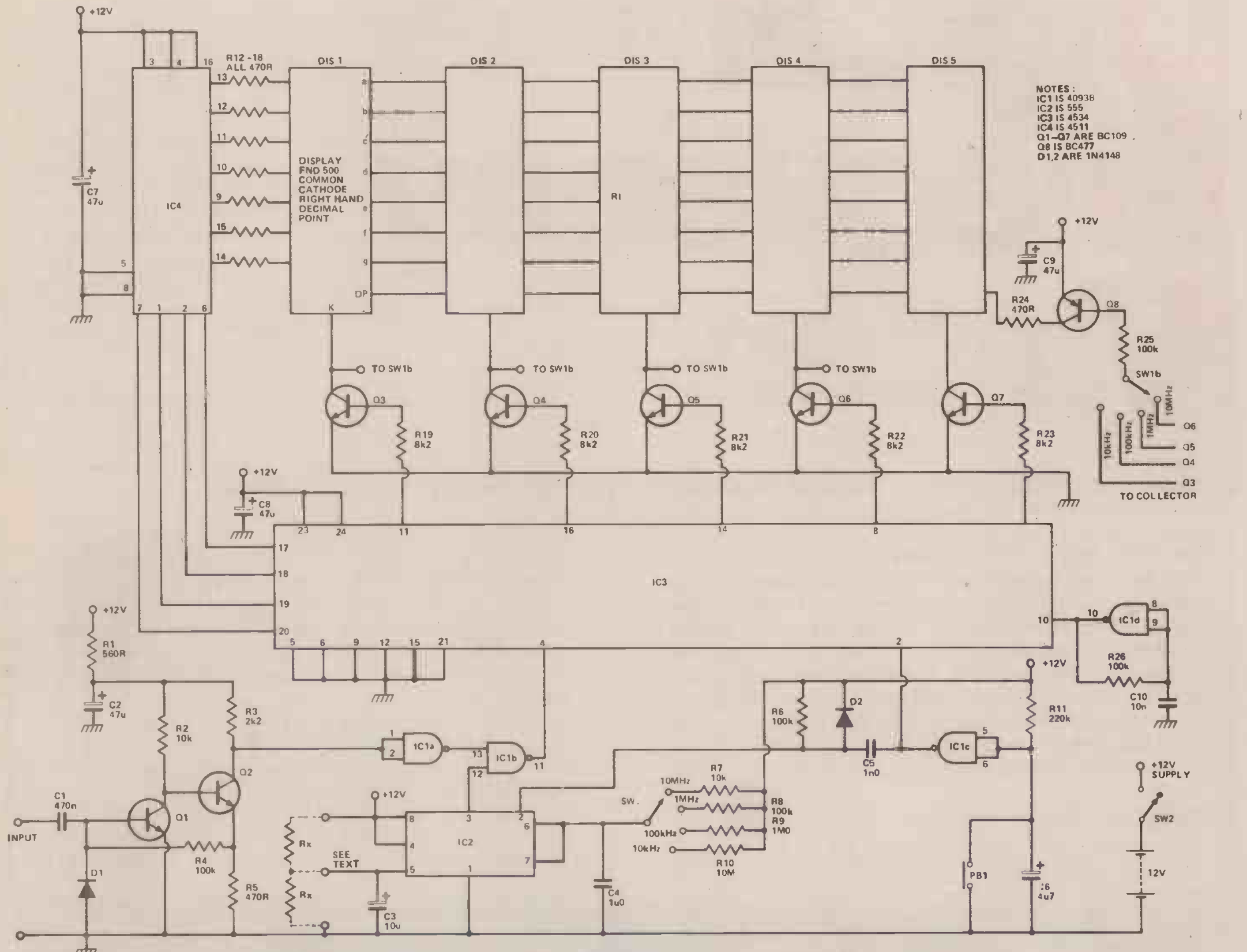


Fig. 1. Circuit diagram of the HE DFM. By using close tolerance components for C4 and R7 to R10 accuracy should be assured.

How It Works

Circuit operation is most easily understood by considering each section separately. This approach makes troubleshooting much simpler too.

THE AMPLIFIER

Transistors Q1, 2 form a simple direct-coupled amplifier. The DC operating point is set by negtive feedback via R4. Input signals are capacitively coupled via C1. The value chosen gives good results between 20 Hz and 2 MHz. The amplified signal appears at Q2 collector where it is 'squared-up' by Schmitt trigger gate IC1a whose output dirves one input of IC1b. Components R1, C2 provide a smooth 'decoupled' supply for the amplifier.

THE COUNTER WINDOW GENERATOR

Input pulses are only allowed to reach the counter (pin 4, IC3) when the other input of IC1b is 'high'; ie at about twelve volts. The input is driven from a 555 counter, IC2, connected as a monostable multivibrator. This means that upon being triggered when the voltage at pin 2 drops below about one-third of the supply voltage, the chip will generate a pulse whose length is determined by the values of C4 and one of the switch-selectable resistors R7, 8, 9, 10. This pulse provides a 'window' during which time signal transitions at the amplifier input are counted. The number of transitions (that is just another way of saying changes from one level to another) in a certain period; say a second, is expressed as the frequency of the input waveform. This means that a frequency of 50 Hz is just a way of saying that there are fifty cycles of change in one second of time. A cycle is a change from positive to negative and back again. By changing the counter window length, we can provide our frequency meter with different ranges. This circuit generates a window of ten secs., one sec., one tenth sec., or one hundredth sec. depending on the choice of resistor R10 to R7; giving a full scale measurement from 9.9999 kHz to 9.9999 MHz.

A novel feature of the 555 chip used in this design is its ability to provide a large range of output timing periods with good accuracy. Using a polyester capacitor for C4 and close tolerance resistors

How it Works

for R7 to R10, the timing intervals obtained will be very close to ten times multiples of each other. This means that if the circuit can be accurately set up on one range then the other ranges will fall into line automatically. Fortunately the 555 has another trick up its sleeve as the timing period, even with fixed values of R and C, can be varied considerably by use of the control input, pin 5.

With the unit set to the lowest range, a 50 Hz signal from the low voltage output of a transformer (say 6 or 9 volts) may be applied to the input via a resistor (about 1 MO should do). After depressing and releasing PB1, the display should flicker as the unit counts until a steady number is displayed. The mains frequency is 50 Hz but the display will probably read 55 Hz or so. A resistor 'Rx' should now be connected between 'C' and 'N' and a new reading taken. Different values of resistance should be tried until the display indicates 50 Hz (0.0500) or at least something close. Don't be surprised if a slightly different reading is obtained even with the same value of resistance for Rx. We found a value of 56 k was about right. If a value less than 10 k is required then C4 should be replaced. In the unlikely event that the display reads less than 50 Hz then the resistor should be connected between 'C' and 'P'. Any value down to 4 k7 may be used. Once one range is calibrated, the accuracy of the other ranges will depend on the tolerance of resistors R7, 8, 9, 10. Capacitor C3 prevents noise from upsetting things at the control input.

COUNTER AND TRIGGER

Depressing PB1 causes the output of IC1c to go high to a logic '1' resetting the counters in IC3. When PB1 is released, C6 charges via R11 and IC1c output goes low removing the rest signal from IC3 and triggering the monostable IC2 which enables gate IC1b to pass signals to the counter input (pin 4, IC3). IC3 contains five decade counters which means that it can count up to 99,999 before 'overflowing' and starting again from zero. The output of each stage is presented in binary-coded-decimal form on pins 17, 18, 19, 20. Each stage uses all four pins but only one stage at a time is connected to them. Simultaneously, one of the digit driver outputs goes high corresponding to the stage whose value is being output. The binary-coded-decimal signals are converted to drive a seven-segment display by IC4 and the appropriate digit is enabled by Q3 to Q7 driven from the digit driver outputs pins 11, 16, 14, 8, 7. The decimal point is driven from Q8 which is turned on at the appropriate time by controlling it from the digit driver transistors via SW1b. The technique of using a few pins to carry many signals at different times is known as multiplexing. The multiplexer circuitry inside IC3 needs to be driven by an external clock and this is provided by IC1d which, with R26 and C10, oscillates at about 700 Hz. (Try using the meter to check this after you have built it!) The exact frequency is not important. Resistors R12 to R18 and R24 serve to limit current flow in the display driver and the LED displays. Do not be surprised if the resistors feel a little warm. They dissipate about 200 mW and this is quite normal.

The 47μ capacitors dotted around the circuit help to prevent interaction between different stages and are deliberately sited close to individual chips and transistors.

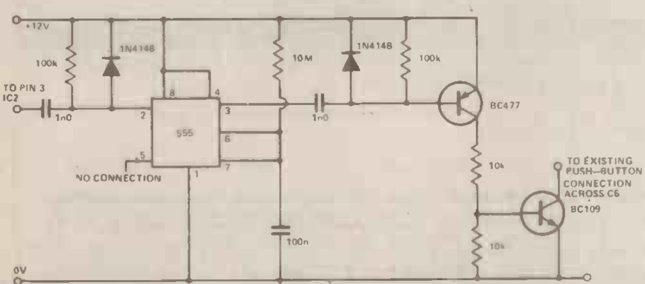
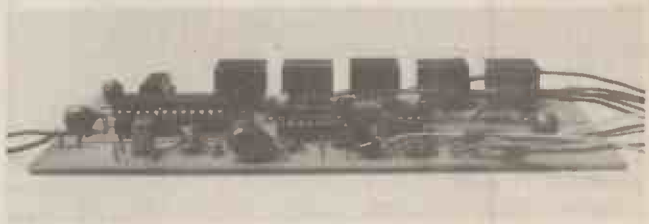


Fig. 2. Suggested additional circuitry to perform "auto update" on DFM.

sophisticated units of this type use a crystal oscillator and divider chain to provide accurate timing (just like in your digital watch). As this would have added considerably to the cost of the project an analogue technique based on the ubiquitous 555 timer chip has been used. This is not too much of a problem as the 555 is capable of providing accurate and repeatable time delays set by choice of just one resistor and capacitor and a simple technique is outlined in "how it works" for calibrating all four ranges.

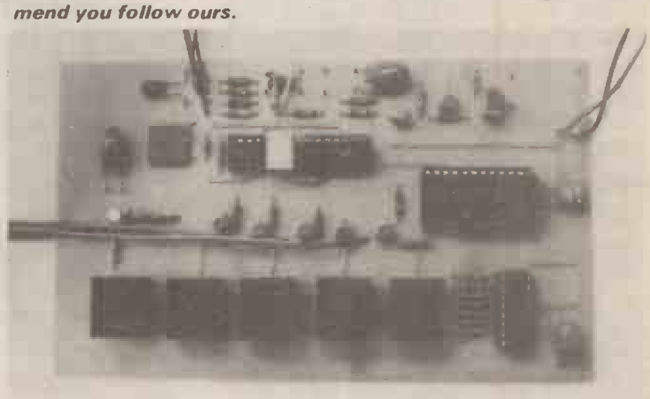
CONSTRUCTION AND USE

If you are confident of your ability to handle CMOS and make the many interconnections required then almost any constructional technique may be used. However, we



Above. Side view of the DFM. By keeping a low profile it's easier to mount the unit in its box.

Below. Although the layout is not critical we strongly recommend you follow ours.



Parts List

RESISTORS (All ½W 5%)

R1	560R
R2	10k
R3	2k2
R4, 6, 25, 26	100k
R5, 12 to 18, 24	470R
R7	10k
R8	100k
R9	1M0
R10	10M
R11	220k
R19 to 23	8k2
Rx	See text

(Resistors R7 to R10 will effect the accuracy and stability of the DFM. Use two per cent resistors if you can obtain them. Otherwise, use whatever you can get — the circuit will still work).

CAPACITORS

C1	470n ceramic
C2, 7, 8, 9	47μ tantalum
C3	10μ tantalum
C4	1μ0 polycarbonate
C5	1n0 ceramic
C6	4μ7 tantalum
C10	10n ceramic

SEMICONDUCTORS

IC1	4093B
IC2	555
IC3	4534
IC4	4511B
Q1 to Q7	BC109
Q8	BC477
D1, 2	1N4148
DIS 1 to 5	FND500

common-cathode seven-segment LED displays.

MISCELLANEOUS

PB1 push-button switch   SW1 2 pole — 4 way

SW2 SPST

Buylines

Most of the components are fairly ordinary and should be available from the usual mail-order suppliers. The specified LED displays and IC3 are available from Technomatic.

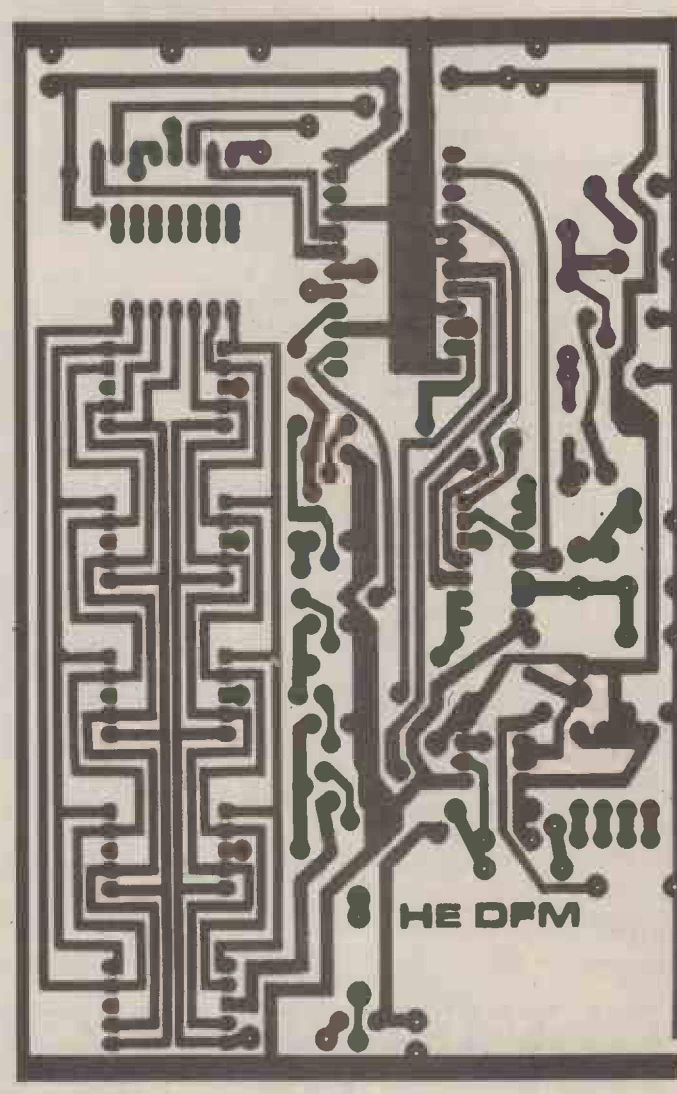


Fig. 3. PCB foil pattern for DFM.

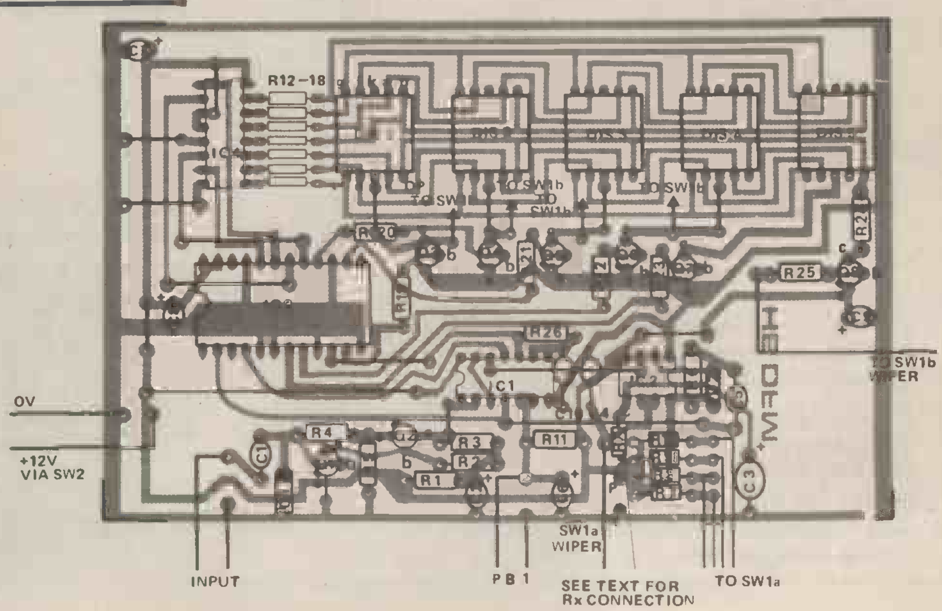
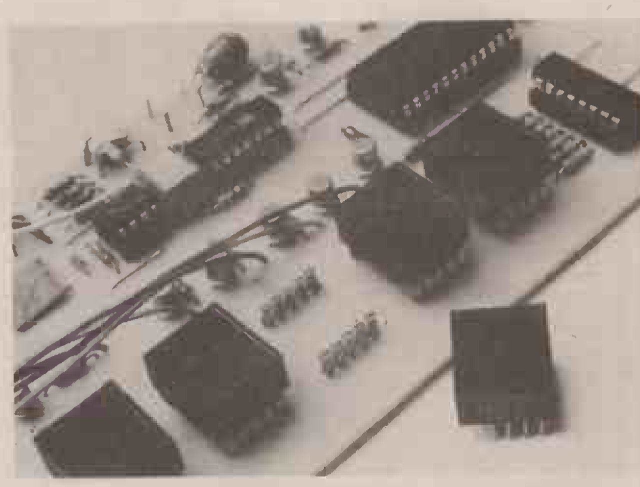


Fig. 4. Overlay diagram, we suggest you use sockets for all IC's. Note that the capacitors C2, C6, C3 are bent flush to the PCB to enable the board to fit neatly in its case.

strongly recommend that our PCB design is used as this will cut down the chance of any error creeping in.

If you do use a PCB then construction is quite straightforward. There are sixteen wire links to make and these should be inserted first as they pass beneath many of the other components. Use an insulated link for the connection between IC2, pin 3 and IC1, pin 12 to avoid a possible short circuit to C4. The other components may be inserted almost as they come to hand although it helps to have some kind of system to facilitate checking. The best course is to follow the parts list; resistors first followed by capacitors and finally the semiconductors. This technique minimises the chance of overheating the semiconductors though modern silicon devices are fairly hardy anyway. We usually use IC sockets; avoiding handling problems and enabling the chips to be re-used or replaced if they fail. The LED displays may be soldered to the PCB or ''soldercon'' pins can be used. These are do-it-yourself IC sockets which are supplied in strip-form. You just break off as many as you need; in this case five, solder them into the board then break off the unwanted metal carrier strip at the top of the pins by grasping it with a pair of pliers and repeatedly flexing it back and forth. The displays should be mounted so that the decimal point is facing away from the nearby edge of the board. In fact the displays will still work if you put them in back to front but you will see some pretty funny numbers!

