everyday electronics

DEC. 71

15p

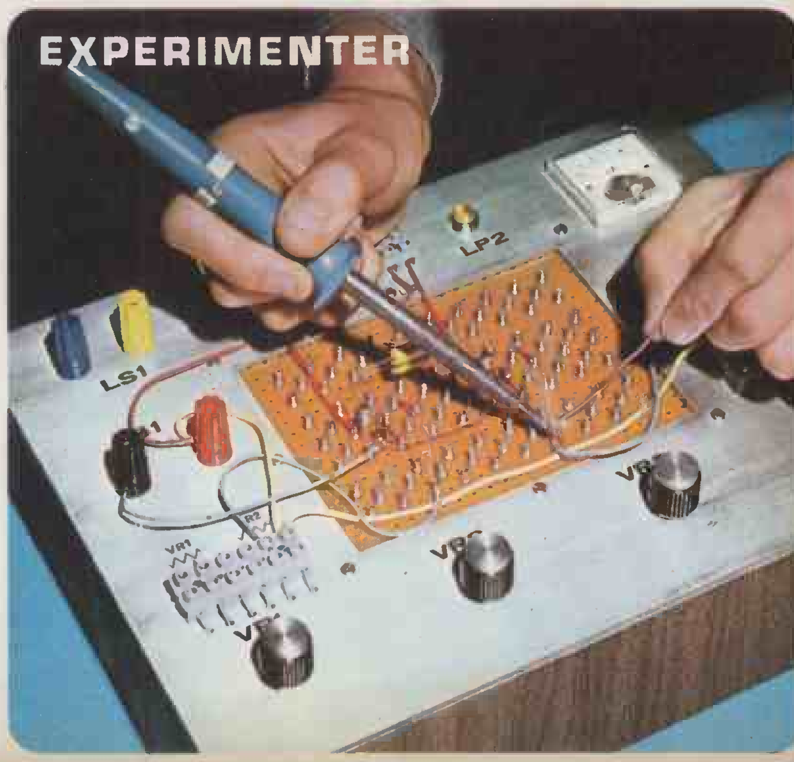
A NEW MAGAZINE BRINGING A FASCINATING HOBBY TO EVERYONE

PROJECTS EASY TO CONSTRUCT
THEORY SIMPLY EXPLAINED

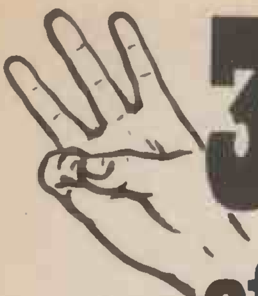
FUZZ BOX

CIRCUIT BUILDING
DEMO-DECK
FOR THE BEGINNER

....AND THE EXPERIMENTER



PHOTOGRAPHIC
COLOUR METER



3 WAYS

HOME RADIO (Components) LTD.
Dept. EE, 234-240 London Rd.,
Mitcham, CR4 3HD. 01-648 8422

of obtaining components *quickly & easily*

1 CALL AT No. 240 London Rd., Mitcham

If you live within easy reach of Mitcham or are in the area at any time do call on us. We are almost opposite Mitcham Baths. We open 9 a.m. every weekday. On Wednesdays we close 1 p.m. and all other days, including Saturdays, 5.30 p.m. On Saturdays we have extra staff to deal with queries. We carry a vast stock of components, and 999 times out of a 1,000 we can immediately lay our hands on the particular item required.

3 and ORDER BY MAIL OR TELEPHONE

Although we are kept busy selling "over the counter" we supply even more by Mail Order. You can telephone any time of day or night, Sundays included. If you ring out of office hours a recording machine takes your message for us to deal with as soon as we open shop again. Our number is 01-648 8422. If you wish to order by post our address is in the panel at the top of the page. We deal with all orders promptly.

2 JOIN OUR CREDIT ACCOUNT SERVICE

We began our Credit Account Service about 18 months ago and it has proved extremely popular. Little wonder! Our customers find it a very simple and convenient way of purchasing all their radio and electronic needs. We supply pre-paid envelopes and order forms and no matter how many orders you send us you make only one payment per month. There are several other advantages with our Credit Account Service. Please write or phone for details.

WHICHEVER WAY YOU CHOOSE you need the Home Radio Catalogue

In its 315 pages are listed over 8,000 components, over 1,500 of them illustrated. Each copy contains 10 Vouchers, each worth 5p when used as instructed. Free Supplements are supplied regularly to keep you up-to-date. The Catalogue costs 50p over the counter, or 70p including postage and packing.

Post this Coupon with Cheque or PO for 70p

Please write Name and Address in block capitals.

Name ....

Address ....

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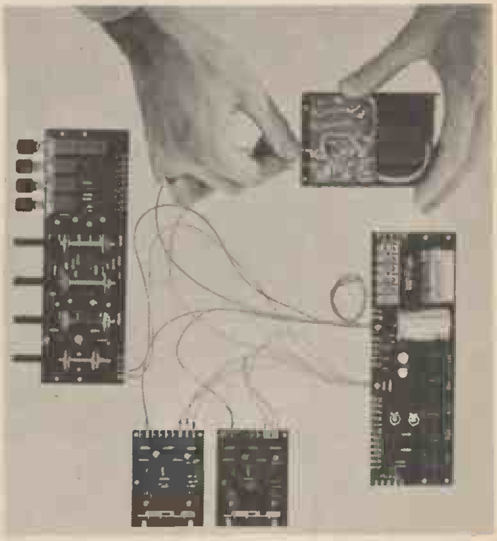
HOME RADIO (Components) LTD.
Dept. EE, 234-240 London Rd., Mitcham, CR4 3HD

The price of 70p applies only to catalogues purchased by customers in the U.K. and to BFPO addresses.

Project 605 the new simple way to assemble Sinclair high fidelity modules



For several years now you have been able to assemble your own high fidelity system to world beating standards using Sinclair modules. We have progressively improved these technically but hitherto the method of assembly at your end has remained the same – there has been no alternative to a soldering iron. Now for those who prefer not to solder, there is an alternative – Project 605.

In one neat package you can now obtain the four basic Project 60 modules plus a fifth completely new one – Masterlink – which contains all the input sockets and output components you previously bought separately. Also in the Project 605 pack are all the inter-connecting leads, cut to length and fitted at each end with plugs which clip straight onto the modules, eliminating soldering completely. The pack contains everything you need to build a complete 30 watt stereo amplifier together with a clear well illustrated Instruction Book. All you have to do is to arrange your modules in the plinth or case of your choice and then clip them together – the work of a few minutes.

Your hi-fi system will, as we said, match the finest in the world and you can add to it at any time to increase power or extend the facilities. For example a superb stereo FM Tuner unit is obtainable for only £25.

Guarantee If within 3 months of purchasing Project 605 directly from us, you are dissatisfied with it, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter. No charge for postage by surface mail. Air-mail charged at cost.

sinclair

Sinclair Radionics Ltd., London Road.,
St. Ives, Huntingdonshire PE17 4HJ.
Telephone: St. Ives (04806) 4311

Specifications

Output – 30 watts music power (10 watts per channel R.M.S. into 3 Ω).

Inputs – Mag. P.U. – 3mV correct to R.I.A.A. curve 20–25,000 Hz ± 1dB. Ceramic pick-up – 50mV. Radio – 50 to 150mV. Aux. adjustable between 3mV. and 3V.

Signal to noise ratio – Better than 70dB.

Distortion – better than 0.2% under all conditions.

Controls – Press buttons for on-off, P.U., radio and aux. Treble +15 to —15 dB at 10 kHz. Bass +15 to —15 dB at 100 Hz. Volume. Stereo Balance.

Channel matching within 1dB.

Front panel – brushed aluminium with black knobs.

Project 605 comprises Stereo 60 pre-amp/control unit, two Z-30 power amplifiers, PZ-5 power supply unit, the unique new Masterlink, leads and instructions manual complete in one pack. Post free

£29.95

To SINCLAIR RADIONICS LTD., ST. IVES, HUNTINGDONSHIRE PE17 4HJ

Please send Project 605 post free ☐ Details and list of stockists ☐

Name ....

Address ....

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for which I enclose £29.95 cheque/money order/cash. E.E. 2B

G. F. MILWARD 369 Alum Rock Road, Birmingham B8 3DR. Tel. 021-327 2339

SPECIAL 50p PACKS. ORDER 10 PACKS AND WE WILL INCLUDE AN EXTRA ONE FREE ! ! !

RESISTORS, ¼/½ watt		
assorted	100	50p
Wire-wound 1 to 3 watt	20	50p
5 to 7 watt	15	50p
10 watts	10	50p
Multi-tapped	12	50p
PAPER CONDENSERS		
TV types	50	50p
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VOLUME CONTROLS		
Assorted	5	50p
NUTS AND BOLTS. Mixed length/type		
8 B.A.	100	50p
6 B.A.	100	50p
4 B.A.	100	50p
2 B.A.	100	50p
METAL SPEAKER GRILLES 7½in. x 3½in.	6	50p
EARPIECES, MAGNETIC		
No Plug	6	50p
2·5mm Plug	4	50p
3·5mm Plug	4	50p
500 MICRO-AMP LEVEL METERS	1	50p
VEROBOARD, TRIAL PACK 5 BOARDS + CUTTER		50p
TRANSISTORS		
P.N.P. Untested but mainly O.K.	50	50p
N.P.N. Untested but mainly O.K.	50	50p
OCP 71 equivalent	5	50p
Light-sensitive Diodes	10	50p
(These produce up to 1ma from light)		
OC44 Mullard 1st grade	4	50p
OC45 Mullard Boxed	5	50p
2G378 Output, Marked	5	50p
2G371 Driver, Marked	5	50p
ASY 22, Marked	5	50p
BY 127 Rectifiers	4	50p
IN4007 Rectifiers (1200V peak)	4	50p
STC 3/4 Rectifiers	6	50p
DIODES (OA 81 & OA 91)	40	50p
WIRE		
Solid Core. Insul. 100yds.		50p
Stranded ditto 50yds.		50p
SOLAR CELLS		
Large Selenium	2	50p
Small	3	50p
(6 cells will power a Micro-matic radio)		
CO-AXIAL CABLE		
Semi Air-spaced 15yds.		50p
CRYSTAL TAPE RECORDER MIKES	1	50p
CYRSTAL EARPIECES		
3·5mm Plug	2	50p
TRANSISTORISED Signal Injector Kit	1	50p
TRANSISTORISED Signal Tracer Kit	1	50p
TRANSISTORISED CAR REV. COUNTER KIT (Needs 1 ma. meter as indicator)	1	50p

STOCKTAKING CLEARANCE! IMPOSSIBLE TO REPEAT!
We have huge numbers of components in quantities too small to advertise individually. In order to "clear the decks" we have made up parcels containing a mixture of carbon and wire-wound resistors, electrolytic and paper condensers, controls, transistors, diodes etc., for a tiny fraction of normal price. It is emphasised that these are mixed parcels only—contents cannot be stipulated! Sold only by weight.

Gross weight 2 lb. ... ... £1 (postage 20p)
Gross weight 5 lb. ... ... £2 (postage 30p)

Unrepeatable Offer ! ! ! !
Surplus VEROBOARDS, 3¾" x 2½" x ·15"
Only 10p each or £1·00 per dozen

TANTALUM CAPACITORS. COMPARE THE PRICE—ONLY 10p EACH ! ! ! !

Sub-miniature types		*Miniature types*		5·6 µF	35 volts
0·047µF	50 volts	0·022µF	20 volts	8·2 µF	10 volts
0·056µF	50 volts	0·033µF	20 volts	8·2 µF	35 volts
0·07 µF	20 volts	0·047µF	20 volts	15 µF	35 volts
0·1 µF	20 volts	0·068µF	35 volts	18 µF	35 volts
0·1 µF	50 volts	0·12 µF	35 volts	22 µF	15 volts
0·18 µF	20 volts	0·15 µF	35 volts	27 µF	120 volts
0·33 µF	35 volts	0·22 µF	50 volts	56 µF	15 volts
0·47 µF	35 volts	0·47 µF	50 volts	56 µF	20 volts
0·68 µF	20 volts	0·68 µF	35 volts	150 µF	6 volts
1·0 µF	15 volts	0·68 µF	50 volts		
2·2 µF	3 volts	1·0 µF	35 volts	*Standard*	
2·7 µF	15 volts	1·0 µF	75 volts	6·8 µF	50 volts
2·7 µF	35 volts	1·8 µF	20 volts	7·5 µF	20 volts
3·0 µF	12 volts	2·2 µF	20 volts	8·2 µF	150 volts
10·0 µF	1·5 volts	2·7 µF	50 volts	12 µF	35 volts
		3 µF	12 volts	12 µF	50 volts
		3·3 µF	15 volts	39 µF	20 volts
		4 µF	20 volts	82 µF	20 volts
		4·7 µF	35 volts	050 µF	15 volts
		5·6 µF	6 volts	270 µF	6 volts

NEW ! NEW ! NEW ! NEW !

An aerosol spray providing a convenient means of producing any number of copies of a printed circuit both simply and quickly.
Method: Spray copper laminate board with light-sensitive spray. Cover with transparent film upon which circuit has been drawn. Expose to light. (No need to use ultra-violet.) Spray with developer, rinse and etch in normal manner.

Light sensitive aerosol spray £1
Developer spray 50p

G. F. MILWARD, Drayton Bassett, Tamworth, Staffs. Postage (minimum) per order 15p.

WELCOME NEW READER ! !

For those of you who haven't heard of LST:—

LST are one of the oldest companies in Electronics Mail Order.

LST have a reputation for quality and service second to none.

LST stock only top quality components from the biggest names in Electronics.

LST's prices are the lowest possible commensurate with quality.

LST's 44 page catalogue is available FREE, the only Company to our knowledge making this offer!

SPECIAL EXPERIMENTORS BARGAIN PACK OFFER!
To introduce the new reader to electronics—a fascinating hobby—LST are offering for a limited period only a special package deal containing common transistors & diodes, common values of resistors and capacitors, solder, circuit board, and other useful brand new components at the special bargain price of £2—Our normal catalogue price over £4!!! Just place a tick in the box—tear out coupon, fill in your name and address, LST will ship your catalogue (free) or your bargain pack (£2) by return.

£2

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STOCKISTS-DISTRIBUTORS OF: IR, WELLER, MULLARD, NEWMARKET, SIEMENS, RCA, ISKRA VEROBOARD, S-DECS, TEXAS, G.E., MOTOROLA.

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TICK BOX

9 Vol Gramophone Unit. Collaro battery operated with pick up on unit plate. 4 speed auto-stop turnover cartridge. Price £2·50 plus 40p post and insurance.

Buy Time Slot Meter. Made by Sangamo Weston. 3 types—one for each coin, 2½p, 5p or 10p. Price £1·75 each plus 25p post and insurance.

Photo Electric Kit. Contains photo cell, relay, transistor and all parts to make light operated switch. Originally £2. Limited quantity to clear. £1·25 plus 20p post and insurance.

Desk/Hand Mike. Made by Acos. Crystal insert in neat plastic case which opens at right angles for desk or opens completely for hand holding. Good general purpose mike. Price 85p each.

Printed Circuit Kits. Hagato Pk. 3 facilities in kit form include printing, etching, resist removal, polishing and complete manufacture of printed sets to own specifications. Price £1·25+20p.

DEMO DECK

as described last month

£6 post free

Laboratory Instruments. For horizontal use in strong black reinforced bakelite cases with screw down terminals especially suitable for experiments and demonstrations. All have precision meters (manufacturers quoted accuracy of better than 1·5%). Following available:

D.C. Voltmeter 0-300v. f.s.d. moving coil mirror scale meter size approx. 5 × 4½ × 1½ in. Price £1·75.

D.C. Voltmeter, 0-30v. f.s.d. moving coil mirror scale meter. Size approx. 5 × 4½ × 1½ in. Price £1·75.

AC/DC Milliameters 3 range, moving iron mirror scale meter. Range selection 25, 50 and 100mA by selection switch mirror scale (coil resistance marked) size, 7½ × 5 × 3½ in. type 35999/1. Price £9·75.

Micrommeter 100 micro amps f.s.d., moving coil mirror scale precision meter (coil resistance marked) size, 5 × 4½ × 2½ in. type M/109/1. Price £3.

Galvometer 20-0-20 f.s.d. moving coil precision laboratory instrument of extremely high sensitivity (3 × 10-7 A per division). Size approx. 6½ × 3½ × 2 in. Price £5.

Parmeko Neptune Series C. Core Transformers. These transformers are beautifully made, steel encased, stove enamelled black, upright mounting. All have normal 50cps. primary 230/240v. with primary screen and are new and unused. Small quantities only of each type available as follows:
Model 6000/79. 275-0-275v. at 330mA, and 6·3v. at 4·6a. Price £4·50, + 50p post.
Model 6000/71.290-215-0-215-290 at 125mA, and 2 at 6·3v. 6a. Price £4·50 + 40p post.
Model 49. 250v. at 10mA, 6·3v. at 3a., 5v. at 0.75a. Price £2 + 30p post.
Model 47. 620-0-620 at 9mA. 4v. at 1A. Price £4·50 + 40p post.

Parmeko Neptune C. Core Chokes. These are encased and match the transformers above.
Model 6000/73 4H at 560mA. £2·50 + 40p post.
Model 55. 1OH at 1mA. £2·50 + 40p post.
Model 49. 1OH at 70mA. £1·50 + 30p post.
Model 69. 1OH at 110mA. Price £2 + 40p post.

Fuse Holders. Heavy duty type B.S.S. 88 440. Reyrolle power fuse holders. English Electric type S.100.1, ex. equipment. Price 50p.

Fuses. H.R.C. 100A, 160A, type EA..... Eng. Electric 100A, 160A, type 84TF ...... Kantark 60 A., new, all at 25p each.

Electronic Car Ignition. In addition to the kits for 12v. cars we can also supply systems for 6v. cars. These are not kits but made up and ready to work. Price £5·50 + 30p post.

Carbon Resistors. We are now stocking these in a big way and will be pleased to quote special prices to quantity buyers. Made by Erie. Morganite or Dubiliar.

	Price each			
	1-9	10-99	100-999	1,000 up
½ watt	1p	8p	6p	5p
1 watt	2p	18p	15p	125p
2 watt	4p	32p	30p	275p

Special Resistor Assortment Offer (1). 100 × ½ watt resistors made up of 2 each of 50 different values fairly evenly spaced between 1 ohm and 10 megs. Price 50p.

Special Resistor Assortment Offer (2). 1,000 × ½ watt resistors made up of 20 each of 50 different values fairly evenly spaced between 1 ohm and 20 megs. Price £4.

Special Resistor Assortment Offer (3). As offer 1 but 1 watt. Price £1.

Special Resistor Assortment Offer (4). As offer 2 but 1 watt. Price £8.

12 Way Sub-Miniature Multi-core Cable 7·0076 copper cores, each core P.V.C. insulated and of different colour. P.V.C. covered overall and approx. 3/16 in. thick. Price 20p per yard.

DRILL CONTROLLER

NEW 1KW MODEL

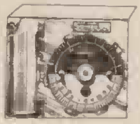
Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. £1·50 plus 13p post and insurance. Made up model also available. £2·25 plus 13p post and p.

Neon Indicator Lamps. With amber lens, standard type with built in resistor for mains. 10p each, 10 for 90p.

Condensers. Another addition to our range. 500µF at 50v. 15p each, 10 for £1·25.

MICROSONIC KEY CHAIN RADIO

7 transistor Keychain Radio in very pretty case, size 2⅞ × 2⅞ × 1⅛in.—complete with soft leather zipped bag. 7 transistor, ferrite rod, Loudspeaker.
In transit from the East these sets suffered corrosion as the batteries were left in them but when this corrosion is cleared away they should work—offered without guarantee except that they are new. Price only £1·25 less batteries plus 13p post. 6 for £7 post free. Pair of rechargeable batteries and charger 85p.



24-HOUR TIME SWITCH

Made by Smiths, these are AC mains operated. NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods per 24 hours. 5 amp changeover contacts will switch circuit on or off during these periods. £2·50 post and ins. 23p. Additional time contacts 50p pair.

THE FULL-FI STEREO SIX

The amplifier sensation of the year

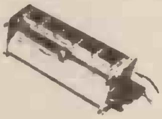
You will be amazed at the fullness of reproduction and at the added qualities your records or tuner will reproduce. Built into metal cabinet elegantly styled in simulated teak finished to blend with modern furnishings, this amplifier uses an integrated solid state circuit with an output power of 6 watts R.M.S. split over the two channels. The amplifier is ideal for use with normal pick-ups and tuners, it has a double wound mains transformer and ganged volume and tone controls—also switching for Mono to Stereo, tuner or pick-up. Other controls include "treble lift and cut", "balance" and separate mains on/off switch. UNREPEATABLE PRICE is £9 plus 38p post and insurance.

THIS MONTHS SNIP

POCKET CIRCUIT TESTER

Test continuity of any low resistance circuit, house wiring, car electrics. Tests polarity of diodes and rectifiers. Also ideal size for conversion to signal injector (circuit supplied). 30p or 2 for 50p post paid.

