Hobby Electronics

50p
May '80
ISSN 0142-6192

WIN A HEATHKIT LCD HAND-HELD MULTIMETER

Travelling Alarm Clock

RADIO CONTROLLED MODEL SURVEY

Hi-Fi Pre-Amp Project

Speaker Project

Model Train Track Cleaner

ambit
INTERNATIONAL

IT'S HAPPENNED* AGAIN !

THE PART THREE CATALOGUE IS PUBLISHED & WE HAVE MOVED TO BIGGER PREMISES.

Yes, it's here at last - the all new Part Three Catalogue. Fun for all the family, and the usual update on all that is new, worthwhile and exciting in the world of Radio and Communications. A big section on frequency synthesis techniques covering broadcast tuners, to communication quality transmitter systems. More new products than ever - RADIO CONTROL parts, crystal filters, ceramic filters for 455kHz and the new range of TOKO CFSH low temperature coefficient types for 10.7MHz. Details on new radio ICs, including the new HA11225, the CA3189E lookalike with 84dB signal to noise, and adjustable muting threshold. Radio control ICs - and an updated version of the RCM&E 8 channel FM receiver - now with an Ambit designed screened front end, with 27MHz ceramic bandpass filter. LCD panel clock timer modules - the neatest and best LCD panel DVM yet (only £19.45 each + VAT), the new 5 decade resolution DFM3 for LW/HF/VHF with LCD readout. The DFM6 with fluorescent display to 10kHz resolution on VHF, 1kHz on SW. A 1kHz HF synthesiser with five ICs - the list is endless. Get your copy of the catalogue now. Post publication price is 60p (inc PP etc). The previous two sections are also required for a complete picture: Parts 1 & 2 £1 the pair. All 3 £1.50. And don't miss our spot the gibbon contest, together with a quiz to see if you can spot the differences between a neolithic cave drawing and a circuit diagram of one of our competitor's tuners.

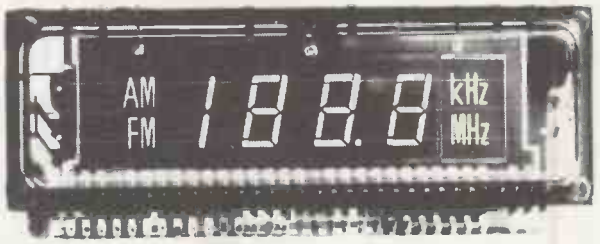
(* Yes, we still haven't learnt how to spell.)

Updated RCME FM radio control RX kit

- 8 Channel RC receiver (FM)
- Single IC RF/IF/Detector
- Single IC decoder
- 27MHz ceramic filter input
- FET RF stage with double tuned bandpass filter
- Dual ceramic filter IF
- Based on RCM&E FM system
- Best quality SLM servo connector block
- ONLY £16.10 inc VAT (kit) (includes new SLM case)

DOES YOUR ONE GLOW GREEN IN THE DARK ??

Our DFM4 does, since it uses a vacuum fluorescent display for direct readout of MW/LW/FM. Basically the same as the DFM2, (LCD Version). £24.45 kit (inc VAT) Transformer with all necessary windings for DFM4 - £2.50 inc VAT.



Not illustrated here - but also now available is the DFM6. This is a vacuum fluorescent display version of our immensely popular DFM3 (LCD). Resolution is 100Hz to 3.9999MHz, 1kHz to 39.999MHz, and 10kHz to 200.00MHz; all standard IF offsets (inc. 10.7MHz on shortwave) are available via diode programming.

New series of radio modules in fully screened cans:

UM1181 VHF band 2 VARICAP TUNERHEAD

5 tuned circuit, with image/spurii better than -80dB, buffered LO output, MOSFET RF stage, FET IF preamp, tunes with only 1½ to 8v, -9dBm 3rd order intercept. 1off price £12.00 inc VAT. (100off/ OA)

911225 FM IF strip with all mod cons for the HiFi tuner:

All types use 80-dB S/N Hitachi IC, with muting, AFC, AGC, meter outputs for signal level and centre zero. IF preamp stage.

'A' Dual linear phase ceramic filters, with MOSFET (AGC'd) IF preamp and a 3rd narrow filter with OC filter selection. Dual tuned FM detector stage. £23.95 inc VAT (built)

'B' Dual ceramic filters, single tuned detector stage £14.95 inc VAT

(All 'A' series units are set up with a spectrum analyzer for best THD)

91072 AM RADIO TUNER MODULES - DC TUNED and DC SWITCHED Available February '80

All include buffered LO output, mechanical IF filter (TOKO CFMO) 1-10v tuning bias, switching by a single pole to earth

A MW/LW (150 to 350kHz LW range) with ferrite rod antenna

B As 'A' but also including SW1 or SW2 (specify.)
SW1 = 1.8 to 4MHz SW2 = 5 to 10MHz

C With both SW ranges

Prices -one off INC VAT

'A' £14.43 'B' £15.90 'C' £17.50 (Custom types OA)

There is a danger - when advertizing in some magazines - that because we do not find space to list everything we sell in every ad., that some readers forget about half the ranges we stock. So to summarize the general ranges:

TOKO	Chokes, coils for AM/FM/SW/MPX. Audio filters etc Filters: Ceramic for AM/FM, LC for FM, MPX etc. Polyvaricons ICs for radio, clock LSI, radio control MPX decoders etc
Micrometals	Dust iron cores for toroids for resonant and EMI filters Toroid mounts
Hitachi	Radio/audio/mpx linear ICs 100W MOSFETs, small signal FETs, MOSFETs and bipolar

And the following groups of products from a broad range of sources:

Semiconductors -specializing in radio devices, Plessey SL1600, EUROPE's best selection of AM/FM and communications devices. Power MOSFETs, WORLD's LOWEST NOISE AUDIO small signal transistors, BAR graph LED drivers for linear and log.
CD4000 series CMOS, TTL/LPSNTTL, standard linears (741, 301, 3080 etc). MPUs, memories. Small signal transistors from AEG BC237/8/9 families etc. (1000 off BC239C : 5.2p ea)
LEDs: AEG 3mm/5mm round, 2.5x5mm flat, red, greem, orange, yellow. The best prices you will find for quality products.
MOSFETs for RF signal processing, including the BF960 UHF device, and 3SK51 for VHF. Varicap diodes for 17:1 capacity ratio tuning

FREQUENCY READOUT LSI from OKI, with a one-chip answer to most digital frequency display needs (and various modules).
Crystal and ceramic ladder filters from leading manufacturers, ferrite rods, various ferrite beads and a range of crystals for 'standard' frequencies and both AM and FM radio control at 27MHz. Trimmer capacitors.
METERS - a new range of linear movement types, plus many 'indicator' types for VU, all types of tuning indicators etc.
SOCKETS - a new range that are better quality than Texas low profile, yet better priced.
Modules for AM/FM/STEREO, complete kits for tuners, audio amplifiers from Larsholt.
SWITCHES - complete low cost DIY systems for push button arrays, keyboard switches.
DOUBLE BALANCED MIXERS - MCL SBL1, replacement for MD108 etc. And cheaper.

OUR LATEST MOVING EXPERIENCE :: At last, we have moved to the address below. There is car parking for customers approaching via North Service Road (an extension of North Road Avenue, entrance opposite the Brentwood Fire Station.) Pedestrian access from the High Street (alongside 117 High Street). The new building is six times bigger than our Gresham Road offices, and we will be installing a much expanded sales counter in the fullness of time. NEW TELEPHONE NUMBER (0277) 230909, TELEX NUMBER (as before) 995194 AMBIT G. See you there !

200 North Service Road, Brentwood, Essex.

Hobby Electronics

MAY 1980 Vol.2 No.7

Editor: Steve Braidwood, G3WKE.
Assistant Editor: Rick Maybury.

See page 28.

See page 35.

See page 20.

PROJECTS

FEATURES

NEWS & INFO

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Simply ahead . .

I.L.P's PROVEN RANGE OF HIGH

- **FIVE POWER AMPLIFIERS EACH ENCAPSULATED WITHIN LARGE HEATSINK.**
- **PRE-AMP/ACTIVE TONE CONTROL MODULE COMPATIBLE WITH ALL I.L.P. AMPS AND POWER SUPPLIES.**
- **SEVEN MATCHING POWER SUPPLY UNITS (FOUR WITH TOROIDAL TRANSFORMERS).**
- **EASY ASSEMBLY DESIGNS WITH WELL PRESENTED INSTRUCTIONS.**

Chosen in more countries throughout the world than any other U.K. make

I.L.P. constructional modules are different. Whereas most others come with components neatly arranged on open P.C.B.s with little else, I.L.P. modules are encapsulated within totally adequate heatsinks and need no extra components to complete them. As a result, I.L.P. power amplifiers, pre-amp and matching power supply units are infinitely more rugged, impervious to working in extremes of temperature and can be easily positioned to requirement. No additional metal work is needed to take away heat, connections are minimal and utterly simple. Circuitry, workmanship and performance are of the highest standards, equal to the demands of loudspeakers, pick-ups, tuners, digital signals, etc., even more exacting than those of today, making amplifier systems less than the best completely inadequate. Now study the tested and guaranteed specs. for I.L.P. That is why more people in more countries prefer these British designed and made modules.

Why toroidal?

Toroidally wound transformers are more compact than their conventionally laminated equivalents, being only half as high and heavy. Their circular profile ensures greater operating efficiency and as such are particularly valuable in heavy duty applications. We have our own production section for winding and making toroidal transformers enabling us to offer this much sought-after type at competitive prices. Four of the larger models in our range of power supply units are now supplied with this type.

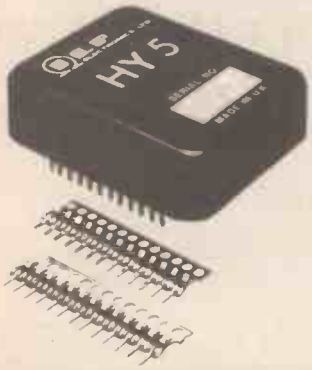
PRODUCTS OF THE WORLD'S FOREMOST SPECIALISTS IN ELECTRONIC MODULAR DESIGN

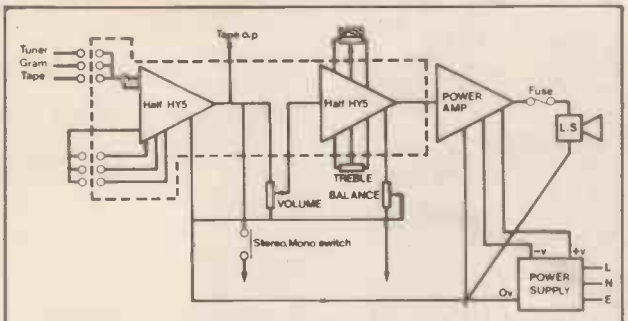
AVAILABLE ALSO FROM WATFOR CTRONICS, MARSHALLS AND CERTAIN OTHER SELECTED STOCKISTS

and staying there

PERFORMANCE MODULAR UNITS

HY5 PRE-AMPLIFIER



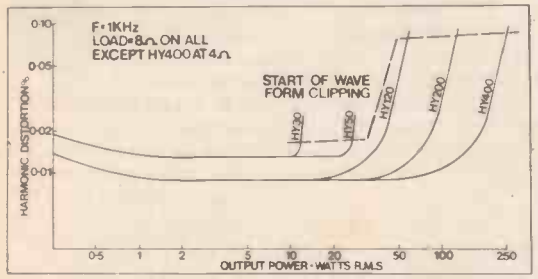


VALUES OF COMPONENTS FOR CONNECTING TO HY5
Volume – 10KΩ log.
Bass/Treble – 100KΩ linear. Balance – 5KΩ linear.

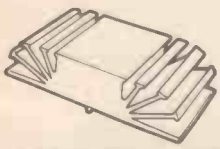
The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm. and provides multi-function equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits; 500 mV out. Distortion at 1KHz–0.01%. Special strips are provided for connecting external pots and switching systems as required. Two HY5's connect easily in stereo. With easy to follow instructions.

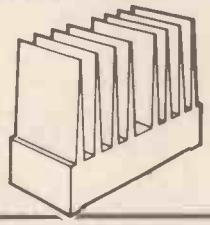
£4.64 + 74p VAT

THE POWER AMPLIFIERS



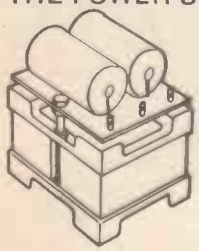
Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0- +20	105x50x25	155	**£6.34** + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0 +25	105x50x25	155	**£7.24** + £1.09
HY120	60 W into 8 Ω	0.01%	100dB	-35 -0- +35	114x50x85	575	**£15.20** + £2.28
HY200	120 W into 8 Ω	0.01%	100dB	-45 -0- +45	114x50x85	575	**£18.44** + £2.77
HY400	240 W into 4 Ω	0.01%	100dB	-45 -0- +45	114x100x85	1.15Kg	**£27.68** + £4.15





Load impedance – all models 4 - 16Ω
Input sensitivity – all models 500 mV
Input impedance – all models 100KΩ
Frequency response – all models 10Hz - 45KHz - 3dB

THE POWER SUPPLY UNITS *(Laminated and Toroidal)*



I.L.P. Power Supply Units are designed specifically for use with our power amplifiers and are in two basic forms – one with circuit panel mounted on conventionally styled transformer, the other with toroidal transformer, having half the weight and height of conventional laminated types.

PSU 30	±15V at 100ma to drive up to five HY5 pre-amps	£4.50 + £0.68 VAT
PSU 36	for 1 or 2 HY30's	£8.10 + £1.22 VAT
PSU 50	for 1 or 2 HY50's	£8.10 + £1.22 VAT
PSU 70	with toroidal transformer for 1 or 2 HY120's	£13.61 + £2.04 VAT
PSU 90	with toroidal transformer for 1 HY200	£13.61 + £2.04 VAT
PSU180	with toroidal transformer for 1 HY400 or 2 x HY200	£23.02 + £3.45 VAT

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5 YEAR GUARANTEE
7-DAY DESPATCH ON ALL ORDERS
INTEGRAL HEATSINKS
BRITISH DESIGN AND MANUFACTURE
FREEPOST SERVICE
–see below

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Simply fill in order coupon with payment or credit card instructions. *Post to address as below but do not stamp envelope – we pay postage on all letters sent to us by readers of this journal.*

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Canterbury, Kent CT2 7EP.
Telephone (0227) 54778 Telex 965780

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. . . . . .
NAME . . . . . .
ADDRESS . . . . . .
. . . . . .
Signature . . . . . .

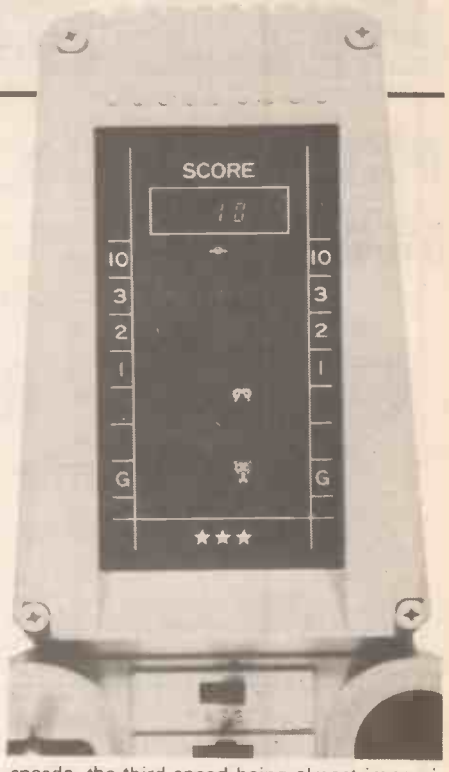
Monitor

POCKET ALIENS

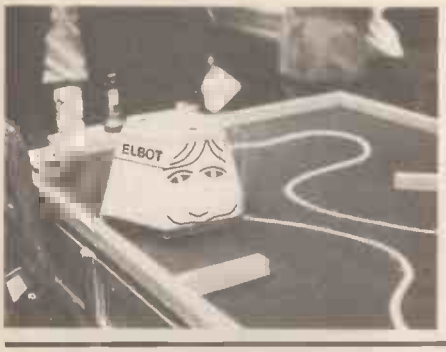
Two new games for your approval this month. First the boring one (well, compared to the second one). It's another variation on the electronic Mastermind theme. This one has a six digit hidden-code facility and it also squeeks. Like the previous Mastermind games it comes complete with a little plastic wallet, score cards and a genuine Mastermind pen.

Now for the second game. It is called Galaxy Invader and is based on what must be the most popular video game in the whole Universe, Space Invaders. Most of you will have seen them already in Pubs and arcades and probably like us, lost quite a few quid trying to save Mankind.

On the screen of the strange looking box a series of little alien gentlemen (we think!) try to move across and down the length of the screen to land on your home base. To add a little spice to the proceedings they also spit jagged missiles at you, any of which will rob you of one of your three 'lives'. Your only protection lies with a laser gun that you command with the aid of a joystick (for aiming) and a red coloured 'Fire' button. Each Alien that you hit counts for either 1, 2 or 3 points (depending how far down the screen it has progressed) and 10 points for hitting the flying saucer that flits across the top of the screen. The game can be played at three



speeds, the third speed being almost impossible. The aim of the game (poetry and puns yet) is to score the magic 199 points with the minimum of lives lost. Each action, firing, winning and losing is supported by a selection of sound effects and tunes. So far we have exhausted three sets of batteries in as many days. It's doubtful whether NIC (Nick Nicholls) will ever get his review model back. However, he tells us that for £22.95 he'll let you have one that he has been saving. Whilst you're there you may like to give the Mastermind game the 'once-over', that will set you back £21.95. Both of these games can be found at 61 Broad Lane, Tottenham N15 4DJ.



THE LAST WORD

Latest of the talking microprocessing boxes is the new Texas Speaking Language Translator. Just released in the US it will chat to you in four languages (at the moment) and will enable you to communicate by stringing words together into simple phrases. The memory ICs of the Texas translator have provision for around 300 phrases and something like 3000 words. Price in the US is 270 dollars (approximately £130, [illegible] you can add a few quid (initially) to the US price for when it comes over here but just like its less verbal predecessors it should drop below the £100. [illegible] mark.

HOBBYTRONIC '80

They do things rather differently in Germany. Their electronic shows are sometimes two or three times as big as ours so we took the opportunity of visiting one of the biggest called Hobbytronic '80. It was held in Dortmund at the end of February, our host at the show was none other than Herr Udo Wittig the Editor of our German ETI. 'Elrad' had one of the biggest stands at the show, star of the Elrad stand was undoubtedly the 'ELBOT', the German version of our own HEBOT. On the day we arrived a TV crew has just finished making a short film on ELBOT for a news programme to be broadcast that very evening. HEBOT is now an international star.

Looking round the show it was soon clear that our German cousins are really getting into the amateur computer scene. PETs Nascoms Apples and a few home-grown devices were in considerable abundance. Second in terms of popularity was most definitely CB. As you probably know CB is legal in West Germany (although the output power is restricted to 0.5 watts), something like half the stands were devoted to CB equipment. It was understandably irritating to see 40 channel 4 watt rigs going for as little as £25 (these were marked 'For Export Only') an awful lot of people seemed to be buying them up as fast as they could be uncrated.

STRIP EASE

Actually, we've got two or three strippers in the HE offices but none of them match up to the model we're featuring here. You could say! really hot stuff.

This stripper will completely strip off insulation on wires between 12 and 24 AWG. If that sounds impressive then just listen to this, it will also tackle those problem jobs, wires coated in PTFE and nylon.

It achieves these remarkable feats by heating the cutting blades up to 1700°F in just a few seconds, all at the touch of a button. The heating electric elements are powered (low voltage, high current) from an internal transformer run from the mains.

If you would like to know more about the 'Stripall TW1 (bet we could have thought up a better name!) then get in touch with Eraser International Ltd at: Unit M, Portway Industrial Estate, Andover, SP10 3LU.

News from the Electronics World

VICE CLAMPDOWN

Aggravated by awkward angular assemblies? Telepro Multi-purpose Work Holder to the rescue. This sucker-footed, multi angular (360 degrees rotation, 180 degree tilt) work clamp is for you. The reversable jaws (one side serrated the other shaped) will hold those delicate components gently but firmly in its fully detachable clamp. A spring loaded knob allows the pressure to be accurately applied. The clamp comes with metal and soft nylon jaws as standard but Telepro can supply replacements and an alternative stand that can be fitted into a bench vice.

The photograph on the right shows the free-standing model gripping a multi-way switch in its jaws. At the bottom are a pair of jaws showing the pre-formed holes for gripping cylindrical objects (down to 1mm in diameter).

We're not sure how much it costs but out experience in the past with such devices has proved their worth time and time again. Telepro are waiting for your enquiry at: Stiron House, Electric Avenue, Westcliff-on-Sea, Essex, SS0 9NW.

PUFF BOX

It has never ceased to amaze us why so many multimeter manufacturers seem to ignore the capacitor on their wares. The circuitry needed to measure capacitors is relatively simple, all the other gubbins is already there, meter, switches, etc. Oh well, ours not to reason why, etc, etc. . . . 15

So much for the HE gripe of the month. Actually it leads us rather neatly to this month's test gear offering. It is a capacitance meter (how about capacitance meter manufacturers putting multimeters in their boxes?) and it comes from Havant Instruments. This model, quaintly entitled the 820 is an economical multi-range instrument that is completely self-contained. Its 10 ranges cover from 0.1pF to 1 Farad. Accuracy is in the order of 0.5% or 1% of full-scale. The four digit LED display clearly indicates the value of the capacitor under test. The capacitor is inserted into a set of contacts on the body of the instrument (a couple of jack sockets are provided for in-circuit tests). The display flashes when the range is exceeded. The 820 weighs in at around 1.5 pounds and will run from either dry cells or Ni-Cads. Havant will be able to fill you in with all the details. They live at: Unit 3, Westfields, Portsmouth Road, Horndean, Hants.

BOOK REVIEWS

Two from our old friend Babani this month. The first is called "Choosing and using your Hi-Fi". (Author Maurice L. Jay BP68 ISBN 0 900162 89 9, £1.65).

This book is clearly aimed at the 'layman', about to go out and spend several hundred pounds on a Hi-Fi system. It explains the seemingly endless technical terms used to describe modern Hi-Fi and can be used to judge what type of system is best suited to your needs. If you're a bit doubtful about all these terms and buy on looks alone then treat yourself to this little book, it could save you a packet.

Our second book is simply entitled "Electronic Games". (R. A. Penfold BP 69 ISBN 0 900162 90 2 £1.75). The book is divided into two sections, the first deals with simple circuits, each with a suitable stripboard layout. The second contains a selection of slightly more ambitious circuits. The games described range from a simple 'Heads or Tails' circuit to an impressive looking 'Noughts and Crosses' and the intriguing sounding 'Broken IR Beam Game'. We must say that some of the circuits are a little complex, but the games in the first section could be confidently tackled by anyone who can solder.

AMATEUR EXHIBITION

The British Amateur Electronics Club (BAEC) are holding an exhibition from July 12 th to 19th at the 'Shelter', The Centre of the Esplanard, Penarth, South Glamorgan. (About five miles from Cardiff). So all you Welsh electronics enthusiasts get along to this exhibition, we're sure it'll be worthwhile.

ROBOT CORNER

It seems that Robots are here to stay. Latest news comes from a company called Unimation. Their UK subsidiary have just tied up a deal with the National Research and development Council (NRDC) to produce an assembly-line type robot (the sort that you see on the Fiat ad) in Telford. This small scale Unimate will be mostly of American design but we (the British) hope to be supplying some of the Software expertise to make it do its quite impressive tricks. The model to be made on these shores is to be called the Puma and already the order book for these devices is well into triple figures.

LATE BIT

We've just heard from Doug Pitt (author of NBTV) that the NBTV Association are to hold their sixth Annual Convention at Trent Polytechnic, Clifton, Nottingham. The date is Saturday April 26th commencing 12 noon. Anyone wishing to attend can obtain a ticket (free) from Doug Pitt

ERRATA

Some of our sharp-eyed readers have noticed the missing connection on Fig.1. of the CD ignition System in last months HE. On the secondary of T1 we omitted to show the connection between the 0 V tapping and the +V line immediately below. The PCB *and* Overlay diagrams are correct.

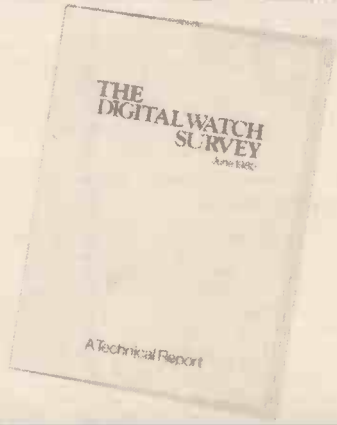
A late one this, it concerns the short Circuit on page 33 in the March issue. Sound Operated Switch. We omitted to show that the junction of R6 and R7 connect to the base of Q3.

Watch NEWS
MAY 1980 60p

SPECIAL REPORT
FREE
to all readers

Don't buy a digital watch

until you read this report



There are so many digital watches on the market, with varying functions, that the average person is bound to feel somewhat confused.

A new survey of the electronic watch industry has been produced to clarify this confusion and to give an unbiased and objective answer to the many questions that are constantly being raised.

by Trevor Raven.
C.Eng. AMBIM. MIERE

- ✳ How accurate are electronic watches?
- ✳ Who makes Seiko's?
- ✳ What is the importance between brand names?
- ✳ Is solar power worth the extra money?
- ✳ What are the most important features in a watch?
- ✳ When will prices stop falling?

The survey answers all of these questions and tells you what to look for in a quartz watch; how they work; why the prices vary so much; what the future holds.

FREE OFFER

Send today for this free technical report, plus news of a unique Metac offer to beat all special offers.

Complete the coupon below and send it FREEPOST (no stamp required) and we will post, **Same Day Despatch**, the technical report giving you all you need to know about electronic watches and details of our special offer.

Which is the best watch?

These four watches are very different in price, durability and functions. How would you choose between them?

This unbiased and objective report helps you to make this decision and gives you a deeper insight into the rapidly changing and exciting world of the micro-chip.

For your free copy of the report, complete and return the coupon to: Metac Electronic & Time Centres, 24-hour Despatch Centre, FREEPOST, 47A High St., Daventry, Northants.

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HE5

STEVENSON
Electronic Components

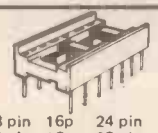
OPTO

LED's	0.125in.	0.2in	each
Red	TIL209	TIL220	10p
Green	TIL211	TIL221	15p
Yellow	TIL213	TIL223	15p
Clips	3p	3p	

DISPLAYS

DL704	0.3 in CC	130p
DL707	0.3 in CA	130p
FND500	0.5 in CC	100p

SKTS



Low profile by Texas

8 pin	10p	18 pin	16p	24 pin	22p
14 pin	12p	20 pin	18p	28 pin	26p
16 pin	13p	22 pin	20p	40 pin	38p

3 lead T018 or T05 skt. 12p each.
Soldercon pins: 100 for 60p.

PCBS

VEROBOARD

Size in.	0.1in.	0.15in.	Vero
25 x 1	16p	–	Cutter 110p.
2.5 x 3.75	52p	45p	
2.5 x 5	60p	55p	Pin insertion
3.75 x 5	70p	70p	tool 150p.
3.75 x 17	250p	210p	
SS pins/100	45p	45p	

Fibreglass board: 80p each.
Alfac – 33p per sheet.

RESISTORS

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	0.85p
0.5W	2p	1.5p	1.3p

Special development packs consisting of 10 of each value from 4.7 ohms to 1 Megohm (650 res) 0.5W £8.50. 0.25W £5.30.

METAL FILM RESISTORS
very high stability, low noise rated at ¼W 1%. Available from 51ohms to 330k in E24 series. Any mix:

	each	100+	1000+
0.25W	4p	3.7p	3.5p

POTENTIOMETERS
Preset vertical or horizontal 100 ohms - 1M 6p
Rotary 5K-2M2 Log or Lin single . 30p
Rotary 5K-2M2 Log or Lin double 90p
Slide 60mm travel 5k-500k Log or Lin, single 60p
Suitable knobs for above with coloured caps in red, blue, green, grey, yellow and black. Rotary controls 16p each. Slide type 12p each.

MISC.

Murata Ultrasonic Transducers	350p pair
64mm 8 ohm speakers	100p each
64mm 64 ohmspeakers	100p each
SRB 17W soldering iron	430p each
Reel of 22swg solder (39.6m)	320p each
Desoldering tool	510p each
Precision screwdriver set	170p each
Titan Electric drill	1095p each
Minaiture 606 and 909 at 100mA transformers	110p each

SWITCHES

TOGGLE

Standard	SPST 36p	DPDT 50p
Miniature	SPDT 75p	DPDT 85p
Subminiature	SPST 58p	DPDT 78p

SLIDE

Standard	DPDT 17p
Miniature	DPDT 16p

ROCKER (10A rating)
SPST 34p each. SPST 46p each.
ROTARY
1P12W, 2P6W, 4P3W or 3P4W 51p each
Key operated DPDT (Yale key) 395p each
PUSH

Non locking	- push to make	16p each
	- push to break	22p each
Locking	- SPST	75p each
	- DPDT	100p each

REGULATORS

LM309K	140p
LM317T	220p
LM323K	480p
LM723	40p

100mA + ve		1A + ve		1A – ve	
78L05	30p	7805	70p	7905	85p
78L12	30p	7812	70p	7912	85p
78L15	30p	7815	70p	7915	85p

TRANSISTORS

AC127	22p	BC548	11p	TIP32C	60p
AC128	22p	BCY71	16p	TIP2955	66p
AC176	22p	BCY72	15p	TIP3055	53p
AD161	40p	BD131	40p	ZTX107	12p
AD162	40p	BD132	40p	ZTX108	12p
BC107	12p	BD139	33p	ZTX300	14p
BC108	10p	BD140	33p	ZTX500	15p
BC108C	12p	BFY50	23p	2N3053	25p
BC109	12p	BFY51	23p	2N3054	56p
BC109C	12p	BFY52	23p	2N3055	50p
BC147	9p	MJ2955	100p	2N3702	9p
BC148	9p	MPSA06	16p	2N3704	9p
BC177	16p	MPSA56	16p	2N3706	9p
BC178	16p	TIP29C	60p	2N3819	20p
BC182	10p	TIP30C	48p	2N3904	10p
BC182L	10p	TIP31C	50p	2N3905	10p
BC184	10p	DIODES		2N3906	10p
BC184L	10p	1N914	4p	2N5459	33p
BC212	10p	1N4148	3p	2N5777	50p
BC212L	10p	1N4002	5p	1N4006	7p
BC214L	10p	1N4148 £1.50 per 100.		1N5401	14p
				BZY88ser.	8p

CAPACITORS

POLYSTYRENE
High quality foil type. 63V working, 5% tol.
22pf to 100pf . . . . . 7p each
1500pf to 0.01uF . . . . . 9p each

TANTALUM BEAD
0.1, 0.15, 0.22, 0.33, 0.47, 0.68
1 & 2.2uF @ 35V . . . . . 10p each
4.7, 6.8, 10uF @ 25V . . . . . 18p each
22 @ 16V, 47 @ 6V, 100 @ 3V . . 22p each

MYLAR
0.001, 0.01, 0.022, 0.033, 0.047 . . . 4p each
0.068, 0.1 . . . . . 5p each

POLYESTER
Mullard C280 series
0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1. 6p ea.
0.15, 0.22 . . . . . 8p each
0.33, 0.47 . . . . . 12p each
0.68 . . . . . 17p each
1.0uF . . . . . 22p each

CERAMIC
Plate type 50V. Available in E12 series from 22pF to 1000pF and E6 series from 1500pF to 0.047uF . . . . . 2p each

MINIATURE TRIMMERS
Miniature film type, in 1.4pF – 5pF, 2pF – 22pF, 2pF – 22pF, 2pF – 10pF, 5.5pF – 65pF. 22p each

RADIAL LEAD ELECTROLYTICS

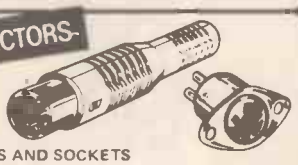
63V	0.47	1.0	2.2	4.7	10	6p each
			22	33	47	8p each
	100					16p each
			220			20p each
25V	10	22	33	47		6p each
	100					8p each
		220				12p each
				470		18p each
	1000					28p each

PACKS

Specially developed packs intended for development work.

¼W CF resistor, 10 each value E12 series 4.7 ohm to 1 Megohm (650 total)	530p each
½W CF resistor, 10 each value E12 series 4.7 ohm to 1 Megohm (650 total)	850p each
¼W MF 1% resistor, 10 each value E24 series 51 ohms to 330K (930)	2950p each
Preset potentiometers 5 each value from 100 ohms to 1 Megohm (65)	390p each
Polyester capacitors 5 each value 0.01 to 2.2uF (70)	690p each
Ceramic plate capacitors 10 each value 22pF to 0.01uF (310)	575p each

CONNECTORS



DIN PLUGS AND SOCKETS

	plug	chassis socket	line socket
2 pin	8p	8p	12p
3 pin	12p	10p	12p
5 pin 180°	12p	11p	17p
5 pin 240°	14p	11p	22p

JACK PLUGS AND SOCKETS

	unscreened	screened	socket
2.5mm	10p	15p	8p
3.5mm	10p	16p	9p
Standard	16p	30p	19p
Stereo	23p	39p	22p

1mm PLUGS AND SOCKETS
Suitable for low voltage circuits, Red & Black.
Plugs: 7p each. Sockets: 8p each.

4mm PLUGS AND SOCKETS
Available in blue, black, green, brown, red, white and yellow. Plugs: 12p each. Sockets: 13p each.

