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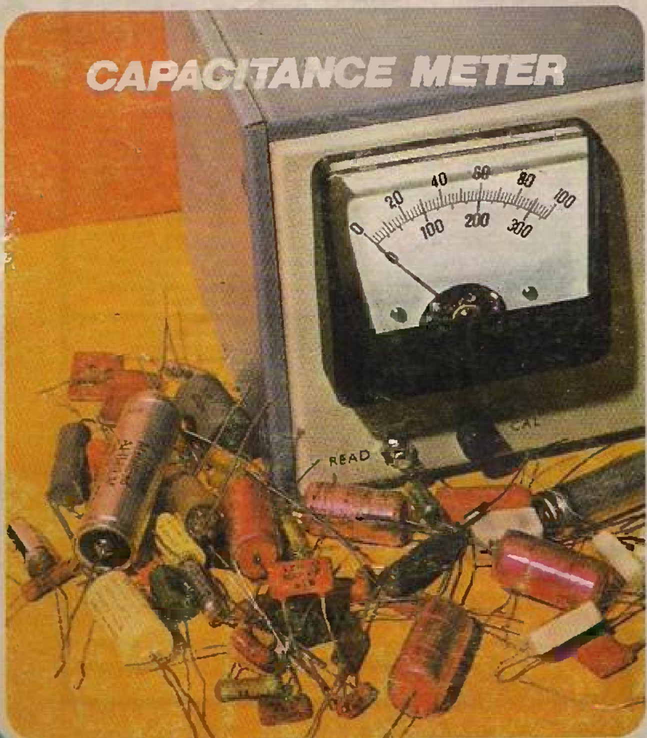
everyday electronics

SEPT. 72

15p

INFRA-RED BURGLAR ALARM

CAPACITANCE METER



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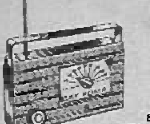

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Anyone from 9 years up can follow the step-by-step, easy as ABC fully illustrated instructions. No soldering necessary. 76 stations logged on rod aerial in 30 mins.—Russia, Africa, USA, Switzerland, etc. Experience thrills of world wide news, sport, music, etc. Eavesdrop on unusual broadcasts. Uses PP3 battery. Size only 3" x 4½" x 1½" Only £2·75 + 20p p. & p. Kit includes cabinet, screws, instructions, etc. (Parts available separately).

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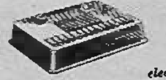
Amazing Radio Construction set! Become a radio expert for £2·45. A complete Home Radio Course. No experience needed. Parts including simple instructions for each design. Illustrated step-by-step plans, all transistors, loudspeaker, personal phone, knobs, screws, etc. all you need. Presentation box 45p extra as illus. (if required) (parts available separately) no soldering necessary. Send £2·45 + 20p p. & p.

ELECTRONIC ORGAN



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Don't confuse with ordinary electronic organs that simply blow air over mouth-organ type reeds etc. Fully transistorised. SELF CONTAINED LOUDSPEAKER. *Fifteen separate keys span two full octaves—play the "Yellow Rose of Texas", play "Silent Night", play "Auld Lang Syne" etc. etc.* You have the thrill and excitement of building it together with the pleasure of playing a real, live, portable electronic organ. NO PREVIOUS KNOWLEDGE OF ELECTRONICS NEEDED. No soldering necessary. Simple as ABC to make. *Anyone over nine years can build it easily in one short evening following the fully illustrated, step-by-step, simple instructions.* ONLY £3·25 + 25p p. & p. for kit, including case, nuts, screws, simple instructions, etc. Uses standard battery (parts available separately). Have all the pleasure of making it yourself, finish with an exciting gift for someone.

FIND BURIED TREASURE? Transistorised Treasure Locator

This fully portable transistorised metal locator detects and tracks down buried metal objects—it signals exact location with loud audible sound (no phones used)—uses any transistor radio which fits inside—no connections needed. FINDS GOLD, SILVER, COINS, JEWELLERY, ARCHAEOLOGICAL PIECES ETC. ETC. *Extremely sensitive, will signal presence of certain objects buried several feet below ground* No knowledge of radio or electronics required. *Can be built with ease in one short evening by anybody from nine years of age upwards,* with the clear, easy to follow, step-by-step, fully illustrated instructions—Uses standard PP3 battery. No soldering necessary. Kit includes nuts, screws, wire, etc. ONLY £2·85 + 25p p. & p. (Sectional handle as illustrated 95p extra). Parts available separately. Made up looks worth £15.

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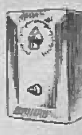
INGENIOUS ELECTRONIC SLEEP INDUCER

ONLY £3·25

CAN'T SLEEP AT NIGHTS? DO YOU WAKE UP IN THE NIGHT AND CAN'T GET OFF TO SLEEP AGAIN? WOULD YOU LIKE TO BE GENTLY SOOTHED OFF TO SATISFYING SLEEP EVERY NIGHT? Then build this ingenious electronic sleep inducer. *It even stops by itself so you don't have to worry about it being on all night!* The loudspeaker produces soothing audio-frequency sounds, continuously repeated—but as time goes on the sound gradually becomes less and less—until they eventually cease altogether. *the effect it has on people is amazingly very similar to hypnosis.* A control is provided for adjusting the length of times, etc., all transistor, can be built by anyone over 12 years of age in about two hours. No knowledge of electronics or radio needed. Extremely simple, easy-to-follow, step-by-step, fully illustrated instructions included. *No soldering necessary.* Works off standard batteries, extremely economical. Size only 3" x 4½" x 1½"—take it anywhere. Kit includes case, nuts, wire, screws, etc. SEND £3·25 + 25p p. & p. (parts available separately).

