Open Channel News On UKCB Radio

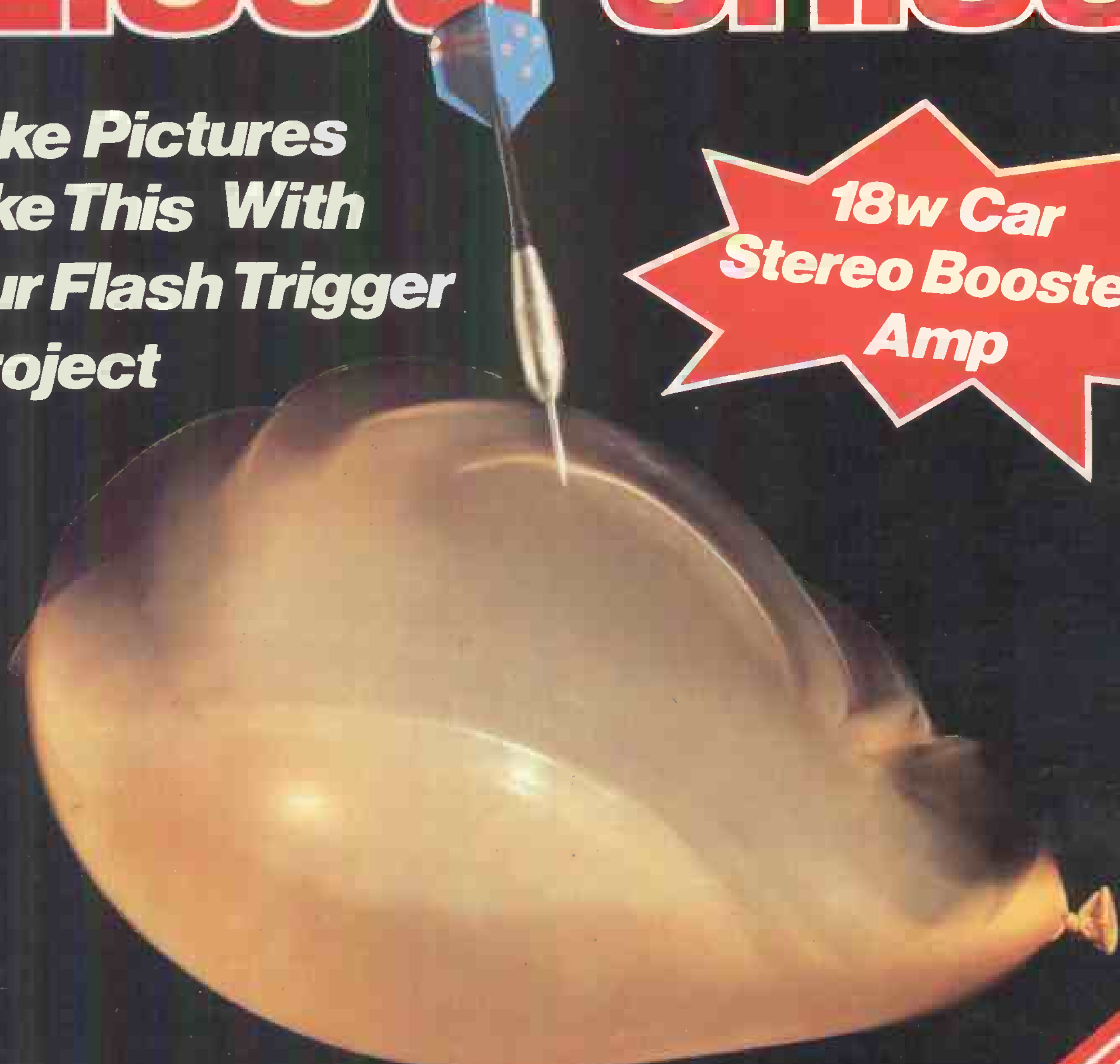
Hobby Electronics

ISSN 0142-6192

July '80

50p

Take Pictures Like This With Our Flash Trigger Project



18w Car Stereo Booster Amp

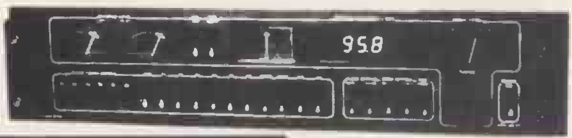
Electronics For The Master Spy

Hazard Flasher For Your Car

Push-Button Volume Control Project

Electronics In The New Cameras

Complete Audio/Tuner Kits



Mk III FM Tuner series

Carriage for Mk III tuner £3 inc

The Mark III series FM tuner has been updated, and now includes a centre zero tuning meter as standard. The instruction manual has been meticulously revised, enabling easy assembly by constructors of various levels of experience - a preview copy may be purchased for £1.00.

Mark III A series 'Reference series' tuner modules ....£171.35 inc.
Mark III B series 'Hyperfi' modules, with switched IF BW, pilot cancel decoder ....£198.95 inc.

A matching synthesiser unit will be made available later this year, and can be retrofitted to either version. All versions include digital frequency readout/clock, VU deviation meters, 6 preset stations, 10 turn pot manual tuning, toroidal PSU, output level adjustment, 110/240v AC input. Full alignment service available.

Power Amplifier

Style and performance - with a real 'belt and braces' PSU design.

After a couple of preview comments, it seems that many of you are waiting to hear about the matching HMOSFET power amplifier for the Mk III tuner. Well, it's out at last - complete with twin toroidal PSUs for comfortable 80W RMS per channel, over 100W peak, but limited by thermal shutdown of the HMOS. 10W - 100W log LED output peak indicator, DC offset protection and switch-on pause relay. AC or DC input coupling, direct or relay protected output terminals. The works.
Only one version of this item: Complete kit ....£178.25 inc. Carr. £5.

Preamplifier

More features and facilities, thanks to DC switching and control design

Previewing the most comprehensive audio preamplifier yet...... DC switching of 7 inputs, plus two tape in/outs. 2 low pass, 2 high pass active filters, genuine volum- 'ated loudness, 1dB channel matching, with DC volume, balance, bass and treble controls. itable for bus/remote control, tape dubbing, switched monitor etc. 80dB S/N+, THD -75dB or better. Pluggable PU equalization boards, tone control override. Price for complete unit about £149 ex VAT.

Radio/Audio/Communications Modules

LW-MW-SW-SW DC tuned and switched

91072 - All switching of bands by a single pin to gnd. Varicap tuned, with LO output for synth. MW/LW version or MW/LW plus 1 or 2 SW bands
MW/LW: £15.58 +1SW £16.73

VHF Tunerheads

Europes largest stock range for broadcast and communications. Probably also the world's - details in the catalogues and PL. Specials are also supplied in the region 30-220MHz.

Pilot Cancel PLL Stereo decoders

944378-2
£26.45

Again, Europe's widest range of stereo decoders including pilot cancel PLL types. The pic shows the 944378 - pilot cancel including post decoder 26/38kHz filtering and muting preamp output

Switched bandwidth FM IF strips

Broadcast FM IF strips for all occasions, including the new 911225 - with diode switched narrow filter option, ultra linear phase ceramic filters, 84dB S/N, and 0.04% THD (40kHz deviation). Plus usual things like AGC, AFC, dev. mute, level meter drive. £23.95 (supplied in screen can with 0.1 edge connection system)
Also the 7230 hyperfi series - as the 911225, but with slope controlled AFC that operates in conjunction with signal level - and an extra IF amp stage for DXing.

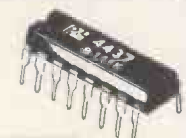
Various digital frequency displays

The World's largest range of receiver DFMs is now joined by the DFM7 (shown) - and L shaped version of the DFM3 with remote display mount connector possibility - 1kHz SW resolution with 455kHz or 10.7MHz offsets, 100Hz res up to 3.9999MHz, and VHF to 299.99 MHz in 10kHz steps : £41.75

Semiconductors

Radio/Communications ICs

FOR COMPLETE LISTINGS - SEE OUR NEW PRICELIST

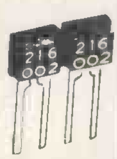


CA3089E	2.11	HA1197	1.61	SD6000	4.31
CA3189E	2.53	CA3123E	1.61	TDA4420	2.59
HA1137W	1.95	TDA1072	3.09	MC1330P	1.38
HA11225	2.47	TBA651	2.53	MC1350P	1.38
HA12412	2.81	TDA1090	3.51	KB4412	2.24
KB4420	1.95	TDA1220	1.61	KB4413	2.24
TBA120S	1.15	TDA1083	2.24	KB4417	2.53
KB4406	0.80	TDA1062	2.24	MC3357P	3.16

SL1610	1.84	SL1626	2.80
SL1611	1.84	SL1630	1.86
SL1612	1.84	SL1640	2.17
SL1613	2.17	SL1641	2.17
SL1620	2.50	SL6600	4.31
SL1623	2.80	SL6640	3.16
SL1624	3.77	SL6690	3.68
SL1625	2.50	MC1496	1.44

VARICAP DIODES........
A section from our PL:

BA102	0.35	16:1 ratio AM tuning	
BB204	0.41	KV1215 9v triple	2.93
BB105	0.41	KV1211 9v dual	2.01
BB109	0.31	KV1225 25v triple	3.16
MVAM2	1.93	BB212 9v dual	2.25



POWER MOSFETS

100W PA's made simple

Since pioneering the 100W complementary MOSFET technique - Hitachi have developed a range of output devices and drivers that ought to revolutionise opinions and attitudes towards the design of all LF amplification systems. We have a new 48 page application note (£1.50 inc) and complete sets of parts, modules and now the new complete PA system (see above).

2SK133	120v N-ch 100W MOSFET	£6.33	2SJ48 Pch complement	£6.33
2SK135	160v N-ch 100W MOSFET	£7.29	2SJ50 Pch complement	£7.39
PA101B	Kit for 100W MOSFET PA less Heatsink £16.10. (£23 inc heatsink/bkt)			

ULTRA LOW NOISE PU PREAMPLIFIER

The HA12017 is the last word in PU preamps, and general low noise audio design. It is an SIL IC, with 86dB S/N in RIAA configuration, 10v RMS output capability, 0.002% typ THD at 10v RMS output (imagine the overload margin !!). It comfortably supercedes discrete circuit designs in terms of price/performance, and takes the art beyond the TDA1042's capabilities. (Replaces HA1457) £1.80 each - or an RIAA applications PCB with two ICs for £5.75. Complete with Rs&Cs £9.95.

Radio Control ICs

We have various RC ICs, including NE544 NE5044, and two new ones from OKI

KB4445 - 4 channel dig.prop. FM TX IC. 30mW out (amplifyable) -£2.30 inc
KB4446 - 4/5 ch. dig. prop FM RX IC. Suits KB4445 or RCME syst. £2.65.
KB4445/6 pair: £4.75. New 8 page data sheet 35p + SAE. More RC ICs in list

CMOS, LPSNTTL, TTL, MPU: Listings in the new pricelist.

Most CMOS is available in low volume - also LPSN. Standard linears and TTL OK.

Things like ICM7216B, ICL8038, 8080A, 6800P, 2708, NE555, NE556, etc

Coming Soon..........

Contain yourselves, RF fans ! Not yet ready for a full launch until autumn, but previewed here.

SSB transceiver system : 10kHz to 1000MHz !!

A modular VLF to UHF SSB TX/RX system at last. With the correct first mixer, the basic PCB covers 10kHz to 1000MHz - using LO fed from ext. source (Our 2 IC Mullard synth for instance) and RF PA for TX OP. 0.2uV basic sensitivity in HF, Typ cost for HF synth SSB RX will be less than £200. Add an RF PA for full TRX for another £50. See one in our foyer, and marvel.

Components

Crystal Filters

Most popular types are available ex-stock, and in quantity.

10.7MHz	25kHz Channel spacing 8pole	£16.67
	12½kHz ..	£17.82
	2.4kHz SSB	£19.78
	Monolithic dual roofing filter	£2.30
34.5MHz	1.3dB loss, 80dB stopband HF first filter in synth. RX	£36.80
RC XTALS	FM pairs (no spilts)	£3.74
	AM pairs ..	£3.57
USB/LSB	Xtals for 10.7SSB filter	£2.88 ea

Piezo Sounders

The most efficient warning sounders yet

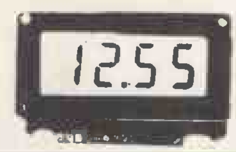
The latest thing in electro-acoustic efficiency. 1mA of drive from CMOS will give an SPL of 83dB - 10v RMS drive from CMOS uses 3mA for 100dB SPL at 4.8kHz (88dB at 1.65kHz)
The data sheets shows various drive circuits, and give full specifications with regard to broadband responses and power consumption etc. 1 off 44p inc. 100 off 28.75p (25p ex vat)

Keyboard switches and caps

From the world's most widely used switch manufacturers - ALPS - come the biggest and best range of keyswitches, and data entry keyboard switches. The SCM81101 is shown here, with the KT5 2-part cap (with clear top, to enable easy fitting of your chosen legend. Other types are available with built in LED, 90° mounting etc.
SCM81101 : 17p, KT5 : 16p - or 29p/pair

LCD CLOCKS
LCD DVM

Clocks use 1.5v at 15uA only. DVM 9v/1mA



CM161: 7mm LCD 12/24hr, alarms etc £11.44 each
CM172: 13mm, 12hr, alarms,timer etc £14.32 each
CM174: 13mm, 12hr, min/sec stopwatch £14.32 ea
DVM 176: ICM7106 based LCD 3½digit £22.36 each

WHAT's NEW at AMBIT

NEW PRICELIST/SHORTFORM:- 28 pages, FOC with A5 SAE pse

Bigger print than our recent one page list and vastly extended

If you still need convincing to invest £1.60 in the cats, be mean and get this first.

POWER MOSFET APPLICATIONS HANDBOOK by HITACHI :

£1.50 each - or free with pairs of HMOS and the PA101B

Everything you should know about HMOSFET devices theory and applications.

CATALOGUES 60p ea , all three for £1.60
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CWO PLEASE - Commercial MA terms on application. Goods are offered subject to availability, prices subject to change - so please phone and check if in doubt

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

Parts 1-3 AMBIT catalogues 60p ea, or £1.60 the lot.

Hobby Electronics

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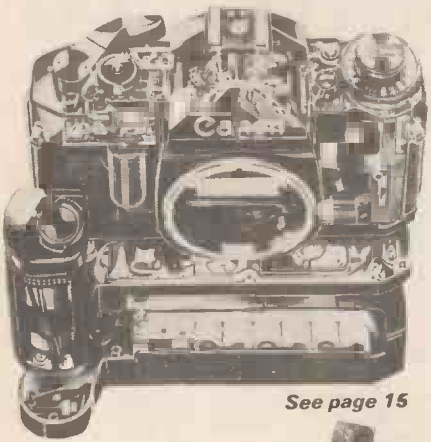

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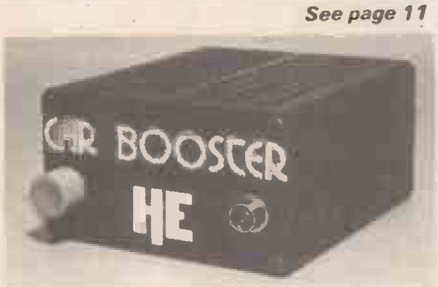

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PROJECTS

FEATURES

NEWS & INFO

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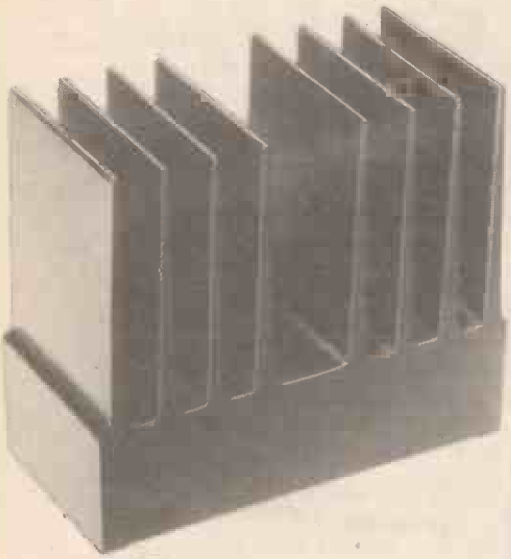
ABC

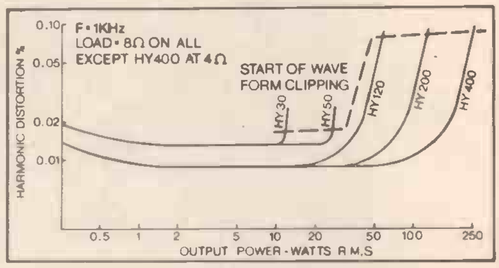
Simply ahead...



ILP PRE-AMPS ARE COMPATIBLE WITH ALL ILP POWER AMPS AND PSUs

POWER AMPLIFIERS

ILP Power Amplifiers are encapsulated within heatsinks designed to meet total heat dissipation needs. They are rugged and made to last a lifetime. Advanced circuitry ensures their suitability for use with the finest loudspeakers, pick-ups, tuners, etc. using digital or analogue sound sources.



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%	100 dB	-20 -0- +20	105x50x25	155	**£6.34** + 95p
HY50	30 W into 8 Ω	0.02%	100 dB	-25 -0- +25	105x50x25	155	**£7.24** + £1 09
HY120	60 W into 8 Ω	0.01%	100 dB	-35 -0- +35	114x50x85	575	**£15.20** + £2 28
HY200	120 W into 8 Ω	0.01%	100 dB	-45 -0- +45	114x50x85	575	**£18.44** + £2 77
HY400	240 W into 4 Ω	0.01%	100 dB	-45 -0- +45	114x100x85	1 15Kg	**£27.68** + £4 15

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

POWER SUPPLY UNITS

ILP Power Supply Units with transformers made in our own factory are designed specifically for use with ILP power amplifiers and are in two basic forms – one with circuit panel mounted on conventionally styled laminated transformer, for smaller PSU's – in the other, for larger PSU's, ILP toroidal transformers are used which are half the size and weight of laminated equivalents, are more efficient and have greatly reduced radiation.

PSU 30 ± 15V at 100mA to drive up to 12 x HY6 or 6 x HY6-6 £4.50 + £0.68 VAT

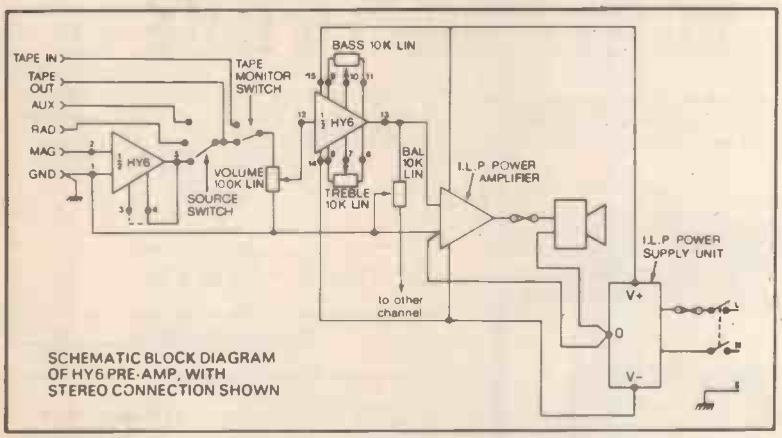
THE FOLLOWING WILL ALSO DRIVE ILP PRE-AMPS

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 60 with toroidal transformer for 1 HY 120 £9.75 + £1.46 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
PSU 180 with toroidal transformer for 1 HY400 or 2 x HY200 £23.02 + £3.45 VAT

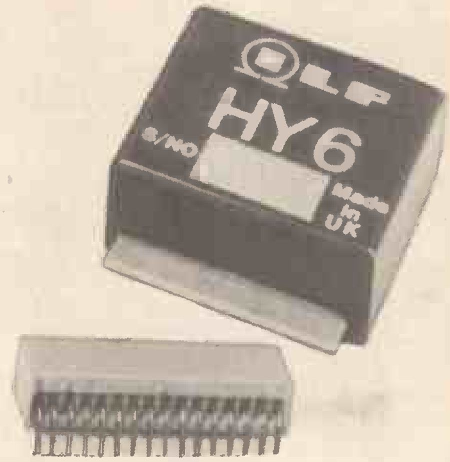
ILP

AVAILABLE ALSO FROM WATFORD ELECTRONICS, MARSHALLS AND CERTAIN OTHER SELECTED STOCKISTS.

this time with two new pre-amps



SCHEMATIC BLOCK DIAGRAM OF HY6 PRE-AMP, WITH STEREO CONNECTION SHOWN



HY6 *mono* HY6–6 *stereo*

When ILP add a new design to their audio-module range, there have to be very special reasons for doing so. You expect even better results. We have achieved this with two new pre-amplifiers – HY6 for mono operation, HY6-6 for stereo. We have simplified connections, and improved performance figures all round. Our new pre-amps are short-circuit and polarity protected; mounting boards are available to simplify construction.

Sizes – HY6 – 45 x 20 x 40 mm HY6-6 90 x 20 x 40 mm. Active Tone Control circuits provide ± 12dB cut and boost. Inputs Sensitivity – Mag PU – 3mV· Mic – selectable 1-12mV All others 100mV: Tape O/P – 100mV· Main O/P – 500mV: Frequency response – D.C to 100KHz – 3dB.

HY6 mono
£5.60
+ VAT 84p

HY6-6 stereo
£10.60
+ VAT £1.59

Connectors included

B6 Mounting Board
78p + 12p VAT

B6-6 Mounting Board
99p + 15p VAT

- LOW DISTORTION - Typically 0.005%
- S/N RATIO - Typically 90 dB (Mag. P.U. - 68 dB).
- HIGH OVERLOAD FACTOR - 38 dB on Mag. P.U.
- LATEST DESIGN HIGH QUALITY CONNECTORS.
- REQUIRE ONLY POTS, SWITCHES, PLUGS AND SOCKETS.
- COMPATIBLE WITH ALL ILP POWER AMPS AND PSUs.
- NEEDS ONLY UNREGULATED POWER SUPPLY ±15V to ±50V.

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Monitor

WORZEL PROTECTION

If we'd expected any printable responses we'd have used this photo in a caption contest. The truth is the machine at the bottom left is a radio-controlled trolley which whisks Barbara Windsor through Southern Television's 'Worzel Gummidge' series. The photo is from Chromatronics of Harlow who protected Barbara from the effects of interference on the control channel.

REVOLUTIONARY METER

How about this portable digital tachometer, designed to work in areas of high ambient light? Made by Power Instruments Inc of the USA this instrument, designated 1893, costs around £165 from the UK importers. It will measure RPM instantly at between ¼" to 30" distance from a rotating object, using a beam of reflected light. To make the measurement a small piece of reflective tape is attached to the object and the beam from the tachometer is pointed at the tape.

Accuracy is assured by the internal quartz controlled oscillator, typically this will be ±1 RPM over the range 10-100000 RPM.

It comes complete with carrying case, marking tape, disc set and two feet of reflective tape. For more information contact: Electronic Brokers, 49/53 Pancras Road, London NW1 2QB.

NOISE ANNOYS

This nifty, state-of-the-art little gadget looks set to help a lot of people lead quieter lives. It is the PMP-20 audio frequency test meter. It will measure very high levels of noise (−50 to 30dB) over the frequency range of 30Hz to 20 kHz. As you can see this instrument is fully portable and runs from it's own internal batteries. The LCD display flashes about two hours before the batteries are exhausted, if the voltage drops any further the meter switches off to avoid giving false readings. More information is available from Wandel & Golterman (UK) Ltd, 40-48 High Street, Acton, London W3.

HOBBYPRINTS

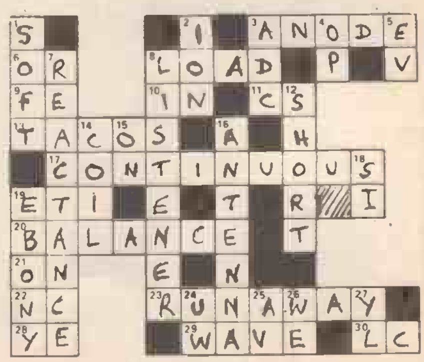
Since we're sure you've all rushed out to buy the Project Special, here are some things you should know about the Hobbyprints advert in it. Firstly, the listing is incomplete; Sheet 103 also has the Graphic Equaliser, and Sheet 105 also has the Photographic Timer. Second, if you want to build the Hobbytune, you'll also need Hobbyprint L (small), because that's where the keyboard and tuning board are.

As we are changing manufacturers, there will be some delay in the production of Hobbyprints S, T and U.

HEATH CONTEST RESULT

Despite a few problems with the presentation of this contest we had a fabulous response, with approximately 500 correct entries. The contest was a little more difficult than we had planned due to a couple of non-essential clues going astray following production problems on the May issue. Some people were also concerned about the indeterminate status of the square down-one-and-one-to-the-left of square 18. This should be blacked-in or left blank. Still, it was a fair contest, everyone started with the same information.

The winning entry was drawn on Friday, May 16th, and the prize goes to Mr. T. N. Backler of Capel St Mary, Ipswich. He receives a Heathkit 1M-2215 hand held LCD multimeter kit, courtesy of Heath Electronics (U.K.) Ltd.



The correct Solution to our Crossword.

VIDEO VILLAINS

Two new cartridges for the Atari Video Computer this month. The first is entitled 'Superman' and jolly good fun it is too. The game is essentially for one player and involves what Atari aptly describe as an adventure. You, the player controls Superman. The game begins by Clark Kent walking the streets of Metropolis, suddenly a bridge blows up, Clark Kent has to find his way to a telephone kiosk to change into Superman. From then on you have a number of tasks to complete, Lex Luthor and his five henchmen must be rounded up, the bridge re-built and the deadly Kryptonite missiles must be avoided. If Superman comes into contact with this rather nasty (and noisy) stuff he must seek out Lois Lane to regain his powers. What makes this game unusual is the field of play, rather than restrict the characters to one screen area, you have the whole of the city of Metropolis to play in. You can move a block at a time by traversing the screen in any direction whereupon a new block appears. You can also travel around the city via the subway system. The game is played without a preset time limit but with a clock display in the screen area. So far the best time to complete all the tasks and return (as Clark Kent) to the Daily Planet Building is two minutes 52 seconds. That sounds quite impressive, and it is but the first time it was switched on our ace Superman player took more than two hours to complete the game. This game is a real challenge and we defy anyone to get bored with it or beat 2 minutes 52 seconds.

Game number two is the long awaited version of Space Invaders. This cartridge has an amazing 112 variations on the Space Invaders theme ranging from a simple two player set-up to a really nasty game involving invisible monsters. As usual both these cartridges are available from that well known purveyor of games NIC in Tottenham. Superman costs £23.95, Space Invaders £29.95.

WATFORD ELECTRONICS

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POLYESTER CAPACITORS: Axial lead type.
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n **9p**; 18n **10p**; 22n, 33n **11p**; 47n, 68n **14p**; 100n **17p**; 150n, 220n **24p**; 330n, 470n **41p**; 680n **62p**; 1μF **64p**; 2μ2 **82p**; 4μ7 **85p**.
160V: 39μF, 100n, 150n, 220n **11p**; 330n, 470n **19p**; 680n, 1μF **22p**; 1μ5, 2μ2 **32p**; 4μ7F **36p**.
1000V: 10nF, 15n **20p**; 22n **22p**; 47n **26p**; 100n **38p**; 470n **53p**; 1μF **175p**.

POLYESTER RADIAL LEAD CAPACITORS: 250V:
10n, 15n, 22n, 27n **5p**; 33n, 47n, 68n, 100n **7p**; 150n **10p**; 220n, 330n **13p**; 470n **17p**; 680n **19p**; 1μF **22p**; 1μ5 **30p**; 2μ2 **34p**; 4μ7 **60p**.

FEED THROUGH CAPACITORS
1000pF 350V **8p**

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in μF). **500V:** 10 **50p**; 47 **78p**; **250V:** 100 **65p**; **63V:** 0.47, 1.0, 1.5, 2.2, 2.6, 3.3, 4.7, 6.8, 8, 10, **8p**; 15, 22, 47, 32, 50 **12p**; 63, 100, **27p**; **50V:** 50, 100, 220, **25p**; 470, **32p** 1000, **60p**; **40V:** 22, 33, **10p**; 100, **12p**; 2200, 3300, **85p**; 4700, **98p**; **35V:** 33, **10p**; 330, 470, **32p**; 1000, **49p**; **25V:** 10, 22, 47, 80, 100, **8p**; 160, 220, 250, **15p**; 470, **25p**; 640, 1000, **35p**; 1500, **40p**; 2200, **45p**; 3300, **77p**; 4700 **85p**; **16V:** 10, 47, 68, **7p**; 100, 125, **8p**; 220, 330, **14p**; 470, **20p**; 1000, 1500, **30p**; 2200, **36p**.
TAG-END TYPE: 450V: 100μF **180p**; **70V:** 4700, **165p**; **64V:** 3300 **98p**; 2500 **90p**; **50V:** 3300 **135p**; 2200 **99p**; **40V:** 15000 **399p**; 4700 **130p**; 4000 **92p**; 3300 **93p**; 2500 **85p**; 2200 **85p**; 2000+2000 **120p**; **30V:** 4700 **110p**; **25V:** 15,000 **195p**; 6400 **120p**; 4700 **100p**; 3300 **85p**; 2200 **60p**.

TANTALUM BEAD CAPACITORS
35V: 0.1μ; 0.22; 0.33; 0.47; 0.68, 1.0μ; 2.2μ; 3.3μ; 4.7; **25V:** 10; **20V:** 6μ8; **16V:** 2μ2; 4μ7; 10. **15p. 16V:** 22μ; 25p; 47; 100 **50p**; 220 **80p**. **10V:** 15μ, 22μ, 33, **24p**; 100 **35p**; **6V:** 47μ; 68; 100 **28p**; **3V:** 100 **20p**.

MYLAR FILM CAPACITORS
100V: 0·001, 0·002, 0·005, 0·01μF **6p**
0·015, 0·02, 0·04, 0·05, 0·056μF **7p**
0·1μF, 0.2 **9p**. **50V:** 0.47μF **12p**

MINIATURE TYPE TRIMMERS
2.5-6pF; 3-10pF; 10-40pF **28p**
5-25pF; 5-45pF; 60pF; 88pF **35p**

COMPRESSION TRIMMERS
3-40pF; 10-80pF; 25-190pF **33p**
100-500pF **45p** 1250pF **58p**

POLYSTYRENE CAPACITORS:
10pF to 1nF **8p**; 1.5nF to 10nF **10p**

SILVER MICA (Values in pF) 3·3, 4·7, 6·8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 180 **11p** each; 220, 250, 270, 300, 330, 360, 390, 600, 820 **16p** each; 1000, 1200, 1800, 2200 **26p** each.

CERAMIC CAPACITORS 50V: 0·5pF to 10nF **4p**; 22n to 47n **6p**. 100n. **7p**.

EURO BREADBOARD £5.20.

POTENTIOMETERS: Rotary, Carbon, Track. 0.25W Log & 0.5W Lin.
500Ω, 1KΩ & 2KΩ (Linear only) Single Gang **29p**
5KΩ-2MΩ Single Gang **29p**
5KΩ-2MΩ Single Gang D/P Switch **65p**
5KΩ-2MΩ Double Gang **88p**

SLIDER POTENTIOMETERS
0-25W log and linear values 60mm
5KΩ-500KΩ single gang **70p**
10KΩ-500KΩ dual gang **80p**
Self Stick Graduated Bews **30p**

PRESET POTENTIOMETERS
Vertical & Horizontal
0.1W 50Ω—5MΩ Miniature **7p**
0·25W 100Ω—3.3MΩ horiz. **10p**
0·25W 200Ω—4.7MΩ vert. **10p**

RESISTORS — Carbon Film, High Stability, Low Noise. Miniature Tolerance 5%.

RANGE		VAL	1-99	100+
¼W	2Ω2—4M7	E24	2p	1p
½W	2Ω2—4M7	E12	2p	1p
1W	2Ω2—10M	E12	5p	4p
2%Metal Film 10Ω-1M			6p	4p
1%Metal Film 51Ω-1M			8p	6p

100+ price applies to Resistors of each value not mixed.

S-Dec **350p** T-Dec **400p**
U-Dec 'A' **465p** U-Dec 'B' **699p**

OPTO ELECTRONICS
LEDs plus clips
TIL209 Red **13**
TIL211 Grn. **17**
TIL212 Yel. **18**
.2" Red **15**
.2" Yel. Grn. **18**
Square LEDs **30**
ORP12 **63**
2N5777 **45**
LD271 **40**
SFH205 **98**
TIL32 **58**
TIL78 **70**
7 Segment Displays
TIL321 C.A .5" **115**
TIL322 C C .5" **115**
DL704 C Cth .3" **99**
DL707 C.A. .3" **99**
.3" Green CA **150**
DL747 C.A. .6" **180**
FND357 **120**
MAN3640 **175**
10 Seg CA **150**
LCD 3½ Digit **875**

SWITCHES
NEC, Blackbody, Red, Grn, Blue, Yel.
SRL Latching **125p**
SRM Momentary **125p**

SUB-MIN TOGGLE
SP changeover **59p**
SPST on/off **54p**
DPDT 6 tags **70p**
DPDT c/of **79p**
DPDT Biased **115p**

SLIDE 250V:
1A DPDT **14p**
1A DP c/off **15p**
½A OPDT **13p**
4 pole c/over **24p**

PUSH BUTTON
Spring loaded
SPST on/off **65p**
SPDT c/over **75p**
DPDT 6 Tag **90p**

VOLTAGE REGULATORS

1A	TO3	+ ve		—ve	
5V	7805	145p		7905	220p
12V	7812	145p		7912	220p
15V	7815	145p			—
18V	7818	145p			—
1A	**TO220**	Plastic Casing			
5V	7805	60p		7905	65p
12V	7812	60p		7912	65p
15V	7815	60p		7915	65p
18V	7818	60p		7918	65p
24V	7824	60p		7924	65p
100mA	**TO92** Plastic Casing				
5V	78L05	30p		79L05	65p
6V	78L62	30p			—
8V	78L82	30p			—
12V	78L12	30p		79L12	65p
15V	78L15	30p		79L15	65p

CA3085	95p	LM323K	625p	TAA550	50p
LM300H	170p	LM325N	240p	TBA625B	95p
LM305H	140p	LM326N	240p	TDA1412	150p
LM309K	135p	LM327	270p	78HO5	595p
LM317K	350p	LM723	39p	78HG5	650p

We stock parts for most of the projects in this magazine.

ACCESS
Just phone your order through. We deal with the rest (min. £10 please).

SWITCHES Miniature Non-Locking
Push to Make **15p** Push Break **25p**
ROCKER: SPST on/off 10A/250V **30p**
ROCKER: Illuminated (white) Chrome bezel Lights when on: 3A 240V **80p**
ROTARY: (ADJUSTABLE STOP) 1 pole/2-12 way, 2p/2-6 way, 3p/2-4 way, 4p/2-3 way **43p**
ROTARY: Mains 250V AC. 4 Amp **50p**

DIL SOCKETS (Low Profile — Texas) 8 pin **10p**; 14 pin **12p**; 16 pin **13p**; 18 pin **16p**; 20 pin **22p**; 24 pin **36p**; 28 pin **39p**; 40 pin **50p**.