CMOS

		4023	20p	4054	120p	4502	120p
		4024	50p	4060	120p	4507	60p
		4025	20p	4063	120p	4508	330p
		4026	160p	4066	60p	4510	80p
		4027	45p	4068	20p	4511	90p
4000	20p	4028	85p	4069	20p	4512	80p
4001	20p	4029	85p	4070	20p	4516	80p
4002	20p	4031	220p	4071	20p	4518	80p
4006	90p	4033	150p	4072	20p	4520	80p
4007	20p	4036	350p	4073	20p	4527	90p
4008	95p	4039	300p	4075	20p	4528	90p
4011	30p	4040	110p	4076	90p	4529	150p
4012	20p	4041	85p	4077	20p	4531	150p
4013	35p	4042	80p	4078	20p	4532	130p
4014	80p	4043	95p	4081	20p	4538	160p
4015	80p	4046	110p	4082	20p	4543	110p
4016	30p	4048	60p	4086	75p	4566	170p
4017	65p	4049	45p	4093	60p	4558	120p
4018	90p	4050	45p	4095	110p	4559	420p
4020	100p	4051	70p	4098	120p	4581	330p
4022	100p	4053	80p	4501	20p	4585	110p

LSTTL

		74LS47	80p	74LS126	45p	74LS175	90p
		74LS48	90p	74LS132	80p	74LS190	90p
74LS00	16p	74LS54	22p	74LS136	50p	74LS191	90p
74LS01	22p	74LS73	35p	74LS138	75p	74LS192	90p
74LS02	16p	74LS74	35p	74LS139	75p	74LS193	90p
74LS03	22p	74LS75	40p	74LS151	60p	74LS195	90p
74LS04	16p	74LS76	40p	74LS155	65p	74LS196	90p
74LS08	22p	74LS78	45p	74LS156	80p	74LS197	85p
74LS10	22p	74LS83	68p	74LS157	70p	74LS221	100p
74LS13	38p	74LS85	85p	74LS158	65p	74LS251	70p
74LS14	65p	74LS86	40p	74LS160	75p	74LS266	35p
74LS20	22p	74LS90	40p	74LS161	68p	74LS290	80p
74LS21	22p	74LS93	55p	74LS162	80p	74LS365	55p
74LS27	28p	74LS95	65p	74LS163	80p	74LS366	55p
74LS30	22p	74LS107	45p	74LS164	80p	74LS367	55p
74LS32	30p	74LS114	40p	74LS165	80p	74LS368	55p
74LS37	40p	74LS123	80p	74LS173	135p	74LS386	50p
74LS42	60p	74LS125	45p	74LS174	95p	74LS670	200p

TTL

		7442	40p	7493	30p	74157	40p
		7445	50p	7496	38p	74164	55p
7400	12p	7447	50p	74121	29p	74165	55p
7402	12p	7448	45p	74123	40p	74174	55p
7404	14p	7473	23p	74125	38p	74177	50p
7408	16p	7474	23p	74126	36p	74190	50p
7410	14p	7475	26p	74132	46p	74191	50p
7413	24p	7476	25p	74141	48p	74192	50p
7414	39p	7485	55p	74145	48p	74193	50p
7420	14p	7486	18p	74148	90p	74194	50p
7427	22p	7490	30p	74150	55p	74196	50p
7432	18p	7492	30p	74154	68p	74197	50p

LINEAR

		LM10	400p	LM3909	72p	TBA800	80p
		LM301A	30p	LM3914	280p	TBA810S	110p
		LM308	70p	LM3915	280p	TDA1008	350p
709	40p	LM318	85p	LM3911	120p	TDA1022	630p
741	18p	LM324	52p	LM13600	160p	TDA1024	120p
747	50p	LM339	55p	MC1496	80p	TDA2020	360p
748	35p	LM348	100p	LM1458	40p	TL071	75p
7106	850p	LM377	170p	LM1830	180p	TL072	135p
AY-1-0212	660p	LM378	230p	MC3340P	135p	TL074	200p
CA3046	70p	LM3795	410p	MC3360P	135p	TL081	45p
CA3080	75p	LM380	80p	MM57160	650p	TL082	85p
CA3130	90p	LM381	140p	NE531	110p	TL084	125p
CA3140	50p	LM382	120p	NE555	23p	TL170	60p
FX209	820p	LM383	200p	NE556	60p	XR2206	390p
ICM7555	100p	LM386	90p	NE566	120p	XR2207	450p
ICM7556	POA	LM387	120p	NE567	120p	ZN414	80p
LF347	135p	LM389	100p	NE570	420p	ZN419	POA
LF351	45p	LM391	170p	NE571	460p	ZN424	150p
LF353	85p	LM1310	140p	NE5537	POA	ZN425E	420p
LF355	92p	LM2917	280p	RC4136	100p	ZN460	360p
LF356	95p	LM2924	160p	SAD1024	1310p	ZN1034	230p
LF357	92p	LM3900	60p	SN76477	230p		

MICRO

		2112	220p	CPU's		SUPPORT	
		2114LP	420p	6800	650p	6810	350p
		4116	620p	8080A	610p	6821	600p
		2708	680p	Z80	1090p	6850	550p
21L02	120p	2716	1980p			AY5-1013	370p

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10

Miniclocks

Do you have trouble getting up in the mornings? Then why not build our HE Travelling Alarm? Guaranteed to give you that get-up-and-go feeling

THE FOUR HE MINI-CLOCK PROJECTS are based on the very latest CM161 miniature clock-display module, which is available from Ambit International for about £10. This module has a 4-digit liquid crystal display and the entire unit draws a total current of only ten or so microamps from a 1.5 volt supply, enabling the unit to run for years from a single battery. The complete module measures approximately 36mm x 18.5mm x 7.5mm, with the display occupying a mere 22mm x 8.8mm.

The CM161 module can readily be 'pre-programmed' by the owner to give either a European- or an American-style DATE format and to give either a 12-hour or 24-hour TIME display format. The module gives readouts of time, day and date and typically maintains timing accuracy within 2.5 minutes per year. The display is provided with a manually-activated incandescent backlight, for night-time use. The unit also has a couple of 24-hour alarm outputs, for use with external alarm-generator circuitry: the alarm can readily be set via a couple of push buttons.

You can see from the above description that you have a fair number of options and plenty of individual choice when using this module, which makes it hard for HE to be pedantic in recommending methods of 'project' construction. You may, for example, choose to use the module without its alarm facility, either as a simple pocket clock or as a timepiece that is permanently built into a car, radio, or piece of furniture. To help you choose your options, the following section gives details of the basic clock module.

The basic clock module has a miniature PCB mounted on its rear. The PCB contains a number of solder pads, both for pre-programming the unit's display format and for making external power supply and control connections, as shown in Fig 1. The first thing you'll need to do when you get one of the modules is to pre-program it to give either a 12- or 24-hour time format and to give either a European-style (DAYS — MONTHS) or American-style (MONTHS — DAYS) date display. This programming is done by making two small solder bridges (using a miniature soldering iron) between certain of the function pads. Fig 1 shows the bridges required for a 12-hour European-type display. Table 1 gives details of the display options.

Your next step, after pre-programming, will be to give the module a functional check and learn to 'drive' it via its push-button switches. Fig 2 shows the basic test circuit, which can also be used as a practical circuit in 'fixed' applications (e.g., built into a radio or car, etc) in which the alarm function is not required. Connections are made to the module via its solder pads: make particular note of the polarity of B1, the 1.5 volts supply battery. Once you've built the circuit of Fig 2 you can test it as follows.

Connect battery B1 to the basic circuit of Fig 2, taking special care to fit it in the correct polarity. The display will read 1:00 in 12-hour format or 01:00 in 24-hour format. Operate the SET switch (PB1) once: the colon (:) part of the display will now flash once per second, indicating that the clock module is 'initialised' and operating correctly. You can now set the module to the correct time, thus:

To set the module to the correct time, briefly press MOD switch PB2: the HOURS digits to the left of the colon will start to flash, indicating that they are ready to be set: operate SET switch PB1 repeatedly until the correct hours are indicated (Note: in the 12-hour mode, an 'A' (AM) or 'P' (PM) sign will also appear at the right of the display and must also be set to the correct value via the SET switch). Once the HOURS are set, briefly press the MOD switch again: the MINUTES digits to the

FUNCTION PAD	SOLDER TO SOURCE PAD	DISPLAY DIGIT 1st 2nd : 3rd 4th	REMARK
D	V_{DD}	DAYS MONTHS	EUROPEAN STYLE
M	V_{SS}	MONTHS DAYS	AMERICAN STYLE
2	V_{DD}	HOURS : MINUTES	24-HOURS FORMAT
1	V_{SS}	HOURS : MINUTES	12-HOURS FORMAT

Table 1. Connection details for programming the basic CM161 module to give alternative types of display.

right of the colon will now flash, indicating that they are ready to be set: operate SET switch PB1 repeatedly until the correct minutes are set, then briefly operate MOD switch PB2 again and press SET switch PB1 once. The unit should now revert to normal operation and display the correct time.

You can now set the unit to the correct date and day, thus:

To set the module to the correct date and day, press and hold down MOD switch PB2 (for about 3 seconds) until the numeric days/months date display appears, with one of the digit sets (either months or days) flashing: now operate SET switch PB1 repeatedly until that digit set reads the correct value. Now operate MOD switch PB2 briefly: the other digit set will now flash: set it to the correct value via SET switch PB1. Now briefly operate MOD switch PB2 again: a flashing DAY sign will now be displayed: use SET switch PB1 to set the correct day-of-the-week and then briefly press MOD switch PB2 once again, at which point the display will revert to the TIME mode: if necessary, re-set the time setting, as already described.

Once you've initially set the time and date, you can learn to use the SET button, as follows:

Normally, the unit displays hours and minutes only. Alternative displays can, however, be called up via the SET button, thus:

(a). A momentary press of the SET button causes the date to appear for one second, followed by day-of-the-week for another second, after which the display automatically returns to the hours and minutes mode.

(b). If the SET button is held on, the display repeatedly alternates between the date (for one second) and the day (for one second).

(c). Seconds can be called up by briefly pressing the SET button twice within two seconds. The display will return to the hours-minutes mode on another momentary press of the SET button.

To complete the module testing procedure, shield the face of the display from external light and press the LMP button: check that the built-in backlight turns on and illuminates the display.

The basic test circuit of Fig 2 can be used as a practical circuit for use in 'fixed' applications (e.g., built into a radio, car, piece of furniture, etc) in which the alarm facility is not required.

Fig 3 shows how the basic circuit can be modified for use in portable applications, such as pocket watches, etc. In this case, slide switch SW1 is wired in series with the MOD and LMP buttons, to ensure that they are not activated inadvertently.

Fig 4 shows how a very-low-power 24-hour alarm facility can be added to the basic circuit. The alarm time can be pre-set via the ALS and SET buttons and the alarm signal consists of a very low power 1kHz tone that is pulsed on and off once per second and turns off completely after 15 seconds.

The CM161 clock module is provided with two alarm outputs (AL1 and AL2). The AL1 output is normally V_{DD} potential: when activated, it generates a 1kHz signal, interrupted at a 1Hz rate, for 15 seconds. The AL2 output is also normally at V_{DD} potential: when activated, it switches alternately between V_{DD} and V_{SS} at 1Hz, for 15 seconds. The procedure for setting and displaying the alarm time is as follows.

To set the alarm time, briefly press the ALS button twice within a 3 second period: a flashing HOURS numeral set

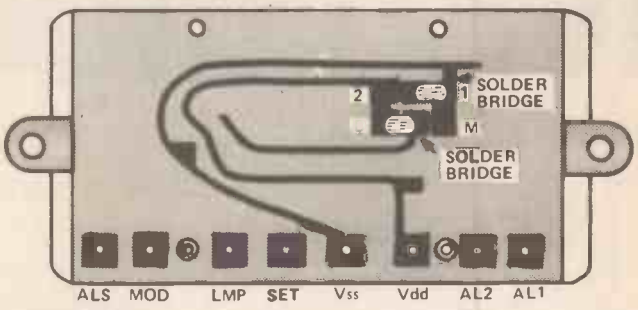


Fig. 1. Detailed view of the rear of the CM161 clock module showing method of 'programming' to give a 12 hour readout and European-style date format.

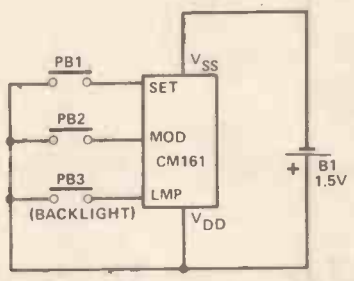


Fig. 2. The basic test circuit for project 1. A practical clock circuit for use in 'fixed' applications. The alarm facility is not used.

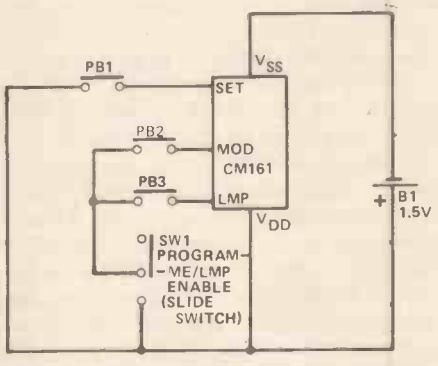
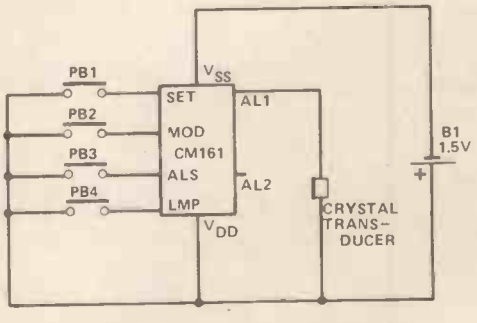


Fig. 3. Project 2 version of the basic circuit for use in portable applications. The slide switch prevents inadvertent operation of the Mod and Lamp switches. The alarm facility is not used.



NOTES:
AL1 OUTPUT IS NORMALLY AT V_{DD} POTENTIAL: WHEN ACTIVATED, GIVES A 1kHz TONE INTERRUPTED AT 1Hz RATE, FOR 15 SECONDS.
AL2 OUTPUT IS NORMALLY AT V_{DD} POTENTIAL: WHEN ACTIVATED, SWITCHES ALTERNATELY BETWEEN V_{DD} AND V_{SS} AT 1Hz, FOR 15 SECONDS.

Fig. 4. Project 3. The basic clock circuit with a low-power alarm facility.

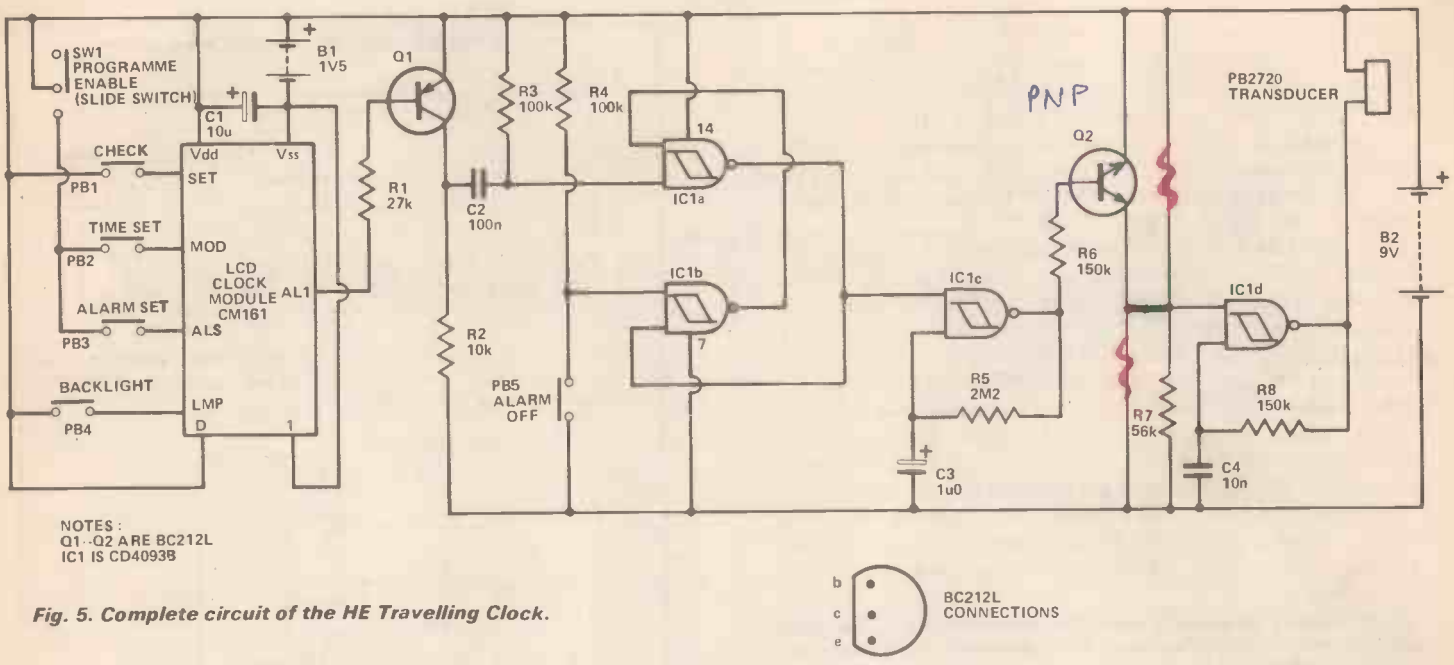


Fig. 5. Complete circuit of the HE Travelling Clock.

How it Works

The AL1 'alarm' output of the CM161 clock module is normally at V_{DD} potential. When the alarm activates, however, the AL1 terminal alternates between the V_{DD} and V_{SS} potentials at a 1 kHz rate, interrupted at a 1 Hz rate, for 15 seconds.

In our 'travelling' clock circuit the AL1 output signal is amplified by Q1 and used to switch on self-latching flip-flop IC1a-IC1b via C2. When the flip-flop is on it 'enables' 1 Hz astable multivibrator ICIc, which in turn pulses 2 kHz astable ICld on and off via Q2. The output of IC1d is fed to a miniature transducer, which thus produces a 2 kHz (approx) tone that is pulsed on and off at a 1 Hz rate under the alarm condition. The alarm can be turned off, once the AL1 signal has terminated after 15 seconds, by briefly operating PB5 and resetting the flip-flop to the off state. Note that the alarm circuit is powered from it's own 9 volt PP3 battery.

will appear to the left of the colon and an 'A' sign and a treble-clef (alarm) sign will appear to the right: operate the SET button repeatedly to set the required alarm hour. Briefly press the ALS button once: the 'A' sign will be replaced with flashing MINUTES numerals: operate the SET button repeatedly to set the required alarm minutes. Finally, briefly press the ALS button once more. The display will now revert to the normal TIME display mode, but with the treble-clef alarm sign displayed. The treble-clef sign will extinguish when the alarm goes off.

The alarm time can be displayed at any time via the ALS BUTTON. Briefly pressing the ALS button causes the alarm time to be displayed for about 3 seconds, after which the display reverts to the normal TIME mode with the treble-clef 'alarm' sign on its right. Pressing the ALS button down for a few seconds causes the alarm time to be displayed for 3 seconds, after which the display reverts to the normal time mode but without the treble-clef 'alarm' sign.

A 2-BATTERY 'TRAVELLING' CLOCK

The only criticism that we have of the basic CM161 clock module concerns its' alarm output, which turns off automatically after 15 seconds and is, because of the use of a 1.5 volt supply, very limited in sound volume. We decided to overcome this 'defect' and produce a reasonably compact 'travelling' clock with a self-latching alarm output that has to be turned off manually and which produces a fairly good level of sound output. The results of our efforts are shown on this month's front cover.

The full circuit of our travelling clock is shown in Fig 5. It has all of the TIME and ALARM facilities already described and has a PROGRAMME ENABLE slide switch wired in series with the MOD (time set) and ALS (alarm set) buttons to prevent inadvertent operation. The AL1 alarm output of the CM161 module is fed to an independently-powered (9 volt) alarm generator circuit. When the alarm actuates it self latches and produces an initial LONG tone (2 or 3 seconds) which is then pulsed on and off at a 1 Hz (approximately) rate: the alarm continues to sound until RESET button PB5 is operated.

Our unit is housed in a plastic case measuring approximately 103mm x 59mm x 30mm (see Buylines). The five push-button controls are mounted on the top of the case.

CONSTRUCTON AND USE

Start construction by pre-programming and testing the basic CM161 clock module, as already described. Next, make up the alarm module PCB as shown in the overlay, taking special care to fit all semi-conductors and electrolytic capacitors in the correct polarity. ICI is a CMOS device and should be fitted in a 14-pin socket. Use

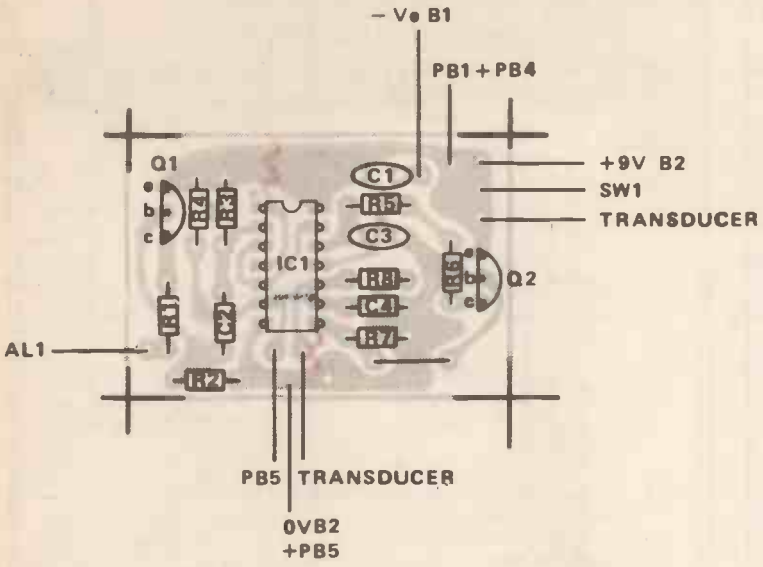


Fig. 6. Overlay diagram of the HE Travelling Alarm Clock. Take care to ensure that all polarised components are inserted the right way round.

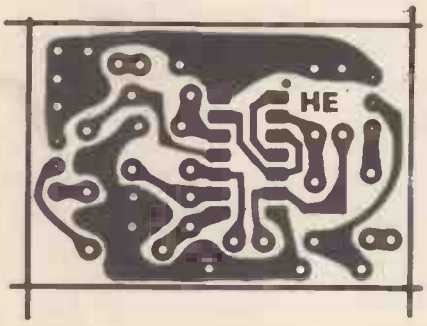


Fig. 7. PCB pattern for the travelling alarm clock.

Veropins to facilitate external connections to the PCB. When the PCB is complete, test it as follows:

Temporarily connect the PB2720 transducer in place (the transducer has three leads: ignore the blue one). Temporarily connect PB5 in place. Connect B2 (a 9 volt PP3 battery) to the board. Briefly short the board's AL1 terminal to B2's O V line and check that the alarm activates, as already described. Check that the alarm can be turned off after 15 seconds by briefly closing PB5.

When the above checks are complete, you can assemble the complete unit into a suitable case. On our prototype, the PCB and clock-module battery B1 are mounted in the main compartment of the BOC706B case: B2 (the PP3) is fitted in its' own compartment. The five push-button switches are fitted on the top of the case: the slide switch and transducer are fixed in place in the upper half of the case with epoxy resin. The CM161 clock module is fitted to the metal end-plate of the case with epoxy resin and is viewed through a suitable cut-out. Take special care when interconnecting the various parts of the project.

When construction is complete, use the SET and MOD buttons to set the time, date and day and the SET and ALS buttons to set the alarm time, as already described. You can then invite all your friends to call in and see your superb handywork.

Parts List

RESISTORS (All ¼W 5%)

R1	27k
R2	10k
R3,4	100k
R5	1M2
R6,8	150k
R7	56k

CAPACITORS

C1	10µ 16v Tantalum
C2	100n polycarbonate
C3	1µO 35v Tantalum
C4	10n polyonate

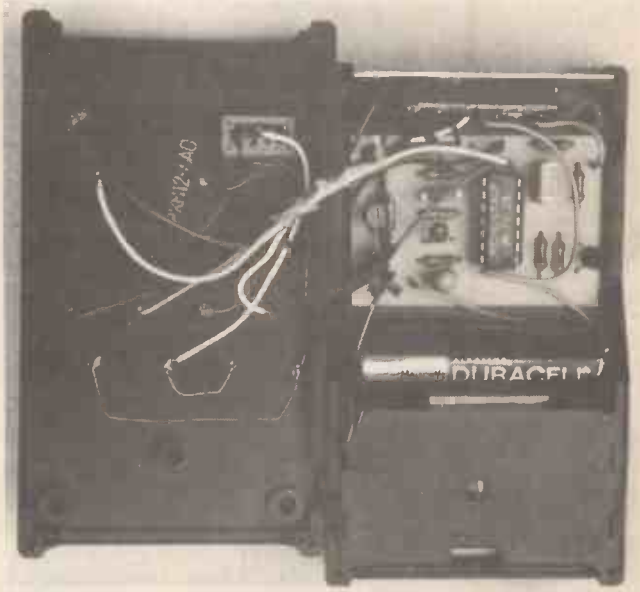
SEMICONDUCTORS

LCD clock module	CM161
IC1	4093B
Q1,2	BC212

MISCELLANEOUS

Transducer PB2720	
B1	HP7 1.5V
B2	PP3 9V

SW1 PCB type slide switch SPDT.
PB1-5 any low-profile keyboard momentary type push buttons.
Case
PCB
300mm of enameled copper wire.



Inside our version of the Alarm Clock. We made no attempt to miniaturise the design. Doubtless you could adapt our design to your own enclosure.

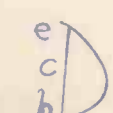
Buylines

The LCD clock module and transucer can be obtained from AMBIT international.

The case is available from West Hyde Developments. order as BOC 706B. All other components should be readily available from major stockist that advertise in this issue.

HE

from p.14 Errata in June Issue :- Q2 is PNP
Emitter connect to +Vo
Collector to junct R7 & IC1d
Base is correct.



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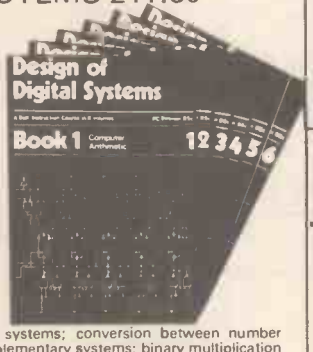

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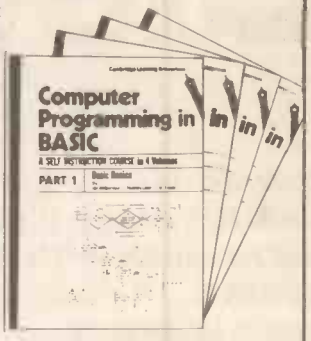

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Clever Dick

How do you like our new cartoon? Well, it's tough if you don't because you're stuck with it for the next few months. Anyway down to this month's letters

WE'LL START THIS MONTH with the bad news. Clever Dick has proved so successful that we just don't have the capacity to answer all your letters. We're getting up to 300 letters a month and even working 24 hours a day it's getting impossible to reply to them all.

So from now on we'll only answer letters through the column unless it's really urgent or important. If you feel your letter fits that description please enclose an SAE and mark the envelope 'Really Urgent and Important' and we'll do our best. Otherwise the best chance to get your letter published and replied to is to keep it short and interesting. As a bonus we'll send an HE Binder to the author of the best letter each month.

Now, down to business with Barry Hayton and his comments on the detection of noisy woodworm (see March CD, letter from Cliff Robertson).

Dear Dick,

Regarding the location of woodworm by electronic means; in the mid-fifties a friend assisted a local vicar with a similar project. After clamping a microphone to one of the most heavenward roof timbers he warmed up his suitcase sized home built Hi-Fi rig, then turned up the gain.

He heard a noise. Not the binary audication of amorous Death Watch beetles (the target) or even the rustle of angels wings — surely the purest of 'white noise', but an increasing rhythmic cacophany.

Fearful for the glass about him, both eclessiastical stained and electronic (remember valves), he switched off. In the quiet that followed he heard the approaching source of the seismic noise. A goods train was entering the cutting beyond the churchyard hedge.

I regret I have no technical advice to offer Mr Robinson.

Barry Hayton
Co. Durham

PS. Do I get a binder?

A-spiring beetles in the belfry, a testament to the woodworms holeyness perhaps?

PS, yes you do get a binder but only for cheek.

Burping tape recorders, whatever next? R. Harrington has a woeful tale to tell.

Dear CD,
BURPS VERSUS BLIPS — HELP

Re the above, 'Burps' I can get rid of with 'RENNIES', its the 'Blips' that are the big problem.

Apart from Electronics, my other hobby is involved with 'Sound Effects' recording. 'Good for You' you might say but unfortunately I live within 300 yards of several radar scanners belonging to HMS Collingwood, radar school.

These scanners are causing a very undigestible 'Blip' any time I play the tape recorder which is a mid to high priced machine.

Is there a Mr Spock in the office with or without funny shaped ears who could show me the green light on how to eliminate these cursable noises, without destroying the entire naval base?

One suggestion was poor earth, but this has been checked.

Seriously, is there a device that can be bought or made that will eliminate this nuisance — or any suggestions please?

R. Harrington
Hants.

Our only suggestion (albeit a little drastic) is to use a modified version of the ETI Click Eliminator. Apart from that we can only hope one of you with your fetile imaginations can come up with an answer. Any ideas?

This question keeps cropping up, the one about using an old telly for a 'scope. G. Scott has this to say.

Dear Dick,

Is it possible to make a small plug-in unit to convert a television to an oscilloscope? Could it be done in much the same way as a television game?

G. Scott
Gwent

Sorry to say no. The television sets we all know and love have all been designed to display waveforms (the TV picture) at one specific frequency. The scanning coils around the neck of a TV tube are optimised to run at line frequency only (that's 15.625 kHz) and 50 Hz for the horizontal deflection. It is possible to modify a set to display low frequency (around audio frequencies) waveforms simply by ditching most of the timebase circuitry and RF stages but it really is a lot of trouble. The other method is to use an external video and sync generator circuit to produce simple 'oscillograph type patterns, one company actually make a commercial box of tricks to do just this. It is called the Videograph and is to found in our sister mag ETI. (ETI had a

circuit for the Videograph some time ago). In either case you will probably end up spending nearly as much on this unit or the modifications that it would cost you to buy a new oscilloscope.

Sharp-eyed George Dalton makes an observation . . .

Dear Dick,
Love that illustration of the DFM on April's cover. It is shown functioning with half the components missing. For your next trick??

George Dalton
Romford.

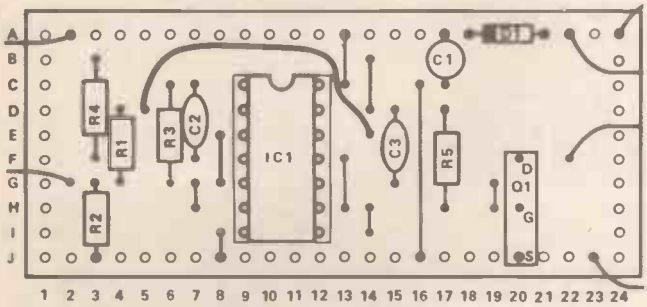
April Fool — that our excuse!

Our last letter this month comes from F. Chewdray, (that's only a guess, the handwriting was somewhat indecipherable).

Dear Dick,
I have just started reading HE and I want to build the Miniboard 6 Watt Siren. As I'm a beginner I don't know much about electronics. The picture you have shown in the article for the underside of the board was rather poor, I cannot see where the parts go. I wonder if you could send me a clear diagram.

F. Chewdray.
Lancs.

Sorry about that Mr/Mrs/Ms/Miss Chewdray, (that'll teach you to have bad handwriting) we have heard from a few other people concerning this particular project. It seems that quite a few copies had poor reproduction on this picture. For all of you that have got stuck we have printed a clearer (we hope) drawing of this project below. In the future we will be using line drawings for these Vero-based projects so we shouldn't have any more problems (Famous last words?)



It seems great minds do think alike. Letters from Adrian Shurmer of Cliftonville, Kent and Chris Burrows of Great Yarmouth a few weeks ago, both had requests for Sound-to-Light converters of three or more channels. At about that time we were putting the finishing touches to our plans for the projects for the next few months. We also thought it would be a good idea to include a STL project. Hopefully it will be appearing around the latter part of this year and if you're lucky maybe we will include a circuit for disco stroboscope. How about a light show special. Miss a single copy and you'll never know. See you next month. **HE**

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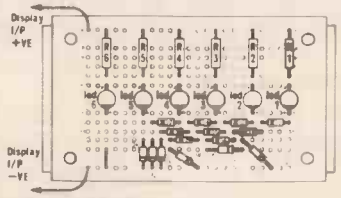

YOU WILL NEED

e.g. LED Bar Graph (a previous project)
components EXP300 or EXP350
D1 to D15 — Silicon Diodes
R1 to R6 Resistors
LED 1 to LED 6 Light emitting diodes

For the full detailed instructions, including "Electronics by Numbers" circuit diagrams, simply take the coupon to your nearest CSC stockist or send direct to us and you will receive "THREE FREE PROJECTS FROM CSC".

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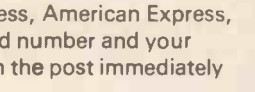

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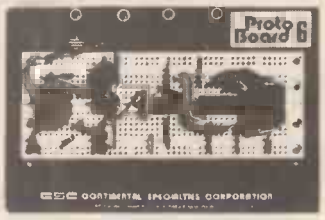
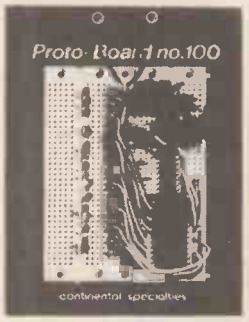


PB6 Kit, 630 contacts, four 5-way binding posts accepts up to six 14-pin Dips.

PROTO-BOARD 6 KIT £9.20



PB 100 Kit complete with 760 contacts accepts up to ten 14-pin Dips, with two binding posts and sturdy base. Large capacity with Kit economy.

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Toys For Boys

Rick Maybury revisits his deprived childhood (they only had Meccano sets in those days), and puts the latest crop of radio-controlled toys through their paces.

OKAY, you've got around fifty quid to spend and it's burning a hole in your pocket, what can you buy with it? As usual, HE to the rescue. We suggest you purchase batteries, yes that's right batteries, you'll need every penny of it to keep your new radio control toy properly fed. This month we've been spending money like water to try and keep our batch of models on the road. Admittedly we did have well over a dozen of them at one stage, nevertheless, even a most innocent looking little Dune Buggy managed to eat up a complete set of batteries after about an hour of moderate use. Considering the popularity of these models it may be prudent to buy some shares in Ever-Ready of Mallory.

So, in the interests of true investigative reporting we are now going to tell you how we got on and offer some suggestions on what to buy if you feel your life is incomplete without one of these models.

WHEELS, TRACKS AND PROPS

Basically, all of the models we reviewed fell into one of three categories. The four-wheelers, tracked vehicles (tanks, etc) and propeller driven craft (actually we only had one boat but it still counts).

The degree of control (by that we mean the *radio* control), varied enormously. In the last six months the toy market has been literally flooded with cheap (and mostly nasty) little cars that purport to be multi-function R/C models. The ones we are talking about usually cost under £10 and are easily identified by a single button on the transmitter. The very earliest specimens fell into the "Reverse and Turn" group. They worked quite simply by having the car (or whatever) set up to travel in a straight line, the steering is actually rigid. When the transmitter button is keyed it immediately throws the drive motor into reverse. On the underside of the car is a fifth wheel arranged on a little raised track that turns through 90 degrees. As the car reverses it engaged the fifth wheel which, because ofthe inclined track lifts the front wheels off the ground and rotates the car. It all sounds a bit complicated but you'll soon see how they work simply by looking at one in your local toyshop. But look is all you will do, on no account buy one. For a few pounds more you can have a genuine radio controlled car that goes in the direction you want it to. For the purpose of this survey we have excluded "reverse and turn" systems, all the models we reviewed are steerable, although one or two are a bit slow in doing it — more of that later.

although one or two are a bit slow in doing it — more of that later.

CONTROL SYSTEMS

Generally speaking there are three types of radio control. There is proportional control (usually digitally encoded) where by the amount of movement imparted on a control, eg the steering wheel corresponds exactly to the degree of movement on the control serface, the front wheels of the car. If the system has been well-designed it will also mimic

the speed of change of the control, if you turn the steering wheel quickly, the front wheels should respond with equal rapidity.

The second system is sometimes known as "Bang Bang" or 'multi channel'. It is not at all sinister, it merely means that a car (for instance) can be turned either to the left or right, usually by means of two buttons. You have no choice as to how sharp the turn is (except by skilfully "blipping" the control) but the difference in price between a digital proportional R/C system and a simple multi-channel set up can more than make up for any inherent deficiencies.

There is a third method of steering a vehicle or controlling a particular aspect of the models behaviour called "Sequential Control". Four of our review models had some form of sequential control, it simply enables a greater number of functions to be controlled. Unfortunately this is usually at the expense of time. As the name sequential implies, the particular function you require, eg, reverse, is reached by sequencing through one or more other commands, eg forward. The models we had that used sequential control all seemed to use the facility quite well and it does make the overall system more versatile. However, because of the time-lag in control functions it was only suitable for slow models like the tanks or buggies.

HOW THEY WORK

One of the most surprising things we discovered in this survey was the almost total absence of state-of-the-art (to quote a well-known phrase) ICs. Almost all of our review models had discrete transistor circuitry in both the transmitter and receiver modules. actually this is no bad thing on land-based models, space and weight are not really at a premium and in one case it enabled us to carry out a repair. This would have been virtually impossible on one of the latest single IC designs.

It was quite amusing to see the same Rx/Tx boards in models coming from different manufacturers. It was less amusing to see how they managed to interfere with each other, especially at the height of some important race. This should be borne in mind of you plan to hold a backyard Grand-Prix.