SOOTHE YOUR NERVES, RELAX WITH THIS AMAZING RELAXATRON

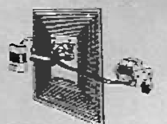


Only £2·75

CUTS OUT NOISE POLLUTION—SOOTHES YOUR NERVES! Don't underestimate the uses of this fantastic new design—the RELAXATRON is basically a pink noise generator. Besides being able to mask out extraneous unwanted sounds, it has other very interesting properties. For instance, many people find a rainstorm mysteriously relaxing, a large part of this feeling of well-being can be directly traced to the sound of falling raindrops!—a well known type of pink noise. IF YOU WORK IN NOISY OR DISTRACTING SURROUNDINGS, IF YOU HAVE TROUBLE CONCENTRATING, IF YOU FEEL TENSED, UNABLE TO RELAX—then build this fantastic Relaxatron. Once used you will never want to be without it—TAKE IT ANYWHERE. Uses standard PP3 batteries (current used so small that battery life is almost shelf-life). CAN BE EASILY BUILT BY ANYONE OVER 12 YEARS OF AGE using our unique, step-by-step, fully illustrated plans. No soldering necessary. All parts including case, a pair of crystal phones. Components, nuts, screws, wire, etc. no soldering. £2·75 + 25p p. & p. *Parts available separately.*

Find buried treasure with this READY BUILT & TESTED TREASURE LOCATOR MODULE

ONLY £4·95



FULLY TRANSISTORISED PRINTED CIRCUIT METAL DETECTOR MODULE. *Ready built and tested*—just plug in a PP3 battery and 'phones and it's working. Put it in a case, screw a handle on and YOU HAVE A PORTABLE TREASURE LOCATOR EASILY WORTH ABOUT £20! Extremely sensitive—penetrates through earth, sand, rock, water, etc.—EASILY LOCATES COINS, GOLD, SILVER, JEWELLERY, HISTORICAL RELICS, BURIED PIPES, ETC. Signals exact location by "beep" pitch increasing as you near buried metallic objects. *So sensitive it will detect certain objects buried* SEVERAL FEET BELOW GROUND! GIVES CLEAR SIGNAL ON ONE COIN £4·95 + 30p carr. etc. (High quality Danish Stethoscope headphones £2·75 extra if required.)

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Listen in to AIRLINES, PRIVATE PLANES, JETPLANES. *Eavesdrop on exciting cross talk between pilots, ground approach control, airport tower, Hear for yourself the disciplined voices hiding tenseness on talk downs.* Be with them when they have to take nerve ripping decisions in emergencies—Tune into the international distress frequency. Covers the aircraft frequency band including HEATHROW, GATWICK, LUTON, RINGWAY, PRESTWICK, ETC. ETC. CLEAR AS BELL. This fantastic fully transistorised instrument *can be built by anyone over nine in under two hours.* No soldering necessary. Fully illustrated simple instructions take you step-by-step. Uses standard PP3 battery. All you do is extend rod aerial, place close to any ordinary medium wave radio (even tiny portables). NO CONNECTIONS WHATEVER NEEDED. SEND ONLY £2·85 + 20p p. & p. for kit including case, nuts, screws, wire, etc. etc. (parts available separately).

CONCORD ELECTRONICS LTD. (EE9U) 12, Archer Street, London, W.1.

INSTRUMENTAL AUDIO EFFECTS

SUPER "FUZZ" UNIT KIT. CONNECTS BETWEEN GUITAR & AMPLIFIER. OPERATES FROM 9v BATTERY (not supplied). ALL COMPONENTS AND PRINTED CIRCUIT BOARD WITH FULL INSTRUCTIONS. KIT PRICE: £2·60 post paid.

CREATE "PHASE" EFFECT ON YOUR RECORDS, TAPES ETC., UNIQUE CIRCUITRY ENABLES YOU TO CREATE PHASE EFFECT AT THE TURN OF A KNOB. OPERATES FROM 9v BATTERY (not supplied) COMPLETE KIT OF COMPONENTS WITH PRINTED CIRCUIT BOARD & FULL INSTRUCTIONS. KIT PRICE: £2·60 post paid.