JACKSONS VARIABLE CAPACITORS

Dielectric		0 2 365pF with slow motion Drive	450p
100/300pF	205p	00 208/176	350p
500pF	250p	00 208/176 with slow motion drive	410p
6:1 Ball Drive 4511/DAF	145p	C804-5pF: 10: 15: 25: 50pF	150p
Dial Drive 4103 6.1/36:1	775p	100, 150pF	335p
Drum 54mm	59p	'L' 3x310pF	725p
0-1.365pF	325p	00.3x25pF	550p
00 2.365pF	395p		

DENCO COILS

'DP' VALVE TYPE		RFC 5 chokes	99p
Range 1 to 5 Bl., Rd., Tl., Wht.	92p	RFC 7 (19mH)	120p
6-7 BYR	85p	13: 14: 15: 16: 17	110p
1.5 Green	105p	18/1.6	104p
'T' type 1 to 5, Bl. Rd. Wht. Yl	105p	18/465	114p
B9A Valve Holder	29p	TOC 1	110p
		MW5FR	112p
RDT2	108p	MW/LW SFR	120p

VEROBOARD 0 1 0.15 0.15 (copper clad) (plain)

	0 1	0.15	0.15 (plain)
2½ x 3¼"	58p	51p	30p
2½ x 5"	68p	62p	35p
3¾ x 3¾"	68p	—	—
3¾ x.5"	77p	86p	65p
2½ x 17"	215p	185p	125p
3¾ x 17"	264p	229p	155p
4¾ x 17"	345p	—	245p

Pkt of 36pins **22p** 'DIP' Board **290p**
Spot face cutter **105p** 'VQ' Board **129p**
Pin insertion tool **140p** Veroblock **324p**

DIODES

AA119	25
AA129	20
BA100	10
BY126	12
BY127	12
CR033	157
OA9	50
OA47	12
OA70	12
OA79	15
OA81	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	9
OA202	9
IN914	4
IN916	6
IN4001/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IS44	20
3A/100V	18
3A/400V	20
3A/600V	26
3A/1000V	30

We stock a wide selection of Electronic Books and Magazines

ZENERS
Range: 2V7 to 39V 400mW **8p each**
Range: 3V3 to 33V. 1.3W **15p each**

NOISE
Z5J **180p**

BRIDGE RECTIFIERS

(plastic case)	p
1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	50

DIAC
ST2 **25**

SCRs Thyristors

0.6A/200V	30
0.8A100V	30
0.8A200A	35
1A100V	42
1A200V	47
1A600V	70
5A300V	35
5A600V	43
8A300V	48
8A500V	58
8A600V	65
12A300V	59
12A500V	92
15A700V	195
2N4444	140
BT106	150
C106D	38
TIC44	25
TIC45	45

TRIACS

3A100V	48
3A200V	49
3A400V	50
8A100V	54
8A400V	64
8A800DV	108
12A100V	60
12A400V	70
12A800V	130
16A100V	95
16A500V	150
25A800V	295
25A100DOV	480
T28000D	120

TTL 74

7400	11	74125	45	74LS74	40	4021	105
7401	12	74126	55	74LS75	48	4022	95
7402	12	74128	74	74LS76	45	4023	25
7403	14	74132	70	74LS83	105	4024	76
7404	14	74136	65	74LS85	105	4025	25
7405	18	74141	85	74LS86	45	4026	180
7406	48	74142	195	74LS90	50	4027	48
7407	48	74143	350	74LS92	75	4028	82
7408	22	74145	90	74LS93	75	4029	105
7409	22	74147	180	74LS95	115	4030	60
7410	19	74148	145	74LS96	180	4031	225
7411	25	74150	150	74LS107	45	4032	128
7412	20	74151	75	74LS109	75	4033	175
7413	33	74153	75	74LS112	80	4034	210
7414	62	74154	140	74LS113	65	4035	125
7416	31	74156	80	74LS114	48	4036	365
7417	31	74157	75	74LS122	70	4037	115
7420	19	74159	185	74LS123	95	4038	118
7421	38	74160	99	74LS124	180	4039	360
7422	26	74161	99	74LS125	60	4040	105
7423	32	74162	99	74LS126	60	4041	80
7425	30	74163	99	74LS132	95	4042	80
7426	44	74164	120	74LS136	55	4043	95
7427	35	74165	120	74LS138	70	4044	95
7428	35	74166	155	74LS139	90	4045	175
7430	20	74167	240	74LS145	120	4046	130
7432	28	74170	230	74LS147	210	4047	98
7433	38	74172	420	74LS148	175	4048	65
7437	35	74173	120	74LS151	96	4049	45
7438	30	74174	105	74LS153	85	4050	48
7440	20	74175	82	74LS155	96	4051	80
7441	74	74176	90	74LS156	96	4052	80
7442	71	74177	90	74LS157	76	4053	80
7443	120	74178	149	74LS158	85	4054	130
7444	116	74180	90	74LS160	120	4055	135
7445	116	74181	290	74LS161	98	4056	135
7446	132	74182	88	74LS162	110	4057	1900
7447	99	74184	145	74LS163	100	4059	575
7448	99	74185	145	74LS164	164	4060	130
7450	20	74188	299	74LS165	165	4061	1225
7451	20	74190	135	74LS166	166	4062	995
7453	20	74191	135	74LS173	105	4063	120
7454	20	74192	135	74LS174	147	4066	58
7460	20	74193	135	74LS175	110	4067	430
7470	41	74194	105	74LS181	295	4068	26
7472	31	74195	198	74LS190	120	4069	26
7473	40	74196	130	74LS191	120	4070	30
7474	34	74197	90	74LS192	125	4071	25
7475	56	74198	195	74LS193	125	4072	25
7476	41	74221	140	74LS195	125	4073	25
7480	55	74246	195	74LS196	120	4075	25
7481	120	74247	195	74LS197	120	4076	99
7482	75	74248	195	74LS221	120	4077	48
7483	94			74LS240	225	4078	30
7484	113			74LS241	225	4081	88
7485	121			74LS242	232	4082	28
7486	33			74LS243	232	4085	90
7489	215			74LS244	225	4086	90
7490	57			74LS245	270	4089	150
7491	88			74LS247	135	4093	89
7492	59			74LS248	135	4094	240
7493	59			74LS249	135	4095	105
7494	95			74LS251	130	4096	105
7495	75					4097	350
7496	95					4098	115
7497	180					4099	190
74100	130					4160	125
74104	62					4161	125
74105	62					4162	125
74107	36					4163	125
74109	60					4174	130
74110	54					4175	120
74111	68					4194	125
74112	150					4408	790
74116	198					4409	790
74118	99					4410	790
74119	125					4411	1020
74120	105					4412F	1520
74121	42					4412V	1520
74122	55					4415F	850
74123	95					4415V	850
						4419	320
						4422	570

74LS

74LS00	13	74LS30	24
74LS01	13	74LS32	30
74LS02	15	74LS42	80
74LS03	15	74LS47	85
74LS04	20	74LS48	120
74LS05	23	74LS55	70
74LS08	23	74LS63	150
74LS09	23	74LS73	40
74LS10	20		
74LS11	32		
74LS12	32		
74LS13	40		
74LS14	75		
74LS15	40		
74LS20	21		
74LS21	32		
74LS22	40		
74LS26	48		
74LS27	45		
74LS28	48		

CMOS★

4000	18
4001	18
4002	24
4006	92
4007	22
4008	82
4009	40
4010	48
4011	24
4012	24
4013	45
4014	85
4015	85
4016	42
4017	82
4018	88
4019	48
4020	99

4432	1050	LM380	80
4435	1050	LM381	145
4440	999	LM382	125
4450	350	LM386	99
4451	350	LM387	150
4452	—	LM1458	40
4490F	750	LM3900	60
4490V	750	LM3909N	70
4501	28	LM3911	125
4502	125	LM3914	240
4503	75	M252	625
4506	75	M253AA	1150
4507	60	MC1304P	260
4508	325	MC1310	149
4510	99	MC1312P	195
4511	150	MC1458	45
		MC1488	85
		MC1489	90

LINEAR ICs

2102-2	225	MC1495	350
2114	299	MC1496	92
2708	495	MC1710	79
4116	395	MC3340P	120
6502	995	MC3360P	120
6800	800	MC3401	62
709C 8 pin	35	MC3403	135
710	67	MFC6040	97
733	125	MK50398	635
741C 8 pin	17	MM5303	635
747C	78	MM5307	1275
748C	36	NE518	210
753	150	NE543	210
810	159	NE544	185
81LS95	130	NE555	22
881LS96	130	NE556	55
81LS97	140	NE560	325
AY-1-0212	595	NE561	395
AY-1-1313A	660	NE562	410
AY-1-1320	315	NE564	425
AY-1-5050	190	NE565	120
AY-1-5051	160	NE566	160
AY-1-6721/6	210	NE567	170
AY-3-8500	390	NE571	420
AY-3-8910	850	RC4136	10
AY-5-1224A	235	S556B	225
AY-5-1230	450	SAB3209	425
CA3011	110	SAB3210	250
CA3018	68	SN76003	240
CA3020	186	SN76013	140
CA3023	191	SN76023	140
CA3028A	80	SN76033	195
CA3035	235	SN76477	175
CA3043	275	TAA621	250
CA3046	71	TBA120	70
CA3048	214	TBA641	250
CA3059	175	TCA965	120
CA3080E	65	TDA1008	310
CA3081	190	TDA1022	675
CA3085	85	TDA1024	105
CA3089E	215	TDA2020	320
CA3090AQ	375	TL061	54
CA3123E	150	TL071CP	45
CA3130	85	TL074	140
CA3140	48	TL081	42
ICL7106E	795	TL082	70
ICL7107	975	TL083	95
ICL8038CC	340	TL084	120
ICM7205	1159	UAA170	150
ICM7216A	1950	UAA180	150
ICM7217A	790	Z80	990
ICM7555	89	Z8014	1099
LD130	452	Z80CTC	595
LF356	90	Z80P10	660
LM10	395	ZN1034E	200
LM300HX	170	ZN1040E	685
LM301A	23	ZN414	80
LM308	70	ZN424E	130
LM318	205	ZN425E	415
LM324	45		
LM339	70		
LM348	90		
LM349	125		
LM379	375		

TRANSISTORS

AC125	35	BC183	10	BF244	24	OC42	48	ZTX502	17	2N3771	179				
AC126	25	BC183L	10	BF256	45	OC44	55	ZTX503	15	2N3772	195				
AC127	22	BC184	10	BF257	30	OC45	30	ZTX504	25	2N3773	283				
AC128	20	BC184L	10	BF258	28	OC70	28	ZTX531	25	2N3819	20				
AC141	27	BC187	22	BF259	28	OC71	28	ZTX550	25	2N3820	45				
AC142	28	BC212	9	BF594	30	OC72	25	2N526	58	2N3822	130				
AC176	25	BC212L	9	BF595	28	OC76	36	2N696	36	2N3823	70				
AC187	26	BC213	9	BFR39	25	OC77	76	2N697	25	2N3866	90				
AC188	24	BC213L	9	BFR40	28	OC81	35	2N698	40	2N3903	20				
ACY17	60	BC214	10	BFR41	24	OC82	50	2N699	30	2N3904	18				
ACY18	60	BC214L	10	BFR79	24	OC83	48	2N706	19	2N3905	18				
ACY20	53	BC307B	12	BFR80	24	OC84	45	2N708	19	2N3906	17				
ACY21	35	BC328	12	BFR81	24	OC140	110	2N918	33	2N4037	52				
ACY22	60	BC338	12	BFX29	28	OC170	85	2N930	18	2N4058	17				
AD140	70	BC441	27	BFX81	45	OC171	45	2N961	61	2N4061	17				
AD149	75	BC461	27	BFX84	26	TIP29	31	2N1131	22	2N4062	15				
AD161	42	BC477	35	BFX85	28	TIP29C	60	2N1132	24	2N4069	12				
AD162	42	BC516	40	BFX86	28	TIP30	32	2N1302	35	2N4859	65				
AF114	60	BC517	40	BFX87	28	TIP30C	43	2N1304	50	2N4871	50				
AF115	60	BC547	10	BFX88	28	TIP31A	38	2N1305	35	2N5135	42				
AF139	40	BC548	7	BFY50	21	TIP31C	40	2N1671B	120	2N5136	42				
AF178	70	BC549	10	BFY51	21	TIP32A	40	2N2160	350	2N5138	20				
AF180	70	BC557	15	BFY52	20	TIP32C	54	2N2219A	22	2N5172	13				
AF186	50	BC558	10	BFY71	20	TIP33A	54	2N2220A	23	2N5179	60				
AF239	42	BC559	10	BRY39	39	TIP33C	70	2N2222	20	2N5180	80				
BC107	10	BCY70	14	BSX20	20	TIP34A	63	N2369	15	2N5191	70				
BC108	10	BCY71	14	BSY65	30	TIP34C	75	2N2476	125	2N5305	40				
BC108B	11	BCY72	16	BSY95A	18	TIP35A	135	2N2484	25	2N5457	32				
BC108C	12	BD131	42	BU105	115	TIP35C	105	2N5172	13	2N5458	32				
BC109	10	BD132	42	BU205	125	TIP36A	145	2N2497	22	2N5459	32				
BC109B	12	BD133	50	BU208	215	TIP36C	255	2N2646	48	2N5485	35				
BC109C	12	BD135	30	E113	38	TIP41A	105	2N2894	30	2N5777	45				
BC117	20	BD136	30	E176	55	TIP41B	185	2N2904	24	2N6027	40				
BC119	23	BD137	35	E421	158	TIP42A	50	2N2905A	22	3N128	112				
BC137	20	BD138	35	MJ2955	90	TIP42B	55	2N2908	22	3N140	112				
BC140	28	BD139	30	MJE340	54	TIP120	72	2N2907	22	40311	60				
BC143	26	BD140	30	MJE37D	58	TIP121	90	2N2926G	10	40313	125				
BC147	69	BD145	175	MJE371	54	TIP142	125	2N3053	19	40316	86				
BC148	8	BD695A	85	MJE520	65	TIP147	145	2N3054	55	40317	52				
BC149	10	BD696A	85	MJE521	74	TIP2955	72	2N3055	48	40324	85				
BC153	20	BDY17	195	MJE2955	99	TIP3055	65	2N3121	40	40326	52				
BC154	13	BDY60	110	MJE3055	70	TIS43	60	2N3133	43	40327	62				
BC157	10	BDY61	165	MPF102	66	TIS44	25	2N3136	33	40348	105				
BC158	10	BF115	26	MPF103	38	TIS90	20	2N3250	30	40360	43				
BC159	11	BF167	30	MPF104	36	TIS91	24	2N3442	40	40361	45				
BC160	28	BF173	25	MPF105	40	ZTX107	11	2N3568	20	40362	42				
BC167A	11	BF177	24	MPF106	40	ZTX108	11	2N3663	14	40407	52				
BC168C	11	BF178	25	MPSA05	15	ZTX109	11	2N3702	10	40408	68				
BC169C	11	BF179	30	MPSA06	16	ZTX300	13	2N3703	10	40411	280				
BC170	15	BF180	39	MPSA12	22	ZTX301	15	2N3704	10	40412	65				
BC171	11	BF194	11	MPSA55	22	ZTX302	20	2N3705	10	40467	95				
BC172	11	BF195	11	MPSA56	22	ZTX303	25	2N3706	10	40468	60				
BC177	15	BF196	12	MPSU06	56	ZTX304	17	2N3707	10	40576	190				
BC178	14	BF197	12	MPSU56	60	ZTX314	24	2N3708	11	40594	95				
BC179	15	BF198	16	OC28	120	ZTX326	45	2N3709	11	40595	98				
BC182	10	BF200	29	OC35	125	ZTX341	20	2N3710	10	40603	90				
BC182L	10	BF224A	18	OC36	130	ZTX500	15	2N3711	10	40636	130				
				OC41	125	ZTX501	15	2N3713	215	40673	68				

News from the Electronics World

SUITE YOURSELF

We could say that this is the new lightweight, all purpose anti-fallout sunbathing suit but we won't. Instead we'll tell you all, how, for just £400 you can enroll on the Underwater NDT Technicians Course at Fort Bovisand. NDT stands for Non-Destructive Techniques, presumably that means you won't be blowing things up, anyway it all sounds like good fun. At the end of the course, if you're still with it and have passed the exams you will qualify for the new CSWIP certificate that means you can go and do non-destructive things underwater. Contact The Plymouth Ocean Projects Limited, Fort Bovisand, Plymstock, Nr Plymouth in Devon for details.

TECHNICAL QUERIES

We have decided to streamline our postal technical query service. In future all known errors and alterations will be filed on Data Cards, one per article or project. Whenever possible, queries will be answered by sending out a photocopy of the relevant card(s). Please bear the following points in mind:

a) We can't help you if you just say "It doesn't work". Try to isolate which section of the circuit is giving you problems. Our article on Project Fault Finding in December '79 HE gives useful hints on this.

b) Try to be concise. We can give you a better service if we don't have to play 'Spot the Query' with a six page letter.

c) Our engineers have good reasons to use the components they do — so don't change them to unspecified types. Similarly we cannot answer queries about modifications you have made to our projects.

d) We cannot answer enquiries on articles, etc, not from our magazines, and we cannot undertake design work of any sort for individuals.

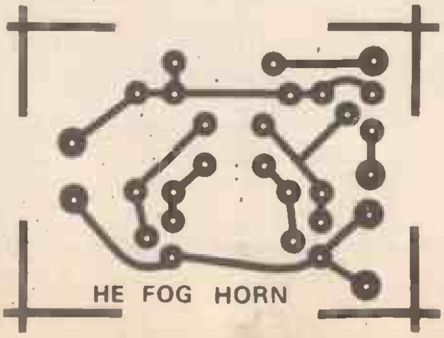
e) Please don't ask questions that can be answered by reading adverts in the magazine.

f) Please enclose a stamped self-addressed envelope (preferably foolscap) or International Reply Coupons and write the name of the project or article on the back (e.g. "Electronic Ignition, April '80 HE"). Any enquiries without an sae will not get a personal replay.

NEW BUTTON BOX

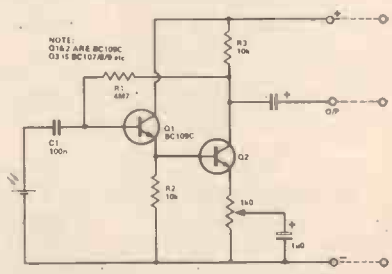
Over the past few months there seems to have been a distinct lack of new calculators. We can remember back to last year when it seemed that Casio sent us news of at least five new calculators a month. Ah well, times have changed, the calculator market has been completely swamped (to say the least) and there really isn't too many more functions that can be crammed onto an IC. (Remember the days when it was actually considered to be really with it just because your calculator has a 'Constant' button. These days you couldn't hold your head up in decent company if you didn't have at least 200 scientific functions, bubble memory, alphanumeric display and thirty year battery life with solar powered back up systems for the nuclear pile).

It was therefore most intriguing to receive news of this inncodent looking little calculator from Commodore. Did it have an in-built minature VDU, would the memory have the capacity to store all human knowledge in a chip the size of a pin head? Actually no, it is just a simple, honest to goodness calc called the LC4512. Nothing really remarkable, the 8+2 digit display will show you the results of all the in-built scientific functions and will cost around £15. Not startling really but then sometimes it does us good to appreciate just how much technology we have all come to take for granted in the last few years. Bring back the mechanical adding machine!



NBTV

We received a letter from Doug Pitt the other day. He is the chairman of the Narrow Bandwidth TV Association, apparantly he has received rather a lot of letters concerning the feature he wrote for us a couple of months ago. It seems that some of you noticed that Fig 11 in part two had some of the values missing. Poor Mr Pitt was actually blameless, it was all our fault, so by way of an apology we have the diagram printed below, this time with the missing values in their proper places.



SILICON SOCCER

No, this hasn't got anything whatsoever to do with TV games, it concerns Leicester City Football Club using a microcomputer system to sort out all their ticketing problems.

The big bonus, as far as using a computer is concerned, will be the easing of paperwork for advance bookings and season tickets.

They aquired the computer for a £20 000 transfer fee from Geest Computer Services. This has one program that the fans will never see.

CAPTION COMPETITION

Cease, desist, send us no more. The caption competition in the April Issue was meant to be a joke. You should have realised by the closing date (April 1st). Well, so many of you took the trouble to write in that we'll have to dish out a few prizes so we are sending the best five a Tee Shirt each. They are: Richard Small in Nottingham, M. Casey in Hendon, 'Micro Man,' Berkshire, D. Green in Arundel and Campbell McKay, BFPO 10.

We won't be printing any of the entries because they are all disgusting (but funny!).

ERRATA

It has come to our notice that someone switched the PCB foil pattern for the Fog Horn project last month (P65) for another Egg Timer PCB. The correct PCB is published left. If we ever catch those responsible you may be assured that the noises they will be making will be considerably louder than any Fog Horn!

You may have noticed the odd numbering of the diagrams in Hobby Chit-Chat last month. To correct this, add one to each reference in the text after Fig. 3, i.e. Fig. 4 becomes Fig. 5 and so on.

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F-80. As above but with black resin case/strap with S/S back and front trim.

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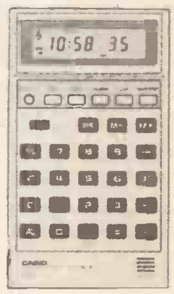
LADIES' CASIO 10 models from **£12.95**

NEW 11-NOTE MELODY MAKER

CASIO ML-82



Clock, calendar, musical alarm, hourly chimes, 1/10 second stopwatch to 24 hours; net, lap and 1st & 2nd place. Calculator with musical keys, full memory, %, square roots. 9/32 x 2½ x 4¾ inches. ONE YEAR BATTERIES (RRP £22.95)

£19.95

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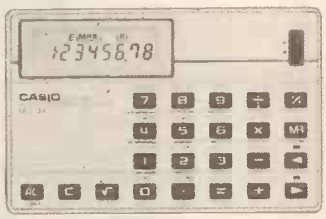
CASIO MC-34 CARD



34 conversion functions, 17 metric, 17 reversible. Distances, weights; areas, volumes and temperatures. Calculator with GT memory, %, square roots, 1,100 hours batteries. 5/32 x 3¼ x 2⅛ ins.

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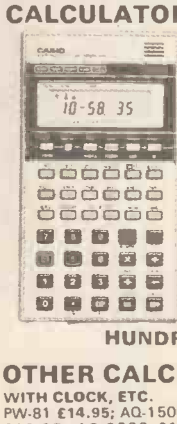

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Hours, minutes, seconds, am/pm, day. Calendar pre-programmed to year 1999. 24-hour alarm. Alarm timer, interval timer, or 1/100 second stopwatch; net, lap, 1st and 2nd, place. Fractions, %, cube roots, 5 levels parentheses, hyperbolics, standard deviations, co-ordinates, conversions. X to Y, X to M. ¼x2¾x5⅛" (RRP £27.95)

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SEIKO

PRICES SLASHED!

TSI Alarm Chronograph

With countdown alarm. Hours, minutes, seconds, alpha day and date on upper display; and day, date, month, alarm and hourly chimes. Countdown alarm (upper display). Stopwatch from 1/100 sec to 12 hours; net, lap, and 1st and 2nd place times. Stainless steel. Glass.

Only £44.95

TS7 Alarm Chronograph

100M Water Resistant. Suitable for swimming, water skiing etc. Hours, minutes, seconds, day, date and month. Programmable weekly alarm. Interval alarm timer up to 16 hours. Hourly chimes. Stopwatch, 1/100 second to 20 minutes, then seconds to 12 hours. Upper display — lap times. Lower display — Total time.

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Two Alarms, local and world time (dual tones). Hourly chimes. Normally displays hours, minutes, seconds, day; or optionally hours, minutes, day, date, month. World time mode displays an atlas with each of the 19 time zones highlighted when selected. Date and summer time functions.

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TS2 Alarm Chronograph

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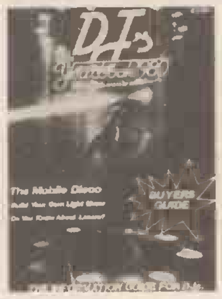
ELECTRONICS DIGEST: SUMMER '80

Electronics Digest is a new quarterly from the Modmags Specials Department. The Summer 1980 issue reprints the best of Tech Tips from the last couple of years of ETI, and is, in fact, the third volume in the ETI Circuits series. Circuits are classified by type for easy access by the designer who needs inspiration.

£1.50 +30p (p&p)

DJ's YEARBOOK 1980

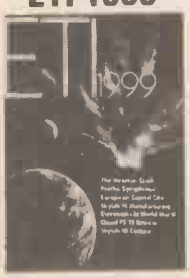


How to make your own light show (two versions), how to manage the business side, how to operate, how to build a mixer-amplifier. About the Disc Jockey's Federation, about insurance, about publicity. The most comprehensive-yet-published Directory of Manufacturers and Suppliers.

And if you're thinking of starting your own mobile disco business, the DJ's yearbook will set you off on the right lines.

£1.50+30p (p&p)

ETI 1999



ETI 1999 is what we think a magazine will look like in 19 years time. Read about Europe's new capital city, the latest development in hifi loudspeakers, what's happening in space, and World War Three. This four-colour magazine comes in a special folder and makes an ideal gift for an SF or electronics enthusiast.

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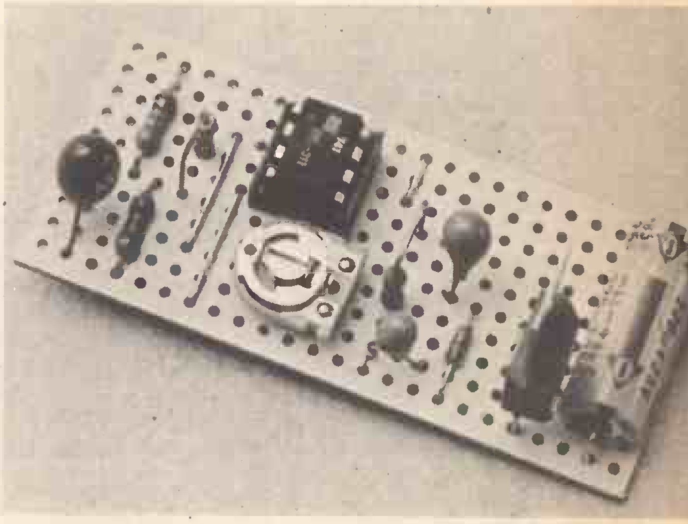
ETI CIRCUITS No 1
ETI CIRCUITS No 2

Each volume contains over 150 circuits, mainly drawn from the best of our Tech-Tips. The circuits are indexed for rapid selection and an addition al section is included which gives transistor specs, and plenty of other useful data. Sales of this publication have been phenomenal — hardly surprising when the circuits cost under 1p each!

£1.50+30p (p&p) each

Sound Operated Flash Trigger

Faster than a speeding bullet (almost), the HE Flash Trigger will produce those out-of-the-ordinary photos.



If the photo on our cover caught your eye, this is the project for you. Though it uses less than twenty components, it offers the photographer an opportunity to instantaneously "freeze" the action and create fascinating photographs using just an ordinary camera and a simple electronic flash gun.

No special optics are required and you should be able to use even the simplest camera with this unit; a "pinhole" camera would do! It is necessary to set up your camera in a darkened room, or conduct your experiments at night, with the shutter open. Most cameras have a "B" or "T" position on their speed selector dials. You may need to use a locking shutter release cable. Don't open the shutter until you are ready to take the picture. If you have a tripod you will find it helpful — otherwise you'll probably need an assistant to hold the camera or direct the action.

The electronic flash gun is positioned for best lighting and the unit can be switched on and connected. A control on the board enables you to adjust the unit's sensitivity to suit your application. Now, whenever the ambient sound exceeds the threshold level the unit will fire the flash gun. Remember that if the unit is set for high sensitivity, the flash gun is likely to go off when someone slams a door upstairs or when a flea jumps into the microphone! Experiment with the sensitivity setting, microphone positioning and lighting angle with a few trial-runs before you open the shutter and expose the film.

This unit will work with any electronic flash gun. Most of them have a flash duration of a thousandth of a second or less so you can "stop" slow motion — though you will not be able to "freeze" an insect's wings. (If you don't believe me, try it . . . . but remember; bees sting!) For certain shots it is useful to be able to vary the delay between the sound-making event and the triggering of the flash. For the bursting balloon shot on our cover, for instance, this delay had to be precisely controlled. The delay is proportional to the distance between the sound source and the microphone (approximately one thousandth of a second per foot).

The circuit as shown has a gain of at least 100. With high output crystal inserts you may find that there is too great a sensitivity. This can be reduced by changing the value of R4 from 100k to 10k or simply by replacing R4 with a piece of wire! When you come to connect the unit to your flash gun remember that thyristors only work "one way round". If it does not work first time, reverse the leads and try again. There may be a high voltage at the trigger terminal of an undischarged flash gun. Try not to discharge it through your finger or you may have a surprise!

CONSTRUCTION

We used veroboard, though any method of construction may be used. A simple circuit like this lends itself to breadboarding. If you do use veroboard then just follow our drawings and check the "Hints For Constructors". Any nine volt battery will power the unit — we used a PP3. Keep the leads to the crystal microphone short or use screened cable (connect the screen to the junction of R1, R2, and C1).

You can try connecting other transducers in place of the crystal microphone. An LDR, for example the ORP12 cadmium-sulphide light dependent resistor, should make the unit sensitive to changes in light intensity. We have not tried it but experience has shown that LDRs usually work best at low light levels — so if you do try, mount the LDR at the end of a cardboard tube or make a light shield with some rolled up paper. Once you have the unit working, you can set the sensitivity to the required level and shoot away.

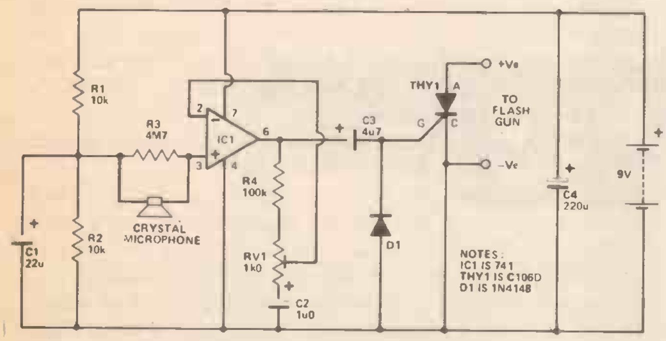


Fig. 1. The circuit diagram of the Flash Trigger.

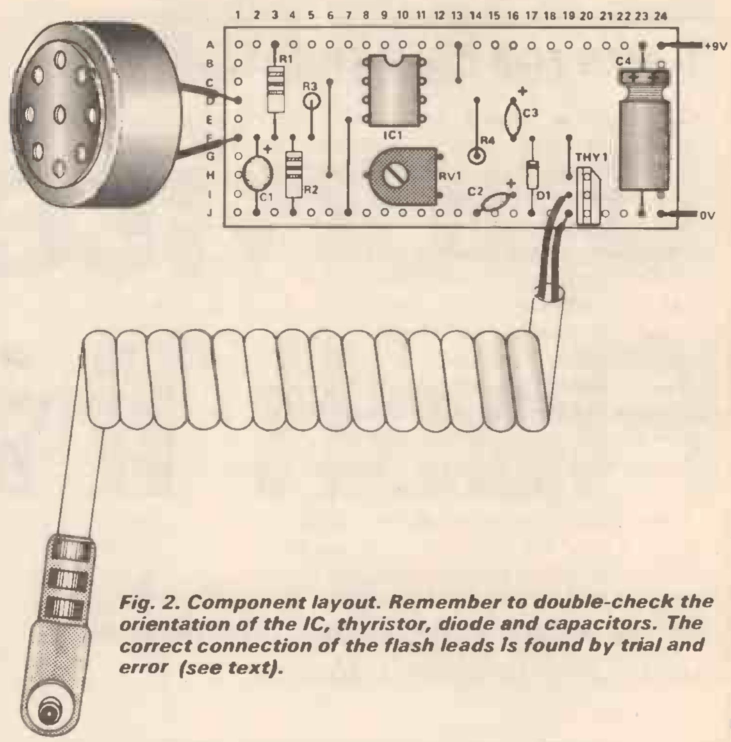


Fig. 2. Component layout. Remember to double-check the orientation of the IC, thyristor, diode and capacitors. The correct connection of the flash leads is found by trial and error (see text).

How it Works

Sound waves striking the microphone are transformed into electrical impulses and amplified by IC1. The gain of this stage is variable by adjustment of RV1. When there is no sound, the output of IC1 (pin 6) will be steady, at about four or five volts; roughly half the supply voltage. Capacitor C3 prevents current from flowing into the gate of the thyristor until a sound impulse causes the output of IC1 to swing towards the positive rail. Diode D1 provides a recharge path for C3.

The thyristor is an electronic switch. It will switch on very fast when the current flowing through the gate-cathode junction exceeds a certain value. The 'turn-on' current for the C106D is about 200uA (two ten thousandths of one amp). Once turned on, the thyristor will stay on, even if the gate current is removed, until the current from the anode to cathode falls below a few milliamps. This is a very useful feature in some circuits and causes no problem here as the flash gun discharges in a fraction of a second and the thyristor switches off again. Note that the thyristor will only conduct current in one direction. With the voltage across its terminals reversed, it behaves just like an ordinary diode and no current flows until the breakdown voltage of the device is exceeded.

Buylines

All of the components used in this project should be available from your usual supplier or from the larger mail-order companies.

Parts List

RESISTORS (All ¼W, 5%)	
R1, 2	10k
R3	4M7
R4	100k
POTENTIOMETER	1k0 LIN preset
CAPACITORS	
C1	22u 25V tantalum
C2	1u0 35V tantalum
C3	4u7 35V tantalum
C4	220u 25V electrolytic
SEMICONDUCTORS	
D1	1N4148
IC1	741
THY1	C106D
MISCELLANEOUS	
Crystal microphone	
9V battery (PP3)	
Flash extension lead	
1in x 2½in Veroboard	

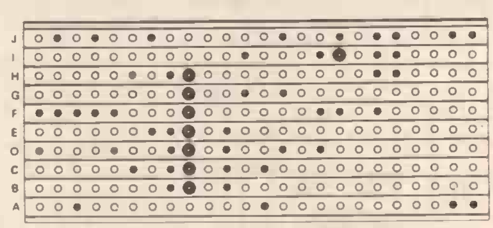


Fig. 3. The underside of the board. The large circles show where to cut the tracks, the dots are soldering points for the component leads.

Sound Operated Flash Trigger

HINTS FOR CONSTRUCTORS

Cutting the board. Rotate the "spot face cutter" while pressing gently to make the breaks in the copper track. If you do not have Vero's special tool, use a drill — ⅛" is about right. Always check that no bits of copper swarf are shorting to an adjacent track.

Inserting components. Long nose pliers come in handy for forming leads and inserting components. Do not bend the leads close to the body or they may break off. Check that components are not shorting to each other or to any wire links on the board.

Always insert the low profile components first: wire links, resistors, capacitors etc. Put the semiconductors in last.

Soldering. Make sure the component leads and the soldering iron are clean. If you use new components there should be no problem. Use a small soldering iron. 15 watts is ideal; 25 watts is really a safe maximum. Hold the components still when you solder them AND until the solder has set — about five seconds. Do not use too much solder or you may bridge the tracks and BE QUICK!

When the joint is cool, trim the lead with a pair of sidecutters.

HOW I SHOT THE FRONT COVER PICTURE USING THE HE FLASH TRIGGER

A day in the life of our cover photographer, Steve Crawley.

For this shot I set the shutter to B (or T) with the camera on a tripod in a dark studio. I used an aperture of f16 and Kodak Ektachrome 200ASA EPD film.

Lighting was provided by one Metz 402 flash unit and a white reflector to fill in the shadows. The sensor on the flash was set to 200 ASA f16 and I placed the balloon 4ft in front of it. The duration of the flash is 1/25,000-1/30,000 of a second.

The balloon was blown up as hard as possible and placed in front of a black velvet background.

The position of the microphone is critical. I used Polaroid film to find the correct distance — in this case 2ft 3ins. With the microphone at 3ft the balloon is completely demolished leaving the dart in mid air!

After a few hours of experimentation, trial and error, and sheer luck I managed to come up with a few reasonable shots for the HE artists to shape into a cover. The actual shot chosen shows one of a series of smoke-filled balloons about 25% demolished. **HE**

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Electronic Components

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Cabinets	Etching equipment	Rams
Cables	Heatsinks	Resistors
Capacitors	IC sockets	Switches
CMOS	Knobs	Tools
Crossovers	Mains Transformers	Triacs

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Due to stock and administrative problems over the last few months, the quality of our service had suffered considerably. These problems have now been resolved and we are confident that we can now offer the quality of service we had been accostomed to. We wish to convey our apologies to any customers who have been inconvenienced.

All prices include VAT. Please add 50p carriage on orders below £15. Contact our sales office with your requirements on: **01-464 5770**

BARCLAYCARD VISA

OPTO

	0.125in.	0.2in.	
Red	TIL209	TIL220	10p
Green	TIL211	TIL221	16p
Yellow	TIL213	TIL223	16p
Clips	3p	3p	

DISPLAYS

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

TRANSISTORS

				TIP30C	70p
				TIP2955	65p
				TIP3055	60p
				ZTX107	12p
AC127	25p	BC547	8p	ZTX108	12p
AC128	25p	BCY71	18p	ZTX109	12p
AD161	40p	BD131	35p	ZTX300	14p
AD162	40p	BD132	35p	ZTX500	15p
BC107	10p	BD139	35p	2N3053	25p
BC108	10p	BD140	35p	2N3055	55p
BC109	10p	BFX29	25p	2N3702	9p
BC147	9p	BFX84	26p	2N3703	9p
BC178	16p	BFY50	23p	2N3704	9p
BC182	10p	BFY51	23p	2N3819	22p
BC182L	10p	MJ2955	98p	2N3905	10p
BC184	10p	TIP29C	60p	2N5777	50p
BC184L	10p	DIODES			
BC212	10p	1N914	4p	1N4148	3p
BC212L	10p	1N4001	4p	1N4002	5p
BC214	10p	1N4006	7p	1N5401	14p
BC214L	10p	BZY88 series 8p each.			

LINEAR

		LM324	52p	MM57160	650p
		LM339	55p	NE531	140p
		LM348	100p	NE555	23p
741	18p	LM377	170p	NE556	60p
747	70p	LM378	230p	NE567	120p
748	40p	LM380	80p	RC4136	100p
7106	850p	LM381	140p	SN76477	230p
CA3046	70p	LM382	120p	TBA800	80p
CA3080	75p	LM386	90p	TBA810	110p
CA3130	100p	LM387	120p	TDA1022	630p
CA3140	60p	LM1458	40p	TL081	45p
LF347	170p	LM1830	180p	TL082	85p
LF351	45p	LM3900	60p	TL084	125p
LF353	90p	LM3909	72p	XR2206	390p
LF356	95p	LM3911	120p	ZN414	80p
LM301A	30p	LM3914	320p	ZN425E	475p
LM318	85p	LM3915	320p		

PACKS

Specially designed packs intended for development work at a considerable saving.

¼w resistors. 10 of each value 4.7ohm to 1 Mohm. a total of 650 resistors. 530p each.

½w resistors. 10 of each value 4.7ohm to 1 Mohm. a total of 650 resistors. 875p each.

Presets. Pack of 5 of each value from 100ohms to 1 Megohm. a total of 65 presets. 390p each.

LED's. Pack containing 10 of each colour LED 0.2 size. Total of 30 Led's + clips. 450p each.

Zeners. Pack of 5 of each value from 2U7 to 33V A total of 130 zeners. 880p each.

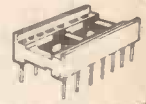
CMOS

		4025	25p	4072	25p
		4026	150p	4081	30p
		4027	50p	4082	30p
		4028	90p	4085	85p
4001	25p	4029	110p	4093	80p
4002	25p	4040	110p	4095	110p
4006	95p	4042	85p	4510	90p
4007	25p	4046	110p	4511	100p
4011	30p	4048	60p	4518	90p
4013	45p	4049	50p	4520	110p
4015	85p	4050	50p	4527	165p
4016	48p	4052	80p	4528	100p
4017	80p	4060	120p	4532	125p
4018	90p	4066	63p	4543	170p
4020	110p	4068	25p	4583	80p
4022	100p	4069	25p	4585	115p
4023	25p	4070	25p		
4024	60p	4071	25p		

SKTS

Low Profile Texas

8 pin	9p	22pin	20p
14pin	11p	24pin	22p
16pin	12p	28pin	26p
18pin	16p	40pin	38p
20pin	18p		



SWITCHES

TOGGLE

Standard	SPST 40p	DPDT 55p
Miniature	SPDT 80p	DPDT 90p
Subminiature	SPST 65p	DPDT 85p

SLIDE Standard DPDT 17p. Miniature 16p each.

PUSH Push to make 16p. Push to break 22p.