RELIABILITY

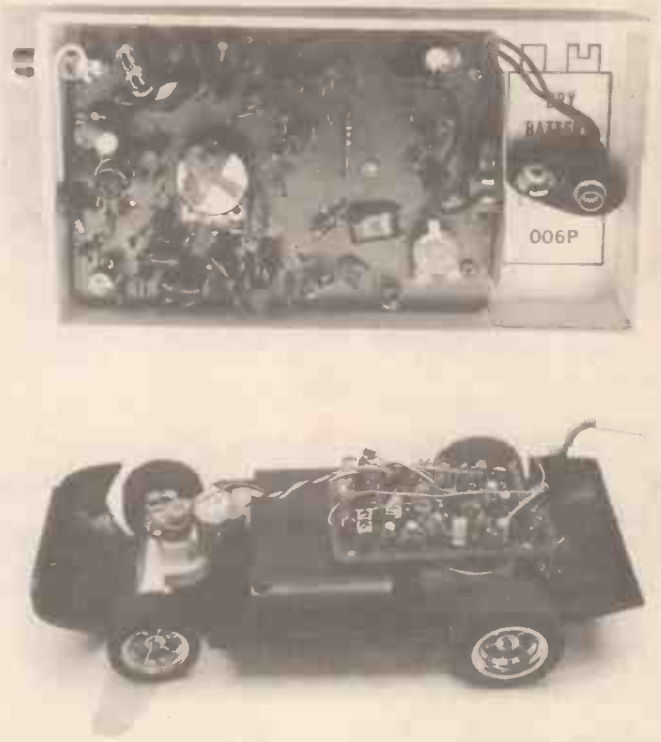
Apart from one model arriving inoperative (an output transistor for the steering motor bent over so its leads were shorting) none of our models gave the slightest trouble. Interference between adjacent transmitters was annoying but most of the models had their operating frequency clearly marked on either the box or transmitter. The "La Trax" models are sold as a "side-by-side" racing team so no problems should arise there.

All of the ready-to-go systems (you just add batteries) were made of plastic, well, what did you expect? This may make them slightly fragile. Ours took a quite severe battering and apart from the odd chipped wing most came through relatively unscathed. One thing to watch out for th ugh is careless feet. Several of our models escaped death by squashing only by sheer luck.

Just to give you an idea of the upper end of the R/C market we've included a 'do it yourself' kit. The actual degree of skill needed to assemble the kit is minimal but you do need to install your own R/C system. Generally they are much more expensive than the ready-built variety. In return they are capable of much higher speeds and are considerably more robust. You pays your money .

Before you turn over the page a few words in conclusion. Most of these models are toys. No serious R/C modeller would touch them with a bargepole, but not everybody is a model freak. If you're like us, essentially "weekend drivers", then there is sure to be something here to suit most tastes and pockets. Beware of the gimmicks, they soon pall, our favourites had minimum extras, just steering (Proportional preferred) forward and reverse (not necessarily proportional). A good turn of speed is essential, you may not need it at first but you'll certainly want it as you become more adept. Tanks are obviously not for the racers amongst us. They have their own fans, our attempts at a tank battle were thwarted by interference bear this in mind if you plan to add to your armoury!

One final note to the persons who stole our Mercedes and Leopard tank models (which were on loan). The



Inside one of the 'La Trax' models. As you can see there is a distinct lack of ICs in both the TX and RX circuits.

transmitter and aerials you require to control the mode. are still in our possession. If you would like to come to the Modmags Office, we would be more than happy to show you how they work.

Please note that all of these models operate on the 27 MHz R/C band and require a licence before they can be used. This is available from the Home Office Radio Regulatory Department.

SUPPLIERS

Most of these models will be in your high street toy and model shops but in case of difficulty they may be obtained from the companies below who were good enough to lend us the samples for our review.

(1) **Tandy.** Most models at all branches.
(2) **NIC.** 61 Board Lane, Tottenham, London, N17.
(3) **Fringewood.** 1 Hatton Court, Ipswich, Suffolk.
(4) **Action Gable Ltd.** 480 Fulham Road, London SW6.

INTEL CORVETTE STINGRAY

Functions:
Steering — fully proportional. Forward and reverse — 'bang bang'.

Features:
Spot frequencies for side-by-side racing.

Model:
A good looking model of indeterminate scale, sturdy construction.

Price and supplier:
£25.00 (3).

Comments:
For the price this represented one of the best digital proportional models. It was somewhat sluggish compared to the other racing cars but this was possibly due to its weight. Quite reasonable on batteries, up to an hour on a set of alkaline cells. Range is around 40 feet. TX-PP3, RX 4 × HP2.

RADIO SHACK PORSCHE 928

Functions:
Steering — proportional, forward and reverse — semi-sequential.

Features:
No extras.

Model:
Good, sturdy 1/21 scale, nice detail.

Price and supplier:
£24.95. (1).

Comments:
The transmitter has been cunningly styled to look like a full-blown digital proportional set-up. We were understandably amused to discover that the forward/reverse function was semi-sequential and unless you held the control stick in the down position there was no way to keep the model stationary. The steering was actually quite good and the range almost equal to the best. Battery consumption was average. The low price makes this model well worth thinking about. Range 25-30 feet. TX-PP3, RX-4 × HP2.

INTEL PANZER HUMMEL

Functions:
Steering via left and right tracks — proportional. Forward and reverse functions sequential.

Features:
Gun elevates, used also to indicate forward or reverse function.

Model:
1/30th scale — caused dome disquiet amongst 'purists'.

Price and supplier:
£25.00 (3).

Comments:
This and the Tiger models are based on the same R/C system and drive motors so performance is pretty similar. Both models climbed well and gave a range of 25 to 30 feet. Neither were particularly bad using batteries and would give around an hour uninterrupted use. Range 40 feet. TX-PP3, RX 2 × HP2, 1 × PP3.

INTEL PANZER TIGER

Functions:
As Hummel.

Features:
Turret rotates, also used to indicate forward or reverse function.

Model:
As Hummel.

Price and supplier.
As Hummel.

Comments:
Virtually identical to the Hummel in all respects. We preferred this to the Hummel purely on looks. Range 40 feet.

LEOPARD TANK

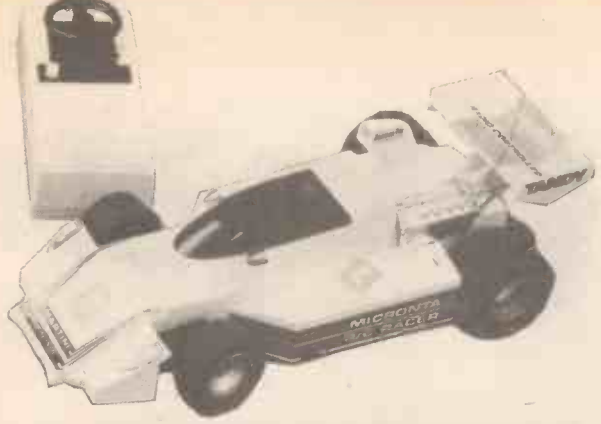
Functions:
Steering only — 'bang bang'.

Features:
Turret will swivel manually and gun will elevate, again manually.

Model:
Detail slightly better than the Intel model but only just. Still scorned by true model buffs.

Price and supplier:
£19.95. (2).

Comments:
Climbing ability was excellent and battery drain adequate. We found that it tended to shed a track on thick carpet and care was needed when manoeuvring on all but the smoothest of surfaces. The lack of a stop or reverse function was a bit limiting. The R/C system is identical to the one in the MTB. Range 25-30 feet. TX-PP3, RX-3 × HP2, 1 × PP3.



RADIO SHACK F1 RACING CAR

Functions:
Steering — 'bang bang', forward and reverse — 'bang bang'.

Features:
No extras.

Model:
Indertiminate scale and style, solid construction.

Price and supplier:
£15.99. (1).

Comments:
This was definitely one of our favourites. It was nearly the fastest and was one of the most difficult to master. However, with perseverence it could be controlled almost as accurately as the proportional jobs. It did tend to suffer from interference from nearby transmitters but we feel that its very low price coupled with its amazing turn of speed and economical battery consumption make it well worth thinking about. Range 15-20 feet. TX-PP3, RX-4 × HP7, 1 × PP3.

RADIO SHACK OFF ROAD PICK-UP

Functions:
Steering, forward, reverse, stop — all sequential.

Features:
Four-wheel drive.

Model:
A really rugged little motor, good looking.

Price and supplier:
£19.95. (1).

Comments:
In contrast to the articulated lorry we felt that this model was decidedly lacking. The sequential control is a positive nuisance. Considering the price we reckon that unless you specifically want a four-wheel drive model (it does climb well) you would be better off with something else. Range 15-20 feet. TX-PP3, RX-4 × HP7.

INTEL MERCEDES

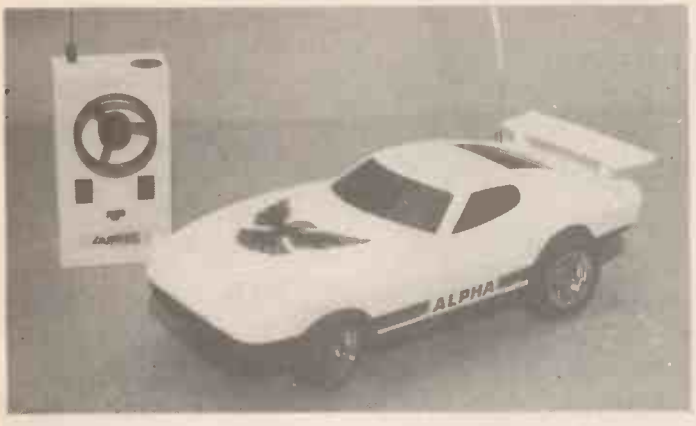
Functions:
Steering fully proportional, forward and reverse fully proportional.

Features:
Flashing indicators, reversing lights, siren (operates in reverse), headlights.

Model:
Another good-looking model, again slightly heavy.

Price and supplier:
£44.00 (3).

Comments:
As far as the features were concerned this model scored well. The performance wasn't startling, just adequate. This model proved to be so popular that someone actually stole the review model but not the transmitter. TX-PP3, RX 4 × HP2.



LA TRAX ALPHA

Functions:
As Cobra.

Features:
As Cobra.

Model:
As Cobra.

Price and supplier:
£50.00.

Comments:
The £5.00 saving on this model was the only discernible difference with the Cobra.

MOTOR TORPEDO BOAT

Functions:
Steering only — 'bang bang'.

Features:
Twin screws.

Model:
Quite a good-looking scale (1/25th) model, quite sturdy and waterproof.

Price and supplier:
£25.95. (2).

Comments:
Unfortunately this was the only boat we could get hold of in time so it was difficult to evaluate. We do know that it will not fit in the bath and when let loose on a boating lake was near-impossible to control adequately. The main omission as far as we were concerned was its inability to stop or reverse which made manoeuvring somewhat difficult. The model did have one saving grace, it is very fast and the twin screws make steering a positive delight. Range 25-30 feet. TX-PP3, RX-3 × HP11, 1 × PP3.

RADIO SHACK TRACTOR/TRAILER

Functions:
Steering, forward, reverse and stop, all sequential.

Features:
Detachable trailer with opening doors, cones for manoeuvrability tests.

Model:
Good-looking, brightly coloured. We especially approved of the wording (CB) on the side of the trailer.

Price and supplier:
£13.99. (1).

Comments:
At first glance the all-sequential control seemed a bit of a disadvantage. The single button on the transmitter, when pushed stopped the tractor unit, the horn on top of the cab rotates until the desired function is reached and the button released. Because the tractor is slow moving this is not such a drawback, in fact considerable skill is required to dock the tractor with the trailer. Good fun. Range 10-15 feet. TX-PP3, RX-4 × HP7.

LA TRAX MUSTANG II COBRA

Functions:
Steering — fully proportional. Forward and reverse — 'bang bang'.

Features:
Four spot frequencies for side-by-side racing, provision for rechargeable batteries, see comments.

Model:
1/21th scale, nothing startling in the authenticity department, good solid construction.

Price and supplier:
£55.00

Comments:
This and the Alpha models are to be sold under the Palitoy banner and are expected to be on sale about now. The steering on these models was about the best of any of the pre-built models, it was extremely precise and reliable. The price of £55.00 may seem a little steep but we are told that this will include a full set of re-chargeable batteries and a mains charger. You'll need them as this was one of the heaviest users of batteries. TX-PP3, RX-4 × HP2.

LETRICAR

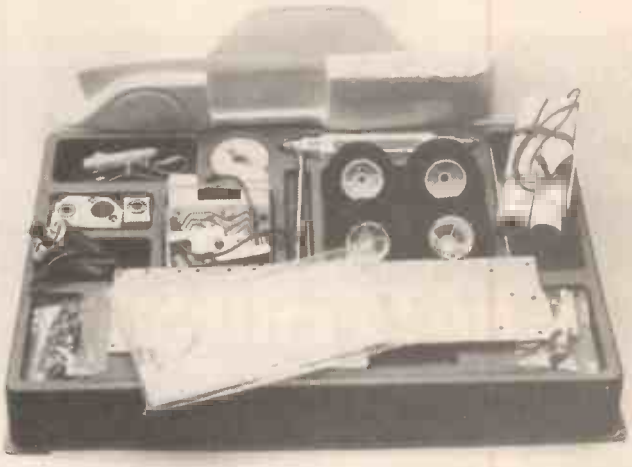
Functions
Provision for steering and throttle-extras added as required.

Features:
Will accept virtually any system and can be painted to suit taste. Kit includes steering gear, motor, quick charge Ni-Cads and charger

Model:
Four in range, review model is BMW/21st scale. Chassis and body very sturdy, can survive quite dangerous-looking impacts.

Price and supplier:
£49.95 (ex R/C gear). (2)

COMMENTS:
We thought it would be a good idea to include at least one 'build-it-yourself' model in this survey. This particular model can be assembled by virtually anyone with a screwdriver and is complete except for the R/C system. The built up version we had was easily capable of 30-40 MPH on a single charge of its vented Ni-Cads. (Charge time around 20 minutes from a 12V car battery. A run would last around 10 minutes). Given that a two channel proportional system will add around £50.00 to the bill you can have a semi-professional model car racing set up for about £100.00. Be warned though, at top speed this model can be lethal, luckily the sturdy aluminium chassis can take all kinds of knocks, your legs will not. We still have the scars to prove it.



AUTO COMMAND Z 28

Functions:
Steering and speed — fully proportional.

Features:
Engine sound, horn, dashboard control, working dials, lights.

Model:
Rugged and sturdy though a trifle heavy.

Price and supplier:
£55.00. (4).

Comments:
Definitely the star of the show as far as gimmicks went. The most unusual aspect of this model was the 'sucker-footed' dashboard transmitter. From this console you could control both steering, speed and direction, plus you could activate the cars horn from the horn button set in the middle of the steering wheel. The rev-counter dial on the dashboard responded to the gear lever mounted throttle and the on/off switch was an imitation ignition key. When the transmitter was switched on the ignition light on the dashboard lit up. All of these gimmicks didn't quite make up for the lack of speed but the controlability of this model would make it an ideal present for someone in the lower age group to whom speed is not essential. Range 25-30 feet. TX-4 × HP2, RX 4 × HP2.

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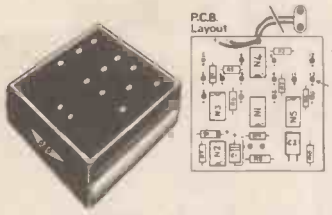

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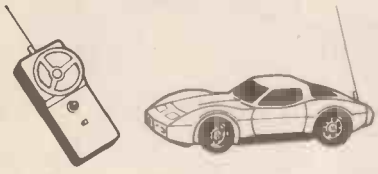

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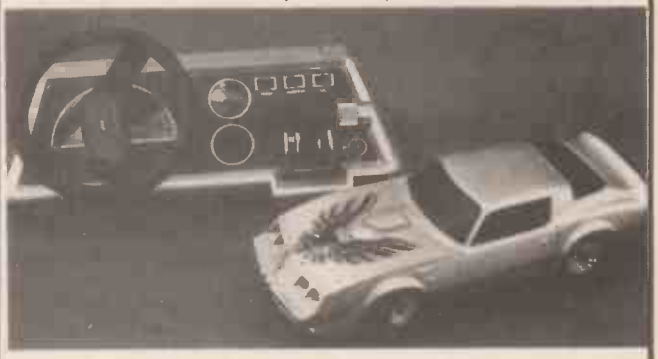
AUTO COMMAND REMOTE CONTROL CAR

(As reviewed by Hobby Magazine May 1980)



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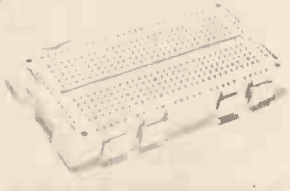

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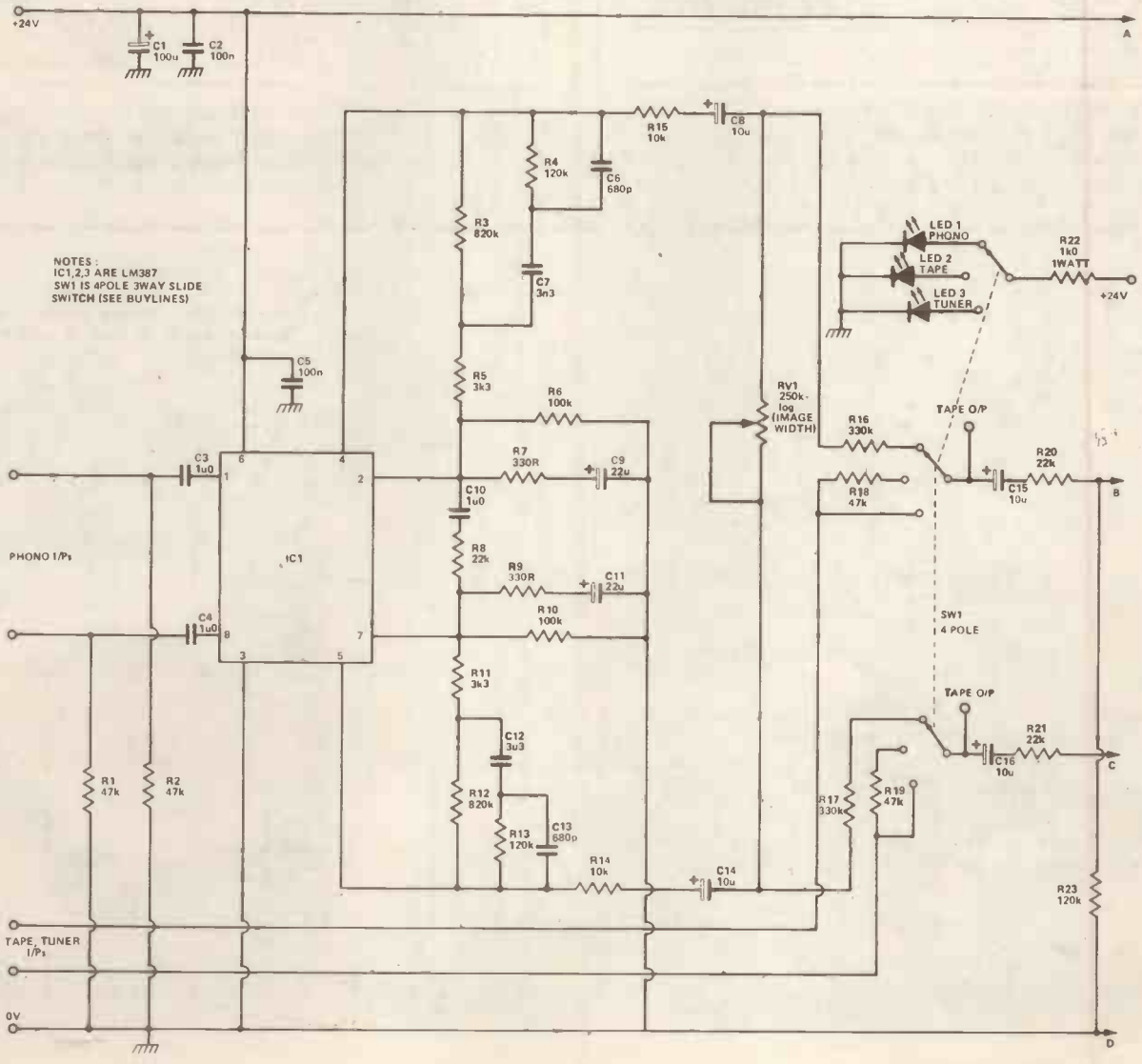
Attractive yellow tray 285x165x42mm with clear hinged lid and moveable compartments. Up to 15 can be made from dividers supplied. As an added bonus, a selection of new surplus components are included, all for the special low price of **£3.95.**

5080 Pre-Amp

Concluding the HE system 5080 audio amplifier we now provide details of a high specification pre-amplifier



OUR MAIN INTENTION in the design of the 5080 Pre-Amp was to produce a fairly easy to build good quality pre-amplifier, complementary to the 5080 Power Amp in both appearance and performance. An identical style of case was used; but three times the length, ie 300mm against the 100mm case of the power amp, which enables the total effect of the system (see photographs) to be quite unique and impressive. The system's performance is equally impressive and rates well with much more expensive, commercially available amplifiers — more about the performance later, let's get back to the case.

It is a fact that until recently the amateur electronics market has suffered from a distinct lack of good quality, reasonably priced cases, in which to house projects. Over the last couple of years however, the hobbyist has seen a slow increase in the number made available to him. Perhaps this particular case deserved special note. In fact, we were so impressed with the good looks and quality of it that we have already planned some further projects using it — so keep your ear to the ground and your eye on HE in the coming months.

Although the 5080 Pre-Amplifier was designed to match the 5080 system there is no reason, of course, why it should only be used as such. The ability to match

How it Works

IC1 forms a dual RIAA equalised pre-amplifier for a low level input from a magnetic cartridge. If a magnetic cartridge were to be amplified without this equalisation then the overall sound would be too trebly and not bassy enough. The equalisation networks in the feedback loop of the pre-amps counteract this and provide a level response.

Stereo image width control is through RV1, a pot simply connected between the O/Ps of these pre-amps. At its full resistance, little or no crosstalk occurs, therefore a correct stereo image is obtained. At zero resistance 100% crosstalk occurs and a mono signal is obtained as the result.

To increase the image past stereo to "Extreo" (extended stereo) a technique is used to allow "negative crosstalk". Out of phase signals from both pre-amps are fed back to the other pre-amp, tending to cancel the crosstalk in that pre-amplifier. The signal thus appears louder in the first pre-amp and therefore further to that side. By omitting C10 and R8 from the circuit this extra stereo facility is counteracted and likewise leaving RV1 from the board reverts the pre-amp to an ordinary stereo pre-amplifier.

The input is selected by SW1, a 4-pole, 3-way slide switch, allowing for I/Ps from the phono pre-amp, a tape recorder and a tuner. One of the two remaining poles of the switch is used to switch on LEDs, to give a visual indication corresponding to the input in use.

IC2 and 3 provide a buffer/tone control stage formed from the Baxendall feedback network of RV2 and 3 and associated components. Balance is given by RV5 and volume by RV4.

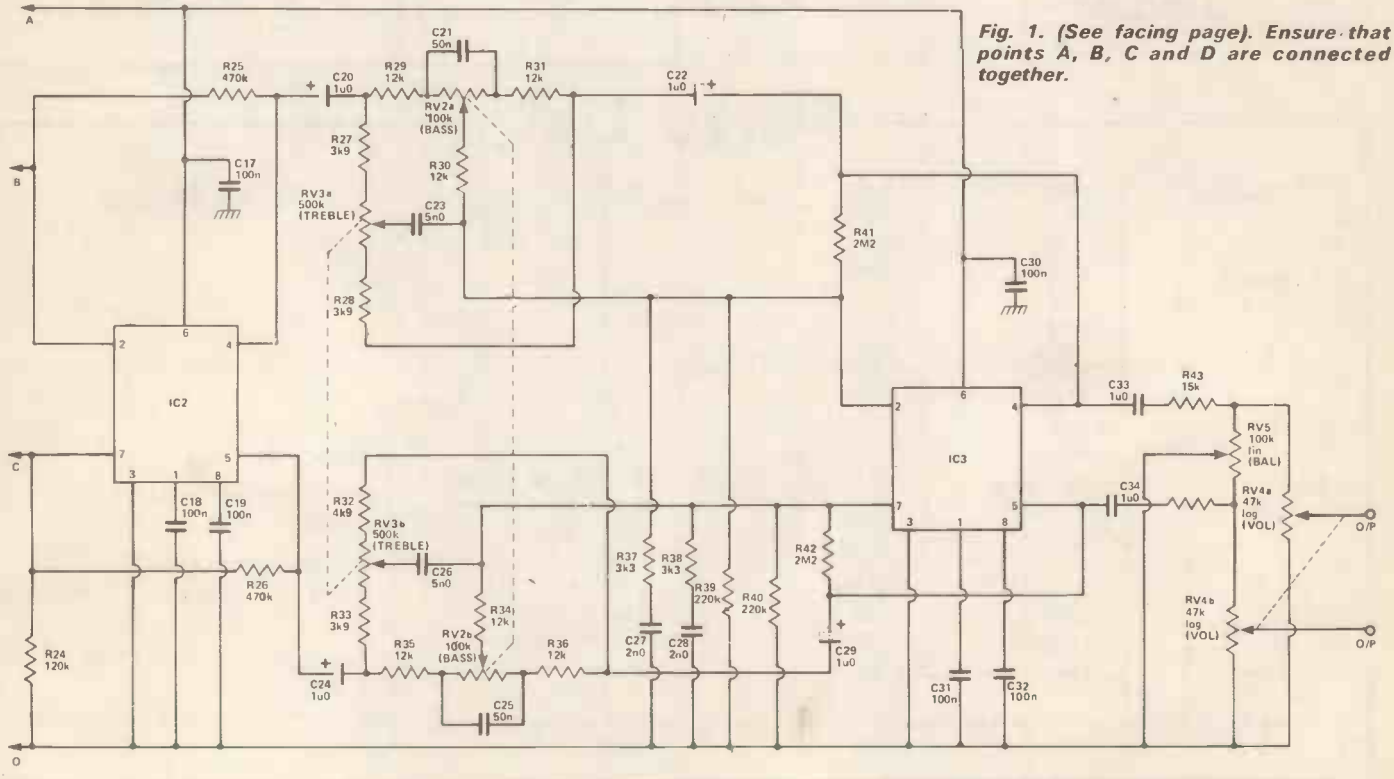


Fig. 1. (See facing page). Ensure that points A, B, C and D are connected together.

virtually any power amplifier was an important criterion throughout the design of the pre-amp. It accommodates inputs from magnetic cartridge, tape recorder and tuner, selected by a three position slide switch. The I/P in use is indicated by coloured LEDs alongside the selector switch. These LEDs also provide a "POWER ON" indication.

Incorporated in the phono (magnetic cartridge) circuitry is a relatively unique control of image width, which can extend the stereo signal past normal, creating the impression that the sound is coming from further afield than it actually is. This effect really does have to be heard to be believed and once you have listened to a record in "Extreo" it is quite a let down to listen to the same recording in "ordinary" stereo. It must be remembered, though, that Extreo is, unlike stereo sound, only a gimmick and it produces nothing which shouldn't be there in the first place. Be that as it may, the extra stereo image created can be used to advantage in the smaller room — and just try it with "cans" on.

The three IC circuitry keeps component count down whilst maintaining the high specifications and performance required of the pre-amplifier, eg a high signal to noise ratio and low distortion.

CONSTRUCTION

All components are included in one way or another on, the PCB making construction relatively simple due to the complete lack of flying leads between the circuit board and switches, potentiometers, etc. Nevertheless, care must be taken, especially when fitting the input selector switch SW1. This is a four pole-three way slide switch in a very compact body and therefore the contacts are very close together. The PCB holes for the switch should be drilled with no more than a 0.6mm drill as any larger than this will probably lift the thin copper track at this part from the board. Also because of the closeness of track you will have to take particular care in soldering, as solder jumps can very easily occur.

All five potentiometers are mounted and bolted on

Fig. 2. PCB for the pre-amp.

Buylines

IC1-3 should be readily available from most of the larger mail order companies. SW1 will be found in the Maplin catalogue. The case is, of course from West Hyde Developments. Finally the pots we used were from Electrovalue, but if you can obtain smaller ones then do, because that will ease construction somewhat.

Parts List

RESISTORS (All ¼W, 5% except where stated otherwise).

R1, 2, 18, 19	47k
R3, 12	820k
R4, 13, 23, 24	120k
R5, 11, 37, 38	3k3
R6, 10	100k
R7, 9	330R
R8, 20, 21	22k
R14, 15	10k
R16, 17	330k
R22	1k 1 watt
R25, 26	470k
R27, 28, 32, 33	3k9
R29, 30, 31, 34, 35, 36	12k
R39, 40	220k
R41, 42	2M2
R43, 44	15k

POTENTIOMETERS

RV1	220k LOG
RV2	100k LIN Dual
RV3	470k LIN Dual
RV4	47k LOG Dual
RV5	100k LIN

CAPACITORS

C1	100u 16 V Elect
C2, 5, 17, 18, 19, 31, 32	100n Polyester
C3, 4, 10, 33, 34	1u Polycarbonate
C6, 13	680p Polystyrene
C7, 12	3n3 Ceramic
C8, 14, 15, 16	10u 16 V Elect
C9, 11	22u 16 V Tantalum
C20, 24	1u 16 V Elect
C21, 25	50n Polyester
C22, 29	1u 16 V Tantalum
C23, 26	5n Polystyrene
C27, 28	2n Polyester
C30	100n Ceramic

SEMICONDUCTORS

IC1-3	LM 387
LED 1	RED LED
LED 2	YELLOW LED
LED 3	GREEN LED

MISCELLANEOUS

SW1 4 pole, 3 way slide switch (see Buylines.

Case (see Buylines).

I/P and O/P sockets — 8 phono sockets.

Power connection — 3-pin DIN plug and socket.

Knobs — collet fixing (to allow for short spindles).

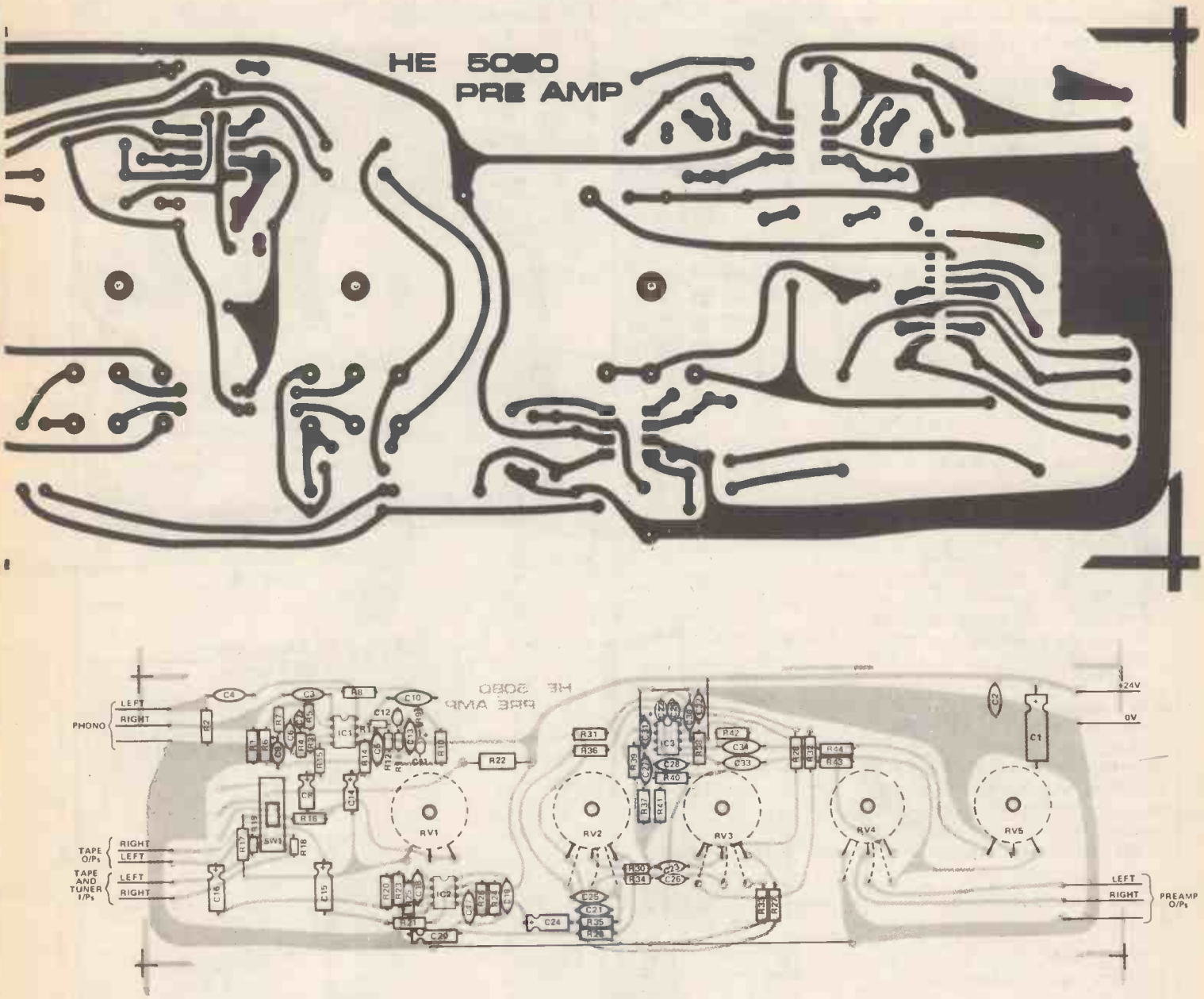


Fig. 3. Overlay diagram for the pre-amp.

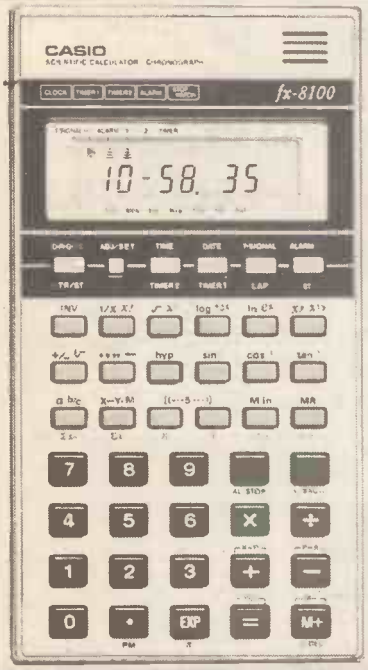
board, from the copper side and attached using short wire links from the connections to the corresponding pads on the board. If you intend using the same case as ours you will need to use pots with only a small depth of body, ie 20mm or less. Using anything longer than this will mean that you have to cut so much off the spindle to get the board into the case that there is not enough left to attach the knobs. As it is, it will be a close fit.

There should be no more problems until the time comes for fitting the board into its case. The three input selection LEDs should be first mounted into the case directly above their corresponding connection points on the board. The pot spindles are then cut to length, this is best done by sliding the board in and marking, measuring and cutting each spindle in turn. Leave as much spindle as possible. The above restrictions, of course do not occur if a larger box is used, but in this case the pre-amp may not look as good.

Finally, the end panels of the case are drilled and fitted with I/P, O/P and power connectors (phono sockets for in and out, 3 pin DIN for power). It is best to use screened lead for I/P and O/P connections between sockets and board. To attempt to avoid hum loops and earthing problems around the phono input part of the circuit (IC1 and associated components) earth the screened lead at the board end *and* the socket end. The other signal connections should only need earthing at the socket end and *not* the board end, but it may be worthwhile experimenting with earths to find the optimum sequence.

And so that, coupled with the 5080 Speaker project later in this issue, just about winds up the 5080 modular stereo amplifier system. When finished, the proud owner and builder will be able to sit back and listen to the superb sounds of his good looking system. We reckon that it will have been well worth the effort. **HE**

Casio's new SUPERCALC!



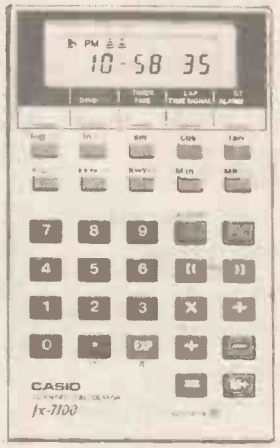
You always wanted a calculator that does everything except make tea —

HERE IT IS!