TANGENTIAL HEATER UNITS



This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. We have a few only. Comprises motor, impeller, 2kW element and 1kW element allowing switching 1, 2 and 3kW and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only need control switch. £3·50. 2kW Model as above except 2 kilowatts £2·50. Don't miss this. Control Switch 35p. P. & P. 40p.

LAST MONTH'S FEATURES

Kits of parts available as follows:—

HOME SENTINEL INTRUDER ALARM

Complete kit, with case £3·75.

SNAP INDICATOR

All components but not case or battery 75p.

WINDSCREEN WIPER CONTROL

All components including metal for chassis £1·50.

RECORD PLAYER

All components, but not case, loudspeaker, record deck or pick-up £5·15

DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 7 feet of heavy cable. Wired up ready to work, £2 less plug £2·25 with fitted 13 amp plug; £2·40 with fitted 15 amp plug, plus 23p P. & I.

CAPACITOR DISCHARGE CAR IGNITION

This system which has proved to be amazingly efficient and reliable was first described in the Wireless World about a year ago. We can supply kit of parts for improved and even more efficient version (P.W. June), price £4·95. When ordering please state whether for positive or negative systems. Plus 30p post.

15 WATT 12in HI-FI SPEAKER

Is undoubtedly one of the finest loudspeakers that we have ever offered, produced by one of the country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi and public address. Handling 15W R.M.S.—Cone moulded fibre—Freq. response 30-10,000 c.p.s.—specify 3 or 15 ohms. Chassis diam. 12in.—12⅞in. over mounting lugs. Overall height 5⅛in. A £10 speaker offered this month for £3·75 plus 30p post and insurance.

FUZZ BOX

and colour temperature meter featured in this issue. To receive these kits quickly, send quoted approx price and any change due will be refunded.

Commutator Motor. Small, size approx. 3 in. plus 1 in. of shaft. 3 in. high × 1½ in. wide, but high speed and very powerful. These motors operate from the mains. Are particularly useful as they can be speed controlled by our thyristor kit or by variable resistor. £1 each.

Auto Light Kit. The circuit for this appeared in *Practical Wireless*, October issue. It is a simple circuit but has many uses: Parking light, porch light, etc. Uses light cell and two transistors. Complete kit, no case 95p. Suitable case 20p.

Charger Kit. Comprises of a 3 amp. transformer. 5 amp. rectifier and a pair of hefty crocodile clips. With wiring diagram. £1·40 plus 20p post and insurance.

SPARTAN Portable RADIO

Long and medium wave, 7 transistor, size 6in. × 4in. × 1⅞in. with larger than usual speaker giving very good tone. Built-in ferrite aerial and telescopic aerial for distant stations. A real bargain complete with leather case, carrying sling, earplug and case £3·75 plus 25p post and ins.

Thermistor Bead Type. For instruments, medical applications, etc. ITT No. GL23. 75p each. 10 for £6·75.

3 Core Mains Leads. Special offer this month is a 6ft. lead with 23/36 cores and coloured according to the new code i.e., Brown—live; Yellow/Green—earth; Blue—neutral. Price 6p each or 10 for 50p.

Integrated Circuit Mountings. Enables I.C's to be plugged in and out for quick substitution and to prevent damage to soldering. 14 pin type 14p each or 10 for £1·26. 16 pin type 16p each or 10 for £1·44. Note these are suitable for use with printed circuit or vero boards.

Plain Paxolin Panels. Medium thickness. Ideal for fronts and for transistor projects generally.

Size	1	10	Size	1	10
6×2	6p	54p	6×6	18p	£1·62
12×2	12p	£1·08	12×6	30p	£2·70
6×2½	7p	63p	6×8	21p	£1·89
12×2½	14p	£1·26	12×8	40p	£3·60
6×4½	12p	£1·08	12×12	60p	£5·40
12×4½	24p	£2·16	24×12	£1·00	£9·00

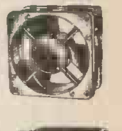
70 THINGS YOU CAN MAKE

Send S.A.E. today for list of 70 constructor projects – instruments – alarms – counters – locks – radios, etc., etc.

0-8 AMMETER

2 in. square full vision face for flush mounting. Moving iron instrument. Ideal for charger. Price 43p each. 10 for £3·90.

PAPST MINIATURE EXTRACTOR FANS



Beautifully made as are all papst motors. Intended for cooling computers but suitable for any equipment. Size 4⅝in. square and 1½ in. thick. Price £2 each. Post and insurance 20p.

24hr CLOCK SWITCH

In metal case with 13 amp. socket. Smiths movement, 2 ons and 2 offs per 24 hours. Very neatly made and finished. Original retail price £7 each. Few only, new and perfect. £4·00 each.

NUMICATOR TUBES

For digital instruments, counters, timers, clocks, etc. Hi-vac XN. 3. Price £1·45 each. 10 for £13.

SNAP ACTION SLIDE SWITCH

Rated 5a. 240v. Made by Arrow. Type fitted in the handles of electric drills, vacuums, etc. 5p each. 10 for 45p.

Where postage is not stated then orders over £5 are post free. Below £5 add 20p. Semiconductors add 5p post. Over £1 post free. S.A.E. with enquiries please.

J. BULL (ELECTRICAL) LTD.

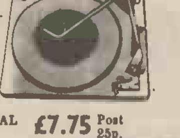
(Dept. E.E.) 7 Park Street, Croydon CRO IYD

PHILIPS PORTABLE PLAYER CABINET

Size 18 × 15½ × 7½in. Cut for B.S.R. UA12/14/15/16/25 deck. Amplifier space 14. × 5 × 3½in. Satin aluminium front grille. Really smart appearance. Black/White. Chrome fittings. **£4** Post 25p

BSR C.109 SUPERSLIM

STEREO AND MONO



Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. AC 200/250v. Size 13½ × 11½in. Above motor board 3½in. below motor board 2½in. with STEREO and MONO XTAL **£7.75** Post 25p.

GARRARD SINGLE PLAY TA Mk II Stereo/Mono £10
GARRARD PLAYERS with Sonotone 9TA Cartridges. Stereo Diamond and Mono Sapphire. SP25 Mk II £15
Model 3500 Stereo and Mono Autochanger £14. Post 25p.

RECORD PLAYER PORTABLE CABINET **£3·75**
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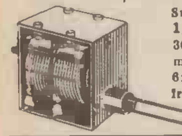

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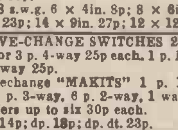

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32/450V	20p	8+8/450V	18p	32+32/450V	33p
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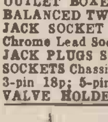

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everyday electronics

PROJECTS... THEORY.....

A DELICATE TOUCH

To anyone not previously familiar with the technical aspect of electronics, the constructional projects included in last month's issue were probably quite revealing. Not least in the modest quantity of parts involved and their small size. It is really surprising what can be achieved with just a few tiny components which one could hold quite comfortably in the palm of the hand.

Maybe it looks altogether too simple for words. And in a sense it is. But beginners should take their first steps with thought and care, and be duly appreciative of the need to develop a certain dexterity in the manual work involved: in the manipulation of the components and wiring, and in the making of good sound soldered joints. A delicate touch closely akin to that of the scientific instrument maker is the kind of manual skill required in modern electronic construction work.

WHAT'S IN A NAME?

It will be noted that we frequently use the word "gadget" as a general term of convenience applicable to most of the constructional projects featured in this magazine. We employ the word in its original sense, meaning a small fitting or contrivance. However, modern usage has tended to downgrade the word gadget so that in some minds it has become synonymous with "gimmick."

To avoid any misunderstanding, we must explain that all designs offered to private constructors are practical items, capable of providing definite useful functions. True some may have a rather more serious application than others, but all are designed to a purpose. For the want of a better or more appropriate term, "gadget" will continue to be used when referring to the small items of electronic equipment. But gimmicks pure and simple, or gimcrack items, will not be our concern.

PROVED DESIGNS

One further point must be made clear in this connection. All EVERYDAY ELECTRONICS projects are tested and proved by our own technical staff prior to being presented to our readers. We do not deal in "paper designs." A hobby is a hobby: nevertheless time is a valuable commodity, none more so than the "spare" variety. We want to help our readers use it profitably, enjoyably, and economically.

STOP PRESS

Our thanks to those who have already written following the publication of our first number. Next month we will publish a selection of readers' letters. We welcome all views, so why not drop us a line if you have not already done so?

Fred Bennett.

Our January issue will be published on Friday, December 17

EDITOR F. E. BENNETT • ART EDITOR J. D. POUNTNEY • M. KENWARD • P. A. LOATES

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....EASY TO CONSTRUCT
....SIMPLY EXPLAINED

VOL. I NO. 2 DECEMBER 1971

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

Special Offer

As a service to all our readers and especially those who are new to electronic construction we offer the Everyday Electronics Tool Kit at a special price. For further details of this offer see page 97.

Photographic Colour Temperature Meter

By D. Bollen

Get the colours right with this Photographic Colour Temperature Meter. It tells you simply and quickly what correction filters to fit to your camera.

PHOTOGRAPHERS who use reversal film to make colour transparencies often find that a particular shot turns out to have an unnatural red, yellow, or blue tinge. Unlike the human eye, a colour film cannot compensate for small changes in the "quality" of daylight and other light sources.

A film correctly balanced for standard daylight will record subjects under household tungsten lamp illumination with a deep red hue, but the most perceptive photographer sees the same scene as no more than orange-yellow. Similarly, a subject in shade under a clear blue sky is depicted as deep blue by the film, but is seen as bluish grey by the eye.

A simple colour temperature meter of the type described here will help to reduce the number of failures on a roll of film by showing when colour casts are present, and will also assist in the selection of camera filters to eliminate such casts.

COLOUR TEMPERATURE

If a black body such as a piece of carbon, is heated, it will exhibit a range of colours as its temperature increases, from a dull red, through orange and yellow, to a bluish white. Obviously, the colour of the carbon is closely related to its temperature, and the characteristics of most common light sources are close enough to that of

Approximate cost of components

£ 2·75 plus case

Components....

Resistors
R1 1kΩ
R2 2·2kΩ
All ±10%, ½ watt carbon except where stated.

Potentiometers
VR1 100Ω horizontal skeleton pre-set
VR2 2kΩ slider type pre-set
VR3 500Ω wire wound (1 watt type)

Light Dependent Resistors
PCC1, PCC2 ORP12 (2off)

Meter
ME1 100-0-100 μA moving coil centre zero, stereo balance type

Switch
S1 Single pole push-to-make

Miscellaneous
B1 9V PP3 type
Cellophane (see text), knob with pointer.
Plain perforated s.r.b.p. board 2in x 1½in x 0·15in matrix and pins.
Formica for case or suitable plastic box.
Connecting wire
Battery connectors.
L.D.R. Holders (see text).

a black body to allow a similar correlation between colour and temperature to be used. Table 1 lists the equivalent colour temperatures of several kinds of light source.

One way of measuring colour temperature is by means of two photosensors, one behind a red filter and the other behind a blue filter, with the filters adjusted so that the sensors give equal outputs under standard daylight conditions. If the photosensors are then illuminated by a light source which is either more red or more blue than standard daylight, the sensor outputs will differ by an amount roughly proportional to the change of colour temperature.

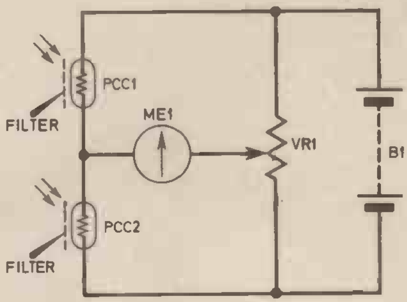


Fig. 1. Basic circuit diagram.

CIRCUIT OPERATION

It would be possible to wire the two photosensors in such a way that colour temperature could be read straight from a voltmeter scale, but this would involve taking the meter to bits for calibration, and an unwanted load would be placed on the photosensors by the internal resistance of the meter. Such an arrangement would also be sensitive to changes in battery voltage, so a nulling technique was chosen for the colour temperature meter, using an easily calibrated potentiometer.

In the basic circuit of Fig. 1, the photosensors are light dependent resistors (l.d.r.s) PCC1 and PCC2. The resistance of these l.d.r.s decreases when they are exposed to light. As long as both sensors are equally illuminated they should have similar resistance values irrespective of light intensity, and the voltage at the junction of the sensors will remain constant. The slider of potentiometer VR1 in Fig. 1 is adjusted to give the same voltage as the sensors so no current flows through centre-zero ME1, hence, no load is placed on the sensors.

Assume now that sensors PCC1 and PCC2 are provided with blue and red filters respectively. Under even illumination of both sensors, light

Table 1: COLOUR TEMPERATURE OF LIGHT SOURCES

Source	Temperature in degrees Kelvin
Candle	1,900
100 watt household lamp	2,800
Photoflood lamp	3,400
Direct sunlight, sunrise or sunset	2,000–4,000
Direct sunlight, noon	4,500–5,500
Sunlight plus white clouds or haze	5,900
Electronic flash or blue flashbulbs	5,900
Sunlight plus clear blue sky	6,650
Light overcast	6,650–7,150
Heavy overcast	8,350
In shade, sunlight plus white clouds or haze	7,150
In shade, clear blue sky	9,000–25,000

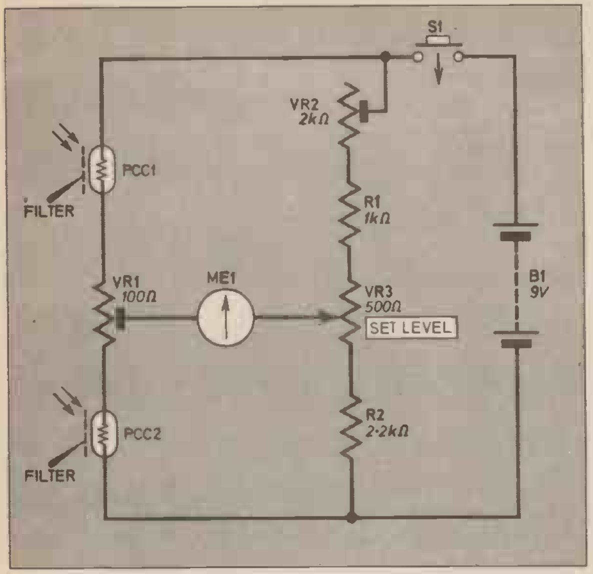


Fig. 2. Complete circuit diagram of the Photographic Colour Temperature Meter.

from a predominantly blue source will pass virtually unhindered through the blue filter to PCC1, but will be blocked by the PCC2 filter. Thus, with more light reaching PCC1, it will have a lower resistance than PCC2 and the voltage at the junction of PCC1 and PCC2 will rise, causing the meter pointer to deflect away from zero.

Much the same applies with red light, but here the meter pointer will deflect in the other direction as the voltage at the junction of PCC1 and PCC2 falls. Potentiometer VR1 is adjusted to bring the meter reading back to zero, and the change of colour temperature is given by the angular rotation of VR1 spindle.

CIRCUIT REFINEMENTS

The circuit of Fig. 1 would not work well in practice, for the following reasons. Sensors PCC1 and PCC2 would have to be perfectly matched if the instrument was not to respond to changes in light intensity as well as colour temperature, blue and red filters would have to be of known density and colour, and only a small centre portion of VR1 total track resistance would be usable.

In the complete circuit of the colour temperature meter Fig. 2, a low value potentiometer VR1 is inserted between PCC1 and PCC2 to eliminate l.d.r. resistance mismatch under high light intensities; this component also protects the sensors against an excessive current flow. In conditions of dim illumination, the resistance of the sensors can be equalised by masking one of them with a spot of ink or paint, as described later.

To simplify construction and reduce cost, the colour temperature meter uses simple blue and red filters made from several layers of coloured cellophane (obtainable from most stationers), and VR2 is included in the circuit of Fig. 2 to correct individual filter variations and allow for circuit tolerances.

Calibrated potentiometer VR3 in Fig. 2 has a low track resistance in relation to the total resistance of the chain formed by VR2, R1, VR3 and R2, so that full use can be made of VR3 rotation to provide widely spaced calibration points.

CONSTRUCTION

The case for the prototype was constructed from Formica, but almost any non-metallic case of suitable dimensions could be used. The case should be drilled to the dimensions given in Fig. 3 before any further construction is undertaken. Once the drilling is complete meter ME1 can be fixed as can the two l.d.r.'s.

The sensors PCC1 and PCC2 are housed in small, opaque cylinders made from plastic cigar holder stoppers or bottle tops, see Fig. 4. Each l.d.r. holder must be cut-down with a sharp knife to make the internal height equal to the height of the l.d.r., to ensure a wide-angle of light acceptance. Blue and red filters are fitted at a later stage. The l.d.r.'s are glued into the holders which are then glued to the case.

The preset potentiometers VR1 and VR2 are mounted on a piece of plain perforated s.r.b.p. board using mounting pins as indicated in Fig. 5. Potentiometer VR3 can then be mounted through a hole cut in the board and resistors R1 and R2 connected—one pin is used for R2. The board is then fixed inside the case using VR3 mounting.

Switch S1 can now be inserted through its

Photograph showing the inside of the Photographic Colour Temperature Meter.

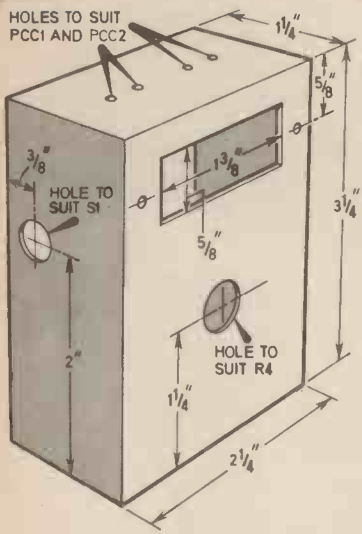
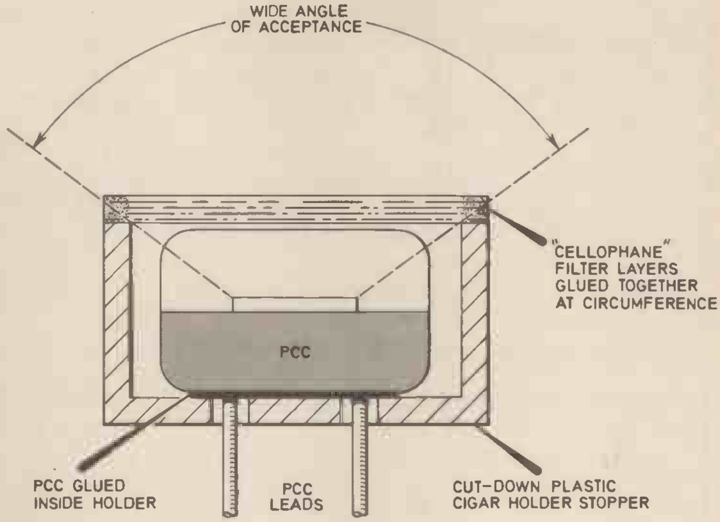


Fig. 3. Case drilling diagram.

Fig. 4. Details of the l.d.r. and filter mount.



Photographic Colour Temperature Meter

Fig. 5. Layout and wiring of the complete unit S1 is not mounted on the s.r.b.p. circuit board.

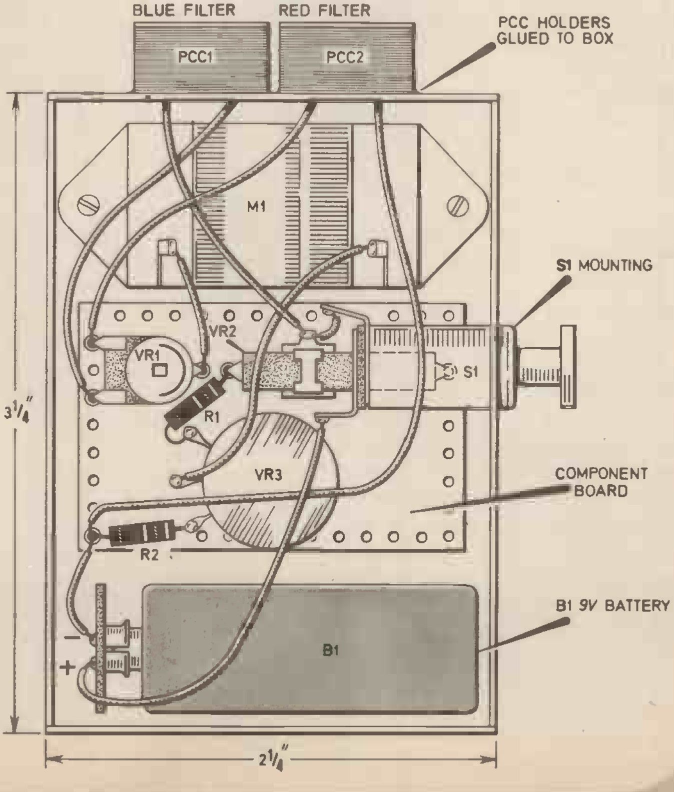


Fig. 6. Dial calibration.

mounting hole and securely fixed. Finally, wire up the unit, as shown in Fig. 5, using p.v.c. covered stranded wire. Make sure to leave enough wire between S1 and VR2 wiper for adjustment of VR2. Connect the battery observing the correct polarity and the instrument is ready for setting up.