TTL

		7447	65p	74123	50p
		7448	65p	74125	60p
		7472	35p	74126	60p
		7473	38p	74132	70p
7400	15p	7474	36p	74141	95p
7401	15p	7475	40p	74145	90p
7402	15p	7476	40p	74150	120p
7404	16p	7483	80p	74154	110p
7406	38p	7485	80p	74157	80p
7408	22p	7486	35p	74164	120p
7410	18p	7490	45p	74165	120p
7413	35p	7492	55p	74174	100p
7414	56p	7493	45p	74175	95p
7420	16p	7494	70p	74190	100p
7427	30p	7495	70p	74191	100p
7430	30p	7496	70p	74192	100p
7432	35p	74121	45p	74196	100p

76 College Road, Bromley, Kent BR1 1DE.

TTLs by TEXAS

7400	11p
74S00	60p
7401	12p
7402	12p
7403	14p
7404	14p
74S04	90p
7405	18p
7406	40p
7407	40p
7408	17p
7409	19p
7410	15p
7411	24p
7412	20p
7413	30p
7414	40p
74C14	90p
7416	27p
7417	27p
7420	17p
7421	40p
7422	22p
7423	34p
7425	30p
7426	40p
7427	34p
7428	36p
7430	17p
7432	30p
7433	40p
7437	35p
7438	35p
7440	17p
7441	70p
7442A	60p
7443	112p
7444	112p
7445	100p
7446A	93p
7447A	75p
7448	80p
7450	17p
7451	17p
7453	17p
7454	17p
7460	17p
7470	36p
7472	30p
7473	34p
7474	30p
7475	38p
7476	35p
7480	50p
7481	100p
7482	84p
7483A	90p
7484	100p
7485	110p
7486	34p
7489	175p
7490A	36p
7491	80p
7492A	46p
7493A	36p
7494	84p
7495A	70p
7496	65p
7497	180p
74100	130p
74107	34p
74109	55p
74116	200p
74118	130p
74119	210p
74120	110p
74121	34p
74122	48p
74123	48p
74125	75p
74126	60p
74128	75p
74132	75p
74136	75p
74137	50p
74141	50p
74142	200p
74145	90p
74147	190p
74148	150p
74150	130p
74151A	70p
74153	70p
74154	120p
74155	90p
74156	90p
74157	70p
74159	190p
74160	100p
74161	100p
74162	100p
74163	100p
74164	120p
74165	130p
74166	120p
74167	200p
74170	240p
74172	450p
74173	120p
74174	90p
74175	85p
74176	90p
74177	90p
74178	160p
74180	93p
74181	160p
74182	90p
74184A	150p
74185	150p
74186	500p
74188	325p
74190	120p
74191	120p
74192	120p
74193	120p
74194	120p
74195	95p
74196	95p
74197	80p
74198	150p
74199	150p
74221	160p
74251	140p
74259	250p
74278	290p
74279	110p
74283	160p
74284	360p
74285	360p
74290	150p
74293	150p
74298	200p
74365	100p
74366	100p
74367	100p
74368	100p
74390	200p
74393	200p
74490	225p

74LS SERIES

74LS00	14p
74LS02	16p
74LS03	18p
74LS04	16p
74LS05	25p
74LS08	22p
74LS10	20p
74LS11	20p
74LS13	40p
74LS14	72p
74LS15	45p
74LS20	20p
74LS21	40p
74LS27	38p
74LS30	20p
74LS32	27p
74LS37	36p
74LS38	36p
74LS42	70p
74LS47	90p
74LS51	24p
74LS55	30p
74LS73	50p
74LS74	38p
74LS75	45p
74LS76	45p
74LS83	110p
74LS85	100p
74LS86	40p
74LS90	50p
74LS92	70p
74LS93	60p
74LS96	110p
74LS107	45p
74LS109	60p
74LS112	100p
74LS113	90p
74LS114	45p
74LS122	80p
74LS123	70p
74LS124	180p
74LS125	60p
74LS126	60p
74LS132	95p
74LS133	30p
74LS136	55p
74LS138	75p
74LS139	75p
74LS145	120p
74LS147	220p
74LS148	175p
74LS151	100p
74LS153	60p
74LS154	200p
74LS155	90p
74LS156	90p
74LS157	60p
74LS158	90p
74LS160	130p
74LS161	100p
74LS162	140p
74LS163	100p
74LS164	120p
74LS165	160p
74LS166	180p
74LS173	110p
74LS174	110p
74LS175	110p
74LS181	320p
74LS190	100p
74LS191	100p
74LS192	100p
74LS193	100p
74LS195	140p
74LS196	120p
74LS197	120p
74LS221	120p
74LS240	175p
74LS241	175p
74LS242	170p
74LS243	170p
74LS244	195p
74LS245	350p
74LS247	140p
74LS248	140p
74LS249	140p
74LS251	140p
74LS253	140p
74LS257	120p
74LS258	160p
74LS259	160p
74LS266	100p
74LS273	195p
74LS279	90p
74LS283	170p
74LS298	249p
74LS324	200p
74LS348	200p
74LS365	100p
74LS367	100p
74LS368	100p
74LS373	180p
74LS374	195p
74LS378	200p
74LS390	160p
74LS393	160p
74LS445	140p
74LS668	100p
74LS669	100p
74LS670	400p

4000 SERIES

4000	15p
4001	25p
4002	20p
4006	95p
4007	25p
4008	80p
4009	40p
4010	50p
4011	25p
4012	25p
4013	50p
4014	84p
4015	84p
4016	45p
4017	80p
4018	89p
4019	45p
4020	100p
4021	110p
4022	100p
4023	27p
4024	50p
4025	20p
4026	130p
4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4033	180p
4034	200p
4035	110p
4036	295p
4037	115p
4038	120p
4039	295p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	110p
4047	100p
4048	55p
4049	50p
4050	49p
4051	80p
4052	80p
4053	80p
4054	150p
4055	125p
4056	135p
4059	600p
4060	140p
4063	120p
4066	55p
4067	450p
4068	27p
4069	20p
4070	30p
4071	25p
4072	25p
4073	25p
4075	25p
4076	107p
4081	27p
4082	27p
4086	72p
4089	138p
4093	80p
4094	250p
4095	95p
4096	95p
4097	340p
4098	120p
4099	200p
40100	220p
40101	132p
40102	180p
40103	180p
40104	99p
40105	99p
40106	99p
40107	60p
40108	470p
40109	100p
40110	300p
40114	250p
4502	120p
4503	70p
4507	55p
4508	290p
4510	99p
4511	150p
4512	80p
4514	265p
4515	300p
4516	110p
4518	100p
4520	100p
4521	250p
4526	108p
4527	150p
4528	120p
4532	140p
4534	550p
4538	120p
4543	180p
4553	450p
4556	72p
4560	250p
4569	250p
4572	40p
4583	90p
4584	90p
4585	150p
4724	250p
40097	90p
14411	1100p
14412	1100p
14433	1100p
14500	700p
14599	290p
CD22100	350p
CD22101	700p
CD22102	700p

INTERFACE ICs

DM8123	175p
DP8304	450p
DS8835	250p
DS8836	150p
MC1488	100p
MC1489	100p
25S10	350p
75107	160p
75150	175p
75154	175p
75182	230p
75322	300p
75324	375p
75325	375p
75361	300p
75363	400p
75365	350p
75451	72p
75491/2	96p
8T26	250p
8T28	300p
8T95	200p
8T97	200p
81LS95	140p
81LS96	140p
81LS97	140p
81LS98	140p
9601	110p
9602	220p

93 SERIES

9301	160p
9302	175p
9308	316p
9310	275p
9311	275p
9312	160p
9314	165p
9316	225p
9321	225p
9322	150p
9334	380p
9368	200p
9370	200p
9374	200p
74S00	80p
74S04	60p
74S05	75p
74S08	75p
74S10	80p
74S20	60p
74S30	60p
74S32	90p
74S37	90p
74S64	60p
74S74	90p
74S85	300p
74S86	180p
74S112	120p
74S114	120p
74S124	300p
74S132	160p
74S133	75p
74S138	225p
74S139	225p
74S157	250p
74S174	250p
74S175	320p
74S194	350p
74S241	450p
74S260	70p
74S373	500p
74S374	500p

LINEAR I.Cs

AY1-0212	600p
AY1-1313	668p
AY1-1320	320p
AY1-5050	140p
AY3-1270	840p
AY5-1224A	240p
AY5-1315	600p
AY5-1317A	775p
CA3019	80p
CA3046	70p
CA3048	225p
CA3080E	72p
CA3086	48p
CA3089E	225p
CA3090AQ	375p
CA3130E	90p
CA3140E	50p
CA3160E	100p
CA3161E	140p
CA3162E	450p
CA3189E	300p
CA3280	100p
DAC1408-8	200p
FX209	750p
ICL7106	850p
ICL8038	340p
ICM7555	80p
LF356P	95p
LM10C	425p
LM301A	30p
LM311	120p
LM318	200p
LM319	225p
LM324	50p
LM339	75p
LM348	95p
LM377	175p
LM380	75p
LM381AN	160p
LM709	36p
LM710	50p
LM725	350p
LM733	100p
LM741	18p
LM747	70p
LM748	35p
LM2917	250p
LM3900	70p
LM3909	70p
LM3911	130p
LM3914	250p
LM3915	250p
LM4136	120p
MC1310P	150p
MC1458	48p
MC1495L	350p
MC1496	100p
MC3340P	120p
MC3360P	120p
MK50398	750p
ML920	775p
MM57160	620p
NE531	150p
NE555	22p
NE556	70p
NE561B	425p
NE562B	425p
NE565	130p
NE566	155p
NE567	175p
NE571	425p
RC4151	400p
SAB3209	POA
SAD1024A	1250p
SFF96364	1100p
SL490	400p
SN76003N	250p
SN76013N	140p
SN76013ND	120p
SN76023N	140p
SN76023ND	120p
SN76477	200p
SP8515	750p
TAA621	275p
TBA641B11	225p
TBA651	200p
TBA800	90p
TBA810	100p
TBA820	90p
TBA950	300p
TCA940	175p
TDA1004	300p
TDA1008	320p
TDA1010	225p
TDA1022	600p
TDA1024	120p
TDA1034B	250p
TDA1170	250p
TDA2002V	325p
TDA2020	320p
TL071	50p
TL072	95p
TL074	150p
TL081	46p
TL082	85p
TL084	130p
TL170	50p
UAA170	200p
UDN6118	320p
UDN6184	320p
ULN2003	100p
XR2206	350p
XR2207	400p
XR2211	600p
XR2216	675p
XR2240	400p
ZN414	90p
ZN419C	225p
ZN424E	135p
ZN425E	400p
ZN1034E	200p
95H90	800p

VOLTAGE REGULATORS

Fixed Plastic TO-220

1A	+ve		-ve	
5V	7805	60p	7905	70p
12V	7812	60p	7912	70p
15V	7815	60p	7915	70p
18V	7818	60p	7918	70p
24V	7824	60p	7924	70p
100mA	TO-92			
5V	78L05	30p	79L05	70p
12V	78L12	30p	79L12	70p
15V	78L15	30p	79L15	70p

OTHER REGULATORS

LM309K	135p	78HGKC	600p
LM317T	200p	78H05KC	600p
LM323K	550p	78MGT2C	135p
LM723	37p	78P05	900p
		79HGKC	700p

OPTO-ELECTRONICS

2N5777	45p	ORP60	120p
OCP71	130p	ORP61	120p
ORP12	90p	TIL78	70p

OPTO-ISOLATORS

ILD74	130p	TIL111	90p
MCT26	100p	TIL112	90p
MCS2400	190p	TIL116	90p

LEDS

0.125"		0.2	
TIL32	75p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	Rectangular	
TIL216 Red	18p	LEDs (R, G, Y)	30p

DISPLAYS

3015F	200p	NSB5881	570p
DL704	140p	TIL311	600p
DL707 Red	140p	TIL312/3	110p
707 Gr	140p	TIL321/2	130p
DL747 Red	225p	TIL330	130p
747 Gr	225p	7750/60	200p
FND357	120p	**DRIVERS**	
FND500	120p	9638	200p
FND507	120p	9370	200p
MAN3640	175p	UDN6118	320p
MAN4640	200p	UDN6184	320p

TRANSISTORS

AC126	25p
AC127/8	20p
AC176	25p
AC187/8	25p
AF116	50p
AD149	70p
AD161/2	45p
AU107	200p
BC107/8	11p
BC109	11p
BC117	20p
BC147/8	9p
BC149	10p
BC157/8	10p
BC159	11p
BC169C	12p
BC172	12p
BC177/8	17p
BC179	18p
BC182/3	10p
BC184	11p
BC187	30p
BC212/3	11p
BC214	12p
BC237	15p
BC327	16p
BC337	16p
BC338	16p
BC461	36p
BC477/8	30p
BC516/7	50p
BC547B	16p
BC548C	9p
BC549C	18p
BC557B	16p
BC559C	18p
BCY70	18p
BCY71/2	22p
BD131/2	50p
BD135/6	54p
BD139	56p
BD140	60p
BD189	80p
BD232	95p
BD233	75p
BD235	85p
BD241	70p
BD242	70p
BDY56	200p
BF200	32p
BF244B	35p
BF256B	70p
BF257/8	32p
BF259	36p
BFR39	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFX29	30p
BFX30	34p
BFX84/5	40p
BFX86/7	30p
BFX88	30p
BFW10	90p
BFY50	30p
BFY51/2	30p
BFY90	90p
BRY39	45p
BSX19/20	20p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU205	200p
BU208	200p
BU406	145p
E300	50p
E308	50p
E310	50p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJE340	70p
MJE2955	100p
MJE3055	70p
MPF102	45p
MPF103/4	40p
MPF105/6	40p
MPS6531	50p
MPS6534	50p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA42	50p
MPSA43	50p
MPSA56	32p
MPSA70	50p
MPSU06	63p
MPSU07	90p
MPSU45	90p
MPSU65	78p
OC28	130p
OC35	130p
TIP29A	40p
TIP29C	55p
TIP30A	48p
TIP30C	60p
TIP31A	58p
TIP31C	62p
TIP32A	68p
TIP32C	82p
TIP33A	90p
TIP33C	114p
TIP34A	115p
TIP34C	160p
TIP35A	225p
TIP35C	290p
TIP36A	270p
TIP36C	340p
TIP41A	65p
TIP41C	78p
TIP42A	70p
TIP42C	82p
TIP54	160p
TIP120	120p
TIP122	130p
TIP142	130p
TIP147	130p
TIP2955	78p
TIP4055	70p
TIS43	34p
TIS93	30p
ZTX108	12p
ZTX300	13p
ZTX500	15p
ZTX502	18p
ZTX504	30p
2N696	35p
2N697	25p
2N698	45p
2N706A	20p
2N918	45p
2N930	18p
2N1131/2	20p
2N1613	25p
2N1711	25p
2N2102	70p
2N2160	350p
2N2219A	30p
2N2222A	30p
2N2369A	20p
2N2484	30p
2N2646	45p
2N2904/5	30p
2N2906A	30p
2N2907A	30p
2N2926	9p
2N3053	30p
2N3054	65p
2N3055	48p
2N3442	140p
2N3553	240p
2N3565	30p
2N3584	250p
2N3643/4	48p
2N3702/3	12p
2N3704/5	12p
2N3706/7	14p
2N3708/9	12p
2N3773	300p
2N3819	25p
2N3820	50p
2N3823	70p
2N3866	90p
2N3902	700p
2N3903/4	18p
2N3905/6	20p
2N4036	70p
2N4037	65p
2N4058/9	12p
2N4060	12p
2N4061/2	18p
2N4123/4	27p
2N4125/6	27p
2N4401/3	27p
2N4427	90p
2N4871	60p
2N5087	27p
2N5089	27p
2N5172	27p
2N5179	90p
2N5191	90p
2N5194	90p
2N5245	40p
2N5296	55p
2N5401	50p
2N5457/8	40p
2N5459	40p
2N5460	60p
2N5485	44p
2N5875	250p
2N6027	48p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2N6292	65p
2SC1172	150p
3N128	120p
3N140	100p
3N141	110p
3N201	110p
3N204	100p
40290	250p
40361/2	75p
40364	120p
40408	70p
40409	85p
40410	85p
40411	300p
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40595	120p
40673	75p
40841	90p
40871/2	90p

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OA202	10p
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1N4148	4p
1N4001/2	5p
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Electronics In Photography

Latest developments exposed by Phil Gerring, HE's hot-shoe, hot-shot photographer.

SINCE JOSEPH NIEPCE produced the first photographic image in 1826 the science of photography has advanced beyond all recognition. Indeed Niepce, confronted with a modern SLR compact, would be at a loss to know what it is — let alone how to use it. Niepce's first photograph took eight hours to expose; today the same scene can be captured in 1/1000 of a second (at a far better quality).

The camera manufacturers are continually bringing out new models incorporating the latest technology. Photography is such big business that Kodak, the world's longest photographic company, spend more (world wide) on advertising than the U.S. do on defence.

This article follows and explains the development of electronics as applied to photography, and looks into the future.

EXPOSURE METERS

As far back as 1873 a guy by the name of Willerby Smith noticed that the conductivity of a piece of selenium varied with the amount of light falling on it. Despite this early instance of photo-conductivity, it wasn't until the 1930s that the first commercial electric light meter was developed. Since then there have been many advances and developments. In the late 40s germanium and silicon were applied to photo-voltaic and photo-conductive uses. In the 50s light meters became a permanent fixture on cameras and in the 60s 'Through the Lens' metering was instituted on both semi-automatic and fully automatic cameras.

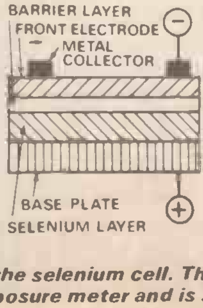


Fig. 1. Structure of the selenium cell. This was used in the first commercial exposure meter and is still popular today.

There are four different types of photocell used in exposure meters. The first of these are selenium cells or barrier layer cells (Fig. 1). They generate their own electricity (photovoltaic) and use a sensitive galvanometer attached to a mechanical claculating dial. Their sensitivity is limited and dependent on the area of cell exposed to the light. The light meter uses a baffle to limit the acceptance angle to that of the camera lens employed. Its advantages are that it requires no power supply and is relatively inexpensive. It is, however, too large to be incorporated inside the camera and does not perform very well in low light levels.

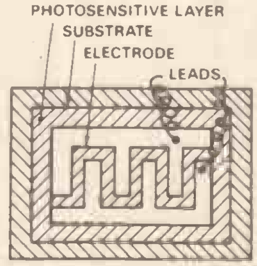


Fig. 2. The cadmium sulphide cell, with leads for the external power supply. Its sensitivity allows its use in TTL metering.

The cadmium sulphide cell (CdS) is a photosensitive cell and an increase in light reduces its resistance to a flow of electricity, thus increasing the flow of current from a battery across the cell (Fig. 2). A sensitive galvanometer is used to calculate the exposure setting (see Fig. 4). It is usually employed as a 'Through The Lens' light meter (TTL) as it is very compact. It is more sensitive than the selenium cell and responds well in low light levels. Its disadvantages are that it tends to retain or memorize a light level (it is slow to respond to a new one) and it is also very sensitive to red light which results in under-exposure of red subjects.

Silicon cells (Si) are solid state photodiodes (Fig. 3) that generate a minute current (photovoltaic). This is then amplified to obtain a useful output and an op-amp is used as a current-to-voltage converter with a suitable

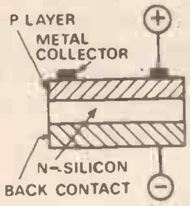


Fig. 3. Silicon cells are extremely fast reacting and very small.

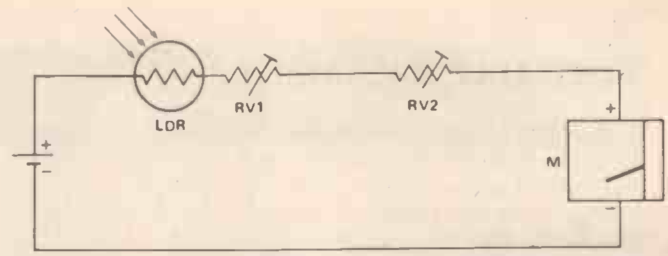


Fig. 5. An early design for an in-camera exposure meter. RV1 and RV2 are connected to the shutter speed and film speed respectively.

feedback resistor to give high output voltage in proportion to the incident light on the cell. This then gives a significant response even at low light levels and also a linear response over a wide range with an almost instantaneous response to changing levels. As these cells are small and reliable, they are used in common camera bodies. Being very sensitive to red light, they are often fitted with blue filters and called Silicon Blue Cells (SBC) which give a better acceptance of the spectrum. However, the cell becomes unreliable in temperature extremes.

The fourth type is the gallium arsenide phosphide cell (GaAsP). This is a fast-reacting compact photocell and provides reliable readings in blue and red light. It also responds well in low light levels and is not over sensitive to temperature extremes. It is similar to the Silicon cell in that it responds about 1000 times faster than the CdS cell. It is, however, a fairly recent innovation and is not at the moment in common use.

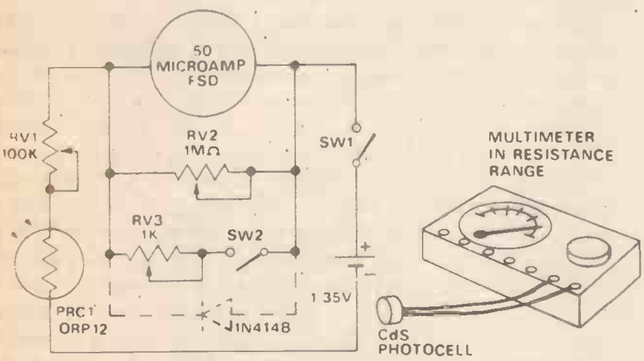


Fig. 4. Circuit diagram of a basic hand-held CdS lightmeter. This version has two ranges which are individually calibrated by RV2 and RV3.

SEMI AUTOMATIC CAMERAS

A practical semi-automatic system first became possible with the development of a compact photosensitive resistor which could be installed in or on the camera. The next development was to directly link the light meter circuitry to the shutter, aperture and film speed controls. This was achieved using a series of variable resistors. By the mid-70s the cameras used a moving coil meter with a needle as an indicator.

There are two basic metering systems. One uses a two needle system. A "match" needle is linked to the ASA film speed which is directly linked to the metering coil. The aperture and shutter are linked to the other needle, which may have a ring attachment at its end. The photographer adjusts the ring until it is aligned with the needle by altering the shutter speed and aperture controls.

The other major system uses the needle centre method (Fig. 5). All the exposure controls as well as the light-dependent resistor are connected to a single needle which is situated at the side of the viewfinder and is free to swing between two markings. If the needle swings towards the +ve end of the scale this indicates that the picture will be over-exposed and conversely, if it swings the other way it will be under-exposed. The photographer can then adjust his aperture and/or shutter speed accordingly.

The drive circuits for the integral systems, as described above, in modern 35mm cameras can be very basic arrangements. For example, the single-ended circuit operates a meter by measuring the amount of light falling on the LDR through the lens of the camera. As the ASA of the film and the shutter speed are preset, the meter can be centred by adjusting the aperture ring. (Note: The aperture is not connected to the circuit.)

This circuit arrangement has disadvantages and can be unreliable because it is dependent on a constant voltage supply from the battery. So if the battery voltage fluctuates above or below its normal it is going to result in a faulty meter reading and consequently affect the exposure.

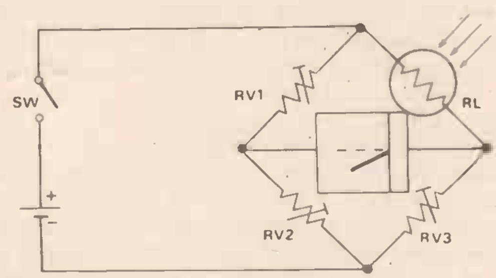


Fig. 6. A Wheatstone bridge arrangement.

A more reliable circuit is achieved by using a Wheatstone bridge arrangement (Fig. 6), which operates independently of any fluctuations in the battery voltage.

The sensitivity of the microammeter in the metering system of semi-automatic cameras is so crucial that should it get damaged the whole metering system would have to be replaced and this can be very expensive. So when LEDs first appeared on the market, camera manufacturers were quick to see the obvious advantages of these solid state devices, and they began developing them for application in photography. Linked to a drive 'chip', these devices have many advantages over the old moving coil metering system. The most common display arrangement used is a vertical column of three LEDs. The top and bottom LEDs glow red to indicate either over- or under-exposure. When the exposure is correct the middle LED glows green.

AUTOMATIC CAMERAS

In the 50s crude forms of automatic exposure meters were being built into cameras but these were mainly mechanical systems designed for the amateur market.

They were not always reliable and had a fixed shutter speed. The aperture was adjusted electro-mechanically. A photo-voltaic cell would measure the incident light and power a servo motor which then adjusted the aperture using a series of geared wheels.

Another popular system in early 'automatic' cameras used the needle trap method. A meter is used to read the output from a photocell and then the meter needle is clamped into position (which doesn't do a microammeter much good). Then on depressing the shutter button a lever travels to the position at which the needle was trapped and adjusts the aperture as it moves. This sytem is accurate but easily damaged. It can, however, incorporate a range of resistors which allows for a variety of shutter speeds.

By the early 60s microcircuitry was beginning to come into its own and in 1968 Konica brought out the first fully-automatic electronic 35mm SLR. All the other major manufacturers soon followed with their own versions.

Most of these early auto cameras have an 'aperture priority' control whereby the photographer sets the film speed on the dial which is in turn linked to the exposure calculator circuitry. Then, by moving the aperture control only, the camera works out the correct shutter speed to go with the chosen aperture. This is done using a comparator chip which can accept the output from the photoelectric cell and the variable resistances from the aperture and film speed settings.

Most of the recent auto-exposure cameras use electro-magnetic aperture control with a direct electronic link made to the timing circuitry giving faster and more accurate exposures. The early versions had automatic aperture controlled by levers and servos.

Micro-electronic developments, such as more 'intelligent' and compact chips as well as flexible circuit boards and greatly increased reliability, have made it possible for cameras to have more than one auto-exposure mode. As well as manual operation they are capable of aperture priority or, with the flick of a switch, shutter speed priority. This dual mode feature coupled with an increased reliability is particularly attractive to professional photographers.

Some modern cameras are pre-programmed by the manufacturer so that if there is either too much or too little light for the exposure even after the shutter or aperture has gone to its limits, the camera will take over the setting. These alterations are usually displayed in the viewfinder so that a check can be made in case the settings are not close enough to get the desired effect.

Some cameras make use of stepped programmes. These are mainly incorporated in compact 35mm cameras in the higher price range. The exposure rating is staggered between the aperture and exposure settings, thus giving the photographer a balanced setting between depth of field (aperture) and fast exposure (shutter speed).

Using electronic shutters and apertures enables cameras to operate with continuous exposure values to give more accurate and more consistent exposures. There are some recent fully automatic cameras where the light reading is taken partly off the actual surface of the film emulsion. So with fast-reacting electronics a shutter speed or aperture can be corrected in mid-exposure. In compact cameras a stepless exposure works only above 1/100th of a second so that camera shake problems are minimised.

ELECTRONIC SHUTTERS

Polaroid produced the first commercially-available electronic shutter to operate efficiently in the small body of a camera. The other major manufacturers soon followed but with more professional systems. The development of mechanical shutters had attained a high standard by the time electronic shutters appeared on the scene and initially there were no real advantages in using an electronic shutter except where weather conditions were extreme.

The electronic systems gained the advantage though when they were linked to the automatic exposure systems . . . In 1971 Asahi Pentax introduced the Pentax ES (electronic shutter) and this set the route by which the electronic shutter was going to develop.

There are two basic types of shutter used in cameras, they are the 'between-the-lens shutter' (ie between the elements of a compound lens) and the 'focal plane shutter.'

Between-the-lens arrangements have appeared in many different forms from a single blade type as found in the simpler cameras such as Instamatic cameras, and the lower-priced Rangefinder Compacts. More expensive cameras use a between-the-lens arrangement with more than one blade. This system has fewer operating problems than the focal plane shutter because it allows an even one step illumination over the whole film area. The first form of electronic shutter which appeared in the 60s was the electronically operated spring-loaded diaphragm shutter. This shutter uses an electromagnet to attract a lever which moves a collar attached to the shutter leaves. The electromagnet is connected to a switch and a power supply, normally a small battery.

When the exposure button is depressed, this energizes the coil which attracts the lever and a capacitor-resistance network starts timing. When the exposure is completed, the electromagnet is de-energized and the shutter is closed by the force of a spring acting on the lever. Another arrangement of shutter control is by the use of permanent magnets in place of the spring. The use of magnets reduces mechanical moving parts and also closes the shutter more efficiently than a spring. Automatic exposure systems can be linked to this shutter by exchanging the resistor network with a silicon cell device which can judge the exposure while light is landing on the film surface.

Mechanical timing arrangements were used at first to control these shutters, but microcircuitry has made it possible to incorporate an electronic timer. When the electro-magnet in the shutter is activated it also trips a switch which allows a capacitor to charge at a predetermined rate, controlled by a variable resistor or by a resistor series network. This is linked to the shutter speed setting on the camera and when the voltage in the capacitor attains a critical level a transistor switching circuit will take over and cut off the current to the solenoid allowing the shutter to close.

The focal plane shutter is not situated in the lens but directly in front of the film plane. One blade shuts out the light. When the shutter is released it slides across. When the film has been exposed for the correct length of time a second blade follows across to complete the exposure.

The most common type of electric shutter is a spring loaded system which is attached to and cocked by the film wind-on lever. The electronics are similar to those in the between-the-lens shutter, using a capacitor charged via a variable resistor (Fig. 7). By pressing the shutter release trigger, switch (SW2) is closed and this allows current to pass through an op amp which in turn charges a solenoid. The charged solenoid pulls a spring tensioned lever up to the electromagnet and at the same instant releases a catch allowing the first shutter blade to shoot along its track close to the focal plane. At the same instant, the resistor and capacitor circuit starts timing the shutter. After the set time the op amp switches off and discharges the solenoid. The lever is then released and the spring returns to its starting point at the same time releasing the second blade and covering the film again.

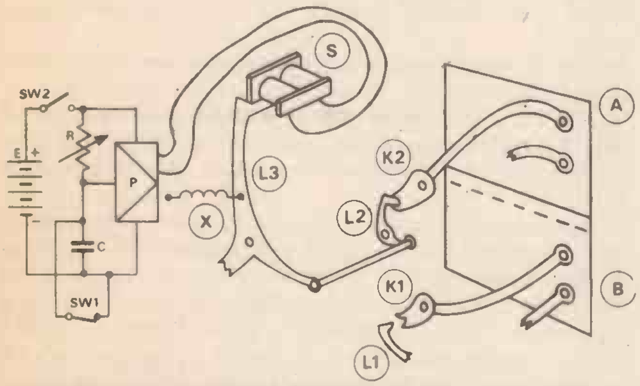
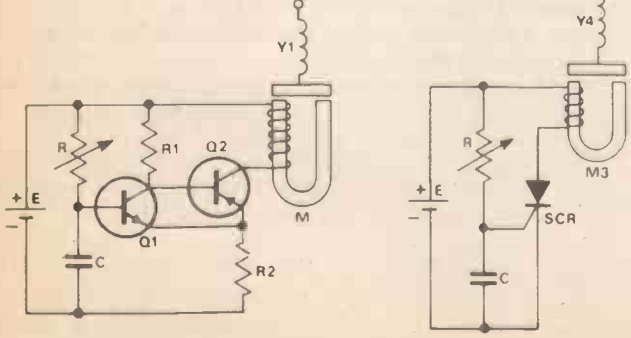


Fig. 7. Many electronic shutters still require complex lever arrangements to function.

There are several types of electronic timing used in conjunction with electronic shutters, the most popular being the Schmitt trigger and the SCR. In the Schmitt circuit (Fig. 8), the capacitor is charged up to a level predetermined by the resistor R. When the trigger voltage is reached, the 'off' and 'on' transistors are switched over. The SCR circuit (Fig. 9) can operate using very low power levels. The SCR starts out as an open circuit. When the power is connected, the first shutter blade is released and the capacitor charges up to a low gate voltage which then triggers the SCR (to a closed circuit). This puts a voltage across the solenoid which in turn attracts the lever releasing the second blade of the shutter.



Figs. 8, 9. The Schmitt trigger and SCR timers.

AUTOFOCUS

Cameras have developed rapidly in recent years with the aid of high technology electronics. Cameras can decide and set their own shutter speed, aperture and even film speed controls to give you fully automatic operation. The next stage was the development of autofocusing, so that a camera could calculate the distance of the subject from the lens to bring it into focus.

The first autofocus camera was developed by Canon in 1963 but autofocusing cameras did not actually come onto the market until 1978 with an autofocus camera designed by Konica. There are now three systems used. The first, and at the moment most predominant, system is based on the Honeywell Visitronic Autofocus Module. This uses a system of comparing the contrast of light on a subject as viewed by two banks of light sensitive cells.

The second is a system used by Polaroid. This sends out an ultrasonic wave (sonar type) at the subject for automatic focusing. The third and newest system is one used by Canon which bounces an infra red light beam off the subject.

In the Honeywell system light from the subject passes through two windows on the front of the camera and is reflected by a series of mirrors into the autofocusing module. Here the two light sensitive panels (silicon photocells) compare the lighting contrast from the two views of the subject. The contrast is a maximum at the point of exact focus and falls away on each side of it.

The sonar system employed in Polaroid cameras works on the same principle as that used by submarines. A transducer sends out and later receives the sound waves and converts them into electrical energy. The transducer sends out a chirp lasting about 1/100 sec towards the subject. The chirp contains four ultrasonic frequencies between 50 and 60 kHz. A crystal oscillator clock times how long it takes for the chirp to rebound onto the camera and a chip calculates the focal setting from this information, a servo motor adjusting the lens accordingly.

The Canon autofocus system uses an infra red light beam to assess the correct focus. It works using an IRED (infra red light emitting diode) which sends out a beam of invisible light of about 900 nm (nanometres) wavelength. The camera has two rangefinder-style windows. The infra red leaves one window and scans the subject scene from left to right through an angle of about 10°. When the receiving sensor is receiving the maximum signal, the IC electronics informs the lens of the correct setting, and all this takes about 120 milliseconds.

Each system has its advantages and disadvantages. The Honeywell is compact and for the first time afforded quick, easy, sure, sharp automatic focusing for all photographers. It does, however, have a slight 'memory' whereby it retains previous focal settings and does not function very dependably in dim light or low contrasting light (and is therefore inadqute for flash). It can also have trouble focusing on small repetitive patterns.

The advantage of the ultrasonic or sonar system is that it does not depend on bright lighting of the subject and so can focus in absolute darkness. The only drawback is if a solid object such as a window lies between the subject and the camera, as the sonar cannot then judge the distance to the subject.

The infra red system works in almost any situation in which the Honeywell system does not and it can focus even in total darkness. It can also focus through glass. The only drawback to the system is that it may not work well on subjects with low reflectance characteristics. It is the infra red system which will probably predominate autofocusing systems in cameras during the 80s.

ELECTRONIC FLASH

1851 saw the first electronic flash when Fox-Talbot, an early photographic pioneer, borrowed equipment from Faraday and demonstrated the use of an electric spark as an artificial light. But it wasn't until the 20th century that electronic flash became available as a convenient light source. Flash guns require a DC power supply, capacitors, flash tube, triggering circuit and a reflector. Modern flash guns have flash tubes filled with xenon surrounded by a toughened glass envelope. This is connected to a capacitor which has been specifically designed for flash guns and similar instruments, and these are called either energy storage or auto flash types.

There are three types of flash guns which make use of varying sizes of capacitor depending on the application. Low power amateur flash guns make use of capacitors charged from 180-500 volts. Portable studio guns use 500-1500 volts and industrial giants can use 1500-15000 volts. As thousands of volts are discharging through the flash circuit, there will be several hundred amps moving along the flash tube for 1/250th to 1/1000th of a second. Therefore the power produced can be as high as a 100kW at the peak of the flash.

In modern portable flashguns the capacitor requires a power pack running from a few 1.5 pencil batteries. The small 1.5 volt cells can charge the capacitor up to sufficiently high voltage by using a transistor 'invertor' circuit (Fig. 10). This circuit oscillates at an audio frequency (this accounts for the whining noise heard as the flashgun charges up). The oscillator produces an AC voltage which is stepped up by a transformer and the high-voltage AC is then converted back to DC by a rectifying diode, and goes to charge the storage capacitor via a current limiting resistor. The flash gun then has to be fired to release the stored charge.

It is critical that the flash synchronizes precisely with the shutter. A synchronizing switch is built into the camera. This switch cannot directly handle the flash current, so it is used to trigger a thyristor in the flash unit.

Charge control circuits are built into flashguns to ensure constantly bright flashes regardless of the state of the batteries. This circuit fully charges the capacitor before switching off to conserve the battery power. But if the voltage drops below a certain % level the circuit will automatically switch itself back on again to keep the flash at a consistent level. A small neon light is included in the circuit and lights up to indicate when the flash gun is fully charged.

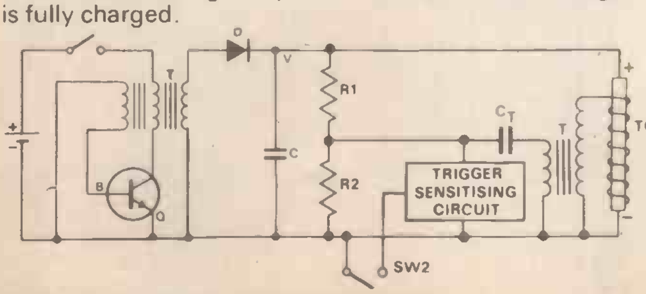


Fig 10. Basic diagram of a manual flashgun.

In recent years automatic flashguns have become keenly competitive with ordinary flashguns (as described above). The automatic flashguns use a fast acting photocell such as a silicon photodiode. These cells operate so quickly that they are able to calculate the correct exposure setting while taking the light reading off the subject. In the flashgun the cell is used to read the amount of light reflected from the object and transfer the information to an integrated circuit which works out when enough light has been reflected to register on the film. It then shuts off the flash by cutting the power supply.