CASIO FX-8100 (left) 46 scientific functions, clock, calendar, alarm, countdown alarm, interval alarm timer, hourly chimes, 1/100sec stopwatch. ONE YEAR BATTERY LIFE approx. (continuous use). LC Display; 8 digit mantissa plus 2 digit exponent. 5 level parentheses, full access memory. Trigs, logs, hyperbolics, standard deviations, co-ordinate conversions, sexagesimal to decimal conversions, fractions, percentages, cube roots, sign change, register exchange, Pi entry etc. CLOCK displays hours, minutes, seconds, am/pm and day. CALENDAR pre-programmed to 1999; day, date, month and year. 24-hour ALARM, hourly chimes. Countdown ALARM TIMER, interval (repeater) alarm timer or 1/100 second STOPWATCH measuring net, lap and first and second place times to 10 hours. 6.6 × 70 × 129mm (¼ × 2.¾ × 5.⅛ inches). Leatherette wallet. RRP £27.95.

All this for ONLY £24.95!

It's got the lot!



Casio FX-7100

RRP £27.95
ONLY £24.95

FX-7100 (above). Card version of the FX-8100. ONE YEAR BATTERY LIFE, 8 digit display and 39 scientific functions (does not have hyperbolics, fractions or calendar function). With clock, alarm, and hourly chimes. Interval alarm timer or 1/100 sec stopwatch. Wallet. 3/16 × 2⅛ × 3⅝ inches.

CASIO ★★★★★ Star Buys ★★★★★ SEIKO

CASIO 81QS-35B ALARM CHRONOGRAPH

ONLY £29.95 RRP £34.95

Stainless steel, mineral glass, water resistant. 5-YEAR BATTERY.
Hours, minutes, seconds and day. Day, date, month and year calendar pre-programmed to 2029. 12- or 24-hour display. **24-hour alarm, hourly chimes, stopwatch** from 1/100 second to 7 hours, measuring net, lap and first and second place times. Backlight for night time viewing.

CASIO C-80 CALCULATOR WATCH

ONLY £24.95 RRP £29.95

Black resin, mineral glass, water resistant. FINGER-TOUCH KEYBOARD.
Hours, minutes, seconds, am/pm and day. Day, date and month auto calendar pre-programmed to 2009. Professional 24-hour **stopwatch** measuring net, lap and first and second place times to 1/100 second. **Dual time,** 24-hour. 8 digit calculator. Backlight for night-time viewing. 44.9 × 35.8 × 10.2mm.

SEIKO TS2 ALARM CHRONOGRAPH

ONLY £47.50

Stainless steel encased, Glass, splash resistant. 2-YEAR BATTERY.
Comprehensive display of hours, minutes, seconds, day, date and month. **24-hour alarm and hourly chimes. Stopwatch** from 1/100 second to 20 minutes, then seconds to 20 hours. Upper display — lap times, lower display — total time. 8mm thick — 8.8mm including front buttons.

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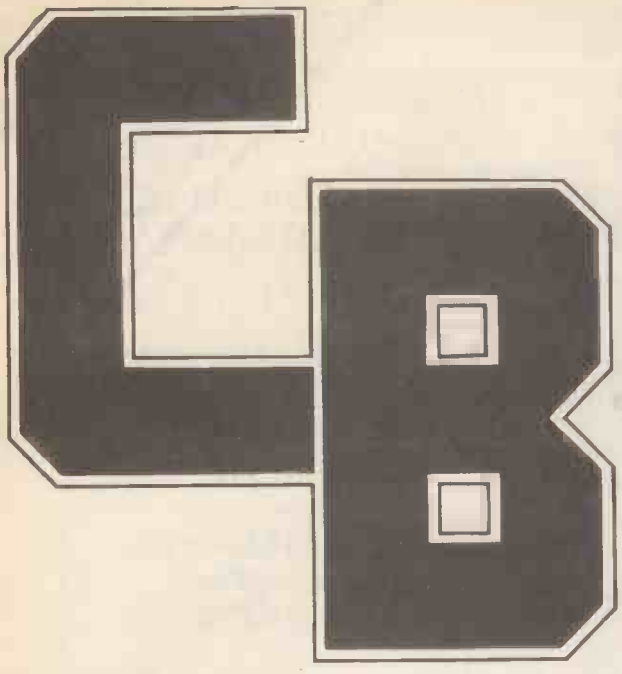


Breaker One Four

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

Now get yourself into print, register your Handle now, or forever wonder if you're choice was original. BOF has been to the Custom Car Show — full report.

BY WAY OF AN EXPERIMENT we've decided to put BOF in the middle section of the magazine. Now people who are offended by CB can tear it all out without damaging the rest of the mag. On the other hand some of you may enjoy reading about CB so much you can now gently remove these pages and keep them handy for reference.

Quite an eventful month really, more and more companies are beginning to take notice of CB and in their infinite wisdom are choosing HE to make themselves known. We would like to welcome these people to our pages and wish them every success. Worth mentioning is the Rovofone from messers Georgerange. As you will see from their ad this fine looking instrument has a number of interesting features and is certainly the best and most professional one we've seen so far. We hope to have a report on this device in next month's BOF if they can spare one for us to look at. By the way we promised to tell you why Wintjoy are after details of local calling channels. They hope to be publishing a CB diary for next year and a map of calling channels is one of the features they will be incorporating. Now isn't that more interesting than a boring tide table for the Humber Estuary. If you still haven't written to them yet, then hurry up before they put up the cost of a stamp again.

Back to the CB scene in general. You may have heard about the GLCs meeting last month. It was held at County Hall in London on Friday the 14th of March and was attended by our old friends Richard Towne, Theo Yard and representatives from all the national CB organisations and clubs. Prior to the meeting the GLC had issued a consultative document on CB (ISBN 0-7168 obtainable free from the GLC) outlining the GLCs attitude to CB. As you will have heard the GLC are strongly in favour of CB and come up with some interesting ideas for a service. Briefly, the meeting was set up to co-ordinate policy for the London campaign. Along with the 230 MHz proposal they are now considering a further recommendation for the now (almost) defunct 405 line broadcast frequencies that live on and around 40-50 MHz. The service is set to be phased out in the next few months and as far as we are aware nobody else wants to have anything to do with it. Now wouldn't that be handy?

NATIONAL DIRECTORY

How many Huggy Bears, Black Knights and Crusaders are there running about? Would you like to know if your Handle is original, well so would we. What we are proposing to do is set up a national directory of handles and categorise them roughly in areas. Each Handle will be allotted a number, similar to the Amateur Callsigns so get in early for a low number. If you want to help us out all you have to do is pop your Handle down on a postcard (or letter if you're feeling ultra cautious) and as near a local '20' as you're prepared to divulge. Obviously we don't need to know your name and address but that's up to you. Your '20' doesn't have to be too specific, if you live in a larger city then if you can narrow it down to as small a district as possible then it'll make our task easier. When we get enough Handles then we'll publish them as a pull-out section for you to keep handy.

Obviously this scheme will only work if as many of you as possible co-operate, you don't have to be a Breaker to have a Handle, if you've decided what Handle you'll use should CB become legal then we would still like to hear about it. Club chairmen or secretaries could send us a club list (with your membership's approval of course) and that would be appreciated. Tell your friends.

Send your postcard or letter to Breaker One Four, Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE and mark the card or envelope 'Handles' and with a bit of luck you'll see your Handle in print in a month or so. Go on, it only costs 10 pence.

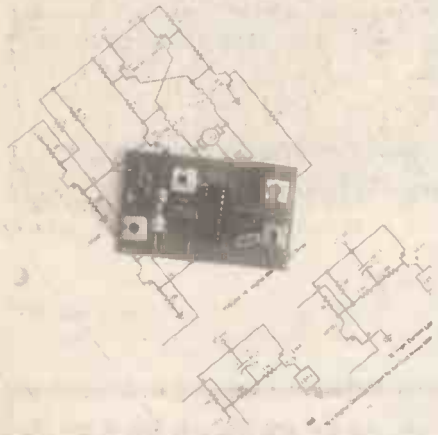
DEMO 3 AND CARNIVAL

The weekend of the 26th and 27th of April should be

Hobby Electronics

Next Month

HE RADIO CONTROL



Can it be true? Yes, of course it is, all the problems have been sorted out and next month we will be presenting what must be the last word in terms of simple to build, 2 channel proportional R/C systems.

The Tx, Rx units are based on just two, that's right, two, purpose-built ICs. External circuitry has been kept to an absolute minimum, consequently it will cost a fraction of a commercial system. Designed primarily for land-based vehicles, boats, cars etc it will enable even the most un-skilled constructor to put together a really first-class R/C combo in just a couple of relaxed evenings.

More than that we're not prepared to say, we are keeping the system under close wraps. We're sure it's going to revolutionise constructional radio control. Make sure you place your order early as the June issue is sure to be a sell-out. You have been warned!

CATALOGUE SURVEY

Do you buy components through the services of mail-order companies? If you do then you cannot afford to miss this survey into the various companies, the cost of their components, the service they offer and the quality of their catalogue. Who is the cheapest? Last year we came up with some pretty surprising results, find out if things have changed.

METRONOME

Don't miss a beat with this nifty, state-of-the-art little gadget. This revolutionary design has completely done away with cumbersome ICs. Yes, that's right, absolutely no Integrated Circuits. In fact we have used just four components and if that isn't state-of-the-art, what is?

CITIZENS BANNED II

Next month is something of an anniversary for us. It will be exactly one year since we published our feature 'Citizens Banned'. In those twelve months we have carried the campaign for CB (sometimes struggling) into the open. Our petition (which around half our readers signed) gained Government recognition, generated national Newspaper, TV and Radio coverage and was the catalyst for forming CB clubs up and down the country. Something like 250 000 people are actively engaged in the campaign for legalisation MPs, Government Officials, Doctors, in fact everyone and anyone who wants the right for free speech.

In our second major feature we will be looking back over the past year and seeing how the campaign has fared.

EGG TIMER

Something really different for the gadget fans next month. Our Egg Timer is a solid-state version of the 'sand-in-a-glass'' egg timer that has been around for hundreds of years. Shake it and set it down and depending upon whether you want a hard or soft boiled egg it will warble at the appointed time. No switches to worry about, is it magic? Find out next month.

FOG HORN

We're shore you'll build this circuit once you sea it. But be warned your popularity will be at a very low ebb if you use it in the car. It is LOUD, very LOUD, so loud in fact, the only place you'll be able to use it is at sea.

The June issue will be on sale May 9th

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

pencilled in your diaries right now. On the 26th we have the third in our series of London Demos, same time and venue as the last one. (That's Speakers Corner, Hyde Park around 11 AM). Around a thousand people (our estimate) turned up for the last one and it was a real success so try and get along, you won't regret it.

If, after all that marching you've still got some energy left, then get yourself along to Cannon Hill Park in Birmingham where Keith Townsends mob are organising the first ever CB Carnival. Already booked to attend is a cavalcade of some 50 American cars from the local Hot rod clubs. Patrick Wall MP and John Butcher MP and a Hot Air Balloon should also be there. Patrick Wall has somehow been persuaded to go aloft in this contraption, doubtless to spread the word to the assembled masses. (Maybe some of his more verbal Westminster colleagues will be supplying the hot air). Several other local organisations look set to attend, a Police Dog display team even. (Keith assures us that there are no sinister overtones to this particular attraction. Several CB companies are rumoured to be interested and maybe we will be popping up, who knows? Anyway, it all sounds like good fun and besides it'll help the cause. Do try and turn up but remember NO RIGS, you'd be remarkably stupid to do so after the recent events at Alexandra Palace.

WINTJOY CORNER

Well, it does look that way some months, in all fairness though, young Glynn Hall down there in Shepperton does take the trouble to let us know what he is up to. Latest news from Glynn is that they now stock a very complete range of spare parts, Output transistors, PLL ICs etc etc. They also have a full set of crystals for £1.50 each and that can't be too bad.

CLUBS

Only one this month (clubs, where are you?), it is a little unusual in that it is from Germany, we are certainly flattered by their choice of name.

Breaker-One-Four Club.
Napier Barracks,
BFPO 20
Secretary OK Korral.

As promised, a picture of the glass-mounted aerials seen in Germany last month

OPEN LETTERS

As you can imagine we get quite a few letters to BOF each month. Most are complimentary, a few irate and

THE BASE STATION
Size: 8" x 11½" x 3"

THE HANDSET
Size: 9" x 3" x 2¾"

THE CARRYING CASE

'DIAL' on a LEADLESS MOBILE EXTENSION RADIO TELEPHONE

The Parliament of The British Isles, Rovafone and a new telephone breakthrough open the door to new consumer savings

Britain's phone system is the world's greatest. No country can compare. But what has made our phone system even greater is the recent parliamentary decision to allow consumers to plug in their own phones — phones they can buy themselves.

We will soon be able to choose which phone we want to plug in. And that creates competition, and competition usually results in lower prices, innovative products and better service.

We do now have lower prices and a very exciting new product which we have selected as the best example of the new telephone ownership decision. The big break for you is neither of these things, but something far more reaching, but more of that later.

THE NEW PHONE

It's called the Rovafone Mobile Telephone System. And its manufacturer is a supplier of phones to other large telephone companies.

Rovafone is the Greatest innovative product of its kind in the World and of this century . . . It's a Breakthrough in communications for both industry and residential use.

Why?

This solid state, microchip telephone has **no cumbersome leads** to cart about. **Is completely portable.** Enables you to dial and answer calls at will up to a radius of what is an **incredible 3 to 5 miles range** . . . up to now impossible . . . inside or outside. Whether in the garden, farm, warehouse, office, basement, or whenever you're not near your phone.

What other features?

Takes up to 16 digit telephone numbers, has last number redial, push buttons, pager and intercom, security coded, rechargeable cells, charger, carrying case, belt clip and only weighs 28 ounces.

THE 'DIAL FREE' KEYBOARD

The pushbuttons save time and money and temper. Simply key in the number as fast as you like. It goes straight into memory and is automatically dialled for you. Number engaged! Simply press Redial button and number will be recalled again automatically. Number remains in memory until updated with new number.

Pushbutton dialling, works anywhere in the world, you are not charged by the telephone company for this extra service. Assuming that you have rotary dial service at present, you are actually able to Push Button Dial for FREE.

The unmanned 'Automatic' **Base Station** only item to connect. Simply attach two wires to your telephone line, and you don't have to disconnect present phone (still operational). You're on the Air within seconds ready to go. And since Rovafone operates exactly like a phone it's very easy to use. No technical know-how required.

Intercom and Pager. Touch one button on the base station (base station also very compact) and Rovafone bleeps and you can talk direct to any telephone on the same line as the base station. This saves you time as you are easy to locate and can take necessary action straight away, instead of having to run backwards and forwards getting in a tizz. And the base station is easy to re-locate.

Security Access Coded. No other mobile phone can access your telephone line unless required as Rovafone has a digital code to prevent this happening. Means complete private two-way conversations.

Rechargeable Cells. Saves You Money. Holds a single charge for 40 hours due to a unique energy saving circuit. The charger supplied takes a mere 3.5 hours to fully charge cells and be fully operational.

Light Weight. Only 28 ounces and is easily hand carried, clipped to belt or just simply slung over shoulder using the black grained carrying case supplied.

Low Price. The Rovafone is only £364.95 complete. It will pay for itself quickly, not only in convenience, but with savings up to £20 a month rental over 5 years.

When you determine the true cost of telephone ownership, you compare costs over 5 years. Even a £15 charge monthly equals a staggering £900 or over twice the cost of Rovafone.

A PERSONAL TEST

All you do now is order Rovafone. They'll be in the shops next year. Or avoid the wait and order one now, directly from us.

We were the first major distributor of Rovafone Mobile systems in the UK and have delivered thousands to homes throughout the country.

Put one in now — you'll really appreciate the efficiency, time saved, convenience and other savings.

If service is ever required, we have a prompt service by mail offering Free replacement of system up to **one year.**

In our experience the only items which go wrong are the rechargeable cells and they are easy to replace, and available.

TRY ONE TODAY

We urge you to at least give Rovafone a try. A complete personal test right in your own home, under everyday conditions. Order one today from Goregrange Communicators Ltd. under our 30-day trial period.

Plug it in. See how nice it looks, see how easy it is to dial numbers by pressing buttons and how little space it takes up, and how convenient and efficient it is.

YOUR SILENT PARTNER

Think how much hassle Rovafone saves you by being constantly on call, ever alert and forever keeping you in constant contact with the outside world at a second's notice. Find out how much better you sound at the other end. See what a great talking point it will make with your friends, colleagues and associates.

NOW FOR THE ALL IMPORTANT BREAK MENTIONED EARLIER . . .

We Now Take A Big Risk!!! That's right! But we're so confident about Rovafone measuring up to what you've been told, and that you'll be 100% pleased with it that we are prepared to take the risk — so this is what we propose . . .

You send us a cheque for £364.95 and for 30 days from date you receive complete Rovafone system, check it all out thoroughly at no risk whatever. And remember the 30 days only start from when you receive the system. Not before.

If you're not totally convinced after this 30-day period (which will give you a chance to put Rovafone completely through its paces) simply return the complete system to us and we'll refund your £364.95 in full, plus a cheque of our own to cover your postage costs incurred on returning the system to us.

You have nothing to lose except a few minutes of time and a 12p stamp cost.

To order your Rovafone Mobile Telephone System send your cheque for £364.95.

We'll send you the **Rovafone Base Station, Rechargeable cells, Charger, attractive Black grained carrying case, Belt Clip. Full instructions and One full year's guarantee covering the whole system.**

Why not act ahead of the crowd and order an exciting space age way to catch those calls immediately. Order your Rovafone System at no obligation today.

*Please note normal range of Rovafone is one mile. For 3-5 miles range special booster and compact external aerial required at £95 extra inclusive. Nothing else to buy. (Ranges quoted are under optimum terrain transmitting conditions.) Remember a missed call means lost business!

Order within 7 days and receive a 'Free Gift' worth an incredible £20 and it's yours to keep whether you keep Rovafone or not. (Add VAT at 15% to the price.)

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Leasing available for limited companies. 100% Rental.
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(FREE DEMONSTRATIONS)
Not at present. PO approved.

one or two decidedly unpleasant. As space is so limited we cannot print as many letters as we would wish. Every now and again though, (this month for instance) we get letters that just have to be published. This month we have two. We'll make no comment, they are addressed to you.

OPEN LETTER TO ALL CB OPERATORS IN UK

By operating on 27MHz within the UK you are breaking the law. If caught you will be fined and your equipment seized.

I am in favour of CB in UK but until such time as it becomes legal you are only making the authorities even more hesitant by your illegal 27MHz operations. Yes it may be good fun, OK you cause no trouble to other radio users, OK other countries have it. These are not valid arguments because as you all well know 27MHz operation is illegal. By all means join pressure groups, clubs, etc but do not break the law. Taking the law into your own hands will only cause trouble and delay the authorisation of CB radio in UK.

Do not buy 27MHz equipment because if CB does become legal it certainly will not be on 27MHz in UK.

If you want to take up radio as a hobby become a radio amateur. The Class B licence exam is relatively easy and you will find nationwide radio amateurs only too willing to help. A Class B radio amateur can operate on all bands from 144MHz (2 metres) upwards and use all modes except Morse, SSB, FM, RTTY, Slow Scan TV, Normal TV. The Repeater Network available throughout the UK on both 2M and 70cms gives virtually nationwide coverage, better than you can do on Channel 14!

As it is highly likely that if CB radio does come to UK it will be a VHF allocation and you will be gaining useful experience for that time by operating on the amateur bands.

A word of warning:

Some 'Good Buddy's' are using BIG Boots and I mean big. They are causing a lot of interference to 28MHz Radio Amateurs apart from TVI and are asking for trouble from the moment they press the button. I hasten to add trouble from the authorities.

If any of you want more information on amateur radio you can write to me or contact the RSGB (Radio Society of Great Britain), 35 Doughty Street, London WC1N 2AE.

Jeff Harris, G3LWM, and member of the CBA

SO WE WANT CB DO WE?

The question is "Who Wants CB?" Is it just the old faithfuls who write regular letters to the Home Office and drive poor Tim Raison crazy with an endless stream of postcards, or are they merely the tip of a great big iceberg?

I know the answer to this question and so do you. SO LET'S GET OUT THERE AND PROVE IT!

Don't give us the old moonshine about not being able to write letters or attend marches because you might get busted. Over twelve hundred people attended the last march in London. THEY HAVE NOT BEEN BUSTED!

A large number of very influential people are putting in a lot of work on our behalf. LET'S GIVE 'EM SOME HELP!

It's great fun to attend your club meetings and put yourself on the outside of some good ale but it has no

direct effect on the campaign. If YOU want CB then YOU must tell the Home Office so. YOU HAVE A VOICE. USE IT!

To those who just sit back and wait to see what happens I can only say: IF YOU WANT IT, FIGHT FOR IT!

Keith Townsend
MCBRC

ALLY PALLY

The promise of a couple of free tickets lured us down to Alexandra Palace for this years Custom Car Show (why don't they ever come to our shows?). Armed with some copies of HE we were accosted by a couple of scantily clad young ladies (why don't they ever come to our shows?) who insisted on posing for our ace photographer with said journal (actually, it didn't quite happen like that but we can all dream, can't we?).

Apart from the delightful Vicky and Sandra we saw plenty of rather prettily painted cars and vans, quite a few sporting strange-looking aerials. One or two of our advertisers were to be found selling their wares to a very enthusiastic crowd (thanks to Andy Marshall of CB Equipment Specialists for the Buzby stickers and how about letting us have some of your goodies for review?). The punch line to this little story takes the form of a cautionary tale. We heard, that something like 10 people got busted during the course of the show, simply because they chose to arrive in cars with rigs in. The Ally Pally area has always been popular with breakers (because it is quite high up), consequently it has been equally popular with the gentlemen from the Home Office and C & E. That wasn't very clever, now was it?

Is this a normal reaction, show HE to your girlfriend and find out.

CB CIRCUITS

Quite a few of you have written to BOF in the past few weeks with requests for circuits. Apart from any other considerations it would be illegal for us to publish any kind of circuit capable of acting as a transmitter for voice modulated signals on 27 MHz so please don't ask.

Still on the subject of letters John Denelly wrote to us asking about the mysterious CB Tee-Shirts we

threatened to get some months ago. Our main problem was deciding upon a design, and the information (at the time) that CB was about to be legalised. We would have looked a bit stupid with 10,000 ''Legalise CB'' Tee-Shirts hanging about our offices.

Anyway, to cut a long story short, we are going to have a competition for the best design for Hobby Electronics Tee-Shirt. It should use our CB logo (at the top of the first page of Breaker One Four) and preferably include the words Hobby Electronics or HE somewhere in the design. Apart from that it can be as imaginative, outrageous, etc as you want. Remember that intricate designs don't always reproduce too well and try and limit it to three colours, two are even better (that doesn't include the base colour of the shirt). Now for the prize, as you would expect from us it will be good, apart from the pleasure of seeing your design adorning chests up and down the country we will award the winner a years subscription to HE, a copy of the record ''Convoy'', 10, of our now famous CB stickers and if you can get down to London, lunch on the company paid for by our Editor Steve Braidwood (that's if we can find the combination to his wallet).

Send your entries (include an SAE if you want it back) to: T-Shirt Competition, Breaker One Four, Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE.

LATE NEWS

One or two last-minute items this month. Firstly concerning our late news last month. We have since heard that the Minister of Telecommunications for Eire has set up a working party to look into the possibility of setting up a CB service. They anticipate a favourable outcome within the next four months. As a final postscript to this story we have also heard that because of a peculiarity in their laws, rigs can be sold over the counter, quite legally. All VAT, duty etc having been paid. Of course they are not allowed to be used but that's another story.

Our second titbit concerns a gentleman somewhere north of Watford that had a nocturnal visit from our friends at the Home Office and Customs and Excise. They came well prepared with warrants, and twelve burly policemen. All they could find (after an extensive search) was a Burner (not illegal in itself), a blank cassette and would you believe it, two copies of HE, all of which were promptly seized. We hope that the gentlemen involved were suitably impressed with our journal, it would save them a lot of trouble if they turned to page 15 where they can find a subscription form.

HE's POLICY ON C.B.

HOBBY ELECTRONICS, as its name implies, is a magzine for people who think new technology is fun. The role of the magazine is to aid our readers by introducing them to new devices, new equipment, and new ways of using either.

We believe that 2-way radio communication is fun. We feel the regulations governing the use of radio in Britain are too restrictive, and we know our readers agree (half of them signed a petition to the government asking for radio rights similar to those of citizens in the USA).

Until Britain gets a Citizens' Radio Service most of our readers are deprived of the fun of 2-way radio. Many of our readers are actively campaigning for their radio rights and Hobby Electronics will report on these activities.

The staff of the magazine do not, have not and never will condone the illegal use of radio. Until Britain gets a Citizens' Band you will have to apply for a licence under the existing regulations if you want to use a radio transmitter. If that's not good enough then you should change the regulations. After all, this is a democracy.

HE

Hobby Electronics Book Service

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★ Prices may be subject to change without notice.

NEW

CONSTRUCTORS PACK 7

ALL THE PARTS TO BUILD THE PRACTICAL ELECTRONICS TRAVELLER CAR RADIO

* EASY TO BUILD * 5 PUSH BUTTON TUNING * MODERN STYLING DESIGN * ALL NEW UNUSED COMPONENTS * 6 WATT OUTPUT * READY ETCHED & PUNCHED P.C.B. * INCORPORATES SUPPRESSION CIRCUITS

The pack contains all the electronic components to build the radio, you supply only the wire and solder as featured in the Practical Electronics March issue.
The P.E. Traveller features pre-set tuning with five push button options, black illuminated tuning scale, with matching rotary control knobs, one, combining on/off volume and tone-control, the other for manual tuning, each set on wood simulated fascia.
The P.E. Traveller has a 6 watts output, negative ground and incorporates an integrated circuit output stage, a Mullard IF module LP1181 ceramic filter type, pre-aligned and assembled and a Bird pre-aligned push button tuning unit.
The P.E. Traveller fits easily in or under dashboards.
Complete with instructions.

£10.50 p&p £1.75

CONSTRUCTORS PACK 7A
Suitable stainless steel fully retractable locking aerial and speaker (approx 6" x 4") is available as a kit complete.
£1.95 Per Pack, p & p £1.00.
Pack 7A may only be purchased at the same time as Pack 7.
NOTE: Constructor's pack 7A sold complete with radio kit
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A FEATURED PROJECT IN PRACTICAL ELECTRONICS

R T V C

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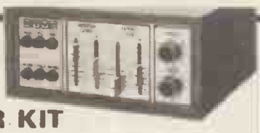
NEW 12+12 AMPLIFIER KIT



An opportunity to build your own 12 watts per channel stereo amplifier with up-to-the-minute features. To complete you just supply screws, connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs—tape, speakers and headphones. By the press of a button it transforms into a 24 watt mono disco amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus 2 power amplifier assembly kits. Also featured 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia panel with matching knobs. Easy to assemble teak simulate cabinet and ready made metal work. For further information instructions are available price 50p. Free with kit.
Size 9¼" x 8¾" x 4" approx
NOTE: for use with 4 to 8 ohms speakers. p&p £2.55 **£13.95**

TWO WAY SPEAKER KIT To suit above amp. Comprising 2. 8" approx Phillips base unit, and 2. 3½" approx tweeters with 2 crossover capacitors **£4.95** p&p £1.65.

Available only to first time purchasers of the 12 + 12 kit.

50 WATT MONO DISCO AMP

£30.60
p&p £3.20

Size approx 13⅜" x 5¼" x 6¾"
50 watts rms 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.

NOW AVAILABLE

30 + 30 WATT STEREO AMPLIFIER

Viscount IV unit in teak simulate cabinet Silver finish rotary controls and pushbuttons with matching fascia, red mains indicator and stero jack socket. Functions switch for mic magnetic and crystal pickups, tape tuner and auxiliary. Rear panel features fuse holder. DIN speaker and input socket 30 + 30 watts RMS 60 + 60 watts peak for use with 4 to 8 ohm speakers.
Size 14⅜" x 3" x 10" approx.
BUILT AND READY TO PLAY p&p £3.30 **£32.90**

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ACCESSORIES Suitable mains power supply parts, consisting of mains transformer, bridge rectifier, smoothing capacitor and set of rotary stereo controls for treble, bass, volume and balance **£3.00** plus p&p £1.60

Two Way Speaker Kit Comprising of two 8" x 5" approx. 4 ohm bass and two 3½" 15 ohm mid-range tweeter with two cross-over capacitors.
Per stereo pair plus p&p £1.70 **£4.05**

R T V C

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£76.00 p&p £4.00 100 WATT MONO DISCO AMP

Brushed aluminium fascia and rotary controls. Size approx. 14" x 4" x 10¼"
Five vertical slide controls, master volume, tape level, mic level, deck level. PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level control (PFL) lets YOU hear next disc before fading it in. VU meter monitors output level. Output 100 watts RMS 200 watts peak

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Stereo pair 350 kit. System consists of 13" x 8" approx wooter with rolled surround. 3½" Goodman tweeter crossover components and circuit diagram. Frequency response 20 Hz to 20 KHz. Power handling 15 watts RMS 20 watts max 8 ohm impedance

£18.25
Per stereo pair
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BSR P200 £25.50

Belt drive chassis turntable unit semi-automatic, cueing device. p&p £3.00
Shure M75 6 Magnetic Cartridge to suit. **£7.95**

BSR Manual single play record deck with auto return and cueing lever, fitted with stereo ceramic cartridge 2 speeds with 45 r p m spindle adaptor ideally suited for home or disco use
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PHILLIPS RECORD PLAYER DECK GC037

HiFi record player deck, belt drive complete with GP401 magnetic cartridge—LIMITED STOCK. **£27.50** complete.
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ETI JUNE 1980

WHAT TO LOOK FORWARD TO IN OUR NEXT ISSUE! ON SALE MAY 2ND.

DESIGNERS HANDBOOK

Now this is the one that even we've been waiting for. Many is the rainy Sunday that has passed with the enthusiast huddled intent over his workbench. Many too are the times he has howled loud into the storm when a project fails to operate for the want of one small piece of circuitry to link this with that or that with this, that or the other.

Information to allow him to design his own circuits quickly and simply is sadly lacking. Books take everything too seriously and at too much length. Looking anything up takes hours -- by which time the rain has stopped and . . . . . .

Next month we present our Analogue Designers Handbook from the man of many nodes, Tim Orr. He presents the quick and easy way to amplifiers, filters, oscillators etc. etc. — and they'll be all your own work! Can you afford to miss it?

DRUM SYNTHESISER PROJECT

No, I don't believe you've never heard one of these. Just about every single produced in the last millenium has those noises all over it. You know, those noises — the ones that sound like a cat being stepped on backwards at great speed.

If you really don't know what we're going on about you'd better read ETI next month hadn't you?

HOUSE WIRING

So you think you know how it's done eh? Just wait until you pull the bathroom cord one day and the toast pops up: switch on the hall light only to have the TV burst into life . . . . . Before long the house is a mass of ripped out wiring and is echoing to the sound of slamming front doors as enraged spouses storm into the sunset. Don't do it until you've read our superb article from Ray Marston next month!

FM LINE DISTRIBUTION

Have hi-fi in any room in the house without extra wires. Superb sound that follows you around. Uses the mains to (safely) distribute an audio signal anywherethe wires are connected to. The answer to a million prayers!

TAPE RECORDER RESPONSE OPTIMISATION SYSTEM

It's one hell of a title for an extremely straightforward little device that will allow you to optimise bias conditions on any tape recorder. Works with a minimum of fuss and doesn't cost more than the Empire State Building to construct.

ANTI-MATTER

Better forget the Star Trek reaction pods. Throw away the tickets to another Universe. Instead read our explanation of the real truth (?) behind around and for anti-matter.

Articles mentioned herein are in an advanced state of preparation, however, circumstances may dictate charges to the final contents.

INVASION FROM ANOTHER WORLD

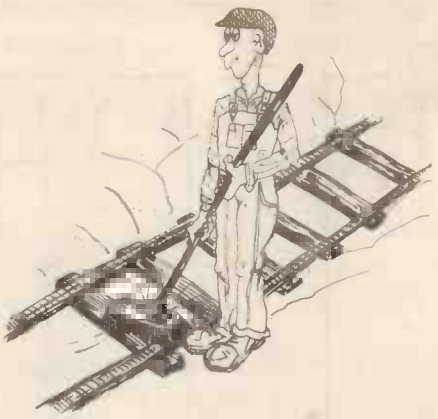
Detail of the Contents Page

All across the nation ordinary citizens have been intrigued by the appearance of thousands of blue and silver folders. These folders first appear on the shelves of newsagents and quickly they find their way into the hands of innocent shoppers. These (previously normal) individuals have since reported the emergence from the folder of a colourful magazine-like object with the markings "ETI 1999" clearly visible in front aspect. Further inspection has shown a polyfolio structure with pages of fascinating articles and pictures from another world — a world both strange and uncannily familiar.

The latest development in the ETI 1999 story is the aggregation of a few thousand of the alien objects, withdrawn into their protective folders, at the Hobby Electronics office. Further, we have received a demand for thousands of pounds and instructions to send units of "ETI 1999" to anyone who sends £1.50 + 30p (P&P) to Sales Office (Specials), Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE.

Detail of the Contents Page

Track Cleaner



Have your loco's got the lurgy? Clean through to the shine with this — state of the art — all electronic track cleaner.

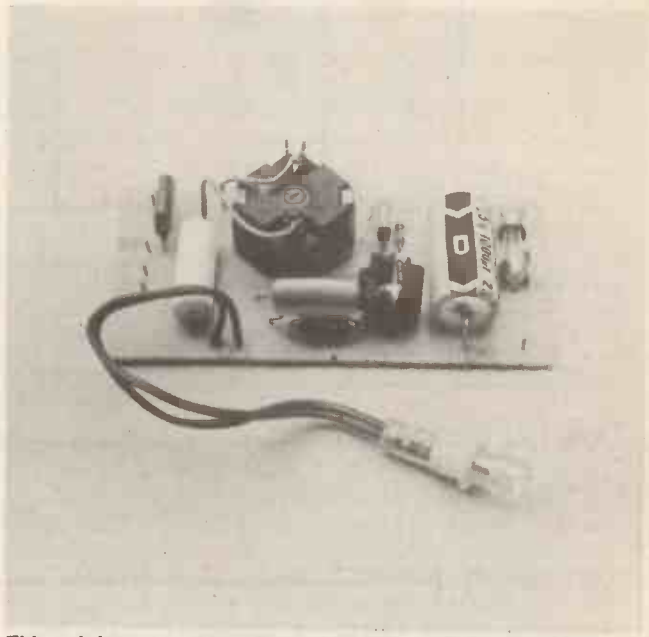
ONE OF THE BIGGEST problems with any model railway system is the poor performance obtained when trying to run trains at low speeds — when shunting for example. Oxides, grease and dirt on the track cause loss of electrical contact and produce an annoying and unrealistic jerky motion.

We reckon that the most important factor in obtaining good low speed performance from a locomotive is the maintenance of good electrical contact between the power source and the motor. Using existing technology, the best way to achieve this is to use a so called 'track cleaner' system, in which a high voltage (800 volts peak-to-peak) high impedance (tens or hundreds of kilohms) high frequency (tens or hundreds of kHz) signal is imposed on the power source signal, thus ensuring that power signals are unimpaired by oxides and gunge on the track, pick-ups and motor brushes. The nifty lIttle gadget that achieves this uses only one transistor and a few other components and can be readily connected in any system.