Apart from the need for both sensors to be placed side by side, as closely as possible, the instrument layout can be modified to suit individual requirements.

SETTING UP

Adjust VR1, VR2, and VR3 to the mid-track position. Place the colour temperature meter about 3 feet from a 100 watt pearl lamp, aligned so that PCC1 and PCC2 receive exactly the same amount of light. Press S1 and use the tip of a finger to find out which sensor needs masking to bring the pointer of ME1 to zero, then place a spot of ink or paint (black) on the face of the selected l.d.r. to achieve balance.

Next position the colour temperature meter with sensors almost in contact with the 100 watt bulb (maximum illumination), taking care that PCC1 and PCC2 receive the same amount of light. Adjust VR1 for zero balance.

The next stage is to prepare the red and blue filters, made from orange and pale blue (avoid mauve) cellophane respectively. Cut a paper disc to the outside diameter of the sensor holders. Fold orange and blue cellophane several times and cut out the filter discs with sharp scissors using the paper disc as a template. Glue four discs of blue cellophane on the PCC1 holder as shown in Fig. 3.

Take the colour temperature meter out of doors on an overcast day, well away from walls or trees. Set VR3 to the mid position and commence placing red filter discs over PCC2 until ME1 reads near zero when S1 is pressed. About twelve orange cellophane discs (red filter) will be required because the l.d.r. is more sensitive to red than blue light. The red filter discs can now be glued on the PCC2 holder, and the meter is ready for calibration.

CALIBRATION

In the absence of standard light sources, the following method of calibration is suggested. Make a temporary paper disc dial for VR3, with the scale shown in Fig. 5 lightly pencilled in. Set the pointer of VR3 at 2,800 degrees Kelvin and position the colour temperature meter a few inches from a 100 watt pearl bulb. With PCC1 and PCC2 equally illuminated, press S1 and adjust VR2 for zero balance.

For the next calibration check, choose a heavy overcast day, within an hour of noon, and set VR3 pointer to 8,350 degrees Kelvin in summer, 8,100 degrees Kelvin in spring or autumn, or 7,800 degrees Kelvin in winter. With sensors pointing straight up at the sky, press S1 and observe the null meter. If the meter does not read zero, adjust VR3 for a null and mark the position of VR3 pointer on the paper disc dial. It should now be possible to gauge the discrepancy, if any, between the VR3 setting and the scale of Fig. 5.

If necessary, reposition the pointer knob on VR3 spindle and go through the above checks again for a new setting of VR2 until agreement is reached with the Fig. 5 scale. It is recommended that the temporary VR3 scale be left on the temperature meter for a few weeks so that various checks can be made, using Table 1 as a guide, and transparencies can be evaluated. When satisfied with results, a permanent scale can be made for VR3. A more accurate calibration technique is possible if several colour correction filters are available.

MIRED VALUES

Special correction filters may be placed in front of a camera lens to modify the colour temperature of light falling on the film. If the scene being photographed has a blue cast, a reddish filter of the right grade will give the transparency a normal colour balance. Correction filters are also used to achieve special effects, and to match a daylight type film to artificial light or vice versa. There is, however, a practical difficulty in selecting the right filter for the job. A given grade of filter will have a much greater effect at higher colour temperatures than at lower ones.

To make the process of filter selection simple, correction filters are graded in values based on the reciprocal of colour temperature, called the mired, see Fig. 5 and Table 2. A given grade of filter will always produce the same amount of correction anywhere on the mired scale.

Colour correction filters are identified by the letter R or B (standing for red or blue) followed by a number which is the filter rating in mireds divided by ten. For example, an R6 filter will make the colour of a light source more red by an amount corresponding to a shift of 60 mireds. Two filters placed together have an additive effect, a B6 plus a B12 will give a total shift towards blue of 180 mireds.

When the colour temperature meter has been roughly calibrated, it is a simple matter to interpolate between major calibration points with correction filters. Suppose that the colour temperature meter is reading the light from a 100 watt bulb with VR3 set to 2,800 degrees Kelvin (356 mireds), a B12 filter interposed between PCC1, PCC2, and the light source will raise the effective colour temperature by 356 − 120 mireds = 4,240 degrees Kelvin, thus giving a fresh calibration point. With several filters, and a few known light sources, the whole colour temperature scale can be filled in by the above method.

USING THE METER

Since the object of the meter is to measure the colour of light sources only, avoid reflected light from brightly coloured objects, clothes, and green grass, etc.

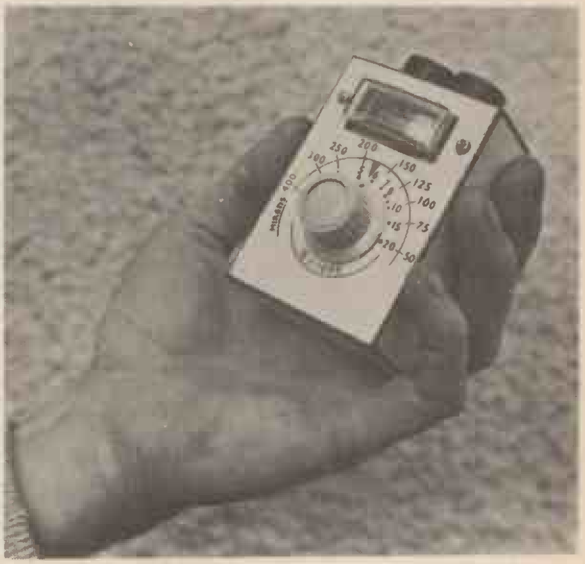
To take a shade reading out of doors, either stand in the shade of a neutral colour building with the meter pointing away from it towards the sky, or interpose the body between the meter and the sun. Always make sure that both sensors receive the same amount of light.

To measure the colour temperature of sunlight, the best method is to angle a sheet of white paper towards the sun and take a reading from the paper. A similar method can be employed to take an integrated reading of mixed sunlight and skylight, by having the sheet of paper horizontal with the meter looking down at it. Alternatively, point the meter straight up at the sky with the sun illuminating both sensors evenly from front or back. ▣

Table 2: COLOUR TEMPERATURE AND MIRED SCALES

Degrees Kelvin	Mireds
2,500	400
2,850	350
3,330	300
4,000	250
5,000	200
6,650	150
8,000	125
10,000	100
13,300	75
20,000	50

$$\text{Mireds} = \frac{1,000,000}{\text{degrees Kelvin}}$$



MEMORY STORE

by George Dunning

MY Father, like most of his contemporaries, had been during the late twenties an enthusiastic d.i.y. wireless constructor. Evidently, the radio we know was evolved on hundreds of breadboards in back kitchens—from delicate crystal sets through temperamental t.r.f.s with leaky grids to superhets with horn loudspeakers—by amateurs such as he.

One of my earliest recollections was of a great moment, when after much adjustment and careful tuning he summoned the whole household to the earphones. After a dramatic silence during which the phones were passed around, everybody joyfully agreed that it definitely was the sound of a violin and the earphone was held to my tiny ear to witness the historic event.

Not long after that, fairly reliable sets with cone speakers appeared on the market: the enthusiasm for wireless construction waned and the whole paraphernalia was retired to the shed.

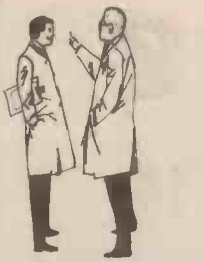
Many years later in a dark corner I discovered a large torroidal coil and on blowing the dust from its label I read "What are the wild waves saying?" My curiosity was aroused and I asked the inevitable question: "How does wireless work, Dad?" His answer was curt and final; "You've no time to fiddle about with that, lad while there's studies to attend to". It remained a mystery—a thing I dismissed from my mind so that in time I not only did not know, but I did not want to know about things electronic; they were not my line of country.

And so it remained until the mid fifties. At that time I was working as a routine chemist and I began to notice how the advent of electronics enabled automatic physical methods to cut out some of the lengthy analytical chemical methods. It became increasingly clear that my livelihood would eventually be threatened and so, in short, I decided that as I could not beat them then I must join them. Accordingly I enrolled for evening classes in Telecommunications.

Thus I entered the world of electronics comparatively late in life. The wireless theory I acquired led me naturally via journals such as Practical Wireless and later Practical Electronics to the fascinating hobby of electronic gadgetry. No elaborate workshop was needed. Armed with a multirange meter, a soldering iron and a pair of strippers most projects could be tackled on the kitchen table.

For me the fascination lies in innovation. I cannot ever remember having copied a constructional item, component by component. My projects are usually a hotch-potch of several past constructional features and ideas arranged so as to exploit some component new to the amateur market: a thyristor replacing a relay, an i.c. replacing both vibrator and amplifier together. The excitement comes in finding out if it will work.

Looking back, I would say that by learning the theory first I gained greater pleasure and was able to build more efficiently sooner—but it was by no means essential to efficient construction. With only a knowledge of Ohm's Law and a healthy respect for Finnigan's Law anyone at any time can jump in at the deep end and soon be swimming around with those hitherto strange fish; the amateur constructors.



SHOP TALK

By Mike Kenward

UNFORTUNATELY we have to write the copy for Shop Talk before the previous issue is on sale and hence no "feedback" from you, the readers, is available to tell us if indeed we did solve all your buying problems. However, if any general buying points do arise from various articles we should be able to deal with them in the following issue.

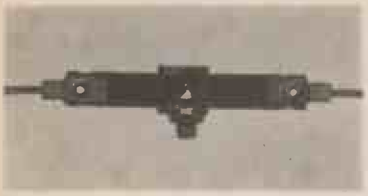
Having had a few phone calls concerning R.S. Components arising from another source it is possibly worthwhile reinforcing what was said last month, and also to mention that one or two firms are now specialising in R.S. Components parts and a look at adverts at the back may be advantageous.

After looking through the components lists this month it would appear that nearly all the components are readily available.

Photographic Colour Temperature Meter

The slider preset potentiometer may not be easy to get for the *Colour Temperature Meter*, other types could be used but the slider fits in well. Some of the London shops should be able to help if your supplier cannot. The push button used by the author will probably not be obtainable but any "press for on" push button that is not too big should be all right; there are a number generally available.

The original case looks very neat and is made of white Formica, held together with Araldite.



Fuzz Box

Well, the *Fuzz Box* should be straightforward as far as buying goes. Once again the author's case looks neat and is both strong and inexpensive.

Demo Deck

Take note of the piece about RS Components above and you should have few problems in buying for the *Demo Deck*. Strangely enough, the only real buying problem Mike Hughes had was in obtaining the 0·06 amp (60 milliamp) bulbs. If you cannot get them Home Radio are the people to write to.

Our *Demo Deck* cabinet was made by a professional from Afrormosia Mahogany and looks very presentable. Obviously, many people could not make up such a good cabinet but our design is recommended as it has facilities for all the necessary bits and pieces.

Teach-In

If you have any problems buying those few resistors for next month's *Teach-In*, you are just not trying. If you get 5 per cent types so much the better, they will probably not cost any more.

New Products

To protect your hands, clothing, the kitchen table and even carpets, a soldering iron stand is a must. You should never hang your iron on equipment or the edge of a table as it is all too easy

to reach across it and burn a hole in your clothing or skin.

If you have an area where you can set up a permanent work bench then buy a good stand and screw it to a bench. If you have to move around or use "borrowed space" then buy a good free-standing iron stand. This will help when you clear the work area as you can move the iron in the stand without having to wait or it to cool.

There are many stands available and most iron manufacturers make a stand for their irons. One universal one that was sent to us some time ago is shown in use with an Adcola Invader Iron left. This stand is well constructed and is available as a free standing or bench mounted type, and will take any iron with an element diameter less than ½ inch. It is attractively finished in red anodised aluminium, with a tip cleaning pad, made by Stangard and is available from Home Radio (Components) Ltd., for £1·33 (bench mounted) or £1·83 (free standing as shown).

Bradewik is a sort of "solder sucker," it is designed to remove solder from joints being desoldered. This should prove useful when working on the *Demo Deck* as it will prevent those large blobs of solder from building up around the tag posts.

To desolder a joint, simply apply the wick simultaneously with a soldering iron, the wick will soak up the solder as it melts. The solder-filled part of the wick can then be cut off.

Bradewik is available in four width sizes from 0·025 inch to 0·1 inch, the 0·075 inch sizes (Green Label) should suit most constructors. Available from Light Soldering Developments Ltd., 28 Sydenham Road, Croydon, CR9 2LL, or retail shops, the cost is 90p for approximately five feet of any width.

Windscreen Wiper Control

Part Two

By S.B. Squire

LAST month we showed how the unit can be fitted to cars with single speed field coil motors however, some cars are fitted with two speed wipers using a field coil motor, the wiring diagram for these motors is shown in Fig. 6a, Fig. 6b shows how the unit is wired to this system. If required the unit may be used to operate the wipers at either of the two speeds depending on the wiper switch position (1 or 2) that the yellow wire from RLA1 is connected to. Wiring shown in Fig. 6b is for positive earth, reverse X and Y for negative earth systems. The green wire is not used and need not be fitted.

PERMANENT MAGNET MOTORS

During the last few years permanent magnet wiper motors have been fitted to many cars and these motors are wired up as shown in Fig. 7a. You will notice that the parking switch shorts out the motor when it is turned off. This is so that the motor stops quickly. Most cars fitted with permanent magnet wiper motors are wired negative earth and Fig. 7b shows how the unit is wired to such a system. Notice that the wire between the wiper switch and the parking switch is broken and the normally closed side of the set of changeover relay contacts inserted in this line (green and blue wires from RLA1).

The normally open contact (yellow wire from RLA1) is wired to the other side of the wiper switch. The blue wire must be wired to the wiper switch—the non earth side.

If your car has a permanent magnet motor and is wired for positive earth, simply reverse wires X and Y shown in Fig. 7b.

The fourth and final system is the two-speed permanent magnet type, again usually wired for negative earth. It is possible to use this unit with these motors but only on the first switched speed, reference to Fig. 8a will show the car wiring normally used with such a motor and Fig. 8b shows how to wire the unit to the motor, note that the normally closed side of the change-over contacts are wired between the wiper switch and the parking switch (blue and green wires from RLA1) while the third—normally open contact (yellow wire from RLA1) is wired

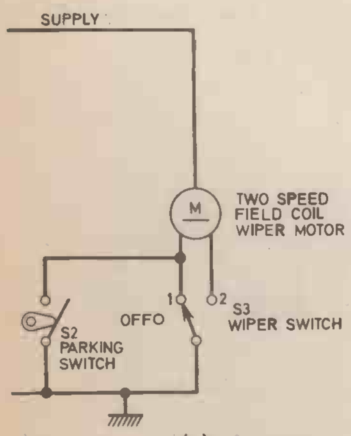


Fig. 6a. Wiring diagram for a two speed field coil wiper motor.

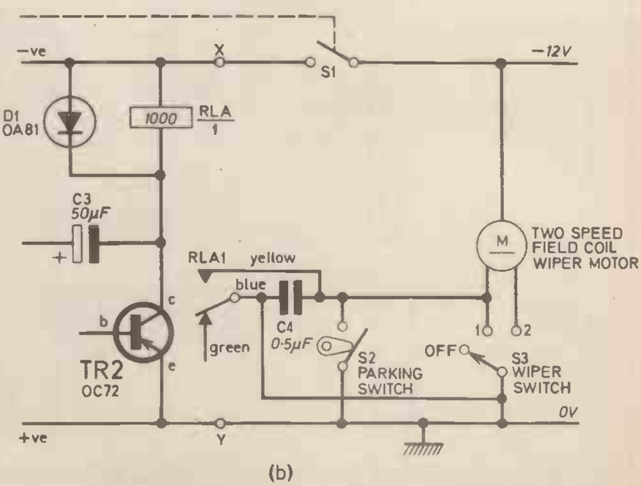
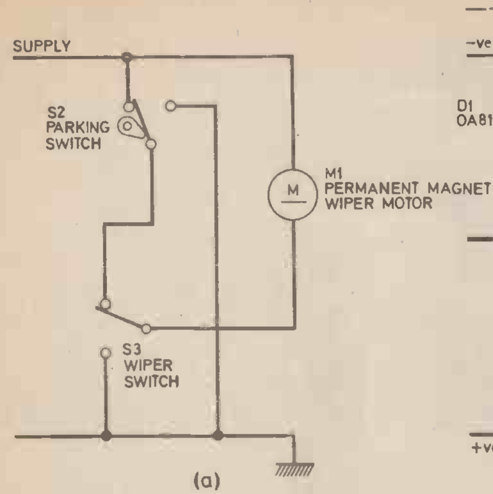


Fig. 6b. Showing how the unit is wired to a two speed field coil system—positive earth shown. In this configuration either speed can be used depending on which wiper switch position the yellow wire is connected to.



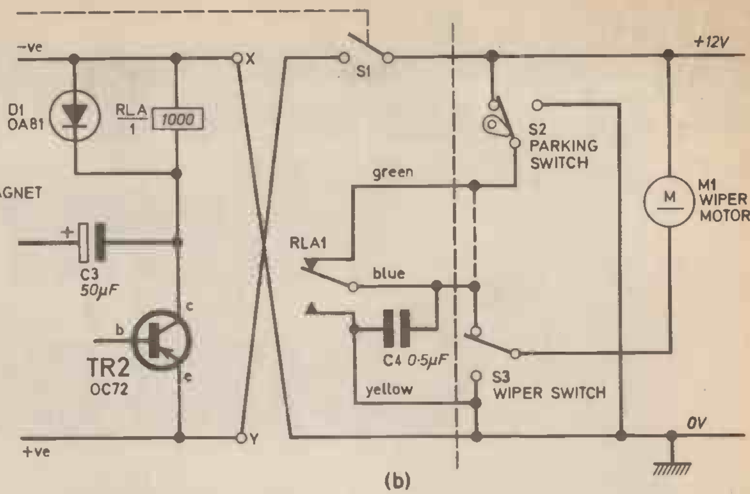


Fig. 7a. Wiring diagram of a three wire permanent magnet wiper motor.

Fig. 7b. Showing how the unit is wired to be used with a permanent magnet motor. Note that the wire between the wiper switch and the parking switch has to be disconnected, and the relay contacts wired in. Negative earth system shown.

to earth. The centre contact (blue) must be connected to the wiper switch as shown.

If your car has a positive earth two-speed permanent magnet motor simply reverse wires X and Y.

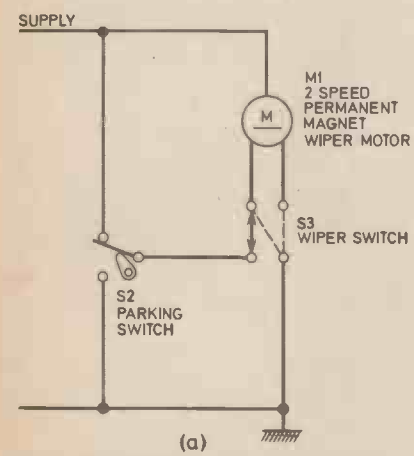
IDENTIFYING THE CAR WIRING

You should be able to determine the type of motor used in your car from the number of connecting wires on the switch, i.e., 2 wires (single speed)—field coil; 3 wires (two-speed)—field coil dual speed; 3 wires (single speed)—permanent magnet; 4 wires (two-speed)—permanent magnet. It should be possible to obtain a wiring diagram and find out which colour wires go where and how the various switches are wired up, but if this is not possible then you will have to trace the wires on the car to find out how to wire in your controller.

OPERATION

Once the unit is fitted to the car it is operated without touching the normal wiper switch. With the wipers off, switching on the unit will give one wiper sweep (back to the park position) approximately every five seconds. Further rotation of the control knob will increase the time interval between sweeps up to approximately 25 seconds. The 0 to 10 scale on the knob can be used as a guide to the delay time.

For normal operation of the wipers simply switch off the unit and turn on the wiper switch. in the normal way. ▣



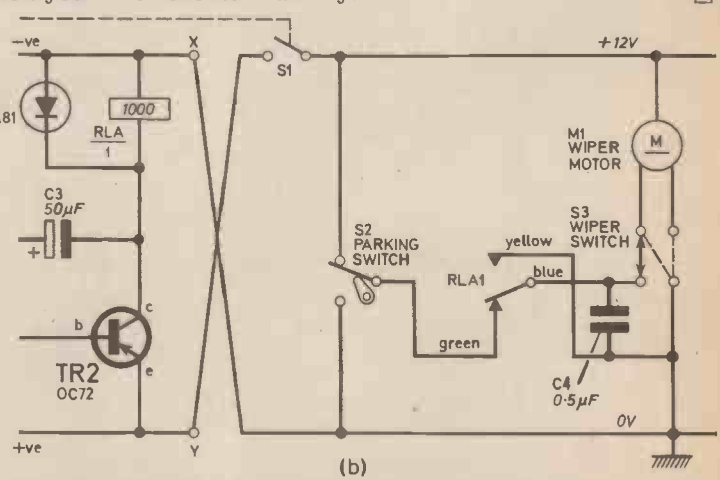
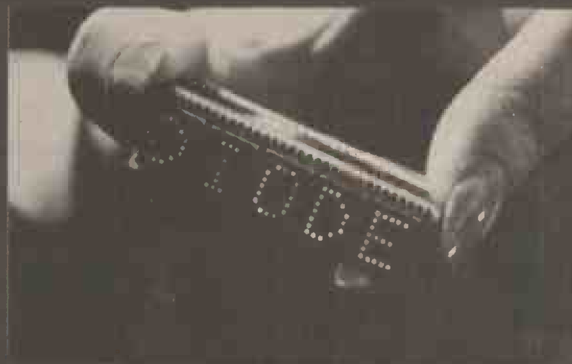


Fig. 8a. Wiring diagram for a two speed permanent wiper motor.