There are few connections to make to the board and the only ones which need special care are those to SW1. These should be arranged so that when one section is connected to R7, the other section connects with the collector of Q6 and so on as the ranges are selected. This gives a display reading directly in kilo-Hertz with a moving decimal point so each range is selected and facilitates reading the display.



One of the display units removed from its socket. Note C2 and C6 are mounted flush to the board.

In use, the highest range should be used first and then lower ranges selected as required. This avoids false readings as the counter overflows. The unit is quite sensitive and will tolerate many waveforms though it becomes fussier on the highest range, preferring a sinusoidal waveform. The basic design will only update the display following a depression of PB1. Included here is a simple update circuit which you can add if you like. It works by imitating the action of depressing PB1 electronically about one second after the display has settled. Any method of construction may be used for this little circuit and there shouldn't be much difficulty in making the required connections to the main board.

Whichever way you build it, this project will provide you with an economical piece of test gear — off the shelf and made to measure. **HE**

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12:30 pm 45
Hours mins secs
8 14 TH
Month date day
0:00 00
Min secs 1/10 1/100

6 digit, 11 functions, Hours, mins., secs., day, date, day of week, 1/100th, 1/10th, secs., 10X secs., mins. Split and lap modes. Back-light, auto calendar. Only 8mm thick. Stainless steel bracelet and back. Adjustable bracelet.

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Month date day
7:30 A
Alarm

6 functions plus Alarm. Conference signal, 5 minute snooze alarm, Conference signal sounds 4 secs. before main alarm to give advance warning and an option to cancel. Snooze sounds 5 mins. after main alarm and is always preceeded by the conference signal.

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QUARTZ LCD ALARM CHRONOGRAPH with 12/24 display

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Hours mins secs
8 14 TH
Month date day
0:00 0
Min sec 1/10th
7:30 A
Alarm

Hours, mins, secs, day of week. Month, date, day of week, alarm, hour, mins., a.m./p.m. 24 or 12 hour display mode. Alarm test. Chronograph, lap time, stop watch 1/10 secs.

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8 14
Month date
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Secs

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Narrow Bandwidth Television PART 1

How do you fancy building your own closed circuit TV system for around a fiver? How about making video recording on an ordinary domestic tape-recorder? Sounds too good to be true, but it is as Doug Pitt of the Narrow Bandwidth TV Association explains in this major two part feature.

READERS of popular radio and electronics magazines may have noticed references, over the past few years, to NBTV (or LDTV as it is sometimes called).

Quite simply, this indicates a resurgence of interest in the old 'Baird' system of mechanical TV, called 'Narrow Bandwidth' because the signals generated in the formation of the pictures occupy roughly the same range as audible sound, that is, up to about 12 KHz only.

The alternative label, 'Low Definition', refers to the relatively coarse picture structure, of roughly 24 to 64 parallel lines, compared to the Modern European standard of 625 lines which is 'high' definition.

Television since 1946 is almost wholly linked to the cathode-ray tube display (perfected as a mass-produced component during World War II) and to the high definition picture of many hundreds of lines. It is not generally appreciated that the mechanical systems maintained their superiority, even with 405 line signals, right up to 1939.

Familiarity with the mechanical systems is now rarely encountered. It is confined to an older generation who experienced the excitement of the pre-war television broadcasts or the more thoughtful readers of technical encyclopedias who may have been stimulated by such odd entries as 'Nipkov Disc', to seek further knowledge.

THE THIRTY LINE BROADCASTS

Broadcasting of TV entertainment programmes were started by the British pioneer, John Logie Baird, in 1929 and continued under joint Baird/BBC direction until late 1935.

Broadcasts were confined to the early morning and late evening to avoid 'contact' with normal sound broadcasting, and used two medium waveband frequencies, the second for the accompanying sound. Naturally, two receivers were needed, as with early stereo-sound broadcasts.

The pictures were both transmitted and displayed by mechanical devices and used thirty (vertical) lines, with 12½ pictures per second. To the modern TV viewer, a thirty line picture is mind-boggling, accustomed as it is to the luxury of 625 horizontal lines for picture composition.

Photograph from a CRT screen of a 48 line picture. Pictures of this quality are easy to duplicate on relatively simple equipment. (The use of a CRT for display is simply to produce a better photograph.)

Suffice it to say that for single-person acts (singers, instrumentalists, ventriloquists, magicians, and the like), it proved both adequate and exciting and attracted all the top-flight cabaret entertainers of the period to the 'little screen'. Some, like Arthur Askey, are still around to talk about it.

Like all medium-wave transmissions, especially at the higher frequency end of the band, they were receivable, after dark, over a wide area, so that BBC/Baird TV became a talking point from Iceland to Morocco, and from the Azores to Warsaw.

The receivers (mainly home-built from kits pf parts) consisted, in their simplest form, of a rotating disc of aluminium, a driving motor, a neon lamp, and some sort of synchronising device — if only in the form of a well-trained finger!

MODERN NBTV

The revival of activity in this field, with which the author is associated, takes the 1930-35 experience merely as a starting point. Since it is a practical rather than a nostalgic movement, all modern devices, components, and materials, are employed and at the receiving end of the process, old TV's and oscilloscopes are unhesitatingly pressed into service. The domestic tape-recorder, quite adequate for the frequency range of NBTV signals, provides a storehouse for programmes and for their transmission through the post. Stereo recorders enable instant synchronised sound to be added.

WHAT DOES NBTV OFFER?

It is important neither to exaggerate nor under-estimate the possibilities of the system. The moving pictures produced are inferior in detail to those of, say 8 m m home movies and do not (as yet) provide colour. On the other hand, their cost of production is virtually zero, as tapes can be continually re-used.

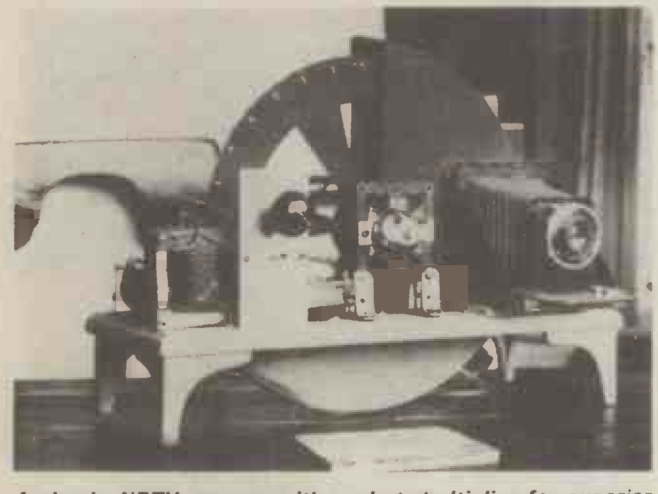
They are clearly inferior to the familiar high definition TV pictures, but the wide bandwidth required for these, (several megahertz) inhibits their use by radio amateurs and restricts storage to those who can afford a highly expensive VTR machine.

Compared to the Slow Scan branch of amateur TV, NBTV requires a bandwidth some four times as wide, but as a compensation, provides the vital quality of *movement* which no amount of stationary perfection can match in terms of human interest.

Above all, NBTV is *very inexpensive,* opening up TV experimentation to all with the patience and determination to build the required apparatus themselves. Its circuitry is relatively simple and its mechanics offer unlimited scope for ingenuity. It is perfectly adequate for 'personal' and 'close-up' subjects.

If you examine the printed examples of photos taken from NBTV displays, making allowance for picture degradation caused by the necessary 'screening' for magazine printing, then imagine these pictures *in motion,* you should get a fair idea of NBTV's potentialities and limitations.

On the other hand, if you are thinking of using the system to produce a new version of 'War and Peace', with a cast of two thousand Cossacks — forget about it!



A simple NBTV camera with a photomultiplier for superior definition at low light levels.

THE START

No attempt is made in this article to describe a complete NBTV system. That would be far too complicated and likely to put you right off the subject. Instead, the principal techniques and terms will first be explained, and secondly, some simple experiments, involving few special components and relying heavily on the 'junk box', will be described. If, after pursuing these, sufficient interest has been aroused, you can seek (easily obtained) further information.

PICTURE ANALYSIS AND SYNTHESIS

In all conventional TV systems the picture is 'analysed' into a steady stream of electrical information about its graduations of brightness, and then re-synthesized into a semblance of the original form in two-dimensional space, using the stream of information (video signal) as building material.

The direction and sequence of the analytical 'passes' is of trivial importance, provided they match the corresponding movements at the receiving end *precisely* and in *perfect synchronism.* Usually, and following P. Nipkov and J. L. Baird, they are of *parallel lines* in *ordinary sequence* and in the *same direction.* The simplest method of achieving this is by means of a Nipkov Disc, as shown in Figure 1.

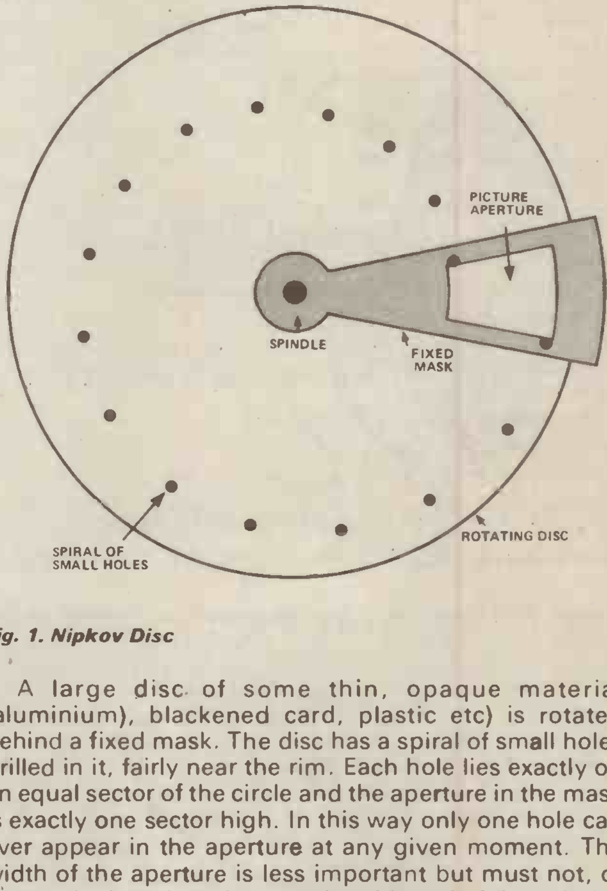


Fig. 1. Nipkov Disc

A large disc of some thin, opaque material (aluminium), blackened card, plastic etc) is rotated behind a fixed mask. The disc has a spiral of small holes drilled in it, fairly near the rim. Each hole lies exactly on an equal sector of the circle and the aperture in the mask is exactly one sector high. In this way only one hole can ever appear in the aperture at any given moment. The width of the aperture is less important but must not, of course, be less than the complete 'throw' of the spiral.

If a diffused light is placed *behind* in the disc at the aperture position and the disc rotated rapidly, an evenly illuminated 'raster' of parallel curved lines will appear in the aperture, the individual holes vanishing through 'persistence of vision'. Each revolution of the disc completes one exploration of the whole area of the picture aperture.

If the light behind the disc fluctuates, lighter or darker patches will appear within the area, these building up the picture in a receiver. In the case of a camera, a convex lens is arranged in front of the mask at such a distance as to focus a sharp image of the subject onto the disc. The light behind the disc is replaced by a photosensing device to convert the analysed picture into electrical signals. Two such discs, mechanically and electrically coupled, constitute a complete NBTV closed-circuit system.

If the principal is not clear from the fore-going description, a model made of two pieces of card and a 'butterfly' paper-fastener should enable the basic notion of *scanning* to be grasped.

A variant of the Nipkov (or perforated) disc is the perforated drum shown in Fig. 2. It works in just the same way and can be made from a round biscuit tin or similar. The raster lines are straight instead of slightly curved as in the disc. It is very easy to mark out the helix of holes on the curved surface because a helix, when straightened out, becomes a *slanting straight line.* For this reason, a strip of paper wrapped round the drum to measure the circumference then removed and creased into equal parts, can quickly determine the hole positions when used as a template. Oddly, the drum has never been as popular as the disc.

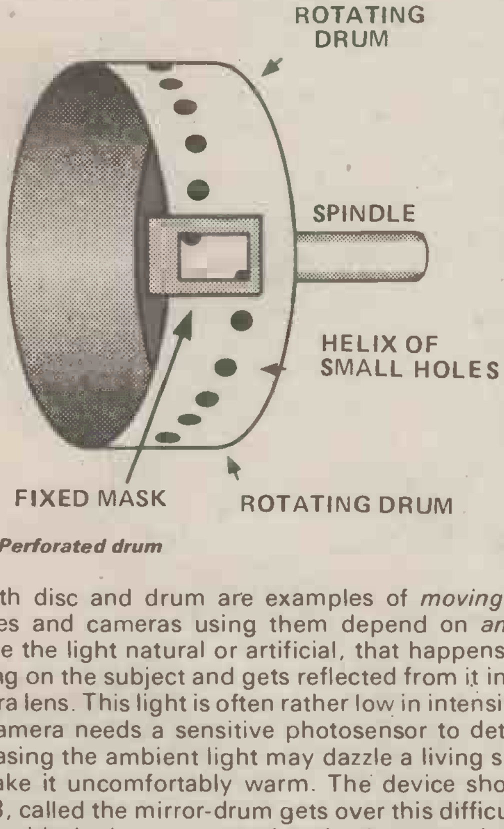


Fig.2. Perforated drum

Both disc and drum are examples of *moving point* devices and cameras using them depend on *ambient light* ie the light natural or artificial, that happens to be shining on the subject and gets reflected from it into the camera lens. This light is often rather low in intensity and the camera needs a sensitive photosensor to detect it. Increasing the ambient light may dazzle a living subject or make it uncomfortably warm. The device shown in Fig. 3, called the mirror-drum gets over this difficulty by using a blacked-out room and projecting a moving spot of intense light onto the subject in the form of a raster of parallel lines. Because of the rapid movement, the subject sees and feels the projected spot as dim and cool, while the photosensor records a high level of reflected light.

The raster is produced, because the flat mirrors arranged around the curved surface of the drum form a perfectly regular polygon when viewed *parallel* to the

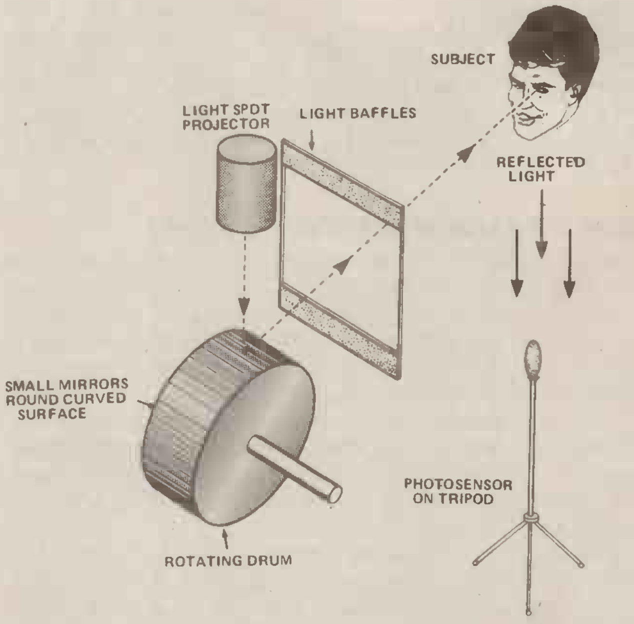


Fig.3. Mirror Drum 'Flying Spot' camera

axle, but are each tilted at a slightly different angle when viewed *at right angles* to the axle. The light baffles are needed to prevent more than one spot of light reaching the subject at any moment and are just a larger version of the mask used on a disc. The whole process is called 'Flying Spot'.

MOVING IMAGE SCANNERS

Moving point devices, like all those described so far, favour photosensors with a fairly large sensitive area, small detectors such as phototransistors, with only a tiny sensitive area, are difficult to employ. For these, *'moving image'* scanners can be used. Two examples are illustrated.

The first, (Fig. 4) uses a disc with lenses instead of holes. It is called a Lens Disc and there is the familiar spiral arrangement. Because of weight and expense, plastic lenses are preferred. Each lens focuses a sharp picture of the subject onto the screen in the centre of which is a small hole. Immediately behind the hole in the screen is a photosensor of small size. When the disc rotates, a succession of images, each in a slightly different position, sweeps across the screen. The analysing effect is just the same as though the hole were moving and the image were stationary.

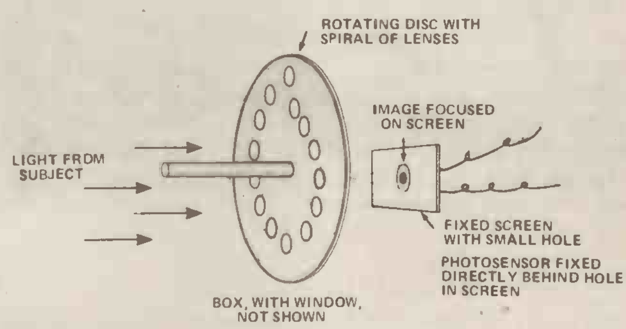


Fig.4. Lens Disc Camera

Another moving image type of scanner is shown in Fig. 5. It employs the mirror-drum shown in Fig. 3 in combination with one good quality lens. Again, a succession of images moves across the screen with one small hole in it. In both moving image devices shown, the screen and photosensor are arranged to have a small 'fore-and-aft' freedom of movement for the purpose of focusing.

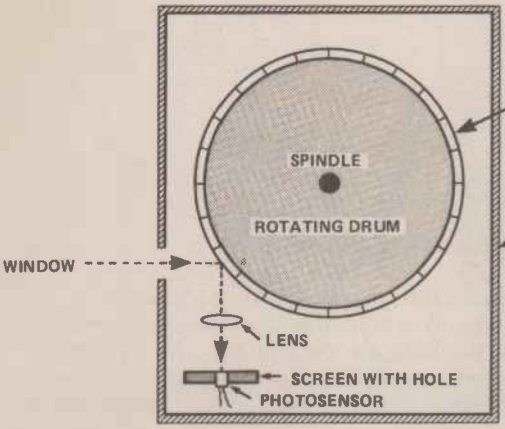


Fig.5. Mirror Drum Camera

AN EXPERIMENTAL NIPKOV DISC

Before constructing your first disc, it is necessary to decide how many holes the spiral is to have, that is, how many lines the picture is to be built up of. You will also have to decide what aspect ratio the picture is to be and how big.

A useful size of disc to start with is 1ft diameter because a ready-made black plastic disc of this size is easily obtainable in the form of a discarded LP record. However, make sure it has been discarded because of scratches, not because of warping.