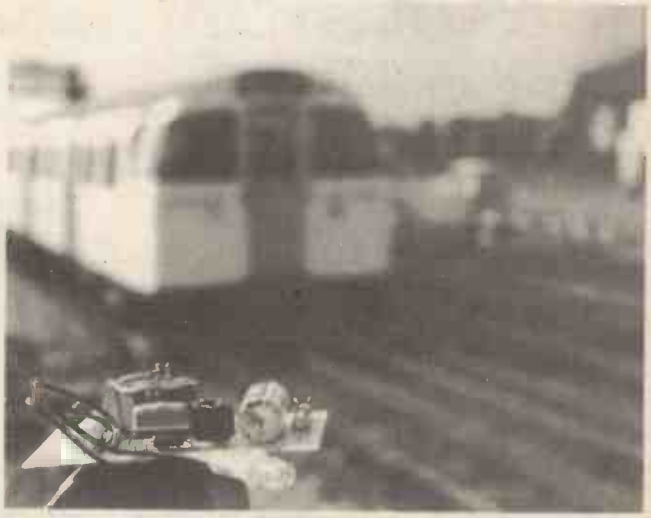
CONSTRUCTION

The unit is assembled on a small PCB. Any method of construction may be employed but use of a PCB makes the job much easier. Note that Q1 needs a clip-on heat sink. The blocking oscillator transformer is a 'special' that you have to wind for yourself. The ferrite core assembly comes apart to reveal a plastic former on which the coils should be wound. The 'primary' is wound first, using 77 turns of 22 swg wire. Do not worry if you can only get 60 or so turns on — it will still work. This winding can be covered with a thin layer of insulating tape. The 'secondary' comprises 6 centre tapped turns (3-0-3) of 32 swg insulated copper wire. The completed transformer is fixed to the PCB 'upside-down', with its connection tabs sticking upwards. Note that in use Q1 is connected to the 'secondary' of T1, and the output is taken from the 'primary'.

To use the unit, simply connect the two wires that normally go to the track in your system to the 'track driver' input — either way round it doesn't matter — and connect the wires from your track to the unit's output. The neon will light when the track cleaner is operating. When contact is restored the neon will extinguish. Power for the circuit can be obtained from the unregulated DC supply available from most train controllers. Any voltage from twelve to twenty should suffice but make sure that you connect it the right way round — or sparks will fly!



This miniature power-house will take the tarnish off your tracks. The ferrite-cored transformer makes an efficient high voltage generator that will really dust off the debris.



Whatever your layout . . . big or small . . . this shocking system will put your trains on the right track. The neon illuminates when the system's operating; so you will always know when your trains are on strike.

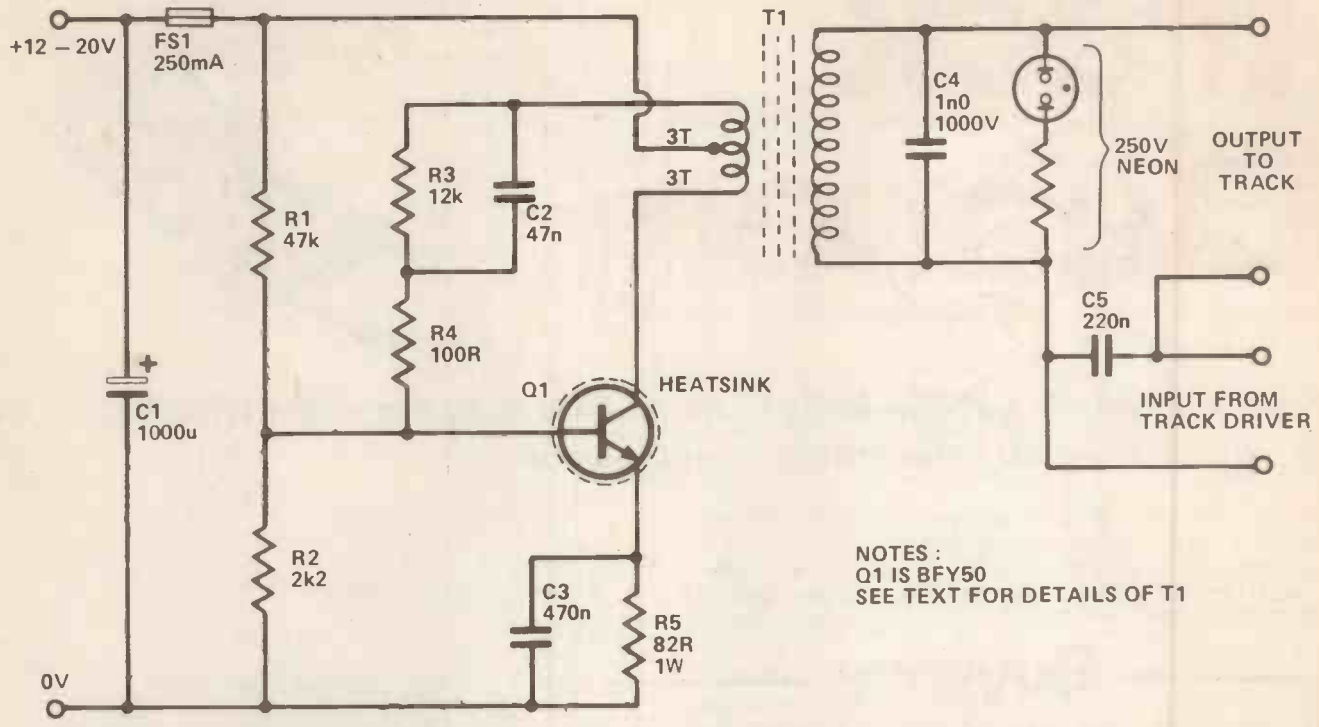


Fig. 1. Circuit diagram of the HE track cleaner. You can use any method of construction, however, use of our PCB will save you time and effort and helps to ensure success 'first time'.

How it Works

The track cleaner is designed around Q1 which is wired as a modified blocking oscillator. The circuit is tuned by the T1 inductance and by C2 and C4, and oscillates at roughly 100 kHz. The C4 value is large enough to minimise the effects of track capacitance. Several hundred volts peak-to-peak are developed across T1 secondary, but are produced at a fairly high impedance (harmless) level.

The secondary of T1 is wound with fairly heavy guage (low resistance) wire. The train controller signals are fed to the track via this winding. Consequently, when a heavy load (a locomotive motor) is placed across the track the resulting low impedance 'kills' the oscillator output, and only the train control signals reach the track. When, on the other hand, a high impedance appears across the track (due to loss of contact with the locomotive) the oscillator becomes functional, and the high voltage plus train control signals are fed to the track. The resulting high-voltage high-frequency signal is sufficient to break through most thin films of dirt, oil, and oxides, and restore contact with the locomotive motor.

Capacitor C5 is wired across the 'input' side of the train controller signal line to prevent the high-voltage signal from reaching the electronic control circuitry. A neon lamp illuminates when the track cleaner is functional, thus indicating loss of contact with the track. The track cleaner circuitry is protected with a 250 mA fuse.

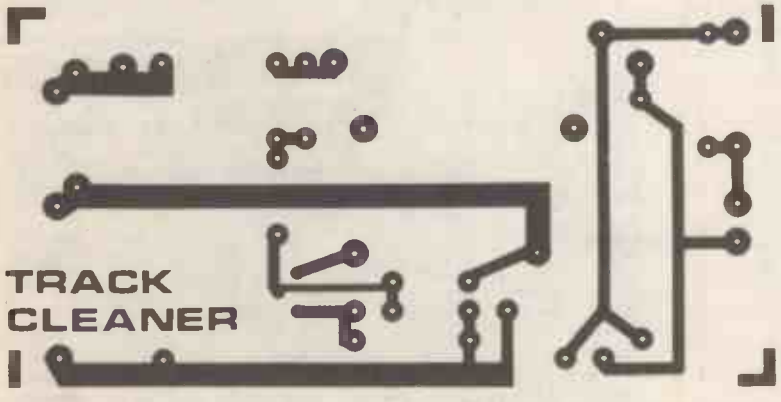


Fig. 2. PCB foil pattern for the track cleaner. A simple design like this one is an excellent choice for anyone planning to produce their own printed circuit boards. So get on the right lines and make tracks today.

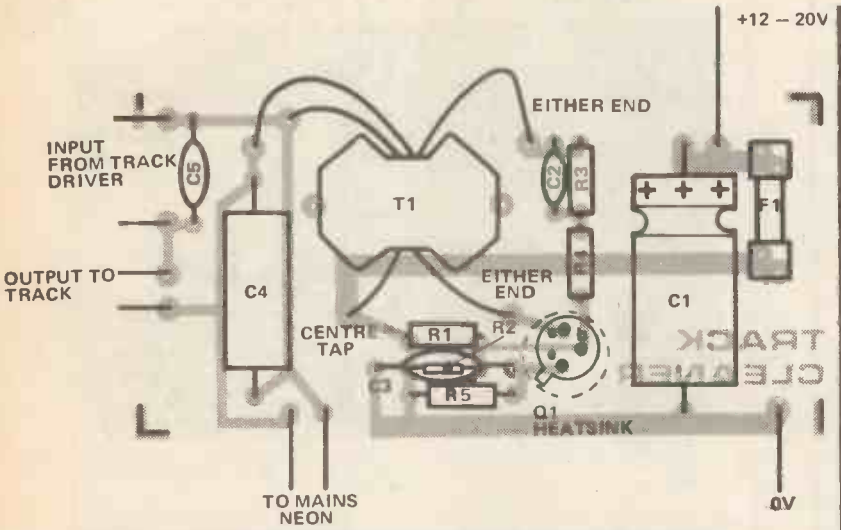


Fig. 3. Overlay for the track cleaner. Watch out for R2 which is mounted beneath capacitor C3.

Buylines

The ferrite core assembly RM10-250 should be available from Watford Electronics. A suitable capacitor for C4 can be obtained from Marshall's.

Parts List

RESISTORS (all ¼W, 5%)

R1	47k
R2	2k2
R3	12k
R4	100R
R5	82R 1W

CAPACITORS

C1	1,000µ electrolytic
C2	47n polyester
C3	470n polyester
C4	1 n 1,000V mixed dielectric
C5	220n polyester

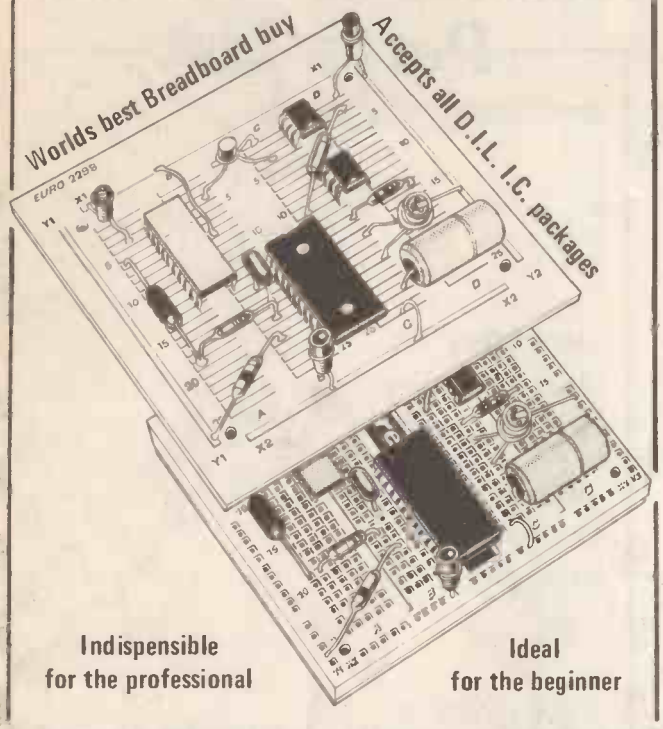
SEMICONDUCTOR

Q1	BFY 50

MISCELLANEOUS

'Mains' neon fuseholder and 250 mA fuse RM 10-250 ferrite core assembly heat sink.

First the EuroBreadBoard
Now the EuroSolderBoard



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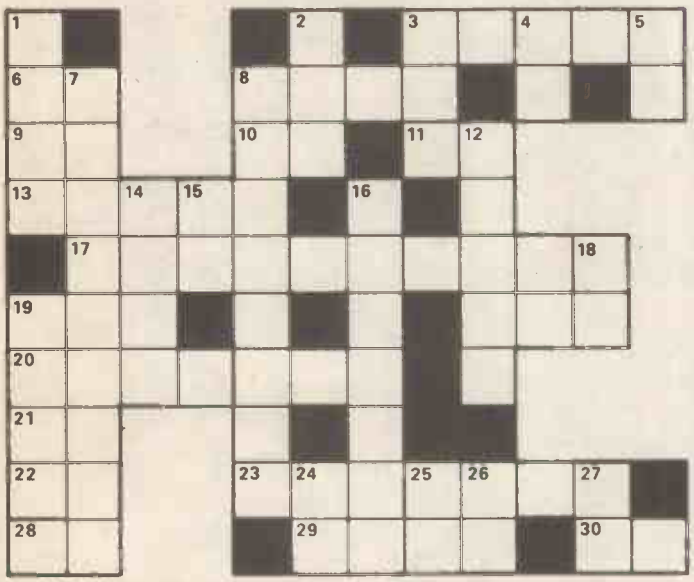

WIN A

HAND-HELD LCD MULTIMETER

See February's HE for full details of the Heathkit IM-2215 meter. Put simply, this is one of the best portable meters on the market — over 200 hrs operation from all alkaline PP3, twenty-four ranges, low-battery indication, etc. Price £85.15 inclusive of VAT and postage.

Certain words in our crossword are common electronics terms for which Orme has done the cartoons below. A word of advice: You will probably find it easier to stick to the written clues!

12 Down, 29 Across, 8 Down,

3 Across.

HOW TO ENTER

Send your completed crossword (facsimile, photocopy or cut-out) to HEATH CONTEST, Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE, to arrive by 15th May 1980.

7 Down.

17 Across, 29 Across.

CLUES, ACROSS:

3. The positive approach (to an LED, etc).
6. 00 gives 0, 01, 10 or 11 gives 1.
8. Where the power goes.
9. Further Education name for iron.
13. Mexican food (nothing to do with electronics!).
17. Unbroken.
19. HE's older brother.
20. Locates stereo image.
21. See 15 down.
22. Opens when activated.
23. Resistor in emitter circuit prevents this hot escape.
28. UB+DC.
29. Cycles in a stream.
30. Resonant combination.

CLUES, DOWN:

1. Be*ware* of programs.
2. Charged atom.
3. Takes an analogue signal to bits.
4. Minor operation for amplifiers.
5. Unit of nuclear energy.
7. Impedance without resistance.
8. BBC's magazine for short-wave enthusiasts?
12. Unopen circuit, not for beer drinkers.
14. Two-terminal low-pass filter.
15. Most things work better when switched on this mode.
16. RF transducer.
18. Ergs, joules, watts, metres, . . .
19. Black wood.
24. AA+TV.
25. Tape-slide presentation.
26. HA+OD.
27. Ham for the girlfriend.

RULES: The winner will be the sender of the first correctly-completed entry drawn at random after the closing date (15th May 1980). The contest is open to all readers of Hobby Electronics unless they are employees of Modmags Limited or Heath Electronics (UK) Limited. The decision of the Editor will be final.

TTLs by TEXAS

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AD149	70p	BFR80	25p	TIP32C	82p	2N3702/3	12p
AD161/2	45p	BFR81	25p	TIP33A	90p	2N3704/5	12p
AU107	200p	BFX29	30p	TIP33C	114p	2N3706/7	14p
BC107/8	11p	BFX30	34p	TIP34A	115p	2N3708/9	12p
BC109	11p	BFX84/5	40p	TIP34C	160p	2N3773	300p
BC117	20p	BFX86/7	30p	TIP35A	225p	2N3819	25p
BC147/8	9p	BFX88	30p	TIP35C	290p	2N3820	50p
BC149	10p	BFW10	90p	TIP36A	270p	2N3823	70p
BC157/8	10p	BFY50	30p	TIP36C	340p	2N3866	90p
BC159	11p	BFY51/2	30p	TIP41A	65p	2N3902	700p
BC169C	12p	BFY90	90p	TIP41C	78p	2N3903/4	18p
BC172	12p	BRY39	45p	TIP42A	70p	2N3905/6	20p
BC177/8	17p	BSX19/20	20p	TIP42C	82p	2N4036	70p
BC179	18p	BU104	225p	TIP54	160p	2N4037	65p
BC182/3	10p	BU105	190p	TIP120	120p	2N4058/9	12p
BC184	11p	BU108	250p	TIP122	130p	2N4060	12p
BC187	30p	BU109	225p	TIP142	160p	2N4061/2	18p
BC212/3	11p	BU205	200p	TIP147	160p	2N4123/4	27p
BC214	12p	BU208	200p	TIP2955	78p	2N4125/6	27p
BC237	15p	BU406	145p	TIP4055	70p	2N4401/3	27p
BC327	16p	E300	50p	TIS43	34p	2N4427	90p
BC337	16p	E308	50p	TIS93	30p	2N4871	60p
BC338	16p	E310	50p	ZTX108	12p	2N5087	27p
BC461	36p	MJ2501	225p	ZTX300	13p	2N5089	27p
BC477/8	30p	MJ2955	90p	ZTX500	15p	2N5172	27p
BC516/7	50p	MJ3001	225p	ZTX502	18p	2N5179	90p
BC547B	16p	MJE340	70p	ZTX504	30p	2N5191	83p
BC548C	9p	MJE2955	100p	2N696	35p	2N5194	90p
BC549C	18p	MJE3055	70p	2N697	25p	2N5245	40p
BC557B	16p	MPF102	45p	2N698	45p	2N5296	55p
BC559C	18p	MPF103/4	40p	2N706A	20p	2N5401	50p
BCY70	18p	MPF105/6	40p	2N918	45p	2N5457/8	40p
BCY71/2	22p	MPS6531	50p	2N930	18p	2N5459	40p
B0131/2	50p	MPS8534	50p	2N1131/2	20p	2N5460	60p
BD135/6	54p	MPSA06	30p	2N1613	25p	2N5485	44p
BD139	56p	MPSA12	50p	2N1711	25p	2N5875	250p
BD140	60p	MPSA13	50p	2N2102	70p	2N6027	48p
BD189	60p	MPSA20	50p	2N2160	350p	2N6107	65p
BD232	95p	MPSA43	50p	2N2219A	30p	2N6247	190p
BD233	75p	MPSA56	32p	2N2222A	30p	2N6254	130p
BD235	85p	MPSA70	50p	2N2369A	16p	2N6290	65p
BD241	70p	MPSU06	63p	2N2484	30p	2N6292	65p
BD242	70p	MPSU07	90p	2N2646	45p	2SC1172	150p
B0X53B	160p	MPSU45	90p	2N2904/5	25p	3N128	120p
BDY56	200p	MPSU65	78p	2N2906A	24p	3N140	100p
BF200	32p	OC28	130p	2N2907A	30p	3N141	110p
BF244B	35p	OC35	130p	2N2926	9p	3N201	110p
BF256B	70p	TIP29A	40p	2N3053	30p	3N204	100p
BF257/8	32p	TIP29C	55p	2N3054	65p	40290	250p
				2N3055	48p	40361/2	45p

40408	70p
40409	85p
40410	85p
40411	300p
40594	110p
40595	120p
40673	75p
40841	90p
40871/2	90p

DIODES

BY127	12p
BYX36-300	20p
OA47	9p
OA81	15p
OA85	15p
OA90	9p
OA91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
IS920	9p

HEAT SINKS

For TO220 Voltage Regs. and Transistors 22p
For TO5 12p

BRIDGE RECTIFIERS

1A 50V	19p
1A 100V	20p
1A 400V	25p
1A 600V	30p
2A 50V	30p
2A 100V	35p
2A 400V	45p
3A 200V	60p
3A 600V	72p
4A 100V	95p
4A 400V	100p
6A 50V	80p
6A 100V	100p
6A 400V	120p

10A 400V	200p
25A 400V	400p

ZENERS

2.7V-33V 400mW	9p
1W	15p

TRIACS PLASTIC

3A 400V	60p
3A 500V	65p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

THYRISTORS

1A 50V	40p
1A 400V	65p
3A 400V	90p
8A 600V	140p
12A 400V	160p
16A 100V	160p
16A 400V	180p
16A 600V	220p
BT106	110p
C106D	45p
MCR101	38p
TIC44	35p
2N3525	120p
2N4444	140p
2N5060	34p
2N5064	40p

LOUDSPEAKERS

Size		
2½"	64R	70p
2½"	8R	70p
2"	8R	90p
1½"	8R	60p

MEMORIES

2102-2L	120p
21078	500p
2111-2	225p
2112-2	300p
2114	525p
2114-2L	600p
4027	375p
4044	900p
4116	700p
5101	510p
6810	350p
74S201	325p
82516	325p

ROM/PROMs

71301	700p
74S188	225p
74S287	350p
74S387	350p
74S470	650p
74S471	650p
74S571	650p
82S137	750p
93427	400p
93436	650p
93446	650p
93448	900p

CPUs

1600	1200p
2650A	2000p
6502	1000p
6800	900p
6802	1250p
6809	2500p
8080A	550p
8085A	1400p
1NS8060	1100p
Z80	1100p
Z80A	1250

EPROMS

1702A	500p
2516	2100p
2708	800p
2716	2100p

SUPPORT DEVICES

3245	400p
6522	1100p
6532	1100p
6820	500p
6821	500p
6850	500p
8205	320p
8212	225p
8216	225p
8224	400p
8228	525p
8251	700p
8253	1200p
8255	550p
8257	1100p
8259	1400p
Z80P10	650p
Z80AP10	750p
Z80CTC	650p
MC14411	1100p
MC14412	1100p

UART

AY-3-1015P	500p
AY-5-1013P	400p
IM6402	500p
TMS6011NC	400p

CHARACTER GENERATORS

3257ADC	990p
MCM6576	1000p
RO-3-2513 U.C.	600p
RO-3-2513 LC.	650p
SN74S262AN	900p

KEYBOARD ENCODER

AY-5-2376	900p

TRANSFORMERS
(prim 220/240V)

6-0-6	100mA	88p
9-0-9	75mA	92p
0-120	12500mA	280p
0-25V (5VA)		250p
9-0-9 1A		270p*
12V 2A		350p*
0-12-15		
20-24-30 1A		340p*
15-0-15 1A		285p*

(Please add 50p p&p charge to all marked * above our normal p&p charge)

RESISTORS High Stab 5% E12
Carbon Film

¼W 10R-1M one value	7p/5pcs
½W 10R-10M one value	5p/3pcs

Miniature Presets

Hor/Vert 100R-1M	12p
Carbon Track Pots	
5K-1M Log or Lin	
Single	30p
Single with Switch	60p
Dual	72p

SLIDER POTS 60mm Track
LIN 5K, 10K, 50K, 100K 60p
LOG 10K 60p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	10p	18 pin	20p	24 pin	28p
14 pin	11p	20 pin	22p	28 pin	32p
16 pin	12p	22 pin	25p	40 pin	40p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	70p	24 pin	90p
14 pin	40p	20 pin	75p	28 pin	110p
16 pin	55p	22 pin	80p	40 pin	140p

SUBMINIATURE SWITCHES

Toggle	
SPST	60p
SPDT	65p
DPDT	70p
DPDT (centre off)	85p
Push to make	15p
break	25p
Push latching SPCO	60p
SLIDE DPDT	18p
ROCKER SPST	28p

WAFER

1P/12W	45p
3P/4W	45p
4P/3W	45p
2P/6W	45p

CRYSTALS

100KHz	300p
1MHz	370p
1.008MHz	370p
3.2768MHz	350p
3.579545MHz	200p
4MHz	350p
8.867237MHz	400p
10.7MHz	350p
18MHz	300p
26.690MHz	210p
27.145MHz	210p

COUNTERS

74C925	475p
74C928	600p
ICM7216B	£20
ICM7217A	850p
ZN1040E	700p

TTL & ECL

MC4024	325p
MC4044	325p
10116	70p
10231	350p

ANTEX SOLDERING IRONS

C-15W	400p
CX-17W	420p
CCN-15W	420p
X25	420p

SPARE BITS

C/CX/CCN	46p
X25	50p

SPARE ELEMENTS

C/CX/X25	180p
CCN	200p

ADCOLA IRONS

K1000	550p
K2000	550p

VEROBOARDS

DIP Breadboard
4.15×6.15 270p
(Suitable for 20, 14 pin or 16×16 pin DIL ICs) DIP Breadboard as above with tracks for 31 way connector 340p
V-Q Boards for ICs 105p
(No track cutting)

CONNECTOR PLUGS

31 way Plug	110p
31 way Socket	110p
S-100 Busboard	£12

EDGEBOARD CONNECTORS 0.156" PITCH

2×10 way	85p	2×22 way	135p
2×15 way	100p	2×25 way	160p
2×18 way	120p		

SPECIAL OFFERS (subject to stocks)

555	£18/100	7805	£5/10
741	£16/100	7812	£5/10
2114L-3	£4.50	7905	£6/10
2114-2L	£6.00	7912	£6/10
2708	£6.75		
2716 (plus 5V only)	£21.00	P&P + VAT Extra	
4116 (200 ns)	£40/8		

BREADBOARDS

EXP350 3.6" x 2.1" (Up to 3 x 14 pin ICs)	£3.15
EXP650 3.6" x 2.4" (Up to 1 x 40 pin IC)	£3.60
EXP300 6" x 2.1" (Uto 6 x 14 pin ICs)	£5.75
EXP600 6" x 2.4" (Up to 1 x 40 pin DCs)	£6.30

IC TEST CLIPS

14 pin	£2.60	40 pin	£4.90
16 pin	£2.75		£7.90

PROTOBOARD (R) SOLDERLESS BREADBOARDS

Socket Strips Bus Strips: Binding Posts mounted on sturdy base plate

PB6	6 x 14	DIL ICs	£9.20
PB100	10 x 14	DIL ICs	£11.80
PB102	12 x 14	DIL ICs	£22.95
PB103	24 x 14	DIL ICs	£34.45
PB104	32 x 14	DIL ICs	£45.95

(The above boards are suitable for all DIL ICs)

16 KEY KEYPAD (Reed Switches)	£4.00
UHF Modulators	£3.75
Reed Switches (12VA)	£0.25
LOGIC PROBE	£18.00
MULTIMETERS	
SUPERTESTER 680R	£33.00
MICROTEST 80R	£17.00
TMK500	£22.00
Pocket multimeter	£4.75

COMPUTER KITS
MEMORY MAPPED VDU INTERFACE KIT

SERIAL I/P VDU INTERFACE KIT	£45.00
ELF II MICROCOMPUTER KIT	£56.00
ELF II WIRED AND TESTED	£79.95
GIANT MONITOR BOARD KIT FOR ELF II	£99.95
4K STATIC RAM BOARD FOR ELF II	£35.00
ASCII KEYBOARD KIT	£69.44
(Please add 75p p&p to all above items)	£50.58

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Ultrasonic Switch
Drill Speed Controller
Digibell
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TOP PROJECTS
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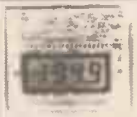
DISPLAY LIGHTING KITS

Each unit has 4 channels (rated at 1KW at 240V per channel) which switch lamps to provide sequencing effects controlled manually or by an optional opto isolated audio input

DL 1000K
This kit features a bi directional sequence speed of sequence and frequency of direction change being variable by means of potentiometers Incorporates master dimming control **£14.80**

DLZ1000K
A lower cost version of the above featuring undirectional channel sequence with speed variable by means of a preset pot Outputs switched only at mains zero crossing points to reduce radio interference to minimum **£8.00**
Optional Opto Input
DLA1 **60p**

DIGITAL VOLTMETER/ THERMOMETER KIT



Based on the ICL7106 This kit contains a PCB resistors presets capacitors diodes IC and 0 5" liquid crystal display Components are also included to enable the basic DVM kit to be modified to a Digital Thermometer using a single diode as the sensor Requires a 3mA 9V supply (PP3 battery) **£20.75**

24 HOUR CLOCK/APPLIANCE TIMER KIT

Switches any appliance up to 1kW on and off at preset times once per day Kit contains AY-5-1230 IC, 0 5" LED display mains supply display drivers switches, LEDs, triac PCBs & full instructions

CT1000K Basic Kit **£14.90**
CT1000KB with white box (56 x 131 x 71mm) **£17.40**
Ready Built **£22.50**

MINI KITS

These KITS form useful subsystems which may be incorporated into larger designs or used alone Kits include PCB short instructions and all components

TEMPERATURE CONTROLLER/THERMOSTAT
Uses LM3911 IC to sense temperature (80 C max) and triac to switch heater PCB (4 cm sq) potentiometer plus all other components included with instructions
500W **£3.20** 1KW **£3.50**

SOLID STATE RELAY
Ideal for switching motors lights heaters etc from logic Opto isolated with zero voltage switching Supplied without triac Select the required triac from our range **£2.80**

BAR/DOT DISPLAY
Displays an analogue voltage on a linear 10-element LED display as a bar or single dot Ideal for thermometers level indicators etc May be stacked to obtain 20 to 100 element displays Requires 5-20V supply **£6.75**

BURST FIRE/PROPORTIONAL TEMPERATURE CONTROLLER
Based on the TDA1024 Zero Voltage Switch this kit contains all the components required to make a burst fire power controller or a proportional temperature controller enabling the temperature of an enclosure to be maintained to within 0 5 C
1 5KW **£5.25** 3KW **£5.55**

INTEGRATED CIRCUITS

555 Timer	21p
741 Op Amp	19p
AY 5-1224 Clock	£2.60
AY-5-1230 2 Clock Timer	£4.50
AY-3-1270 Thermometer	£6.20
ICL7106 DVM (LCD drive)	£7.00
LM377 Dual 2W Amp	£1.45
LM379S Dual 6W Amp	£3.50
LM380 2W Audio Amp	80p
LM382 Dual low noise pre-amp	£1.00
LM386 250mW low voltage amp	75p
LM1830 Fluid Level Detector	£1.50
LM2907 f-v Converter	£1.40
LM3909 LED Flasher Oscillator	55p
LM3911 Thermometer	£1.20
LM3914 Dot Bar Driver	£2.10
SN76477 Sound Effects Generator	£2.75
MM74C911 4-digit display controller	£6.50
MM74C915 7 segment-BCD converter	96p
MM74C926 4-digit counter with 7-seg outputs	£4.50
S566B Touchdimmer	£2.50
S9263 Touchswitch 16-way	£4.85
TBA800 5W Audio Amp	58p
TBA810AS 7W Audio Amp	85p
TDA1024 Zero Voltage Switch	£1.00
TDA2020 20W Audio Amp	£2.85
ZN1034E Timer	£1.80

All ICs supplied with data and circuits Data sheets only 5p

LEDs

LEDS

0 1" Red	9p
0 1" Green	12p
0 1" Yellow	12p
0 2" Red	9p
0 2" Green	12p
0 2" Yellow	12p
0 2" clips	3p
Rectangular Red	18p
Rectangular Green	20p
Rectangular Yellow	21p

CAPACITORS

Polyester 250V

0 01	6p	0 22	12p
0 002	6p	0 33	12p
0 033	7p	0 47	15p
0 047	7p	0 68	18p
0 068	7p	1 0	24p
0 1	7p	1 5	27p
0 15	11p	2 2	31p

Electrolytics A Axial R Radial

63V	1 0 R	3p	16V	10 R	3p
	2 2 R	3p		22 R	3p
	4 7 R	4p		33 R	3p
	10 R	5p		47 R	4p
	47 R	8p		100 R	5p
25V	22	6p		220 R	6p
	47 A	6p		470 R	8p
	100 A	6p		1000 R	15p
	110 A	9p	10V	47 A	6p
	470 A	16p		100 A	6p
	1000 A	20p		220 A	6p

Tantalum (bead)

35V	0 1	7p	10V	22	12p
	0 22	7p	6 3V	33	12p
	0 47	7p		47	14p
	1 0	7p	3V	100	14p
25V	2 2	8p			
	4 7	9p			
	10	12p			

DISPLAYS

DL304 Red 0 3" c c pin compatible with DL704 **70p**
DL307 Red 0 3" c a pin comp DL707 **70p**
DL847 Red 0 8" (pin comp DL747) c c **£1.80**
DL850 Red 0 8" c c (pin comp DL750) **£1.80**
DL727 Dual 0 5" c a Red **£1.50**

MINI TRANSFORMERS

Standard mains primaries 240V a c
100mA secondaries
6-0-6V **80p**
9-0-9V **85p**
12-0-12V **90p**

D.I.L. I.C. SOCKETS

8 pin	8p	18 pin	17p
14 pin	12p	28 pin	24p
16 pin	14p	40 pin	36p

Soldercon Pins **50p** 100

VOLTAGE REGULATORS

Available in 5V 12V & 15V versions
78L series 100mA pos **26p**
79L series 100mA neg **60p**
78 series 1A pos **52p**
LM317T adjustable 1 2V-37V 1 5A **£1.80**

BOXES

Moulded in high impact ABS Supplied with lids and screws Black or white

B2 95 x 71 x 35mm **65p**
B3 115 x 95 x 37mm **78p**

RESISTORS

¼W 22ohm 10M
Pack of 10 (one value) **10p**
10 Packs (10 values) **90p**

ZENER DIODES

400mW 3 3V-30V **8p**
1 3W 7 5-27V **15p**

TRIACS

400V Plastic Case (Texas)

3A	49p	16A	90p
8A	58p	20A	165p
12A	85p	25A	190p
6A with trigger			80p
8A isolated tab			65p
Diac			18p

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- Improved acceleration/top speed
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Fits all 12 v negative-earth vehicles with coil/distributor ignition up to 8 cylinders.

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Die pressed case Ready drilled aluminium extruded base and heat sink, coil mounting clips and accessories All kit components are guaranteed for a period of 2 years from date of purchase Fully illustrated assembly and installation instructions are included

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GENT'S ALARM CHRONO
(12/24 CYCLE)

A really superb watch and module with numerous facilities available. It can be set as a 12 or 24-hour watch with hours, minutes, seconds, a.m./p.m. and weekday indication always on display. A unique calendar is built into the watch. You can have month followed by date or date followed by month. It's entirely up to you. A 24-hour alarm can be set to anytime within a 24-hour period whether in the 12 or 24 cycle.

The chronograph has a twelve-hour capacity and runs at 1/105. Split and lap mode facilities are available.

Battery hatch, mineral glass, long life battery and a closely woven adjustable stainless steel strap finish the watch off with impeccable looks.

ONLY £16.50!

GENT'S QUARTZ ANALOGUE

A truely superb timepiece with extreme accuracy. A choice of two colours on this outstanding watch are available. Blue or white.

The calendar in the watch can be set to give a readout in either French or English, with date indication being automatic.

An infinite adjustable stainless steel strap is built in as part of the watch.

The watch is fitted with a long-life battery and comes with luminous marking to aid night-time vision.

ONLY £19.95

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ZETRON! THE UNRIVALLED RANGE IN ELECTRONIC DIGITAL WATCHES. ZETRON!

GENTS (4 BUTTON) CHRONO

A new style chronograph with two buttons either side of the watch. Constant display of hours, mins, secs, with the added feature of weekday and am/pm indication. Month, date and weekday is an optional display with date indicator. The chrono has split and lap mode facilities running to 1/100sec. 10 function, 4 flags and 6 digits. Back-light and adjustable stainless steel strap.

ONLY £8.95

GENTS MEMORY CALENDAR ALARM CHRONO

LATEST TECHNOLOGY!
Constant display of hours, mins, secs, weekday and snooze alarm indication. A further two optional display modes are available, one being the calendar and month, which can be increased or decreased to give the appropriate month of the year. A 1/100th sec chrono with split and lap mode facilities is built into the watch. A 24 hour alarm with a 10 minute snooze function is also standard to the watch. A further feature is the back-light and fully adjustable stainless steel strap.

VALUE AT £19.95

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Narrow Bandwidth Television PART 2

Now for Part Two. In this concluding episode Doug Pitt explains how to adapt your Televisor for use as a camera / monitor and how to record your productions on an ordinary domestic tape recorder.

ALREADY Part One of this feature has caused quite a stir. It seems quite a few of you may be building Televisors. If you do why not send us a picture of your creations. Now for Part Two and the final construction notes. Please note that certain stages of construction involve the use of mains or high voltage electricity. TAKE CARE.

EXPERIMENT 1

Take a rectangular piece of blackened card or similar and cut out a picture aperture of the correct shape as shown in Fig. 1. (see April HE). You may have to use a sharp blade rather than scissors. Paste a piece of greaseproof or tracing paper over the aperture to form a diffusing screen. Finally, glue the card to one end of the cross bar so that it lines up correctly with the spiral on the disc and as close to the disc as possible without actually touching it when it revolved.

Now connect up a neon lamp to the mains *with a limiting resistor in series*. You can use two neons or even three in series, but *never connect neon lamps in parallel*. Insulate all bare wires before switching on, to avoid shocks.