Fig. 8b. Showing how the unit is wired for a two speed permanent magnet wiper motor. Note that the wire between the motor and the first switch position must be disconnected and the relay contacts wired in. Negative earth system shown.

electronics



PAST & PRESENT

By Prof. G.D. Sims, OBE, PhD *(Southampton University)*

The second half of our story opens with the introduction of integrated circuits—and the beginning of microelectronics. Some of the significant new applications that have already emerged as a result of technological developments are mentioned, and finally, some likely prospects for the future are discussed.

Top left: Cold cathode neon filled numerical indicator tubes. Such devices are used in electronic measuring and computing equipment to provide visual readout of data *(Mullard)*

Bottom left: Ferranti Mark I Computer at Manchester University 1951. This was the first British electronic computer. It employed 3,000 valves, and a refrigeration system; cathode ray tubes were used as data stores, in addition there was a magnetic store. This picture shows just part of the computer, the central processor and the control desk *(Ferranti)*

Top right: Small size solid state display made up from a matrix of tiny gallium arsenide phosphide light-emitting diodes. Can be arranged to provide numbers or words of any length *(Marconi)*

Bottom right: The latest Ferranti Computer, Argus 500, is a fast computer system for on-line applications. The central processor, the sub-unit at extreme left of picture, can operate with one microsecond core stores. Compare this small sub-unit with the large cabinets required to house the central processor of the Mark I *(Ferranti)*

THE success of microelectronics as we know it today stems largely from the exploitation of the silicon planar process. A typical integrated circuit may contain a number of transistors, resistors and capacitors all made within the same silicon "chip" the interconnection pattern between them being evaporated on after all of the components have been formed. "Large scale integrated circuits" can contain thousands of devices all made in the same piece of silicon.

The majority of integrated circuits commercially available at the present day, however, are the simpler ones and these alone open up a host of new possibilities in electronic design for both professional and amateur alike.

Integrated circuits for colour television. From left to right: colour demodulator, central signal processor, voltage reference source, and intercarrier sound i.f. and detector *(Mullard)*

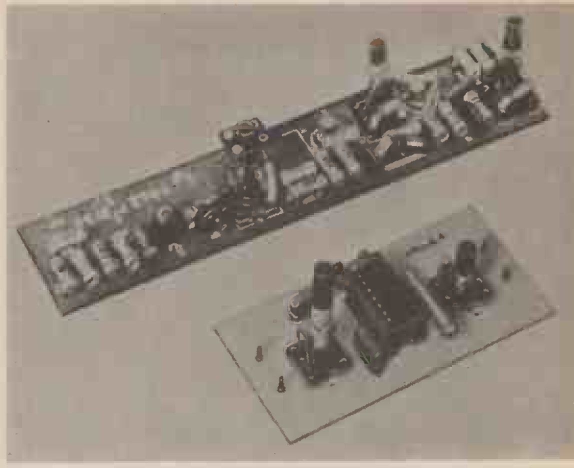
LINEAR INTEGRATED CIRCUITS

Whereas at one time the task of wiring up separate components to form an amplifier was "bread and butter" to the engineer, it is now often possible to buy a suitable amplifier integrated in a single chip and ready for use. "Linear" integrated circuits (such as amplifiers) are commonly available in a variety of forms and can be regarded as the design blocks of our future systems in much the same way that the transistor, and earlier still the valve, were in the past.

DIGITAL INTEGRATED CIRCUITS

Integrated circuits, however, have come to be most widely used in "digital" (pulse) applications such as those involved, for example, in the design of the computers to which we have referred.

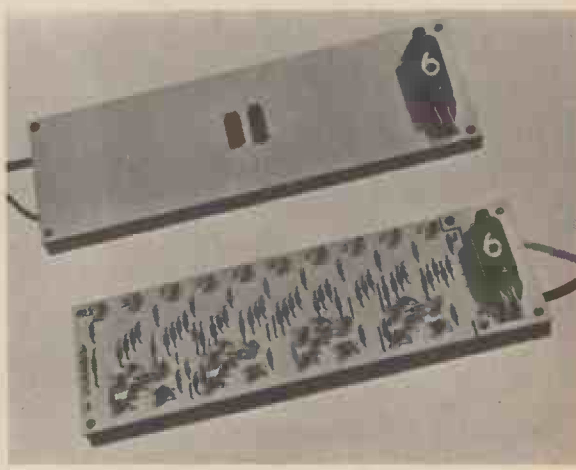
We have already drawn attention to the fact that electronic circuits can make yes/no decisions and hence "think". The design of "thinking" systems therefore is very much concerned with the design of "logical systems", which perform deductive tasks in much the same way that a human being does. It is this link with logic which has given impetus to much of the digital integrated circuit development.



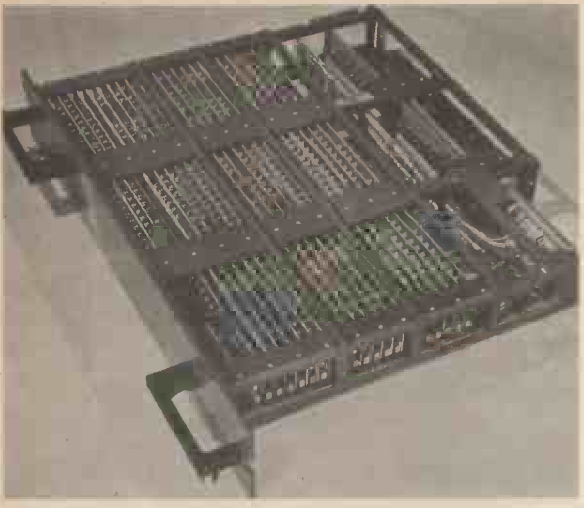
Contrast between the conventional "discrete component" version of a colour receiver i.f. amplifier, and one incorporating a linear integrated circuit *(Mullard)*

Many "families" of such integrated circuits are available, each forming a comprehensive range of logical functions and some of these are now extremely cheap to buy. In many other applications besides computing, for example in control systems and in communications, it is better to design in terms of digital building blocks rather than around the linear circuits traditionally used; and many future developments, of increasing interest to amateurs, will centre around the uses of these digital modules.

The microcircuit therefore is the key to our future. Let us look at the advances which electronics has made possible in recent years and at the same time some of the problems which lie ahead.



Decade counter using two digital integrated circuits (top) compared with a similar device using discrete components *(Mullard)*



The central processor of the Argus 500 Computer. This unit incorporates 980 integrated circuits and 220 discrete semi-conductor devices; and is 30in. high, 22 deep and 5in. wide *(Ferranti)*

MAN/MACHINE PROBLEMS

One area which is currently exciting great interest is the man/machine interface problem, coupled with the question of how can we replace human functions by electronic systems?

At the present time electronic systems exist which can learn fairly satisfactorily to read even handwriting, though as yet they are far from being sufficiently perfect for use, for example, in letter or parcel sorting. However, if standard alphabets are used the possibility of such tasks as stock control being performed by machines which scan invoices and ultimately, perhaps, even audit books, seems to be within the realms of the possible.

A related problem is concerned with the identification and artificial production of those attributes of sounds which characterise speech. Clearly knowledge of this kind is vital also to the elimination of those characteristics which produce discomfort in human beings and to the alleviation of noise pollution generally.

Similar techniques to those used in this field of "pattern recognition" can also be used in medical diagnosis to compare patient information with that of previous cases in order to predict appropriate methods of treatment.

All of these applications depend upon suitable electronic circuits which will recognise, classify, identify and compare, symbols, signals or noises, and it is only with the coming of cheap electronics that such systems—previously regarded as being too expensive or too complicated to make—are now possible.

ELECTRONICS AND "MEDICINE"

Mention of the medical field touches upon one of those areas where electronics has now started to make very significant contributions; we can for example now produce an artificial hand so sensitive that it can pick up fragile objects without crushing them and so positive that it can hold objects tightly, merely when the human mind controlling the hand thinks that it wishes to perform one or other of these functions. Such a hand is actuated by signals from nerve endings in the body and will imitate any movement which a natural hand would have performed.

Further development is still needed before such aids find general application as certain electromechanical problems still exist, but the pure electronics, which interprets the nerve signals and controls the hand motion, can now be reduced to a volume and weight compatible with a normal limb size: all of this thanks to the development of microelectronic techniques.

A related application also envisages the use of

Prototype model of adaptive artificial hand. It is driven by six compact d.c. permanent magnet motors and contains about thirty transducers. These provide the control system with detailed information about the object being grasped such as its shape, position and stability; they also monitor the forces, velocities and positions of the digits. This experimental device weighs twice as much as its human counterpart. Commands for the control system are derived from myo-electric signals produced by the operator *(Dept. of E.E., Southampton University)*

Diagnosis by Computer. This heart specialist in the United States uses an electronic telephone to transmit a patient's heart record from this electrocardiograph to a computer. The computer will analyze the signals and return a diagnosis in about two minutes *(U.S. Information Service)*

microelectric techniques to produce feedback signals to control nervous or spasm conditions, or to make up for damage to the nerve paths, which act as the normal communication channels between the brain and limbs, such as might be associated with some forms of paralysis. A whole family of related devices, which is now coming under consideration, involves such items as talking aids for those with speech defects, or typing aids for those who have lost the use of limbs.

A voice operated typewriter, actuated by spoken signals in the form of a kind of morse code, can now be made and the possibilities which this kind of device opens up are tremendous. One could, for example, now envisage a small computer making its time available to a range of aids of this type, enabling a complete office or workshop to be manned by people who were disabled in one way or another.

The fact that electronics could now offer employment possibilities to the handicapped is both important and exciting and could not have been contemplated a few years ago. In this area, however, we are only just at the beginning of the road.

AUTOMATED DESIGN AND PRODUCTION

Many other previously manually executed jobs of course are now already performed by special purpose computer systems. For example, electronic control of machine tools is finding increasing use in industry.

In this case the operator specifies to the control system just what shape the machine is to cut—he does this by way of data on punched tape or cards—and the machine proceeds to produce the work automatically with little need for human intervention.

Further back in the design chain, newly developed electronic draughting machines are also rapidly gaining acceptance. Production of, for example, a radar system may require as many as 20,000 detail drawings, which such a machine, suitably programmed, can produce on command from basic master sketches.

Initially the master is produced from data typed into the machine while other parts of the sketch are drawn in using a light pen controlled by the "draughtsman". Amendments can also be made via the light pen and the drawings can thus be amended and up-dated when necessary.

Designer in dialogue with computer. A senior designer is shown adding another stage to the MOS microcircuit which he is designing in co-operation with a Myriad computer. He is using a light pen to put a new section into the main circuit design, having called it from the computer store using the keyboard. *(Marconi)*

Similar computer based design techniques are used in the production of large scale computer systems themselves where the back wiring diagrams are both devised and produced by computers: the same is true of the printed circuit boards on which the components and individual microcircuits are housed. The computer can lay out these boards in an optimum way and what was once a very tedious and time consuming human operation has now been reduced to a straightforward programming exercise.

COMPUTER AIDED DESIGN

Computer aided draughting to which we have just referred should not be confused with "Computer Aided Design" (C.A.D.), which is attracting excited interest in all branches of the engineering industry.

In the electronics field, circuit diagrams and systems specifications can be fed into a computer which will in turn calculate all the component values to meet the specification. Before the electronic system is actually built, the machine will simulate any design arrived at, see if it is perfect and in some cases can even lay out the various masks needed to produce microcircuits of which the system will ultimately be built.

Clearly techniques of this kind are unnecessary with simple circuits and systems such as the amateur would need to deal with, but the complexity of many of the things the professional electronic engineer is now called upon to produce is such that only with aids of this kind can he complete his assignment in a realistically short time—if at all.

Present limitations of C.A.D. depend mainly upon the size of the computer needed to deal with really ambitious systems, and on the ability of those engaged in semiconductor device research to produce suitable "models" of their device behaviour from which the computer can work. Such limitations apart, however, it is in principle possible for the computer to design an electronic system right from the initial circuit diagram through to the digital information which will control the making of the masks used to produce the component microcircuits of which the system will ultimately be built. Many of these processes are still in the research stage, but the days of at least partly automated circuit production are rapidly drawing nearer.

In other fields of engineering, C.A.D. techniques are used to produce minimum cost systems, for example, in an electricity supply system optimum sizes and kinds of components can be chosen by the computer, using linear programming techniques, to perform within given safety factors any specified function.

MODERN COMMUNICATIONS

In communications, with the advance of digital techniques, (for example, pulse code modulation) microelectronics has again found a natural home and the electronic telephone exchanges of the future will be realised in very different form from those currently installed, as increasing degrees of circuit integration are incorporated.

Problems of signal storage still remain, though acoustic techniques, ferromagnetic bubble storage and more particularly the recent improvements in M.O.S. technology offer hopes of early progress on this front too.

In the field of signal transmission, waveguide techniques have now been developed to the point where they offer advantages in some situations over cable or microwave links. Indeed the Post Office is currently installing a 16 kilometre experimental run of multimode helical waveguide, which is due to be incorporated into regular communications use in 1973.

This 50mm helical waveguide, seen at the Post Office research station Martlesham Heath, can carry several millions of voice channels *(The Post Office)*

A single 50mm helical waveguide can accommodate several millions of voice channels and though these techniques have been in prospect for several decades, it is only recently that the major difficulties have been resolved and the system has become economic. Trunk waveguide systems may well form the future transmission medium on some of the world's busiest communication routes, for the bandwidth available to us for free space microlinks is rapidly being used up.

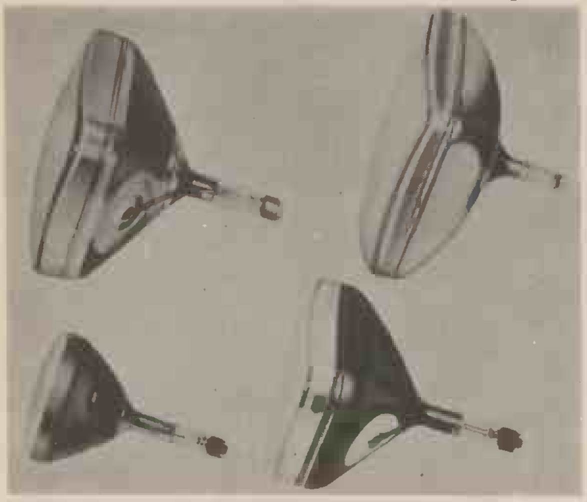
Until recently, even given that the waveguide system itself had presented no problems, the terminal equipment to decode the signals and separate the individual channels would have been formidably complicated, without the electronic sophistication available to us today.

OPTO-ELECTRONICS

What else is in store? We are steadily approaching a new age in which light producing devices offer increasing possibilities as a means of conveying information. New electronic light sources and detectors together with low-loss optical fibres enable us to conduct light round corners and such techniques on a small scale enable the surgeon, for example, to investigate the interior of his patient using illuminated mirrors at the end of a fibre light guide.

In years to come fibres could well serve as a long- as well as a short-distance communication medium offering even greater bandwidth than that which is offered by the waveguide techniques mentioned previously.

We have seen already that there is good reason to dispense with devices depending upon free electrons (as in the old thermionic valves) wherever possible in favour of solid state devices. There are two areas where we have not succeeded; one is in the design of high power transmitting valves where the electron tube still reigns supreme; the other is in the display field where the cathode ray tube also remains unchallenged.



Development of television picture tubes since 1945: (lower left) 9in., 14·6in. front to back; (lower right) 14in., 16·6in., (top left) 17in., 15·6in; (top right) 19in., 12in. *(Mullard)*

The television screen of the future? A new type of display panel using a special "liquid crystal" material is currently under development. Words or other information appear on it when a low voltage is supplied by wires which are concealed in this photograph. Immediate practical uses are likely to be data readouts for control panels, animated labelling for keyboards, and see-through map displays which pilots and drivers can read "head-up" without losing sight of the view ahead. One day, "liquid crystals" might provide television screens thin enough to hang on a wall *(Marconi)*

Yet, once again much research is directed towards finding solid state replacements for these devices, enabling us prospectively to get get rid of high voltages, hot cathodes and relatively short lifetimes. The day of the all solid state camera tube and the solid state display cannot be far away!

RETROSPECT

The pace of this advance has been breathtaking and the rapidity with which we have accommodated it equally so. We take for granted already the computers which process our bank cheques, we take for granted the information which is transmitted back to earth from weather satellites and indeed the fact that we can now receive television pictures from, for example, Japan whereas at one time the only way of doing this was to send a film round the world by aircraft.

We take for granted the safety of the navigational systems in the aircraft in which we fly, that the radio altimeter will tell the pilot the correct height when he is coming in to land, or indeed, even more so, that the automatic landing system will handle the aircraft and not miscalculate the point at which it is supposed to meet the ground! We fail to notice the increasing reliability of our telephone system, of which we are perhaps even less conscious when things go wrong!

All of these developments have occurred within the last fifty years, some within the last fifteen, and because of them and more particularly through our television sets we all know far more about the other countries of the world and their peoples than previous generations could have dreamed of. We have all become accustomed to, and indeed have come to expect, ease of communication and travel in all senses. The social effects of these developments all due to electronics have already been immense even if their source has not always been generally recognised.

It may be, as some have suggested, that the era of rapid developments in electronics is now passing and that as we move into the future the progress will be less spectacular. Past experience teaches one to treat such predictions with caution—though, true or not, we may be assured that the demand for electronics equipment and the need for people who understand how to design it will continue.

With the development of simple, easy to use circuits more and more people will find in electronics a diverting pastime which they can put to useful purposes. The main developments may be behind us but the future nevertheless remains tremendously exciting! ■

ELECTRONIC CIRCUITS–
.....IN THEORY and PRACTICE

TEACH-IN
...FOR BEGINNERS

By Mike Hughes M.A.

2 ELECTRIC CURRENT

THE trouble with an electric current is that you cannot see it. Perhaps this simple fact is the main reason why a mystique has built up about electronics. Once you have a grasp of what causes an electric current to flow then a lot of basic electronics can be understood right away.

CURRENT FLOW

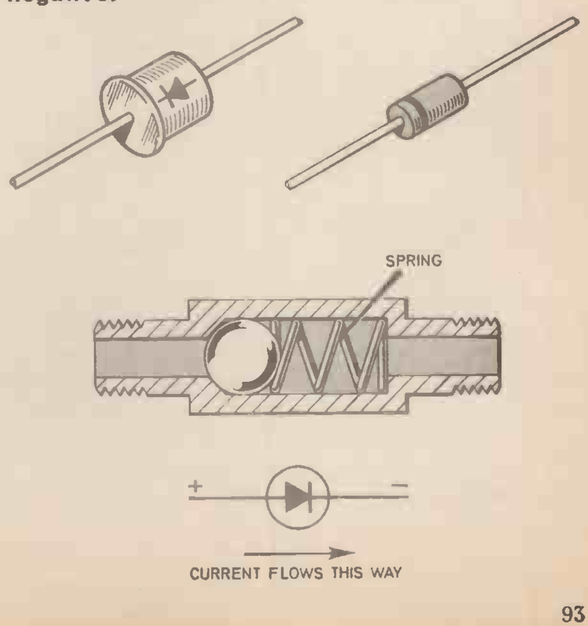
We all take for granted that we can connect a bulb to a battery and make the bulb light up—this is because an electric current flows through the bulb.

How can we prove that current is "flowing"? To have a flow we must pre-suppose that the flow is in one direction only, like a stream. We can show that there is a directional property to current flow very simply but we will need three components: a 9 volt battery, a 9 volt bulb in a lamp holder, and an electronic component called a diode.

We shall be talking about diodes later so at this stage let us consider it simply as a one way valve to the flow of electric current. If you wish to buy a diode capable of doing this experiment you should ask for one having a forward current of 1 amp and a working voltage of at least 12 volts. There are many types to choose from—perhaps the most common having type numbers 1N4001, 1N4002, 1N4003, 1N4004 (the 1N4001 should be the cheapest because it has the lowest working voltage). Fig. 1 shows the appearance of some common diodes that will do. Note there are two wires and either an arrow shaped symbol pointing along the device or a spot or band around one end.

The 1N4001 has a band which corresponds to the end to which the arrow symbol is pointing. This arrow is pointing in the direction along which the diode will allow electric current to flow.