It is best to select the number of holes (n) in the spiral either from the series 12, 24, 48 etc, or the series 16, 32, 64 etc. These two series, interwoven, ie 12, 16, 24, 32, 48 etc are often called 'Pythagorean Numbers' and a circle can be divided into such numbers using only a ruler and a pair of compasses (or dividers) so you don't need a large protractor.

The aspect ratio (a) of a picture means its length (direction of scanning or spot movement), divided by its width (at right angles to scan) and for a *square* this is of course 1, the easiest figure.

The step(s) of the spiral is the small amount of inward (or outward) movement per sector, so ''ns'' is the width of the picture area. Choose ''s'' as any amount eg 1/16'' or 0.5 mm, to make measurements simpler. As an example, we could choose a 32 hole spiral (so n=32), a 3 by 2 picture so a = 3/2 or 1.5, steps of 0.5 mm each, making s = 5 mm. The outermost hole of the spiral will then be $R_{(o)}$ mm from the centre of the disc, according to the formula:—

$$R_{(o)} = \frac{n^2sa}{2\pi} + \frac{(n-1)s}{2}$$

Substituting figures this becomes:—

$$R_{(o)} = \frac{32^2\times.5\times1.5}{2\times3.14} + \frac{31\times.5}{2}$$

The first fraction works out at 122.3 mm and this, incidentally, gives $R_{(m)}$, the radius to the *middle* of the picture area. The second fraction works out at 7.75 mm and these, added together, give about 130 mm. Since an LP record has a radius of 150 mm, this fits rather nicely. So, after drawing 32 sectors on the record, you mark a point 130 mm from the centre and work inwards 1/2 mm each sector.

MARKING THE SECTORS

Clean off the grooves (strictly, 'one' groove!) on one side of the record with rough glass-paper, then polish smooth with fine glass-paper. Stick a small disc of plastic etc, over the central hole and mark on this, a deep pin-prick *exactly* at the centre of the record.

Since 32 is a number in the *second* series mentioned, we start with a true diameter scratched across the centre, using a good steel rule. Using dividers, we bisect these 180° angles to give four sectors of 90° each, then bisect again to give eight of 45° each, and so on until we have scratched 32 sectors of 11.25° each.

The method is simple and enables us to disregard the actual number of degrees altogether. If the number has been in the *first* series, say 24, we should have started by drawing a large circle and stepping off the radius round the circumference (exactly six times) to give a basic six sectors. Bisecting these gives 12 sectors, and again gives the required 24.

Marking the points of the spiral requires a sharp steel point, a good eye, and an accurate ruler. Finish off with a 0.5 mm drill to give clean holes. The fact that the steps(s) have been chosen as 0.5 mm each does not necessitate the choice of a 0.5 mm drill; in practice a larger drill size is preferable, say 50% larger than the step size.

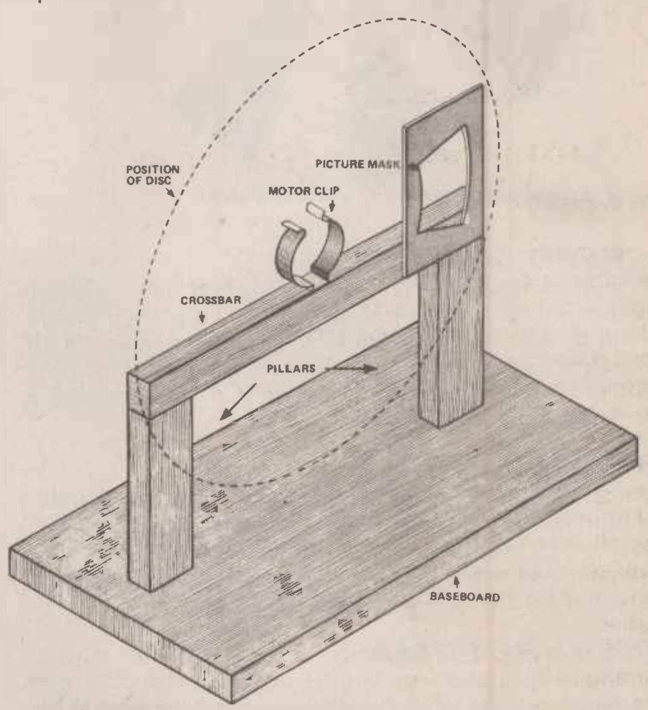


Fig.6. Wooden 'Goal Post' mounting

MOUNTING THE DISC

The simplest mounting is shown in Fig. 6 and is referred to as a 'goal-post'. It consists of a wooden baseboard and three strips of wood. Two of these match the disc's radius and the third matches its diameter. A Terry-clip or similar holds the drive motor or a separate bearing for the disc, if indirect drive is preferred.

CHOICE OF MOTOR

A powerful motor is not needed, provided that the disc has been well balanced and does not wobble. (Sticking on small pieces of card, washers, etc, will effectively cure wobble if carefully done).

Avoid very flimsy motors, such as these used in toys. They produce noise and sparks and 'gobble' up current. Cassette-recorder type motors are much better and justify the extra cost. Before drilling, the centre of the disc to fit the motor-spindle or other axle, stick a paper stroboscope as in Fig. 7 onto one side of the disc.

Indirect drive is preferable to direct, when using a small motor. For this, arrange some sort of bearing for the disc centrally on the crossbar with a pulley-wheel on the axle, and position the motor, with a *smaller* pulley, in a clip directly below on the baseboard. A rubber band completes the drive arrangement.

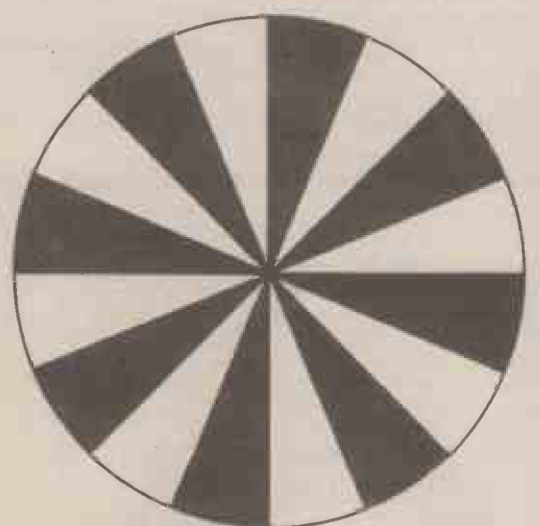


Fig. 7. Stroboscope pattern (approx half size)

SPEED CONTROL

Speed controls used in NBTV are often quite sophisticated, but a simple potentiometer, preferably wire-wound, will do for a start. Measure the motor's DC resistance with a multimeter and choose a potentiometer with roughly the same resistance. Connect the potentiometer in series with the power supply (Fig. 8a).

POWER SUPPLY

Because a very constant speed is needed, dry batteries should be avoided. (They are also expensive and have a short life when used to drive motors). Use a transformed-mains supply, as for model trains or cars, or a rechargeable battery such as a lead-acid type.

PICTURE LAMP

Ordinary incandescent lamps are useless as TV light sources because of thermal lag in the filament. Mains

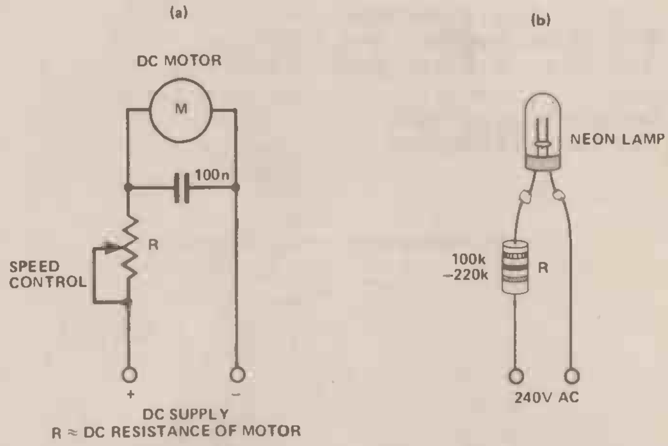


Fig. 8. Connections for motor and lamp

neons are ideal, but manufacture of suitable types ceased years ago (except on the Continent) and you may have to make do with the very cheap wire-ended sort that are generally available. However, these have no limiting resistor built into them so *when used on mains, they must have resistor minimum 100 KΩ, connected in series*. For non-mains usage, this resistor is unnecessary.

Some of the old mains-type neons are still to be discovered and are well worth searching for. In addition, many surplus alpha-numeric tubes are of the neon type and, with their segment pins strapped together, work well as light sources. Small fluorescent 'strip' tubes and mercury vapour lamps have also been successfully substituted for neons, but the latter give off ultra violet light and should not be looked at except through a diffusing screen of some sort. **HE**

Two examples of NBTV pictures taken directly from the screen. The quality looks a bit rough but this is mostly due to the inherent difficulties with photographing this system. In practice the quality is quite acceptable.

Next month in part 2 Doug Pitt explains how to make a camera for your Televisor. With the aid of some simple experiments you can actually start to record your own programmes on an ordinary domestic tape recorder. This could start a new craze, watch out Philips, JVC and Sony, the HEVCR is coming . . . .

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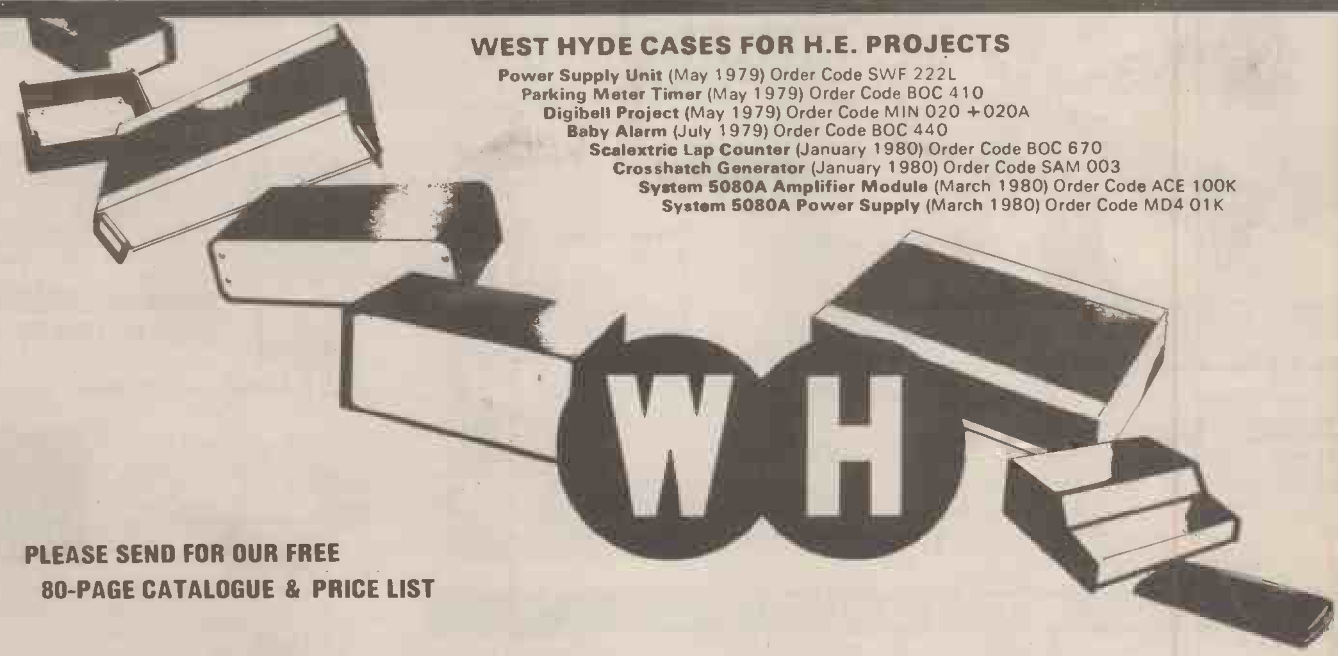

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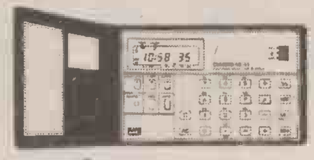

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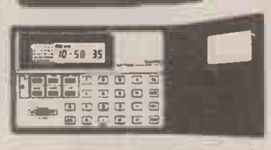

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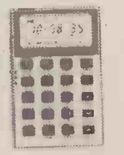

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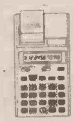

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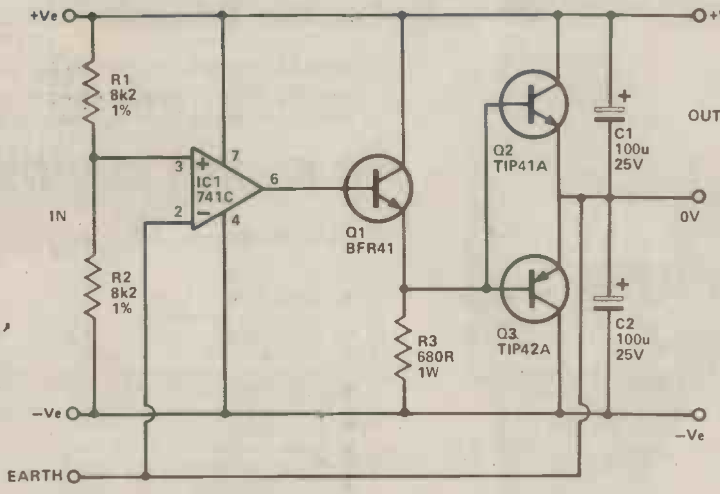
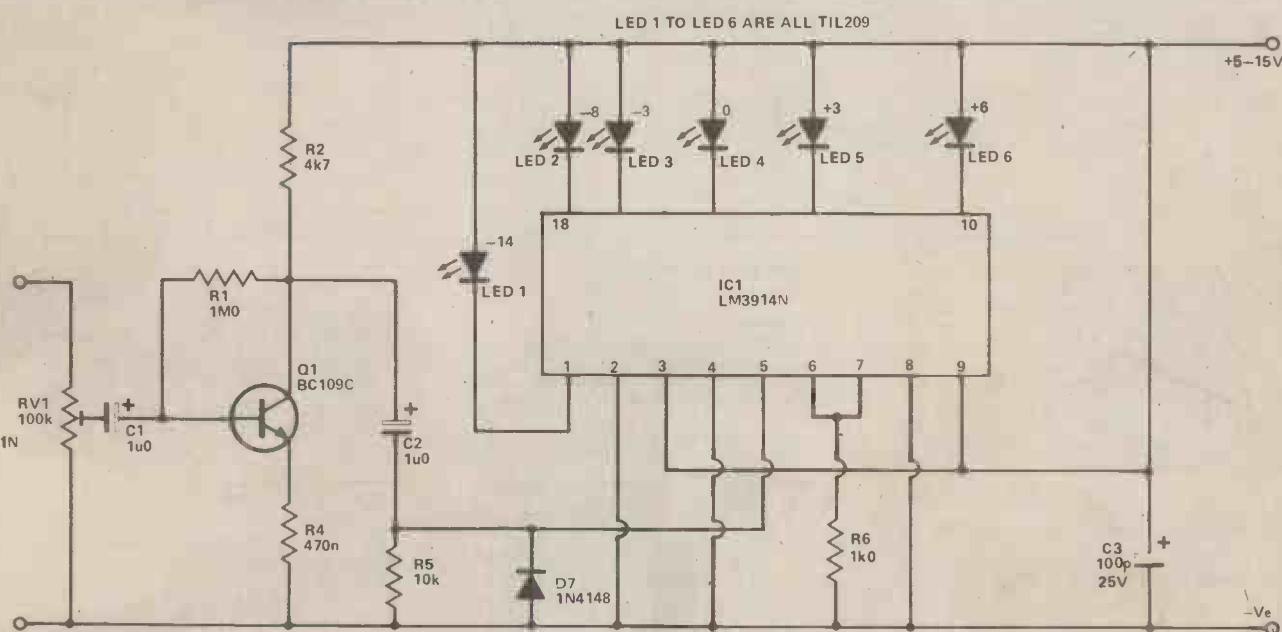


Many operational amplifier based circuits require dual balanced power supplies, and cannot be powered direct from most workshop power supply units which normally only have a single output. One way around this problem is to have an add-on unit, such as the circuit shown here, which can be used to produce a low impedance centre tap on the output of a workshop power supply. If this centre tap is connected to the earth socket of the power supply, and made the 0 V rail, the positive and negative rails will be at equal potentials relative to the 0 V rail, but of opposite polarity. Thus the dual balanced positive and negative rails are provided, but each output rail is, of course, at a potential of only half the input voltage. In other words, for an output of (say) ± 15 volts it is necessary to feed 30 volts into the input of the unit.

This circuit will operate with input voltages of between 9 volts and an absolute maximum of 36 volts, and can handle output currents of up to about 500 mA. or so. The quiescent current consumption is only about 8 to 25 mA., depending on the input potential.

Basically the circuit consists of a potential divider circuit (R1 and R2) to produce an accurate potential of half the input voltage, and a buffer amplifier which is fed with this voltage and produces a low inpedance output at the same potential. The buffer amplifier uses operational amplifier IC1 driving emitter follower stage Q3 — R3, which in turn drives complementary emitter follower stage Q2 — Q3. There is a 100% negative feedback loop from the output at Q2 and Q3 emitters to the inverting (—) input of IC1, giving the amplifier the required unity voltage gain. The high gain of the circuit plus the negative feedback gives a low output impedance so that loading of the output does not pull the 0 V rail significantly off-centre. A complementary output stage is used as this gives the unit a low quiescent current consumption.

If the unit is used at currents of more than about 100 mA., Q2 and Q3 will probably need to be fitted with heatsinks to prevent them from overheating small, finned, bolt-on-types should be sufficient.



LED VU METER

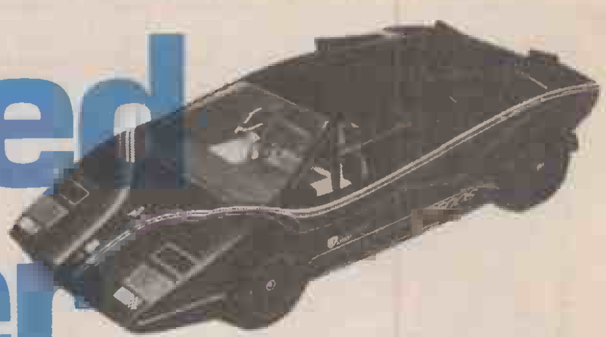
This very simple peak reading VU meter circuit uses six LEDs to indicate six signal levels. Indicators are provided at —14, —8, —3, 0, +3, and +6dB, or any other levels having the same spacing (e.g. —17, —11, —6, —3, 0, and +3dB, if preferred). Only about 24 mV peak to peak is needed in order to activate the highest LED indicator, and so the circuit is sufficiently sensitive to be used with any normal item of audio equipment.