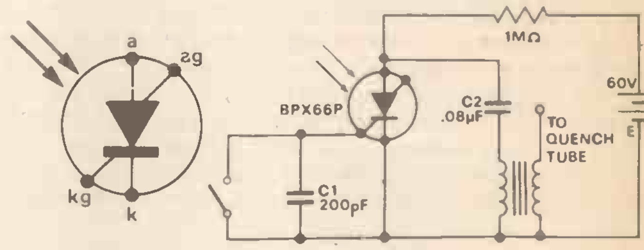


Fig. 11. The extra circuitry required for an automatic flashgun.

The auto flashes of the 60s used a system called 'Dump Quenching' which meant that when the integrated circuit decided that there had been enough light emitted it would cut out the flash by shorting the remainder of the power in the capacitor to the negative rail. The system worked well but wasted a lot of power, so in the early 70s a 'Blocking Quench' system was introduced (Fig. 11). This used a silicon sensor and integrated circuit as before but instead of shorting the circuit it used a faster thyristor which cut the power from the capacitor to the flash gun thus leaving the capacitor still partially charged.

On some recent auto exposure cameras there is a special connection for flash guns made by the same manufacturer (for the really dedicated) whereby the exposure calculation circuitry controls the flash power directly and also has an LED readout in the viewfinder informing the photographer of the state of readiness of the flash gun and also whether there was enough light to illuminate the subject correctly.

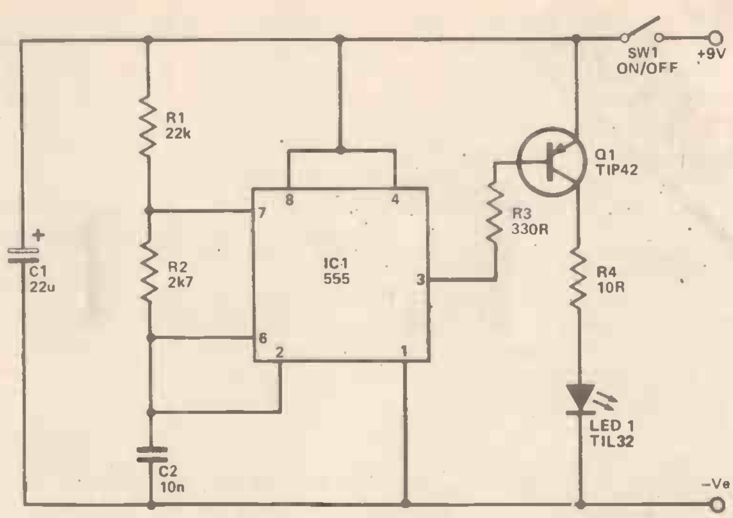
Recent innovations in portable flash photography include double flash heads on one body — one a low power flash and the other high power, for bounce diffused lighting. Rollei have recently introduced their latest flash which has an illumination range of 80 feet for an average speed film. The development in their flash is that it has an LED readout — and when the ASA film speed and aperture used are fed in it works out the distance the flash can cover.

This gives some idea of the way in which electronic flash photography is rapidly developing. The flashguns these days can even switch the cameras electronic shutters to the speeds required to take flash pictures.

All the figures illustrating this article are reproduced from "Electronics And The Photographer" by T. D. Towers, and appear by permission of the publishers, Focal Press. We recommend this book to anyone wanting to read further on this subject. It is available from your bookshop at £6.95. (If you have any difficulty obtaining it write to Focal Press, 31, Fitzroy Square, London W.1. enclosing £6.95 plus 80p p+p).

Short Circuit

INFRA-RED INTRUDER ALARM



This intruder alarm is of the type where the alarm sounds when an invisible beam of infra-red light is broken by the intruder. The circuit is intended to feed an existing burglar alarm system, and units of this type are not usually used as the only method of intruder detection. The system is very simple, and requires no special lenses or filters for operation over distances of about 2 metres or less. A short range is usually sufficient to cover entrances to rooms, span corridors, etc..

The unit actually consists of two separate circuits, one being used to produce an infra-red beam, and the other being used to detect this beam and sound the alarm if there is a break in the signal. In common with most systems of this type, a pulsed infra-red beam is used. Unless of high power, it would be difficult to produce a continuous beam circuit that would give good reliability and a useable range, since the beam would otherwise tend to be swamped by the ambient infra-red level. A modulated beam can easily be differentiated from the ambient infra-red radiation, enabling a low power beam to be employed.

The transmitter is based on the popular 555 timer IC, and it is used in the standard astable mode. R1, R2, and C2 are the timing components, and these give an operating frequency of roughly 5.25kHz. A standard 555 oscillator does not produce a true squarewave output, as the output is in the high state for a longer period than it is in the low state. This is due to the fact that the output goes high during the time that C2 charges up through the relatively high resistance of R1 plus R2 in series, and low while C2 discharges through the low resistance of R2 and an internal transistor of IC1. The values used in this case give an output which is in the low state for only about 10% of the time.

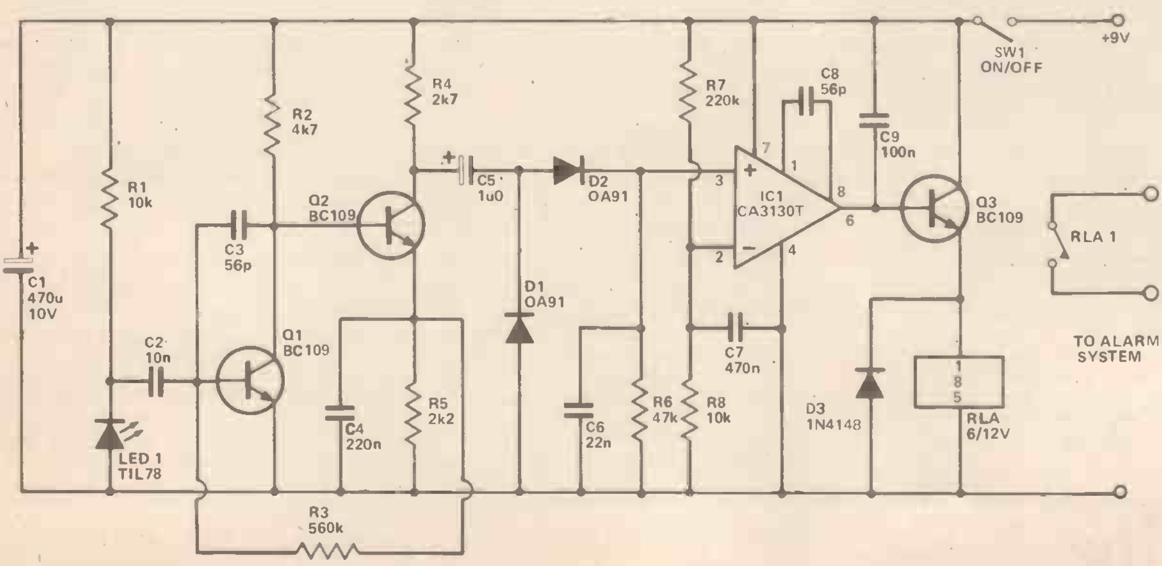
During these brief negative output excursions Q1 is pulsed on by the base current it receives via R3. It then passes a current of about 500 mA. to infra-red LED1 by way of current limiting resistor R4. Of course, the average current through LED1 is only about 50 mA., and this system therefore gives fairly strong pulses of infra-red together with a reasonably low average current drain. There is no output from LED1 in the visible light spectrum.

At the receiver the pulses of infra-red are detected by photodiode LED1. This is fed from the supply rails via load resistor R1. The pulses of infra-red cause the leakage current through LED1 to increase momentarily, giving a series of small voltage pulses at the junction of R1 and LED1. These are fed by C2 to the input of a straight forward high gain amplifier which uses Q1 and Q2 in a conventional two stage direct coupled arrangement. C2 and C4 are purposely given low values so that the circuit has a poor response at low frequencies. This gives good rejection of 50 Hertz signals produced by LED1 picking up the infra red radiation from mains powered lighting. The circuit has high gain at the much higher operating frequency of the transmitter circuit though.

The output from the amplifier is coupled by C5 to a rectifier and smoothing circuit which utilizes D1, D2, C6, and R6. The positive bias produced by this circuit is fed to one input of operational amplifier IC1. The other input is fed with a bias voltage by R7 and R8. Normally the fixed bias to the inverting (—) input will be higher than the bias fed to the non-inverting (+) input. IC1 is used as a comparator, and under these conditions its output goes high, energising the relay coil with discrete buffer stage Q3 being used to provide the fairly high drive current required. If an intruder breaks the beam momentarily, the charge on C6 rapidly decays, taking the voltage fed to the non-inverting input of IC1 below that at the inverting input. IC1's output then goes low, the relay is switched off, and relay contacts RLA1 open so that the main alarm system is triggered.

The system is fail-safe in that if the power to either the transmitter or receiver should cease, or be switched off, the relay contacts will open and trigger the main alarm system.

The current consumption of the circuit is about 45 mA. when the relay is switched on, and about 3 mA. when it is switched off.



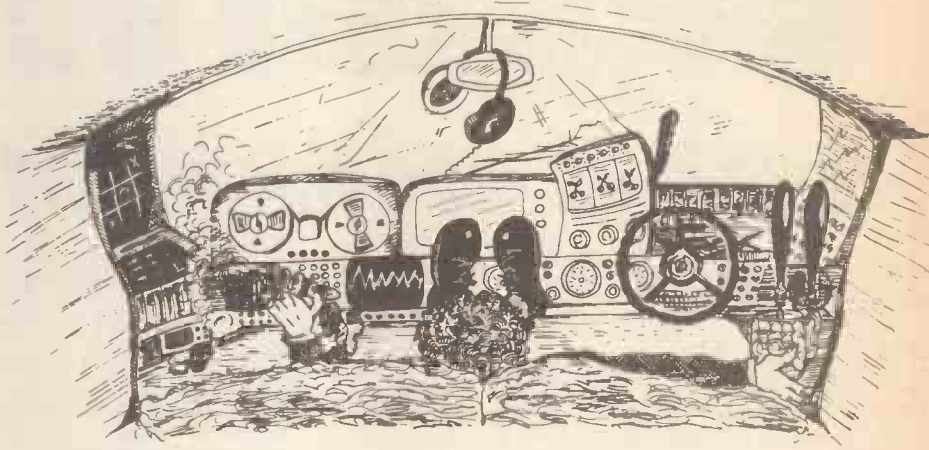
Next Month

Hobby Electronics

PASS THE LOOP

Time again for another of HE's famous game projects. This time we have taken the ageless pass the loop' game where a steady hand and nerves of steel are needed to thread a wire loop over a complex wire shape. We have brought it bang up to date with a variable timer, a noise generator to tell you when you've succeeded and some clever circuitry that will tell you when you have failed.

This elegant little circuit is an ideal fund-raiser for fetes, fairs or just good old fashioned fun at parties. The circuitry is extremely simple, ideal for 'old hands' and newcomers alike.



VIBRATION DETECTION

Bothered by burglars then this has got to be for you! The HE vibration detector is sensitive enough to detect a fly tip-toeing across the sensor or adjusted to respond to the heavy tread of a villain going through your drawers. Protect your property with this revolutionary little circuit, we even connected our prototype to the office copies of HE, whoever is pinching them will be in for a suprise! However you decide to use it don't miss next month's issue for full constructional details.

ICE

Or, to put it another way, In Car Entertainment. The world's leading Hi Fi manufacturers are now looking to the car to be the big 'boom' market for the eighties. Next month Terry Bentley, a leading motoring journalist looks at some of the equipment currently available. Is it worth spending £500 on a radio cassette player, can the small speakers ever match up to large devices used in domestic Hi Fi, what about the acoustics of the small metal boxes we drive? All these questions and more will be answered next month.

EQUITONE

In conjunction with our stereo booster we proudly present the 'Equitone', this cunningly simple device will allow you to make more of your existing car Hi Fi system. Three fully independent tone filters to control Bass, Mid and Treble. It has got to be heard to be believed.

TELETEXT

Tired of watching ordinary TV programmes? These days the BBC and IBA transmit something like 1000 'pages' of information with the existing TV signal. If you have the correct decoder these pages are available completely free. Currently you can call up information about the latest weather reports, Stock Market information, what's on at your local cinema to the number of seats available on airline flights.

The system was pioneered by engineers at the BBC during the late sixties and early seventies, so we thought it would be appropoiate to ask the BBC to tell us all about Teletext. One of the BBC's top engineers puts pen to paper next month, exclusively for HE, in what must be one of the most informative articles ever written about Teletext, past, present and future! Plus, we have news of some of the latest developments that have yet to be announced see it first in HE next month.

The August issue will be on sale July 11th

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

Watch NEWS

JULY 1980 60p

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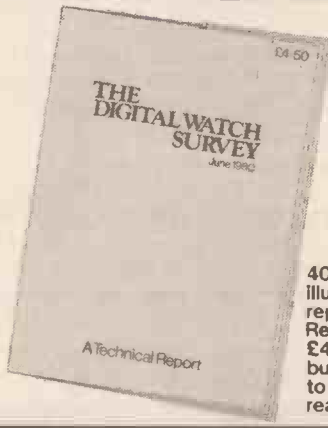

40 page illustrated report. Retail price £4·50 but just £1 to our readers.

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?

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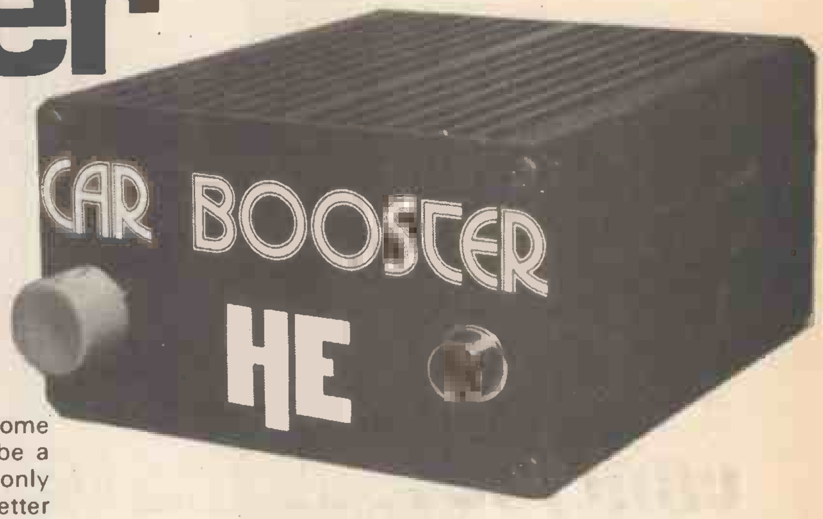
HE7

Car Booster

Have a quickstep in the carpark, discos in the drive or merely freak out on the freeway with the HE Car Power Booster.



EVERY ONCE IN A WHILE, the HE Project Team come up with a design that is virtually guaranteed to be a winner. And we feel that this project is just that! Not only is it easy to build, but it looks good, sounds even better and is cheap! Now, we can't be any fairer than that, can we?

The HE Car Booster consists essentially of two small printed circuit boards (one per channel for stereo), each of which holds the circuitry for an 18-watt power amplifier. The "18-watts" is not 18-watts "music power," "peak power", or "any old-power" that some equipment manufacturers specify when they talk of their devices but 18-watt true RMS into speakers of 4Ω impedances. In actual fact when we put the finished booster to test in our lab we recorded a full 22 watts RMS per channel — and that is loud!

Because the amplifier circuit contains the almost unbelievable sum of only 13 components, the PCB is consequently very small (less than three square inches), and it really is incredible that so few can sound so loud. The credit for this efficiency can be taken by the use of a purpose designed IC — The Hitachi HA 1388 which is a 12-pin, Single-in-line, plastic package and it really does all the donkey work. This chip brings in-car audio boosters to the amateur electronics world with a bang and anybody with a soldering iron and a steady hand is within reach of constructing their own.

Readers of May's HE may remember us saying that we were going to use the stylish SINK BOX case again, after it was used so successfully in the 5080 Stereo System. Well, here it is, holding the HE Car Booster, in a 100 millimetre length — a good 50% or more smaller than available ready-built units of similar power and performance. Because of its small size the booster is mountable either behind the dashboard of your car so as not to be seen, or simply fastened to the existing cassette/cartridge player or radio whose output is to be boosted.

All you need is the HE Car Booster, a pair of 20-watt speakers (more on them later) and a signal from your sound source (be it cassette, radio or whatever) and you can be enjoying about 40 watts of Hi-Fi audio inside your car. That means even in a car with the noisiest of engines we reckon you'll have enough volume there to blow your roof off.

CONSTRUCTION

The low component count of the circuit means construction is very simple. The only thing to watch is the correct polarisation of capacitors so follow the overlay carefully.

The metal tab of the IC should of course go to the outside of the board to make contact with the case. There is no need to use isolating washers between the IC and case as the metal tab of the IC is at ground potential, if your car is negative earth.

Switch SW1 connects in series with the positive supply line and LED 1 with series resistor R_3, go across the supply connections to one of the boards.

The two boards bolt to the bottom of the case, facing each other and slightly offset, so that the large capacitors C10 on each board do not touch any component on the other board.

All connections, the on/off switch SW1, and the LED go onto the end panels. We suggest the use of spring-loaded connections to the speakers; Phono sockets are best for the I/P from your cassette player and either a heavy duty (over 4 amps) power connector, or simply flying leads, for supply connections. Remember that all speaker connections should be isolated from earth, if you short any one of the four leads to 0 V that channel will cease to operate.

It is not necessary to adapt your existing cassette/cartridge player/radio if you don't want to. The HE Car Booster is designed to accept a signal from the speaker O/Ps of the source. A simple parallelled connection somewhere along the speaker line, either from the existing speaker end or the existing sound source end, will suffice. If you want to make a plug in/out connection you can put a couple of Phono sockets into your cassette player but this is not essential. You must however make sure that the grounded lead of each speaker connection is taken to the ground I/P of the corresponding channel of the booster and the signal lead to the signal I/P. Figure 4 gives suggestions how to connect the Booster.

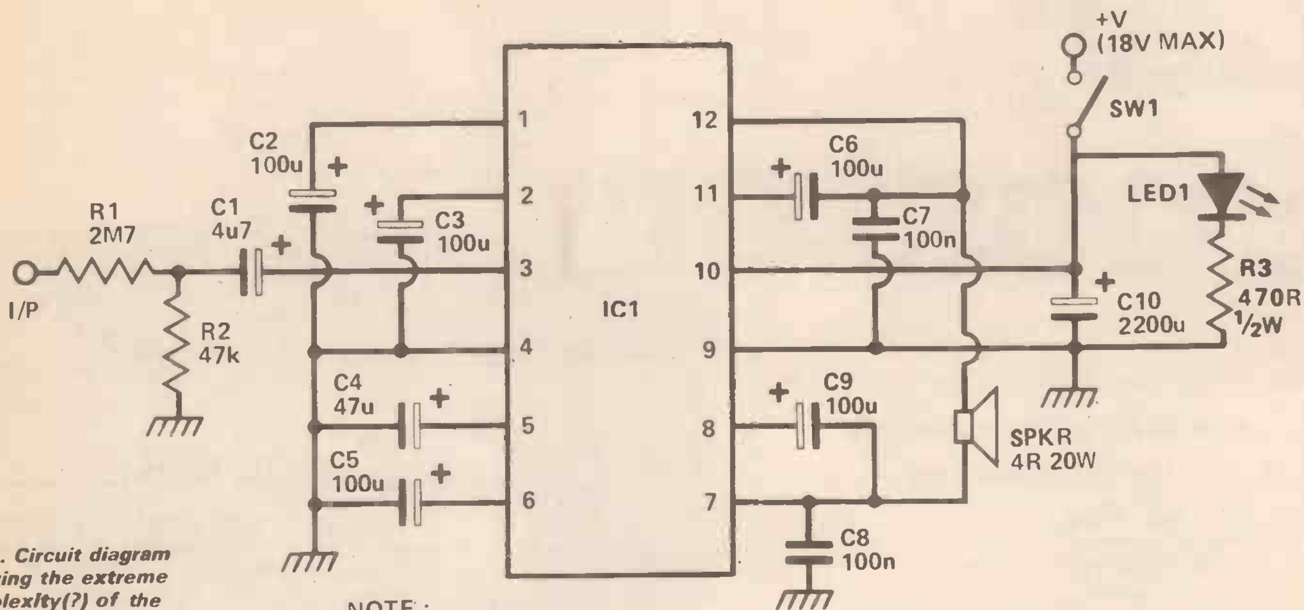


Fig. 1. Circuit diagram showing the extreme complexity(?) of the HE Car Booster — one channel.

NOTE :
IC1 IS HA1388

How it Works

The HA 1388 is an 18-watt amplifier IC designed and manufactured specifically for use in car amplifiers.

A normal power amplifier, operating from the voltage available on a car electrical system i.e. nominal 13 volts DC can only produce an output voltage swing of no more than 6 volts amplitude (12 volts peak to peak) across the load. The maximum RMS power available is 4.5 watts.

However, the HA 1388 has two such amplifiers in the IC which operate out of phase with each other. Figure shows the concept of the design. AMP 1 acts as a non-inverting amplifier, whose O/P is fed to the speaker and the inverting I/P of AMP 2. The outputs of the two amplifiers are therefore completely out of phase, producing voltage swings of 24 volts peak to peak (12 volts amplitude) across the speaker. This doubling of voltage quadruples the power available from 4.5 to 18 watts.

It should be noted that neither speaker terminal is at ground potential, unlike the input to the amplifier, or the outputs of the car cassette player. Care should be taken therefore to isolate them from ground.

Parts List

RESISTORS (ALL ¼W, except where stated otherwise)

R1	2M7
R2	47K
R3	470R, ½W

CAPACITORS

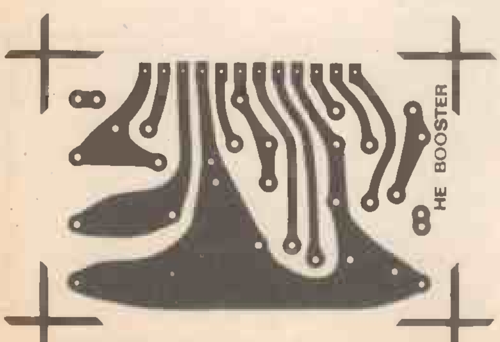
C1	4u7 16V Tantalum
C2,3,5	100u 6V3 Tantalum
C4	47u 6V3 Tantalum
C6,9	100u 10V Tantalum
C7,8	100n Ceramic
C10	2200u 16V P.C. Mounting Elect.

SEMICONDUCTORS

IC1	HA 1388
LED	RED LED

MISCELLANEOUS

SW1 Single pole, latching push button
4 Spring action terminals, 2 red, 2 black
2 Phono sockets
In-line fuse holder and 3 amp fuse.
Case.



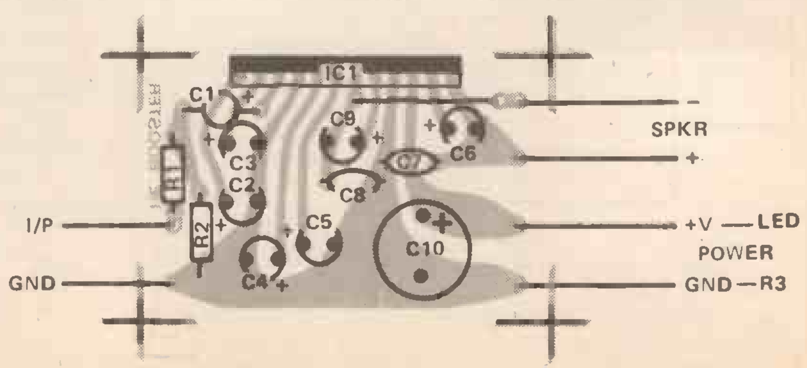
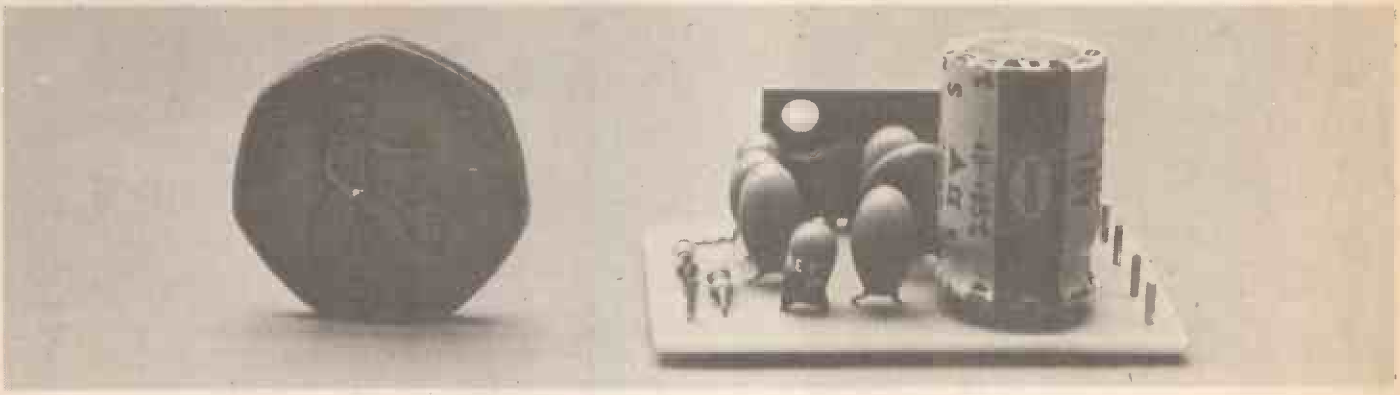


Fig. 2. PCB overlay.



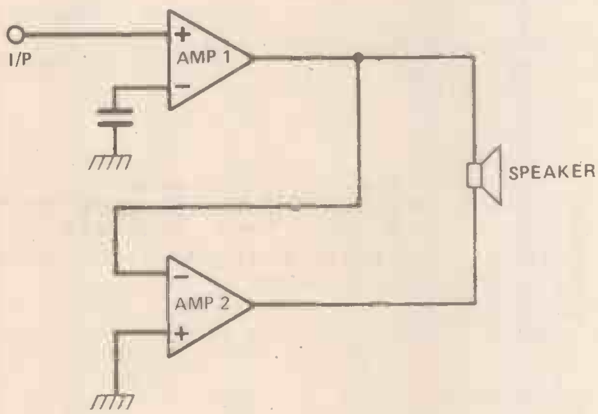


Fig. 3. Simplified internal circuitry of the HA 1388.

Buylines

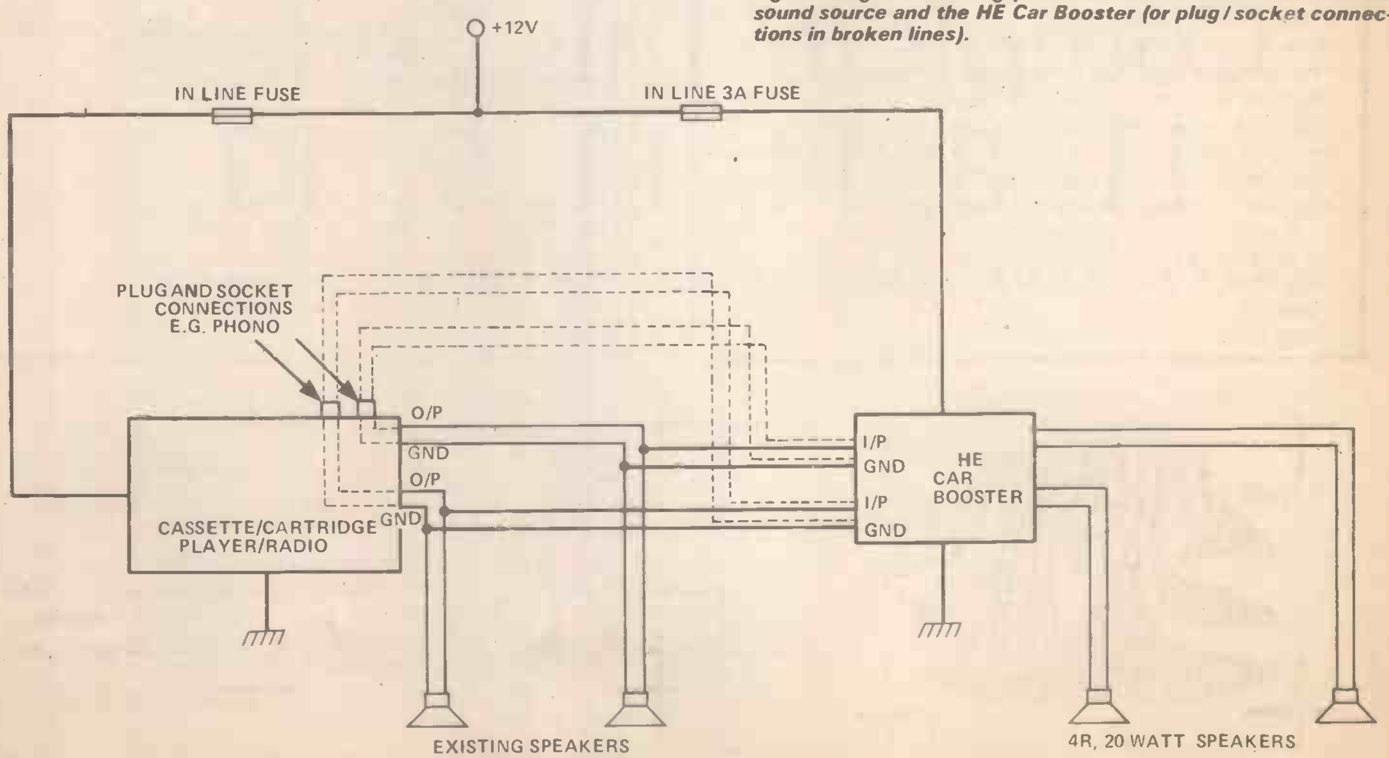
Ambit International are stocking the HA 1388 power amplifier IC and to our knowledge are the only suppliers this side of the Rising Sun.

The case is, of course from our old friends, West Hyde Developments and is the Sink Box in a 100mm length.

Although quite a few mail order companies hold car speakers in their stock, after a great deal of research and painful earache we found the exceptional range stocked by Tandy to be worth a close look. Their door-mounting speakers, no. 12-1855 were the cheapest we could find to handle the power but overall, the pod speakers, no. 12-1853 were the best value for money and of a very, very good quality. We have used Tandy before and have never been disappointed by their goods or their service.

All other components will be easy to come by.

Fig. 4. Diagram showing permanent connection between the sound source and the HE Car Booster (or plug/socket connections in broken lines).



SPEECH PROCESSOR

Speech processors are primarily used in radio transmitting equipment, but can be used in public address systems, disco equipment, etc., where it is necessary for a speech signal to be as effective as possible.

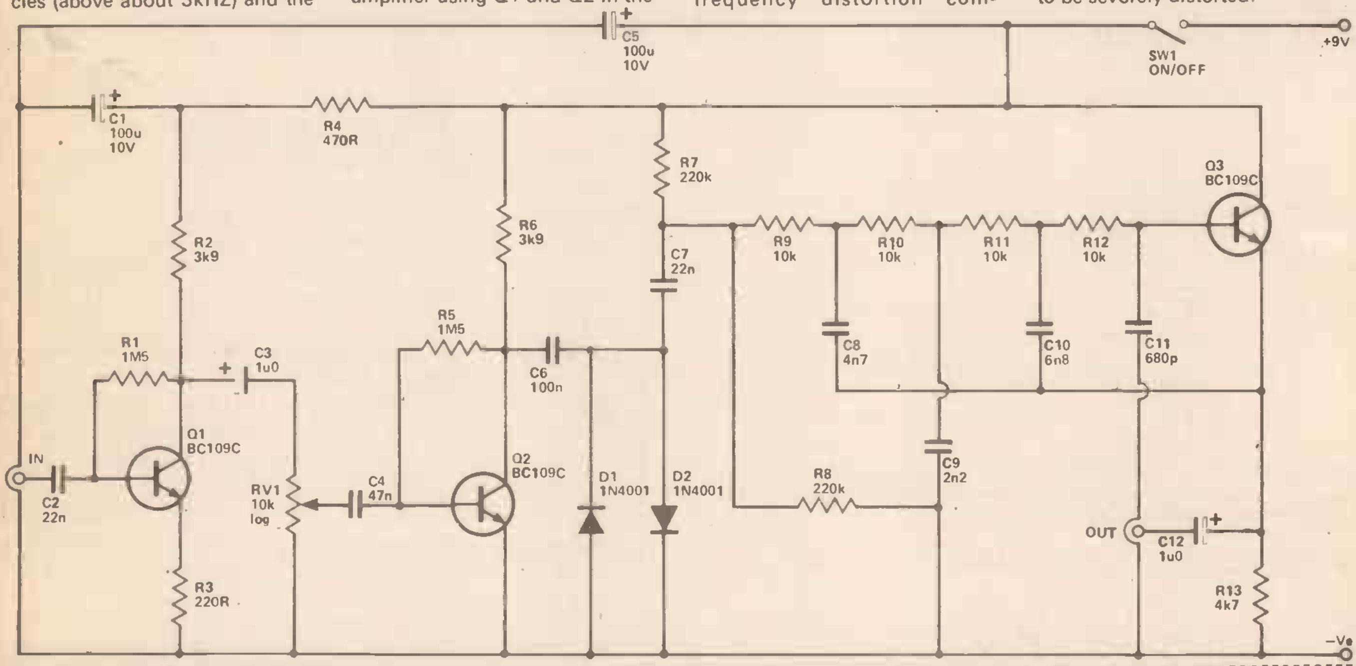
Bass frequencies do not aid the intelligibility of speech, and treble frequencies are of little help either. The signal can therefore be made more effective by attenuating the higher frequencies (above about 3kHZ) and the lower frequencies (below about 250Hz), and then boosting the signal to compensate for the reduction in its amplitude.

A speech signal has a rather spikey waveform, and the average signal amplitude is rather low in comparison to the peak level. The signal is given considerably more "punch" if the peak levels are reduced, but the lower levels are not compressed.

In this circuit the signal from the (50k impedance) microphone is amplified by a two stage preamplifier using Q1 and Q2 in the common emitter mode. RV1 is microphone gain control. The output from the preamplifier is coupled by C6 to a simple clipping circuit which uses D1 and D2 to clip the signal at about ± 0.5 V. In use the output from the preamplifier will be somewhat higher than this, and so signal peaks will be severely reduced in amplitude by the clipping circuit, but signals below ± 0.5 V. will not be affected.

This gives the required compression, but also distorts the signal and generates high frequency distortion components. These are considerably attenuated by an active low pass filter based on Q3 and having a nominal 18dB. per octave roll off rate. This gives a reasonably "clean" signal, and provides the required high frequency attenuation. The low frequency attenuation is obtained by using low value coupling capacitors in the circuit.

RV1 is adjusted to give the desired amount of compression, and should not be advanced too far as this would cause the output to be severely distorted.