Fig. 1. Two common diode encapsulations are shown above a ball-valve which represents a diode. Water can flow from left to right but not from right to left, likewise a diode allows electric current to flow only in the direction of the arrow in the symbol (shown below the ball valve). This assumes that current flows from positive to negative.



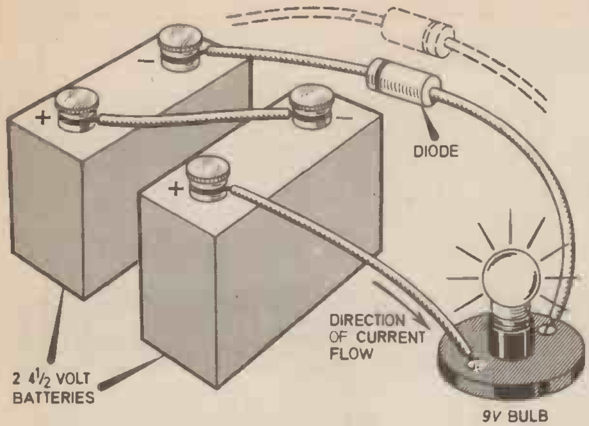


Fig. 2. The bulb lights with the diode connected as shown but will not light if the diode is reversed as in the broken line drawing.

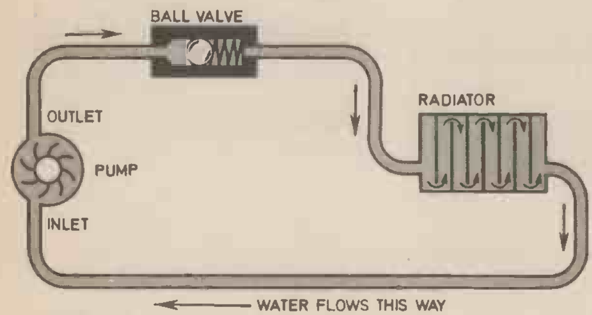


Fig. 3. Water analogy of Fig. 2.

Connect the lamp to the battery with two wires and see that the lamp lights. Reverse the leads to the battery: the lamp still lights. Now put the diode in the circuit. Connect the banded end of the diode (arrow head end) to the *negative* terminal of the battery; the other end to the bulb; the other side of the bulb to the *positive* terminal (we say that the battery, bulb and diode are connected in series). The lamp lights again. Now reverse the diode in the circuit so that the banded end is pointing towards the bulb. The lamp does not light because the diode does not allow current to flow through it this way round (Fig. 2).

By referring to the way the diode was connected in the circuit we can decide which way the current was flowing. It was, in fact, from the positive terminal through the bulb and diode into the negative terminal. This simple circuit has a nice analogy if we consider water as electricity, a pump as our battery (producing pressure) a spring loaded ball valve as our diode, and a radiator as the lamp (Fig. 3).

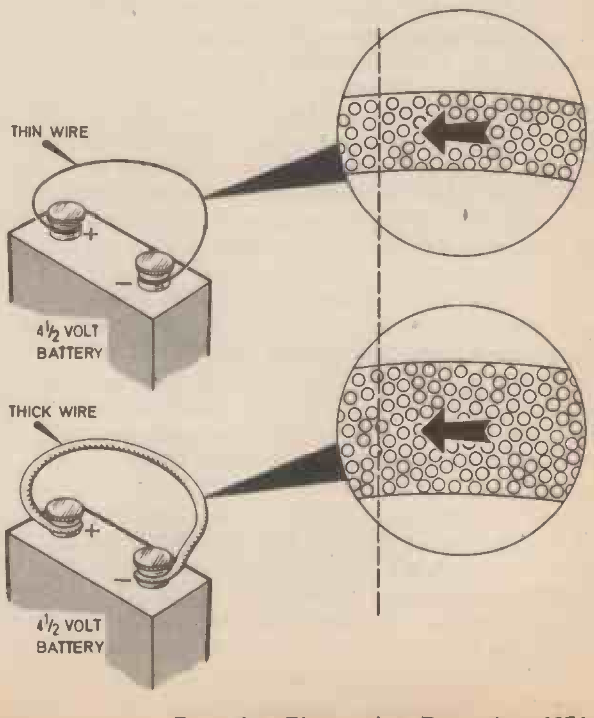
DEFINITION

We shall return to this analogy shortly but first let us simply describe what constitutes an electric current. It is quite simply the transfer of energy from one place to another, the energy being transmitted by the movement of minute particles of matter called electrons. These electrons have a negative charge and like north and south poles of a magnet the negatively charged electrons are attracted to positive potential (voltage)—they are repelled by a negative voltage.

Every material has a number of free electrons within it; copper has a great many and hence is capable of carrying more electric current (for a given cross section) than most other materials—we call it a good conductor. Glass has very few free electrons and hence we call it a bad conductor (or an insulator).

If a piece of copper wire connects the positive terminal to the negative terminal of our battery (do not do this in practice because you will run the battery down) we can imagine the free electrons in the copper moving from the negative terminal to the positive. Note that here is an ambiguity; although electrons move from negative to positive we say (by definition passed down through the ages) that current flows from positive to negative. This sounds confusing but does not usually cause many headaches and because it is such a ridiculous ambiguity it is easy to remember. Unfortunately the definition cannot be changed easily because all the rules of electromagnetism are based on it. During the series we will always assume that conventional current flows from positive to negative.

Fig. 4. More electrons move pass the dotted line per second with a thick wire than do with a thin wire.



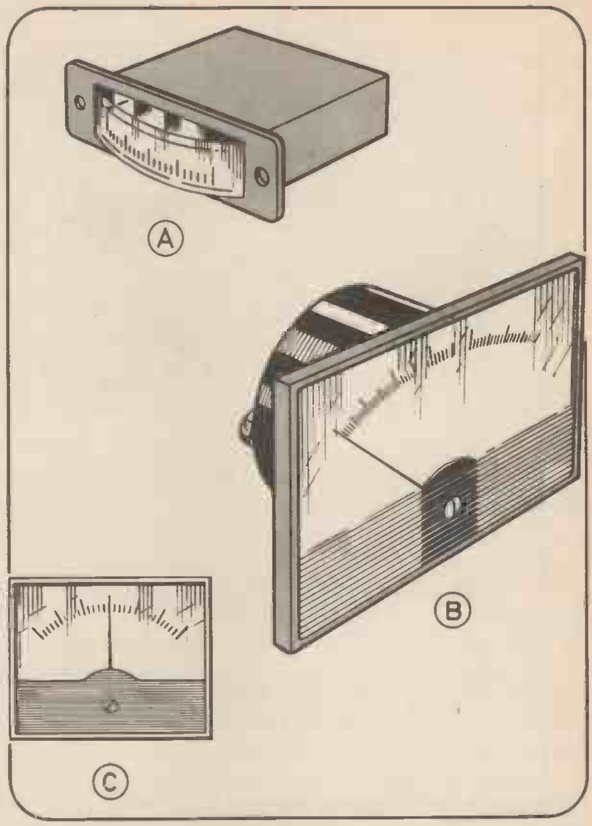
If we had a thick piece of copper wire we would expect more electrons to move past a given point per unit of time than with a thin piece (Fig. 4). Likewise if our battery had a higher voltage it would seem logical that we would get the same sort of effect. This is exactly what does happen. We call the rate of movement (flow) of electrons the **electric current**, the battery voltage is the pressure or motive force driving them, we call this the **electro motive force** (e.m.f. for short) and the copper wire is the conductor which has the ability of allowing large numbers or small numbers of electrons to move depending on its area of cross section; we call this the **resistance** to flow.

WATER ANALOGY

Having defined the basic elements of a real electric current let us now return to our analogy with water. We have already used the terms pressure and flow. We can demonstrate electrical resistance by having a water pipe of small bore connected in series with a pump—similar to a domestic central heating system. The smaller the bore, or the more radiators we have, the higher the pressure we need from our pump to maintain the flow.

It is common practice to measure water pressures relative to a given "head" of water. At the inlet of the pump the pressure is zero because this is our reference point. At the outlet the pressure will be high and positive and in between the various radiators we will still measure positive pressures but they will get less and less as we go round the circuit (Fig. 5).

If we took the junction of radiators B and C as our reference we would measure positive pressures on the "upstream" side of the point and negative pressures on the "downstream" side. What we are in fact measuring is the "pressure difference" between two points. If we have a high resistance to flow between two points we will get a corresponding high pressure difference. This is exactly what happens with an electric current. Let us replace the pump with a battery and the radiators with electronic components called resistors (Fig. 6.)—these are devices which have been specially designed to restrict the flow of current and have values measured in **ohms**. The drawing on the left shows the components as they would appear in real life but now look at the schematic diagram on the right which uses symbols to represent the components. B1 is the battery, R1, R2, R3, and R4 represent resistors. The voltage (or e.m.f.) of the battery is the driving pressure, say 4 volts. If all the resistors have identical value we can say that relative to the negative terminal of the battery the potential at the junctions of R1 and R2 is +3 volts, between R2 and R3 is +2 volts and between R3 and R4 is +1 volt.

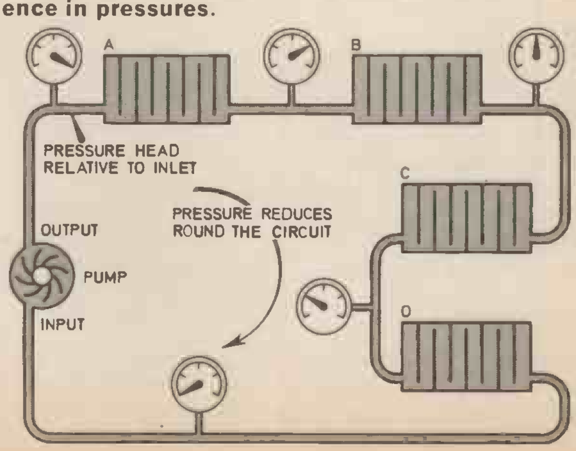


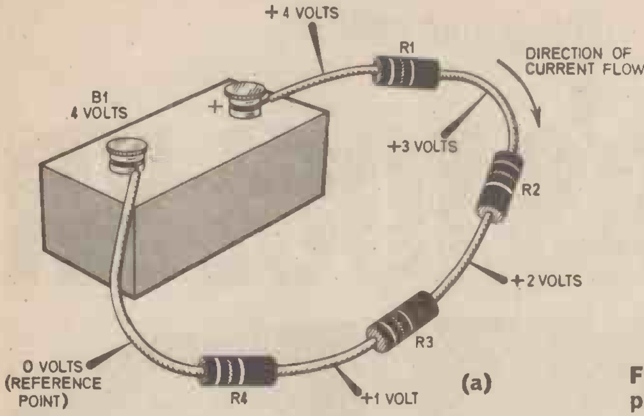
Three types of moving coil meters. A. Edge wise type. B. The "standard" type used in the Demo Deck. C. Centre zero type.

MEASURING CURRENT

It is all very well talking about currents and potential differences but how do we measure them? We have seen that a current flowing through a resistor produces a potential difference. Similarly an e.m.f. across a resistor will produce a current. There is a relationship between these, therefore we should be able to measure potential difference in terms of current. This will be covered in more detail later.

Fig. 5. Water analogy of a circuit showing difference in pressures.





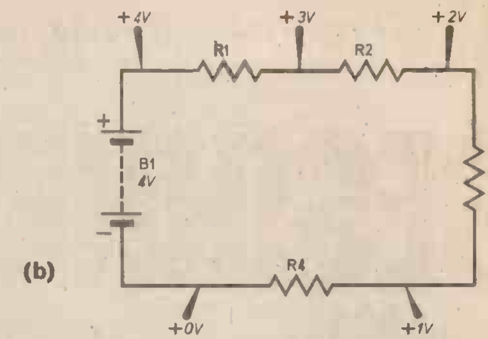


Fig. 6(a). The electronic components that replace Fig. 5. (b). The electronic Circuit diagram.

Most instruments in their basic form measure current and are modified to use the relationship mentioned to measure potential difference (voltage). The most common type in use today is the moving coil galvanometer. A small electric current made to pass through a coil of wire pivoted in a strong magnetic field makes the coil move on its pivot against the action of a spring (Fig. 7). A fine pointer attached to the coil moves over a graduated scale calibrated in units of current (amp or fractions of an amp).

Moving coil meters are specified in terms of their sensitivity. For example those used in cars do not have to be very sensitive as the currents measured are very high (10-20 amp) and the coil is usually only a turn or two of very heavy wire. In electronics we are usually concerned with minute electric currents in the order of thousandths or even millionths of an amp and it is quite common to have a meter having a full scale deflection of 100 millionths of an amp (100 microamp). The wire used for the coil in this case is extremely fine and there are many turns. The price of meters is directly proportional to their size and sensitivity; obviously it is not sensible to buy something that is too good for an application but when obtaining a meter it is always better to err on the side of higher sensitivity—it can always be reduced.

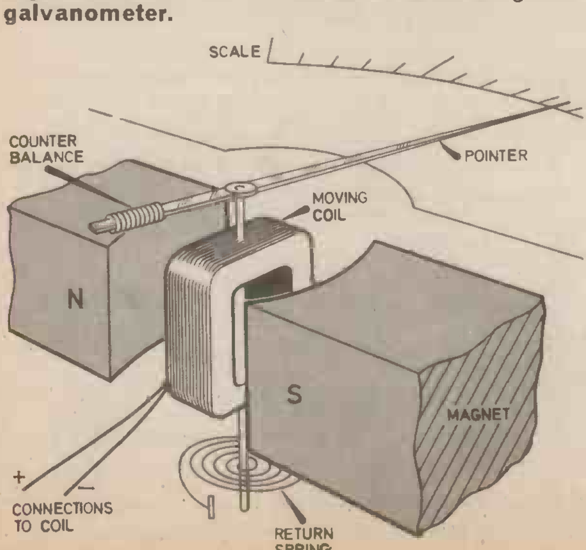
Next month we shall go into more detail about the relationship between current, potential difference and resistance and will carry out some simple experiments. In preparation for this it is suggested that this month you make the *Demo Deck*. This "table top laboratory" will be used frequently during the series and for those with a limited amount of working space it should permit work on the dining room table without too many severe repercussions!

You might be tempted to start experimenting with the *Demo Deck* at this stage; if you are, be extremely careful that you do not pass excessive current through the meter. If you do not understand what this means it is safer to leave things as they are until next month when we shall be putting the deck through its paces, using a few extra components.

The electronic components required are:

2 1,000ohm ± 10% ¼ watt resistors, 2 10,000 ohm ± 10% ¼ watt resistors and 2 22,000ohm ± 10% ¼ watt resistors

Fig. 7. Basis of the movement of a moving coil galvanometer.



Next month: Ohm's law explained and used to make a volt meter on the Demo Deck

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This valuable set of tools contains the items we described in "Teach-In" for beginners last month as being essential to anyone setting out to enjoy the hobby of electronics. Having the right tools makes the job that much easier to do.

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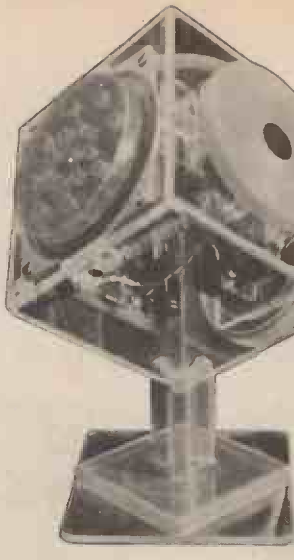

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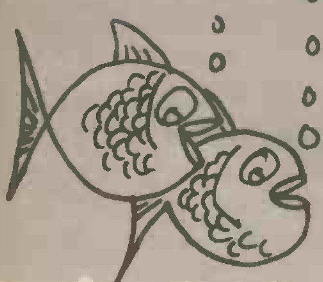
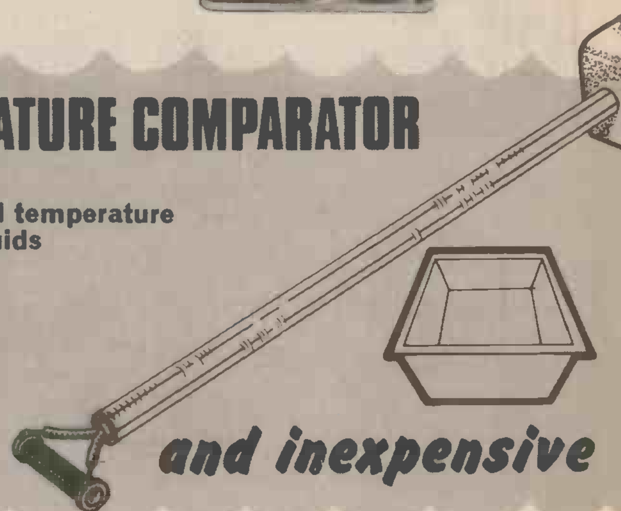


Measures small temperature changes in liquids



...simple and inexpensive

ELECTRONICS AND THE MUSIC SCENE

Describes the way in which electronics has changed the "musical sound" in recent years and the devices that produce the "special effects" now in common use

Some of the fascinating features to be found in the JAN '72 issue of

ON SALE FRIDAY, DECEMBER 17

TEACH-IN

PART 3

Explains fully the resistor colour code. Various experiments are carried out using the Demo Deck in which Ohm's law is verified

DEMO DECK

By Mike Hughes M.A.

Demo Deck for everyone who wants to experiment with electronic circuits and in particular for those following Teach-In.

THE Demo Deck has been designed for the constructor who wishes to carry out simple experimental work with the minimum amount of space utilisation, and who desires also the possibility of re-using components several times over. Most particularly it is used as the work horse of the *Teach-In* series and those readers who are following this in a practical sense are strongly advised to make a Demo Deck so that they can perform the exercises and experiments exactly as described.

THE DECK

The deck itself has no circuit diagram but is a flat bed on which is mounted a range of components, together with a sturdy re-usable soldering board. An important feature of the deck for those with limited space is the special cabinet.

The deck is mounted on a specially designed cabinet, this provides accommodation for tools and components and also housing for the loudspeaker and batteries. Thus at the end of experimental work everything can be tidied away neatly and the unit itself—if built well—is quite attractive in appearance.

No doubt it will be repeated in *Teach-In*, but it is important in any hobby that care is taken—you are your own master but you should set yourself high standards for workmanship and never settle for something that you think you could possibly do better. This is an attitude that should always be taken in electronics because most problems ultimately boil down to untidy or slip-shod workmanship. Make as good a job of this table top laboratory as possible; remember you will be using it as a tool for the rest of this series and probably much longer.

There is no need to follow the details exactly, but those following *Teach-In* are advised not to deviate too far from the published design. Some more advanced constructors may like to use the basic design suitably modified to their own purposes. For the benefit of beginners we shall

Approximate cost of components

£5·50 plus cabinet

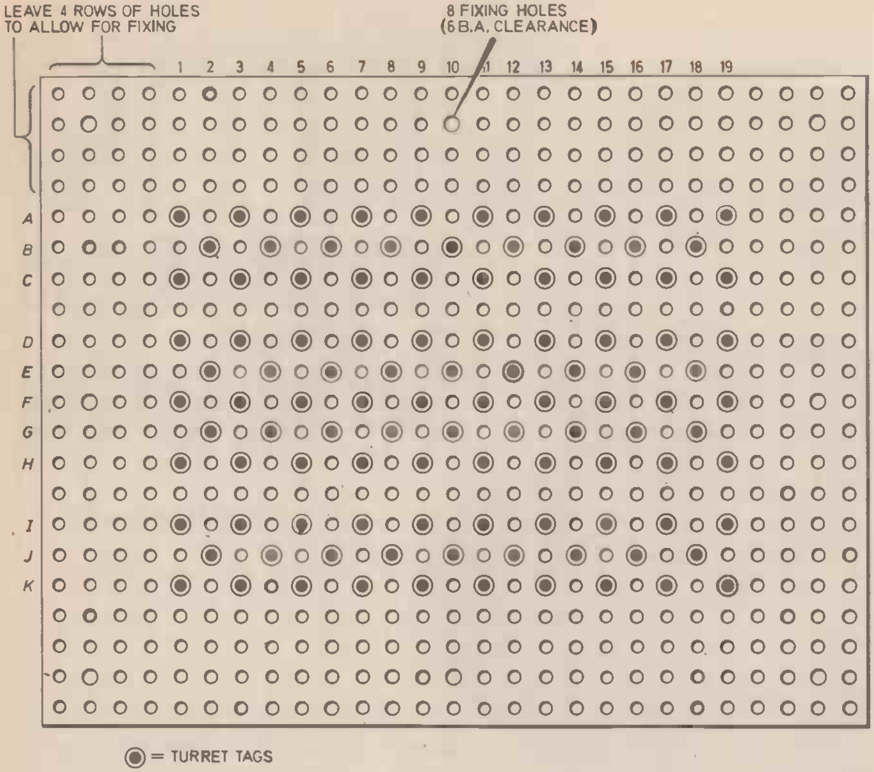


Fig. 1 Pin layout on the small perforated board, note the area left for mounting to the chassis.

specify the components in detail but, of course, some latitude is possible and costs can be cut by careful shopping around.