The circuit is based on an LM3914N bargraph display driver device (IC1), which can be used to drive up to ten LEDs. This is connected so that with 0.12 V at the input only the first LED indicator switches on. With the input raised to 0.24 V the second LED switches on as well, 0.36 V causes three LEDs to switch on, and so on up to an input of 1.2 V or more whereupon all ten LEDs are activated. In this circuit only LEDs 1, 2, 3, 5, 7, and 10 are included in the display, and these are D1 to D6 respectively.

The input signal is taken to a variable attenuator (R1) which enables the sensitivity of the circuit to be set at the correct level. The signal is then passed to a low gain common emitter amplifier based on Q1 which gives a tenfold boost in the sensitivity of the circuit, and ensures that it is adequate in this respect for all normal requirements. C2 couples the output from Q1 to the input of IC1. R5 is the input bias resistor for IC1, and D7 protects IC1 against an excess negative input voltage. Of course, IC1 only responds to the positive half cycles at its input, but this gives perfectly satisfactory results in practice. R6 sets the current fed to each LED at about 12mA, but as the circuit only responds to positive input half cycles the LEDs can switch on for a maximum of about 50% of the time. This gives an effective LED current of about 6 mA. The quiescent current consumption of the unit is about 8 mA, rising to an absolute maximum of about 44 mA with a six LEDs activated.

To calibrate the unit a 0dB test signal should be fed into the monitored equipment, and R1 is then adjusted for the lowest sensitivity that does not cause the 0dB LED to extinguish. The input impedance of the unit is about 80k and it will only lightly load the monitored equipment.

R/C Speed Controller



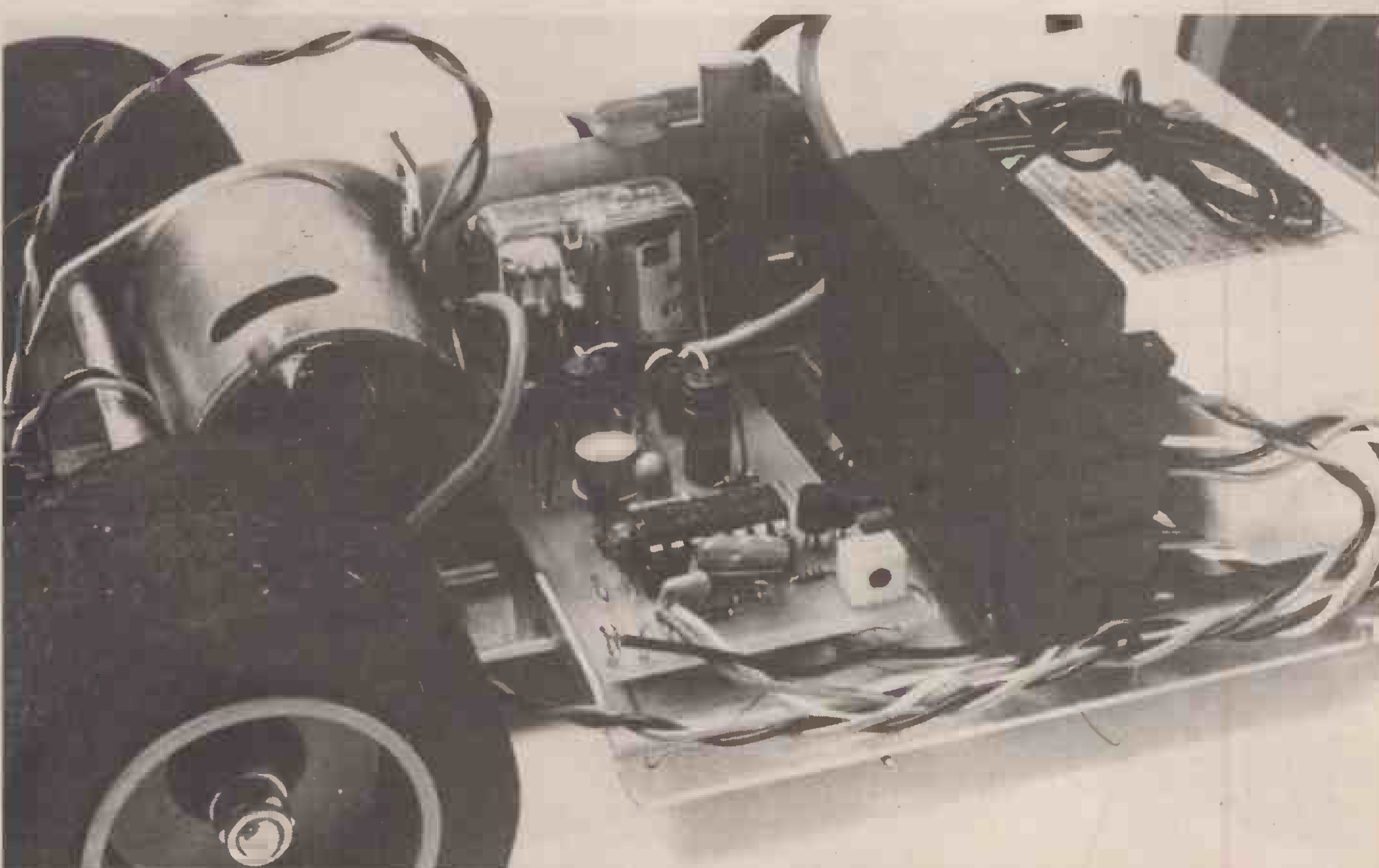
A state-of-the-art unit that allows precision control of model electric motor speed and direction via a single radio control 'proportional' channel. The unit can supply motor currents up to 15 amps.

THIS DEVICE lets you use a single channel of your proportional radio control system to control both the speed and direction of an electric model motor. The unit has been designed specifically to control the Mabuchi RS-540 racing motor fitted to our Timaya 1/12th scale Countach LP500S Competition Special but can in fact be used to control any 4 V5 to 12 V DC electric motor that draws peak currents below 15 amps (a 15 amp protection fuse must be wired in series with the motor's supply battery).

The unit incorporates two parallel-connected power output transistors, which must be bolted to a decent heat sink: we use the car's metal chassis as the heat sink on our prototype, but other arrangements are, of course, possible. The unit is ideal for use in model boats and large-scale land vehicles. It costs only a fraction of the price of equivalent commercial units.

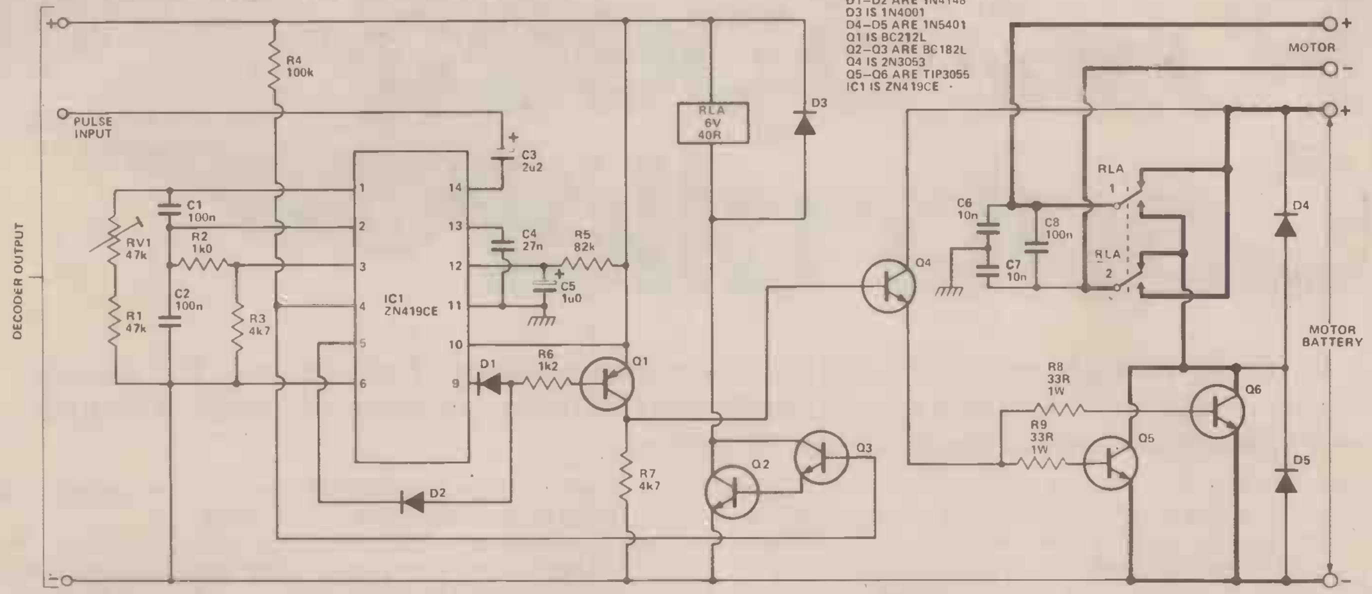
In 'conventional' radio-controlled motor-speed controllers a special heavy-duty rheostat assembly is wired in series with the motor and it's supply battery and has it's moving arm controlled via a conventional rotary-action servo unit which is driven from one of the proportional radio control decoder channels. This system is cumbersome and expensive and, worst of all, gives very poor low-speed motor control characteristics.

Our unit can be used to directly replace an existing servo/rheostat control assembly and gives excellent motor control characteristics right down to 'crawl' speeds. The logic section of the unit is fed (like a conventional servo) directly from one of the receivers



With the Countach's body removed you can see how neatly the controller fits into the chassis pan. Unless space is really at a premium we suggest you stick to our layout.

Fig. 1. Circuit diagram of the Motor Speed Controller. The thick connections are for the high-current carrying motor wires.



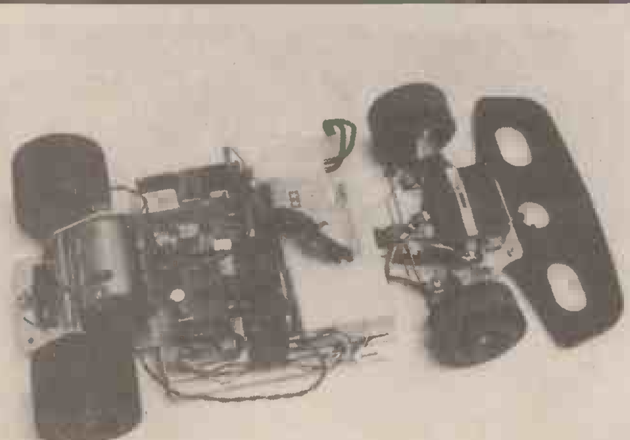
How it Works

A normal proportional radio control 'channel' signal consists of a positive pulse with a width that is variable between approximately 1 mS and 2 mS via the transmitter joystick. The pulse has a nominal width of 1.5 mS with the joystick centred and is repeated at a 'frame' rate of 50 Hz, or once every 20 mS. The 'centred' pulse width can be varied over a limited range by a 'trim' control associated with the transmitter joystick.

All of the 'logic' of our motor speed controller is carried out by IC1 and it's associated components. Each time an input pulse is received via C3 the IC generates a 1.5 mS (nominal) reference pulse (via C1-RV1-R1) which it compares with the incoming pulse width. If the input pulse is less than the reference the IC generates a high output at pin 4 and turns direction-control relay RLA on via Q2-Q3: if the input pulse is wider than the reference, pin 4 goes low and the relay is turned off.

Simultaneously, the pulse-comparator circuitry generates an internal pulse with a width equal to the difference between the two pulses and this pulse is then expanded by a factor of about 20 (via R5-C5) and is presented to pin 5 or 9, depending on the relative 'phase' of the incoming pulse. The pin 5 and 9 signals are then 0RED via D1-D2-Q1 and fed to the power driver circuitry via Q4.

The net result of the above action is that the signal reaching Q4 takes the form of a 50 Hz (nominal) square wave with a mark/space or on/off ratio that is infinitely variable via the transmitter joystick. This waveform is used to switch power transistors Q5-Q6 via Q4 and so control the power feed to the motor via the contacts of the direction-control relay. When the joystick is moved to the extreme position in either direction, full power is fed to the motor. The motor receives zero power when the joystick is centred. IC1 incorporates 'deadband' circuitry (controlled via C4) which ensures that there is a narrow band around the joystick 'centred' position in which zero power is fed to the motor, thus enabling the motor to be easily 'neutralled' via the joystick.



Installed and ready to go in our workshop Countach.

decoder channels via a 3-wire servo harness. The power feed is taken to the motor and it's supply battery via four heavy-gauge leads.

The unit can be used in conjunction with any modern fixed-frame multi-channel proportional radio control system that gives positive decoder output pulses with widths variable over the approximate range 1 mS to 2mS (these are the 'standard' parameters of virtually all modern systems). The unit incorporates only one pre-set pot, which is used to set the motor drive to 'off' or 'neutral' when the transmitter joystick and trim controls are centred. The motor direction is controlled (via the joystick) by a heavy-duty relay mounted on the unit's PCB.

CONSTRUCTION AND USE

Before starting construction, check that your model has sufficient space to accommodate the unit and that

R/C Speed Controller

Parts List

RESISTORS (All ⅛watt 5% unless specified)	
R1	47k
R2	1k0
R3, 7	4k7
R4	100k
R5	82k
R6	1k2
R8, 9	33R 1 watt
CAPACITORS	
C1, 8	100µ resin dipped ceramic
C2	100µ polyester
C3	2µ 2 10 V tant
C4	27n polycarbonate
C5	1µ 0 10 V tant
C6, 7	10n resin dipped ceramic
POTENTIOMETERS	
RV1	47k side adjusting sub-min trimming pot
SEMICONDUCTORS	
IC1	ZN 419CE
Q1	BC 212L
Q2, 3	BC 182L
Q4	2N 3053
Q5, 6	TIP 3055
D1, 2	IN 4148
D3	IN 4001
D4, 5	IN5401
MISCELLANEOUS	
RLA	6 V 40R relay PC mounting 2-pole changeover

Buylines

IC1 should be obtainable from most of the larger mail order companies, e.g. Technomatic.
The printed circuit mounting relay is available from Watford.
Resistors R1-7 are all ⅛watt types which you can get from Electrovalue.
All other components are fairly common types which should present no difficulties regarding availability.

adequate heat-sinking arrangements are possible. If your model does not have a metal chassis that can be used as a heat sink, a suitable sink (capable of dissipating about 15 watts) will have to be constructed.

All components, including the heavy-duty direction-control relay (see Buylines), are mounted directly on the PCB. Note that sub-miniature components are used where possible and that IC1 is mounted in a 14-pin socket. Take particular care in the construction to observe the polarities of all semiconductor devices, etc. When construction is complete check that there are no shorts between tracks and then give the unit a function check as follows.

Make three connections between the unit's input and one of the receiver decoder outputs, as shown in the circuit diagram and the overlay, using a standard 3-wire servo harness and socket. Switch on the receiver and transmitter and check that relay RLA can be turned on and off via the transmitter joy stick.

If all is well, make two connections from the unit's output to the motor, using heavy gauge wire, and two connections to the motor battery, taking care to wire a 15 amp fuse in series with the battery positive lead. Now operate the transmitter again and check that the motor speed and direction can be controlled via the joystick. If necessary, reverse the motor lead connections to obtain the desired direction of motor rotation.

Centre the joystick and it's associated 'trim' control and adjust RV1 so that the motor goes into the 'off' or 'neutral' mode under this condition. Advance the joystick and check that the motor reaches full speed with the stick slightly short of the 'full' position. If full speed is not obtained, increase the value of pulse expansion resistor R5. Alternatively, you can limit the maximum speed by reducing the R5 value.

When the above checks are complete, fix the unit into place in the model via the two power transistors. If you are using the chassis as a heat sink, note that it must either be electrically insulated from all other circuitry or the two power transistors must be mounted via suitable insulation washers. Also note that the unit's output-to-battery connections do not need to be provided with an on/off switch.

HE

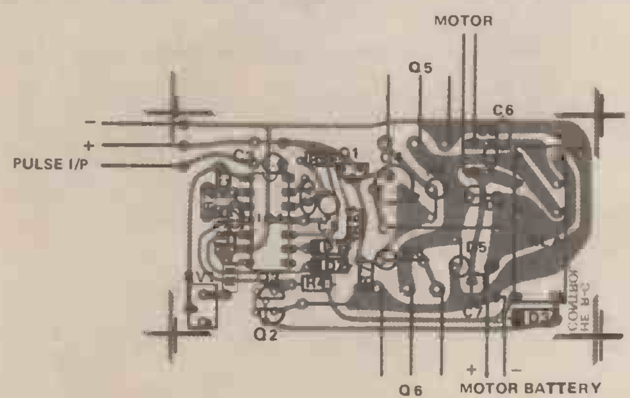


Fig. 2 (left) Overlay diagram for the R/C Motor Speed Controller.

Fig. 3 (right) PCB foil pattern. Ensure the relay tags are securely soldered.

HE MARKET

LCD CHRONO

We feel we've got to tell you carefully about this offer. Why? Because our price is so enormously lower than anywhere else you may suspect the quality.

The display is LCD and shows the seconds as well as the hours — and minutes — press a button and you'll get the date and the day of the week.

Press another button for a couple of seconds and you have a highly accurate stopwatch and hundredths of a second displayed and giving the time up to an hour. There is a lap time facility as well — and of course a back light.

Our Chrono comes complete with a high grade adjustable metal strap and is fully guaranteed.

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ALARM-CHRONO LCD

This new addition to our unbeatable selection of bargains is no ordinary LCD watch. It's a slim, multi-function, dual time chronograph alarm watch, no less.

This model will show hours, minutes, seconds, date, day of the week, stop watch, split time, alarm and alternate dual time zone — not all at once, of course. There is also a night light.

Hours, minutes, seconds and day of the week are displayed continuously, while the date will appear at the touch of a button. The day of the week is indicated by a flag. When used as a stopwatch, the maximum count is 0.1 secs. short of thirteen hours.

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Please allow 28 days for delivery

PLACE

DIGITAL ALARM CLOCK RADIO

THIS IS THE THIRD digital alarm clock that we are offering (we regret the earlier versions are no longer available). We have sold thousands and thousands of these and our buying power enables us to offer a first rate branded product at a really excellent price.

The Hanimex HC-1100 is designed for mains operation only (240V/50Hz) with a 12 hour display, AM/PM and Alarm Set indicators incorporated in the large display. A switch on the top controls a Dim-Bright display function.

Setting up both the time and alarm is simplicity itself as buttons are provided for both fast and slow setting and there's no problem about knocking these accidentally as a 'locking' switch is provided under the clock. A 9-minute 'snooze' switch is located at the top.

An example of this clock can be seen and examined at our Charing Cross Road offices.

£10.60

You probably won't believe us as we're selling the goods but we're going to tell you anyway! We have *rejected* eight clock radios for Marketplace, they were all cheap enough but the quality was so poor that we couldn't have lent our name to them. However, we are now able to offer another portable LCD Clock Radio to you which meets our standards.