Set the speed control at maximum resistance and put the disc into motion, holding the neon lamp close to the paper stroboscope. Gradually increase the speed until the black stripes appear to stand still. The disc is now running at exactly 12½ revs. per second (RPS). For 50 Hz mains, the rule is:—

$$\text{RPS} = \frac{100}{\text{No. of black stripes}}$$

Allow time for the motor to reach a constant running temperature (a few minutes) making the necessary speed adjustments. Now fix the neon behind the diffusing screen and look through the disc from the other side. You should see four stationary black stripes in the picture area. This is true, however many holes are in the spiral. Note that if your room illumination is by striplight, the motor speed can be checked using this, but the effect is less sharp than with a neon lamp. Try various speeds with the disc. Each speed gives its own particular pattern of stripes, varying in number and in angle and in speed of travel.

Home-built camera / Monitor with two discs. Improvisation is the name of the game. We can't vouch for the efficiency of St Bruno tins but you get the idea.

EXPERIMENT 2

Many radio sets, tape recorders, and 'gram' amplifiers have an output at low impedance for an extension speaker. This is usually marked 'Ext LS' or just 'LS'. Provided that the output is at least half a Watt or so and that the loudspeaker is intended to be of 3 ohms approx., a valve output transformer can be used to drive your neon lamp. A VOT is the transformer that drives the loudspeaker in any valve type apparatus and is easily obtained from a scrap TV etc.

The wires that would normally connect to the loudspeaker are attached to the 'LS' terminals and the neon lamp (or lamps) to the other side. In other words, it is used *in reverse*.

If the radio, recorder, or other source of signal is now switched on, the lamp should flicker when the volume is turned up sufficiently. With the disc in motion, a changing pattern will appear, rather in the manner of an

oscilloscope, recording sound. Note that in this usage, a limiting resistor for the lamp is not strictly necessary, but the volume should not be advanced to the point where a purplish colour creeps into the light. This is a sign that the lamp is being overloaded.

LAMP BIASING

Although a neon is capable of switching on and off quite quickly enough for TV use, it does so rather suddenly, and the patterns obtained in Experiment 2 are likely to have light and dark portions but few mid-tones. This would be all right for captions but not nearly good enough for portraits and scenes.

As the voltage across a neon lamp is raised, it remains unlit until a precise 'striking' voltage (usually 60-80 V) is reached. For TV usage, a constant biasing voltage of slightly more than this figure is required, to ensure that the lamp is never extinguished. This is readily obtained from a high voltage DC source, suitably smoothed, but it can also be obtained from the signal itself by rectifying and smoothing part of the signal. A suitable circuit appears in Fig. 9.

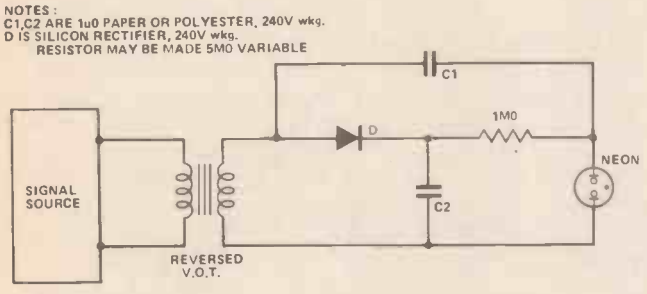


Fig. 9. Self-biasing circuit for a neon lamp. This circuit should improve the definition of the picture by allowing the neon to reproduce half-tones.

EXPERIMENT 3

If the previous experiment is now repeated, the patterns formed from music or speech should have noticeable mid-tones, instead sharply contrasting areas.

At this stage, it would be possible to play a reel of recorded NBTV signals and study a prepared moving picture, but it is far more fun to produce (and perhaps record) your own signals.

A CAMERA-MONITOR

If a camera is constructed separately, all the components have to be duplicated, so expending both time and money, and the problem of synchronisation arises, which cannot be dealt with in this brief introductory article. It is tempting, therefore, to think of a second disc on the same spindle as the first, to provide a camera facility, or even a second spiral of holes in the original disc. Better still, why not use the *same* spiral?

If the camera lens and photosensor are placed at the opposite end of the crossbar to the neon lamp, the little holes will be travelling *downwards* on the lens side when they are moving *upwards* on the viewing side. So if such a camera-monitor could be made to work, the picture would appear upside-down.

This statement is in fact untrue. Because the image focussed onto the disc by the camera lens is *inverted,* the picture will appear right way up. One snag remains however. When the start of the spiral is opposite the lens, the *middle* of the spiral will be opposite the lamp and the picture will appear split down the middle with left and right sides transposed. So, if we use a separate co-axial disc or a second spiral on the same disc, we must be sure to start the second spiral *exactly opposite* to the point where the first spiral started.

This means doing a lot more drilling of holes, but there is a trick for avoiding some of the work. It is called the ''one-and-a-half turn spiral''.

MODIFYING THE DISC

If you have taken care in cutting the aperture in the picture mask, only one spot of light will be visible at any moment and the curved edges to left and right of the aperture will hide any further holes you drill in the disc, either inside or outside the original spiral.

Remove the disc and carefully mark the position of further holes to extend the spiral outwards (or inwards if there is not enough room) for another *half turn.*

If you have chosen the 32 lines, 3 by 2 picture, with 0.5 mm steps, then a half turn (another 16 holes) starting at 130 mm from the centre will bring you to, 130+8=138 mm from the centre.

The LP is 150 mm in radius, so there is still a 12 m.m. margin to spare in this case. The sector lines are already scratched on, so the extra work should not take too long. Use the same drill as before and make sure that all the holes are clear of burrs. Now replace the disc. On the viewing side, the disc functions exactly as before.

Take a second rectangle of blackened card, etc, and cut out a new mask for the camera side. The aperture will need to be very slightly bigger, with the curves facing the other way. No diffuser is needed this time, and when correctly positioned, almost touching the disc, only one hole at a time should transmit light and these should be the *outermost 32* of the total 48. The viewing side exposes the innermost 32 holes, and 16 of the total 48 (the middle third) are common to both sides. This trick has saved the labour of 16 extra holes but the price to be paid is a very accurate mask, especially on the camera side.

'Baird' Televiser. This original equipment (shown without its cover) was built around 1932.

The lens needed for an NBTV camera need not be very elegant and a good glass magnifying lens of around 50 mm (2 inches) focal length will do adequately. The focal length is easily found by focusing an image of the sun on a clear day, onto a piece of paper then measuring the lens-to-paper distance. Fix the lens at this distance in front of the disc with some sort of sliding arrangement (eg, two concentric tubes) to enable the distance to be *increased* a little. (It will never need to be *less*).

The lens can be mounted on either side of the disc, there are advantages and disadvantages in each choice. A light-proof cover for the apparatus will have to be provided, cardboard, painted dull black inside being adequate. Light must be able to enter only via the lens, with a viewing window arranged diametrically opposite for the 'monitor' side.

PHOTOSENSORS

There is a considerable choice of these and the table (Fig. 10) shows some of their characteristics.

Photosensor	Sensitive Area	Gain	Frequency Response	Remarks
Photodiode	Small	Unity	Fast to very fast	Suitable for moving-image scanners, with wide-band pre-amplifiers
Phototransistor	Very small	10–50	Fast	Suitable for moving-image scanners.
Photodarlington	Very small	100–1000	Fairly fast	Noisy. Bandwidth very narrow.
Light Dependent Resistor	Large	Unity	Slow, improving with increased illumination	Needs additional source of light (bias) to speed up response.
Silicon Solar Cell	Large	Unity	Fast	Internal capacitance is limiting factor.
Vacuum Photocell	Large	Unity	Very fast	Low sensitivity per unit area. Needs 50–80 V DC supply.
Photomultiplier	Large	10^6 upwards	Very fast	Expensive, when new. Needs 700—1000 V DC supply.

Fig. 10. Photosensor table.

Since this is an introductory article, the efficient but expensive photomultiplier has been avoided and the solar cell employed as the most suitable for preliminary work. Solar cells appear in a variety of forms but the most useful for our purpose are unmounted silicon wafers, square or rectangular in shape. Avoid those of a different material, in plastic mounts, or round in shape.

Obtain sufficient to cover the whole picture area, on the camera side, when arranged edge to edge. If no leads are attached, solder two thin covered wires to each, the anode being a small bright area on the dark blue front, and the cathode, the whole rear surface. Choose one corner of the cathode rather than the middle. Solder as quickly as possible, as high temperatures damage the cell.

Glue the cells edge to edge onto a flat backing sheet — a piece of thin perspex is ideal. If holes are drilled at the right points in the backing, the cathode leads can pass directly through and the wafers will lie perfectly flat. Use a mild adhesive such as Copydex or Cow Gum, based on latex.

Lastly, connect the cells *in series* to reduce capacitance, and mount on the opposite side to the lens, almost touching the disc, and preferably in company with the following unit.

PRE-AMPLIFIER

Solar cells provide no gain so a pre-amp is very necessary.

This must have low noise high gain, and a wide bandwidth. It is difficult to fulfil all these conditions, but the circuit shown in Fig. 11 performs very well.

It should be mounted in a small metal box connected to the earth line of the circuit to give screening against interference and preferably in company with the solar cell array and its two leads. This scheme reduces interference pick-up from these input leads.

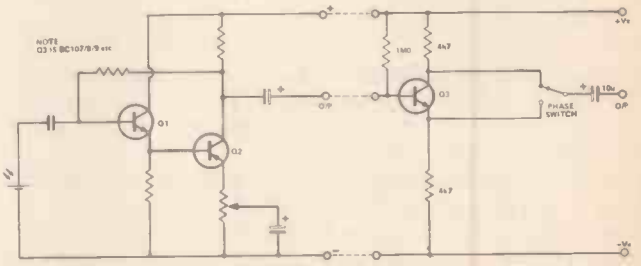
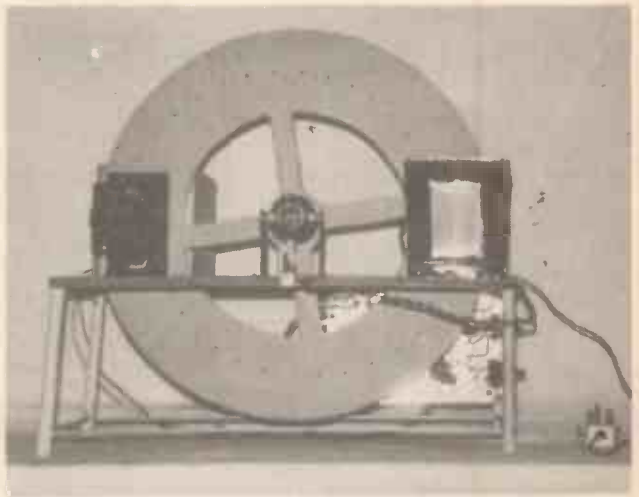


Fig. 11. 'Pre-amplifier with optional extra stage. For details see text.

EXPERIMENT 4

Connect a high impedance earpiece to the pre-amp output, place a caption sheet (one bold letter on a background will do) about four feet in front of the lens and illuminate it with a hundred Watt bulb placed fairly close. No cover is required for the apparatus if this test is carried out in a dark room. As the disc gathers speed, a rising note should be heard in the earpiece, reaching 400 Hz (about upper 'A' in musical terms) at full speed. When the lens is focused sharply on the subject, the dominant tone should become very pronounced and 'crisp'. Moving a hand across the caption board should produce a complex change in sound, easily noted.



Camera/monitor built by a 15 year old Narrow Bandwidth enthusiast.

It now remains only to connect the pre-amplifier output to a main amplifier driving the VOT as illustrated in Fig. 9. You may already possess a suitable amplifier, in the form of a tape recorder or record player, but if not, an LM 380 plus a few minor components should prove adequate (see Fig. 12). Note that the optional (phase splitting) stage of the pre-amp circuit may be omitted if you don't mind transposing the two leads from the solar cell array in the event of your main amplifier providing a *negative* image.

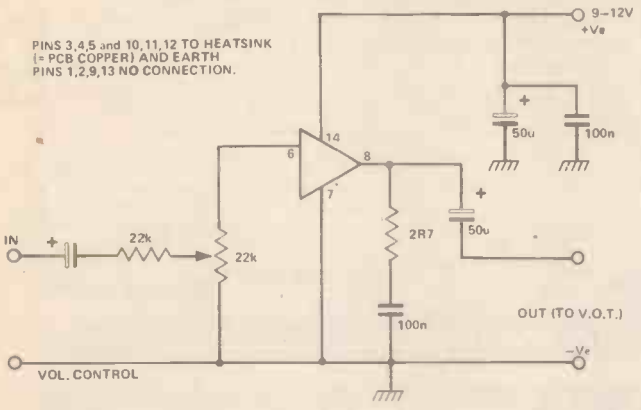


Fig. 12. Simple IC main amplifier.

The diagram (Fig. 13) shows a plan of the finished camera-monitor. The arrangement shown requires a separate wooden mount for the solar cells and pre-amp unit, but avoids the over-your-own-shoulder view when the lens is placed on the other side of the disc. It also discourages feedback of light from the lamp to the photosensor (which can cause oscillation) by interposing the disc itself as a light-baffle.

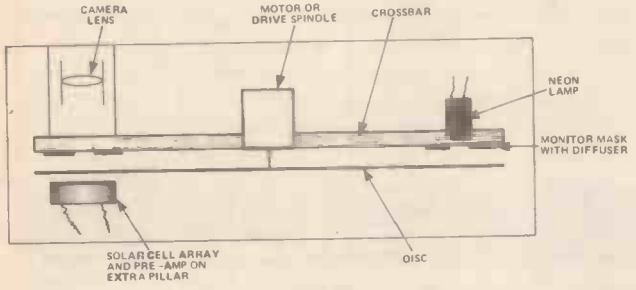


Fig. 13. Plan view of Camera / Monitor layout.

Finally, a light-proof cover and a bright day will enable you to conduct further experiments in daylight.

Using a combined camera-monitor as described, means that the choice of disc speed is largely immaterial, and it will no doubt be adjusted to the point where 'flicker' is not noticeable. However, you may later care to record your pictures for others to see and a precise agreed speed then becomes essential for both parties. The suggested speed of 12½ rps is very suitable for recorded images.

The efficient playback of recorded signals requires sync. pulses to be added to the video signal. The electronic generation and detection of such pulses is too complicated to explain here, but simple black pulses can be provided by a very easy trick.

Take a strip of black paper or card and stick it over the top edge of the picture aperture on the camera side so as to black out at least 10% of the picture's height. The straight edge of the black strip should not be parallel to the top edge of the aperture, but like it, should lie *in line with the spindle* (see Fig. 14).

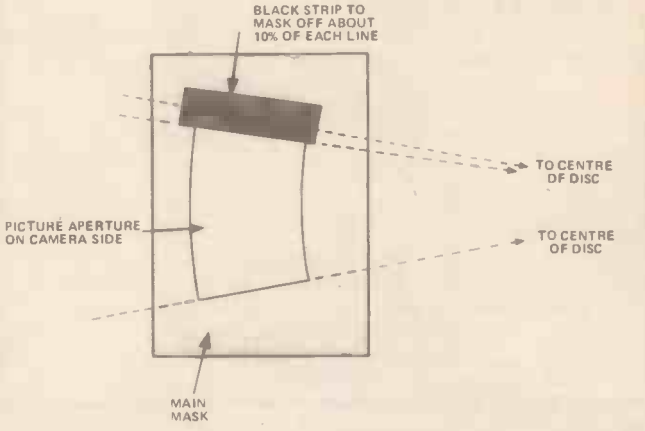
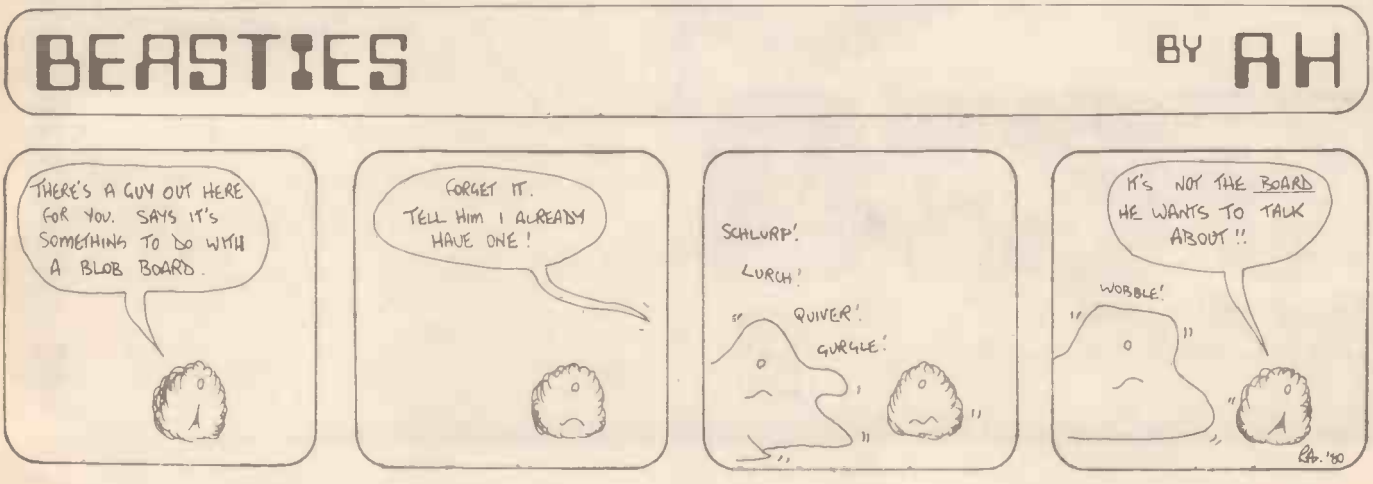


Fig. 14. Simple sync-pulse generator for more advanced systems.

This masking off of a strip of the picture will produce a black pulse at the end of every line, independent of the picture content.

I should like to thank various kind members of the NBTV Association for permission to print photos of their apparatus, and of images produced. **HE**

Doug Pitt is the Chairman of the Narrow Bandwidth TV Association. If you wish to get in touch with them for any help or advice on NBTV then write to: 1 Burnwood Drive, Wollaton, Nottingham. (Enclose SAE).



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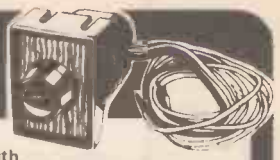

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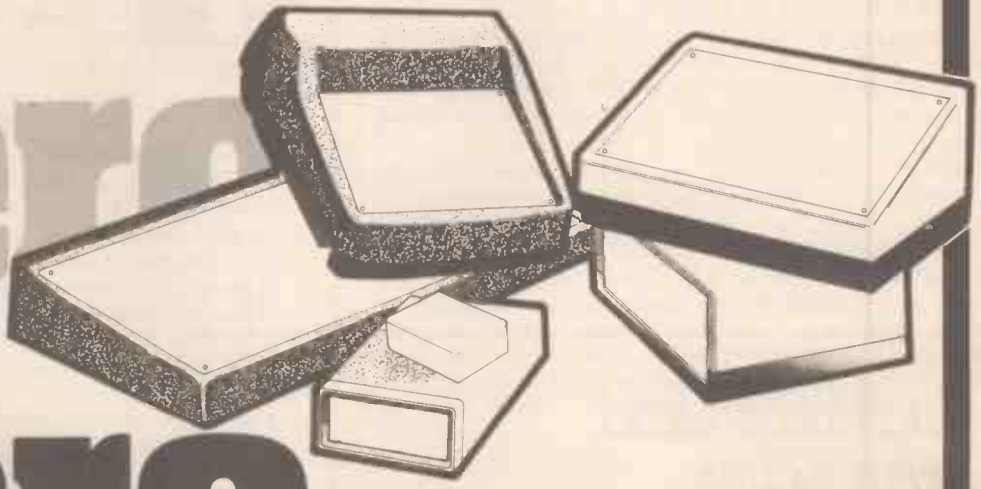

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Crossover Networks

Just before you get out the woodsaw and glue take a look at this short introductory article by Barry Hughes and Philip Goymer of Badger Sound Services on the subtle art of crossover design.

SOONER OR LATER most electronics hobbyists turn their thoughts and their soldering irons to the production of domestic Hi Fi equipment.

The quality of home built audio gear has, during the past decade-and-a-half, undergone a revolution. Even a raw beginner can, with the right information and supplies, put together the electronics of an audio system capable of matching the best commercial types.

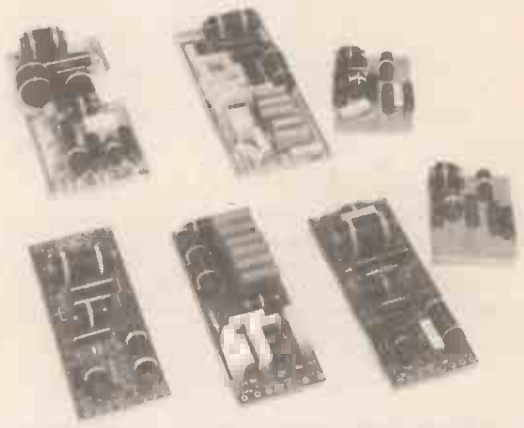
All too often he or she tends to do just that — to concentrate on the electronics and then use any old loudspeaker to reproduce the results. He often buys random Hi Fi drive units on the basis of their individual specifications, or attempts to press into service PA, disco or "power" speakers or simply uses whatever is lying around. All three courses lead to disaster. The first causes (often insurmountable) problems in integrating the drive units, the second produces a system in which subjective performance has been sacrificed in the interests of power handling and the third speaks for itself. Whichever course has been followed, the speaker simply does not do justice to the electronics and our constructor's efforts run away into the sand.

What gets overlooked in this situation is the fact that the modern high fidelity domestic loudspeaker is as highly developed as the electronics of the audio chain. (In view of the strides made of late in speaker design this is probably an understatement). Certainly the actual appearance of a high quality loudspeaker — a box, two or three loudspeaker drive units and some bits and pieces is deceptively simple and it is probably this, coupled with some over simplified treatment in magazine articles which causes the constructor to underestimate the nature of the beast.

CAREFUL DESIGN

A good speaker is a careful harmony of three things:—

(a) The drive units. Most constructors by now are aware of the almost universal practice of using two or three drive units — a relatively large one handling the bass frequencies, a smaller one to cover the treble and, in larger systems a medium sized midrange unit dealing with the bit in between. Each drive unit is specially designed for the frequencies it handles *and the number of drive units is no indication of the quality of the speaker.* It does not follow that a three way system must be superior to a two way type.



A selection of ready-built crossover systems used in top quality speaker designs.

(b) The enclosure or cabinet. In a good speaker this is critical and its design and construction have a significant effect on the final performance. It is purpose designed around the drive units in use and sadly, only by a happy fluke, is it ever possible to produce a good system the way many constructors try — by first making a box and then looking for the hardware to put in it. If a speaker is to be comparable in performance with the best commercial types it *must* be done the other way round.

(c) The crossover network (Fig. 1). This is usually the real crunch and causes the amateur the most headaches. (But hold on there what is a crossover network?). Sorry — the crossover network is an electrical circuit which takes the signal from the amplifier and divides it into frequency bands (a crossover is sometimes called a dividing network) passing to each drive unit the correct band of frequencies, low to the bass driver, high to the treble driver and so on. For those who are into these things it is a *filter circuit.* How does it work? Like this:—

FUNDAMENTALS OF CROSSOVER NETWORKS

1. The inductor — a low pass filter

An inductor, or coil, or choke (they're different names for the same thing) is a coil of wire. That's all. It has the property of resisting the passage of high frequencies

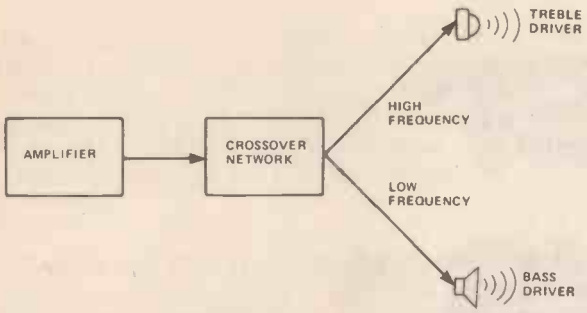


Fig. 1. Typical block diagram of a crossover network.

whilst allowing low frequencies through. The larger the inductor, the lower the frequencies against which it discriminates.

If an inductor is placed in series with a bass speaker as in Fig. 2(a) then the signal fed to the speaker is 'rolled off' as in Fig. 2(b). *Only the low frequencies are passed.* This is the bass section of the crossover.

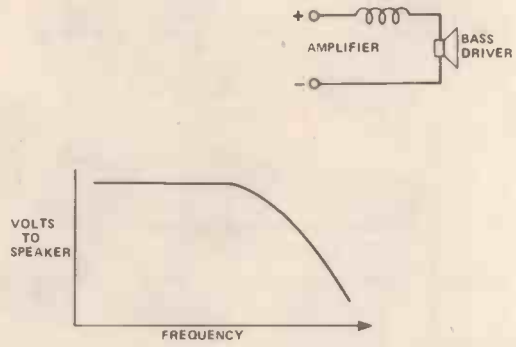


Fig. 2. Adding a coil in series with the speaker attenuates the high frequencies.

2. The capacitor — a high pass filter

Capacitors are more widely used in electronics than inductors and most HE readers will be fairly familiar with them. A capacitor operates in the opposite sense to an inductor. It resists the passage of low frequencies but allows high frequencies through. The smaller the capacitor, the higher the frequencies against which it discriminates.

If a capacitor is placed in series with a treble speaker as in Fig. 3(a) then the signal fed to the speaker is rolled off as in Fig. 3(b). *Only the high frequencies are passed* and we call this the treble section.

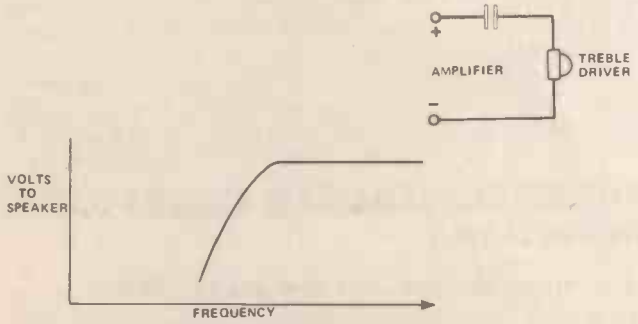


Fig. 3. Adding a capacitor in series with the speaker attenuates the low frequencies.

3. Combining the two into a simple two way network

In Figs. 4(a) and 4(b) we see the results of combining the inductor and the capacitor to form a complete but simple *crossover network*. The frequency at which the two curves cross is called the crossover frequency and crossover frequencies in a two speaker system are typically in the 3 kHz region. For those into decibels both curves are 3dB down at crossover.

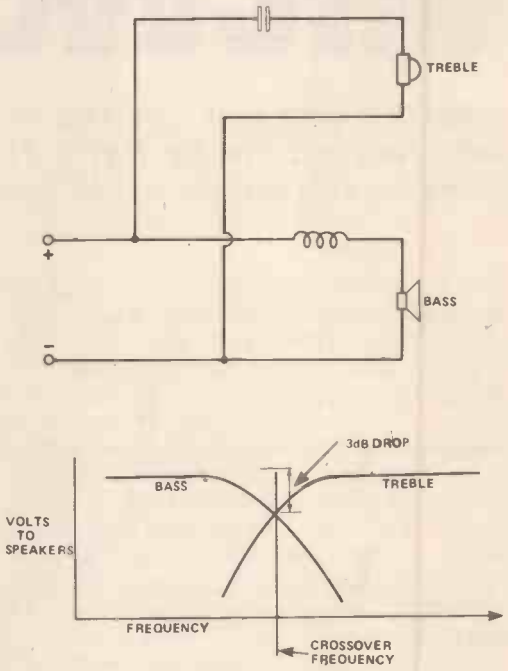


Fig. 4. Combining both capacitors and inductors in the loudspeaker leads forms a simple but effective crossover network.

4. The band-pass filter

In an inductor and a capacitor are placed in series what happens? The capacitor prevents the passage of lower frequencies, the inductor blocks the highest frequencies and the combination agree between themselves to allow through a *band* of frequencies in between as in Fig. 5(a) and (b).

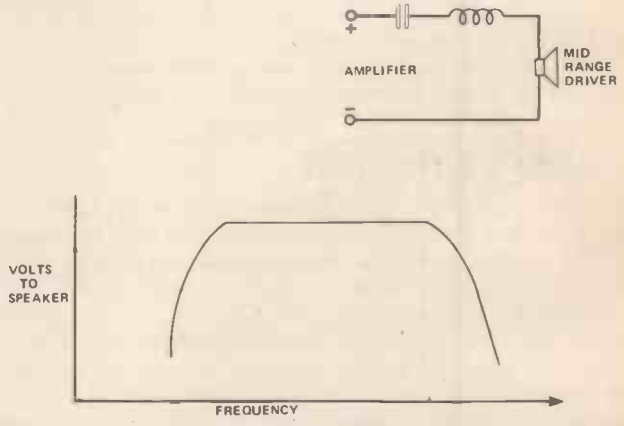


Fig. 5. A coil and inductor in series allows a selected 'band' of frequencies through the network.

5. Making our two way network into a three way network

We add a 'band pass' filter as in Fig. 6 and call this a midrange section. The crossover is now a three way crossover and typical crossover frequencies would be about 400 Hz and 3 kHz. Again the curves are 3dB down at the crossover points.

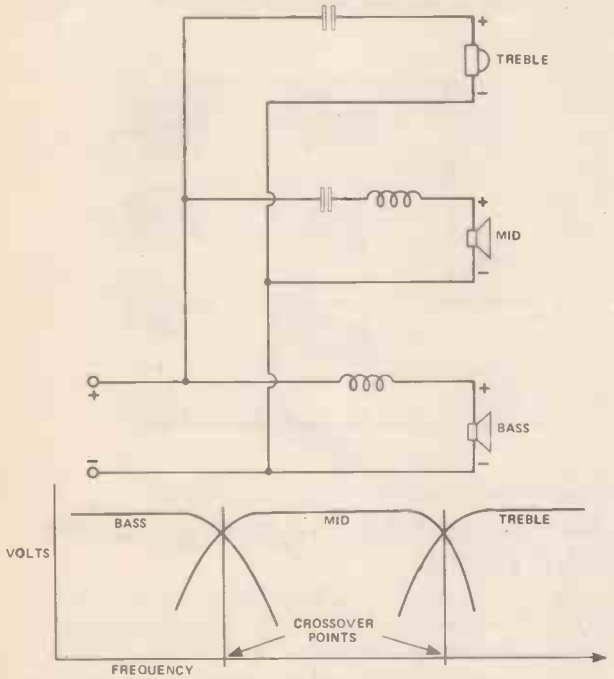


Fig. 6. 'Band Pass' filter.

6. Steepening the slopes

The simple crossovers we have looked at are called "6dB/octave" types. This is an indication of the "rate of slope" or steepness of the curves produced and in our case the output voltages produced reduce by 6dB (i.e. fell to one quarter) every time frequency increases by an octave (i.e. doubles).

The rate of slope is usually steeper than this in practice and this is achieved by adding extra components (shown dotted in Fig. 7). Adding extra components in this way increases the slope by an extra 6dB/octave per extra component to produce 12dB/octave, 18dB/octave, etc., crossovers. Most current commercial types are 12dB or 18dB/octave and can be a mixture of both in the same crossover. There is no "correct" or "better" rate — it will vary from system to system.

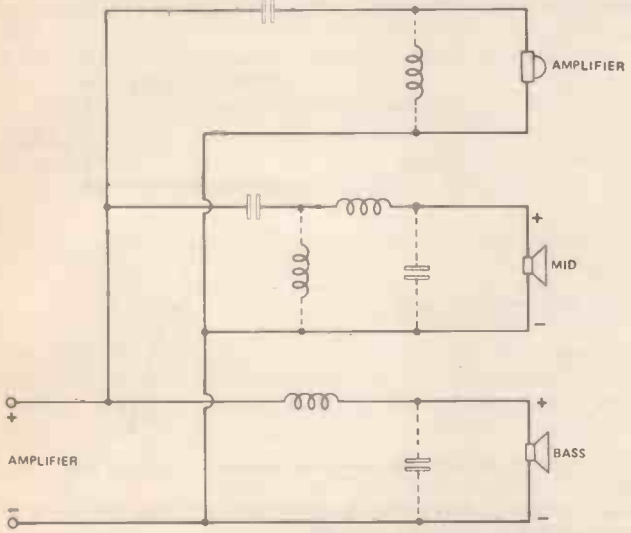


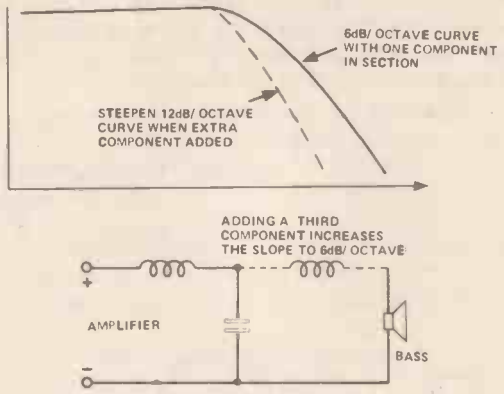
Fig. 7a. Adding extra components (dotted) increases the rate of slope.

7. Fine — how do I design a crossover?

From the relatively simple nature of the crossover circuitry it is easy to be led into believing that its design is a matter of simple calculation.

Even those skilled in electronics fall into this trap.

Taking as an example the bass section of Fig. 7(a) then the formulae would be



$$L = \frac{\sqrt{2}R}{2\pi f}$$

$$\text{and } C = \frac{1}{2\sqrt{2}\pi f R}$$

Where

L = value of inductor in Henries
C = value of capacitor in Farads
f = crossover frequency (—3dB point)
R = resistance of load (in our case the loudspeaker speech coil) in ohms

The problem lies in the value of R. Most people would apply the speaker impedance (usually 8 ohms) and calculate accordingly.

The formula assumes however a fixed resistance of 8 ohms and in our case the load is neither fixed, a resistance nor even 8 ohms!

It is not fixed since in practice the *actual* impedance varies greatly over the working range of the drive units. "8 ohms" is a purely *nominal* figure of no value in calculations.

It is not a resistance since the load (the speaker speech coil) is a coil of wire moving in a magnetic field and presents a complex and varying mixture of inductance and resistance (with some capacitance added for good measure).

It is not 8 ohms since the actual impedance at a given frequency can be as low as 4 ohms or as high as 40 ohms, varying with the frequency applied. Even if one takes the actual impedance at the crossover frequency this is likely to be 15 to 30 ohms or so and will still vary at other frequencies.

This is not just the (often-found) difference between practice and theory in which practical values vary from

theoretical by negligible amounts. We are likely to be out by two or three hundred per cent and one authority has shown that a "theoretical" crossover designed in this way can be worse than no crossover at all! If you want to stick a tweeter on the car radio system this sort of calculation might give you a starting point for playing around, but, a high quality network cannot be designed in this way.

8. Acoustical measurement is the only way

So far we have concerned ourselves with the vagaries of the electrical behaviour of our speaker, but its electrical behaviour is only a part of the problem and *must* not become an end in itself.

Remember that a loudspeaker exists to produce sound and the end product we are looking for is *not electrical at all but acoustical.* Therefore our crossover design has to be dictated by acoustical rather than electrical considerations and these we have not yet even touched on!

Loudspeaker drive units have anything but the desired flat response and so the crossover must not only divide the power into the appropriate frequency bands, but also adjust the behaviour of each drive unit to produce the optimum acoustical response. In short, the terminal voltage response of the crossover in a high grade system has to be the inverse of the *acoustical* response of those particular drive units in that particular enclosure.

Consider at its simplest a speaker having a *falling* bass response. The designer must here use a crossover having a rising bass response to compensate. What if the speaker has a dip in the response? The example in Fig. 8 shows a *tuned circuit* in which, at frequencies determined by the values of L and C the crossover can put a compensating hump into the response to an extent determined by R.

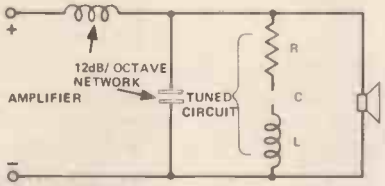


Fig. 8. Tuned Circuit (see text).