TAG BOARD

The basis of the Demo Deck is the tag post board which can be used for soldering up experimental circuits. This is made on a standard piece of R.S. Components perforated board that has holes set on a 0·25 inch matrix. The tags used are from the same manufacturer and are the ones typed "small". The standard layout of pins—that will be used in the *Teach-In* series—is shown in Fig. 1. It can be seen that not all the perforations are used; this is for reasons of economy and clearness of layout; experienced constructors might prefer a full matrix of pins.

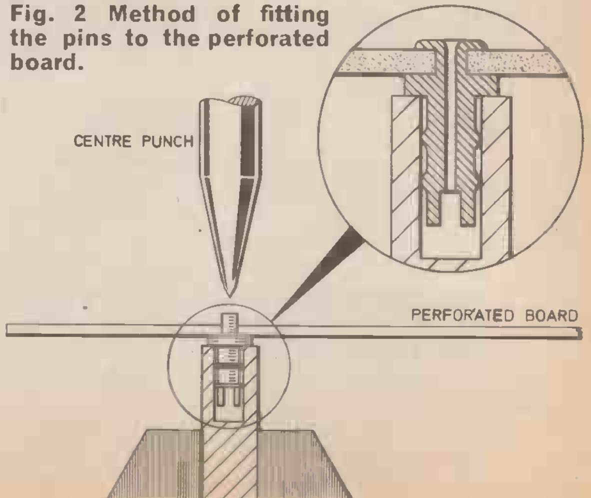
To rivet the pins in position hold the special die (this is supplied with a gross packet of tags) in a vice and insert the long shank of the pin in the die. Offer the perforated board to the short shank end of the rivet—which is protruding from the die—so that the pin is firmly seated in the hole then use a centre punch to splay out the end and, using a small hammer, firmly flatten the rivet and make sure it is holding tightly, see Fig. 2. This should be done for all relevant positions on the board—make sure that the margin around the board is kept clear of pins as this will be used for mounting purposes.

CHASSIS

The chassis of the prototype deck was made out of 14 gauge aluminium plate and obviously this makes a very sturdy job even though the material is a little difficult to work. Other materials can be used but it should be remembered that the unit is designed to give quite some service, therefore ensure that the material is strong enough. A good alternative would be $^3/_{16}$ inch plywood or a strong grade of hardboard. If a wooden panel is used it must ultimately be coated with varnish or enamel paint so that lettering can be added.

The layout of the components can be seen in the photographs so holes should be cut in the panel to facilitate mounting; dimensions for the components used in the prototype are shown in

Fig. 2 Method of fitting the pins to the perforated board.



Components....

Potentiometers

VR1 100 ohm wirewound
VR2 5,000 ohm (5 kilohm) carbon
VR3 25,000 ohm (25 kilohm) carbon
VR4 500,000 ohm (500 kilohm) carbon

Lamps

LP1 6 volt 0·06 amp MES bulb and holder
LP2 6 volt 0·06 amp MES bulb and holder

Loudspeaker

LS1 35 ohm 3⅜ inch diameter (R.S. Components)

Meter

ME1 1 milliamp full scale deflection moving coil meter with 1½ inch square face (S.E.W. type MR38P)

Battery

B1 4½ volt screw terminal bell battery (2 off)

Miscellaneous

1 small perforated board (R.S. Components)
1 gross box small turret tags (R.S. Components)
2 ten way 2 amp terminal blocks (R.S. Components Barrier Strip 2A)
6 Slim screw terminals, different colours (R.S. Components)
Banana plugs to fit screw terminals (optional accessory)—if alternative terminals are used these may not have facility for plugs
Small or medium crocodile clips (optional accessory)
2 yards (approx.) single strand insulated connecting wire
2 yards (approx.) light duty twin flex (for leads to B1 and LS1)
2 yards (approx.) seven strand insulated connecting wire (for connecting leads)
Aluminium or other material for chassis (see text)
Wood for housing (see Fig. 5). Lettering sheet. Varnish etc.

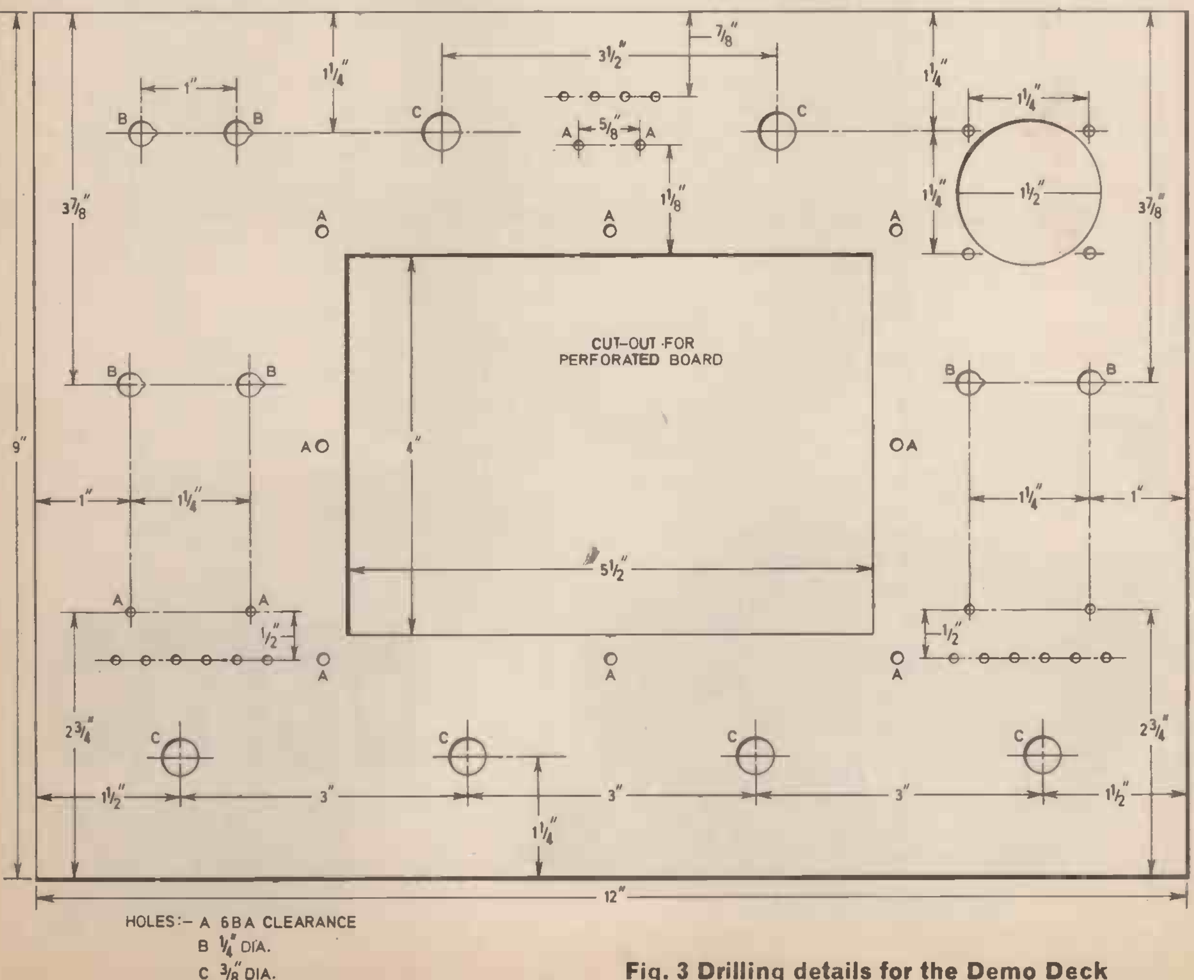


Fig. 3 Drilling details for the Demo Deck

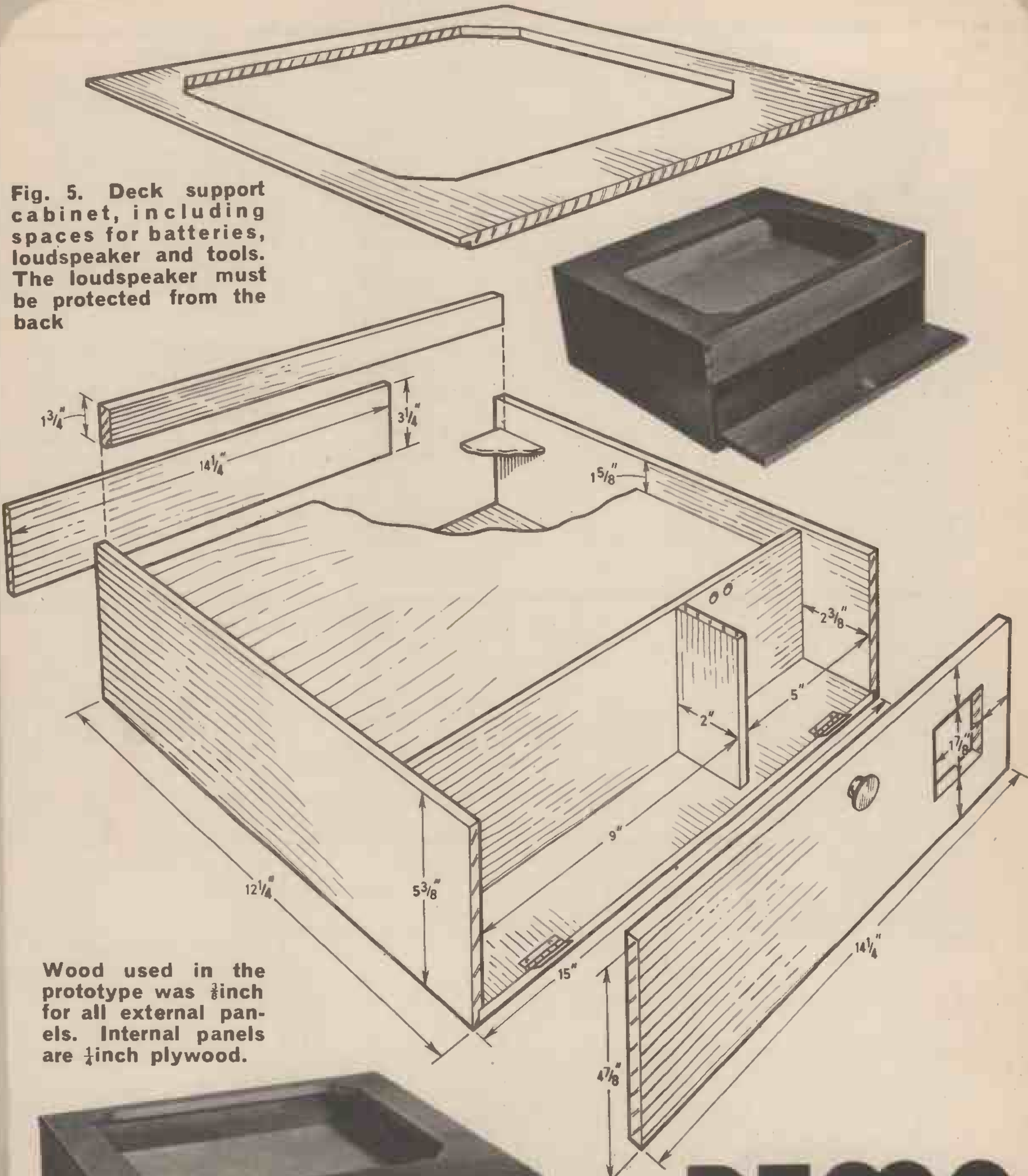


Fig. 5. Deck support cabinet, including spaces for batteries, loudspeaker and tools. The loudspeaker must be protected from the back

Wood used in the prototype was ⅜inch for all external panels. Internal panels are ¼inch plywood.

DEMO DECK

the layout drawing (Fig. 3). It is as well to check the diameter of fixing holes because some components of different manufacture can vary in physical dimensions.

Check that the potentiometers, lamp holders, terminals and meter will fix correctly and then finish off the surface of the Demo Deck. If aluminium is used, make a satin finish by scrubbing the surface in a horizontal direction with fine grade wire wool; lightly dust off the metallic powder produced without getting finger marks on the surface and immediately apply a coat of polyurethane varnish. When dry apply lettering either with transfers or Letraset and then give a final protection coat of varnish. If you have used a wooden surface apply one or two coats of a hard gloss paint and when dry carry out the lettering as above. Finish off with a coat of clear varnish. Each tag should be identified by a number/letter code and this can be applied to the chassis around the edge of the board. The designations are applied as shown in Fig. 1.

WIRING

Now is the time to mount permanently all the components. Take care when handling the 1 milliamp meter and make sure that you have the potentiometers mounted in the right places. If necessary cut the shafts of the potentiometers, to take the knobs, before mounting on the deck. The values of resistance are printed on the side of the potentiometer cans. The underside wiring is only to route the terminals of the components to the Demo Deck terminals and Fig. 4 shows the details. Take note that there is a cross-over in the wiring sense of the potentiometer terminals and ensure that the polarity of the meter is correct. All meters should have the positive terminal marked + or with a red spot of paint. Leave the flying leads from the battery and loudspeaker terminals about 18 inches long: these will be connected to the components mounted in the wooden cabinet.

Set the deck aside and make a suitable support. It is recommended that a cabinet similar to that described in Fig. 5 be made. This will hold the batteries and loudspeaker, as well as having a compartment for tools and small extra components. Fig. 5 shows an exploded view of the prototype design. Make sure that you leave sufficient room to gain access to the batteries and that the rear of the loudspeaker is protected.

All that remains to be done is to make up some accessory leads. It is suggested that you keep an assortment of single ended and double ended crocodile clip leads and two or three single ended banana plug leads. These will be extremely useful for experimentation and can save a lot of frustrating time wasting.

There is only one word which need be said about the use of the deck. While the tag posts can be re-soldered many times it is worthwhile attempting to use the minimum amount of solder otherwise there will be a tendency to build up a large "blob" which can be annoying and ultimately make further soldering difficult. Should the wiring panel reach a condition when it can no longer be used it can be replaced simply by undoing the eight screws and dropping it out. ▣

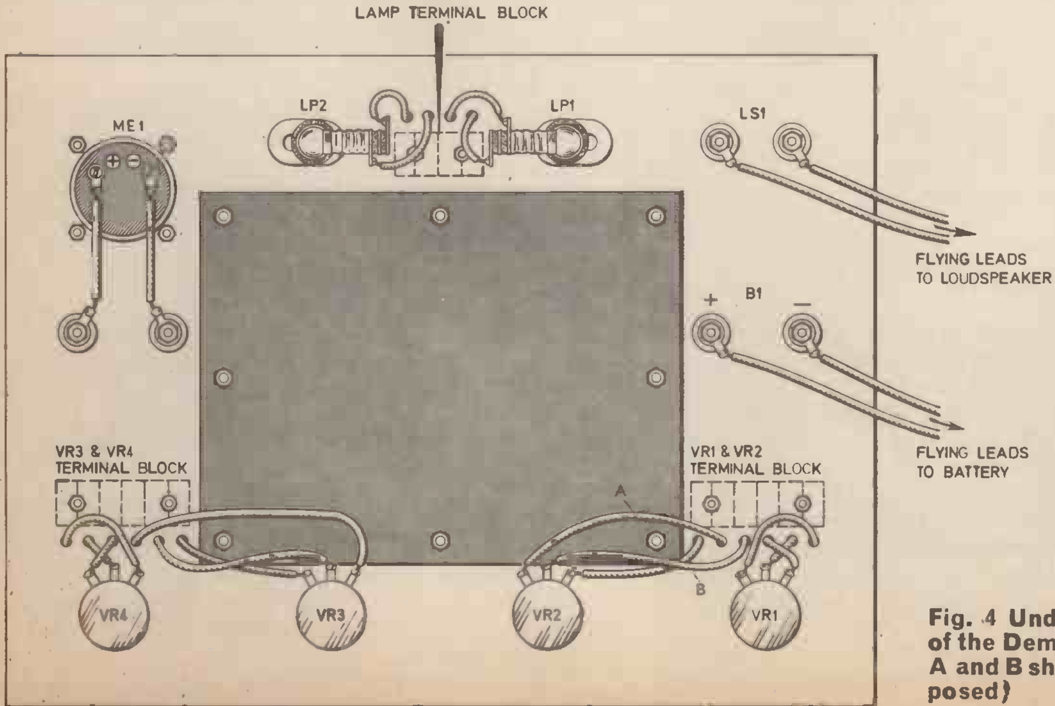


Fig. 4 Underside wiring of the Demo Deck (wires A and B should be transposed)

simple fuzz box

By N.D. Jones

Build this simple fuzz box and add weird and interesting effects to your music.

WITH the revival of the fuzz sound now that "heavy" groups are becoming more and more popular, a fuzz box using the minimum of components has been designed.

The unit is constructed using Veroboard and this is mounted, together with sockets, switch, fuzz control potentiometer and battery inside a constructed aluminium case measuring only 4in. $\times 2\frac{7}{8}$in. $\times 1\frac{1}{2}$in.

CIRCUIT

The circuit diagram for the fuzz box is shown in Fig. 1. It is basically a two-stage transistor amplifier using *npn* transistors. The input is first amplified by TR1 and then passed to the base of TR2. This second stage acts as an overdriven amplifier which clips and distorts the signal, producing the effect called "fuzz."

The bias on the base of TR2 can be adjusted by means of the potentiometer VR1. This changes the nature of the distortion and provides a certain amount of control over the "quality" of the fuzz.

The pre-set VR2 is incorporated to act as a variable attenuator so as to prevent overloading of the main amplifier where permanent damage could be sustained if the output from the fuzz box was too high.

The values of the capacitors C2 and C3 have been chosen so as to provide a certain amount of treble boost which is a desirable effect with the fuzz sound. If more treble boost is required, this can be obtained by decreasing the values of C2 and C3.

WIRING THE VEROBOARD

The position of the components and the wiring on the Veroboard is shown in Fig. 2. All the resistors, capacitors and transistors can quite easily be mounted on a piece of standard Veroboard size $2\frac{1}{2}$in. $\times 1\frac{1}{2}$in. $\times 0 \cdot 15$in. matrix. The copper strips on the underside of the board should be cut as shown in Fig. 2, either with a small drill or the special Veroboard cutting tool that can be obtained from most stockists.

A mounting hole should be drilled at location E1 on the Veroboard so that it may be secured to the lid of the metal case by means of a 6BA nut and bolt.

Mount and solder all the components and

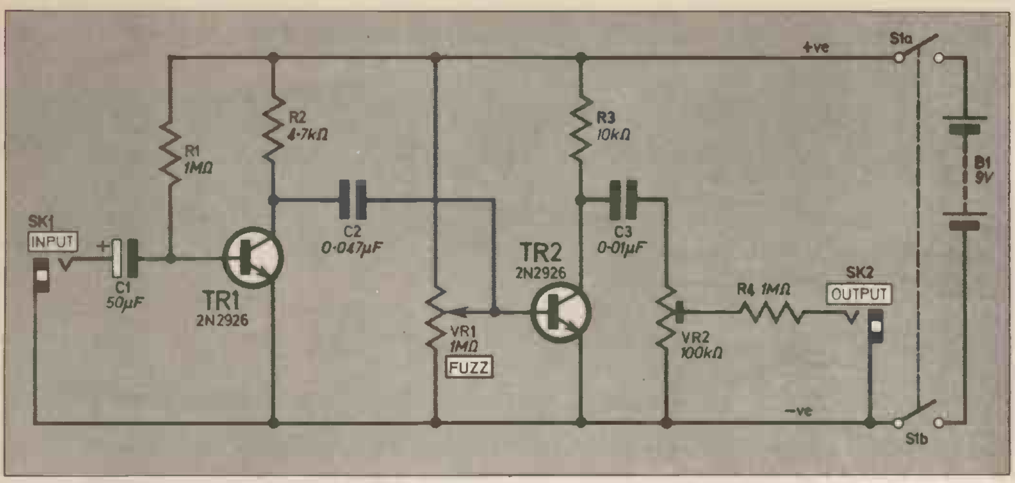


Fig. 1. The circuit diagram of the fuzz box.

flying leads on the board as shown, taking special care when soldering the transistors. It is recommended that a heat shunt be used, such as a pair of pliers gripping the transistor lead being soldered. This conducts away the heat from the soldering iron which would otherwise damage the transistor.

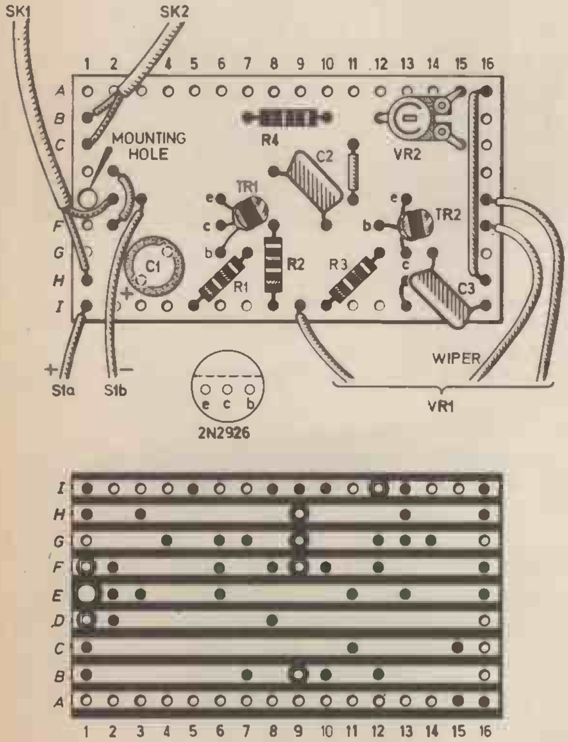


Fig. 2. The layout of the components on the top side and underside of the veroboard. Note that the flying leads to SK1 and SK2 are of screened cable. The transistor base connections as viewed from underneath are shown below. The larger drilled hole at E1 is for mounting purposes.