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AC179	£0.29
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BD132	£0.40
BD133	£0.46
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BD137	£0.40
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BD138	£0.41
BD140	£0.41
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2N2906A	£0.21
2N2907	£0.23
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2N3053	£0.20
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2N3708	£0.08
2N3709	£0.08
2N3710	£0.08
2N3711	£0.08
2N3819	£0.21
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7403	£0.13
7404	£0.13
7405	£0.13
7406	£0.25
7407	£0.25
7408	£0.15
7409	£0.15
7410	£0.13
7411	£0.20
7412	£0.17
7413	£0.28
7414	£0.58
7416	£0.26
7417	£0.26
7420	£0.13
7421	£0.23
7422	£0.18
7423	£0.24
7425	£0.22
7426	£0.26

Type	Price
7427	£0.28
7428	£0.30
7430	£0.13
7432	£0.25
7433	£0.35
7437	£0.24
7438	£0.24
7440	£0.14
7441	£0.58
7442	£0.46
7443	£0.81
7444	£0.81
7445	£0.75
7446	£0.69
7447	£0.55
7448	£0.64
7450	£0.13
7451	£0.13
7453	£0.13
7454	£0.13
7460	£0.13
7470	£0.29
7472	£0.23

Type	Price
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7474	£0.29
7475	£0.33
7476	£0.29
7480	£0.51
7481	£0.98
7482	£0.78
7483	£0.67
7484	£1.01
7485	£0.78
7486	£0.25
7489	£1.96
7490	£0.37
7491	£0.74
7492	£0.40
7493	£0.35
7494	£0.86
7495	£0.58
7496	£0.58
74100	£0.98
74104	£0.45
74105	£0.44
74107	£0.28

Type	Price
74110	£0.41
74111	£0.67
74118	£0.92
74119	£1.36
74121	£0.28
74122	£0.45
74123	£0.46
74136	£0.60
74141	£0.63
74145	£0.63
74150	£0.78
74151	£0.55
74153	£0.55
74154	£0.94
74155	£0.58
74156	£0.58
74157	£0.58
74160	£0.67
74161	£0.71
74162	£0.71
74163	£0.71
74164	£0.78

Type	Price
74165	£0.78
74166	£0.90
74174	£0.75
74175	£0.71
74176	£0.67
74177	£0.67
74180	£1.73
74181	£0.67
74182	£0.81
74184	£0.81
74190	£0.78
74191	£0.71
74192	£0.69
74193	£0.67
74194	£0.71
74195	£0.69
74196	£1.21
74197	£1.21
74198	£2.13
74199	£2.13

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CD4006	£1.06	CD4016	£0.49	CD4025	£0.22	CD4040	£1.01	CD4050	£0.55
CD4007	£0.20	CD4017	£0.94	CD4026	£1.38	CD4041	£0.87	CD4054	£1.27
CD4008	£1.06	CD4018	£0.98	CD4027	£0.58	CD4042	£0.83	CD4014	£0.92
CD4009	£0.52	CD4019	£0.48	CD4028	£0.78	CD4043	£1.01	CD4055	£1.15
CD4010	£0.55	CD4020	£1.04	CD4029	£0.98	CD4044	£0.94	CD4056	£1.55
CD4011	£0.22	CD4021	£0.94	CD4030	£0.55	CD4045	£1.61	CD4069	£0.20

LINEAR

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
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CA3014	£1.55	CA3140	£0.81	NE550	£1.09	72723	£0.52	TAA550B	£0.40
CA3018	£0.75	LM301	£0.33	NE555	£0.28	UA741C	£0.28	TAA621A	£2.30
CA3020	£1.96	LM308	£1.84	NE556	£0.69	72741	£0.28	TAA621B	£2.88
CA3028	£0.92	LM308	£1.15	NE565	£1.38	741P	£0.23	TAA661	£1.73
CA3035	£1.61	LM309	£1.73	NE566	£1.73	UA747C	£0.69	TAD100	£1.50
CA3036	£1.15	LM380	£0.98	NE567	£1.96	72747	£0.69	TBA540	£2.42
CA3042	£1.73	LM381	£1.67	UA702C	£0.53	UA748	£0.40	TBA810S	£0.86
CA3043	£2.13	LM3900	£0.67	72702	£0.53	72748	£0.40	TBA810	£1.13
CA3046	£0.81	MC1303L	£0.98	UA703	£0.29	748P	£0.40	TBA820	£0.81
CA3052	£1.84	MC1304	£2.19	UA709	£0.29	SN76013N	£2.01	TBA9200	£2.88
CA3054	£1.27	MC1310	£1.09	72709	£0.53	SN76023N	£2.01	TCA270S	£2.30
CA3075	£1.73	MC1312	£2.19	72709P	£0.29	SN76110	£1.73	TBA800	£0.92
CA3081	£1.73	MC1350	£1.38	UA710C	£0.46	SN76115	£2.19	TBA120	£0.60
CA3089	£2.30	MC1352	£1.61	72710	£0.35	SN76660	£0.86	TBA641A	£1.84
CA3090	£4.14	MC1469	£3.39	UA711C	£0.37			TBA641B	£2.53
CA3123	£2.19	MC1496	£1.04	72711	£0.37			ZN414	£1.15

THYRISTORS

Volts	No	Price
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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
50	THY1A/50	£0.30
100	THY1A/100	£0.32
200	THY1A/200	£0.37
400	THY1A/400	£0.44
600	THY1A/600	£0.52
800	THY1A/800	£0.67
50	THY3A/50	£0.32
100	THY3A/100	£0.35
200	THY3A/400	£0.37
400	THY3A/400	£0.48
600	THY3A/600	£0.58
800	THY3A/800	£0.75
50	THY5A/50	£0.41
100	THY5A/100	£0.51
200	THY5A/200	£0.57
400	THY5A/400	£0.65
600	THY5A/600	£0.79
800	THY5A/800	£0.93
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
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
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
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

Type	Volts	Price
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
IS10/400	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

volts	No.	Price
2 amp TO5 case		
100	TR12A/100	£0.36
200	TR12A/200	£0.59
400	TR12A/400	£0.82
6 amp		
100	TR16A/100	£0.59
200	TR16A/200	£0.70
400	TR16A/400	£0.88
10 amp		
100	TR110A/100	£0.88
200	TR110A/200	£1.06
400	TR110A/400	£1.29
10 amp Plastic		
400	TR110A/400P	£1.29

DIACS BR100 £0.23 D32 £0.23

BRIDGE RECTIFIERS

Type	No.	Price
SILICON 1 amp		
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 2 amp		
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 10 amp		
50v RMS	BR10/50	£1.73
200v RMS	BR10/200	£1.96
SILICON 25 amp		
50v RMS	BR25/50	£2.19
200v RMS	BR25/200	£2.53

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
AA110	£0.09	BY100	£0.25	BYZ11	£0.52	OA90	£0.12
AA120	£0.09	BY101	£0.25	BYZ12	£0.46	OA91	£0.12
AA129	£0.09	BY105	£0.25	BYZ13	£0.46	OA95	£0.12
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	£0.12	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	SO19	£0.07
BA154	£0.14	BY130	£0.20	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
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BAX13	£0.08	BY206	£0.34	OA81	£0.12	IN4148	£0.07
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						IS920	£0.07

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1503	125	YELLOW	£0.16
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1505	2	GREEN	£0.16
1506	2	YELLOW	£0.16
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Electronic

Rick Maybury has been snooping around this month into the dark and devious world of Electronic Espionage. It seems that these days anyone with a secret worth knowing can be liable to some kind of 'Surveillance' if you're being bugged then don't miss the section on anti-bugging techniques.

WHISPER WHISPER HE WHO DARES, a bug's been planted under the stairs. (Apologies to A A Milne). Planting bugs under stairs is not actually such a good idea as we will see later. Today the Microbug, star of countless spy films means more than just an FM transmitter. The spy industry can now offer a bewildering range of devices that can be anything from a straight 'bug' to a device the size of a small suitcase that will analyse the integrity of up to twelve telephone lines simultaneously. A lot has been happening since the rather clumsy attempt at Watergate, nowadays though, most of the blame for these intrusions into privacy can be squarely laid at the door of the microelectronics industry.

Until the advent of the IC in commercial quantities (in the early 70s) the would-be spy had a relatively limited choice of equipment. The FM transmitter was (and still is) the favourite method of eavesdropping. These very simple circuits, sometimes nothing more than a couple of transistors, can be easily built by amateurs, the circuits are freely available (even in this country). With care they can transmit an almost Hi-Fi like quality signal over a distance of a mile or so and still fit into a matchbox.

Luckily such devices are very easy to locate and immobolise, indeed, much of the equipment on sale in this country is aimed at the 'anti-bug' market. Most bug detectors are nothing more than wide band receivers (usually from 1 to 500 MHz) which locate the transmitter by setting up an RF feedback path to induce the characteristic 'Howl Round' that will increase in amplitude as the receiver is brought closer to the bug's microphone.

Strangely enough it is quite legal to import and sell bugs in this country, as anyone who has an interest in CB radio will tell you the Government introduced legislation in 1967 to prevent the import of cheap 27 MHz walkie talkies. For some reason best known to the Government of the day this left a gaping loophole that permits the sale but not the use, of a large range of transmitting equipment. Take a look sometime through the pages of one of those national classified advertising magazines, you should see scores of small ads offering 'Cordless Microphones', 'Wireless Baby Alarms' or even a blatent 'Miniature FM Wireless Microphone', and they call CB a 'menace'.

The ease of availability of these bugs and their low price has made virtually anyone with a secret a potential target for bugging. If you think that you could be a candidate then at the end of this article we'll give you a

'Counterspy', the anti-bugging shop in London. They can be found just around the corner from the American Embassy!

Espionage

few hints on what to look for, in the meantime let's look at the Telephone, it must rate as the most popular target for eavesdroppers.

BUZBY BLUES

The beauty of the 'phone, from the spys point of view, is its position in a room or office. The 'phone is usually placed on a desk or table around which potentially interesting conversations are bound to occur. The 'phone can be bugged in one of three ways. The most obvious method is to 'tap' the line. In its simplest form a tap will just consist of a couple of wires linked in parallel to the line at some vantage point within the building or at an outside distribution box in the street. If the tap is likely to be a long term affair the usual plan is to connect the wires to a tape recorder via a VOX (Voice Operated) switch, the tap can then be left unattended, save for an occasional visit to change the tapes. The much publicised Home Office tapping operation at Ebury Bridge House is actually quite interesting though mostly sensationalistic journalism. The suggestion that they have the ability to transcribe the conversations directly into a print out is actually nonsense, as any computer buff will tell you. Even the best voice recognition systems have only a 50% success rate, and that is with clearly spoken English. Mind you, you can be quite sure that someone somewhere is working day and night to improve on that!

Detecting a straight Tap is quite straightforward, a device called a 'Blanched Line Voltage Analyser' will tell you if any unauthorised connections have been made to your line, however, it's not much good against an 'authorised' or professional tap at the exchange for instance.

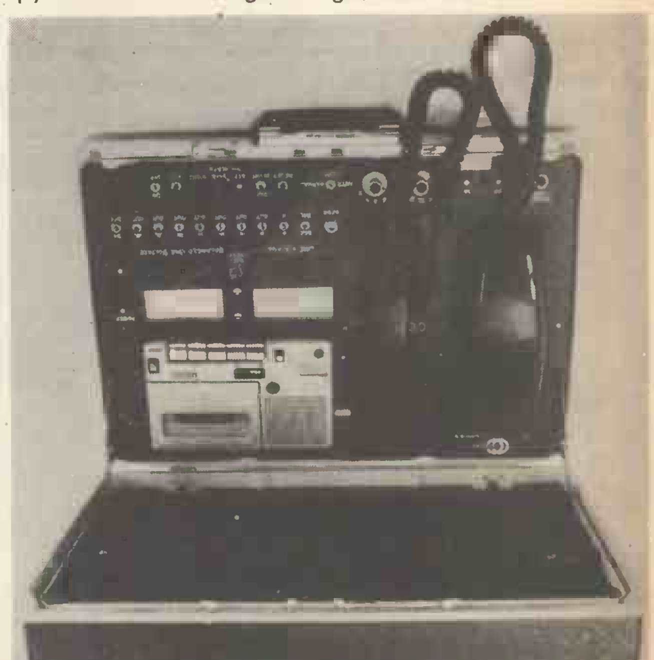
Aside from a physical connection to the line the 'phone offers a couple of other interesting alternatives. Because of the in-built power supply it is ideal for RF bugs, the problem of expiring batteries has always made RF bugs a bit limited. (It was suggested that high levels of RF energy beamed at the American Embassy in Moscow was an attempt by the Russians to re-charge the batteries in their bugs.) Because these bugs are essentially RF, detection again is no real problem.

The third, and probably most elegant (from an electronics point of view) method of phone tampering is the 'Infinity Transmitter'. This cunning little device is little more than a narrow band tone filter and a couple of reed relays. Once implanted inside the phone the spy has only to dial up the phone (on the pretext of a wrong number) wait for the receiver to be replaced and blow a whistle, this activates the relays which keep the line open and the microphone (in the handset) in circuit. There are several, more advanced, variations on the Infinity Transmitter theme, one specimen can be activated without the bell ringing. The use of STD equipment on an international scale makes it theoretically possible to overhear conversations in Australia from the comfort of your armchair in England, mind you, you'll still get large 'phone bills.

BASIC BUGS

Lower down the scale in terms of complexity, but still valid from the effectiveness point of view is the 'Hard Wire' bug. This is usually nothing more than a concealed microphone connected up to an amplifier. The beauty of this system is that, it's almost impossible to detect, the spy is at a disadvantage though, it is much more difficult

Subminiature bug detector, the LED on top blinks when a bug is operating in the room.



A complete anti bug system. The suitcase contains a tap detector, a tap defeater, telephone monitor and scrambler.

to conceal long runs of cable and unless he or she incorporates a tape recorder with a VOX switch it requires almost constant attendance. Several stories however about Hard Wire bugs being built-into buildings during construction sound quite plausible, the Americans in particular have some stories to tell on this score, or so we're told.

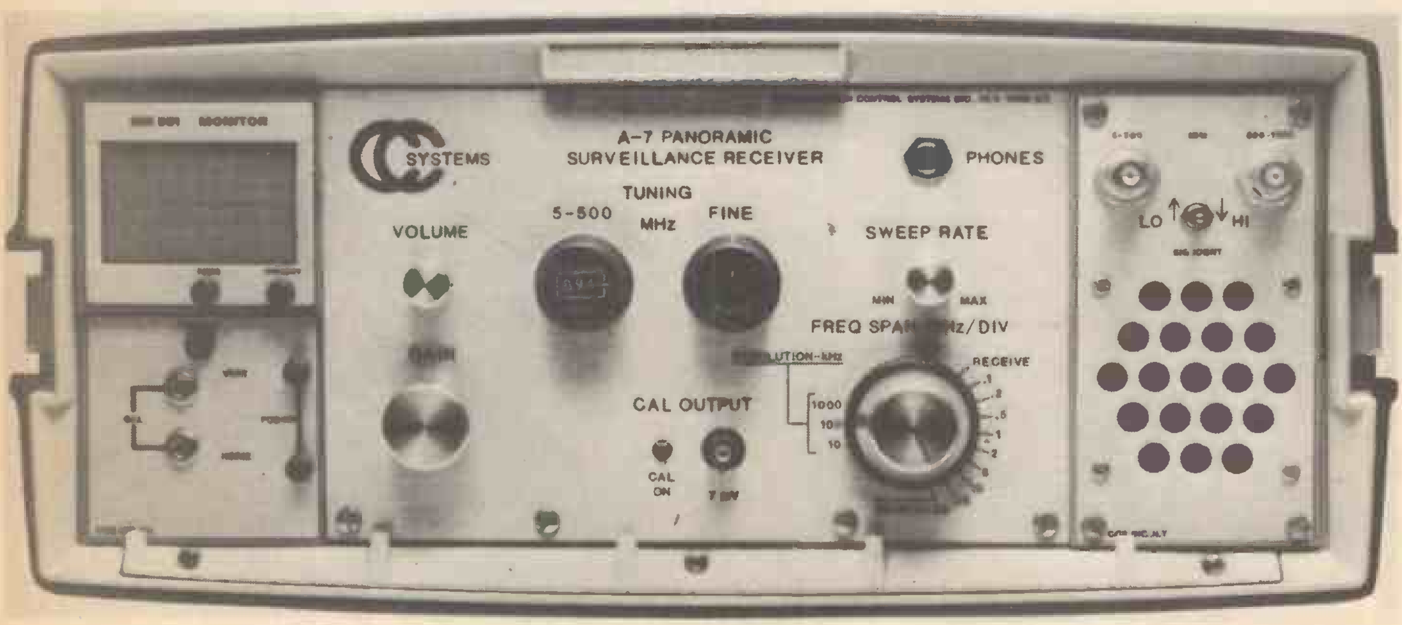
LIGHT LISTENING

Bang up to date now, it's not surprising that our old friend the Laser should pop up somewhere (didn't someone once say that the Laser was an invention looking for an application?). It is now possible to buy yourself a gadget called a Laser Bounce Surveillance Receiver. Operation again is wonderfully simple, sound waves in a room act upon glass imparting minute vibrations onto the glass in sympathy with any speech. A laser (usually outside the visible spectrum) is beamed onto the glass and the reflections, modulated by the vibrations in the glass, bounce back to the receiver to be decoded into speech. It is quite likely that buildings up to a mile away could be 'surveyed' in this way. One further thought, with the trend of modern architects to use mirrored glass in office buildings we suspect that the efficiency of Laser bounce has been improved dramatically.

VIDEO BUGS

With all the improvements in IC technology it's not surprising that video cameras can now be reduced to the size of a five pence piece. Indeed the latest CCD (Charged Coupled Device) cameras, with a couple of ancillary IC and a simple transmitter circuit, can now fit comfortably inside a matchbox. The lens is usually the single largest component! We are led to believe that these cameras operate in extremely low light conditions and quite conceivably in colour. Although we haven't actually seen a system that small, it is clear from our research that you can buy over the counter a 'Video Bug'

Wide band surveillance receiver. This model will tune over the range of 1 to 1500 MHz, a built in oscilloscope shows the devices bandwidth and the presence of any other bugs on other frequencies.



complete with camera, monitor and microwave link for 'remote applications'. . . .

SPEAK THE TRUTH

Latest gadget from across the big pond has the sinister title of a Voice Stress Analyser. Basically this is a device that was developed during the Vietnam War by the Americans to 'humanely' interrogate prisoners. It works by detecting so called 'microtremors' in the voice that are said to occur when the subject is under stress. It remained pretty much a curiosity for several years until some bright spark brought the size of all the gubbins down to IC level. Now you can freely buy (in the States) VSAs that slip into suitcases, the publicity blurb proudly claims that '. . . it is ideal for assessing the integrity of prospective employees . . .'. The implications are quite clear, conventional skin resistance type lie detector (polygraphs) work mainly on variations of skin resistance brought about by sweating (stress). The VSA has no physical connections to the subject, and because it only requires an easily hidden microphone to use, it is easily hidden. Not only can a conversation be analysed 'live' it is also possible to tape the conversation and study it later. The latest type of Voice Stress Analyser even works over the telephone, presumably you can bug someone via your Infinity Transmitter and at the same time tell whether they are telling the truth or not. . . .

DE-BUG YOURSELF

Now as promised we present the Hobby Electronics guide to anti-bugging procedures. Firstly we shall look for RF bugs, assuming that you are dealing with a run-of-the-mill type spy it's a fair bet that any RF bug will be an FM VHF type. Arm yourself with an FM receiver and set it up in the middle of the room. Turn the volume full up and scan up and down the band. Because of the presence of broadcast stations in the middle portion of the band any bug will be either at the lower end or the

Portable Voice Stress Analyser capable of working over the telephone. The results can be displayed either as a two digit display or a hard copy on the integral printer.

A larger device, this has an IC doing most of the work, it will fit neatly inside a telephone.

A watch bug, the aerial is inside the strap, it can pick up a conversation 20 to 30 feet away and transmit it for up to a mile and a half.

upper end, they would be very stupid to tune it in the police band!

Listen for a distinct 'dead' spot, if the room is quiet you'll hear the background noise. Having located a possible carrier walk round the room whistling, this sounds a bit daft but this should help you set up a feedback loop. If the radio suddenly starts oscillating turn the volume down and try to find out in which direction the oscillations get louder. Once you have narrowed it down you should be able to find it with a careful visual examination. The two main types of bug likely to be encountered are the disguised bug, one that has been placed inside an inconspicuous looking object, look at anything that may be new on your desk, a stapler for instance or even the phone. The second type of bug is usually hidden in a place that would not normally be examined, the underside of desks, air conditioning vents, inside the cushion of chairs, behind polystyrene tiling etc.

If you're clear of FM bugs (that doesn't include bugs operating on other frequencies though, you'll need a specialised receiver for that), you should now look at the telephone as a potential source of trouble. The best way to protect yourself against infinity transmitters is to have all your calls routed through a switchboard, direct lines are out. Have you had a visit from any phone engineers lately? If you have then it's a simple matter to check up with the phone company to check credentials. Taking the phone apart to look for bugs is not advisable. Apart from the person who placed the bug knowing straight away that the device has been discovered (you may wish to feed them 'duff' information). The Post Office take a pretty dim view of anyone mucking about with their equipment. They are probably the best people to investigate, or you could get in touch with one of the many firms that now offer a comprehensive de-bugging service. That goes for taps too (unless it is the authorities placing a legitimate tap on your phone in which case they probably wouldn't tell you anyway).

Laser bounce is a bit more tricky to counter, you could go to the expense of fitting low reflectivity glass and double glazing or 'deadening' the glass with a thin film of plastic sheet. Video bugs will be even harder to trace, the obvious give-away will be the lens, it will have to be quite large (a couple of cm across at least) to be effective and it would have a nearby microphone (not all spys can lip-read). Because of bandwidth problems in transmitting video, the RF will be at a very high frequency, again a specialised receiver will be needed. If the video bug has been hard wired then you must look for tell-tale wires, remember too that a cunning spy could use telephone wire, check it out with the PO. If the building you occupy is relatively new then any bug installed at the building stage could be almost impossible to detect, the only answer here is to build a room within a room, this can be used when discussing especially sensitive matters. The Russians apparently do this as a matter of course in all their foreign embassies. If after all these precautions you are still troubled by bugs then the only people who can help you are Rentokill.

HE

We would like to make it clear that 'Counterspy' DO NOT sell bugging devices. However, if you want to see what is available on the 'anti-bugging' market you could do worse than pay them a visit.

The author would like to thank Jo Ann O'Neil and the staff of 'Counterspy' (62 South Audley St, London W1) for their help in preparing this article.

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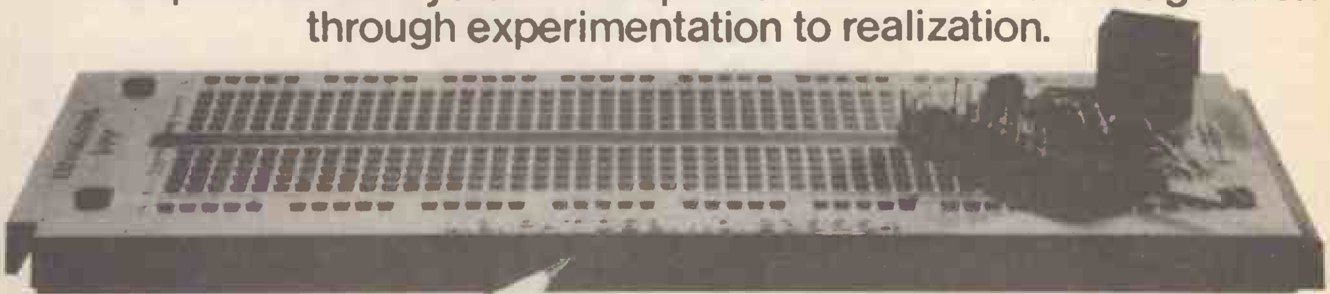
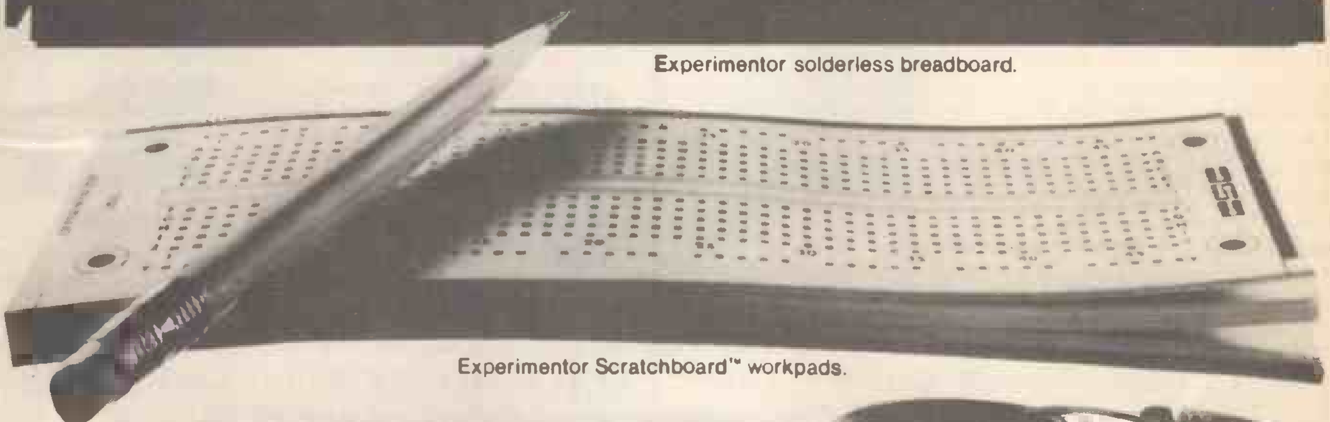


Experimentor solderless breadboard.



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Dual timing facilities are readily available.

Back Light. Fully adjustable stainless-steel strap.

This watch is available in gold or silver.

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Clever Dick

The problem of detecting woodworm in furniture crops up again this month. We need some help with a bee-detector circuit and a useful mod for the Hobbycom. It's all in CD this month.

IT LOOKS AS IF THE WORM HAS TURNED, the woodworm man Cliff Robertson (see CD March) has written to us again.

Dear Dick,

I was pleased to see that my suggestion about woodworm detection was not entirely a damp squib. It is hardly surprising that Barry Hayton's friend received everything within earshot in his experiment at the church, he was clamping his mike to a very large receiving diaphragm. However, it prompted me to try the idea out on my piano — it has a suspended fret carrying the pedals where I have noticed the wood champings on the carpet. An 1710 Akai recorder was handy, and having fixed a rubber shield over the end of one of the microphones, I applied it to the affected part! There was of course the sustained hiss of valves etc, but there was also the unmistakable, irregular gnawing noise. The fret is now in my workshop soaking in Rentokil, after a suitable execution I will have another listen. If you can ask one of your older friends for the loan of a reel-to-reel tape recorder I will send you the tape.

By the way, Cliff Robertson was a film star, I'm just an ancient monument.

Cliff Robertson,
Isle Of Wight.

PS. My first contribution to the electronics world was in Amateur Wireless magazine No. 14, dated September 9th, 1922. It was signed 'CF' which was a severe blow to my pride but the cheque for 10/6 arrived just the same.

Well, what can we say, times have obviously changed. It transpires that Amateur Wireless went out of business soon after your letter was published, an omen for us perhaps? Actually we're willing to take the chance and send you a HE Binder worth £3.8s.6d (about right allowing for inflation).

By the way, what's a reel-to-reel tape recorder?

Is Mr Williams having us on? Read on.

Dear Dick,

I am interested in Beekeeping and have heard of a device for detecting the change of tone of the bees just prior to swarming.

I would be most obliged if you could give me some information about this instrument or give me the address of someone who could help.

Daniel Williams,
Gwynedd.

Come on you lot, how about some more of those weird and wonderful ideas you keep having!

Back to more down-to-earth matters now with this letter from someone who declined to send us their name. We'll call him Mr X.

Dear CD,

Whilst looking through my local library for electronics books I came across '104 Easy Transistor Projects' by Robert Brown.

The problem is that this book is American, the projects that I wish to build use transistors that I have not been able to find in any of the ads in either HE or ETI. Any suggestions? They are: 2N105, 2N1573 and 2N370. Could you advise me of any substitutes or any shops that stock them. Ace Mag, keep up the good work.

Mr X,
Edmonton, London.

No sooner said than done. The famous 'Towers International Transistor Selector to the rescue.

2N105=AC107N,
2N1573=BFY65,
2N370=AF124,
OK?

Now for a reply to the letter from Mr Harrington who had a problem with a nearby radar station interfering with his equipment (electronic that is).

Dear Dick,

As I live in a high-rise block of flats I have the reverse problem to that of Mr Harrington. I find that I am unable to receive transmissions due to the screening effect of the metal reinforcements of the structure.

May I suggest to Mr Harrington that screening might help to stop his interference. This could be made from cooking foil hung on a wooden frame sited between him *and the radar station. It would of course have to be earthed.*

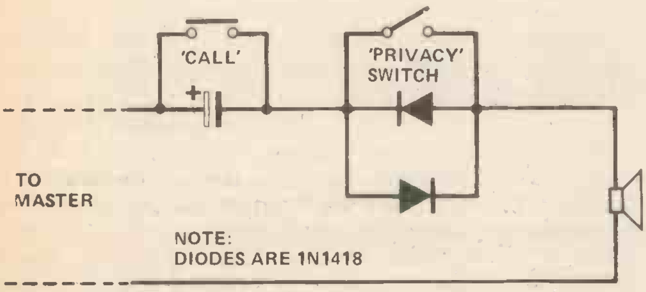
Ray Pearce,
Southampton.

Well, that's one suggestion, how about 'papering' your walls with aluminium foil, it would also help keep your heating bills down.

Rupert Goodwins has a simple modification for the Hobbycom, it goes something like this:

Dear Dick,

A fault on the original Hobbycom is that a sub-station can be operated without it being realised. A simple modification to overcome this problem is as follows.



The diodes (IN1418) allow the call tone or voices from the main station to be heard but the minute voltages from the sub-station speaker are not enough to turn the diodes on.

Rupert Goodwins,
Southway.

That looks pretty good to us. If anyone else has any modifications or suggestions for our projects then why not let us know about it.

Our last letter this month comes from young Paul Collins over there in Chipping Sodbury.

Dear Dick,

Owing to money problems, would it be possible to adapt the Travelling Alarm Clock in the May issue to a LED Display, possibly with the help of a few ICs?

I don't mind if any of the functions are missing provided the Alarm is still there.

Paul Collins,
Chipping Sodbury.

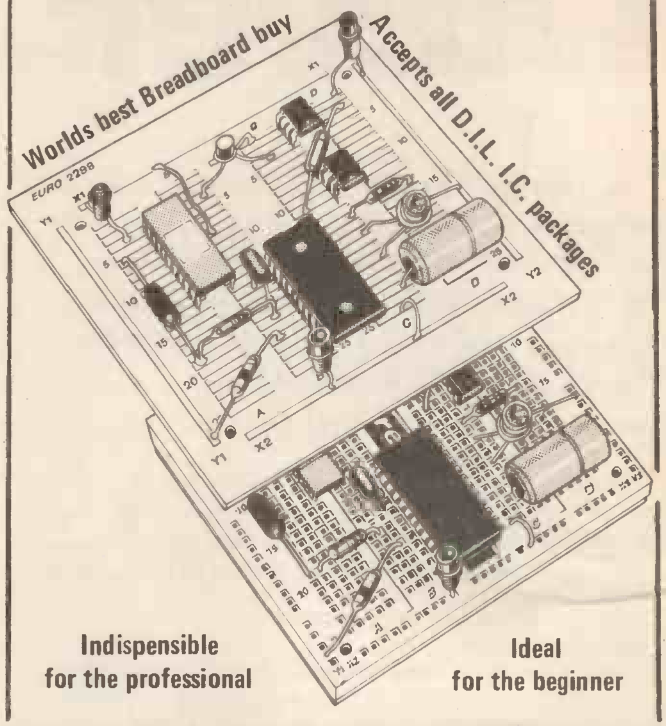
Dear Paul,

Sorry mate, the display is part of the module, even if you used another clock IC you would still need a rather large battery to keep the display going, then you really would have money problems. Stick to our design, at least it works.

Thanks for your letters, keep them coming. See you next month.

HE

First the EuroBreadBoard Now the EuroSolderBoard



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or	2	EuroBreadBoards	@ £11.70	O	Please
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or	1	EuroSolderSucker	@ £ 7.25	O	

All prices are applicable from Jan. 1st 1980 and include VAT and PP but add 15% for overseas orders.

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Please make cheques/P.O. payable to David George Sales and allow 10 days for cheque clearance and order processing

Push-Button Volume Control

A project for the HI-FI buff, experimenter and electronics 'loon'. It's a gadget that lets you control the volume of a stereo amplifier via a single push-button switch; any number of such switches can be wired in parallel and used to control the volume from different parts of the room.

THIS UNIQUE project enables the conventional ganged volume control of a stereo amplifier to be replaced by a single push-button switch. The switch is coupled to a sophisticated IC which processes the push-duration information and then controls the volume of the amplifier (via an electronic module) in accordance with that information.

If the switch is simply closed for a brief period (60 to 400 mS) the volume merely switches from ON to OFF (Mute) or vice versa, depending on the previous state. A longer switch closure (greater than 400 mS) causes the volume level to cycle slowly from minimum to maximum or vice versa for the duration of the closure, taking about seven seconds to span the full volume range: when the switch is released the prevailing volume level is 'remembered' and maintained indefinitely. At switch off or Mute (a brief switch closure) the chosen volume level is 'stored': this volume is automatically set again at switch-on (another brief switch closure).

REMOTE CONTROL

A single push-button switch thus enables the volume to be turned on or off or set to any desired level, as required. In practice, any number of push-button switches can be wired in parallel: these switches can, if desired, be located remotely from the main amplifier, enabling the volume to be remotely controlled from any number of points.

Our push-button volume control project uses three individual circuits, each built up on it's own PCB. The main circuit uses five ICs and is used to generate a DC output control voltage via the push-button switch. This output is used to control an electronic stereo 'pot' circuit that is designed around a single IC and built on a small PCB. The third PCB circuit is a LED bargraph voltage-level indicator, which is intended to mount on the front panel of the stereo amplifier to give a visual indication of the amplitude of the DC control voltage.

The two small PCB modules are powered from a 15 volt regulator that is built into the main PCB, which in turn can be powered from any 18 to 30 volt positive supply that is available in the existing stereo amplifier and capable of supplying currents up to about 150 mA. The three modules are intended to be built into an existing stereo amplifier. Figure 1 shows how the three PCBs are interconnected.

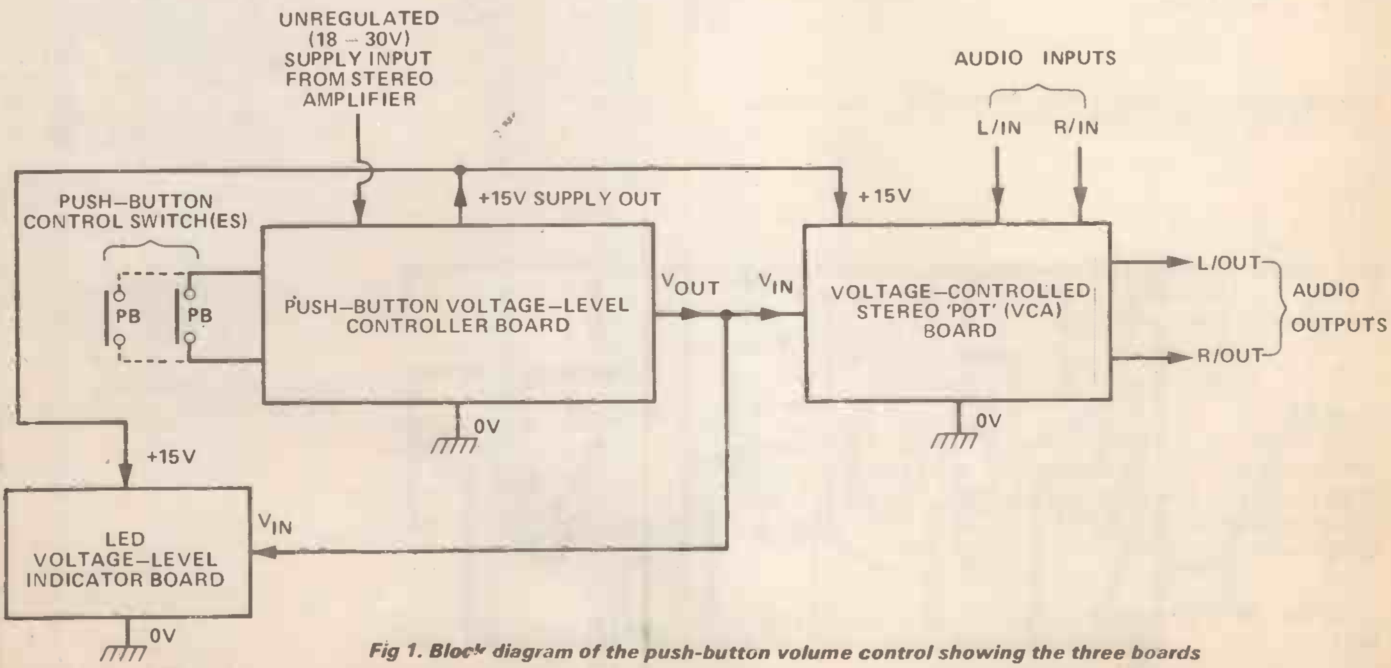


Fig 1. Block diagram of the push-button volume control showing the three boards

CONSTRUCTION AND TEST

The project is built up on three individual PCBs, each of which can be used as a self-contained project. Construction of the boards should present few problems if the usual care is taken to observe the polarities of all semiconductors and electrolytics and to follow the overlay details. We recommend that all ICs be fitted in suitable sockets.

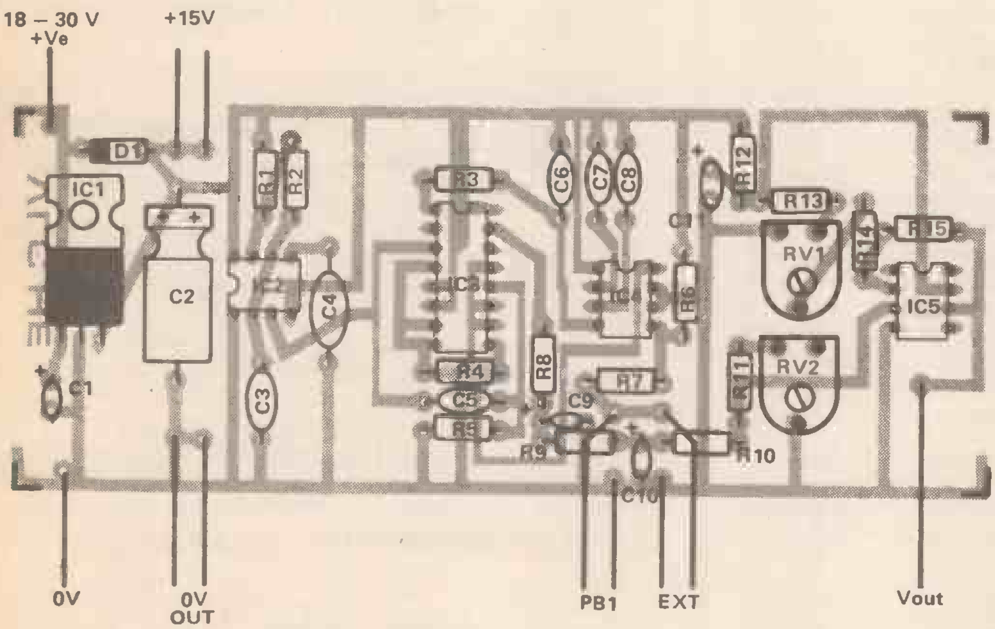
Start construction by building the large push-button voltage-level controller unit. Note that IC4 is a Siemens S566B touch-dimmer IC and must not be confused with the similarly numbered NE566N voltage controlled oscillator IC. When construction of the unit is complete, connect it to a suitable power supply, fit PB1 in place, connect a voltmeter between ground and the V_{out} terminal and give the circuit a functional test by operating PB1: it should be possible to ramp the voltage up and down or switch it to zero via PB1, as already described.

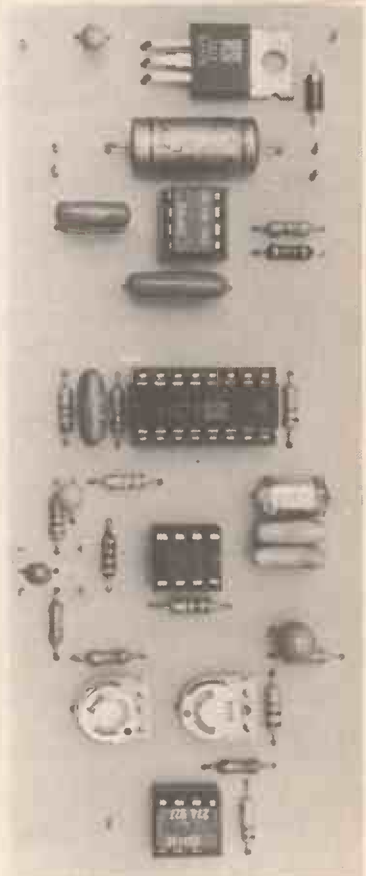
Next, build up the LED voltage-level indicator board, taking special care to test all LEDs before soldering them into place on the PCB. When construction is complete, connect the circuit to the 'push-button' circuit board as shown in Fig 1 and check that an illuminated line of LEDs can be ramped up and down via PB1.