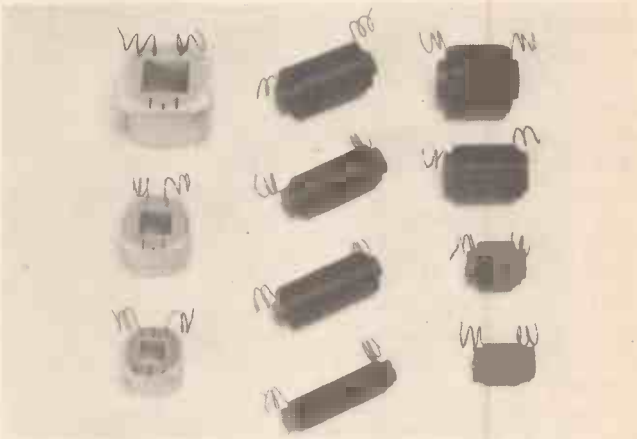
In this, and more subtle ways the designer integrates drive units and crossover network into a close partnership so that, in some cases, even the dimensions of the baffle (the front of the enclosure carrying the drive units) can influence the crossover circuitry.

Unlike the simple electrical characteristics, acoustical adjustment is beyond mere calculations. It can only be carried out by measurement under anechoic (literally "free of echo") conditions either in a special acoustically "dead" room or in the open air using accurately calibrated microphones.

Such resources are usually completely beyond the amateur and it is our contention that the amateur cannot — without a large slice of luck or some help from the professionals — produce a crossover which will enable a speaker system to realise the performance of the best current commercial types.

Manufacturers of the better drive units can supply crossovers and/or the necessary data and the specialist suppliers listed in this article can similarly supply in respect of those drive units they handle. It must be noted, however, that there are many drive units advertised in magazines *for which no crossover data exists.*

Since no supplier is going to commission acoustic measurements just to sell an odd pair of crossovers, then you have no chance of constructing a Hi-Fi speaker from such drive units and they should be avoided like the plague so far as this purpose is concerned. For similar reasons, the general purpose, non-specific crossovers sometimes advertised are useless so far as real Hi-Fi is concerned.



A selection of inductors used in crossover design.

9. Components used in crossovers

INDUCTORS:

Inductors used in practical crossovers are almost always ferrite cored nowadays. The ferrite dust cores used on good quality networks are special grades having saturation levels in excess of the handling capacity of the drive units and so the criticism levelled at ferrite cores — insufficient power handling without distortion — no longer applies. Ferrite cored inductors need far fewer turns of wire for the same inductance than do air cored inductors and so coil resistance is kept low with consequently lower losses. Since copper is expensive, ferrite cored inductors can be cheaper than air cored.

The best ferrite inductors, in the author's opinion, are those produced by Falcon Acoustics of Norwich. Falcon's technique is to avoid the use of coil formers, cheeks and tape and to bend the wire turns directly onto the ferrite rod. A very stable inductor of close tolerance, low losses and good heat dissipation results.

Air cored inductors are very little used — they are expensive and offer a high coil resistance but they can be of value:—

(a) For very high power work such as in theatres or

(b) When the high resistance is needed, so avoiding the addition to the circuit of a fixed resistor. Typical ferrite and air cored inductors by Falcon appear in the picture above Fig. 9.

Crossover inductors usually have values from 0.25 to 10mH.

CAPACITORS:

The most widely used capacitor in high grade networks is the reversible (or non-polarised) electrolytic. Essentially this consists of two electrolytic capacitors connected "back to back" in the same case with the result that, unlike conventional electrolytics, no polarising voltage is needed. Reversible electrolytics are typically found in crossovers in values from 2μF up to 100μF and 63 V working.

Polyester capacitors are sometimes used in lower values but beyond about 6.8μF they lose out heavily on cost and size.

Some Hi Fi writers (who really should know better) occasionally air the view that reversible electrolytics should be avoided on the grounds that they introduce high distortion. No evidence is ever offered to support this view which completely overlooks the experience, practice and results of the best systems manufacturers who use such capacitors almost exclusively. It further overlooks simple practicality — have they ever *seen* a 60μF polyester?

The capacitor is a very critical component in the acoustical "tailoring" considered earlier. Firstly (values permitting) the designer may choose either polyester or electrolytic on the basis of the required loss factor, effect on circuit, etc, etc. The only correct type of capacitor, as is so often the case in electronics, is the one chosen by the designer.

Secondly the capacitor will have been carefully selected for exact value in the light of the acoustic adjustment required.

The large scale specialist manufacturer of crossovers normally holds his electrolytic capacitors in 20% tolerance and selects from these by hand measurement as required. Thus a 50μF 20% capacitor may have a true value anywhere from 40μF to 60μF. If circuit adjustment happens to call for a value of, let us say, 57.5μF then this value is found by hand measurement of the 50μF stocks and selection of those falling within the required specification. He could achieve the same result by selecting "low" 60μF or even 72μF types. The exact value of the capacitor is the same in each case but the marked nominal values (50, 60 or 72μF) would vary widely. For this reason the published circuits of quality crossover networks are usually totally unreliable since they show only the nominal and not the selected value of the capacitor. Even if the amateur is aware of the exact value required he is unlikely to have (or be prepared to buy!) the large stock of capacitors necessary in order to have a chance of finding enough of the right values.

Our amateur, observing from a circuit or a board that the network employs a "50μF" capacitor now seeks to get round it by buying close tolerance types. In our case this would still be wide of the mark for even a 2% type would show a maximum value of 51μF as against the 57.5μF we require.

RESISTORS

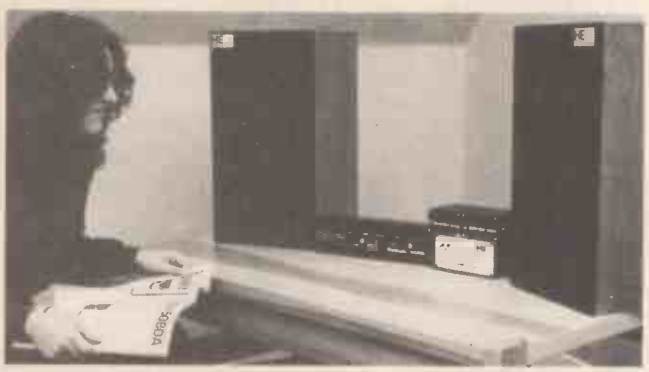
Resistors sometimes appear in crossovers. They perform the same function as in electronics — the adjustment of current and voltage — but are usually of higher wattage and lower values than normally encountered in electronics.

The most commonly used values are in the 1 to 10 ohm range, occasionally a little higher and invariably wire wound.

Resistors in tweeter circuits need a 5 W rating, mid-range calls for 9 W or so. Resistors are rarely found in bass sections. **HE**

System 5080 Speakers

This is what you've been waiting for. The perfect companions to the 5080 system. A pair of speakers from Barry Hughes and Phillip Goymer of Badger Sound Services designed for the 5080 modular system.



Our Lorraine Radmore enjoying the superb sounds from the 5080 system at home.

WE HAVE BASED the system on drive units which offer both high efficiency (at least so far as Hi Fi speakers go) and high power handling for moderate size. This is to ensure that the design can be used with as wide a range of amplifiers as possible and in most rooms. Amplifiers rated at 10 W-60 W RMS per channel with 8 ohm can be used. It thus lends itself perfectly to the HE 5080 system but will suit a more elaborate system should funds permit. This may well be the case as the experience of many Hobbys Electronics readers develops! Please note that we are talking here of normal domestic use for listening on clean signals to speech and music. Sine wave testing is particularly excluded as is the more common type of misuse, eg: —

(a) Running the amplifier into heavy clipping which, by grossly increasing the HF content of the signal, can overload the treble driver. This sort of damage is more likely to occur with small amplifiers since these are more likely to be overdriven.

(b) Running for four hours at a party on 60 W at full volume with the bass control turned fully up and the loudness button press in. The excessive bass content will kill the bass driver.

Both these cases amount to abnormal use (abuse?) and the user will be hearing very distorted signals (at his or her peril!). The constructor who will apply a little commonsense has nothing to fear.

Above. The completed 5080 speaker. This design would look good in any living room.

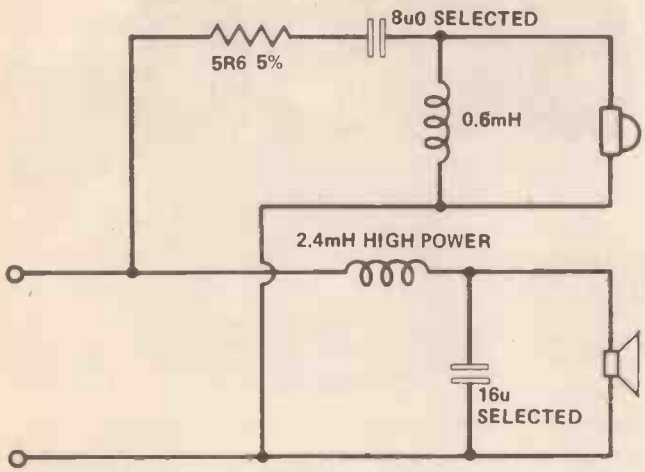


Fig. 1. Circuit diagram of the 5080 crossover.

How it Works

The bass driver is basically a cellulose pulp coned Peerless KP 825. This offers smooth performance and high power handling but its cone material could be improved. For that reason the unit we are suggesting in the parts list is in a modified form with the cone treated by applying a coat of flexible plastic "dope". This smooths the response by reducing cone "break-up" and reduces distortion. Please note that the standard KP 825WF is not recommended.

The treble unit is the partnering Peerless K010DT, an excellent performer in every way. The radiating element is not the *conventional* cone, but a soft dome which offers far better dispersion properties than would a cone *treble* unit.

The circuit of the crossover appears in Fig. 1 and those who have stuck with us so far will not be deterred by its deceptive simplicity. L1 and C1 together form a 12dB/octave bass section. L2 and C2 similarly form a 12dB/octave treble section with R1 adjusting treble level. The capacitors are of course selected as discussed and the inductors are wound specifically for this project to suitably high power handling standards.

For the reasons already outlined, home construction of the crossover is not feasible (inductors wound on aerial rod or from funny sources WILL NOT DO whatever the man in the shop says. Capacitors must be correct type and SELECTED. Ignore this and you are wasting your money.

The suppliers listed at the end of the article will supply fully assembled and tested networks at very modest cost.

The need for integration of drive units and crossover has been stressed and so we cannot enter into correspondence regarding the use of alternative drive units or crossovers in this design. Performance will in every case be degraded.

CONSTRUCTION

The bituminous felt pads appearing in the parts list may puzzle the newcomer. These pads are bonded to the cabinet walls to clean up the bass response by minimising unwanted vibrations. They are manufactured specifically for the purpose and are used by such respected speaker manufacturers as KEF and Spendor. There are no substitutes and on no account should they be omitted.

The BAF wadding is an absorbent material whose function is largely thermal. Again we do not advise substitution — egg boxes, etc, glued to the cabinet walls are quite useless.

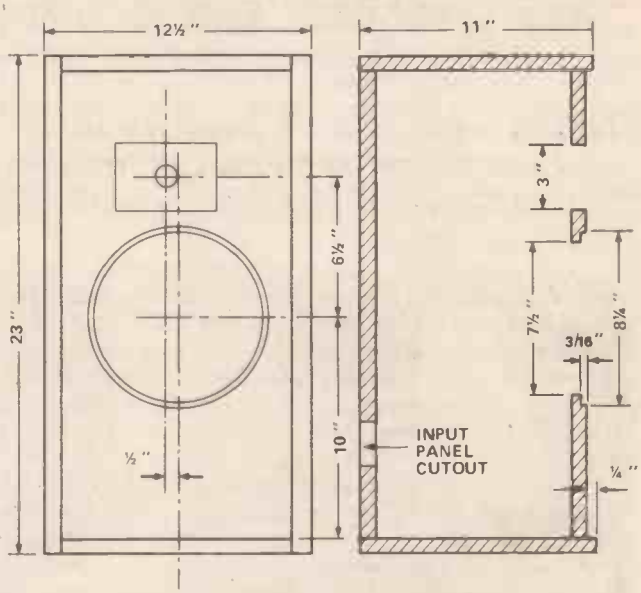


Fig. 2. Details of wood size for the speaker enclosure. Actual building method is left up to the individual constructor.

The chipboard used MUST be high density (flooring grade) and 18mm thick. Ply of the same thickness can be used although more expensive.

Construction of the cabinets (Fig. 2) is not particularly critical providing the following points are observed:—

(a) They must be rigid
(b) They must be to the correct dimensions shown
(c) They must, must be airtight

Providing these requirements are met the constructor may adopt whatever method of assembly he prefers and for this reason detailed instructions are not given. Simply assemble the boxes as per the drawings by whatever method you find most convenient or best suited to your skill. The expert woodworker will need no advice from us but the inexperienced will find that corner battens, with plenty of glue and a 1¼" screw every few inches to be the easiest way. Drill holes for the bass speaker fixing bolts with a ¼" bit (Suitable bolts, T nuts, edge clamps for holding down the drive units are supplied. The treble driver is held in place with small wood screws.

The following notes may help tie up the loose ends:

1. Use water based adhesives (spirit-based adhesives may release solvent vapours capable of damaging the drive units). Evostik Resin W is an excellent woodworking adhesive but bituminous felt pads are fixed with either Aquaseal No 5, Dunlop 'Dunloprufe' or Evostik 'Supaprufe'. These latter three are not strictly adhesives but waterproofing agents used on felt roofs. Most do-it-yourself shops have never heard of them. The best

source is usually a timber merchant or builders' yard — a 1 litre can is enough.

2. Have the wood pieces cut accurately to size by the supplier.

3. Cut out the speaker mounting holes in the front baffle noting that these are arranged as a mirror image pair. The left hand speaker is illustrated. If possible, rebate the drive units flush but do not persist if this causes too much hassle. Use the drive units as templates to mark out rebating areas.

4. Assemble the pieces into a closed box.

5. Access to fix the bituminous felt pads can be gained through the bass driver hole. 'Butter' each pad with a coat of adhesive, using a spatula or spreader. Press the pad onto the inside cabinet wall and allow to set. If the pad attempts to slip down the wall, lay that side face downwards and leave half an hour or so until set.

Fix one pad each on the sides and back of the cabinet, half a pad each on top and bottom, roughly in the middle of the panel. Exact position is unimportant and the pads can be cut with a Stanley knife.

6. Using 4 amp cable, solder all connecting leads to the crossover networks before fitting into the cabinets. Connection data comes with the crossovers.

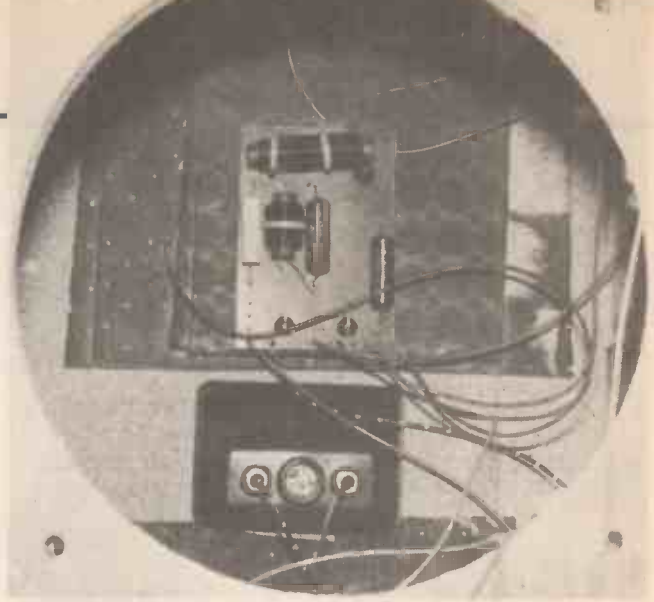
7. Again gaining access through the bass driver hole, lightly screw the crossover network to the back panel of the cabinet. In this position it can be readily reached, in the unlikely event of trouble, by simply removing the bass driver.

8. Fix the T nuts into the bass speaker fixing bolt holes from the rear. These are toothed nuts which become captive to the wood with the result that a spanner is not needed and are indispensable when fitting these front mounting drive units. They will pull into position by using a screw from the front.

9. Roll the BAF wadding into a sausage and stuff it into the cabinet through the bass driver hole. Ensure that a corner will not be able to foul the bass driver but, that apart, placement is quite uncritical.

10. Bring the flying leads from the crossover network out through the appropriate drive unit holes and through the input panel hole. Solder the leads to each drive unit in turn (ensuring correct polarity) and bolt the drive units down on the front of the panel using behind each a 'gasket' of foam draught excluder strip, or bath sealant, Bostik No 5 or any similar non-setting compound which will ensure an air-tight joint where speaker chassis meets the front baffle. Similarly screw down the recessed input panel (a gasket is provided) using small wood screws.

11. Finish by making a grille frame, either window frame style or cut from ¼" ply or hardboard (giving all drive units a very wide berth to minimise diffraction effects) and keeping the frame as thin and as far from the mid and treble units as is practicable. The frame can be fixed to the baffle with nylon grille fixing studs or as preferred. We recommend as a grille cloth stretch jersey obtainable from a drapers or Dan Grille obtainable from Falcon Acoustics. Whatever grille cloth is used it must be acoustically transparent and the easiest way to check this is to listen to the "off station" noise of an FM tuner (or any other source of hiss) while someone lowers a piece of the cloth in front of the treble drive unit. There should be no audible change in the colour of the sound. In the author's opinion Vynair material, commonly sold as a grille cloth fails this test and is totally unsuitable for Hi Fi speakers.



Inside the enclosure showing the crossover network.

12. Finish can be pretty well whatever the constructor prefers. Veneering is the obvious method but there is no reason whatever why one cannot use plastic laminates, paint, hessian, leathercloth or even wallpaper. As with the construction, let the type of finish be decided by the degree of skill available. **HE**

Parts List

WOOD

18 mm chipboard:—		
front/back	21½"×11"	4 off
sides	23"×11"	4 off
top/bottom	11"×11"	4 off
Battening	¾"×¾"	30 ft.
Screws	1¼" no. 6 countersunk	1 box
Evostik Resin W adhesive		1 bottle
Aquaseal No. 5 (see text)		1 litre
BAF wadding	24"×1"×8ft.	
Bituminous felt pads		8
Modified Peerless KP825 bass drive units		2
Peerless K010DT drive units		2
Crossover networks		2
Recessed input panels		2
Grille frame fixing studs		12
Grille cloth ro raste (see text)		

The following suppliers can provide everything except the wood, screws and adhesives:—

Badger Sound Services Ltd,
46 Wood Street,
Lytham St. Annes,
Lancs. FY8 1QG. Tel: St. Annes (0253) 729247

Falcon Acoustics Ltd,
Tabor House,
Norwich Road,
Mulbarton,
Nr. Norwich,
Norfolk NR14 BJT. Tel: Mulbarton (0508) 78272

Buylines

Approximate cost at the time of going to press — £70 per pair excluding woodwork.

Into Electronics Construction

PART 4

BY IAN SINCLAIR

Time now, for some light relief. This month we have some novelty circuits for you to experiment with

BY THIS TIME, with the experiences of Part 3 behind you, you should be getting used to the idea of laying out circuits on the Eurobreadboard. In this part, we're going to get a lot more experience of reading circuit diagrams, building them on the Eurobreadboard, and making them work. We're also going to gather up a lot more knowledge on how these circuits work.

For starters this month, take a look at the circuit of Fig. 4.1. This introduces a component we haven't used before; it's called the LDR, meaning Light-Dependent Resistor, and it also goes under the names of Cadmium Sulphide photocell or photoconductive cell. The LDR name is by far the best of these, because it describes very well what the thing does. The LDR looks a bit like a miniature compass at first sight, but under its glass cover (Fig. 4.2) is a layer of material cut into a zig-zag pattern.

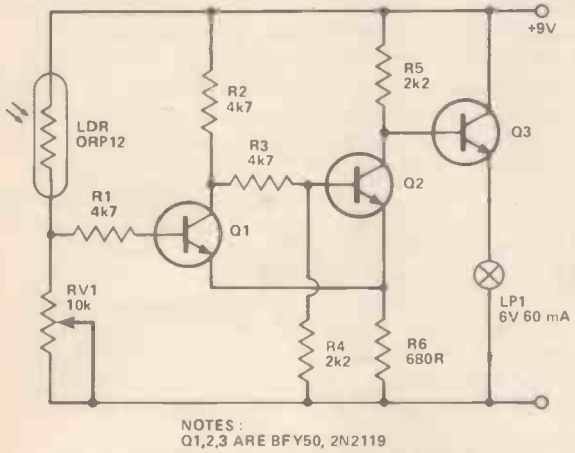


Fig. 4.1. The light-detector circuit, using an LDR as detector.

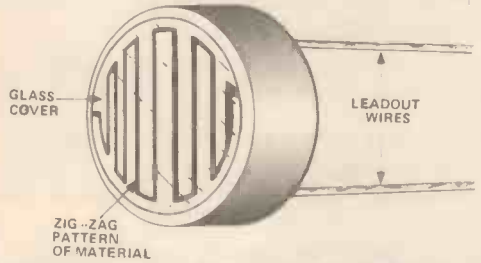


Fig. 4.2. The appearance of the LDR. The ORP12 is specified, but several other types can be substituted.

There are two leadout pins, and it's the resistance between these pins that is of interest to us. What makes it interesting and useful is that the amount of resistance between these pins depends on the amount of light which passes through the cover glass to hit the track material inside the cell. This resistance can change by a large amount. It can be as high as 1M (a million ohms) in a really dark room, and as low as 100 ohms in direct sunlight. Because of this large change of resistance, the LDR is a sensitive detector of light, and the circuit of Fig. 4.1 uses one type of LDR, the ORP12, as a detector for a light-operated switching circuit. This circuit is quite a bit more advanced than our previous ones, so hold on to your hat while we go over it in detail.

To start with, the LDR is connected to the potentiometer in what's called a potential (or voltage) divider circuit. As the name suggests, this is an arrangement which causes a voltage to be divided down to a smaller value. For example, if we have two resistors, 2k2 and 6k8 in series (Fig.4.3), then the total resistance across the 9 V supply is 9k (that's 2.2 + 6.8, yes?) Now there's a simple way to find out how much of that 9 V is across each resistor — the voltage across either resistor is given by:

$$\frac{\text{Total volts x resistance chosen}}{\text{Total resistance}}$$

That looks a bit clumsy, as maths always does when we try to put it into words. What it means is that if we want to know the voltage across the 2k2 resistor, it's just 9x2.2/9, nine volts times 2.2k divided by 9k. That comes to 2.2 V (you don't need a calculator for that one), and the voltage across the 6k8 resistor is found in the same way, it's 9x6.8/9 which is just 6.8 V.

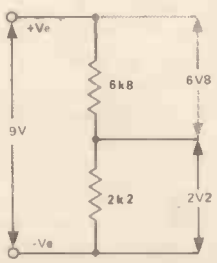


Fig. 4.3. A potential-divider circuit and its action.

With the LDR and the potentiometer RV1 connected as shown in Fig.4.4, there is a potential divider circuit all ready waiting for us. It's output is the DC voltage across RV1. This amount of resistance can be varied by altering the setting of the potentiometer shaft — let's imagine to start with that we've set this resistance to 1k. Now if the LDR is in the shadows and its resistance happens to be, say, 100k, then the voltage across the 1k (RV1) will be very low. The total resistance is 101k, the total voltage is 9 V, so that across RV1 we would get 9x1/100 V, about 0.09 V. That's not very much, and it certainly isn't enough to turn a transistor on.

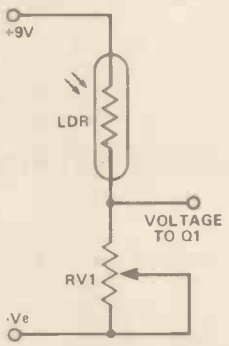


Fig. 4.4. The potential dividing action of the LDR and the potentiometer RV1.

On the other hand, a bit more light on the LDR could reduce its resistance to 1k. In this state, the total resistance is now 2k (1k of LDR and 1k of RV1), and the voltage across RV1 is now 9 × 1/2, equal to 4.5 V; quite a lot more. The effect, then, is that the voltage across RV1 is a lot greater when the light is bright than when it is dim.

SCHMITT TRIGGER

Now let's take a look at the transistor circuit. Q1 and Q2 form what's called a Schmitt trigger, and we need to understand just what that does. R2, R3 and R4 make up another potential divider. For the moment, forget Q1, which might not be passing any current. The arrangement of R2, R3 and R4 can be re-drawn as in Fig. 4.5, which makes the potential-divider action a bit more obvious. The total resistance of all three resistors is found simply by adding their values; it's 11k6. That makes the voltage across R4 equal to 9x2.2/11.6, which is 1.7 V. That's as much arithmetic as we need right now, because we know as much about the voltages in the circuit as we need to.

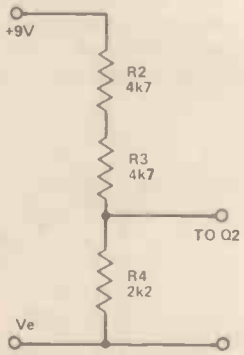


Fig. 4.5. Potential dividing by R2, R3 and R4.

The 1.7 V which is across R4 is also connected to the base of Q2. Now there's never more than about 0.6 V or so between the base voltage and the emitter voltage of a working transistor, and we hope that Q2 is working!. Its emitter voltage will then be 1.7 V — 0.6 V = 1.1 V. That news is rather important for Q1. Q1 has its emitter connected to the emitter of Q2, so that it's at the same voltage of 1.1 V as the emitter of Q2. If we are to make Q1 conduct at all, its base voltage will have to be raised to a value which is about 0.6 V higher than this emitter voltage, around 1.7 V in fact. If the base voltage of Q1 is less than this figure, then Q1 doesn't conduct, only Q2 conducts.

With Q2 conducting, and acting like a low resistance, R5, Q2 and R6 make up another of these potential divider circuits. We don't need to carry out any calculations on this one — just to see that it's enough to keep the voltage at the base of Q3 pretty low. That in turn means that the voltage across Lp1 is low, and the lamp doesn't light. A low voltage, below 1.7 V or so, at the base of Q1 therefore means that Lp1 stays unlit, and the low voltage at the base of Q1 is caused by the LDR being in darkness.

Now what happens if we expose the LDR to a bit of light? Well, as we've seen, it's going to cause the voltage at the base of Q1 to rise quite a bit. Suppose the voltage rises to 3 V. That's well above the 1.7 we reckoned we needed to start Q1 conducting, so we can be pretty sure that Q1 will be conducting well, acting like a low resistance. When that happens, though, the voltage across the collector-to-emitter of Q1 will be low; it can fall as low as 0.2 V. That's not enough to keep the Q2 switched on, and even that small voltage is divided down by R3 and R4, another potential divider. The result is that Q2 simply stops passing current.

Now the base of Q3 is connected to +9 V through R5, and if Q2 isn't stealing the current, it's all going into the base of Q3. That's enough to light the lamp Lp1 brightly, because we're using a higher voltage than we need for this lamp, and it'll stay lit until the LDR is in darkness again. When the LDR is in shadow, the voltage at the base of Q1 goes down again until Q1 switches off and Q2 turns on again. Then we're back where we started from, with Lp1 off.

One practical point about this circuit is important. When you draw out all your circuit junctions, you can't just number them any-old-how. The reason is that the LDR has quite stiff pins, and these musn't be bent because if you try you may break the glass seal of the LDR. These pins are an exact number of Eurobreadboard holes apart, though, so that LDR fits the board exactly — you just have to make sure that the numbering will suit the LDR. The easiest way of doing this is to place the LDR on the board, perhaps between A12 and A15, then pencil in these numbers on the circuit. You can now go ahead and fit in the other components, marking in their positions on the circuit diagram.

What use is the circuit? In its present form, very little, but you can imagine how it could be used. For example, replace Lp1 by a relay, and you have a circuit which could turn on electric motors to pull shutters over a greenhouse to stop it from getting too hot. With another bit of imagination, you can see this circuit controlling room lights, so that the room lights are automatically switched out when the outside light is bright enough. We can also reverse the action by reversing the positions

of the LDR and RV1, as shown in Fig.4.6. This way round, Lp1 lights when the LDR is in shadow, and that makes the circuit useful as an automatic parking light which comes on when the car is in dim light. Once again, using a relay in place of Lp1 can lead to other uses, like an automatic headlamp dipper. Just remember, though, that if you use a relay instead of Lp1, it has to be a 100 ohm 6 V relay, and it must have a diode connected across it shown in Fig. 4.7.

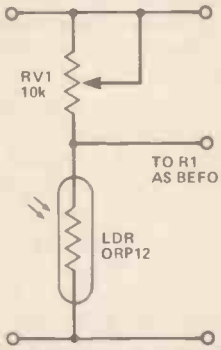


Fig. 4.6. Reversing the action of the circuit.

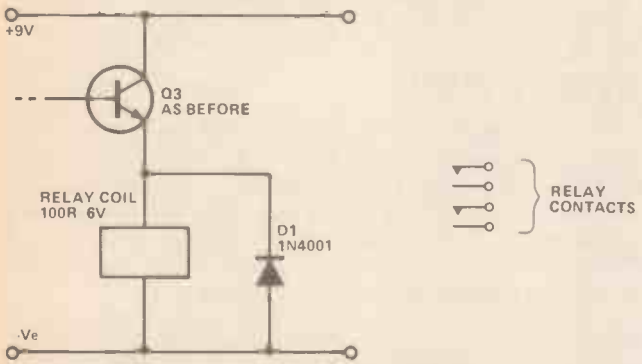


Fig. 4.7. Using a relay in place of the light-bulb.

SMALL SPEAKER

Time for something different now, and to introduce another component. This time it's a miniature loudspeaker, not any ordinary out-of-an-old-telly loudspeaker, but a "transistor" type with a resistance of somewhere between 60 ohms and 80 ohms. That resistance value is important, because if you use any old speaker, chances are it'll have a resistance somewhere between 3 ohms and 10 ohms. That's fine for a lot of purposes, but the little transistors that we're using are liable to have a heart attack if we use them to push current through such low resistances. For this and other circuits, then, we've specified the high resistance type of loudspeaker which is reasonably priced and easy to get — but not from a scrap telly!

Fig. 4.8. The appearance of the loudspeaker; a high-resistance type is essential.

There's a practical point here again — how do we connect the loudspeaker into our circuits? Until we've dealt with soldering (part 5, folks), the easiest way is to strip the insulation from some of our single-core wire, and then wrap the wire through and round one of the tag terminals of the loudspeaker. Secure it by clamping it tightly with pliers, then connect another wire in the same way to the other tag. Strip about a centimetre off the insulation at the other end of each wire, and you can then plug into the Eurobreadboard like any other component. Don't make the wires too short, or you'll have the loudspeaker sitting on top of all the other components.

The circuit in Fig. 4.9 is of a basic sound generator which uses two transistors to generate an electrical signal, and one more transistor to apply that signal to the loudspeaker. There aren't any more new components to learn about, and the generator circuit is essentially the same as the one we used in Part 1, so let's get right into the action.

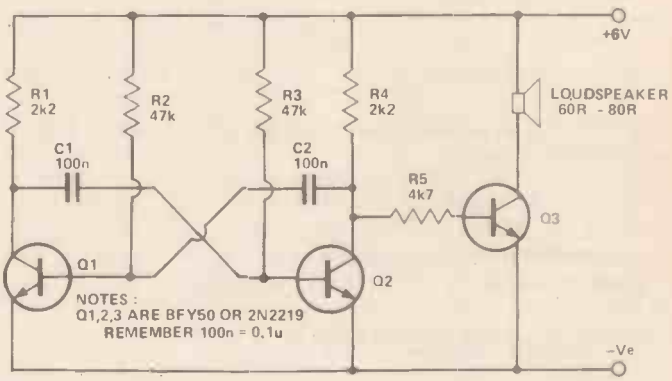


Fig. 4.9. The sound generator circuit, making use of the loudspeaker.

Imagine that Q1 has just turned on. There's every reason for it to turn on fully, because its base is connected to +6 V through R2. When Q1 turns full on, there will be only about 0.2 V between its collector and its emitter, so that the voltage on one terminal of C1 has changed suddenly from +6 V down to 0.2 V. Remember what a capacitor does? The voltage at one terminal changes in the same way as the voltage at the other terminal until the capacitor has had time the charge or discharge. In this case, if Q2 had been conducting, its base voltage would be around 0.6 V or so. When terminal 1 of C1 drops from 6 V to 0.2 V (that's a drop of 5.8 V), then the other terminal which is connected to the base of Q2 must also have the same drop of voltage. Starting at 0.6 V, a drop of 5.8 V gets us to −5.2 V. We can be pretty certain that Q2 will now be shut off, so that only Q1 is conducting. It doesn't last, though. The base of Q2 is connected to +6 V through R3, which is now busy pouring current into C1 to charge it. As a result, the voltage at the base of Q2 rises steadily. Q1 is still conducting happily, unaffected by all this. When the voltage at the base of Q2 reaches that magic figure of between 0.5 V and 0.6 V when a transistor starts to conduct, everything changes over. Q2 becomes a good conductor, its collector voltage shoots down from 6 V to about 0.2 V, and there's a sudden voltage drop, or 5.8 V again, at one terminal of C2. Once again, because the other terminal of C2 will follow its partner, the

voltage at the base of Q1 falls to —5.2 V. Now Q1 has its current cut-off, and Q2 is conducting. C2 is now the capacitor which is charging through R2 until the voltage at the base of Q1 rises to the switch-on value of somewhere between 0.5 V and 0.6 V.

The result of all this is that both transistors keep switching off and on — but the interesting one from our point of view is Q2. When Q2 is switched off, current can flow through R4 and R5 into the base of Q3, turning this transistor on, and making it pass current through the loudspeaker. When Q2 is switched on, it robs current from the base of Q3, so that Q3 doesn't turn on, and no current flows through the loudspeaker. This alternate switching on/off of current through the loudspeaker creates a sound, and the faster the transistors switch the current on and off, the higher the pitch of the sound will be. You can experiment with the different pitches you get by substituting a pair of 0.05 μF, or 0.02 μF or 0.01 μF capacitors for C1 and C2. Remember to switch the circuit off before you change capacitors, though. If you make the values of C1 and C2 too small, the current will switch very quickly, and you won't hear anything.

The rate of switching is called the frequency of the signal, and when this frequency gets about 18 000 times per second, you ear gives up, and you hear nothing, even if the signal is louder than it was at a lower frequency. Most loudspeakers don't work very well at this high frequency either. If you can get hold of a friend (or a school or College lab.) with an oscilloscope, though, you can see what the signal looks like. Incidentally, you'll see frequency referred to in units of Hertz (shortened to Hz). One Hertz just means one complete cycle of on-to-off-to-on-again or current or voltage.

SOUND TO LIGHT

Now for the next trick, a circuit which combines LDR action with a sound generator and a loudspeaker. Oddly enough it doesn't involve using any more transistors, so we can make do with the three we already have. The circuit is shown in Fig.4.10, so you can start pencilling in these loops which show the circuit junctions, and numbering them ready for the Eurobreadboard. Remember that the pins of the LDR mustn't be bent so find two parking spaces for this component right away, then fit the others around it. The loudspeaker is connected into the circuit using wire leads just as before.

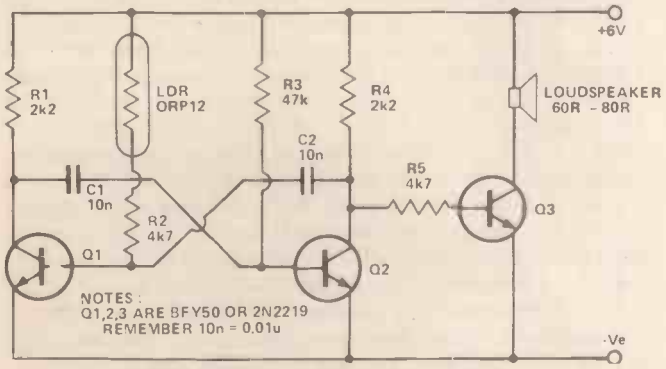


Fig. 4.10. The light-operated sound generator.