Some form of insulation should be placed between the Veroboard and the lid to ensure there is no "shorting" of the rear of the Veroboard by the metal lid. A piece of insulation tape stuck to the lid, under the Veroboard, is sufficient to prevent this.

CASE CONSTRUCTION

The size, shape and material of the case may be tailor-made to individual requirements, but the one shown in the photograph and described here was, besides having a neat appearance, found to be easy to construct and readily able to house all the components in a neat and tidy fashion.

The prototype case was made from 1/16in. thick aluminium sheet to the dimensions given in Fig. 3.

All holes should be drilled before the metal is bent to shape.

The holes for fixing SK1, SK2, and VR1 will require large drill bits, up to $\frac{1}{2}$in. diameter. If these are not available, a smaller hole should be drilled first and then filed with a circular file until the correct size is obtained.

The slot for accommodating the slide on-off switch is easiest made using the "drill and file" method. That is, drill holes at the extremes of the rectangular area to be removed and then straighten up the perimeter with a small file.

The lid, which forms the base, is made from the same material as the body of the case and should have a $\frac{1}{4}$in. lip to enable attachment to the body by means of 2 small self-tapping screws.

The case is now ready for assembly.

ASSEMBLY

Fix SK1, SK2, VR1 and S1 firmly in their positions in the case as shown in Fig. 4, and then wire them to the Veroboard. The length of all these wires should be about 5 to 6 inches.

Screened cable must be used for the connections between SK1, SK2 and the Veroboard. This eliminates interference.

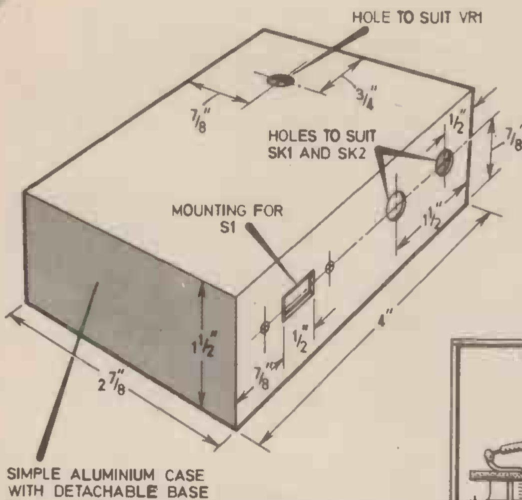


Fig. 3. The case dimensions and positions of holes to be drilled.

simple FUZZ box

Approximate
£ cost of components
1·60 plus case

Components....

Resistors
R1 1M Ω
R2 4·7k Ω
R3 10k Ω
R4 1M Ω
All $\frac{1}{4}$W ± 10%

Potentiometers
VR1 1M Ω log. or linear
VR2 100k Ω skeleton preset

Capacitors
C1 50μF elect. 15V
C2 0·047μF
C3 0·01μF

Transistors
TR1, TR2 2N2926 silicon *npn* (2 off)

Miscellaneous
SK1, SK2 Standard jack sockets (2 off)
S1 Slide on/off switch
B1 9V battery (PP3) and connecting terminal, $\frac{1}{16}$ inch, aluminium sheet for case. 12 in. screened lead. 16 holes x 9 strips x 0·15 in. matrix Veroboard. Control knob.

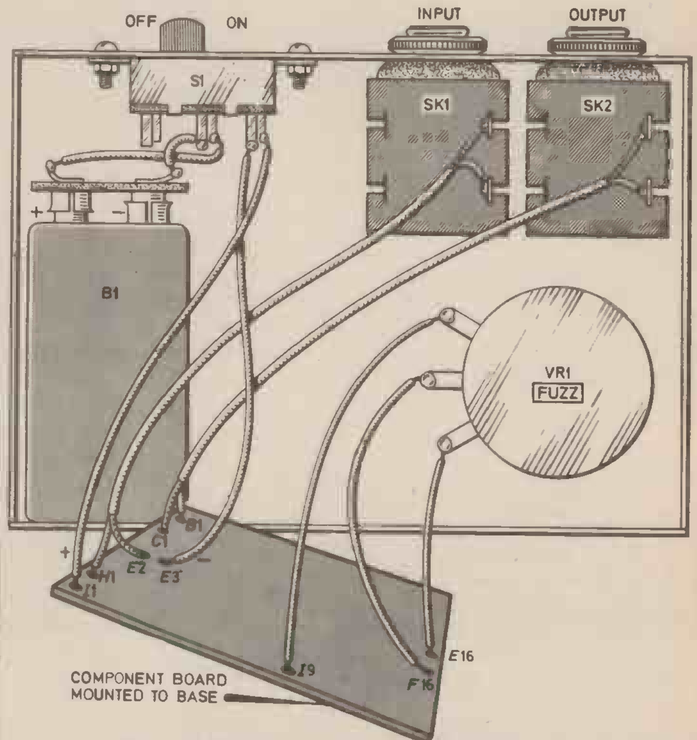


Fig. 4. View of the completed fuzz box from below, showing the wiring of the Veroboard to the switch, sockets and potentiometer.

Connect the battery terminal as shown in Fig. 4 making sure that the polarity is correct, otherwise damage to the transistors may result.

All that remains to be done is to fix the Veroboard to the lid by means of a small nut and bolt, clip in the battery and secure the lid. The fuzz box is now complete and ready for use.

If required a foot switch may be included in the fuzz box to switch in and out the fuzz effect. Such a switch must be arranged to connect the input to the output (SK1 to SK2) and screened lead should be used to wire up the switch.

USES

The fuzz box is used extensively and mostly by "groups" for lead guitar where it is placed between the guitar and the main amplifier, but it may be employed for effect with almost any instrument, such as bass guitar, electronic organ, and even microphone. Weird and interesting sounds may be obtained by using the fuzz box in conjunction with a microphone used to amplify musical instruments such as a trumpet and trombone. This device is a must for the musical sound experimenter.

Ruminations
By Sensor

The I.C. man cometh

The reductions in size and production costs and the improvement in reliability of complex electronic systems, brought about by the use of integrated circuits has lead to their incorporation into all kinds of equipment. Apart from the more obvious applications such as computers and kindred equipment, radar, television and communications systems; integrated circuits can now be found in applications as diverse as washing machines, model aircraft control and in fuel injection and ignition systems for motor cars. With these facts in mind, I began to wonder what the future electronic "foreigner" will be like.

Before writing anything else I must hasten to add that I am not going to discuss genetics; a "foreigner", in industrial terms, is a private job carried out on works premises. The foreigner can take many forms, it may be a small repair job which requires facilities not normally available in the home, such as welding or turning, or it may be a complete piece of equipment, designed and built within the works. Foreigners are usually relatively small in dimensions, or capable of being broken down into small units, so that they can be hidden from authority and eventually smuggled out of the factory.

One thing common to all foreigners is that they seldom reach completion; in the first flush of enthusiasm there is much frenzied activity which is highly infectious. Colleagues will rush to assist with ideas and materials, other departments will lend expertise and facilities, and if these offers of help are not strongly resisted from the outset, the original creator will find that his precious brainchild has been wrenched from his grasp to be broken down into a number of sub projects spread throughout the works.

Further sub-division may then take place and it can be said that the more sub-divisions there are, the less likelihood there is of the project being completed. Also, the rate of working falls off very rapidly after the initial fervour has evaporated—as there are few things more boring than old foreigners, especially other people's foreigners. These rules can be expressed in simplified form as:

$$t_0 = F_r U_s T_{rate} + \Sigma I$$

where t_0 = time to completion

F_r = "foreigner receptiveness" (a constant for the factory)

U_s = the number of unit subdivisions

T_{rate} = the rate of toiling

ΣI = the sum of all the inertia factors of everyone involved (similar rules apply to bona fide jobs but F_r is replaced by a term O representing official support).

But what, you may ask, has all this to do with integrated circuits? Well, integrated circuits are small—one of the essential features of a foreigner; (though I heard that a 60 foot maypole was once built as a foreigner; but that is another story!) they are virtually complete in themselves and often merely require connection to a power supply and some ancillary input or output equipment and they are ready for use. A wide range of timing circuits and audio circuits exists and the versatile operational amplifier lends itself to many projects.

Can we expect to see a flood of baby alarms, exposure timers, model railway controllers and electronic roulette games pouring through the factory gates? I think not, for there is still the problem of the box, case or cabinet. This is where the greatest inertia is traditionally encountered and where $F_r U_s T_{rate}$ approaches infinity. Until we discover how to "grow" boxes around our foreigners, they are doomed to remain what they have always been—memorials to frustrated creativity.

COMPONENT BUYING & SUPPLYING

No. 2 Suppliers

Second of a series of three articles

by Alan Sproxton, Home Radio (Components) Ltd.

. . . wonderful! . . . I have been searching everywhere for one".

I AM sure I am speaking not only for my fellow component suppliers, when I say nothing delights us more than to hear a customer say "Have you got such and such in stock? . . . . *wonderful!* . . . . I have been searching everywhere for one". At the other end of the scale there is the customer who reduces us all to the depths of despair and seems to assume that we run out of something he wants purposely to thwart his plans.

On the whole, you, the customer are sympathetic and understanding, but when you have heard some of our problems, I'm sure you will be even more so. First there are the obvious problems, that we are dealing with thousands of different items and added to that, change in electronics is so rapid that obsolescence is also fast. This is particularly noticeable in transistors, where frequently some types are superseded by new versions before the originals have even reached the public.

The Middlemen

What increases our difficulties is the fact that we are the men in the middle. We are dependent on manufacturers or wholesalers and should they decide that a certain item is not worth handling they stop making it, usually all our tears won't make them change their minds!

There are two factors involved here, percentage of gross profit and stock turn round. The percentage of gross profit can be varied by altering the buying or selling price, but the stock turn (which simply means the speed at which an item sells) depends entirely on the demand!

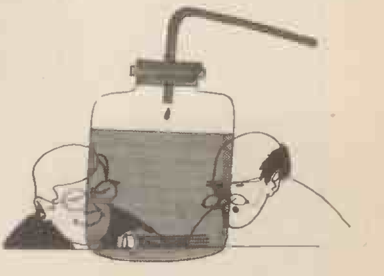
Stock Turn-Over

On the average a supplier might expect to turn his stock over six times during the year for example, if he has 12 plugs in stock, he would expect to sell 72 during a year. One very large firm of electronic wholesalers has a very rigid policy on this and once sales have slumped below a certain level on an item, they just drop it completely. With smaller firms such as ours, if we thought the item irreplaceable we would try and keep it going as a service to customers; but to illustrate how difficult that can be in practice, let me tell you of one actual case.

We used to purchase Pyrex glass aerial strainers from Eddystone Radio. They decided to discontinue them so we went to the manufacturers. They agreed to supply us in minimum quantities of 250, so we went ahead. Then about two years ago they politely informed us that they would not supply us with less than 1,000! As the nett price was over 20p each, this meant an outlay of over £200 for an item we sold at the rate of one or two hundred a year!! Naturally we were compelled to give them up.

Combined Operation

It is with the object of overcoming this difficulty that I recently formed a Group of Suppliers called "Group One". I am very pleased to say that our successes as a group have been reasonably high and we have been able to prevent many items from disappearing altogether. To quote a few, the Standard Maka Switch Kit, Acoustic Acetate Wadding, and the Electroniques SMD2 Drive and Dial. Wherever we see an item threatened which we think ought to remain available to you, the customer, we act to preserve it. Our other basic aim is to keep down prices. It might be appropriate at this point to mention prices because it is one of our most thorny problems.



. . . we act to preserve it

Price Increases

Ever since the last war, prices have been rising faster and faster. When there is a price increase, a manufacturer or wholesaler simply writes to us and states "As from today's date the price of X has gone up by Y per cent". Often they don't even tell us and we only discover it from the invoices.

What a contrast to the position of us dealers! Many of us have thousands of brochures and cata-

28 watts, r.m.s. 40Hz to 40kHz ± 3dB

Viscount III Audio Suite complete £49

There are two stereo amplifiers—the R100 for ceramic cartridges, the R101 for magnetic and ceramic. Both incorporate FETs (FIELD EFFECT TRANSISTORS), just like top-priced units. FETs give you more of the signal you want, and almost none of the background hiss you don't. Both units have a jack socket to plug in headphones and there's a separate output for tape recorder. Filters (an unusual feature in this price range) and tone controls give a wide range of bass and treble adjustment which compensate for input deficiencies and domestic acoustic conditions.

PRICES SYSTEM 1

Viscount III R101 amplifier	£22·00+90p p&p
2 x Duo Type II speakers,	£14·00+£2 p&p
Garrard SP25 Mk. III with MAG. cartridge plinth and cover	£23·00+£1·50 p&p
Total	£59·00

Available complete for only £52·00+£3·50 p&p

SYSTEM 2

Viscount R101 amplifier	£22·00+90p p&p
2 x Duo Type III speakers	£32·00+ £3 p&p
Garrard SP25 Mk. III with MAG. cartridge, plinth and cover	£23·00+£1·50 p&p
Total	£77·00

Available complete for £69+£4 p&p

SYSTEM 3

Viscount III Amplifier R100	£17·00+90p p&p
2 x Duo Type II speakers, pair	£14·00+£2 p&p
Garrard SP25 Mk. III with CER. diamond cartridge, plinth and cover	£21·00+£1·50 p&p
Total	£52·00

Available complete for only £49·00+£3·50 p&p

SPEAKERS Duo Type II
Size approx 17" x 10¾" x 6¾". Drive unit 13" x 8" with parasitic tweeter. Max. power 10 watts. 3 ohms. Simulated Teak cabinet.
£14 pair+£2 p&p.

Duo Type III Size approx 23½" x 11½" x 9½". Drive unit 13½" x 8½" with H.F. speaker. Max. power 20 watts at 3 ohms. Freq. range 20Hz to 20kHz. Teak veneer cabinet. **£32 pair+£3 p&p.**

SPECIFICATION R101
14 watts per channel into 3 to 4 ohms. Total distortion @ 10W @ 1kHz 0·1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K. equalised within ± 1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities; headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to −17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to −12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max) R101—P.U.1 and radio—65dB. P.U.2. −58dB. R100 same as R101 but P.U.2 (for crystal cartridges) 450mV into 3 Meg. *Cross talk* better than −35dB on all inputs. *Overload characteristics* better than 26dB on all inputs. Size approx 13¾" x 9" x 3¾".

R+TV

Radio and TV Components (Acton) Ltd. 21e High Street, Acton, London W3 6NG
323 Edgware Road, London, W.2. Mail orders to Acton. Terms C.W.O. *All enquiries S.A.E.*
Goods not despatched outside U.K.

logues in circulation and consequently we shall be receiving too little money for our goods. When the price jump is big, we finish up selling below cost! We must then, either write to you, the customer, asking for more money (which does not help the customer-dealer relationship), or we must lose money.

Many years ago, we took our prices out of our catalogue and put them in a separate supplement as we argued that although we couldn't reprint the catalogue for every price change, at least we could change a price supplement several times a year. Lately, the rapidity of price changes made even this unworkable and we have now installed an Offset Litho Machine to print our own Price Supplements on the spot. Price changes can be made within minutes and at last we are keeping up with them!

. . . Price changes can be made within minutes

Packing and Postage

One minor problem which I think we have solved fairly well is making a part charge towards the cost of packing and postage. After much thought, we decided to average out the cost of all postage and charge this as a standard rate. At the moment it is 18p per parcel. Naturally the customer who orders some heavy transformers is happy, but the customer who orders 25p worth of resistors less so.

Occasionally a customer might write and say "You charged me 18p for post and packing and I noticed that my 25p worth of resistors were just put in a padded bag with a 3p stamp on it". It is then necessary to point out that our gross profit on the transaction is probably 8p and apart from the bag costing us 3p and the stamp 3p, the staff handling it are earning about 1p per minute! But I must be fair and say we probably receive less than 12 letters a year in this vein. I think even with "cash with order", that probably all dealers lose money on orders under £1—but again it is a service to the customer. We stress again and again, try and send one big order instead of several small orders, help yourself to save postage and also help us!

Stock Control

Nothing frustrates you, the customer, more than to be told that an item you require is out of stock. You may put this down to bad management and poor stock control. Well, a few years ago, one of the giants in the electronic components industry decided to go into the retail side, and produced magnificent catalogues, spent thousands in advertising and yet after a year or two, it was obviously not going according to plan.

Knowing that we had achieved a very modest success in the business, two of the firms executives came and took my partner and I to lunch and it was apparent they wanted to find out what made us tick! When they got round to stock control, they said "What do you do?" and we said "What do you do?" "Well," they said, "when an order comes in it is fed into the computer. The computer makes out the invoice, types the label, checks the stock, and when the stock falls below a certain predetermined level, re-orders! And now, what do you do?"

"Oh!" we replied, "well if we pick up a box and it's empty, we re-order, if the box is battered and worn out (they are cardboard by the way) we obviously should order bigger quantities, if there is more than a certain pre-determined thickness of dust on the box, this item is a slow seller and should be discontinued."

The two executives stared at us in disbelief until we convinced them that we were telling them the truth, and when we pressed them, they admitted they were out of stock of various goods far more often then we were!! We then went on to tell them why—there are too many variables for any computer to cope with, therefore one might just as well do it the simplest way!

Next month I will discuss the influence of magazine constructional articles upon the supply situation.

. . . more than a certain predetermined thicknes of dust

EVENING ELECTRONICS

Many readers, both newcomers to electronics and experienced hobbyists, may be interested in evening classes or clubs for electronic enthusiasts. There are many evening classes run for both beginners and experienced constructors all over the country and we know that some evening Institutes run more than one course. Although these courses will have been going on for more than a month when you read this, most of them will gladly accept newcomers.

If you are interested in joining such a class, we recommend you to get in touch with your local education authority, who can inform you of all the courses in your area. For Londoners the booklet "Floodlight" available from most newsagents gives all the courses being held in the Greater London area.

As well as evening classes there are some electronics clubs operating within the British Isles, the largest of these being the British Amateur Electronics Club. For more information about this club and its activities please write to:

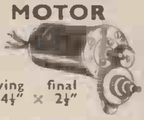
Mr. C. Bogod, The Secretary,
B.A.E.C., 26 Forrest Road,
Penarth, Glamorgan.

EVERYDAY ELECTRONICS may be visiting some evening classes and club activities and reporting on them during the coming months. So if you run or belong to such a group and you feel that you have something interesting to show us or that the arrangement and activities of your group warrant mention, then let us know.

BODINE TYPE N.C.I. GEARED MOTOR

(Type I) 71 r.p.m. Torque 10lb. inch. Reversible. 1/70th h.p. 50 cycle, 0·38 amp (Type 2) 28 r.p.m. Torque 20lb inch. Reversible. 1/80th h.p., 50 cycle, 0·28 amp. "As new" condition. Input voltage of motor 115V a.c. Supplied complete with transformer for 230/240V a.c. Input. Price, either type £3·15 plus 35p P. & P. or less transformer £2·13 plus 27p P. & P.

12 VOLT DC MOTOR

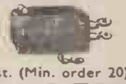


Powerful 1 amp. REVERSIBLE motor. Speed 3,750 RPM complete with external gear train (removable) giving final speed of 125 RPM. Size 4½" × 2¼" dia. Price 95p inc. post.

230V/240V COMPACT SYNCHRONOUS GEARED MOTORS

Manufactured by either Sangamo, Haydon or Smith. Built-in gearbox.
1 rev. per hour. Anti-clockwise rotation.
2 revs. per hour. Clockwise rotation.
3 revs. per hour. Anti-clockwise rotation.
15 revs. per hour. Anti-clockwise rotation.
60 revs. per hour. 1 r.p.m. Clockwise.
Fraction of makers' price. All at 75p incl. P.&P.

MICRO SWITCH



5 amp c/o contacts. Fitted with removable push button assembly. Ex. P.O. 20 for £1 inc. post. (Min. order 20)

MINIATURE LEVEL METER

Approximately 300 micro amp basic, as fitted to Tape Recorders, etc. Strip type dual coloured dial. 50p + 8p P. & P.

ELECTRONIC ORGAN KIT

Easy to build. Solid State. Two full octave (less sharps and flats). Fitted hardwood case. Powered by two penlite 1½V batteries. Complete set of parts including speaker, etc., together with full instructions and 10 tunes. Price £3·00. P. & P. 22p.