Finally, build up the voltage-controlled stereo 'pot' board and then connect it up as shown in Fig 1. Connect suitable audio input signals to the board and check that the output volumes can be varied or set via PB1, as already described. This completes the construction of the system, which can then be installed in a suitable stereo amplifier.

USING THE SYSTEM

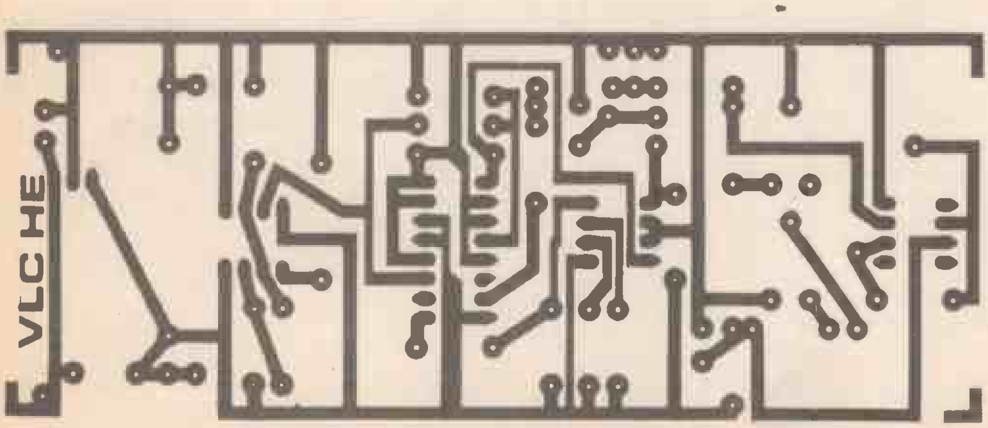
The system is intended to be built into an existing stereo amplifier unit and to be powered from the amplifier's positive supply rail (18 to 30 volts at up to 150 mA). The LED display should be visible on the front panel and placed adjacent to the PB1 control switch. The 'push-





Above: The voltage level controller board

Above Component overlay for the voltage level controller board. Below: PCB design



button' board and the stereo 'pot' board can be fitted in any convenient space: the input and output leads of the redundant stereo pot should be connected to the inputs and outputs of the 'pot' board.

It should be noted that the 'push-button' board generates a good deal of RFI: if you intend to use the board in a unit that includes an LW or MW radio tuner, the board may have to be fitted into a screened case.

When installation is complete, give the system a functional check and get used to the action of control button PB1. The two pre-sets on the 'push-button' board can be adjusted in conjunction with PB1 to give limited 'dead' ranges of control at the max and min volume settings of the system and are adjusted to suit individual tastes. The pre-set on the LED voltage-level indicator board should be adjusted so that all LEDs illuminate under the 'maximum control voltage' condition. Finally, you can, if you wish, connect any number of remotely located push-button switches in parallel with PB1, enabling the volume to be remotely controlled. **HE**

Parts List

PUSH-BUTTON-CONTROLLER

RESISTORS (All ¼W 5%)

R1	4k7
R2	82k
R3, 4	100k
R5, 8	33k
R6	1M0
R7	47k
R9	10k
R10, 14	56k
R11	68k
R12	270R
R13	15k
R15	150k

POTENTIOMETERS

RV1	10k min horiz preset
RV2	47k min horiz preset

CAPACITORS

C1	1u0 Tantalum
C2	100u Electrolytic
C3	100n Polyester
C4	150n Polyester
C5	10n Polyester
C6	2n2 Polystyrene
C7, 8	47n Polyester
C9, 10	2u2 Tantalum
C11	22u Tantalum

SEMICONDUCTORS

IC1	7815
IC2	ICM7555
IC3	CD4027B
IC4	S566B
IC5	CA3140
D1	1N4001

Parts List

STEREO 'POT'

RESISTORS (All ¼W 5%)

R1, 2, 3	22k
R4, 5	47k

CAPACITORS

C1, 7	220n Polyester
C2, 5, 6	100n Polyester
C3, 8	33p Polystyrene
C4, 9	2u2 Tantalum

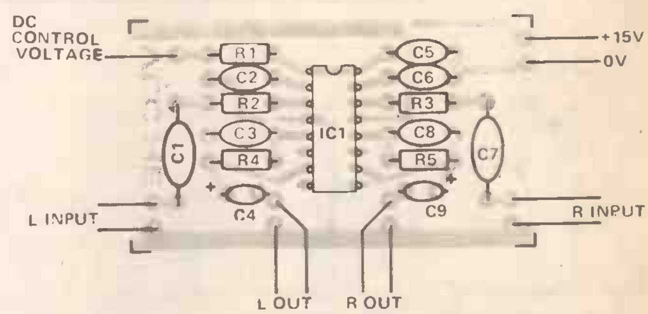
INTEGRATED CIRCUIT

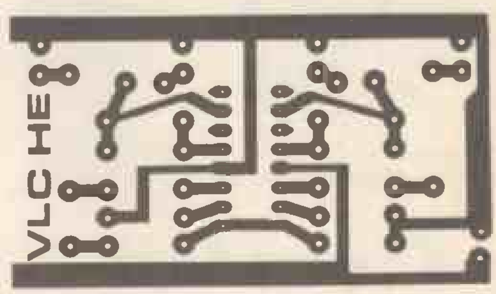
IC1	NE570N

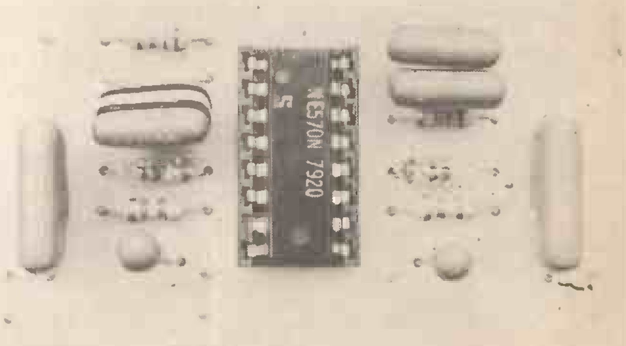
Buylines

The NE570 is available from Watford Electronics

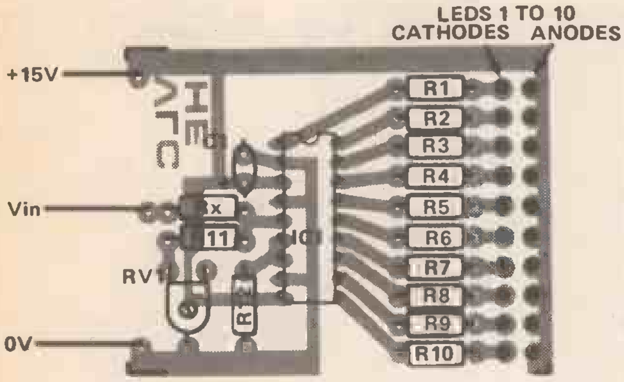
The S566B is available from Electrovalve.

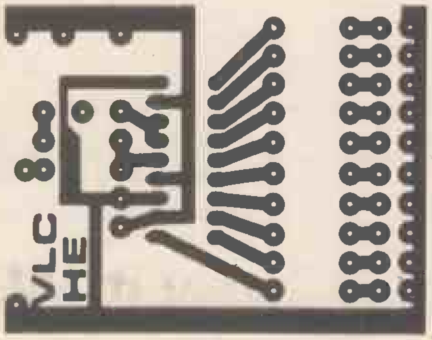




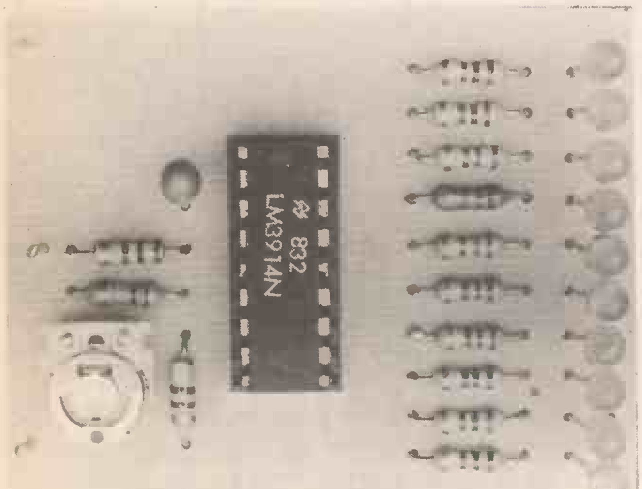


The voltage-controlled stereo pot board





Above: Component overlay for the LED bargraph indicator board. Right: PCB design for the LED bargraph indicator. Below: Photo of the indicator board



Parts List

DISPLAY BOARD

RESISTORS (All ¼W 5%)	
R1 to 10	1k2
R11	100k
R12	820R
Rx	see text
POTENTIOMETER	
RV1	47k min horiz preset
CAPACITOR	
C1	2u2 Tantalum
INTEGRATED CIRCUIT	
IC1	LM3914
Leds 1 to 10	Any LED

How it Works

THE SYSTEM

This project consists of three independent circuit modules. The largest module is a push-button-activated DC voltage generator, which produces an output that can be varied over the range 0 to 12 volts via a single push-button switch. This voltage is used to control the gain of a dual voltage-controlled amplifier (VCA), which acts as a stereo 'pot'. The third circuit module is a LED bargraph voltage-level indicator, which is intended to give a visual indication of the amplitude of the DC control voltage.

THE PUSH-BUTTON VOLTAGE LEVEL CONTROLLER

The heart of the push-button voltage-level controller circuit is IC4, a sophisticated Siemens S566B chip that is specifically designed for use in touch-controlled lamp dimmer applications, in which the 50Hz mains is used to provide a 'clock' signal to the IC. In our present application, IC4 is again clocked at 50 Hz, but in this case the clock signal is derived as follows:—

IC2 is a 100 Hz astable multivibrator circuit, designed around a CMOS version of the 555 timer chip. The 100 Hz output of this astable is fed to one half of dual flip-flop IC3, which divides the input frequency by two and produces a 50 Hz output (at pin 1) which is used to clock pin 4 of IC4 via R3-C6. The other half of IC3 is used to process the outputs of IC2 and IC4 and produce a composite output signal at pin 15.

The net effect of the actions of IC2-IC3-IC4 is that a 100 Hz rectangular waveform normally appears at output pin 15 of IC3. The mark/space ratio (and thus the mean voltage) of this waveform can be varied over a wide range or reduced to zero by suitably operating push-button switch PB1, as already described. This output waveform is converted to pure DC via dual low-pass filter network R8-C9-R9-C10 and then further processed by IC5 to enable the final DC output signal to span the full range of zero to 12 volts.

Most of the 'logic' of the circuit is built into IC4, which processes the PB1 push-duration information and then produces an output signal in accordance with that information. If PB1 is held closed, the final DC output voltage of the unit ramps slowly from zero to 12 volts, or vice versa, for the duration of the switch closure: when the switch is released the prevailing voltage level is 'remembered' and maintained indefinitely. The output can be switched alternately between the prevailing level and zero, or vice versa, by momentary closure of PB1.

The 'push button' circuit is powered from a 15 volt supply derived from the stereo amplifier's supplies via IC1, a 3-terminal voltage regulator IC. The output of IC1 can also be used to power the two remaining modules of the 'volume control' system: the input of IC1 can be fed from any 18 to 30 volt DC supplies that are capable of supplying 150 mA or so.

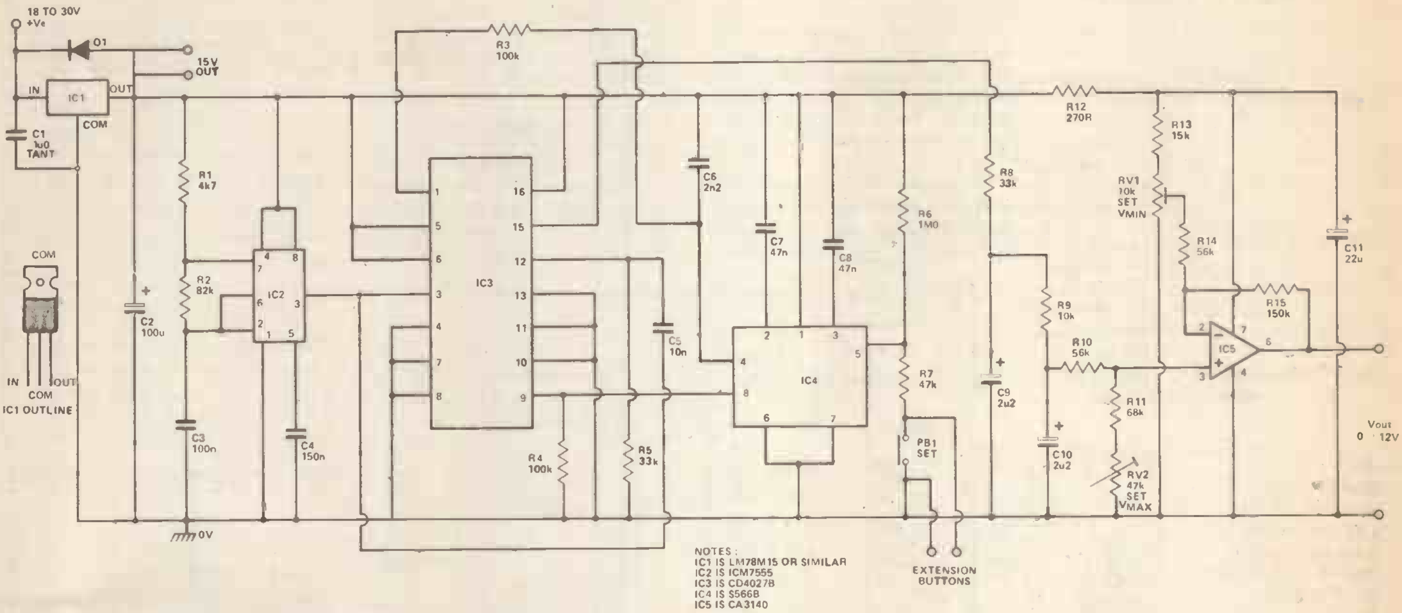


Fig. 2. Circuit diagram of the push-button voltage level controller

How it Works

THE VOLTAGE-CONTROLLED STEREO 'POT'

The NE570N IC used in this module can be regarded as a dual voltage-controlled amplifier. Audio signal inputs are fed to pins 3 and 14 and outputs are taken from pins 7 and 10: the amplifier gains can be controlled by DC voltages fed to pins 1 and 16. In our application, both halves of the IC are gain-controlled by the same DC voltage and the 'gain' can be varied from roughly minus 80 dB at zero volts to plus a few dB at 12 volts. The IC produces negligible audio distortion and can thus be used as a voltage-controlled stereo 'pot'. The circuit is powered from a 15 volt supply derived from the main 'push-button' circuit board.

How it Works

THE LED BARGRAPH INDICATOR

This module is designed around an LM3914 LED dot/bar voltmeter IC. In our application, the circuit is configured so that all LEDs illuminate ('bar' display) at full-scale indication. The circuit indicates full scale with an input of roughly 11-12 volts with the component values shown. The sensitivity can be varied over a limited range via RV1: the sensitivity can also be changed by using an alternative value of Rx.

The bargraph circuit is intended to give a visual indication of the output control voltage of the 'push-button' circuit. The circuit draws roughly 100 mA with all LEDs illuminated and is powered from a 15 volt supply derived from the main 'push-button' circuit board.

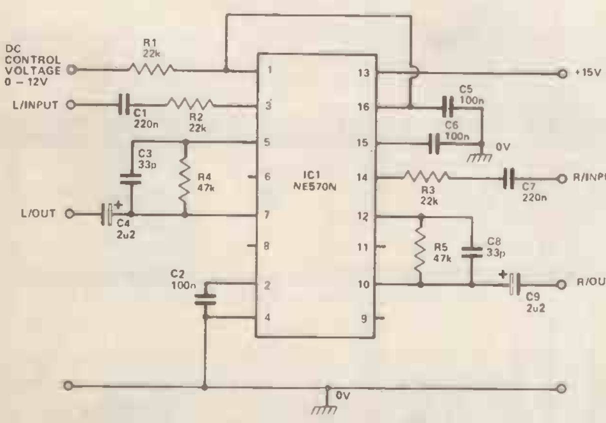


Fig 3. Circuit diagram of the voltage-controlled stereo pot

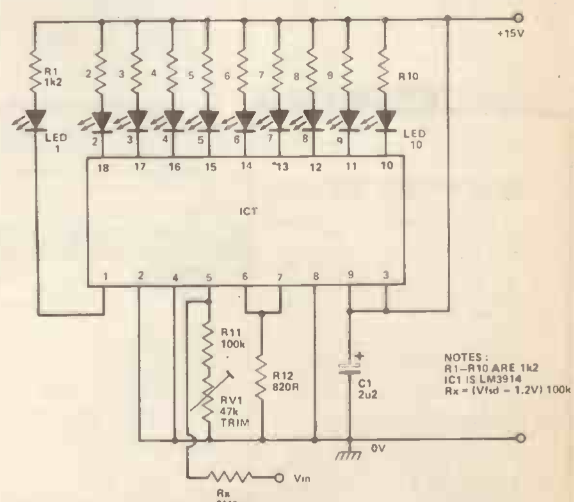


Fig 4. Circuit diagram of the LED bargraph indicator

Short Circuit

TABLE LAMP

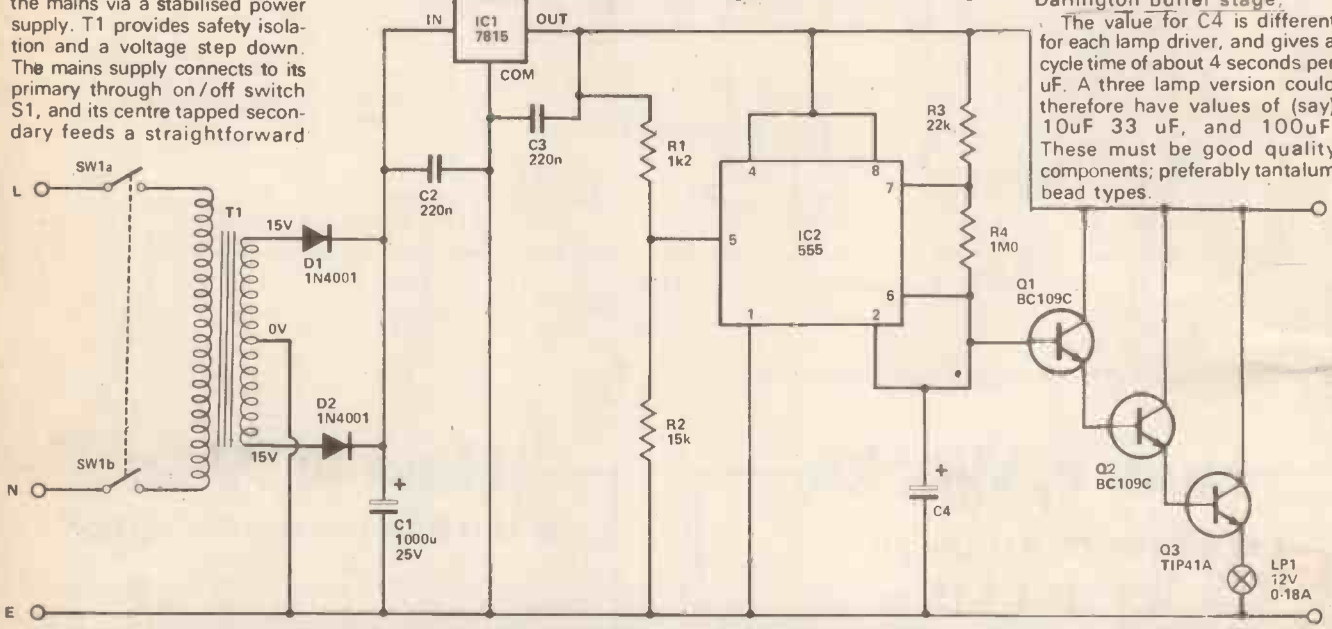
This circuit is for a decorative table lamp that produces a slowly changing background colour. The unit has a number of light-bulbs of different colour, that are slowly varied in brightness. However, they are each modulated at a different rate, giving a constantly changing blend of colour.

The circuit is powered from the mains via a stabilised power supply. T1 provides safety isolation and a voltage step down. The mains supply connects to its primary through on/off switch S1, and its centre tapped secondary feeds a straightforward push-pull smoothing and rectifier network. The resultant DC supply is fed to regulator device IC1, which gives a stabilised 15 volt output. C2 and C3 are decoupling components and should be mounted physically close to IC1.

The remaining circuitry is used to control one lamp. This must be duplicated for each additional lamp, and for best results at least three lamps should be used. There is no need to duplicate the power supply which can power up to five lamp circuits.

IC2 is a 555 device which is used in the astable mode. This type of circuit normally operates by the timing capacitor (C4) charging up to 2/3 V+ via both timing resistors (R3 and R4). The device is then triggered and discharges the capacitor through one of the timing resistors (R4) to 1/3 V+, whereupon the device reverts to its original stage and the capacitor starts to charge again. The circuit continuously oscillates in this way. In this case R1 and R2 have been used to raise the two threshold voltages from their normal levels in order to make the unit more efficient. The roughly sawtooth waveform produced across C4 is used to control the lamp by way of a triple Darlington buffer stage.

The value for C4 is different for each lamp driver, and gives a cycle time of about 4 seconds per uF. A three lamp version could therefore have values of (say) 10uF 33 uF, and 100uF. These must be good quality components; preferably tantalum bead types.



DISPLAYS

DL304 Red 0 3" c c pin compatible with DL704 70p
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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

D.V.M. THERMOMETER KIT

Based on the ICL 7106. 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

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.

MK1 TEMPERATURE CONTROLLER/THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max) and triac to switch heater.
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MK3 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. £4.75

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LM2917 f-v Converter (14 pin)	£1.60
LM3909 LED Flasher/Oscillator	55p
LM3911 Thermometer	£1.20
LM3914 Dot/Bar Driver	£2.10
MM74C911 4 digit display controller	£8.50
MM74C915 7 segment-BCD converter	96p
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DO MAGAZINE REMOTE CONTROL PROJECTS MAKE YOU SEE INFRA RED?

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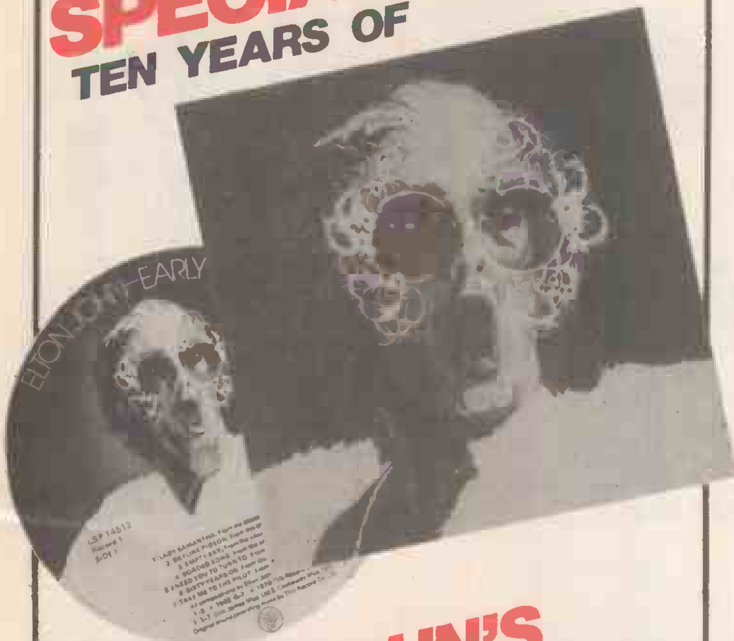

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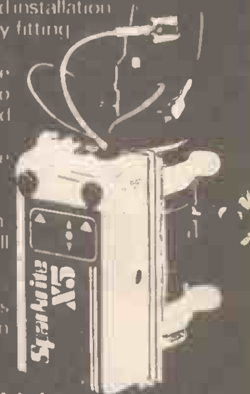

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Short Circuit

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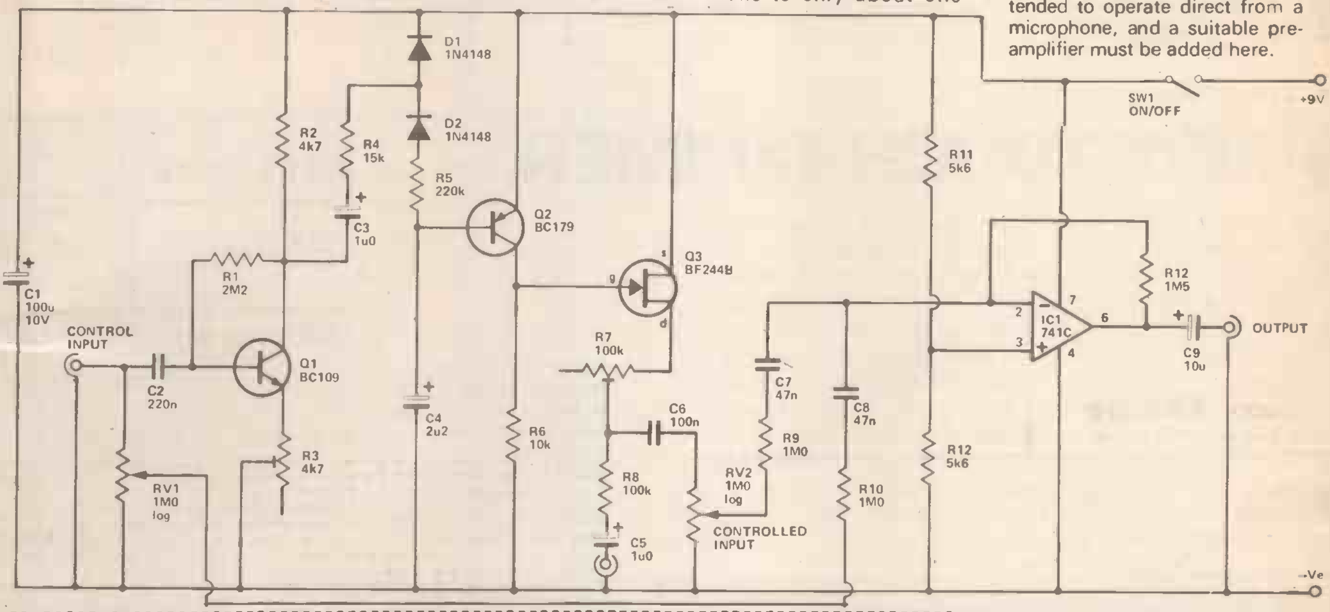
In this circuit, with no control input signal, the controlled signal is fed via C5 and R8 to one input of a conventional two input mixer which is based on ICI

Some of the control signal is applied to the other input of the mixer, and the rest is fed to a common emitter amplifier based on Q1. The output of this is fed to a rectifier and smoothing circuit comprised of C3, R4, D1, D2, R5 and C4. Normally Q2 is cut off, and R6 strongly reverse biases Jfet Q3. Q3 therefore has a very high drain to source resistance (typically about 1,000 megohms), and has no significant effect on the circuit. However, in the presence of a suitable control input signal, the negative bias produced by the smoothing and rectifier circuit switches Q2 hard on, and eliminates the reverse bias on Q3. The drain to source resistance of Q3 then falls to only about one hundred ohms or so, and causes greatly increased losses through R8. Thus the required automatic fade out action is obtained. R7 can be adjusted to give any level of fade out from about −6dB. to about −60dB.

R3 controls the voltage gain provided by Q1, and in practice is adjusted for the lowest gain (highest resistance) that gives reliable operation of the unit. Note that this input is not intended to operate direct from a microphone, and a suitable preamplifier must be added here.



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Tape Sensitivity output typically 150mv. Input 300mv for rated output.

Disc Sensitivity 100mv (ceramic cartridge).

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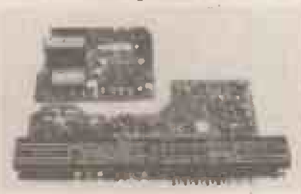

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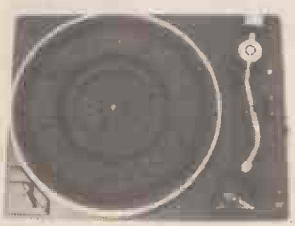

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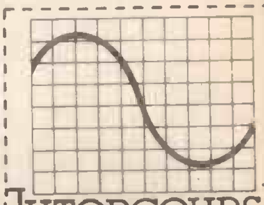

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Kit Reviews

Pete Howells builds a couple of kits from Tandy

TANDY TOUCH DIMMER

DIMMER SWITCHES have been around for quite some time now and are easily available in practically all electrical stores, retailing for around £5 each. This kit from Tandy, however, adds that extra bit of novelty that makes it worth a second glance, in that it can be controlled by a touch sensitive plate rather than by the conventional potentiometer. The idea here is that short touch to the sensor will turn a light on or off, and that a longer, sustained touch will put the light through a dim/bright cycle until the touch is removed; it will then maintain this intensity until turned off. One more thing — when it's turned on again the intensity will be the same as when it was turned off, hence the "built-in memory" designation.

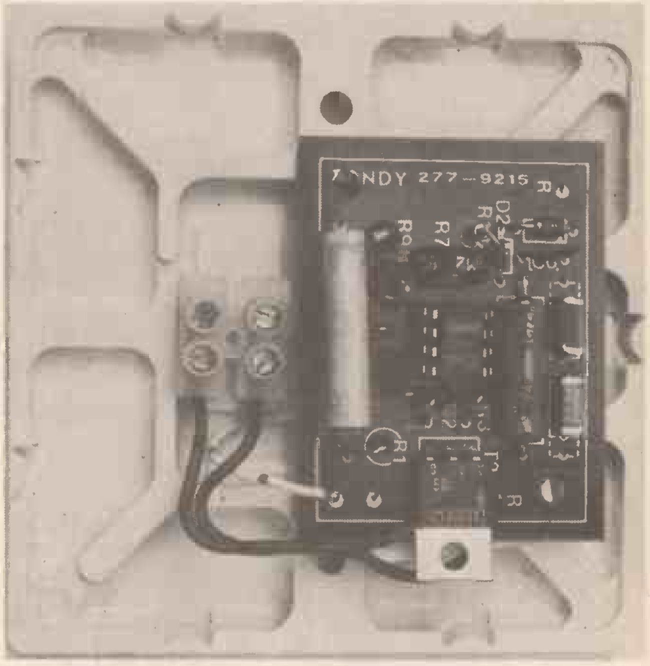
The kit itself consists of the circuit board, drilled, printed with component locations and laquered, the components and the instructions. Now, the instructions are a real gem. You may have thought that the literacy of contributors in this magazine left something to be desired, but please wait until you read these instructions: "This IC is a C-MOS IC, and is very sensible by static charges . . . use a soldering iron with small currency." That bit's easy. Try figuring out how it works. Oddly the English translation takes up about two thirds of the space that those in other languages use, and one can't help wondering about what's been left out. Perhaps the translator couldn't cope with some of the words and just didn't bother. Mind you, he (or she) didn't cope too well with what was left in. Considering how sensible a CMOS IC is, it would have been sensitive to include an IC socket, and although there isn't one in the kit it is worth forking out a few pence on one yourself.

The components can be thrown together on the PCB without any problems, and although the instructions don't say anything about the orientation of polarised components this could be worked out from the markings on the board by anyone familiar with electronic components. A beginner might well end up in trouble, though.

Again the instructions fall down when it comes to telling you what to do with the thing once you've built it. Bear in mind that you're playing with mains currents and that a moment's thought before doing anything rash is in order. No mention is made of safety considerations and the wiring is described in a not too copiously labled diagram. If you're going to fix it into a light switch plate you must make sure that none of the components foul the metal casing at any point.

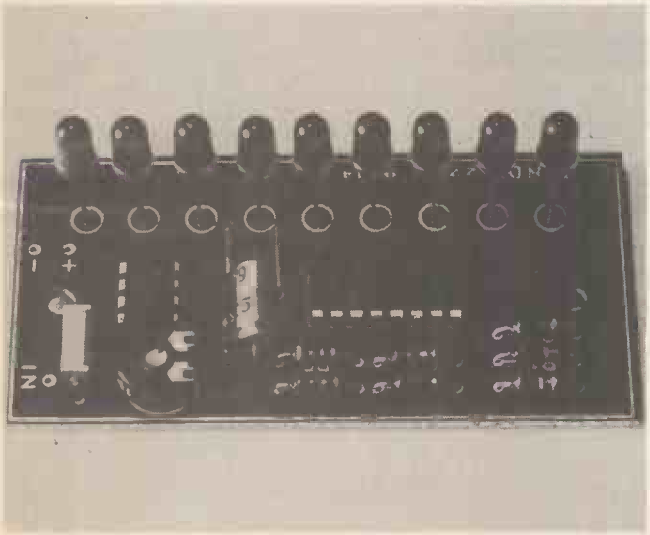
Eventually there comes a time when everything is in place and the power is turned on. You put your finger to the touch plate and — nothing happens. This was very peculiar because two days later it worked perfectly, though at the time no amount of coaxing could make the device sensitive enough to respond to the touch sensor unless it was directly earthed. Since then there have been no problems, and no one has been able to explain why it didn't work at first. Radio interference is very low even with no suppression added. A choke and a capacitor are suggested, though not supplied with the kit; according to the instructions, "This work is depressing parasites."

Right: The dimmer installed on the back of a light switch plate. Sticky pads are a wonderful thing. Below: And from the front — the sensor plate is available from Maplin or Watford.



To make a working unit a couple of extra bits are needed; a connector block (Mains circuits shouldn't be soldered direct into this board), a touch plate (quite neat ones can be bought from most components suppliers) and some form of mount for the inhole gubbins — if it's going to control a room light, a blanking plate (see photo), which is ideal for the job, is quite cheap to buy. Most highly recommended is an eight pin DIL socket for the "sensible" CMOS IC. The kit itself costs £9.95 and with the other bits the total cost will come to something like £11.

TANDY VU METER



Above: The completed board — four wires to connect (12V supply and signal). Below: A picture of Pete's Revox which was used to test the meter.

THE MAJOR PROBLEM when recording audio signals on magnetic tape has always been the difficulty of treading the narrow path between the level of noise inherent in the medium and the level at which the recorded signal saturates the tape. A similar problem arises when running audio amplifiers towards the limits of their performance, when the disturbing phenomenon of clipping occurs. Virtually every tape recorder available today is equipped with a meter to indicate the level of the signal going onto the tape, and a significant number of amplifiers now also boast this feature. The VU (for Volume Unit) meter is marked with an arbitrary scale, with zero corresponding to the maximum usable signal; the recording level, when using a tape recorder, is set so that the indicator never exceeds this point.

Traditionaly the VU meter is a mechanical device and as such it is subject to inertia (the tendency of a moving object not to change its state). The electrical signals being measured, however, are not subject to this restraint and may change strength by several orders of magnitude instantaneously. The initial striking of a string in a piano, for instance, is very much louder than the subsequent resonance and this is faithfully reproduced by the signal passing through an amplifier. A meter measuring this signal will only have had time to set its needle in motion before the signal has died away. At this point technology, in the form of solid state electronics, comes to the rescue.

By using Light Emitting Diodes (LEDs) to replace the coil meter, the mechanics, along with intertia, are eliminated. This kit from Tandy uses the UAA170L IC, specifically designed for this purpose, to control a row of nine LEDs which act as a VU indicator. For your money you get the PCB, components and a set of instructions in four languages. The English translation is slightly dubious —

All the components can be thrown onto the drilled, printed and laquered board without too much fuss, although you've got to be careful with the polarised ones; the instructions don't contain any diagrams. Mounting the LEDs, in particular, needed a second glance as the component locations printed on the PCB were a bit unclear and it was difficult to tell which way round the flat side of the LED should go.

At this point the constructor is left to his own ingenuity. You need a 12 V DC power supply, the chosen signal source, and some means of calibrating the meter (which is sensitive to inputs of from 20 mV to 6 V at full scale deflection). To set up the kit for an amplifier you can use an oscilloscope and a signal generator: connect the generator, set to 1 kHz, to the amplifier input at a suitable level, take the output from the amplifier to the oscilloscope. Adjust the output of the amplifier to the point where clipping just starts (this can be seen on the scope as a flattening of the peaks of the signal waveform) and then adjust the trimmer on the meter so that it indicates a maximum reading. With a tape recorder that already has a VU meter fitted the calibration can be made by feeding in a signal from, again, a signal generator at 1 kHz, adjusting the recording level to maximum using the conventional VU, and then setting the kit can also give a maximum reading.

The kit worked first time and produced a satisfying dancing spot of light (only one LED is lit at any time, as opposed to the system where 'lower' LEDs remain lit; this produces a 'bar' of light which varies in length). The only real quibble that I can think of is that the LEDs supplied were all red: it would have been much prettier, and more useful, to have eight green ones and a single red one at the top of the line.

The completed kit consists of a PCB on which the LEDs are mounted and anyone with the time to drill nine holes in a panel should have little trouble installing it in some existing equipment. A little knowledge (however dangerous it may be) will be required in finding, or manufacturing, a suitable 12 V power source and a point from which to tap the signal. If you want a stereo pair you'll have to buy two kits — they cost £9.95 each. **HE**

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CB HAS NOT BEEN LEGALISED — YET. In the words of Mr William Whitelaw the Home Secretary, in a reply to Mr Patrick Wall MP asking "whether he has completed his examination of the possibility of introducing Citizens Band Radio in the United Kingdom," he replied:

"We have concluded that we favour in principle the introduction of a facility of this general kind.