Now for how it works. Q1 and Q2 form the circuit you're familiar with by now — the oscillating pair of transistors. It's a circuit which is called an astable in the textbooks. This circuit can work only if there's enough current passing into the base of each transistor to switch the transistors on. That's true all right for Q2, with its 47k base resistor, but Q1 isn't so well served, with the LDR connected to R2. When the LDR is in darkness, there will be so much resistance between the base of Q1 and the supply positive line that Q1 isn't going to get enough current to keep it switched on. Shine a light on the LDR, though, and its resistance drops, so that Q1 can operate normally, and the pair of transistors Q1 and Q2 can start oscillating. When this happens, the collector voltage of Q2 is switching between high and low. When the voltage is high, about 4.5 V, current will flow through R4 and R5 into the base of Q3. That, incidentally, is why the voltage at the collector of Q2 can't ever reach +6 V; there's a potential divider formed by R5, R6 and the base-emitter circuit of Q3 which keeps the voltage down a bit even when Q2 cuts off. When Q2 is cut-off, though, Q3 is very definitely on, and current flows through the loudspeaker. When Q2 switches on and its collector voltage drops to 0.2 V, there isn't enough voltage to make Q3 conduct, so that no current flows through Q3 and the loudspeaker.

The circuit is a light-detector, then, which gives out a note when a light-beam hits the LDR. There isn't much you can do to change the sensitivity of this circuit as it stands, except to place dark glasses over the LDR!

NPN TO PNP

The grand finale for this month presents a new component, a different form of transistor. It looks identical to the type we're already using, the 2N2219, but this one, the 2N2905, is a PNP transistor, and it works like an inside-out NPN one. What does that mean? It means that the PNP transistor needs to have its collector connected to battery negative and its emitter to battery positive, for one thing. For another, it means that, to conduct, the PNP transistor has to have its base at a **lower** voltage than its emitter. All these are just the opposite of what's needed for the NPN transistor, which is why it deserves the name "inside-out".

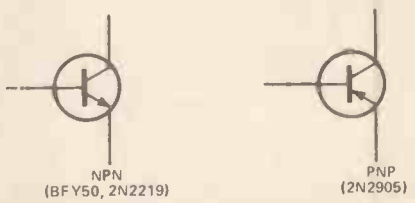


Fig. 4.11. NPN and PNP transistor symbols. The actual transistors look identical.

The circuit in Fig. 4.12 uses four transistor, and Q4 is the PNP one. Don't get them mixed up — it's a good idea to mark the case of the PNP with a blob of quick-drying paint just in case the type number rubs off, as it often does. As usual, you can pencil in the loops so as to build this circuit on the Eurobreadboard. The connections to the PNP transistor are the same as those to the NPN ones, and in the same order.

At first sight, the circuit may look familiar, but it isn't really. Q1 and Q2 aren't an astable pair — you'll see the difference if you look more closely. There's a resistor connecting each collector to each other base, not a capacitor; the capacitors C1 and C2 do a quite different job in this circuit. What effect does this have? Well, for one thing, there's nothing to charge up and change things. If we have Q1 conducting, then its collector voltage is low, and low means about 0.2 V, too low for

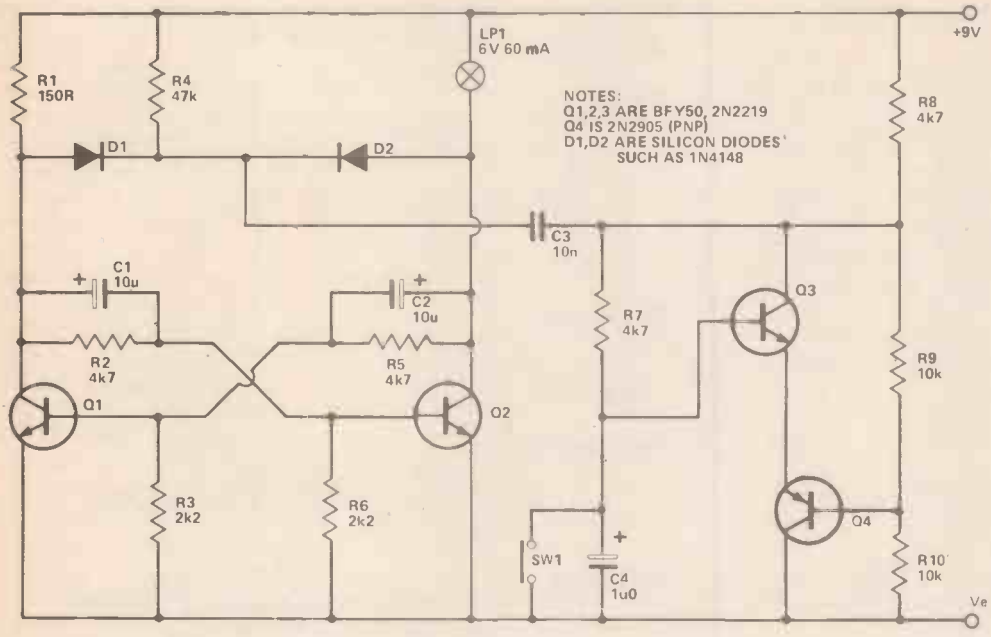


Fig. 4.12. The game-of-chance circuit, or poor man's Ernie.

Q2 to be switched on. That way, Q2 is off, and current through Lp1 flows through R5 into the base of Q1, keeping Q1 on. The current won't be enough to make Lp1 light up, because it is only a few milliamps or so. The circuit could stay like that for as long as you kept the power switched on. Equally well, if Q2 were conducting, the voltage at its collector would be too low to cause Q1 to conduct, so that the collector voltage of Q1 stayed high, keeping Q2 switched on. This is called a bistable or flip-flop circuit, it's as happy one way as the other, and there's nothing within the circuit that might make it go one way or the other. There is, however, something outside.

Q3 and Q4 form another type of astable circuit, a type called a serial multivibrator. The key to its oscillation is the connection of R7 to C4, and the use of the switch SW1. Imagine that this switch is closed. This causes the base of Q3 to be earthed, so that Q3 can't conduct. Q4 certainly can't conduct — its base voltage is several volts positive because of the potential divider circuit R9,R10 and PNP transistors don't conduct when their bases are positive and emitters negative. Like the other pair of transistors in the circuit, this pair will sit like this until something happens.

The something is releasing the switch. When that happens, the current which is flowing through R7 can now start pouring into the capacitor C4 instead of through the switch contacts to earth. Result is that the voltage across the capacitor starts to rise as the capacitor charges. That voltage is also connected to the base of the transistor Q3. The key question now is — at what voltage will Q3 conduct? One thing is certain — it won't conduct when the base voltage is 0.5 V. Why not? Because there's no conducting path at its emitter, that's why. Q4 is a PNP transistor, which conducts only when its emitter voltage is more positive than its base voltage — and its base is connected to a potential divider at a voltage of around 2.4 V. Remembering the usual 0.5 V between base and emitter that is needed to turn a transistor on, that means that Q4 isn't in the conduction business until its emitter voltage is somewhere around 2.9 to 3.0 V. In turn, Q3 can't conduct until its base voltage is about 0.5 V higher than this, because its emitter is connected to the emitter of Q4. That comes to a grand total of about 3.5 V, and the result is that C4 can charge merrily on until it reaches this voltage.

What happens then? All hell is let loose! Q3 and Q4 suddenly start conducting. The voltage at the collector of Q3 drops, which causes the voltage on R9, R10 to drop, so that the base voltage of Q4 drops. Now Q3 and Q4 conduct even better, because they need a lower voltage at the base of Q3 to conduct. Capacitor C4 discharges its current through Q3 and Q4 — but there's a limit. C4 only stores a definite amount of charge, and once that's been pushed through Q3 and Q4, it's gone. The voltage at the base of Q3 is now low, and there's nothing left to keep the two transistors conducting. They shut-up shop, stop conducting, and all the voltages go back to the way they were, with C4 once again charging through R7.

This cycle keeps repeating for as long as the switch SW1 is open, and it results in a thumping drop of voltage at the collector of Q3 several hundred times each second. C3 will communicate that drop of voltage to the two diodes D1 and D2 — what effect will they have?

Suppose Q1 is conducting and Q2 is cut off. The voltage on the anode of D1 must be low, and the voltage on the anode of D2 is high. Which of them will conduct when a drop of voltage occurs at R4, caused by the pulse from the collector of Q3? Yes, of course, it's going to be D2, because a diode conducts when its anode is at a higher voltage than its cathode. What does this sudden voltage drop do? Well, it affects Q1. If the drop is enough to make the collector voltage of Q2 go to zero, even for a very short time, then it will cause Q1 to cut off, and the voltage at the collector of Q1 will rise, turn Q2 on, and keep things that way. The circuit has changed round — Q1 is now conducting and Q1 is off.

Suppose it had been the other way round and Q2 was conducting, with Q1 off. Then the anode of D2 would be at a low voltage and the anode of D1 at a higher voltage. The negative pulse through C3 would then pass through D1. That makes the voltage at the collector of Q1 drop to zero, shuts off Q2, makes the collector voltage of Q2 rise, and so keeps Q1 conducting. Once again, the

negative pulse in through C3 has caused the Q1, Q2 circuit to switch over.

Now what does it do? With Sw1, which is a push-button switch, open, Q3 and Q4 oscillate, and the negative pulse on each oscillation switches Q1 and Q2 over, alternately lighting and extinguishing Lp1. Because Lp1 spends as much time off as on, though all you see is a dim glow. When Sw1 is pressed to the closed position, though, oscillation stops, and the circuit freezes in the state it had just after the previous changeover. Is Lp1 lit? It might be, if Q2 were conducting just as the switch was closed, but if Q1 had been conducting, Lp1 will be unlit. It's the electronics equivalent of tossing a coin — it's purely a matter of chance whether Lp1 lights or not.

It's not such a trivial circuit as it might look. A number of these circuits can generate a set of random 1's and 0's, and that's very ueful if you want to pick a lucky number. The advantage of an electronics lucky number is that you can make a random selection of very large numbers, so large that if we used a ticket for each number, there wouldn't be enough room at Wembley to hold all the tickets, and the chances of picking one wich was truly at random would be pretty poor.

Next month — soldering explained from the start. **HE**

SHOPPING LIST

Resistors:
1 × 150R
1 × 680R
1 × 2k2
1 × 4k7
1 × 10k
2 × 47k

Capacitors:
2 × 10nF (0.01 μF)
2 × 100nF (0.1 μF)
2 × 10 μF

Semiconductors:
1 × LDR, type ORP12 or equivalent
1 × silicon PNP transistor 2N2905 or equivalent.
1 × silicon diode 1N4148

Hardware:
1 × push-button switch (single-pole push-to-make)
1 × "Transistor" loudspeaker, 60 to 80 ohms.

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AL103	£1.36	BC304	£0.44	BFX30	£0.35	TIP32B	£0.48
AU104	£1.61	BC327	£0.18	BFX84	£0.25	TIP32C	£0.50
AU110	£1.61	BC328	£0.17	BFX85	£0.28	TIP41A	£0.50
AU113	£1.61	BC337	£0.17	BFX86	£0.29	TIP41B	£0.52
BC107A	£0.09	BC338	£0.17	BFX87	£0.25	TIP41C	£0.55
BC107B	£0.10	BC440	£0.35	BFX88	£0.25	TIP42A	£0.50
BC107C	£0.12	BC441	£0.35	BFY50	£0.20	TIP42B	£0.52
BC108A	£0.09	BC460	£0.44	BFY51	£0.20	TIP42C	£0.55
BC108B	£0.10	BC461	£0.44	BFY52	£0.20	TIP2955	£0.69
BC108C	£0.12	BC477	£0.23	BIP19	£0.44	TIS43	£0.25
BC109A	£0.09	BC478	£0.23	BIP20	£0.44	TIS90	£0.20
BC109B	£0.10	BC479	£0.23	BIP19		UT4E	£0.23
BC109C	£0.12	BC547	£0.12	2OMP	£0.92	ZTX107	£0.11
BC147	£0.08	BC548	£0.12	BRY39	£0.51	ZTX108	£0.11
						ZTX109	£0.11
						ZTX300	£0.13
						ZTX500	£0.14
						2N1613	£0.23
						2N1711	£0.23
						2N1889	£0.51
						2N1890	£0.51
						2N1893	£0.35
						2N2147	£0.86
						2N2148	£0.81
						2N2160	£1.15
						2N2192	£0.44
						2N2193	£0.44
						2N2194	£0.44
						2N2217	£0.25
						2N2218	£0.25
						2N2218A	£0.23
						2N2219	£0.23
						2N2219A	£0.25
						2N2904	£0.23
						2N2904A	£0.24
						2N2905	£0.20
						2N2905A	£0.23
						2N2906	£0.18
						2N2906A	£0.21
						2N2907	£0.23
						2N2907A	£0.25
						2N2926G	£0.10
						2N2926Y	£0.09
						2N29260	£0.09
						2N2926R	£0.09
						2N2926B	£0.09
						2N3053	£0.20
						2N3054	£0.46
						2N3055	£0.46
						2N3614	£1.15
						2N3615	£1.21
						2N3616	£1.21
						2N3646	£0.10
						2N3702	£0.09
						2N3703	£0.09
						2N3704	£0.08
						2N3705	£0.08
						2N3706	£0.09
						2N3707	£0.09
						2N3708	£0.08
						2N3709	£0.08
						2N3710	£0.08
						2N3711	£0.08
						2N3819	£0.21
						2N3820	£0.40

THYRISTORS

Volts No	Price
10 THY600ma/10v	£0.17
20 THY600ma/20v	£0.18
30 THY600ma/30v	£0.23
50 THY600ma/50v	£0.25
100 THY600ma/100v	£0.29
200 THY600ma/200v	£0.44
400 THY600ma/400v	£0.51

Volts No	Price
50 THY1A/50	£0.29
100 THY1A/100	£0.32
200 THY1A/200	£0.36
400 THY1A/400	£0.43
600 THY1A/600	£0.51
800 THY1A/800	£0.66

Volts	Price
50 THY3A/50	£0.32
100 THY3A/100	£0.34
200 THY3A/400	£0.37
400 THY3A/400	£0.48
600 THY3A/600	£0.57
800 THY3A/800	£0.74

Volts No	Price
50 THY5A/50	£0.41
100 THY5A/100	£0.51
200 THY5A/200	£0.67
400 THY5A/400	£0.65
600 THY5A/600	£0.79
800 THY5A/800	£0.93

Volts	Price
50 THY7A/50	£0.55
100 THY7A/100	£0.58
200 THY7A/200	£0.65
400 THY7A/400	£0.71
600 THY7A/600	£0.89
800 THY7A/800	£0.05

Volts No	Price
50 THY10A/50	£0.58
100 THY10A/100	£0.65
200 THY10A/200	£0.71
400 THY10A/400	£0.80
600 THY10A/600	£1.13
800 THY10A/800	£1.40

Volts No	Price
50 THY16A/50	£0.62
100 THY16A/100	£0.66
200 THY16A/200	£0.71
400 THY16A/400	£0.88
600 THY16A/600	£1.03
800 THY16A/800	£1.59

Volts No.	Price
50 THY30A/50v	£1.36
100 THY30A/100v	£1.64
200 THY30A/200v	£1.87
400 THY30A/400v	£2.06
500 THY30A/600v	£4.03

SILICON RECTIFIERS

200MA	
IS920 50v	£0.07
IS921 100v	£0.08
IS922 150v	£0.09
IS923 200v	£0.10
IS924 300v	£0.11
1 Amp	
IN4001 50v	£0.05
IN4002 100v	£0.05
IN4003 200v	£0.07
IN4004 400v	£0.08
IN4005 600v	£0.09
IN4006 800v	£0.10
IN4007 1000v	£0.11
1.5 Amp	
IS015 50v	£0.10
IS020 100v	£0.11
IS021 200v	£0.12
IS023 400v	£0.14
IS025 600v	£0.16
IS027 800v	£0.18
IS029 1000v	£0.23
IS031 1200v	£0.28
3 Amp	
IN5400 50v	£0.16
IN5401 100v	£0.17
IN5402 200v	£0.18
IN5404 400v	£0.19
IN5406 600v	£0.24
IN5407 800v	£0.28
IN5408 1000v	£0.34

10 Amp	
IS10/50 50v	£0.21
IS10/100 100v	£0.24
IS10/200 200v	£0.26
IS1D/400 400v	£0.40
IS10/600 600v	£0.48
IS10/800 800v	£0.58
IS10/1000 1000v	£0.69
IS10/1200 1200v	£0.79
30 Amp	
IS30/50 50v	£0.64
IS30/100 100v	£0.79
IS30/200 200v	£1.06
IS30/400 400v	£1.43
IS30/600 600v	£2.02
IS30/800 800v	£2.23
IS30/1000 1000v	£2.65
IS30/1200 1200v	£3.31
60 Amp	
IS70/50 50v	£0.86
IS70/100 100v	£0.96
IS70/200 200v	£1.38
IS70/400 400v	£2.01
IS70/600 600v	£2.58
IS70/800 800v	£2.87
IS70/1000 1000v	£3.45

TRIACS & DIACS

2 amp TO5 case	
volts No	Price
100 TR12A/100	£0.36
200 TR12A/200	£0.59
400 TR12A/400	£0.82
6 amp	
volts	
100 TR16A/100	£0.59
200 TR16A/200	£0.70
400 TR16A/400	£0.88

10 amp	
volts	
100 TR110A/100	£0.88
200 TR110A/200	£1.06
400 TR110A/400	£1.29
10 amp	
volts	
400 TR110A/400P	£1.29
DIACS	
BR100 £0.23	D32 £0.23

BRIDGE RECTIFIERS

SILICON 1 amp		
Type	No.	Price
50v RMS	BR1/50	£0.23
100v RMS	BR1/100	£0.25
200v RMS	BR1/200	£0.29
400v RMS	BR1/400	£0.41

SILICON 10 amp		
Type	No.	Price
50v RMS	BR10/50	£1.50
200v RMS	BR10/200	£1.70

SILICON 2 amp		
Type	No.	Price
50v RMS	BR2/50	£0.52
100v RMS	BR2/100	£0.55
200v RMS	BR2/200	£0.60
400v RMS	BR2/400	£0.67

SILICON 25 amp		
Type	No.	Price
50v RMS	BR25/50	£1.90
200v RMS	BR25/200	£2.20

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
AA110	£0.09	BY100	£0.25	BYZ11	£0.52	OA90	£0.11
AA120	£0.09	BY101	£0.25	BYZ12	£0.46	OA91	£0.11
AA129	£0.09	BY105	£0.25	BYZ13	£0.46	OA95	£0.11
AAY30	£0.10	BY114	£0.25	BYZ16	£0.47	OA182	£0.15
AAZ13	£0.17	BY124	£0.25	BYZ17	£0.41	OA200	£0.09
BA100	£0.11	BY126	£0.17	BYZ18	£0.41	OA202	£0.09
BA102	£0.37	BY127	£0.18	BYZ19	£0.41	SD10	£0.07
BA148	£0.17	BY128	£0.18	OA5	£0.69	SD19	£0.07
BA154	£0.14	BY130	£0.19	OA10	£0.40	IN34	£0.08
BA155	£0.16	BY133	£0.24	OA47	£0.09	IN34A	£0.08
BA173	£0.17	BY164	£0.58	OA70	£0.09	IN914	£0.07
BB104	£0.17	BY176	£0.86	OA79	£0.11	IN916	£0.07
BAX13	£0.08	BYZ06	£0.34	OA81	£0.11	IN148	£0.08
BAX16	£0.09	BYZ10	£0.51	OA85	£0.11	IS44	£0.06
						IS920	£0.07

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 (III 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 (0.3" 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

DL727 RED 7 segment D.P. right (0.5" height) 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 (0.6" height) common anode. Single-digit light pipe O/NO 1511 £1.72

OPTO-ISOLATORS

Isolation Breakdown — Voltage 1500 — continuous two 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

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

G.P. SWITCHING TRANSISTORS

TO18sm to 2N706 /9 SY27 28 95A. All useable 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 NP/PNP

G.P. SILICON DIODES

300mW 40PIV (min) sub min. FULLY TESTED. Ideal for Organ builders
30 for 57p; 100 for **£1.72**; 500 for **£6.75**; 1,000 for **£10.35**

VOLTAGE REGULATORS

Positive Case	Price		
uA7805 TO220	£0.75	uA7912 TO220	£0.85
uA7812 TO220	£0.75	uA7915 TO220	£0.85
uA7815 TO220	£0.75	uA7924 TO220	£0.85
uA7824 TO220	£0.75	uA7918 TO220	£0.85
uA7818 TO220	£0.75	72723 14 pin DN	£0.52
		uA723C TO99	£0.52
Negative Case	Price	LM309K TO3	£1.72
uA7905 TO220	£0.85	ZTK 338	£0.12

ZENER DIODES

400 mw (Bzy88) D007. Glass encapsulated range of voltages available 1.3v, 2.2v, 2.7v, 3.3v, 3.9v, 4.3v, 4.7v, 5.1v, 5.6v, 6.2v, 6.8v, 7.5v, 8.2v, 9.1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 39v **No. Z4 10p**

1w-1.5w Plastic and metal encapsulated Range of voltages available 1.3v, 2.2v, 2.7v, 3.3v, 3.9v, 4.3v, 4.7v, 5.1v, 5.6v, 6.2v, 6.8v, 7.5v, 8.2v, 9.1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v **No. Z13 18p**

10w metal stud type SO10 case. Range of voltages available as above **No. Z110 44p**

74 SERIES TTL

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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	£0.55	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	£0.57	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								

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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	Type	Price
CA3011	£0.92	CA3130	£1.06	MC1496	£1.03	72711	£0.36	SN76660	£0.86
CD3014	£1.55	CA3140	£0.80	NE536	£3.05	UA723C	£0.52	SL414A	£2.24
CA3018	£0.74	CA3065E	£0.95	NE550	£1.09	72723	£0.52	TAA5508	£0.40
CA3020	£1.95	LM301	£0.33	NE555	£0.23	UA741C	£0.27	TAA621A	£2.30
CA3028	£0.92	LM304	£1.84	NE556	£0.69	72741	£0.27	TAA621B	£2.87
CA3035	£1.61	LM308	£1.15	NE565	£1.38	741P	£0.20	TAA661	£1.72
CA3036	£1.15	LM309	£1.72	NE566	£1.38	UA7447C	£0.69	TAD100	£1.49
CA3042	£1.72	LM380	£0.97	NE567	£1.95	72747	£0.69	TBA540	£2.41
CA3043	£2.12	LM381	£1.66	UA702C	£0.52	UA748	£0.40	TBA810S	£0.86
CA3046	£0.80	LM3900	£0.66	72702	£0.52	72748	£0.40	TBA810	£1.12
CA3052	£1.84	MC1303L	£0.97	UA703	£0.28	748P	£0.40	TBA820	£0.80
CA3054	£1.26	MC1304	£2.18	UA709	£0.28	SN76013N	£2.01	TBA9200	£2.87
CA3075	£1.72	MC1310	£1.09	72709	£0.52	SN76023	£2.01	TCA270S	£2.30
CA3081	£1.72	MC1312	£2.18	709P	£0.28	SN76110	£1.72	TBA800	£0.92
CA3089	£2.30	MC1350	£1.38	UA710C	£0.46	SN76115	£2.18	TBA120	£0.60
CA3090	£4.14	MC1352	£1.61	72710	£0.34	ZN414	£1.18	TBA641A	£1.84
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BP224	50 CMOS IC Projects	0.95
BP226	Build Advanced Short wave receivers	1.20
BP227	Beginners Guide to Building Electronic Projects	1.25
RCC	Resistor Colour Code Disc	0.20

BRACKETS

Right-angle mounting brackets. Ideal for mounting, PCB, panels et cetera into boxes and cases

18SWG — Mild steel — short face has slotted hole 6.5cm x 3.7cm long face has 3.7cm diam. hole

O/NO:1726 Height 15cm, length 15cm, width 10cm **£0.06**

O/NO:1727 Height 25cm, length 15cm, width 10cm **£0.07**

SWITCHES

Description	No.	Price
DPDT miniature slide	1973	£0.16
DPDT standard slide	1974	£0.17
Toggle switch SPST 1½ amp 250V ac	1975	£0.38
Toggle switch DPDT 1 amp 250V ac	1976	£0.48
Rotary on-off mains switch	1977	£0.58
Push switch — Push to make	1978	£0.16
Push switch — Push to break	1979	£0.21

ROCKER SWITCH	Colour	No.	Price
A range of rocker	RED	1980	£0.35
switches SPST — moulded	BLACK	1981	£0.35
in high insulation	WHITE	1982	£0.35
material available in a	BLUE	1983	£0.35
choice of colours ideal	YELLOW	1984	£0.35
for small apparatus	LUMINOUS	1985	£0.35

Description	No.	Price
Miniature SPST toggle 2 amp 250V ac	1958	£0.81
Miniature SPST toggle 2 amp 250V ac	1959	£0.86
Miniature DPDT toggle 2 amp 250V ac	1960	£0.91
Miniature DPDT toggle centre off 2 amp 250V ac	1961	£1.07
Push-button SPST 2 amp 250V ac	1962	£1.04
Push-button SPST 2 amp 250V ac	1963	£1.09
Push-button DPDT 2 amp 250V ac	1964	£1.34

MIDGET WAFER SWITCHES

Single bank wafer type — suitable for switching at 250V ac 100mA or 150V dc in non-reactive loads make-before-break contacts. These switches have a spindle 0.25 in dia and 30 indexing.

Description		No.	Price
1 pole	12 way	1965	£0.55
2 pole	6 way	1966	£0.55
3 pole	4 way	1967	£0.55
4 pole	3 way	1968	£0.55

MICRO SWITCHES	No.	Price
Plastic button gives simple 1 pole change over action Rating 10 amp 250V ac	1970	£0.29

ANTEX IRONS

1943	15 watt iron element ceramic fitted with 3/32" bit	£4.83
1947	Replacement element for 1943 iron	£2.19
1944	Iron coated bit 3/32" for 1943 iron	£0.63
1945	Iron coated bit ⅛" for 1943 iron	£0.53
1946	Iron coated bit 3/16" for 1943 iron	£0.53
1948	General purpose 18 watt iron fitted with iron coated bit	£4.54
1952	Replacement element for 1948 iron	£2.19
1949	Iron coated bit 3/32" for 1948 iron	£0.53
1950	Iron coated bit ⅛" for 1948 iron	£0.53
1951	Iron coated bit 3/16" for 1948 iron	£0.53
1931	Highly popular ×25 25 watt quality soldering iron ceramic shafts to provide near perfect insulation breakdown voltage of 1500 volts AC and a leakage current of only 3-5uA and another shaft of stainless steel to ensure strength	£4.83
1935	Replacement element for 1931 iron	£1.84
1932	Iron coated bit ⅛" for 1931 iron	£0.58
1933	Iron coated bit ⅛" for 1931 iron	£0.58
1934	Iron coated bit 3/32" for 1931 iron	£0.58
1953	SK1 kit contains 15 watt iron with a 3/16" bit plus two spare solder, heat-sink and a booklet 'How to solder', in presentation display box	£6.38

VEROBOARD

806	3:	Compact tape head cleaning kit	£1.22
810	23:	Tape Editing kit	£2.65
811	24:	Cassette Tape editing and joining kit	£2.76
813	29A:	Salvage cassette	£0.51
814	31:	Cassette Head cleansing tape	£0.71
817	36A:	Record & Stylus cleaning kit	£0.46
818	41:	8-track Cartridge tape-head cleaner	£1.24
819	42:	'Groove Kleen' auto metal record cleaner	£2.65
826	52A:	Cassette storage tray (holds 10)	£0.92
827	53:	Hi-Fi stereo test cassette	£3.17
829	60.	Chrome finish 'Groove Kleen' (plastic)	£2.12
834	69:	Anti-static Hi-Fi cleaning liquid	£0.35
838	78:	Cassette head demagnetiser	£1.50

BIB HI-FI ACCESSORIES

2201 2.5"×5" .1 Copper	£0.71	2211 2.5"×2.5" .15 Copper	£0.63
2201 2.5"x3.75" .1 Copper	£0.61	2212 3.75"×12" .15 Copper	£2.39
2203 2.5"×17" .1 Copper	£2.14	2213 3.75"×5" .15 Copper	£0.90
2205 3.75"×3.75" .1 Copper	£0.71	2217 3.75"×17.5" .1 Plain	£1.79
2206 3.75"×17" .1 Copper	£2.76	2218 3.75"×2.5" .1 Plain	£0.44
2207 4.75"×17.5" .1 Copper	£3.61	2219 5"×3.75" .1 Plain	£0.68
2208 2.5"×1", 5 in pack	£0.85	2223 2.5"×5" .15 Plain	£0.37
2204 3.75"×5" .1 Copper	£0.79	2225 5"×3.75" .15 Plain	£0.56
2210 2.5"×5" .15 Copper	£0.64		

WIRE CONNECTORS

Entirely new range of connectors for Discrete wire. Uniquely designed Wirepost is soldered to the P.C. Board. A pre-stripped wire is inserted into the connector and easily locked by pressing the housing down. The wire is alternatively removed by lifting the housing. Tin alloy plated contacts ensure good as gold performance.

Housing consists of Thermo plastic polyster.

1728 Single connector in red / black or white **£0.12** inc. VAT

1729 Threeway connector black ONLY **£0.23** inc. VAT

1730 Fourway connector black ONLY **£0.28** inc. VAT

FUSE HOLDERS AND FUSES

Description	No.	Price
20mm x 5mm chassis mounting	506	£0.18
1¼in x ¼in chassis mounting	507	£0.14
1¼in car inline type	508	£0.18
Panel mounting 20mm	509	£0.23
Panel mounting 1¼in	510	£0.37

QUICK BLOW 20mm

Type	No.		Type	No.		Type	No.	
150mA	611	7p	1A	615	6p	3A	619	6p
250mA	612	6p	1.5A	616	7p	4A	620	10p
550mA	613	6p	2A	617	6p	5A	621	6p
800mA	614	8p	2.5A	618	7p			

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2.5A	628
250mA	623	2A	626	3.15A	629
500mA	624	1.6A	627	5A	630

All 8p each

QUICK-BLOW 1¼in

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All 8p each

Type	No.	Type	No.	Type	No.
1A	635	2.5A	638	4A	641
2A	637	3A	639	5A	642

All 6p each

NUTS AND BOLTS

BA BOLTS — packs of BA threaded cadmium plated screws slotted cheese head. Supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
1in OBA	839	£1.38	½in 4BA	846	£0.37
½in OBA	840	£0.86	¼in 4BA	847	£0.29
1in 2BA	842	£0.75	1in 6BA	848	£0.46
½in 2BA	843	£0.52	½in 6BA	849	£0.24
¼in 2BA	844	£0.60	¼in 6BA	850	£0.29
1in 4BA	845	£0.51			

BA NUTS — packs of cadmium plated full nuts in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	855	£0.83	4BA	857	£0.35
2BA	856	£0.55	6BA	858	£0.28

BA WASHERS — flat cadmium plated plain stamped washers supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	859	£0.16	4BA	861	£0.14
2BA	860	£0.14	6BA	862	£0.14

SOLDER TAGS — Hot tinned supplied in multiples of 50

Type	No.	Price	Type	No.	Price
OBA	851	£0.46	4BA	853	£0.25
2BA	852	£0.32	6BA	854	£0.25

AUDIO LEADS

No.	Type	Price
107	FM indoor Ribbon Aerial	£0.69
113	3.5mm Jack plug to 3.5mm Jack plug. Length 1.5m	£0.86
114	5 pin DIN plug to 3.5mm Jack connected to pins 3 & 5. Length 1.5m	£0.98
115	5 pin DIN plug to 3.5mm Jack connected to pins 1 & 4. Length 1.5m	£0.98
116	Car aerial extension Screened insulated lead. Fitted plug and socket	£1.44
117	AC mains connecting lead for cassette recorders and radios. 2 metres	£0.78
118	5 pin DIN phono plug to stereo headphone Jack socket	£1.21
119	2+2 pin DIN plugs to stereo Jack socket with attenuation network for stereo headphones. Length 0.2m	£1.04
120	Car stereo connector. Variable geometry plug to fit most car cassettes. 8-track cartridge and combination units. Supplied with inlined fuse power lead and instructions	£0.69
123	6.6m Coiled Guitar Lead Mono Jack plug to Mono Jack plug Black	£1.72
124	3 pin DIN plug to 3 pin DIN plug. Length 1.5m	£0.85
125	5 pin DIN plug to 5 pin DIN plug. Length 1.5m	£0.85
126	5 pin DIN plug to Tinned open end. Length 1.5m	£0.85
127	5 pin DIN plug to 4 Phono Plugs. All colour coded. Length 1.5m	£1.49
128	5 pin DIN plug to 5 pin DIN socket. Length 1.5m	£0.92
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1.5m	£1.21
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	£0.78
131	5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5. Length 1.5m	£0.95
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	£1.13
133	5 pin DIN plug to 2 Phono plugs. Connected pins 3 & 5. Length 1.5m	£0.86
134	5 pin DIN plug to 2 Phono sockets. Connected pins 3 & 5. Length 23cm	£0.78
135	5 pin DIN socket to 2 Phono plugs. Connected pins 3 & 5. Length 23cm	£0.78
136	Coiled stereo headphone extension lead. Black, length 6m	£2.01
178	AC mains lead for calculators, etc	£0.52

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V-0-6V 100mA	£1.04
2022	9v-0-9v 75mA	£1.04
2023	12V-0-12V 100mA	£1.29

MINIATURE MAINS Primary 240V with two independent secondary windings

No.	Type	Price
2024	MT280-0-6V 0·6V RMS	£1.84
2025	MT150-0-12V 0·12V RMS	£1.84

1 AMP MAINS Primary 240V

No.	Secondary	Price	
2026	6V-0-6V 1 amp	£2.88	P.&P. 45p
2027	9V-0-9V 1 amp	£2.30	P.&P. 45p
2028	12V-0-12V 1 amp	£2.80	P.&P. 55p
2029	15V-0-15V 1 amp	£3.16	P.&P. 66p
2030	30V-0-30V 1 amp	£3.97	P.&P. 86p

STANDARD MAINS Primary 240V

Multi-tapped secondary mains transformers available in ½ amp, 1 amp and 2 amp current rating. Secondary taps are 0-19-25-33-40-50V. Voltages available by use of taps, 7, 8, 10, 14, 15, 17, 19, 25, 31, 33, 40, 25-0-25V.

No.	Rating	Price	
2031	½ amp	£3.91	P.&P. 86p
2032	1 amp	£5.06	P.&P. 86p
2033	2 amp	£6.27	P.&P. £1
2035	240V Primary 0-55V @ 2A Secondary	£7.30	P.&P. £1

SPECIAL OFFER

2042 240V Primary 0-20V @ 2A Secondary. By removing 5 turns for each volt from the secondary winding any voltage up to 20V @ 2A is easily obtainable. Ideal for the experimenter **£1.50** P.&P. 86p

CASES AND BOXES

INSTRUMENT CASES. In two sections, vinyl covered top and sides, aluminium bottom, front and back.

No.	Length	Width	Height	Price
155	8in	5½in	2in	£1.73
156	11in	6in	3in	£2.92
157	6in	4¾in	1¾in	£1.79
158	9in	5¼in	2½in	£2.43

ALUMINIUM BOXES. Made from bright alu., folded construction each box complete with half-inch-deep lid and screws.

No.	Length	Width	Height	Price
159	5¼in	2¼in	1½in	£0.85
160	4in	4in	1½c0	£0.85
161	4in	2¼in	1½in	£0.85
162	5¼in	4in	1½in	£0.97
163	4in	2½in	2in	£0.87
164	3in	2in	1in	£0.60
165	7in	5in	2½in	£1.43
166	8in	6in	3in	£1.82
167	6in	4in	2in	£1.18

SLOPE front aluminium boxes with black vinyl base and sides & aluminium back, top & front — strong construction easily accessable.

169	2½in	5⅛in	2¾in	12in	3½in	8in	£5.45
168	1⅝in	7¼in	4in	16in	4½in	11in	£8.31

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