50 in 1 ELECTRONIC PROJECT KIT

50 easy to build Projects. No soldering, no special tools required. The kit includes Speaker, Meter, Relay, Transformer, plus a host of other components and a 56-page instruction leaflet. Some examples of the 50 possible Projects are: Sound Level Meter, 2 Transistor Radio, Amplifier, etc. Price £7·75. P. & P. 30p.

CRYSTAL RADIO KIT

Complete set of parts, including: Crystal Diode, Ferrite Aerial, Drilled Chassis, and Personal Ear Piece. No soldering, easy to build, full step by step instruction. £1·75 inc. post.

230v AC SOLENOID

Extremely powerful with approx. 14lb pull, 1" travel. Fitted with mounting feet. Size: 4" long, 2⅞" wide, 3" high. £2·00 incl. P. & P.

VENNER Electric Time Switch

200/250V Ex. GPO. Tested. Manually set 2 on, 2 off every 24h. Override switch: 10A £2·75, 15A £3·25, 20A £3·75. P. & P. 20p. Also available with solar dial ON dusk, OFF dawn. Price as above.

VARIABLE VOLTAGE TRANSFORMERS

INPUT 230/140V a.c. 50/60 OUTPUT VARIABLE 0.260V
All Types (and Spares) from ½ to 50 amp from stock.

2·5 AMP

SHROUDED TYPE
1 amp, £7·00 2·5 amp, £8·05
5 amp, £11·75
10 amp, £22·50 20 amp. £49·00
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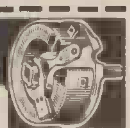

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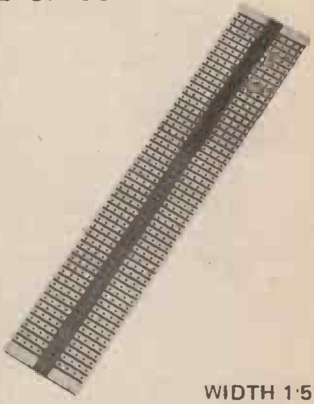

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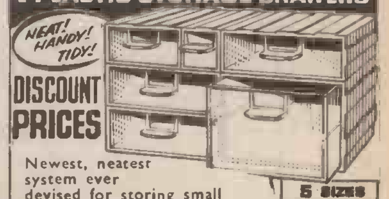

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50µA	£3·60	50V. D.C. ..	£3·10
50–0–50µA	£3·45	300V. D.C.	£3·10
100µA	£3·20	1 amp. D.C.	£3·10
100–0–100µA	£3·45	5 amp. D.C.	£3·10
500µA	£3·35	300V. A.C.	£3·10
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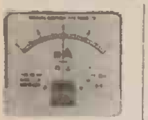
100µA	£2·75	1 amp. D.C.	£2·60
100–0–100µA	£3·10	5 amp. D.C.	£2·60
500µA	£3·00	300V. A.C.	£2·60
1mA	£2·60	VU Meter ..	£3·37
20V. D.C. ..	£2·60		

"SEW" CLEAR PLASTIC METERS

Type MR.85P. 4½in. × 4¾in. fronts.



		50mA	£2·80
		100mA	£2·80
		500mA	£2·80
		1 amp.	£2·80
		5 amp.	£2·80
		15 amp.	£2·80
		30 amp.	£2·90
		20V. D.C. ..	£2·80
		50V. D.C. ..	£2·80
50µA	£3·60	150V. D.C.	£2·80
50–0–50µA	£3·10	300V. D.C.	£2·80
100µA	£3·10	15V. A.C. ..	£2·80
100–0–100µA	£3·00	300V. A.C.	£2·80
200µA	£3·00	8 Meter 1mA	£2·87
500µA	£2·90	VU Meter ..	£3·60
500–0–500µA	£2·80	1 amp. A.C.*	£2·80
1mA	£2·80	5 amp. A.C.*	£2·80
1–0–1mA ..	£2·80	10 amp. A.C.*	£2·80
5mA	£2·80	20 amp. A.C.*	£2·80
10mA	£2·80	30 amp. A.C.*	£2·80

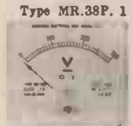
Type MR.52P. 2½in. square fronts.

50µA	£3·10	10V. D.C. ..	£2·00
50–0–50µA	£2·60	20V. D.C. ..	£2·00
100µA	£2·60	50V. D.C. ..	£2·00
100–0–100µA	£2·50	300V. D.C.	£2·00
500µA	£2·30	15V. A.C. ..	£2·10
1mA	£2·00	300V. A.C.	£2·10
5mA	£2·00	8 Meter 1mA	£2·10
10mA	£2·00	VU Meter ..	£3·20
50mA	£2·00	1 amp. A.C.*	£2·00
100mA	£2·00	5 amp. A.C.*	£2·00
500mA	£2·00	10 amp. A.C.*	£2·00
1 amp.	£2·00	20 amp. A.C.*	£2·00
5 amp.	£2·00	30 amp. A.C.*	£2·00

Type MR.65P. 3⅜in. × 3¼in. fronts.

50µA	£3·37	10V. D.C. ..	£2·20
50–0–50µA	£2·75	20V. D.C. ..	£2·20
100µA	£2·75	50V. D.C. ..	£2·20
100–0–100µA	£2·65	150V. D.C. ..	£2·20
200µA	£2·65	300V. D.C.	£2·20
500µA	£2·40	15V. A.C. ..	£2·30
500–0–500µA	£2·20	50V. A.C. ..	£2·30
1mA	£2·20	150V. A.C.	£2·30
5mA	£2·20	300V. A.C.	£2·30
10mA	£2·20	500V. A.C.	£2·30
50mA	£2·20	8 Meter 1mA	£2·37
100mA	£2·20	VU Meter ..	£3·37
500mA	£2·20	50mA A.C.*	£2·20
1 amp.	£2·20	100mA A.C.*	£2·20
5 amp.	£2·20	200mA A.C.*	£2·20
10 amp.	£2·20	500mA A.C.*	£2·20
15 amp. ..	£2·20	1 amp. A.C.*	£2·20
20 amp. ..	£2·20	5 amp. A.C.*	£2·20
30 amp. ..	£2·30	10 amp. A.C.*	£2·20
50 amp. ..	£2·50	20 amp. A.C.*	£2·20
5V. D.C. ..	£2·20	30 amp. A.C.*	£2·20

Type MR.38P. 1 21/32in. square fronts.



		200mA	£1·60
		300mA	£1·60
		500mA	£1·60
		750mA	£1·60
		1 amp.	£1·60
		2 amp.	£1·60
		5 amp.	£1·60
		10 amp. ..	£1·60
50µA	£2·10	3V. D.C. ..	£1·60
50–0–50µA	£1·90	10V. D.C. ..	£1·60
100µA	£1·90	15V. D.C. ..	£1·60
100–0–100µA	£1·75	20V. D.C. ..	£1·60
200µA	£1·75	100V. D.C.	£1·60
500µA	£1·65	150V. D.C.	£1·60
500–0–500µA	£1·60	300V. D.C.	£1·60
1mA	£1·60	500V. D.C.	£1·60
1–0–1mA ..	£1·60	750V. D.C.	£1·60
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5mA	£1·60	50V. A.C. ..	£1·70
10mA	£1·60	150V. A.C.	£1·70
20mA	£1·60	300V. A.C.	£1·70
50mA	£1·60	500V. A.C.	£1·70
100mA	£1·60	8 Meter 1mA	£1·70
150mA	£1·60	VU Meter ..	£2.10

Type MR.45P. 2in. square fronts.

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50–0–50µA	£2 10	10V. D.C. ..	£1·50
100µA	£2·10	20V. D.C. ..	£1·50
100–0–100µA	£1.87	50V. D.C. ..	£1·50
200µA	£1·87	300V. D.C.	£1·50
500µA	£1·75	15V. A.C. ..	£1·80
500–0–500µA	£1·70	300V. A.C.	£1·80
1mA	£1·70	8 Meter 1mA	£1·85
5mA	£1·70	VU Meter ..	£2·25
10mA	£1·70	1 amp. A.C.*	£1·70
50mA	£1·70	5 amp. A.C.*	£1·70
100mA	£1·70	10 amp. A.C.*	£1·70
500mA	£1·70	20 amp. A.C.*	£1·70
1 amp	£1·70	30 amp. A.C.*	£1·70

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Type MR.65. 3½in. square fronts.

		500mA	£1·90
		1 amp.	£1·90
		5 amp.	£1·90
		15 amp.	£1·90
		30 amp.	£1·90
		50 amp.	£1·90
		5V. D.C. ..	£1·90
		10V. D.C. ..	£1·90
		20V. D.C. ..	£1·90
		50V. D.C. ..	£1·90
		150V. D.C.	£1·90
		300V. D.C.	£1·90
25µA	£3·50	30V. A.C.*	£1·95
50µA	£2·75	50V. A.C.*	£1·95
50–0–50µA	£2·35	150V. A.C.*	£1·95
100µA	£2·35	300V. A.C.*	£1·95
100–0–100µA	£2·25	500mA A.C.*	£1·95
500µA	£2·20	1 amp. A.C.*	£1·95
1mA	£1·90	5 amp. A.C.*	£1·95
1–0–1mA ..	£1·90	10 amp. A.C.*	£1·95
5mA	£1·90	20 amp. A.C.*	£1·95
10mA	£1·90	30 amp. A.C.*	£1·95
50mA	£1·90	50 amp. A.C.*	£1·95
100mA	£1·90	VU Meter ..	£3·10

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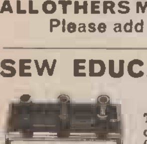

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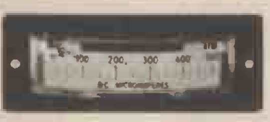
1mA	£4·40	300V d.c.	£4·40
50-0-50µA ...	£4·65		
1-0-1mA.....	£4·40	Dual range	
1A d.c.	£4·40	500mA/5A d.c.	£4·65
5A d.c.	£4·40	5V/50V d.c. ..	£4·65
10V d.c.	£4·40		



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100–0–100µA	£2·90	VU Meter ..	£3·40
200µA	£2·90		

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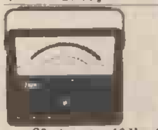

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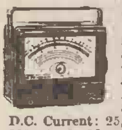

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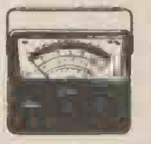

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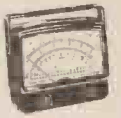
MODEL 500 30,000 O.P.V with overload protection mirror scale 0/·5/2·5/10/25 100/250/500/1,000v. D.C 0/2·5/10/25/100/250/500/1,000V. A.C. 0/50µA/5/50/500mA. 12 amp. D.C. 0/60/K/6 Meg./60 MegΩ. £8·87½. Post paid.



TMK LAB TESTER. 100,000 O.P.V. 6½in. Scale Buzzer Short Circuit Check. Sensitivity: 100,000 O.P.V. D.C. 5K /Volt A.C. D.C. Volts: ·5, 2·5, 10, 50, 250, 1,000 V. A.C. Volts: 3, 10, 50, 50, 250, 500, 1,000V. D.C. Current: 10, 100µA, 10, 100, 500mA, 2·5, 10 amp. Resistance: 1K, 10K, 100K, 10MEG, 100 MEGΩ. Decibels: −10 to +49 db. Plastic Case with Carrying Handle. Size 7½in. x 6½in. x 3½in. £18·90. P. & P. 25p.

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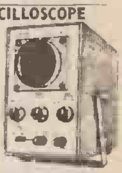

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2G309	30p	2N3566	22p	28303	60p	BC125	15p	BFX44	37p	NKT240	27p
2G371	15p	2N3568	25p	28304	75p	BC126	25p	BFX68	67p	NKT241	27p
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2N388A	49p	2N3572	97p	28503	27p	BC136	15p	BFX86	25p	NKT244	17p
2N404	20p	2N3605	27p	3N83	40p	BC137	15p	BFX87	25p	NKT245	20p
2N696	15p	2N3606	27p	3N128	70p	BC138	20p	BFX88	20p	NKT261	20p
2N697	15p	2N3607	22p	3N140	77p	BC140	35p	BFX89	62p	NKT262	20p
2N698	25p	2N3638	18p	3N141	72p	BC141	35p	BFX93A	70p	NKT264	20p
2N699	30p	2N3638A	20p	3N142	55p	BC147	10p	BFY11	42p	NKT271	20p
2N706	10p	2N3641	18p	3N143	67p	BC148	10p	BFY18	25p	NKT262	20p
2N706A	12p	2N3642	18p	3N152	87p	BC149	12p	BFY19	25p	NKT274	20p
2N708	12p	2N3643	20p	40050	55p	BC152	17p	BFY21	42p	NKT275	20p
2N709	45p	2N3644	25p	40250	50p	BC153	20p	BFY24	45p	NKT278	25p
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2N914	17p	2N3694	18p	40312	47p	BC160	35p	BFY50	20p	NKT404	55p
2N916	17p	2N3702	10p	40314	37p	BC167	11p	BFY51	20p	NKT405	75p
2N918	30p	2N3703	10p	40315	62p	BC168B	12p	BFY52	20p	NKT406	62p
2N929	22p	2N3704	12p	40316	47p	BC168C	15p	BFY53	15p	NKT451	62p
2N930	20p	2N3705	10p	40317	37p	BC169B	14p	BFY56A	57p	NKT452	62p
2N937	52p	2N3706	10p	40319	55p	BC169C	15p	BFY76	42p	NKT453	47p
2N1090	22p	2N3707	12p	40320	47p	BC170	12p	BFY77	57p	NKT713	20p
2N1091	22p	2N3708	10p	40323	32p	BC171	15p	BFY90	65p	NKT717	42p
2N1131	25p	2N3709	10p	40324	47p	BC172	15p	BSX19	17p	NKT734	27p
2N1132	25p	2N3710	10p	40326	37p	BC175	22p	BSX20	15p	NKT736	35p
2N1302	17p	2N3711	10p	40329	30p	BC177	20p	BSX21	20p	NKT773	25p
2N1303	17p	2N3713	187p	40344	27p	BC178	20p	BSX26	45p	NKT781	30p
2N1304	22p	2N3714	200p	40347	57p	BC179	20p	BSX27	47p	OC16	50p
2N1305	22p	2N3715	220p	40348	52p	BC182	12p	BSX28	32p	OC19	37p
2N1306	25p	2N3716	285p	40360	40p	BC182L	10p	BSX60	82p	OC20	85p
2N1307	25p	2N3773	240p	40361	40p	BC183	9p	BSX61	62p	OC22	50p
2N1308	25p	2N3791	275p	40362	50p	BC183L	9p	BSX76	15p	OC23	60p
2N1309	25p	2N3819	34p	40370	32p	BC184	11p	BSX77	20p	OC24	60p
2N1507	17p	2N3820	55p	40406	57p	BC184L	11p	BSX78	25p	OC25	40p
2N1613	20p	2N3823	50p	40407	40p	BC186	25p	BSY24	15p	OC26	25p
2N1631	35p	2N3854	27p	40408	52p	BC187	27p	BSY25	15p	OC28	60p
2N1632	30p	2N3854A	27p	40409	55p	BC212L	12p	BSY26	17p	OC29	60p
2N1637	30p	2N3855	27p	40410	62p	BC213L	12p	BSY27	15p	OC35	50p
2N1638	27p	2N3855A	30p	40412	50p	BC214L	15p	BSY28	17p	OC36	60p
2N1639	27p	2N3856	30p	40467A	57p	BCY10	27p	BSY29	17p	OC41	22p
2N1701	162p	2N3856A	35p	40468A	35p	BCY30	30p	BSY32	25p	OC42	40p
2N1711	24p	2N3858	25p	40528	72p	BCY31	40p	BSY36	25p	OC44	15p
2N1889	32p	2N3858A	30p	40600	57p	BCY32	60p	BSY37	25p	OC45	12p
2N1893	37p	2N3859	27p	40603	50p	BCY33	30p	BSY38	20p	OC46	15p
2N2147	72p	2N3859A	32p	AC107	30p	BCY34	35p	BSY39	22p	OC70	15p
2N2160	57p	2N3860	30p	AC126	20p	BCY38	45p	BSY43	50p	OC71	12p
2N2193	40p	2N3866	150p	AC127	24p	BCY39	60p	BSY51	32p	OC72	12p
2N2193A	42p	2N3877	40p	AC128	20p	BCY40	50p	BSY52	32p	OC73	30p
2N2194	27p	2N3877A	40p	AC151	18p	BCY41	15p	BSY53	37p	OC74	30p
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2N2217	25p	2N3900A	40p	AC154	22p	BCY43	15p	BSY56	90p	OC76	25p
2N2218	20p	2N3901	97p	AC176	22p	BCY54	32p	BSY79	45p	OC77	40p
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2N2222	20p	2N3906	25p	ACY18	24p	BCY70	15p	C450	15p	OC82	25p
2N2222A	25p	2N4058	12p	ACY19	22p	BCY71	20p	GET102	35p	OC82D	15p
2N2297	30p	2N4059	10p	ACY20	20p	BCY72	15p	GET113	25p	OC83	25p
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2N2369A	15p	2N4062	12p	ACY28	17p	BCZ10	27p	GET120	25p	OC140	40p
2N2410	42p	2N4244	47p	ACY39	47p	BCZ11	40p	GET873	12p	OC170	25p
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2N2539	22p	2N4250	18p	ACY44	25p	BD121	65p	GET889	22p	OC201	75p
2N2540	22p	2N4254	42p	AD140	47p	BD123	80p	GET890	22p	OC202	80p
2N2613	35p	2N4255	42p	AD149	47p	BD124	75p	GET896	22p	OC203	40p
2N2614	30p	2M4284	17p	AD150	62p	BD131	75p	GET897	22p	OC204	40p
2N2646	47p	2N4285	17p	AD161	35p	BD132	80p	GET898	22p	OC205	75p
2N2711	25p	2N4286	17p	AD162	35p	BDY10	125p	MAT100	20p	OC206	95p
2N2712	25p	2N4287	17p	AF109	45p	BDY20	105p	MAT101	25p	OC207	75p
2N2713	27p	2N4288	15p	AF114	25p	BDY61	125p	MAT120	25p	OCP71	42p
2N2714	30p	2N4289	15p	AF115	25p	BDY62	100p	MAT121	25p	ORP12	50p
2N2904	20p	2N4290	12p	AF116	25p	BF115	25p	MJ400	107p	ORP60	40p
2N2904A	25p	2N4291	15p	AF117	20p	BF117	47p	MJ420	80p	ORP61	42p
2N2905	25p	2N4292	15p	AF118	44p	BF152	28p	MJ421	80p	P346A	22p
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2N3135	25p	2N5305	37p	ASY28	24p	BF196	15p	NKT125	27p	ZTX108	12p
2N3136	25p	2N5306	40p	ASY29	27p	BF197	15p	NKT126	27p	ZTX109	15p
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2N3391	20p	2N5308	37p	ASY51	32p	BF200	35p	NKT135	27p	ZTX301	15p
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2N3392	17p	2N5310	42p	ASY67	45p	BF225	19p	NKT210	30p	ZTX303	20p
2N3393	15p	2N5354	27p	ASY86	32p	BF237	22p	NKT211	30p	ZTX304	25p
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2N3403	22p	2N5365	47p	BC107	10p	BFW61	47p	NKT214	20p	ZTX502	20p
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2N3414	22p	2N5457	30p	BC113	10p	BFW89	20p	NKT217	40p	ZTX531	25p

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FCJ121	275p
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FCJ141	525p
FCJ201	100p
FCJ211	275p
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FCL101	230p
FCY101	102p
FJH101	25p
FJH111	70p
FJH121	25p
FJH131	25p
FJH141	25p
FJH151	25p
FJH161	70p
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FJJ121	60p
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FJJ191	65p
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FJJ251	125p
FJL101	125p
FJY101	25p
IC10	250p
IC12	250p
L900	40p
L914	40p
L923	40p
MC724P	60p
MC780P	247p
MC788P	146p
MC790P	124p
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SN7450	20p
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SN74164	220p
SN74165	225p
SN74192	175p
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TAA242	425p
TAA243	150p
TAA263	75p
TAA293	97p
TAA300	175p
TAA310	125p
TAA320	72p
TAA350	175p
TAA435	147p
TAA521	132p
TAA522	360p
TAA530	495p
TAA811	445p
TAB101	97p
TAD100	150p
TAD110	150p
SL403D	150p
SL702C	147p
UA702A	280p
UA702C	77p
UA703C	137p
UA709C	125p
UA710C	125p
UA716	187p
UA723C	162p
UA730C	160p
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600 PIV 1A	50p	50 PIV 4A	60p
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100 PIV 2A	60p	200 PIV 4A	70p
200 PIV 2A	65p	400 PIV 4A	75p
400 PIV 2A	75p	50 PIV 6A	62p
		100 PIV 6A	75p
		200 PIV 6A	75p
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4003 200PIV	8p	10p	22p
4004 400PIV	8p	10p	25p
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50+ less 15% 100+ less 20%

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50+ less 15% 100+ less 20%

ZENER DIODES

400MW	1·5 WATT	10 WATT
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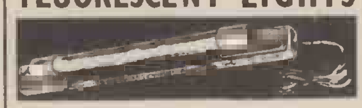

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