The clock is a 12-hour one with AM/PM indicated and a back light. The radio is Medium Wave with very nice quality for a small speaker. The alarm can be either a beep-beep type or the radio, there's also a snooze facility.

The cylindrical construction is in keeping with the very modern styling. The tuning dial is actually incorporated into one of the end caps!

We won't even mention the RRP — but just check on comparable prices — you'll find ours a bargain.

An example of this Clock Radio can be seen and examined at our Charing Cross Road offices.

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Hobby Chit~Chat

HE project editor and chief designer Ray Marston presents ten simple transistor projects to help while away your evenings.

REGULAR READERS of HE will no doubt have noticed (and possibly regretted) the almost total absence of simple transistor circuits from the 'projects' sections of the magazine. The truth is, of course, that one- and two-transistor circuits are usually regarded as a bit 'old hat' these days, when inexpensive ICs such as the 741 Op-Amp and the 555 timer can so easily outstrip them in most applications in terms of performance sophistication and cost effectiveness.

Still, one of the greatest pleasures of hobby electronics comes from actually 'messing about' with circuits and thereby 'learning things'. In these terms, transistor circuits can be as much fun as any other type, so, with these points in mind, we devote this month's 'Chit-Chat' feature to describing ten simple little transistor circuits that you can fiddle with when you have a few spare evenings.

LINEAR AMPLIFIER CIRCUITS

Our first circuit (Fig 1) is a simple common-emitter pre-amplifier that you can use for boosting weak audio input signals to a more useful level. For a simple demonstration of its effectiveness, feed its input from the output socket of a radio and then alternately connect a crystal earpiece between the circuit's input and output. The circuit gives a voltage gain of about 50, so you'll notice a great difference between the input and output signal levels.

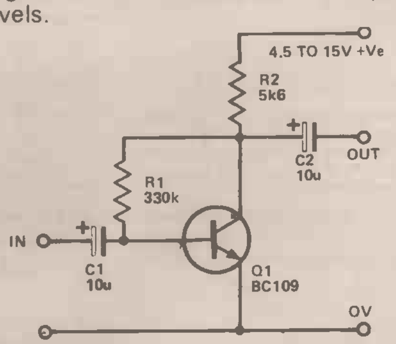

Fig. 1. Simple Pre-Amplifier circuit gives a voltage gain of about 50 and has a frequency response extending from 25 Hz to 120 kHz.

The Fig 2 circuit is a simple emitter follower stage. The main purpose of this circuit is to convert the signal from a high-impedance source (such as a crystal pick-up) into a low-impedance output. The circuit gives unity voltage gain. This particular design has an input impedance of about 180k.

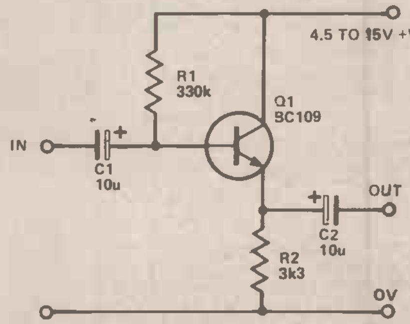

Fig. 2. This simple Emitter-Follower circuit gives unity voltage gain but has an input impedance of about 180 k.

The Fig 3 circuit is a 'tarted up' emitter follower. It uses two transistors and lots of feedback (via C2) to boost the input impedance to about 4MO. The two transistors are wired as a 'Super-Alpha' pair and act like a single transistor with a current gain equal to the product of the two individual gains, about 10 000 in this case.

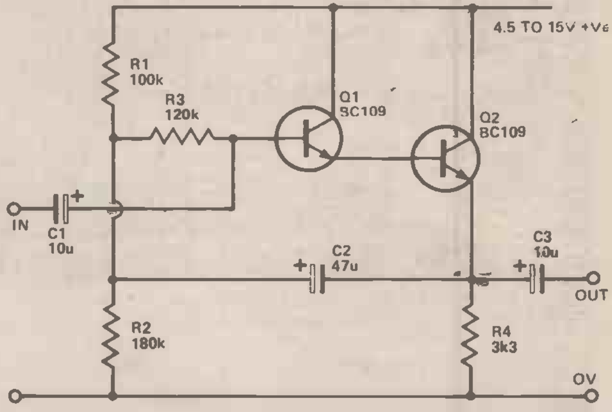

Fig. 3. This 'Bootstrapped' Emitter Follower has an input impedance of about 4MO and can be used to convert a High-Impedance Pick Up to a low-Impedance signal.

Fig 4 shows another application of the 'Super-Alpha' principle, in which Q1-Q2 can be regarded as a single transistor with a gain of about 10 000. In this case the 'transistor' is used in the common emitter mode and uses relay RLA as a collector load. If we assume that the relay turns on at about 100 mA, you'll see that this current can be obtained with a Q1 base current of only 10 uA (= 100 mA/10 000). This current can in turn be obtained via the positive supply line by wiring a resistor of 1MO or so across the probes.

In practice, the relay will turn on at less than 100 mA and the Super-Alpha gain of Q1-Q2 will probably be greater than 10 000, so you'll find that the relay will turn on if any resistance less than a couple of megohms is placed across the probes. Water, steam and skin resistance have resistances below this value, so this simple little circuit can be used as a water, steam or touch-operated relay switch.

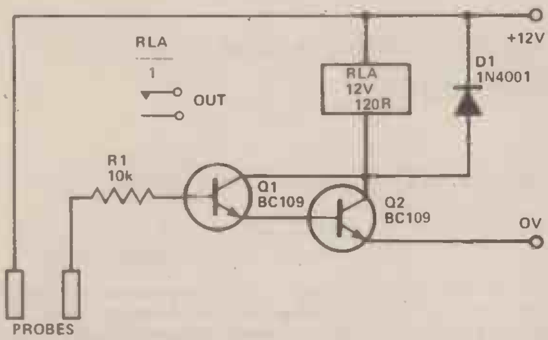

Fig. 4. Touch, water or steam operated relay turns on when a resistance less than a couple of Megohms is placed across the probes.

OSCILLATOR CIRCUITS

Oscillator circuits often make amusing and/or useful projects. One of the simplest oscillators is the 2-transistor astable multivibrator or square wave generator, an example of which is shown in Fig 5. Here, the two transistors are cross-coupled via R-C networks (C1-R4 and C2-R3) in such a way that the transistors alternately switch on and off in opposition to one another. If the R-C networks have equal values, as in Fig 5, symmetrical but anti-phase signals are produced at the collectors of Q1 and Q2, with one transistor turning on when the other is off, and vice versa.

In the Fig 5 circuit LEDs are wired in series with the transistor collectors and flash on and off in opposition to one another at a rate of about 1 flash per second. The

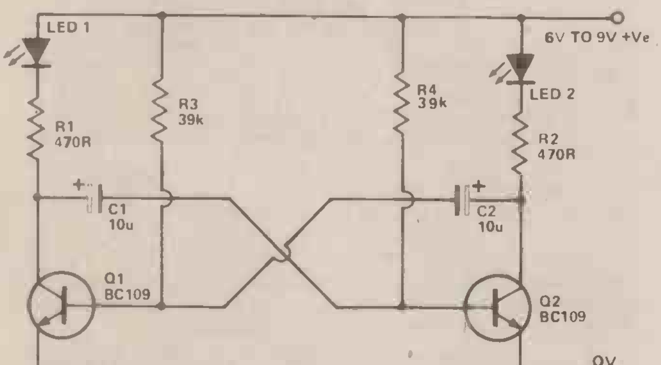

Fig. 5. This LED flasher operates at about 1 flash/second. The rate can be increased by reducing the C1/C2 values or vice-versa.

flash rate can be changed by altering the values of either C1/C2 or R3/R4. This simple 'flasher' circuit provides about 10 seconds of interest to the casual onlooker but hours of pleasure to the avid electronics experimenter.

A simple variation of the astable circuit is shown in Fig 6. Here, a non-symmetrical waveform is generated and is fed to a speaker and limiting resistor in the collector of Q1. The unit can be used either as a 'sound generator' or as a 'morse code practice oscillator'. The tone frequency can be changed by altering the C1 and/or C2 values.

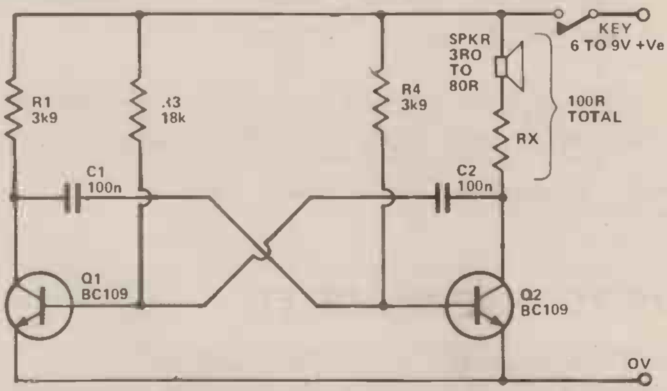

Fig. 6. This Morse-Code oscillator is a simple modification of the Fig. 5. circuit.

Fig 7 is a simple crystal oscillator circuit which can be used to calibrate the dial of a radio or the timebase of a scope. If, for example, you use a 100 kHz crystal, the circuit will give 10 uS markers on a 'scope waveform or 100 kHz harmonic calibration points (100, 200, 300 kHz, etc) on a radio dial. To calibrate a 'scope you need to feed the circuit's output directly to the 'scope's 'Y' terminals. To calibrate a radio, no physical contact is required and it is sufficient to simply place the oscillator close to the radio antenna.

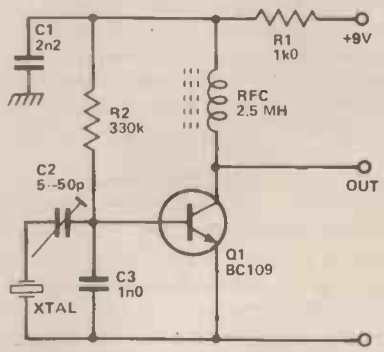

Fig. 7. This simple crystal-controlled oscillator can be used with any good 100 kHz to 5 MHz crystal. C2 can be used to set the crystal against a standard.

The Fig 7 crystal oscillator circuit will only work well with good quality crystals. The 2-transistor Fig 8 circuit, on the other hand, will work with just about any 50 kHz to 10 MHz series-resonant crystal that shows the slightest signs of life. Q1 is wired as a common base amplifier and Q2 is an emitter follower and the circuit acts as a strong oscillator that generates a large-amplitude output. An excellent circuit.

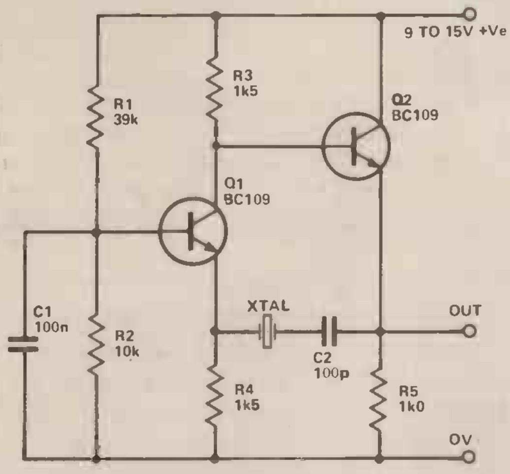

Fig. 8. This wide-range oscillator can be used with virtually any 50 kHz to 10 MHz crystal.

DC-TO-DC CONVERTER

The Fig 9 circuit is a simple design that converts an innocent 9 volt battery supply into a shocking 300 volts DC output. What you do with such an output in the privacy of your own home is your own affair: the mind boggles. The circuit is, however, an absolute MUST for the experimenter.

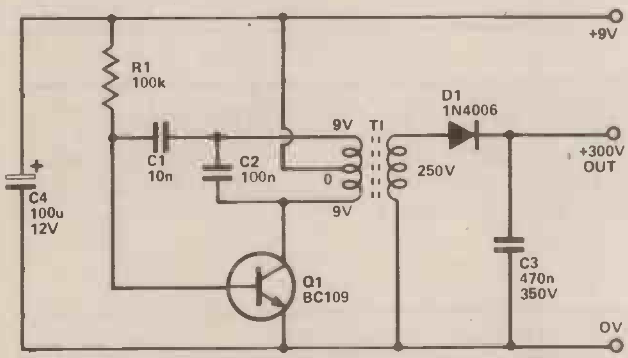

Fig. 9. This simple 9 V to 300 V 'converter uses a 9 V-0 V-9 V mains transformer in the oscillator/inverter mode. Output current is limited to a few mA.

Circuit operation is quite elementary. Q1 is configured as an L-C oscillator, with the primary of any low-power 9 V-0-9 V mains transformer acting as it's 'L' load. This voltage is stepped up to about 350 volts peak at T1 secondary and is half-wave rectified by D1 and used to charge C3. With no permanent load on C3, the capacitor can deliver a healthy but non-lethal 'belt'. With a permanent load on the output, the output fall to about 300 volts at a load current of a few milliamps. A neon 'mains' indicator can be wired across C3 to indicate the presence of the high output voltage.

A LIE DETECTOR

Our final circuit (the lie detector of Fig 10) is most emphatically an 'experimenters' circuit. Here, the 'victim' is connected, via a pair of substantial metal probes, into a Wheatstone bridge circuit formed by R1-RV1-Q1 and R3-R4. The meter, which should be a centre-zero type, is used as a bridge-balance detector. In use, the victim makes firm contact with the probes and, once he or she has attained a relaxed state (in which the skin resistance attains a stable value), RV1 is adjusted to obtain a null on the meter. The victim is then cross-questioned.

The theory of operation is that the victim's skin resistance will change and the bridge will go out of balance if he or she lies or shows signs of emotional

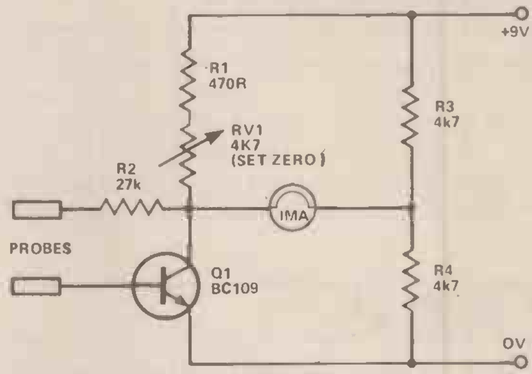

Fig. 10. A simple 'Lie Detector'. The two probes are held in both hands and RV1 is then adjusted for a meter 'null'. Any change in skin resistance (due to embarrassment, etc) causes the meter reading to change.

upset, (embarrassment, etc) when being questioned. Some people claim wonderful results from this circuit. Personally, I find that it gives not the slightest flutter when I lie but goes absolutely berserk when I think about "thingy' (you know). Maybe you'll find the same. **HE**

ETI MAY 1980

THE BLACK HOLE

We proudly present the latest offering from Tim Orr, the prolific producer of music machines — the Black Hole Chorus Machine. It's capable of processing the output of both natural instruments and synthesisers.

In addition to the chorus effect you can also choose genuine vibrato. That's not all — you can select a 'double' chorus option. The speed of both effects can be controlled manually. If you're not into knob-twiddling or you don't have a free hand or two, the Black Hole can be controlled by footswitch. Keep up with what's happening in music machines and much, much more in the next audio special issue of ETI.

KIT SURVEY

Across the length and breadth of this sceptred isle, there are companies producing kits of everything from power supplies and pin ball games to amplifiers and ignition systems. Want to buy a kit? How do you know who the supplier is, where he is, how reliable his product is and how much it costs? You could search through a dozen or so electronics magazines and spend a small fortune on postage to collect a library of catalogues.

Why don't you do it the easy way? Let ETI's fingers do the walking for you. Next month we get it all together — kits, suppliers, prices, quality — in an easy to compare format.

IMAGE CO-ORDINATOR

How to throw your voice without straining your vitals — build the ETI Image Co-ordinator. The clever co-ordinator takes your single vocal (or guitar, etc.) input and splits it in two. What can you do with two half voices? You can recreate a single sound image and make it move around, suggesting a few interesting stage and studio effects. The Image Co-ordinator uses two of the 1537A VCA chips introduced by Keith Brindley in March.

LED VU

Banish the bearings from your VU meters. Change over to a stylish LED display. Our LED VU meter is based on the LM3915, a chip which gives you VU or peak programme (PPM) options with bar or dot display. Look in next month to see the VU from ETI.

SERVO TESTER

Last month's Radio Control Fail—Safe stops your plane or boat disappearing into the sunset if you lose control of a channel, for whatever reason. When you get your plane or boat back onto dry land, a thorough systems check is number one on the list of things to do. A servo fails to operate. Is it the servo or the receiver? You can eliminate the servo by using our servo tester — an unusual and useful little piece of test gear.

SYNTHESISER

The Project 80 Modular Synthesiser returns with designs for the four filters most widely used in music synthesis — low pass, high pass, band pass and phase shift. They are four pole filters with one volt per octave control of their cut-off, or centre, frequency. Voltage control of signal regeneration is also included.

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CB Breaker One Four

Send any news, comments or information you may have to: Breaker One Four, Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE.

Breaker One Four goes up to three pages this month. Now we can bring you even more of the latest news and information. Look out for the pictures of the demonstration and in the coming months equipment reviews

WELCOME to the new style Breaker One Four. We've decided to increase our coverage of the CB scene to nearly three pages (our regular readers need not worry, though, we haven't sacrificed any of our other features or projects).

As you will have doubtless noticed, the number of companies advertising CB accessories has also increased dramatically, a CB magazine can't be far away! This trend reflects the healthy growth in CB over the last few months (it is less than a year since we first published 'Citizens Banned'), and we hope that we have brought legalisation that little bit nearer. Already there have been reports in some national papers taking the view that CB will be legalised in the next few months. We've had our fingers burnt in the past making predictions so we will just continue to bring you the latest news until we have something more definite. Suffice it to say, don't believe everything you read, it's so easy to check these things out, but more of that later. Now to this month's news.

Yes, even BOF makes mistakes, although nobody spotted it, last month we said that the amateur band next door to CB was on 11 metres and CB was on 10. Actually it's the other way round.

CB SOUND EFFECTS

Some of you seem hell-bent on making a name for yourself, why anyone should want to intersperse their conversation with an assortment of squeeks and other outlandish noises, we'll never know. But you're the bosses and in response to the dozens of phone calls here is the address of a company that is willing to sell you one of the famous 'Tweety Boxes' so popular with our American cousins. They are: Frontcrest Ltd, 79 Church Road, Hendon. And may God have mercy on your wallets because they cost something like 40 quid each. Purely in the interests of journalism we'll try and get hold of one of them and tell you exactly what you're letting yourselves in for.

One last note for those of you in the Harrow area, The Harrow and Wembley group that meet at the Queens Arms would like to point out that the High Street in question is in Wealdstone. It appears that there are several High Streets, doubtless with more than one Queens Arms.

NEW CLUBS

A selection of the lastest clubs to open their doors for your notebooks.