The scheme which I am considering would however differ in certain respects from that advocated by those whose ideas are based on the experience of other countries and we are proposing to call it Open Channel. It would take some time to introduce, because current developments in Europe and elsewhere have to be taken into account, and because further work is necessary, for example, to establish a precise frequency band and appropriate technical specification.

I therefore think it important that the general public should have the opportunity to consider the implications of the sort of scheme that might be possible, and to express their views. Accordingly I intend to publish a discussion document on Open Channel within the next few weeks, and I shall take the public reaction to this into account in reaching the final decisions."

That was on Wednesday the 7th of May 1980. It sounds very impressive, but there are one or two little passages that are quite significant.

"It would take some time to introduce. . . ."

We ask, how long? It is not unheard of for a discussion document (Green Paper) to take up to two years to be acted upon!

". . .further work is necessary, for example, to establish a precise frequency band and appropriate technical specifications. . . ."

We took the trouble to phone up the Home Office the day after the announcement, a spokesman told us that:

"We have been carrying out extensive research in our laboratories and have finalised the specifications."

Wait a minute, I thought we were going to be asked?

That aside, the announcement has generated an incredible amount of rumour-mongering. Currently we are receiving up to a dozen phone calls a day suggesting that Open Channel (more about the name later) is going to be anywhere from halfway along the Medium Wave to a frequency that could only be received by NASA.

Favourite at the moment is around 900 MHz, not actually too unconvincing but we'll say no more! We supposedly have a chance to make our views known, and that is exactly what everyone should do. Hopefully we will have the Green Paper in our possession by next month. All being well we'll have some suggestions of our own to make.

Now for that name. Open Channel, say it to yourself a few times, it all sounds terribly British. A quick poll around the BOF office gained mixed reaction, tell us what you think about it.

Last few words before we get back to business, as we said in the first line of this article, CB has not been legalised, it is still important that our feeling be made known, demonstrations are still being organised, the emphasis now is not so much 'We want CB' as 'WE WANT CB NOW.' See you in Trafalgar Square on July 6th.

CLUBS

In the directory last month we said that Andy Donovan was the Chairman of the UBA, in fact he is the President, sorry Andy.

HANDLE DIRECTORY

Yes, we are still going ahead with the Directory of Handles, names are still pouring in by the hundred. This has got to be the last month for entries, closing date is now June 20th. Publication will hopefully be in the September issue, well, part one at least, judging by the number of names we've got already.

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LONDON PETITION

Here we have (above) Dave and Jeff from the Harrow and Wembley CB Group handing over their petition to Richard Town and Bernie Murray of the NATCOLCIBAR steering committee down at County Hall in London on May 13th. The petition contained nearly 6000 signatures. All the signatures are from Londoners, more power to their elbows.

HE PETITION

If you're wondering what to do about the petition we published last month, don't worry, the wording is still relevant. Fill them in and return them either to us or to any branch of Tandy. Remember they must be back by June 30th in time for the July 6th demo. We still haven't got CB!

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OPEN CHANNEL

Now, about that name, 'Open Channel', the first time we heard it our immediate impression was that it would be just one channel. It's that sort of name, now, reason tells us that there is absolutely no-way that we would get just one channel (Is there ???). After saying it to ourselves a few times it has slightly grown on us.

T-SHIRT COMPETITION

Thanks for all the entries to our CB Tee-shirt competition, closing date for entries will be 30th June. If we still haven't received your masterpiece then hurry, there's still time.

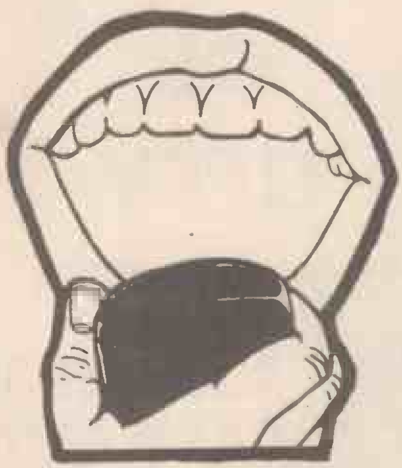
SEATCOVER OF THE MONTH

We know how much you lot like having your photographs taken, we can tell by all the people skulking behind the tea hut at the London demos as soon as e get our cameras out. So, we thought, how about you sending us a picture of your 'seatcover', (girlfriend to all non male chauvenists, we know it's not a very endearing term but it's all we've got).

We would like to brighten up the pages of HE with the odd (not too odd please) picutre of a young lady We wont guarantee instant stardom or a ready made modelling career but who knows. Anyway how about it, any of you breakers want to get your lady into print?

You dont have to be too specific about names and addresses but if you want the photos back please include an SEA.

HE&BOF's first Seatcover Of The Month was sent in by Glen Hall. She's Jilli Newham, 22, a Trainee Computer Operator from Guildford.



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MIKE EVANS

A year ago only two campaign groups were known nationally, namely the CBA and UKCBC, from these sprang such clubs as the 10-4 Club, the UBA, CBNE and many many more.

Today if you stop Mr and Mrs Joe Public in the street and ask them about citizens band radio, I would estimate that 45 per cent of them would say "Yes", they had seen it on the television, heard about it on the radio or even read it in the national or local press, but who do not regard it as a necessary thing.

A year ago it was all "CB can save your life, keep you awake during long-distance driving, keeps you out of traffic jams", in fact the English were becoming very Americanised with these statements. Today the Home Office are looking for more realistic cases, facts and figures which relate to the UK. It is a basic personal freedom to be able to communicate freely with each other.

Not so long ago radio amateurs and radio modellers were very anti-CB, they are less so now due to the possibility of new technology and a break away from 20 year old technology namely 27 MHz. Which we feel 55 per cent of our readers feel must take place if a CB system tailor made for the UK is ever to be envisaged.

In early 1979 there were very few prosecutions brought to the eyes of the general public, in fact CB was well under the carpet. Today with the illegal operators on 27 MHz — and without them where would we be! — it is constantly being brought in the public's attention as to date there have been 1,142 cases.

A year ago most policeman didn't know what a DV27 or rig looked like, but now with memorandums from the Customs and Excise people circulated to all stations, it is a bigger cat and mouse game than it ever was.

Before the Conservative Government was elected last May nobody had heard of the All Party Group of MPs who were looking at the whole question of CB radio — was this the beginning of a more forward looking campaign?

In fact a year ago we never thought we would be bringing you a publication called "Bandstand", reporting on newspaper, television and radio coverage, as well as the demonstrations that have been held this year, and producing articles and letters with such deep feeling on CB from our readers.

A year ago Timothy Raison wasn't such a well known figure, nor I should imagine did he realise that the general public were so passionately in favour of CB radio, and that he would receive over 8,000 pieces of correspondence on the subject.

A year ago who would have dreamed that the GLC would publish a consultative paper on CB radio and ask Londoners for their views on the subject, who would have thought that a National Committee would be formed to promote the legislation of citizens band radio!

The above has all happened, what does the future hold. With all this pressure from so many quarters where are we going! Not having a crystal ball, but reading between the lines, are we to be given a CB system at all? Are we going to get a purely British VHF system? Or are we going to be another Australia? We believe it will be a matter of forgetting 27 MHz and like the British electronics industry have done in the past look around for the best money making system tailored towards financial gain and with this in mind this is the system we will get.

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KEITH TOWNSEND

MCBRC was formed almost by accident as the result of a "bust" which occurred during the local filming of a "nationwide" article on CB. The resultant newspaper publicity culminated in a meeting of just fifteen people with the vague idea that "something should be done". Two local newspapers had recently featured articles about CB and both proved very sympathetic to our aims, even offering suggestions as to how we might test local support.

Our next meeting, a month later, was attended by over fifty people and the club was well under way. The first tangible results of our campaign were the requests for interviews and phone-ins from the various local radio stations. I was interviewed by one pretty lady who was surprised to discover that we were not in fact running a Caroline style pop pirate station. Our initial letter campaign met with a very mixed response which included some surprises such as the letter of tacit support from the local Police Federation. As the result of a request from ROSPA for further information we contacted REACT in Chicago who sent copious details which are currently being studied by the Society. Like many other clubs we received only negative replies from both the AA and RAC.

As the result of some expert conning we obtained free stand space at the Birmingham Custom Car Show in late October. During the four days of this show our membership increased dramatically and the Post Office made handsome profit from the five thousand or so postcards sent to Momma Maggie and Whitehall Willie, whilst the local Rates Dept. got a boost from our parking tickets.

Following our various contacts with other clubs we were proud to host the first national CB Conference in early December, which, after a great deal of discussion resulted in the formation of the National CB Committee. The mere existance of this committee has generated a great deal of media interest in CB while the committee itself has achieved a great deal of respect in official circles.

During these last twelve months we have kept up a steady stream of letters to the Home Office (not all of which have received answers) and pestered as many local MPs as would stop and listen to us. One of our proudest possessions is a letter to a member from the Minister of Transport saying that he believes that the possible advantages of CB outweigh the possible disadvantages.

We have had our good times (the club dance) and our bad times (the night the beer ran out) and our membership, which is open to anyone interested in CB now exceeds 750 including our honorary lady members.

As I write this I and a number of my buddies are experiencing terminal nervous breakdowns, trying to organise Britain's first CB Campaign Carnival.

Hopefully the next one will be to celebrate legalisation.

Keith Townsend, Midlands Citizens Band Radio Club, 1163 Yardley Wood Road, Birmingham B14 4LE.

Next month our old friend Glyn Hall of WintJoy fame tells us his life story.

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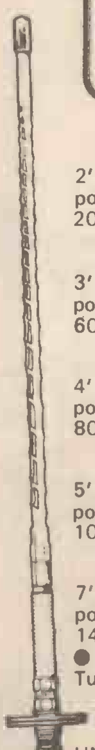

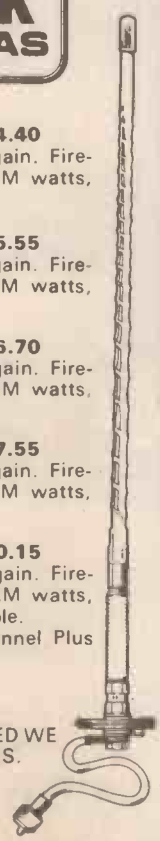

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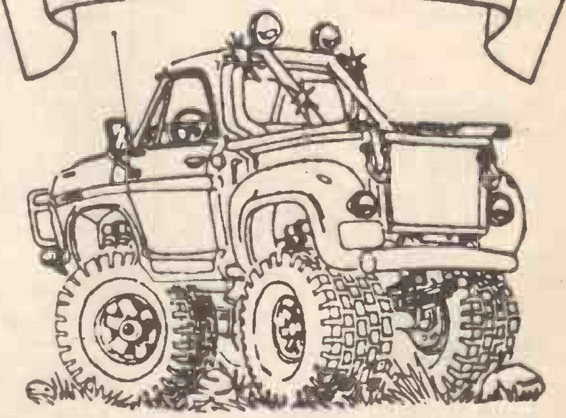

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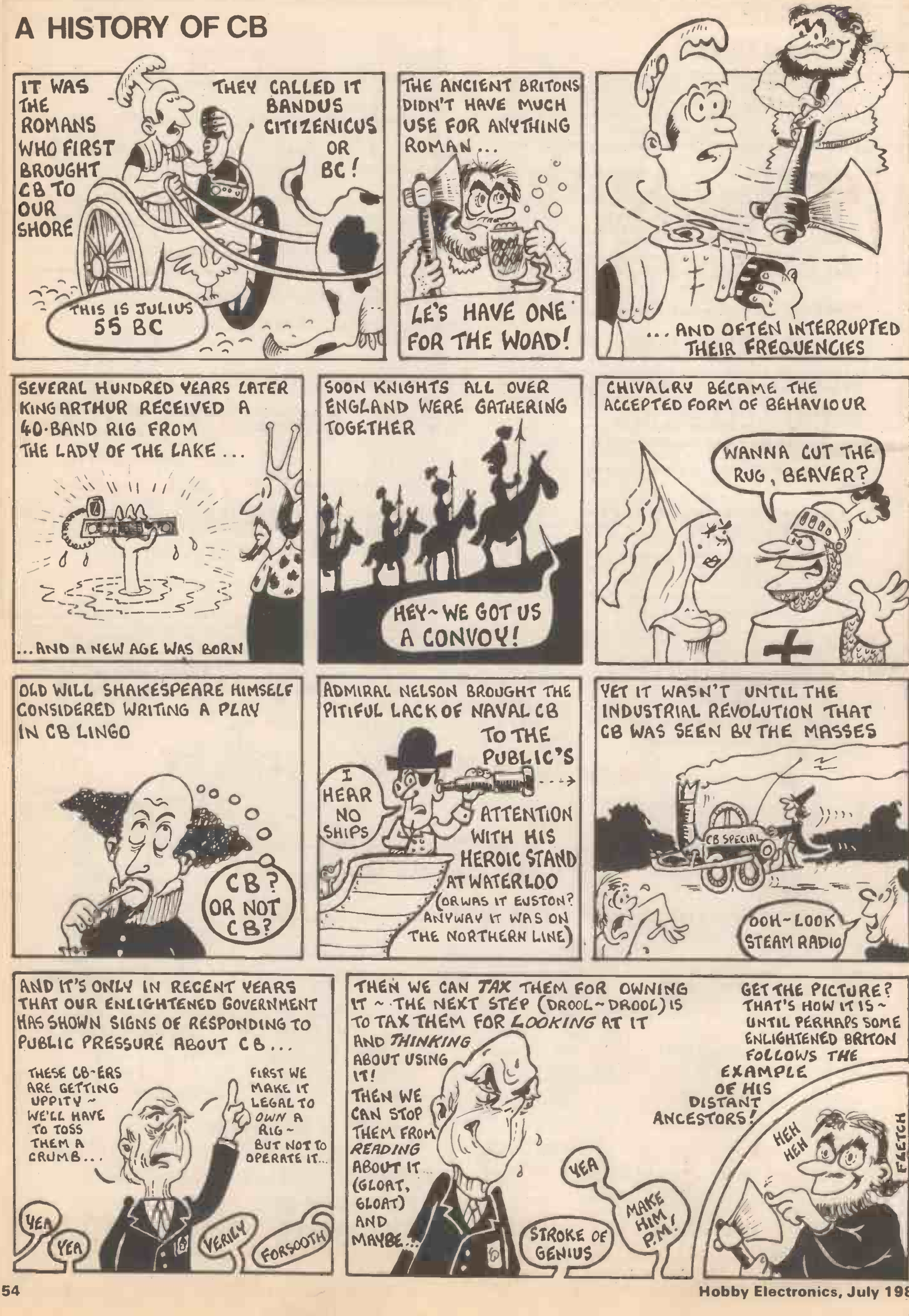

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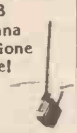

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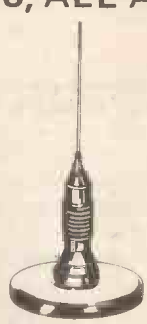

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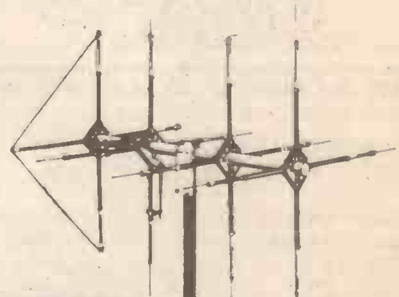

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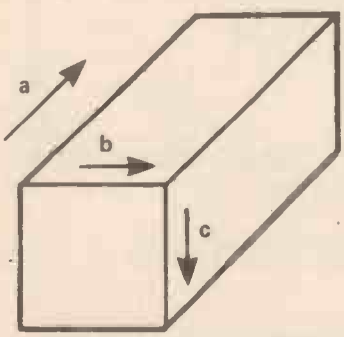
Piezo Electricity

It sparks when you hit it. Well, thats not an altogether bad description of the Piezo Electric effect, but these crystals can do a whole lot more as Ian Sinclair explains.

PIEZO ELECTRICITY HAS been with us for some time, and yet we seem to keep meeting new applications of this remarkable effect. How is it that we can use the crystals to generate sparks, to convert vibration into electrical waveforms, to stabilise the frequency of oscillation, or to make precise electrical wave-filters? Here's how — just switch off that soldering iron for a minute or two.

By this time, you should be getting used to the idea that most materials form crystals. Crystals are regular arrangements of atoms, probably the most perfect structures we know, but that doesn't mean that the structures are exactly alike in each direction. The key word here is isotropic. An isotropic crystal has the same properties in any direction (Fig. 1). Properties in this case means measurable quantities like electrical conductivity, heat conductivity, expansion coefficient, elasticity and all the other measurable quantities which fundamentally depend on how atoms are arranged.



1. An isotropic crystal gives the same readings for quantities like expansivity, resistivity, etc., in any direction along the crystal, a, b, or c.

CRYSTAL CLEAR

An isotropic material is mercifully easy to make measurements on, because you don't have to choose any special direction in the material. The materials we call anisotropic (meaning not isotropic) aren't like this, though, how they behave depends on which direction we choose to work on. Wood is a simple example, everyone who has ever worked on a piece of wood knows how differently wood cuts across the grain as compared to along the grain.

Many crystals are anisotropic, because the spacings between atoms are quite different in different directions along the crystal. The result is that each quantity that we can measure will have different values, depending on the direction that we choose in the crystal.

Now when a crystal is anisotropic, it usually behaves in a peculiar way in a strong electric field. Any material will be affected by a strong electric field; usually what happens is that the material has some electrons separated off, starts to conduct, then sparks across. Some very anisotropic crystals behave differently, their atomic spacings re-arrange themselves a bit. When this happens there is no way the crystal can be the same size as it was before, because the size of the crystal is decided by the size of the atoms and the way they are arranged. Usually what happens is that the atoms move slightly closer to each other *in one direction* so that the crystal becomes slightly shorter in that direction. The dimensions of the rest of the crystal may remain unchanged. These changes of length are very small, but they're certainly not undetectable.

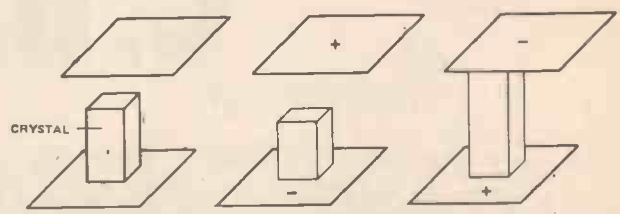


Fig. 2. The drawing's an exaggeration, of course, but it shows the idea. Piezo-electric crystals become shorter in one direction of electric field and longer when the field is reversed.

What makes the process more interesting is that if an alternating electric field is applied to the crystal, it will become longer and shorter alternately, in phase with the field. How do we apply an alternating field? Simple enough, we simply sandwich the crystal between metal plates and connect an alternating voltage between the plates. Since we usually want the distance between the plates to be very small, the usual way of achieving this is to deposit a metal, usually silver, on opposite faces of the crystal, making sure that we have chosen the right direction in the crystal.

With a crystal treated in this way, an alternating voltage across the metal conducting will cause vibration, with the crystal length becoming longer and shorter at the frequency of the AC. This is a piezoelectric transducer, which will vibrate at the frequency of the AC signal and pass on the mechanical vibration to anything in contact with the crystal. Cementing one face of the crystal to a diaphragm creates a piezoelectric tweeter, a loudspeaker unit which will give out a sound wave from the large surface of the diaphragm which is being vibrated by the crystal.

FAST MOVERS

There's no reason to stick to frequencies in the audio range of 30 Hz—20 kHz though. The crystals themselves can vibrate quite happily at much higher frequencies, even up to several MHz. In this way we can have ultrasonic tweeters, giving out invisible beams of air vibration like sound but at frequencies too high to hear. The favourite frequency range is around 35—65 kHz, because the vibration of the crystal can be transferred to air reasonably easily in that frequency range.

Any material that is in contact with the crystal will be vibrated along with it, though, so that this ultrasonic vibration has many applications. One is non-destructive testing. A piezoelectric crystal vibrates a sample, perhaps a metal casting, and the path of the beam of vibration through the material is traced, using another piezoelectric crystal as a detector. An invisible flaw inside the material causes the beam path to be unaccountably shifted, so that the material can be rejected. This principle is used widely, along with X-ray methods, for detecting holes and faults in metal casting, particularly if the casting is valuable or if its failure could cause likes to be in danger. They don't bother too much with things like the kick-start cranks of motor bikes, though!

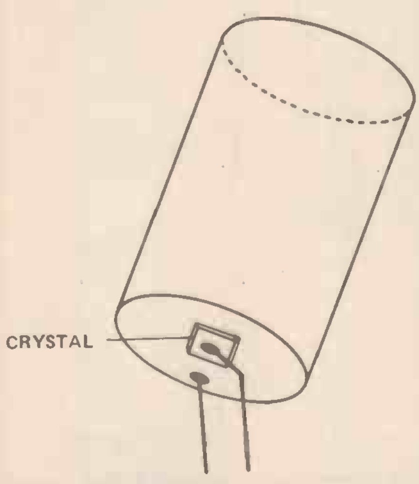


Fig. 3. An ultrasonic cleaner. The metal beaker has a piezoelectric crystal soldered to the base. Leads to the beaker and to a contact on the face of the crystal are fed with high frequency signals from a generator. The vibrations of the crystal cause the liquid in the beaker to vibrate.

CLEAN SOUND

Ultrasonic cleaning is another widespread use of ultrasonics. A piezoelectric crystal is mounted on the base of a metal beaker, so that it will vibrate any liquid in the beaker — the liquid can be water or any grease solvent like benzene, and anything placed in the vibrating liquid will be thoroughly cleaned with no need for scrubbing. Of course, you've all got HE offer digital watches and probably don't remember the old fashioned tick-tock type, but ultrasonic cleaning was the standard method for cleaning these things. Using an ultrasonic cleaner meant that the watch didn't have to be taken apart, so saving an immense amount of time and skilled work.

A piezoelectric crystal with quite a different type of application is the quartz crystal. Quartz crystals are prepared in just the same way as the barium titanate crystals of ultrasonic cleaners, but the aim is not to harness the mechanical vibration but to make use of the electrical behaviour of the crystal. Any insulator with a couple of metal contacts on opposite faces is a capacitor, but the materials we usually make into capacitors are not piezoelectric, so that the capacitor behaves, well, just like a capacitor.

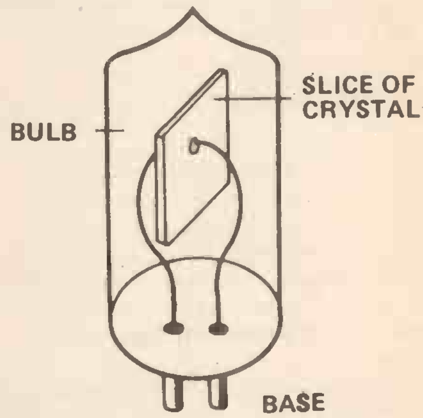


Fig. 4. A quartz crystal inside an evacuated bulb. This is a type of mounting used for crystals that control radio transmitter frequencies.

A capacitor made from a piezoelectric material is rather special, though, because electrical energy is converted into mechanical energy of vibration when the crystal is driven by an alternating voltage. This, in turn, alters the electrical behaviour. A good comparison is a loudspeaker speech coil which may measure 6 ohms on a meter, but whose apparent resistance, equal to AC volts divided by AC amps, can change considerably from one frequency to another because of the transfer of energy from the coil to the core.

The crystal and the loudspeaker also show the effects of resonance. At one particular frequency, the energy converting process is very much more efficient than it is at other frequencies, so that a very large amount of vibration can be caused by a very small amount of electrical energy. Now this resonance is the same sort of effect as we get when an inductor and a capacitor are connected together, either in series or in parallel, but with one important difference. Mechanical resonances are usually very sharply tuned, with a very small bandwidth, a quantity which is measured by the 'Q' factor of a tuned circuit. Q factors of 100 to 250 are considered pretty good by the standards of electrical tuned circuits, but mechanical resonances can achieve Q values of 30,000 or more.

CRYSTAL GAZING

All of that prepares us for the fact that the quartz crystal behaves electrically like an incredibly efficient tuned circuit. At a frequency well below the frequency of mechanical resonance, the whole thing behaves like a capacitor, with a value of reactance which decreases as the frequency is increased, and a 90° phase shift, current leading voltage. This behaviour keeps up until near the frequency of resonance, when the crystal starts to behave as if it had a resistor connected in parallel with the capacitor, allowing more current to flow, and reducing the phase shift. At the first peak of resonance, the crystal behaves for AC like a small value resistor, with no phase shift. This peak is called the series resonant peak. As the frequency of the signal across the crystal terminals is raised, the resistance rises, the phase shifts violently again and at a frequency a few kHz higher than the series resonant frequency another resonance occurs. This time the crystal behaves like a parallel resonant circuit, and at the peak of resonance the resistance appears now to be very high, once again with no phase shift. At higher frequencies still, the crystal behaves like a capacitor again, with a 90° phase shift, current leading voltage.

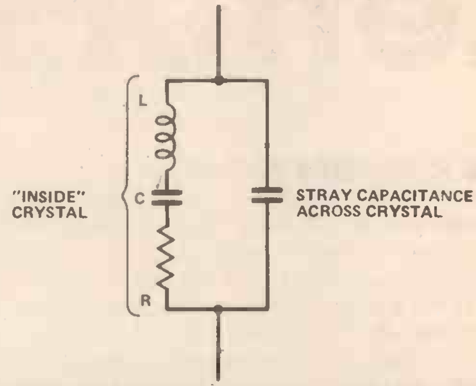


Fig. 6. Equivalent circuit of a crystal — this circuit would behave electrically just like a crystal if we could ever get suitable components for L, C and R.

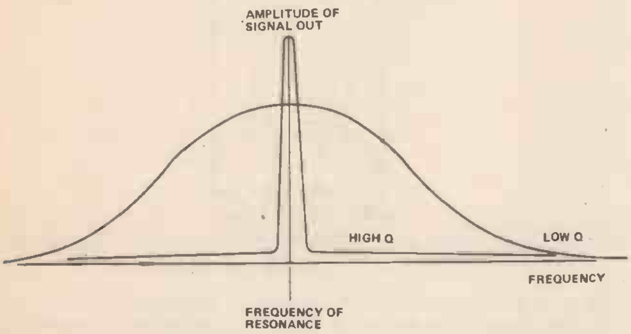


Fig. 5. Q-factor of a tuned circuit. A high-Q tuned circuit tunes sharply to one frequency, so that there is very little output at other frequencies.

All of this leads to crystals being used in oscillator circuits which can maintain a very precise frequency—used for applications as diverse as digital watches and radio transmitters. In addition, crystal filters can be designed which will pass only a very small bandwidth around a selected frequency.

Quartz crystals intended for osillators are never driven very hard—too much vibration could split the crystal—but the vibration can be used. The piezoelectric effect can work both ways however, particularly in ceramic crystals and if we put a second set of electrode plates onto a ceramic crystal then a mechanical vibration of the crystal will cause an alternating voltage to appear across these additional plates. This arrangement can be used as a very efficient filter, passing only a narrow band of frequencies around the resonant frequency of the crystal. This can permit the use of untuned (IC) amplifiers, with just a couple of these ceramic filters providing the tuning. In addition, the removal of unwanted frequencies is much easier than when coil-capacitor tuned circuits are used.

The fact that the effect works the other way around—with mechanical vibration causing an electrical output—has, of course been the basis of ceramic gramophone pickups for many years. Less well known is the application of the same transducers to measure speed and acceleration of aircraft and missiles. The transducers give a voltage proportional to acceleration, and analogue computers transform this into readings of speed and distance. In addition, the transducers which are used as ultrasonic sources can also be used as receivers for the same frequency, so that ultrasonic burglar alarms are possible.

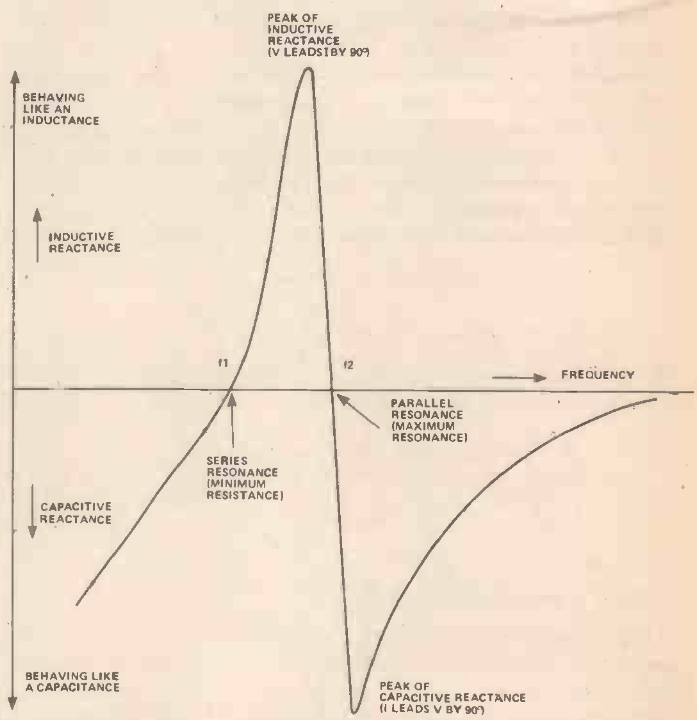


Fig. 7. Electrical behaviour of a crystal. At low frequencies, the crystal behaves like a capacitance, with its reactance decreasing until it reaches zero at f1, the frequency of series resonance. Just about this frequency, the crystal behaves like an inductor, reaching a peak of reactance which then reduces to zero again at f2, the frequency of parallel resonance. The crystal then behaves like a capacitor again, with a peak of reactance occurring before the normal capacitor reactance curve is resumed.

The familiar piezoelectric gas lighter is yet another example of these crystals in use. A barium zirconate crystal can give an enormous voltage, 20kV or more, when it is hit hard enough. These gas lighters pull a hammerhead back against a spring and then suddenly release the lot on the unsuspecting crystal. Result is a sudden pulse of voltage, enough to produce a spark across a gap. Sparks, squeaks and squeezes; they're all part of the piezoelectric story! **HE**

Letters

CB for the Elderly

I'm coming up to 79 years of age, and was a ham in the 20's—2LO days. Your expose re CB is of vital interest to me, having fallen on hard times. No, I am not asking for a handout — just technical help — so here goes. I am a disabled person with invalid carriage, trying to live on Soc Sec. I live in a block of holiday flats, so have no neighbours with a phone — the nearest is ¼ mile away, if it's not vandalised.

I have my own phone now purely to call the doctor or clinic, or for any other emergency help. Now, I have just paid my phone bill — £25 for six months! I have to go without a lot to pay this, no daily paper, or television or cinema, etc etc.

Can I build some sort of a rig to contact someone somewhere! I had visions of contacting the AA, police, ambulance service, or even the fire brigade, just to pass on a message, but of course this is out! Mine is certainly a case for CB.

F. E. W., Bridport

Freebies

If any educational authority or club has need of electronic and electromechanical devices including two record decks, I would be glad to let them go for free as long as they are collected.

My phone number is 01-455 0540 and I can be contacted between 17:30 and 18:30 most evenings.

David St George, G4 IOY

Photomultiplier warning

I am sure that your articles on NBTV have aroused a lot of interest so this information should be of use to your readers, and could save them expense and disappointment.

You mentioned the use of photomultipliers but state that they are expensive. One company advertises these as "G31A Photo Multiplier in stainless steel container with window and built-in resistor network £2 each". This would seem very attractive and would suggest that the devices only need a power supply to be put to immediate use. In the case of the two I bought, this would have meant immediate destruction of the power supply, for the gel in which the whole thing is potted was saturated with electrolyte from the capacitors in the unit (the aluminium cans of these being corroded right through). I thus decided to dismember one of these in order to extract the G31A, which is the important part. The G31A was "soft". Examination of the other unit through the window proved it to be in the same useless condition.

J. G., Calne, Wilts.

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computing today

THE JULY ISSUE
WILL BE ON SALE
JUNE 13th

UART PROJECT

This month we present a companion board to the popular modem project with our UART board. Simple, powerful and flexible were the requirements and that's exactly what it is — so if you have interfacing problems connect to the next issue.

COMPUCOLOR REPORT

The Compucolor II never really took off in this country despite the glowing reviews it received. As a colour graphics machine it offers a variety of functions that are both unique and powerful and our users report contains a detailed discourse in the machines defence. It also provides an interesting insight into the problems that can occur when you try and order machines from abroad, caveat emptor has seldom been more applicable!

MAILING LIST PROGRAM

Is your tongue fed up with sticking all those stamps, envelopes and things? Use CTs mailing list implementation as the basis for your small business, office, club, user group etc etc and save your secretary that feeling of "gummy tongue".

TAKE A TEST

Computerisation and the classroom are thorny subjects but there is a real and ready-made application in the multiple choice type of exam. Our regular contributor, A.P. Stephenson, presents his ideas and programs on this subject. Book your classroom micro for a test with next months educational CT.

HEX A TRUSTY 80

Are you hexed about Hex? Do you know what to do with it when you've got it? Read how one of our readers struggled through the Hex jungle and emerged triumphant with the knowledge. Seriously though, if you are having problems understanding how to link machine code routines to BASIC programs then this is a must for you. TRS-80 owners are advised to queue for this issue as it is going to be much in demand!

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

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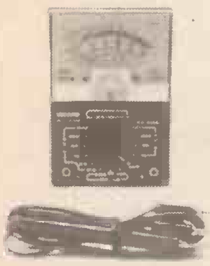

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CAR AUDIO:

● **New Model Stereo Cassette/Radio** M.W., stereo FM and stereo cassette player. 8 Watts per channel, fast forward and autostop, includes fitting kit and FREE SPEAKERS. Sold elsewhere for up to £85 (believe it or not). Our price £45 + £1.40 post. (For negative earth cars only).

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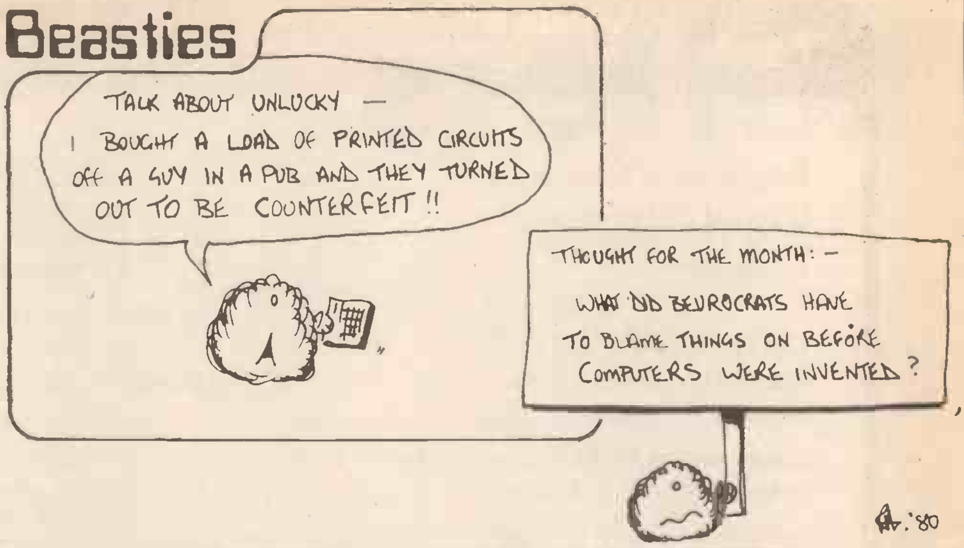

ETI NEXT MONTH

ON SALE JULY 4th

100W MOSFET Amplifier

Yet another in the long line of top line audio projects from ETI. Next month we give you a 100 + 100W power amp with bargraph output display, separate PSUs for each channel and a brilliant sound that puts this unit at the very top end of audio today. You will find it costs a lot less than you think to build, too.

Electromagnetic Pulse Effect.

Never heard of it eh? Most people haven't — yet EMP could be the deciding factor in a nations fight for survival during nuclear attack. With the international situation steadily worsening around us, the facts ETI has turned up about Britain's susceptibility to EMP are very, very disturbing and make mandatory reading for anyone concerned with keeping civilisation alive in the age of the Bomb!

As an indication of the situation, did you know that in 1958 a small warhead test in the Johnstone Islands produced power systems failure in Hawaii, SOME 1000 KM FROM THE EXPLOSION, due to EMP? (The British Isles are approx. 800 km in length).

Video Today — And Tomorrow

Next month ETI takes a detailed look at the expanding world of home video and offers a buyers guide to inform the intending purchaser. In addition we have a look at the next 12 months from Richard Dean (editor — TV and Home Video) — probably the leading writer in the field today.

Circuits Appetiser

How many times have you glanced at book titles all neatly aligned on a shelf and wondered just how interesting they *really* are? Well, as of next month maybe we can help. "110 Timer Circuits for the Home Constructor" has just been released by Newnes and ETI is publishing a chapter from it next month. Circuits galore and full details of this very nifty litttle volume. It is hoped that more books will receive this treatment in the future.

Projects, Projects, Projects, Projects.

In addition to that truly amazing MOSFET AMPLIFIER we have a further four constructional projects for you next month. There is an excellent VCA module which fits in with Project 80 if you're following it. Also we give full details of an ULTRASONIC BURGLAR ALARM which could ensure than any visitors you get are at least invited. Two test gear "quickies" are featured in the shape of a LINEAR CAPACITANCE METER with good accuracy and easy construction and a very versatile LOGIC PROBE to allow you to hunt out those missing bits.

With all this how can you possibly not buy ETI next month?

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

New from Newnes Technical Books

Beginner's Guide to Digital Electronics

Ian Sinclair

Digital electronics affects us all — pocket calculators, digital watches, T.V. games, microprocessors and computers all make use of digital technology. This book provides a readable introduction to the methods, circuits and applications of digital electronics, with practical hints and exercises.

1980 192 pages 0 408 00449 5
£3.25 US$7.50

Electronics — Build & Learn

R A Penfold

An introduction to basic electronics theory for beginners by means of practical experiments: 'learning by doing'. Full instructions are given for building a circuit demonstrator unit; electronics components are then described one by one and used in simple circuits that can be set up on the unit. This is an ideal first book for hobbyists.