Don Valley Breakers (HE)
c/o 282 Ecclesall Road,
Sheffield S11 8PE.
Please note this is also the new address of the Steel City Club mentioned in the December BOF.

G B A (We don't know what it stands for either)
c/o Coronation Service Station,
Middleton Road,
Heywood,
Lancs.
Secretary Bob

DEMO 2 (23rd FEBRUARY SPEAKERS CORNER)

This was much more like it, the rain held off, nearly 1,000 people turned up and a good time was had by all.

BOF arrived at Speakers Corner at the appointed hour (11 am) to find about fifty stalwart CB campaigners collected around the tea hut. (They must have taken our comments on the last demo to heart.) We later discovered that the march had been postponed until midday so it gave us a chance to meet a few of the organisers. In

It was a friendly march, CB is for everyone.

It must have been the tea or the promise of a troupe of majorettes.

attendance were Richard Towne (Technical adviser to the Government Committee on CB), Theo Yard (Councillor for Lewisham), Andy Donovan (we all know him) and the ever-ready Keith Townsend of the Midlands CB club. (Incidentally, next time Keith, have something to eat before you travel all the way from Birmingham.)

Things really started to happen about 11.30, rumours that there was to be a troup of Majorettes to lead the march were soon confirmed by the arrival of said young ladies. Hopes were dashed equally rapidly when it became apparent that the oldest majorette was

Richard Towne signs the latest petition. This one is aimed specifically at Londoners. Andy Donovan (right) awaits his turn.

The ever-hungry Keith Townsend (left) discussing the march with Richard Towne.

approaching 9. Actually the young ladies put on a splendid show and were gallant enough to cover the entire march in a quite strong wind without so much as a murmur. We would like to thank the girls from Kilburn for really livening up the proceedings. Next time girls, how about bringing along your big sisters?

At about 12.00 Richard Towne and Theo Yard had a few words to say to the assembled masses, they sent round some petition forms for everyone to sign. They hope to exceed ours, more power to their collective elbows.

The speeches over, the march finally got underway. The gentlemen in blue provided an escort and assisted in negotiating the Saturday traffic. Keith Townsend provided the entertainment by encouraging everyone to chant as they marched. We think you need some new batteries for that megaphone Keith.

The procession arrived at Waterloo Bridge House (The Home Office) at around 3.00 and after handing over some letters to the gentleman on the door (for the attention of the Home Secretary, the contents of which you can doubtless guess) the demonstrators then pro-

The march with its police escort just before it left Hyde Park. Who is the suspicious character on the left, someone from the Home Office perhaps?

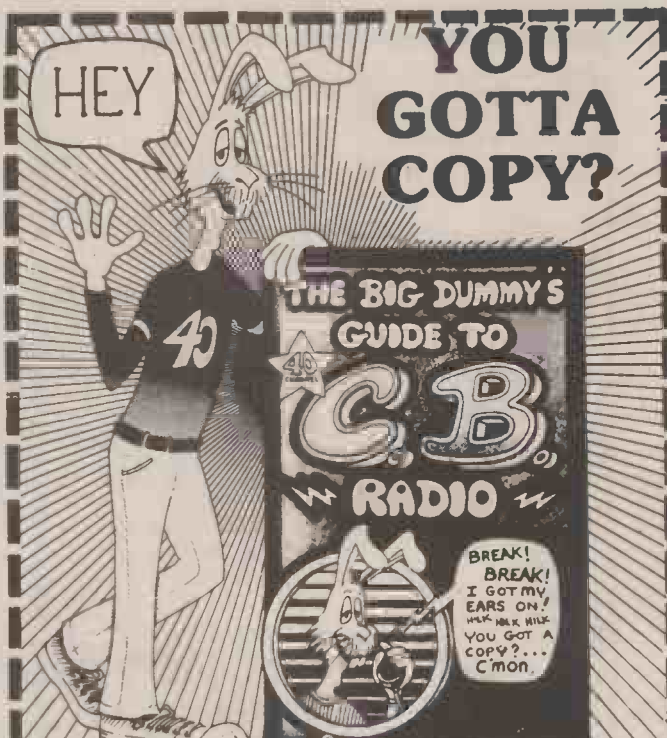
ceeded to the adjacent park for a few more words from the organisers.

The big question is, did it do any good? We are sure it did, but demonstrations are like medicine, they must be taken regularly. The show on Saturday was impressive and it has certainly made a few people take note. The next one on April 27 MUST be bigger, we have shown we mean business now we must convince them that we intend to keep demonstrating for CB until it is legalised. See you at the next one and thanks to everyone who turned up.

The march getting underway, the column stretched for nearly a quarter of a mile.

OVERSEAS CB

We had quite a bit of response to our plea for QSL cards from overseas CBers and we'll be publishing a selection soon. The furthest (distance wise) reply so far has come from Australia, (actually it would be quite difficult to be any further away, interstella CB perhaps?). It comes from a lady called Ma Baker (miss) who lives in Perth, she runs a base station with a half wave antenna at 12 Watts sideband on 27.450. Thanks for the contact. Our second furthest letter comes from John Tennant in Canada, he would like to get in touch with any English CBers. Unfortunately the 4 watts he pushes out might not reach this far so if you would like to have a penfriend



with similar interests then you can write to John at: 508 Village, Morin Heights, Province of Quebec, Canada, J0R 1H0.

GERMAN GEAR

A couple of weeks ago BOF was in Germany to look around one of the largest electronics shows outside the 'States. There wasn't much in the way of really new equipment but a couple of interesting odds and ends were to be found if you looked hard enough.

One of the first things that caught our eye was a pedal bike CB. Obviously with power supply limitations (and remember German CB is limited to 0.5 Watt PEP) the performance wouldn't be up to much but it is a real CB rig and as such might just help someone out one day.

Some unusual looking mikes were on one stand. They looked so strange we were prompted to find out more. They were called Revolver Mike and came in two styles. Both looked something like the butt of a pistol with the barrel removed. The design was so comfortable and the trigger mike key so easy to use we wonder why this type of mike hasn't been tried out before. Both had a simple speech processor circuit built in, similar in concept to the K40 although they required a battery to drive the circuitry.

Antennas were also in considerable abundance. Most interesting were the glass mounted aerials that have been around for a year or so. The base of the antenna actually sticks to the car windscreen (or any other window) and the RF is coupled capacitively through the glass, to a plate stuck on the interior of the car windscreen. Actual performance is difficult to gauge but it does do away with holes in your lovely new car (and it can be removed very quickly indeed). Hopefully we'll have some pix of these new bits and pieces next month.

NEWSLETTERS

Some of the better organised clubs have started sending out newsletters to their members (and to us we hope). The latest example to come into the BOF office is from the MCBRC and makes very interesting reading. If any of the newer clubs are planning to, or have already produced a newsletter we would like to see it. This will enable us to keep in touch with local events and the interesting bits we'll publish for the benefit of everyone.

DEALERS

As you can see from all the ads in this month's issue CB accessories have become big business. Unifax Ltd are currently offering a discount to all BOF readers on antennas if you ention their ad. The Base loader can be yours for just £17 and the screw-on gutter aerial is just £13, sounds OK to us.

LATE NEWS

We heard hours (literally) before we went to press that the Southern Irish Government are likely to legalise CB in the next few months. We hasten to say we couldn't check it up in time and if this proves to be a rumour Keith Townsend will be speaking in a considerably higher voice. We are still against rumour-mongering but we felt this was too important to ignore.

Stay lucky . . . .

HE

Into Electronics Construction

PART 3 BY IAN SINCLAIR

Down to the nitty-gritty this month. We take a look at circuit symbols and how we can connect them up to form circuit diagrams. As usual some more new circuits for you to build

SO FAR, it's been a bit like your first Meccano set, just assembling circuits to a set of detailed instructions. This month, we're going to make the breakthrough to the big world outside, so that you can build any circuit from a circuit diagram. As usual, though, we've a bit to learn on the way.

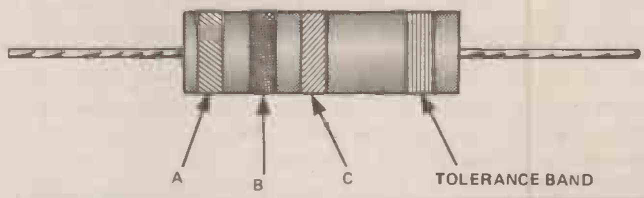
Let's start with some of these components again. Up until now, we've used values of resistors and capacitors without knowing much about these units of measurements, and it's time to set that right. Resistors have their values of resistance measured in units called ohms, and indicated on lists by the letter R after the number. If you see 47R, then, it means a 47 ohm resistor. It's written this way round, because on a circuit diagram, each resistor is given a reference number, which consists of the letter R and then a number. When you see R9 in a circuit, then, it means the 9th resistor in the circuit, not a 9 ohm resistor. A list of values of components might contain an entry:

R9 . . . . . . 47R meaning that resistor number 9 should be a 47 ohm resistor.

We don't use many resistors whose values are only a few ohms. Most of the resistors we use have resistance values of several thousands of ohms, and to save writing all these zeros we use the letter 'k' to mean thousand. At one time, the k was placed after the value, so that 2.2k meant 2.2 thousand, which is 2 200. Nowadays, the k is often used in place of the decimal point, so that the same value would read 2k2, two thousand two hundred. This avoids having to use decimal points (they're small and easily lost), and makes the values a bit clearer. For a few purposes, we need very large values of resistance, so that we also use units of millions of ohms, called Megohms, and indicated as M on a diagram. Don't get this capital M confused with the small m we use for some other quantities.

COLOURED BANDS

Resistance values aren't usually printed on to resistors, they're coded on, using coloured bands. Fig. 3.1 shows how these colours are used to indicate number values, and how these numbers are translated into values of resistance. This three-colour system works because we



A	B	C	TOLERANCE BAND	VALUE	TOLERANCE
BROWN	BLACK	RED	NONE	1000R or 1k	20Y
RED	RED	RED	SILVER	2.2k OR 2k2	10Y
BROWN	GREEN	ORANGE	NONE	15k	20Y
YELLOW	PURPLE	ORANGE	GOLD	47k	5Y
BROWN	BLACK	YELLOW	NONE	100k	20Y

Fig. 3.1 Colour codes and resistor values.

use a set of standard values of resistors, with only two figures apart from zeros. This way we can use a colour band for each figure (called the significant figures), and another for the number of zeros after these two figures. One of the 'significant' figures can be a zero as well.

The values of capacitors are usually printed on to the capacitors. The unit that's used for measuring capacitance is called the Farad, but it's much bigger than we need, so that we use smaller units as the microfarad (written as µF and pF. Japanese manufacturers like to mark values in pF or in nF, but write K in place of nF, some use the colour code, with the number representing the size of the capacitor in pF. Table 3.1 shows some common values in various units.

VALUE IN uF	VALUE IN nF	VALUE IN pF
0.0001	0.1	100
0.001	1	1,000
0.0022	2.2 (or 2n2)	2,200
0.01	10	10,000
0.047	47	47,000
0.1	100	100,000
0.47	470	470,000
1.0	1,000	1,000,000

It is most convenient to use pF for amounts less than one nanofarad (1nF). Similarly we use nF for quantities between 1nF and 999nF, and uF for amounts of 1uF and more. This way, we never have to print decimal points.

WORKING VOLTAGE

As well as the value of capacitance, capacitors need to have their working voltage printed on. This is the greatest voltage that you're allowed to have across the capacitor while its working; you can, of course, have a lower voltage. When you choose a capacitor for a circuit, you must make sure that its printed working voltage is higher than the voltage which it will have to stand in the circuit. For example, if you're using a 9 V battery supply, then most of your capacitors will need to have a working voltage of 12 V or more. The exceptions are capacitors which are used in parts of the circuit where only a low voltage ever exists. For example, if you had a capacitor connected between the base and the emitter of a transistor, the working voltage could be the lowest you can find, 3 V, because the voltage between the base and the emitter of any transistor is usually around 0.6 V never much more.

The larger capacitors, 1 μF and more, are of a type that we call electrolytic. In practical terms, that means that they must always be connected the right way round in a circuit, and the connecting wires or tabs are marked + (red) and — (black) to show you which way round is correct.

Now for the most important item of the day — circuit diagrams. As you will have noticed reading through HE, it's only in this series that your circuits have been given in the form of a table of connections on to a Eurobreadboard. The other circuits in your favourite mag are in the form of circuit diagrams, and until you learn to read and understand these circuit diagrams you can't really get much further into practical electronics. In a circuit diagram each component is shown as a symbol. It's a darn sight easier to draw a symbol (and to read the drawing) than it is to draw or understand the drawing of the actual component, and the symbol helps to remind you that it doesn't matter what size or shape a component is — it's the connections that count. Some of the standard symbols we use are shown in Table 3.2. The zig-zag symbol for resistors is a bit out of date these days, but you will still see it around, so we've included it.

Symbols for specialised devices, ie, FETs etc have been omitted. These devices will be dealt with in more detail at a later date. To avoid confusion we have also left out some obsolete devices although some components, ie, valves are still to be found they are best explained in a separate article.

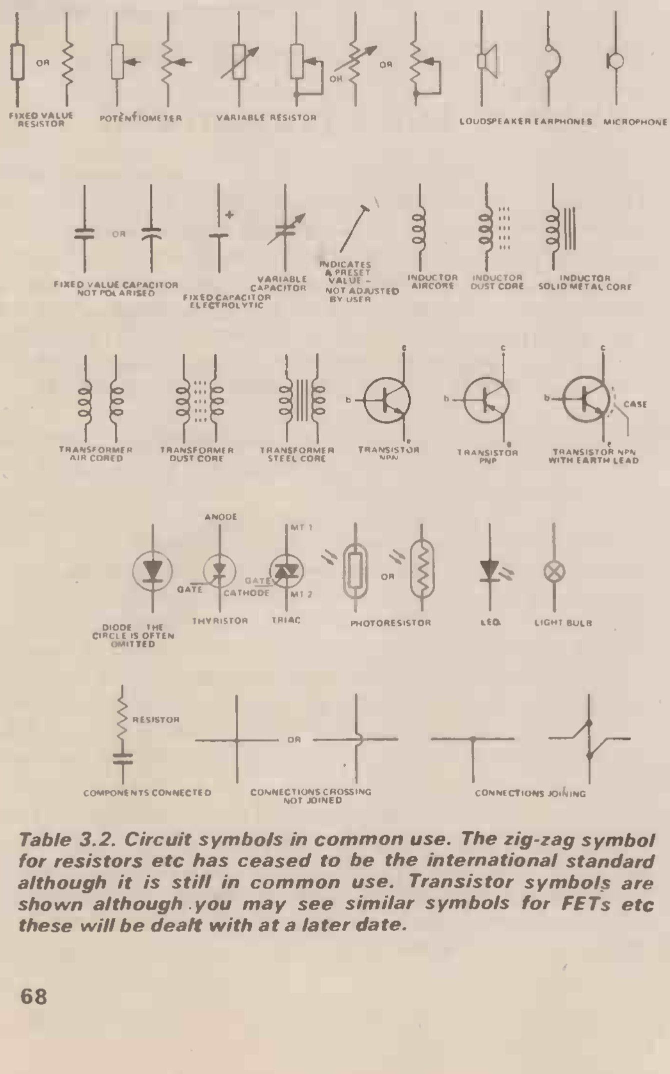


Table 3.2. Circuit symbols in common use. The zig-zag symbol for resistors etc has ceased to be the international standard although it is still in common use. Transistor symbols are shown although you may see similar symbols for FETs etc these will be dealt with at a later date.

CIRCUIT DIAGRAMS

Now a circuit diagram doesn't show you where to plug the component into a Eurobreadboard, nor does it show you where to solder the components into a printed circuit board. What it does show you is how the components are connected together. Take a look at the circuit diagram in Fig. 3.2. This is a circuit which you've already built (Part 2), and its Eurobreadboard connections are shown on the actual diagram. Let's trace through it.

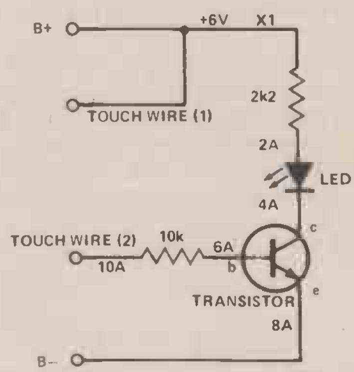


TABLE OF CONNECTIONS :
X1 IS TOUCH WIRE (1); B+; 2k2 TO 2A
2A IS 2k2 FROM X1, ANODE OF LED
4A IS CATHODE OF LED; COLLECTOR OF TRANSISTOR
6A IS BASE OF TRANSISTOR; 10k TO 10A
8A IS EMITTER OF TRANSISTOR; B–
10A IS 10k FROM 6A; TOUCH WIRE (2)

Fig. 3.2 The circuit diagram for the touch-wire circuit.

Start with the +6 V wire from the battery, represented by the line at the top of the diagram marked + 6 V. This shows a connection from the battery to one end of the 2k2 resistor, and to the bit of wire which is labelled 'touch-wire.' It doesn't connect anywhere else, and on the Eurobreadboard this part of the circuit is simply line number XI, with one wire plugged in and connected to battery +, one leadwire of the 2k2 resistor plugged into another hole on the same line, and a third bit of wire plugged into another hole on the same line, and left bare for you to touch, because this is the circuit which lights a LED when you touch two wires.

What about the other end of the 2k2 resistor? It makes only one connection, to the anode of the LED and nowhere else. The circuit shows, incidentally, that this connection is to the *anode* of the LED, something that is very difficult to show on any other kind of diagram. The connections here need only two holes on another line of Eurobreadboard. We have to use a line of the Eurobreadboard which is not used for anything else, because the circuit shows quite clearly that no other connections are made here.

Next step is where the cathode of the LED connects to the collector of the transistor. The collector is always shown as a plain thin line with no arrow, and there's only one connection here, so that we have two holes along one line of Eurobreadboard used. These places where components join each other are called circuit junctions, and there has to be one Eurobreadboard line used for each circuit junction that we have.

Now we've arrived at the transistor, and it has two other connections. The base, represented on the diagram by a thick line, or a hollow flat box, is connected to the other touch wire, so that this is another circuit junction which needs a separate Eurobreadboard line with no other connections made to it. We would have to be careful, incidentally, if we were building this all over again, that the two 'touch' wires never touched each other, or to any other part of the circuit, because this could mean instant death for the transistor. Just as a protection, the 10k resistor has been added between 6A and 10A.

Finally, there's the emitter lead of the transistor. This is the one shown on the circuit diagram with the arrow on it, and it makes a connection to the battery negative (—). Once again, there are no other connections, so that a fresh Eurobreadboard line has to be used — it's a good thing there are a hundred separate lines to choose from!