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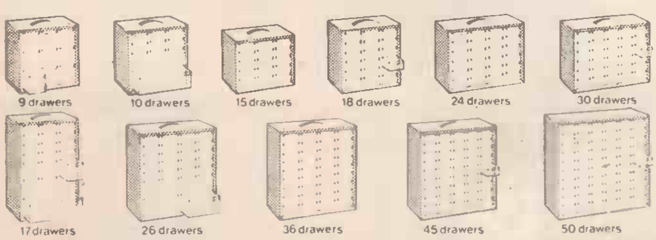

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Hazard Flasher

The HE Hazard Warning Indicator lets you flash around the streets. Adapt your car lighting system with it.

IF YOUR CAR does not feature hazard warning indicators, then this project is for you. It can replace the existing indicator control, still providing the normal indicator functions but giving the added bonus of hazard control, where all four indicator bulbs are illuminated simultaneously.

With the connection of a small 64 ohm impedance speaker an audible warning can be obtained, to warn the driver that the indicator lights are flashing. The frequency of this tone changes when in the hazard mode so that the driver can instantly tell that the feature is operational. Also the standard dash board lamp can be controlled by the unit giving a visual indication of operation.

A single IC does the majority of the work, controlling the rate at which the lights are illuminated, and the frequency of the audible tone. Power Darlington transistors are used as high current electronic switches and the whole circuit is mounted on a small neat printed circuit board which can be fitted either straight under the dash or inside a small case. Personal choice decides the latter.

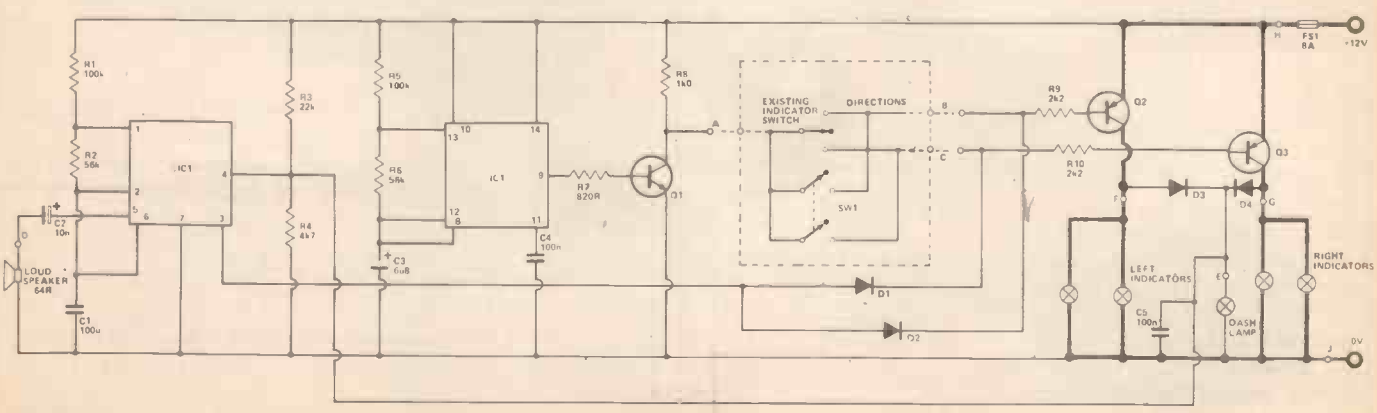
The existing indicator switch in the steering column should be adaptable into the circuit without problem and the only item extra to the circuit will be the hazard ON/OFF switch itself, which you can mount virtually anywhere.

CONSTRUCTION

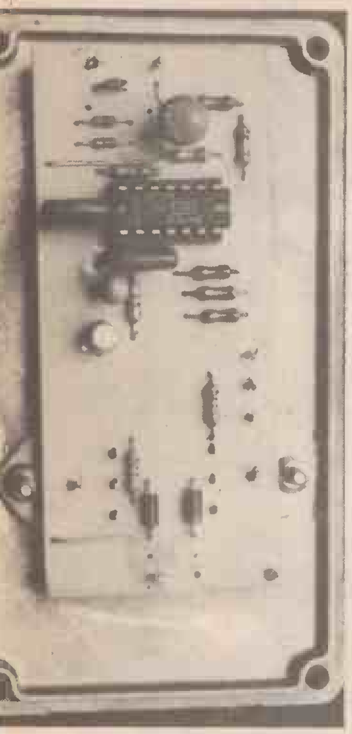
Absolutely nothing special in construction here, apart from the two power transistors. As they tend to run warm they need a substantial heatsink (we used the diecast metal box in which the project was mounted).

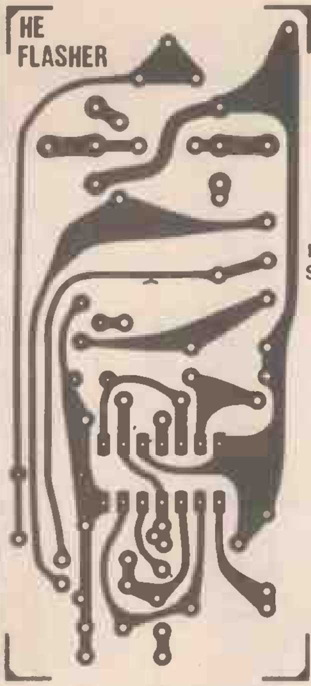
The transistors can be mounted on the underside of the board with the leads bent up and carefully soldered on. We have used this method of construction before and it provides a useful way of heatsinking the transistors while holding the board steady. Heat sink compound and insulating washers must, however, be used to insulate the transistors from the case.

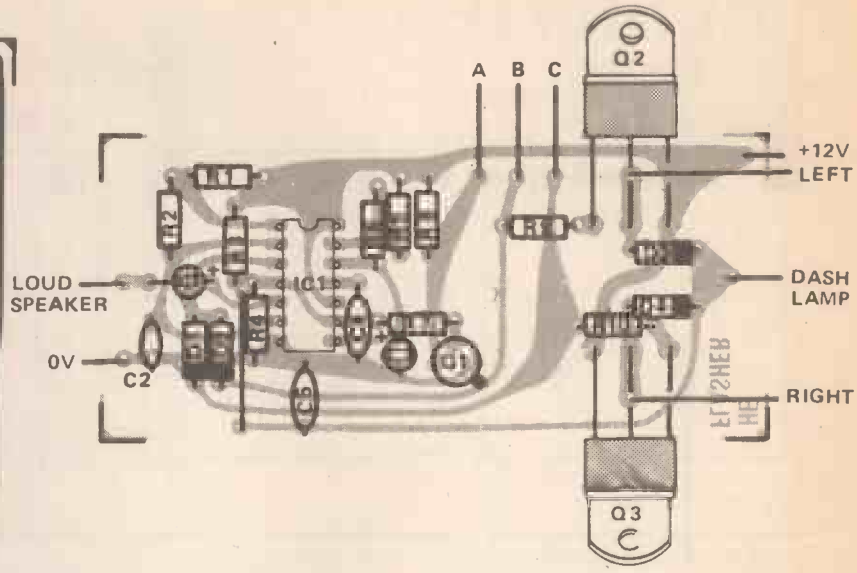
If you wish, the case can be primed and painted with aerosol sprays, but this is really not essential as the unit will probably be fitted behind the dashboard and therefore will be out of sight.



Above: Full circuit diagram of the Hazard Flasher unit.







***Above:* The Flasher installed on the lid of a diecast box.**
***Right:* Component overlay for the Hazard Flasher.**

'Crimp-on-connectors' provide the easiest method of connection to the car electrical circuit, but remember in the positive power supply line to include an in-line fuseholder and 8 A fuse. **HE**

How it Works

The second half of IC1, a dual 555 type timer IC is connected as an astable multivibrator, oscillating at approximately 1Hz.

Q2 and 3 form the power switches necessary to turn the indicator bulbs on and off and are power Darlington transistors. The heavy current path is shown on the circuit diagram as thick black lines.

The transistors are turned on and off by the pulse from the astable oscillator coupled through either the existing indicator switch (which turns either Q2 or Q3 on and off) or the hazard switch which turns both Q2 and Q3 on and off.

The dash board indicator lamp is illuminated via current D3 and/or D4 whenever either of the transistors Q2 or Q3 turn on.

The first half of IC1 is an astable running at an audio frequency variable by the control voltage at pin 3, which is taken from Q2 and 3 bases via D1 and D2. These two diodes control the voltage at pin 3, such that with only one power transistor on the multivibrator has a higher frequency than when both transistors are on. A different tone is therefore obtained for the hazard flasher and the individual direction indicator.

Finally, the astable is enabled by the voltage across the dashboard light — when the lamp is on i.e. when a voltage appears across it, pin 4 of IC1 is taken high which turns on the astable.

Parts List

RESISTORS (All ¼W, 5%)	
R1, 5	100k
R2, 6	56k
R3	22k
R4	4k7
R7	820R
R8	1k
R9, 10	2k2
CAPACITORS	
C1	10u 16V Tantalum
C2	10n Ceramic
C3	6u8 16V Tantalum
C4, 5	100n Polyester
SEMICONDUCTORS	
IC1	556
Q1	BC 109
Q2, 3	TIP 146
D1, 2	1N 4148
D3, 4	1N 4001

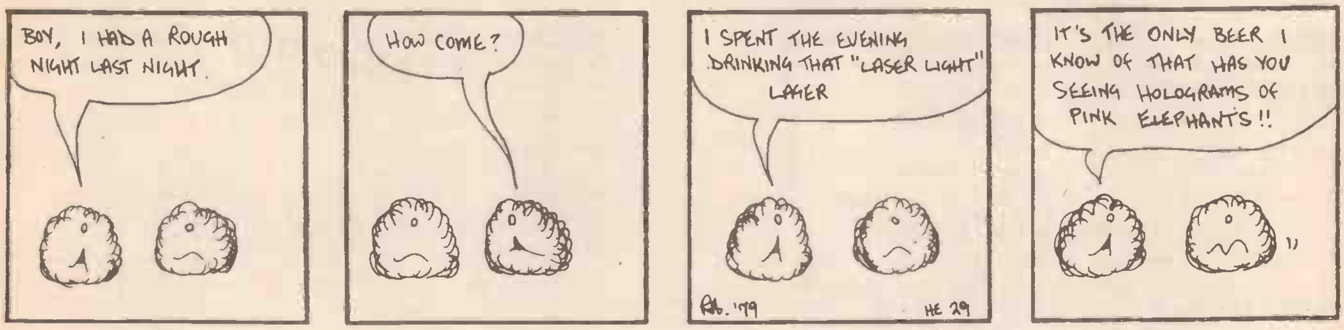
MISCELLANEOUS

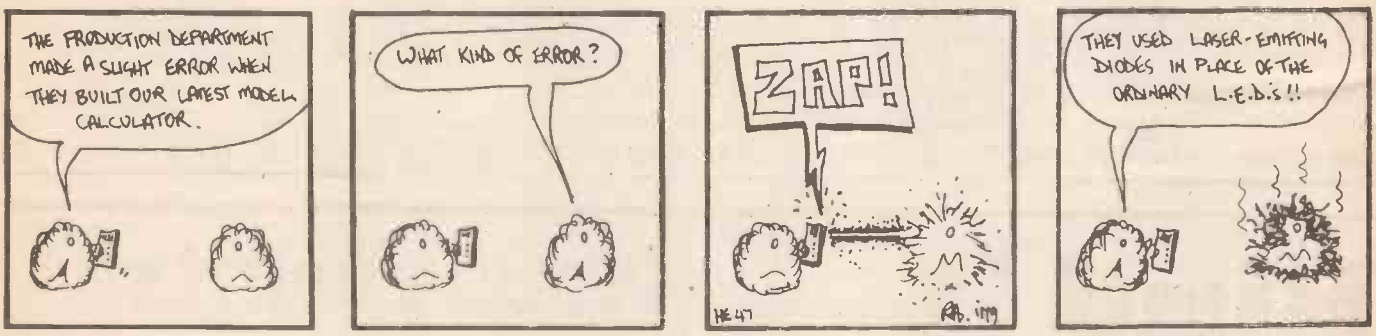
64 ohm miniature loudspeaker, in-line fuseholder + 8A fuse, SW1 DPST toggle switch, diecast box 4½"×2½"×1¼"

Buylines

We can't foresee any problems in obtaining the components for this project. The usual mail order companies advertising in this issue should have all of the components even if your local stockist hasn't.

BEASTIES BY RH





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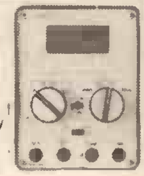

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Into Electronics Construction

PART 6 BY IAN SINCLAIR

All good things come to an end. Ian Sinclair ties up a few loose ends this month with some hints on fault-finding and a look at an amplifier circuit.

WE'VE COME QUITE A LONG WAY since we started this series, assuming at the start that you didn't know a resistor from a capacitor and had never put a circuit together. This is the last part of this series, and it's a good opportunity to tidy up a bit, and deal with some things which had been left aside earlier. We're still keeping to the idea that this is a series for the apprentice constructor, but a bit of knowledge of theory is now the most pressing item on the list, because without it you're eternally stuck with other people's circuits and no idea what to do if things go wrong.

One of the most useful bits of electrical theory is Ohm's Law — it's simple to remember and simple to use, yet it's quite incredibly valuable to us. To understand it properly, though, we have to be very clear about what happens in an electrical circuit, so pin your eyebrows up and take this lot on board.

OHM TRUTHS

An electrical circuit is a load of connections which allow electric current to flow in a complete loop, ending up where it started. There also has to be something which causes the electric current to flow, something which pushes it along. That something, as far as our circuits are concerned will be a battery or a mains power supply unit.

How much current will flow when we connect a battery into a circuit? That depends on two quantities — the voltage generated by the battery (often referred to in textbooks as the EMF, Electromotive Force) and the resistance of the circuit. The voltage of the battery is printed on it — 9 V or 6 V for the batteries we've used in this series, for example. The resistance of the whole circuit will be a quantity which can be measured in units called ohms, or if the resistance is large in units of kilohms. The kilohm or k is just 1000 ohms, and we use k in place of ohms just to avoid having to work with large numbers. Now we can answer the question of how much current flows — it's equal to the battery voltage divided by the total circuit resistance. If we used ohms as a measure of resistance, the current will be a number of amperes (amps); if we used kilohms to measure resistance, the current will be a number of milliamps. The milliamp (mA) is one thousandth of the amp or 10^{-3}A. Most electronic circuits have high resistances and use low amounts of current, so that these units of kilohms and milliamps are more common than the ohms and amps we would use in large-scale electrical circuits. What we've used here is one form of Ohm's Law, which can be written as —

$$\text{current in mA} = \frac{\text{voltage in Volts}}{\text{resistance in k}}$$

For example, if we have 9 V across a 6k8 resistor (value 6.8k, remember) then the current is

$$\frac{9}{6.8},$$

which is around 1.32mA.

That's not the end of it, though. Suppose we know, by measurement, how much current a circuit takes, and we also know the battery voltage. We can use these two bits of information to find out what the resistance of the circuit is — it's simply:

$$\frac{\text{voltage of battery.}}{\text{current}}$$

If, as usual, we know the battery voltage in units of volts and the circuit current in milliamps, then the value of resistance we calculate is in kilohms. For example, using a 6 V battery and measuring a 4mA current means that the resistance of our circuit is

$$\frac{6\text{ V}}{4\text{mA}}$$

= 1.5k or 1k5.

There's a third form of the law. Suppose we have a supply whose voltage is *not* known, but we know the circuit resistance (in k) and the current (in mA) which flows. We can then calculate what the voltage is — it's equal to current x resistance. For example, if a current of 2.5mA flows through a 3k resistance; then the voltage which is pushing it is 3 × 2.5 = 7.5 V. Easy really.

One very old-fashioned way of remembering these effects is to use letters to represent the quantities: V for voltage, R for resistance and I for current, and then we can write Ohms law in the form of equations:

$I = V/R$

$R = V/I$

$V = R.I$ — and Fig. 6.1 shows a method which countless generations of apprentices have used to help them remember which way round the equations go.

$$V = R.I$$
$$\frac{V}{R} = I$$
$$R = \frac{V}{I}$$

Fig. 6.1 The ancient and extremely useful method of remembering Ohm's law.

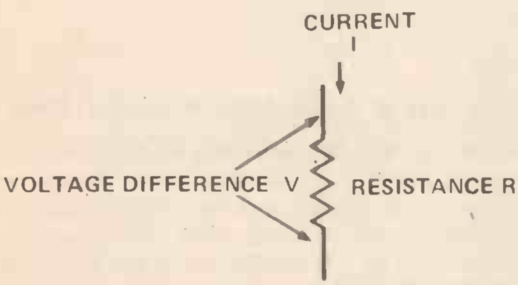


Fig. 6.2 A voltage difference caused by a current flowing through a resistor.

ODD OHMS

Now that's just one use of Ohm's law — relating the voltage of a battery to the current it causes in a circuit — but it applies equally well to any part of a circuit. Suppose we have a resistor which is part of a circuit, as shown in Fig. 6.2. If there's a current flowing through this resistor, then there's a voltage across it, and the voltage just has to be equal to current x resistance. If for example, we have a 2k2 resistor with 2 mA flowing through it, then there's a voltage difference of 2.2x2=4.4 V across the resistor. Why should there be a voltage? This is a resistor, after all, not a battery! The answer is that this is a bit of the battery voltage being used to force current through this resistor. If we didn't have this voltage, there wouldn't be any current. Ohm's law applies exactly to all the resistors in a circuit — if you find that your measurements don't agree with the theory, then it's likely that your measurements are wrong!

There's one very important part of an electronic circuit which doesn't obey Ohm's law, though, and that's the transistor itself, along with its close relative, the diode. The voltage between the collector and emitter of a transistor doesn't have much relation to the current which flows between these points, because the current between collector and emitter is controlled by the base current. Similarly, the voltage between the base and the emitter is almost constant while the transistor is passing current, something between 0.5 V and 0.6 most of the time, even when the current varies by quite a bit. Definitely not according to the ways of Ohm sweet Ohm! By using Ohm's law for the resistors, though, and what we know of how transistors behave, we can sort out circuits which are misbehaving, so that you now have as much theory as you're going to need for quite a time. What you need now for trouble shooting exercises is some way of measuring these important quantities, voltage and current, and that brings us to meters and measurements.

TEST GEAR

If you're serious about this electronics business, if the smell of hot solder had got to you, if it's not good enough just to build one bit every year, then its odds on you're going to be able to make use of a meter. Now you have to be a bit fussy about what sort of meter you buy. Don't for example, be tempted by some of the 'bargain offers' which you see in the advertising pages of papers. These things may be fine for measuring the voltages of a car battery, but they're useless for any sort of electronics circuit apart from the old fashioned valve-operated radios of many years ago. What you have to look for is a device described as a multimeter, and which has a 'figure-of-merit' of *at least* 10000 ohms per volt. Don't let anyone mystify you by talking of the dozens of ranges on the meter he's trying to sell you — your concern is for the ohms per volt figure. Even if every knob is gold plated and it comes with a thousand year guarantee, it's no use if its ohms per volt is less than 10000 and nowadays, 20000 is a much more useful figure. Why? Well, this figure of merit measures how much resistance the meter itself has when you're using it to measure voltages. If the meter has too low a resistance, then it's going to cause quite a large change in the circuit when you connect it, and it certainly won't give you much of a clue about what voltage was there *before* you connected it. It's better to have a good quality meter with 20000 ohms per volt and only a few ranges than one with 5000 ohms per volt, dozens of ranges, flashing dials and an instruction book in Russian/Chinese/ Turkish/Finnish.

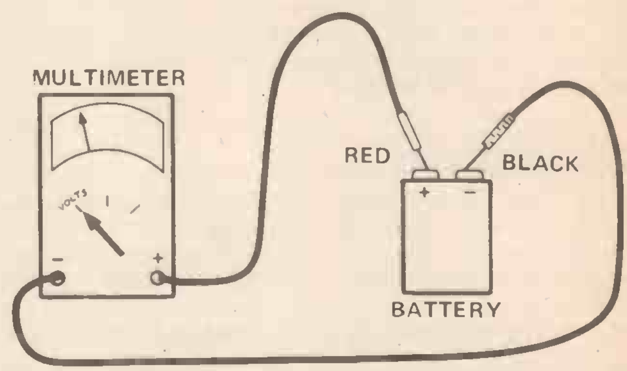


Fig. 6.3 Measuring a battery voltage. The meter must be set to a VOLTAGE range high enough to cope with the battery voltage.

How exactly can you make use of such a meter? Let's start by looking at how you connect a meter in circuit — then we'll see why! The most useful scales are the voltage scales, mainly because they're simple to use. Most circuits have the negative line of the battery connected to all the circuit metal work — it's then called the earth line. If you clip the negative lead from the meter to this earth line or to battery negative if the circuit has no metalwork around it, then you can measure every voltage in the circuit. Start with the battery voltage itself — if the battery is reasonably fresh, then the battery voltage should be pretty close to the voltage which is marked on the battery — 6 V for a PP1, 9 V for a PP9. If the battery is getting near to the end of its life, though, this voltage may be quite a bit lower, especially when the battery is delivering current to a circuit. If you find that your battery voltage shoots down when the circuit is switched on, then it's time to renew the battery — a good rule of thumb is to renew a 6 V battery when it reads 4.5 V and renew a 9 V battery when it reads 6 V. Incidentally, if you take the battery out and measure its voltage you'll usually find that it looks quite normal — a duff battery in its early stages shows up only when it's in circuit and passing current.

MEASUREMENTS

You can do a lot more with a multimeter than just checking batteries, though, you can check every part of a circuit. Suppose you have the situation, which every constructor has to face at some time or another, of a circuit which you've built which simply doesn't work. How do you go about getting it to work? The hard way, of course, is to check every part of the circuit, looking for bad soldered joints, wrong connections, open circuits but that won't find a faulty component for you. The satisfactory method is to make intelligent use of a meter to indicate what's wrong. It's a skill which you learn mainly by experience, but here are a few hints for the sort of battery-operated circuits we've been building.

First of all, if you've just connected up a battery to find that nothing happens, check the battery voltage. Switch the multimeter selector switch to a DC voltage range which is higher than the normal battery voltage (for example, the 12 V range for checking 9 V or 6 V batteries), then clip the negative lead to battery negative and the positive lead to battery positive. Take the voltage reading with the battery also connected to the circuit. If the voltage looks too low, you need a new battery. Make sure that you're reading the right scale — obviously if you've set the range switch to 12 V, then you should be reading on a scale which is marked from zero to 12 — it looks obvious but a lot of people don't seem to realise this!

If the battery voltage looks OK, then check the current which the circuit is drawing. This is quite a different type of reading which needs a different sort of connection. Remove the positive lead which runs from the circuit to the battery, and connect the positive lead of the meter to the battery positive terminal. Now switch the meter to its highest current range, which is usually several amps, and connect the positive lead from the circuit to the meter negative lead. This makes the meter part of the circuit. Your circuit probably takes very little current, so that the amount hardly shows on the largest current range, but if you now switch one at a time, to the lower current ranges, you should find a reading in one range. If the current reading is zero or very small, then there's something missing — the circuit isn't conducting. Either some connections are not properly connected, or a transistor is not conducting — you'll have to check or make further tests to find out which; but at least you have some clue as to what you're looking for.

Suppose everything's OK so far, but the circuit still doesn't work! Put it back the way it was, and prepare the meter for making voltage readings again. That means switch back to the voltage scale you used for reading the battery voltage, and clip the meter negative lead to the battery negative lead. You can now use the meter positive lead to measure voltages in each part of the circuit, and the most obvious places to start with are the transistors. Start by measuring the collector voltages. If the collector voltage of a transistor is about equal to the battery positive voltage, then it's certain that transistor isn't conducting. On the other hand, if the collector voltage of the transistor is so low that it hardly causes the needle of the meter to move, then the transistor is conducting all right, it's conducting so well that it has hardly any resistance. Now compare these discoveries with a description of what the circuit ought to be doing — should we have any transistors cut off, or conducting hard (bottomed)? Once again, the meter has indicated where to check.

It doesn't, of course, tell us why these transistors are cut-off or bottomed, and the next step is to check the voltage between the base of each transistor and its emitter. If each emitter is connected to battery negative, of course, you don't need to make any alterations; keep the meter negative lead fastened to battery negative. If the emitter connects to negative through a resistor, then you'll have to clip the meter negative to each emitter and then take a reading by connecting the meter positive to the base of each transistor, one at a time. For a transistor which is cut-off, the base-to-emitter voltage should be around 0.5 V or less. If your transistor is cut-off (no

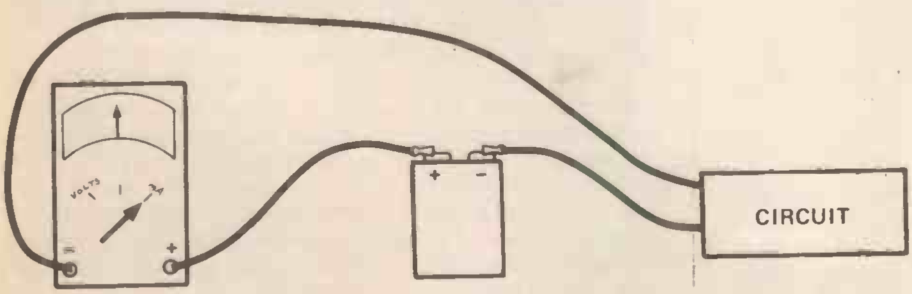


Fig. 6.4 Measuring the amount of current that a circuit takes.

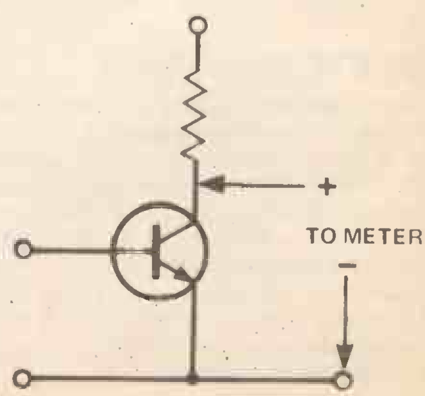


Fig. 6.5 Where to measure the collector voltage of a transistor. The meter must be switched to a voltage range as high as that used for measuring battery voltage.

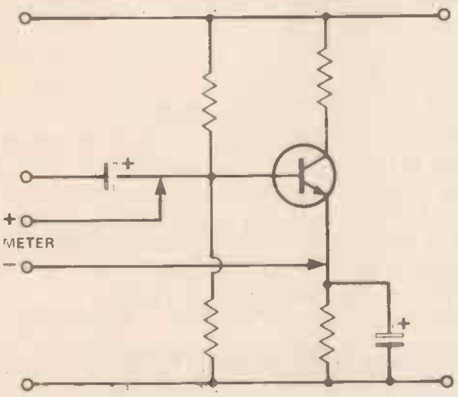


Fig. 6.6 Measuring the voltage between base and emitter. A meter with a good "figure of merit" is needed for this measurement.

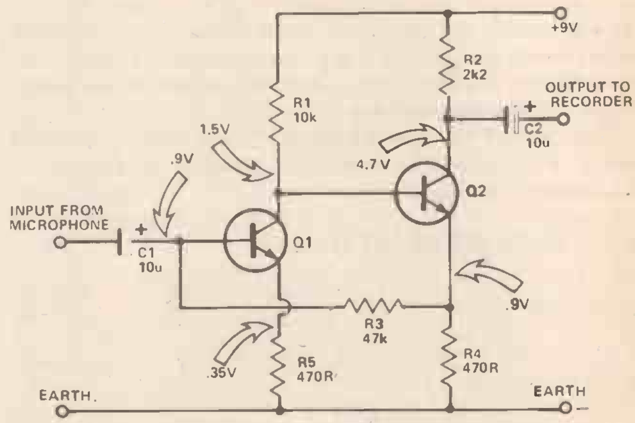


Fig. 6.7 The amplifier circuit. The figures in circles are the "design voltages" for the circuit; actual readings should not be too greatly different.

current flowing, collector voltage high) with a base emitter voltage of 0.6 V or more than it looks suspiciously like a duff transistor you've got there. On the other hand, if you have a transistor which is bottomed, and yet its base-to-emitter voltage is less than 0.5 V, that's another indication of a fault — a different type of fault to be sure, but one which is equally effective at stopping the transistor from working. It's at times like this when you find that you've put the transistor in the wrong way round, and what you thought was the collector is in fact the emitter or the base. . . .

These simple tests take you a long way in checking out the non-worker, and by experience you will soon learn to spot signs of faults. Several circuits, for example, show what the 'normal' voltage at each point should be, so that by checking each of the voltages — nearly always measured with the meter negative connected to battery negative — you can see if there's one which is way out. Small differences (except between emitter and base) don't usually matter too much, they're caused by the tolerances of components values. A 10k resistor, for example, can have a true value anywhere between 8k and 12k, so that circuits which use several resistors can often have voltage readings which differ quite a bit between one sample of the circuit and another. The big differences, more than 20%, usually indicate a fault somewhere, though, and this sort of voltage reading exercise is a very valuable method of fault-finding.

AWKWARD AMPS

Just to end with, we're going practical again. There's one type of circuit we haven't looked at up till now, and that's a voltage amplifier — the sort of circuit you might use btween a microphone and a cassette recorder, for example, to boost the performance of the microphone. The reason we've left it is that the amplifier circuit doesn't have an action which can be made visible — it doesn't flash lights — and it's not nearly so easy to check that it's working correctly. The best method, in fact, is by taking voltage measurements, and we may have to make some adjustments to the circuit to get it operating correctly.

The circuit is shown in Fig. 6.7. This is a type of amplifier which is called a voltage amplifier, because it's job is to make a copy of a signal but with a greater voltage. A signal, as far as an amplifier like this is concerned, is a continual cycle of change of voltage, going from zero to some positive voltage, back to zero, then to a negative voltage and back to zero again. The frequency of such a signal is equal to the number of these complete cycles of change which take place in a second. The amplitude of the signal is the maximum voltage it reaches on each side of zero.

Where do we get these signal voltages from? We get them when we convert any varying quantities into an electrical signal. A microphone, for example, converts sound waves into signals of this sort, and we also get these signals from recordings, using pickup cartridges or tape-heads. A TV camera converts pictures into electrical signals which are a lot more complicated than the simple signals we get from microphones, but the idea of the signal is the same. Amplifying a signal means making a larger-scale copy of the signal, with more volts, but at the same frequency. Very often this amplification mustn't change the shape of the signal — a graph of signal voltage plotted against time should look the same for the output signal as it does for the input. If this is so, then the amplifier gets the name of a linear amplifier; if it doesn't then the amplifier is distorting the signal.

In the circuit shown in Fig. 6.7 two transistors, both NPN types are used. Each of these has to have bias voltage at its base — enough to keep the transistor conducting, but not so much that the transistor is bottomed. Why? Because the signal will cause the voltage at the base of the first transistor to change, up and down as the signal voltage changes — if the transistor cuts off or bottoms, then its output voltage can't be an exact copy of the input.

The important bias component of the amplifier in Fig. 6.7 is the resistor R3, and this one may have to be altered to make the amplifier bias correct, because we can't select exactly what transistors or other components we shall use. Let's take a close look at the circuit.

The signal comes in from the microphone at C1. This signal is very small, less than a millivolt, which is why it needs to be amplified. We need the capacitor because the microphone mustn't have any DC across its terminals, but the transistor must, and the capacitor separates the two — it lets signal voltages through, but it prevents direct current from flowing out of the amplifier circuit into the microphone.

The base of the first transistor has a current flowing into it through R3, from the emitter of Q2. This arrangement is deliberate, it's a type of circuit arrangement called feedback bias, and it causes enough current to flow in Q1 to keep the collector voltage of Q1 pretty low, around 1.5 V. It's that potential divider type of circuit in action again. The collector of Q1 is connected directly to the base of Q2, so that this part is also at 1.5 V DC. Note that these are the steady voltages, before any signal voltage exists. With 1.5 V on the base of Q2, the emitter has to be at a voltage of around 0.9 to 1.0 V — and that in turn keeps current flowing into the base of Q1.

The arrangement keeps itself self-adjusting providing that the correct values are used in the first place. Imagine, for example, what happens if the voltage at the base of Q1 went down. Q1 would conduct less well, so the voltage at its collector would rise. Because the base of Q2 is connected to the collector of Q1, the base voltage and the emitter voltage (0.5 V or so between then, remember) of Q2 would rise — and now more current would flow through R3, causing the base voltage of Q1 to rise again. This sort of self-correcting circuit is what we mean by negative feedback — it's a phrase you will keep coming across in this electronics business.

The negative feedback keeps the bias currents flowing correctly in each of the transistors, then, even if resistor values change, or transistors are replaced. The only thing we have to be sure of is that the circuit is correct in the first place. The circuit of Fig. 6.7 has been designed so that it should automatically be correct, and if you have no meters you'll simply have to take it on trust. If you have a meter, though, measure the voltage at the collector of Q2, with the negative lead of the meter connected to battery negative. This voltage should be somewhere around 4.7 V — that was the 'target' voltage at the design stage. As long as the voltage is between 4.0 and 5.5 the circuit will work reasonably well.

Now what happens when a signal from a microphone is connected into C1? The tiny signal voltage, one millivolt or so causes the voltage at the base of Q1 to vary, a millivolt or so up and a millivolt or so down. This variation makes the current between collector and emitter vary, and so causes the collector voltage to rise and fall in sympathy. At the collector, though, the rise and fall of voltage is several times as great as that at the input.

This is an amplified signal, and it's also affecting the base of Q2. Here again we have the same process, causing the current of Q2 to rise and fall (much more than that of Q1) and so causing a signal voltage at the collector of Q2. This signal voltage can pass through C2, though direct current can't, so that we can connect other circuits to the output at C2 without disturbing the steady voltage on the collector of Q2. The amount of gain from the circuit as it's shown isn't very good, less than a hundred times, but it's quite adequate to make a very noticeable difference when it's connected between a microphone and another unit, such as the input of a cassette recorder (remember that an earth connection is also needed — no one-wire connections if you please!)

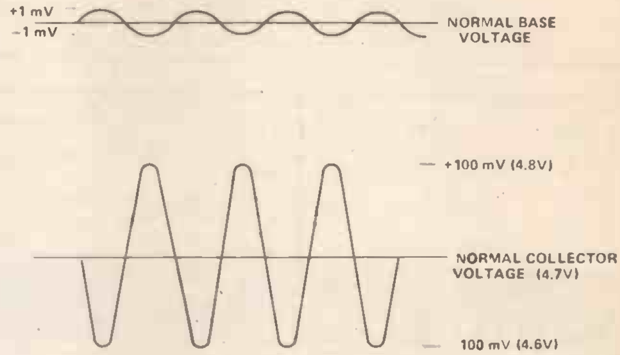


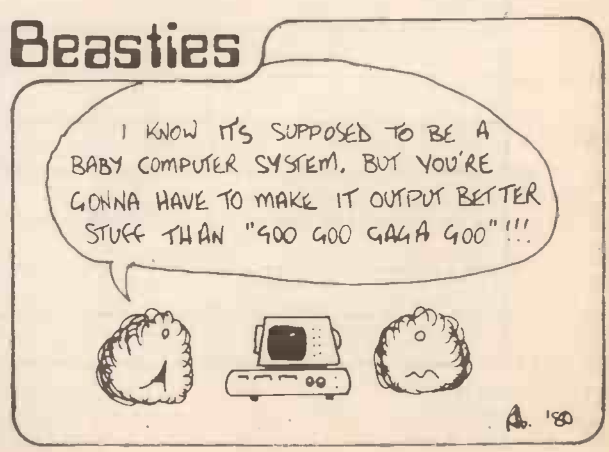
Fig. 6.8 The action of the amplifier. The wave at the output of the amplifier is an enlarged copy of the wave at the input.

To get a much larger value of gain, there's just one very simple modification — connect a 220μF 6 V (or more) capacitor across R4, with its positive terminal towards the emitter of Q2. This will now give you a lot of gain — probably more than you can handle!

AND FINALLY . . .

And now it's farewell. In these six parts we've tried to give you an entry into the fascinating world of electronics construction, and also some idea of how much more there is waiting for you when you begin to understand what it's all about. Where do you go from here? There's the book "Into Electronics" for starters, which is the next step on in electronics circuit theory, and then the other follow-ups of the Into-series. After that — it's up to you. By that time you'll probably have decided that your interests lie in one particular branch of electronics, and you'll be looking for the more specialised titles in the HE list. One thing is sure — you'll find all you need in these pages!

See you next month with a new series. **HE**



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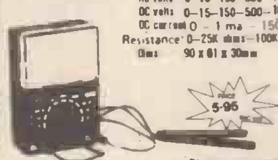

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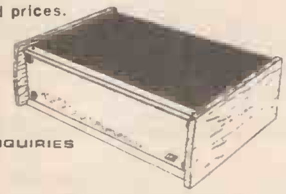

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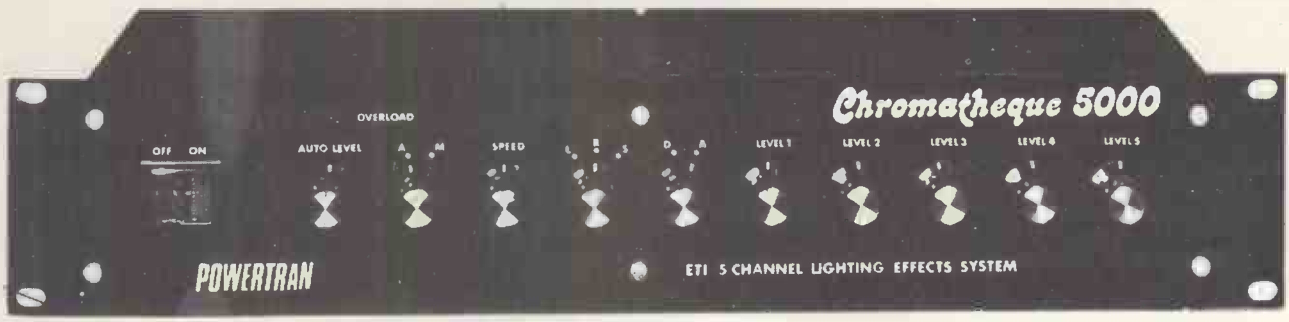

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