SIMPLE SYMBOLS

The circuit diagram, then, shows you at a glance how the components are connected together, and when you get used to them, they also give you a pretty good idea about how the circuit works. Just looking at this one for the last time, you can see how, using your fingers to touch the two 'touch-wires' will cause a current to flow from the battery + to the base of the transistor; and why the LED lights, because current which flows between the collector and the emitter has to pass from the battery + through the LED and the 2k2 resistor to get to the transistor.

Now take a look at two more circuits, both of which you've already built. Fig. 3.3 shows the flashing LED circuit which was the last item in Part 1, and Fig. 3.4 shows the moisture detector which was the pride-and-joy of Part 2. Trace through these circuits, just as we've done in detail for the touch-wire circuit, and make sure you understand what connections are made and how the Eurobreadboard lines are used. That way you get used to reading the circuit diagrams and recognising what components are connected together. Now comes the crunch. You can read a circuit diagram, but how do you build a circuit on to the Eurobreadboard when all you have is a circuit diagram, but no table of connections? It's easy, really, if you just use 'Sinclair's Instant Layout System' (SILS), which goes something like this:—

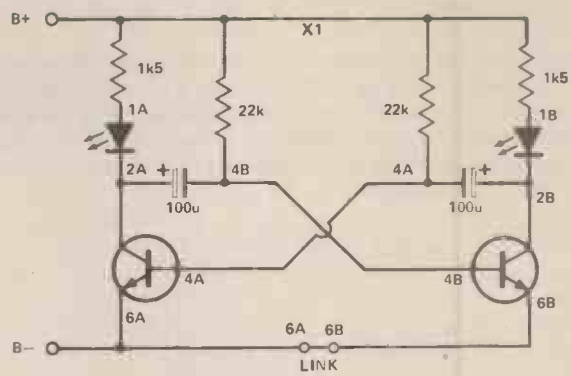


Fig. 3.3 The circuit diagram for the LED flasher.

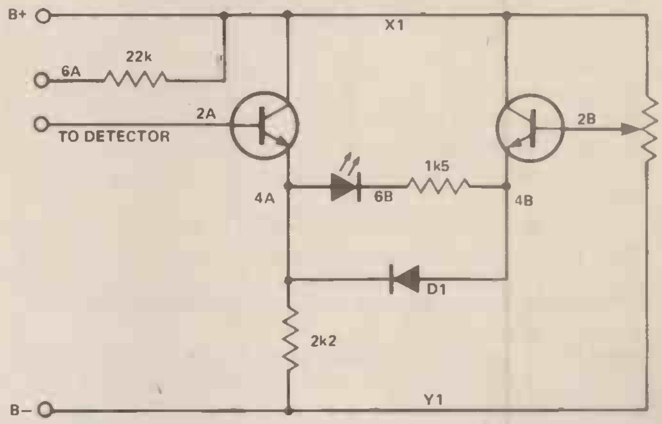


Fig. 3.4 The circuit diagram for the wet/dry indicator.

BACK TO THE BREADBOARD

Circuits consist of circuit junctions (remember) connected by components. At a circuit junction you can expect to find one lead of a component which connects into the junction, plus any other wire leading to battery + or —, or for signals coming into the circuit or going out from it. Just take a look through the circuit diagrams we've shown so far, and pick out these circuit junctions. There are 6 of them in the circuit of Fig. 3.2, 9 of them in the circuit of Fig. 3.3, and 8 of them in the circuit of Fig. 3.4.

For each circuit junction, we use a separate line on the Eurobreadboard. This doesn't just apply to Eurobreadboard construction; as you'll find out later, it also applies when you build on solderboards. What makes the use of the Eurobreadboard special is that the lines are numbered and the columns lettered, which is what makes the circuits so simple to build. In addition, though, it makes the job of construction from a circuit diagram much easier. Here's how. Because each circuit junction needs to use a separate line on the Eurobreadboard we can label each circuit junction on the diagram with a Eurobreadboard line number and letter. Take a look at the simple circuit of Fig. 3.5 — it's the emitter-follower, one of the circuits you build in Part 2. There are five circuit junctions here, so that we need five Eurobreadboard lines for the circuit. We could simply take 1A, 2A, 3A, 4A, 5A if we liked, but this would make the circuit a bit cramped, though there's no other reason for not using these numbers. Life is easier if you give yourself a bit of room, so we can use every other line for this circuit, labelling the battery + circuit junction as 1A, and the others as 3A, 5A, 7A, 9A as shown in Fig. 3.5.

Looks almost too easy, doesn't it? The technique is to pencil a loop around each junction in a circuit, and then simply fill in the Eurobreadboard line numbers, leaving yourself a bit of room. With the components we're using, there's no need to try to build the whole circuit in

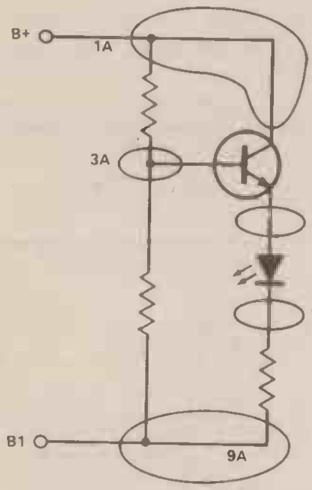


Fig. 3.5 Marking in circuit junctions for Eurobread numbers.

a small corner and there's plenty of space on this board (unlike some others) to play with. Some transistor types have very short leads which are set at only 0.1" apart, and these would have to be placed on three consecutive Eurobreadboardd lines, like 2A, 3A, 4A, for example, but we're not using such components. One very useful tip is to use line XI for battery + and Y1 for battery —.

So far, so good. Now give yourself a bit of practice — design a Eurobreadboard layout for the circuit which is shown in Fig. 3.6. Pencil in loops at each circuit junction, write in the Eurobreadboard numbers, and then construct the circuit. If you get completely stuck, then one possible layout is given at the end of this part (Fig. 3.9). Remember that it's just one of many possible layouts, so that if yours is different it's not necessarily wrong. What *is* wrong is having two junctions on the same Eurobreadboard line, or lines with just one connection.

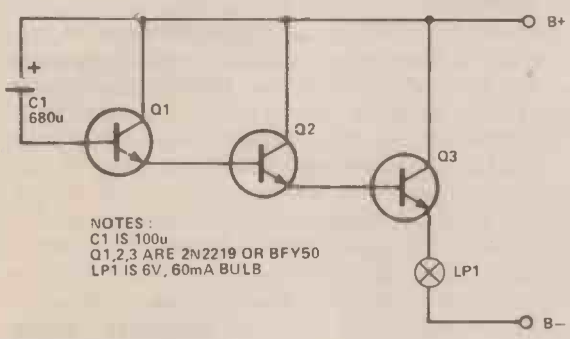


Fig. 3.6 The slow-fade circuit.

Check over your connections carefully, and when you're sure that the layout is correct, connect the battery. Watch the light over a time of a minute or so. Now unplug the capacitor, and plug in another one, any of the values which you have, remembering that these capacitors must plug in the correct way round, with the red (+) end connecting to the + voltage line. What happens?

CONNECTIONS

Looking at the circuit, we can now follow what happens. When the battery is connected, one terminal of the capacitor suddenly has its voltage jacked up to +6 V. Now the important feature of a capacitor is that when you suddenly change the voltage on one terminal, the voltage on the other terminal changes by the same amount, and then goes back to the voltage it had before. The time this takes depends on how large (how many µF) the capacitance is, and how much resistance is connected to the second terminal. In our circuit, the second terminal connects to the base of a transistor, Q1, which doesn't need to pass much current, and which therefore behaves like a large resistance. When the circuit is switched on, the terminal of the capacitor which is connected to the +6 V line suddenly has its voltage changed from zero to +6 V. Because of this, the base of Q1 also has its voltage suddenly changed to +6 V, and the voltage on the base will then start to drop slowly as the capacitor goes back to normal, a process which is called charging.

When the base of Q1 suddenly gets switched to +6 V, through, the emitter voltage also must change. The emitter voltage will change to about +5.5 V when the base goes to +6 V, because there's always about 0.5 V between the base and the emitter voltage of a transistor when it's conducting. This 5.5 V at the emitter of Q1 is connected into the base of Q2, so that the base of Q2, is at a voltage of 5.5 V as well. That, in turn, means that the emitter of Q2 is at 5.0 V, another half-volt down as usual. Now there's 5.0 V on the base of Q3, and 4.5 V on its emitter, and that's the voltage we're using to light the bulb LP1. Since it's a 6 V bulb, the light isn't exactly going to be brilliant.

The light gradually dims and goes out, though, and this happens because the voltage across the capacitor C1 is gradually going back to normal — and normal is zero. What's happening is this. When we made the voltage at the + terminal of the capacitor equal to +6 V by connecting the battery, this automatically made the voltage at the other terminal equal to +6 V. Now this other terminal is connected to the base of Q1, and the capacitor terminal is going to act like a little battery, supplying current to the base of Q1. When a capacitor supplies current like this, though, the voltage of the terminal which is supplying the current will drop. We say that the capacitor is charging — there is an increasing voltage between the terminals (one held at +6 V, one at a lower voltage). We can do this either by keeping one terminal at a constant voltage and passing electric current into the other terminal, causing its voltage to rise, or by letting the current flow in the opposite direction so that the voltage drops. Connecting the terminals together so that they both reach the same voltage is called discharging.

How much current do we take out of C1 as it charges? We can't measure this exactly, but we can get a fair idea of how little it is at the time when the circuit is switched on. Suppose the lamp takes a current of 50 mA (milliamps). If Q3 has a current gain of 50 times, then a base current of 1 mA is needed at the base of Q3 to provide that much collector current. Now this 1 mA to the base of Q3 is provided from the emitter of Q2, and if this transistor also has a current gain of 50 times, then the base current of Q2 needs to be only 1/50 mA, 0.02 mA. This current, in turn, comes from Q1, and its base current, assuming it also has a current gain of 50 times, needs to be only 1/50 of 1/50 mA, which is 1/2500 mA, 0.0004 mA. This is a very small current, so that the capacitor C1 takes quite a long time to charge. If we plug in a smaller capacitor value, charging takes less time, so that the light from the lamp fades much more quickly. It's a useful way of making the light from a small bulb fade slowly over a long period. Incidentally, if the light refuses to fade, it's usually because of a "leaky" capacitor. A leaky capacitor will pass enough DC from the 6 V supply to keep current flowing into Q1, so that the fading action doesn't take place. You can't, of course, use this circuit for a mains voltage lamp, but the same principle can be used, in a rather different circuit, for automatic faders.

MODIFICATIONS

Let's come back to the circuit layout theme for a moment, because there's one type of circuit which can benefit from a slight modification to our technique. Fig. 3.7 shows, once again, the circuit which was featured in Part 1 of this series. There are two ways of building this on a Eurobreadboard both with practical advantages compared to the standard method which we've just described. The point here is that if we pencil in the loops and number them in the usual way, we find that there are some awkward connections — usually one emitter has to be connected to a line which is a bit far away from its base or collector. Now we can get round this in two ways which are particularly useful if transistors with short leads are being used.

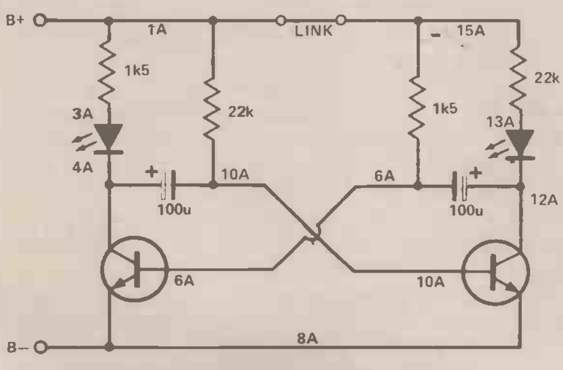


Fig. 3.7 Another way of laying out the LED flasher circuit.

One method is the scheme shown in Fig. 3.7. This method uses the second transistor connected as the "mirror image" of the first one, with both emitter leads in the same line of the Eurobreadboard, and the resistor R bridging the gap back to the + battery line. If we've spaced the circuit out too much for the resistor's leads to stretch, we can use a separate + line to connect R to, and we can connect this to the main + line with a wire link. Either way, it's a lot easier to build and check than the straightforward layout.

The other possible method, Fig. 3.3, makes use of the way that the Eurobreadboard is laid out. We built one half of the circuit on column A and the other half on column B, keeping the transistors at the ends of the lines so that the connections between the A and B columns can cross over easily. We have to use wire links to connect 6A to 6 B, but this is a small price to pay for such a simple method of construction. It's usually easier to plan out than the "mirror-image" method, and it's particularly well suited to the Eurobreadboard.

Now it's have-a-go time. The circuit is shown in Fig. 3.8, so that you have to design a Eurobreadboard layout for yourself. There are two transistors, two capacitors, five resistors, and an LED used, along with a push-button switch. You can just touch two wires together instead of using a push-button switch, but it looks a bit more interesting when the switch is used!

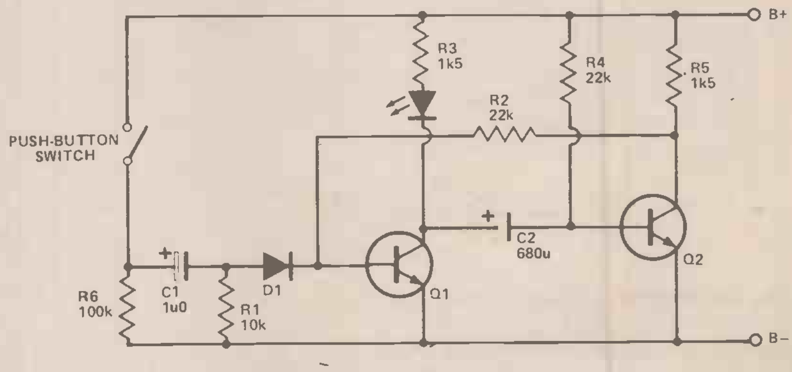


Fig. 3.8 This month's new circuit — a time delay.

Be careful to get the transistors the right way round, and remember that the capacitors are electrolytic types, which have to be connected the right way round. The LED must also be connected right way round if the circuit is to indicate that it's operating correctly. Once you're sure that all is well, connect up to the battery. Is the LED lit? Now press the push-button, and watch the LED. Does it light? How long does it stay lit after you release the push-button?

If you had difficulty with the layout, Fig. 3.6 shows connections, using the A-B column method, but you should try with your own layout first. The way the circuit works is like this.

BOTTOMED

When you switch on first, current flows through R4 into the base of Q2, making this transistor conduct. Because Q2 is conducting well, much better than R5, the voltage at the collector of Q2 is low, about 0.2 V. This is the state we call "bottomed" — the voltage has reached rock bottom. The same voltage appears at the base of Q1, because R2 connects the collector of Q2 to the base of Q1, but 0.2 V is too small to start current flowing into the base of Q1. Since Q1 doesn't pass current, its collector voltage stays high, about the voltage of the battery supply. One terminal of C1 is at zero volts, because of R1, the other is at about 0.2 V. The circuit can remain with the voltages for as long as you like, it's the sort of condition we call stable. Now when the button is pressed, one terminal of C1 is hoisted up to +6 V, and the other one tries to follow. This makes current flow into the base of Q1, so that Q1 conducts well, and the voltage at its collector drops to about 0.2 V. That's because there's a much lower resistance through Q1 to zero volts than there is through to the +6 V of the battery.

The drop of voltage at the collector of Q1 is applied to one terminal of C2, so that the other terminal of C2 also suffers a drop of voltage. The effect of that drop is to stop Q2 conducting, so that its collector voltage rises. There's now enough voltage on one end of R2 to keep Q1 conducting, and the circuit will stay that way for a time. Because Q1 is conducting, with current flowing through R3, the LED is lit.

It doesn't stay like that. C2 is being fed with current from R4, so that it charges up, and eventually the voltage of the base of Q2 reaches 0.5 V, and Q2 turns on again. When that happens, Q2 becomes a good conductor, its collector voltage drops again to a low voltage, and there isn't enough voltage on R2 to keep Q1 switched on. Q1 stops conducting, and the LED goes out. It doesn't matter how long or for how short a time you hold the push button switch down, the LED spends the same amount of time switched on. The diode D1 prevents the circuit from switching back when the push-button is released, so that the timing always depends on R4 and C2.

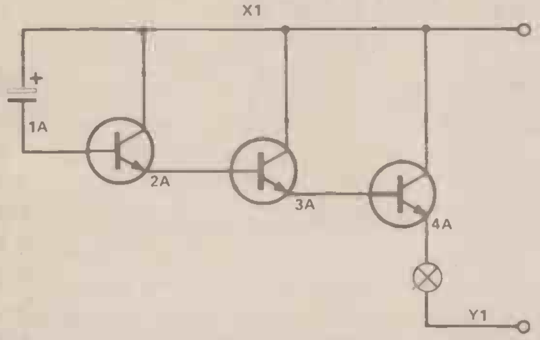


Fig. 3.9 One possible connection diagram for the circuit of Fig. 3.6.

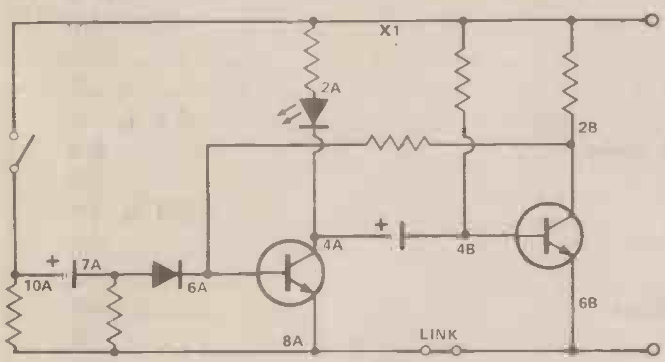


Fig. 3.10 One possible connection diagram for the circuit of Fig. 3.8.

Next month — how to generate sounds from a loudspeaker. **HE**

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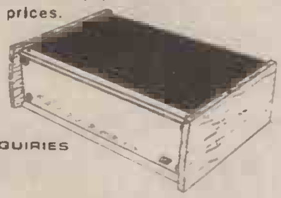

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AD. INDEX

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CAPACITORS

Electrolytic Axial Leads — Order Code Cap 015 + µF + V d.c.
−10% to +50% Tol.

µF / V d.c.	16	25	40	63
1.0				9
1.5				9
2.2				9
3.3				9
4.7				9
6.8			9	10
10		8		10
15	8		9	11
22		8		13
33	8		9	
47		8	11	13
68	9			
100		9	13	
150	9	10		31
220	13		26	36
330			30	40
470		23	32	47
680	21	30	39	54
1000	25	30	59	
1500	35	39		
2200	42			

Trimmers — Order Code
250V D.C. Wkg. Film Dielectric, Miniature

1.4 – 4.1pF	20	Cap 808 A
2 – 8pF	20	Cap 808 B
2 – 20pF	22	Cap 808 C
5.5 – 59.5pF	31	Cap 808 D

Electrolytic Radial Leads — Order Code Cap 034 + µF + Volts
−10% to +50% Tol.

µF / V d.c.	6.3	10	16	25	35	40	50	63
.47								7
.68								7
1.0								7
1.5								7
2.2								7
3.3								7
4.7						7		8
6.8				7			8	9
10			7			8		9
15			7	8			9	11
22		7	8			9	11	
33			8	9		11		
47		8	9		11			
68			9	11				
100		9						
150		11						
220	11							

Electrolytic Can Type — Order Code Cap HR + µF + Volts
High Ripple, IEC Grade 1, Low E.S.R. Supplied complete with Vertical Fixing Clip.

		Ripple @ 85 C	@ 50 C	
10000µF	16V	5.8A	8.1A	238
22000µF	16V	9.8A	13.7A	370
4700µF	25V	4.6A	6.4A	215
10000µF	25V	8.0A	41.2A	282
22000µF	25V	12.8A	17.9A	469
4700µF	40V	5.6A	7.8A	248
10000µF	40V	9.2A	12.8A	393
4700µF	70V	7.5A	10.5A	403

Miniature Low Value — Order Code
Polystyrene, Axial, ±1% Tol., >63V DC Wkg. — Cap 424
Ceramic Plate, Radial, Low K, 100V DC Wkg. — Cap 632
Ceramic Plate, Radial, Med K, 100V DC Wkg. — Cap 630
Ceramic Plate, Radial, High K, 63V DC Wkg. — Cap 629
+ Value

pF	424	632	pF	424	632	630	nF	424	629
1			100	18	7		10	27	8
1.2			120	18	9		12	29	
1.5			150	18	9		15	29	
1.8		6	180	18	9		18	31	
2.2		6	220	18	9		22	31	9
2.7		6	270	20	9		27	42	
3.3		6	330	20	9		33	45	
3.9		6	390	20		6	39	50	
4.7		6	470	20		6			
5.6		6	560	20		6			
6.8		6	680	20		6			
8.2		6	820	20		6			
10		6	1000	20		6			
12		6	1200	20		6			
15		6	1500	20		7			
18		6	1800	20		7			
22		6	2200	20		7			
27		6	2700	20		7			
33		6	3300	20		7			
39		6	3900	20		7			
47		6	4700	25		8			
56		7	5600	25					
68		7	6800	25					
82		7	8200	25					

Polyester Radial Leads — Order Code
Dipped Type, C280/352 Style — Cap 352
Moulded Type, 10.2mm Pitch — Cap 360
+ Value

µF	352	360	µF	352	360
.001		7	.1	7	9
.0015		7	.15	8	10
.0022	6	7	.22	9	11
.0033	6	7	.33	11	
.0047	6	7	.47	14	
.0068	6	7	.68	17	
.01	6	8	1.0	21	
.015	6	8	1.5	30	
.022	6	8	2.2	35	
.033	6	8			
.047	6	8			
.068	7	8			

Tantalum Bead — Order Code Cap PR + µF + Volts
20% Tol.

µF / V d.c.	10	16	25	35
0.1				11
0.22				11
0.47				11
1				11
2.2		11		13
4.7		12	16	18
10	13	16	18	22
22		18		
47	22			

INTEGRATED CIRCUITS

4000 Buffered C-MOS – High Speed

HEF4000	22	HEF4044	1·05	HEF4512	138
HEF4001	22	HEF4046	1·33	HEF4514	313
HEF4002	22	HEF4047	109	HEF4515	374
HEF4006	1·19	HEF4049	57	HEF4516	127
HEF4007	22	HEF4050	57	HEF4517	478
HEF4008	1·00	HEF4051	87	HEF4518	118
HEF4011	22	HEF4052	90	HEF4519	69
HEF4012	22	HEF4053	90	HEF4520	118
HEF4013	57	HEF4066	62	HEF4521	235
HEF4014	1·05	HEF4067	475	HEF4528	124
HEF4015	1·00	HEF4068	22	HEF4532	150
HEF4016	57	HEF4069	22	HEF4534	638
HEF4017	1·00	HEF4070	22	HEF4539	138
HEF4018	1·00	HEF4071	23	HEF4543	194
HEF4019	58	HEF4072	23	HEF4555	98
HEF4020	1·12	HEF4073	23	HEF4556	98
HEF4021	1·07	HEF4075	23	HEF4557	458
HEF4022	1·03	HEF4076	130	HEF4585	122
HEF4023	22	HEF4077	22	HEF4724	214
HEF4024	78	HEF4078	23	HEF40097	11
HEF4025	22	HEF4081	23	HEF40098	92
HEF4026	2·44	HEF4082	23	HEF40106	78
HEF4027	57	HEF4085	80	HEF40160	149
HEF4028	89	HEF4086	80	HEF40161	149
HEF4029	113	HEF4093	63	HEF40162	149
HEF4030	58	HEF4094	219	HEF40163	149
HEF4031	2·50	HEF4104	208	HEF40174	149
HEF4035	138	HEF4502	114	HEF40175	149
HEF4040	107	HEF4505	714	HEF40192	149
HEF4041	94	HEF4508	2·30	HEF40193	175
HEF4042	83	HEF4510	135	HEF40194	149
HEF4043	100	HEF4511	157	HEF40195	149

7400 T.T.L.

N7400N	13	N7444N	92	N74122N	40	N74193N	91
N7401N	14	N7445N	85	N74123N	77	N74194N	73
N7402N	14	N7446AN	85	N74125N	37	N74195N	57
N7403N	14	N7447AN	71	N74126N	37	N74198N	135
N7404N	16	N7448AN	92	N74128N	38	N74199N	122
N7405N	16	N7450N	14	N74132N	38	N74221N	77
N7406N	32	N7451N	14	N74145N	57	N74279N	61
N7407N	32	N7453N	14	N74147N	98	N74298N	77
N7408N	16	N7454N	14	N74148N	88	N74365N	59
N7409N	16	N7460N	14	N74150N	91	N74366N	59
N7410N	14	N7470N	28	N74151N	46	N74367N	59
N7411N	16	N7472N	19	N74153N	43	N74368N	59
N7412N	14	N7473N	28	N74154N	91		
N7413N	23	N7474N	24	N74155N	46	**74LS**	
N7414N	31	N7475N	34	N74156N	46		
N7416N	21	N7476N	30	N74157N	43	N74LS00N	19
N7417N	21	N7480N	32	N74158N	43	N74LS01N	19
N7420N	14	N7483N	63	N74160N	63	N74LS02N	19
N7421N	16	N7485N	80	N74161N	63	N74LS03N	19
N7425N	19	N7486N	25	N74162N	63	N74LS04N	27
N7426N	20	N7490N	40	N74163N	63	N74LS05N	27
N7427N	20	N7491AN	57	N74164N	86	N74LS08N	27
N7428N	23	N7492N	40	N74165N	86	N74LS09N	27
N7430N	14	N7493N	40	N74166N	86	N74LS10N	19
N7432N	20	N7494N	57	N74170N	122	N74LS11N	26
N7433N	23	N7495AN	46	N74173N	77	N74LS12N	26
N7437N	21	N7496N	57	N74174N	77	N74LS13N	48
N7438N	21	N74100N	92	N74175N	55	N74LS14N	74
N7439N	30	N74107N	26	N74180N	57	N74LS15N	26
N7440N	14	N74109N	45	N74181N	205	N74LS20N	19
N7442N	51	N74116N	92	N74182N	57	N74LS21N	26
N7443N	92	N74121N	28	N74192N	91	N74LS22N	26

N74LS28N	35	N74LS138N	99	N74LS253N	117
N74LS30N	19	N74LS139N	99	N74LS257N	117
N74LS32N	27	N74LS153N	88	N74LS258N	117
N74LS33N	35	N74LS154N	138	N74LS260N	29
N74LS37N	35	N74LS155N	93	N74LS261N	321
N74LS38N	35	N74LS156N	93	N74LS266N	54
N74LS40N	27	N74LS157N	93	N74LS273N	143
N74LS42N	60	N74LS158N	97	N74LS283N	117
N74LS51N	27	N74LS160N	129	N74LS290N	117
N74LS54N	27	N74LS161N	117	N74LS293N	119
N74LS55N	27	N74LS162N	144	N74LS298N	149
N74LS73N	35	N74LS163N	117	N74LS365N	121
N74LS75N	44	N74LS164N	119	N74LS366N	121
N74LS76N	46	N74LS170N	220	N74LS367N	121
N74LS78N	39	N74LS173N	132	N74LS368N	121
N74LS83AN	106	N74LS174N	141	N74LS373N	173
N74LS85N	104	N74LS175N	119	N74LS374N	173
N74LS86N	39	N74LS181N	306	N74LS375N	117
N74LS90N	59	N74LS190N	117	N74LS378N	155
N74LS92N	76	N74LS191N	117	N74LS386N	56
N74LS93N	76	N74LS192N	119	N74LS390N	196
N74LS95BN	82	N74LS193N	119	N74LS393N	196
N74LS96N	126	N74LS194N	161	N74LS395N	207
N74LS107N	41	N74LS195AN	119	N74LS490N	143
N74LS109N	45	N74LS196N	132	N74LS670N	239
N74LS112N	45	N74LS197N	132		
N74LS113N	45	N74LS240N	206		
N74LS114N	45	N74LS241N	206		
N74LS125N	53	N74LS242N	206		
N74LS126N	53	N74LS243N	206		
N74LS132N	78	N74LS244N	206		
N74LS136N	49	N74LS251N	117		

LINEAR

CA3046	84
CA3080E	77
CA3130E	99
CA3140E	48
CA3189E	293
LM301AN	34
LM339N	78
LM380N	104
LM381AN	198
LM3900N	75
MC3403P	156
NE531	131
NE536T	259
NE555N	28
NE556N	66
NE566N	171
NE570N	485
NE571N	505
RC4136	146
TBA120S	88
TDA1022	713
TDA1034B	239
TL081CP	84
TL084CN	156
UA741CN	20
UA741CT	47
UA748CN	39

Zener Diodes
400mW C4V7-C33
BZY88/BZX79
+ Voltage 9

Voltage Regulators

LM309DA(K)	119
UA723CN	42
UA7805CU	78
UA7812CU	78
UA7815CU	78
UA7912CU	97
UA7915CU	97
UA78L05CS	38
UA78L12CS	38
UA78L15CS	38

Plessey I/C's

SL440	331
SL445	182
SL610	245
SL612	245
SL620	369
SL621	369
SL622	910
SL624	342
SL630	232
SL640	409
SL680	245
SL1610	177
SL1611	177
SL1612	177
SL1621	239
SL1626	267
SL1630	177
SL1640	206
SL1641	206
SL6640	270
SP8629	475

CASES – Boss Industrial Mouldings

Small Desk Console – Boss Industrial Mouldings
Slope Front Console, Recessed Top
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey

		Order Code
W161, D96, H39 (57)	214	Case BIM1005 OR
W215, D130, H47 (73)	308	Case BIM1006 OR

Plastic Boxes – Boss Industrial Mouldings
Moulded Box and Close Fitting Flanged Lid
ABS Box, C/W Brass Bushes, and Lid In Orange

		Order Code
L112 W62 D31	99	Case BIM2003 OR
L150 W80 D50	131	Case BIM2005 OR
L190 W110 D60	223	Case BIM2006 OR

Plastic Boxes with Metal Lids
Recessed Top Box
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey

		Order Code
L85 W56 D29	112	Case BIM4003 OR
L111 W71 D42	150	Case BIM4004 OR
L161 W96 D53	208	Case BIM4005 OR

Diecast Boxes
Diecast Box and Flanged Lid
Aluminium Box and Lid in Natural Finish

		Order Code
L113 W63 D31	124	Case BIM5003 NA
L152 W82 D50	215	Case BIM5005 NA
L192 W113 D61	334	Case BIM5006 NA

Small Desk Consoles
Slope Front Console, Recessed Top
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey
Ventilation Slots In Base

		Order Code
W105 D143 H32 (56)	236	Case BIM6005 OR
W170 D143 H32 (56)	312	Case BIM6006 OR
W170 D214 H32 (82)	431	Case BIM6007 OR

OPTO ELECTRONICS

Light Emitting Diodes, Individual

			Order Code
.125" (3mm)	Red	16	CQY54
	Green	18	CQY95
	Yellow	20	CQY97
Panel Mounting Clip to suit.		3	LED3 Clip
.2" (5mm)	Red	16	CQY24A
	Green	18	CQY94
	Yellow	20	CQY96
Panel Mounting Clip to suit		5	LED5 Clip

Photoresistors

ORP12	95	ORP12
ORP61	95	ORP61

Phototransistors

OCP71	220	OCP71
BPX25	195	BPX25
BPX29	195	BPX29

Photocoupler

FCD820	165	FCD820

HARDWARE

D.I.L. Sockets — Order Code

8 Pin Low Profile Socket Tin	12	DIL SKT 8
14 Pin Low Profile Socket Tin	14	DIL SKT 14
16 Pin Low Profile Socket Tin	16	DIL SKT 16

Heatsinks

Individual Type for 1 x T05 50°C/W	12	Sink 5F
Individual Type for 1 x T066 10.5°C/W	28	Sink TV2
Individual Type for 1 x T03 7.2 C/W	26	Sink TV3
Individual Type for 1 x T0126 17°C/W	26	Sink TV4
Individual Type for 1 x T0220 17°C/W	26	Sink TV5

P.C.B. Components

Dalo Pen, Blue Ink, Slow Drying	98	Pen 33PC

SWITCHES

Miniature Toggle – Honeywell — Order Code

SPDT		67	SW 8A1011
SPDT	C/Off	81	SW 8A1021
SPDT	Double Bias To Centre	90	SW 8A1041
SPDT	Single Bias To Centre	90	SW 8A1051
SPDT	Bias	84	SW 8A1061
DPDT		99	SW 8A2011
DPDT	C/Off	111	SW 8A2021
DPDT	Double Bias To Centre	123	SW 8A2041
DPDT	Single Bias To Centre	123	SW 8A2051
DPDT	Bias	116	SW 8A2061

Miniature Push – C & K

SP	Push To Make, Momentary	62	SW 8531
SP	Push To Break, Momentary	62	SW 8533

MAINS TRANSFORMERS

Order Code

Secondaries may be connected in series or parallel to give wide voltage range
Primaries 0-220, 240V

6VA Clamp Type Construction 235 each
Approx. 18% Regulation. F.C. 54, H36, W35

0-4.5V, 0-4.5V Secondaries	Trans 6VA	45
0-6V, 0-6V		60
0-12V, 0-12V		120
0-15V, 0-15V		150
0-20V, 0-20V		200

20VA Clamp Type Construction 360 each
Approx. 16% Regulation F.C. 70, H48, W46

0-4.5V, 0-4.5V Secondaries	Trans 20VA	45
0-6V, 0-6V		60
0-12V, 0-12V		120
0-15V, 0-15V		150
0-17.5V, 0-17.5V		175
0-20V, 0-20V		200

SEMICONDUCTORS

1N914	5	BC182L	12
1N4001	5	BC184	11
1N4002	5	BC184L	12
1N4004	7	BC212	11
1N4007	9	BC212L	12
1N4148	4	BC214	11
1N5402	15	BC214L	12
2N2218A	31	BC547	13
2N2369	21	BC548	11
2N2646	46	BC549	12
2N2926G	13	BC557	15
2N3053	19	BC558	15
2N3054	55	BCY70	15
2N3055	55	BCY71	15
2N3055		BD131	39
Full ISB Test	95	BD132	39
2N3442	135	BD139	39
2N3702	9	BD140	39
2N3704	9	BFR90	333
2N3705	10	BFX85	29
2N3773	297	BFY50	17
2N3819	22	BFY51	17
2N3820	39	BFY52	20
2N3904	9	BLX65	262
2N5457	39	BLY93A	2977
2N5459	35	BRY39	50
40673	88	BSX20	21
AC188	24	CL8960	2850
AD161	42	MPF107	36
AD162	42	OA91	8
BAW95D	1200	OC28	118
BC107	14	OC35	105
BC108	14	TIP31A	48
BC108C	18	TIP32A	54
BC109	14	TIP41C	76
BC109B	19	TIP42C	76
BC109C	20	TIP2955	75
BC148	10	TIP3055	60
BC158	10	TIS43	36
BC177	17	ZTX109C	16
BC179	20		
BC182	11		

RESISTORS

Order Code

Carbon Film, Fixed

0.25W, E24 Values 1R0-10M, 5% Tol.	2 each	100/100 (Mult 10/Value)	Res RD¼
0.5W, E12 Values 1R0-4M7, 10% Tol.	3 each	150/100 (Mult 10/Value)	Res RD½
			+ Value

Metal Film, Fixed

0.5W, E24 Values, 5R1-1M, 2% Tol.	8 each	400/100 (Mult 10/Value)	Res MR30
2.5W, E12 Values, 10R-27K, 5% Tol.	16 each	800/100 (Mult 10/Value)	Res PR52
			+ Value

Metal Glaze, Fixed

0.5W, E24 Values, 1M-33M, 5% Tol.	16 each	800/100 (Mult 10/Value)	Res VR37
			+ Value

VERO ELECTRONICS PRODUCTS

2.5" x 5" .1" pitch Veroboard	71	200-21069J
3.75" x 5" .1" pitch Veroboard	79	200-21072D
2.5" x 1" .1" pitch Veroboard (5)	85/Pack	200-21076C
3.75" x 5" .1" pitch Plain Board	68	200-21078H
5.82" x 2.9" .1" pitch V-Q DIP Board	135	200-21084E
Spot Face Cutter	107	203-21013A
Pin Insertion Tool for .040 type pin	147	203-21015F
DS Pins .040 (100)	44/Pack	200-21087G
SS Pins .040 (100)	44/Pack	200-21017B
Verowire Kit (1-pen, 2-wire, 25-comb)	454/Kit	200-21341O
Verowire Combs (25)	109/Pack	200-21339F
Verowire Wire (2)	109/Pack	200-21340G

Skeleton Presets, Miniature — Order Code

0.1W, E3 Values, 100R-1M, Lin. Vertical Mounting	8	Min. Preset V
0.1W, E3 Values, 100R-1M, Lin. Horizontal Mounting	8	Min. Preset H
		+ Value

Skeleton Presets, Standard

0.3W, E3 Values, 100R-4M7, Lin. Vertical Mounting	11	Std. Preset V
0.3W, E3 Values, 100R-4M7, Lin. Horizontal Mounting	11	Std. Preset H
		+ Value

Potentiometer, Rotary

0.5W, E3 Values, 1K-2M2 Lin.	39	Ro Pot Lin
0.25W, E3 Values, 4K7-2M2 Log.	39	Ro Pot Log
		+ Value

Potentiometer, Slider

0.5W, E3 Values, 2K2-470K Lin.	45	Sl Pot Lin
0.25W, E3 Values, 1K0 - 1M0 Log.	45	Sl Pot Log
		+ Value


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