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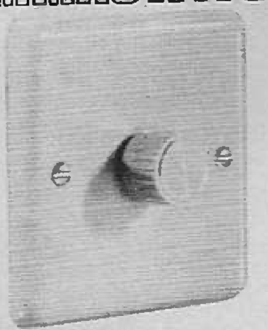
DABAR ELECTRONIC PRODUCTS

98a, LICHFIELD STREET, WALSALL, STAFFS. WS1 1UZ

Vary the strength of your lighting with a DIMMASWITCH



The DIMMASWITCH is an attractive and efficient dimmer unit which fits in place of the normal light switch and is connected up in exactly the same way. The white mounting plate of the DIMMASWITCH matches modern electric fittings. Two models are available, with the bright chrome knob controlling up to 300 w or 600 w of all lights except fluorescents at mains voltages from 200-250 v, 50Hz. The DIMMASWITCH has built-in radio interference suppression:

600 Watt £3·20. Kit Form £2·70
300 Watt - £2·70. Kit Form £2·20

All plus 10p post and packing.
Please send C.W.O. to:

DEXTER & COMPANY

5 ULVER HOUSE, 19, KING STREET, CHESTER CH1 2AH Tel: 0244-25883.

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Guaranteed working from £125.
(Also some not working)

*4 Channel 19in UHF T.V.'s Despatched tested, and in full working order. £20.
*19in Slimline, only requires UHF tuner for BBC2, untested, complete, £8.
*As above but with UHF tuner. £12.
*2 Channel 19in 110° tube, untested. £5
(Carriage £1·50 extra all models).

GY-NORMOUS RADIO BARGAINS!

*2 types, superhets, with push-pull output to internal loudspeaker. Supplied complete with earphone and batteries.
Type A—Very neat little set, still only £1·50 + p. & p. 20p. Including carrying case, instruction sheet, etc.
Type C—Large portable radio as sold nationally. A.M. and F.M. coverage (Yes F.M.—88–108 MHz). Horizontal pointer tuning scale. Operates from own dry batteries or a.c. mains from internal transformer isolated power pack, with provision for rechargeable cells (not supplied). £8 + p. & p. 50p.
All these sets are BRAND NEW and complete in manufacturers original cartons, but may require slight attention—hence bargain prices—cheaper than kits!
CASSETTE RECORD/PLAYER. Leatherette case, complete with cassette, mic. & stand, batteries etc. £12·80 + p. & p. 55p.
*C120 Cassettes. Top quality. 75p + p. & p. 7½p.

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Catalogue which contains data sheets for most of the components listed will be sent free on request. 10p stamp appreciated.

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RESISTORS

½W Iskra high stability carbon film—very low noise—capless construction. ⅓W Mullard CR25 carbon film—very small body size 7·5 x 2·5mm. ½W 2% Electrosil TR5.

Power watts	Tolerance	Range	Values available	Price 1–99	Price 100+
½	5%	4·7Ω–2·2MΩ	E24	1·0p	0·8p
½	10%	3·3MΩ–10MΩ	E12	1·0p	0·8p
½	2%	10Ω–1M	E24	3·5p	3·0p
⅓	10%	1Ω–3·9Ω	E12	1·0p	0·8p
⅓	5%	4·7Ω–1MΩ	E12	1·0p	0·8p
4	10%	1Ω–10Ω	E12	6p	5·5p

Quantity price applies for any selection. Ignore fractions on total order.

DEVELOPMENT PACK

0·5 watt 5% Iskra resistors 5 off each value 4·7Ω to 1MΩ.
E12 pack 325 resistors £2·40. E24 pack 650 resistors £4·70.

POTENTIOMETERS

Carbon track 5kΩ to 2MΩ, log or linear (log ½W, lin ¼W).
Single, 12p. Dual gang (stereo), 40p. Single D.P. switch 24p.

SKELETON PRESET POTENTIOMETERS

Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C. mounting (0·1 matrix).
Sub-miniature 0·1W, 5p each. Miniature 0·25W, 6p each.

TRANSISTORS

AC107	15p	BC107	10p	BF195	15p	OC81	12p	2N3703	12p
AC126	12p	BC108	10p	BFY50	22p	OC82D	12p	2N3704	13p
AC127	12p	BC109	10p	BFY51	22p	OCP71	40p	2N3705	12p
AC128	12p	BC147	10p	BFY52	22p	ORP12	50p	2N3706	11p
AC131	12p	BC148	13p	BSY56	32p	2N2369	16p	2N3707	12p
AC132	12p	BC149	13p	OC26	45p	2N2646	60p	2N3708	10p
AD140	50p	BC157	13p	OC28	45p	2N2926R	9p	2N3709	11p
AD161	33p	BC158	13p	OC35	45p	2N2926O	9p	2N3710	11p
AD162	36p	BC159	13p	OC42	12p	2N2926Y	9p	2N3711	11p
AF114	20p	BD131	75p	OC44	12p	2N2926G	10p	2N4062	12p
AF115	20p	BD132	75p	OC45	12p	2N3054	58p	ZTX302	15p
AF116	20p	BF179	32p	OC70	12p	2N3055	60p	ZTX500	16p
AF117	20p	BF181	25p	OC71	12p	2N3442	140p	ZTX503	16p
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ZENER DIODES

400mW 5% 3·3V to 30V, 15p.

LINEAR IC's (DIL)

709	50p	741	50p
710	50p	748	50p

DIL SOCKET

14 and 16 pin 16p

DIODES

RECTIFIER

BY127	1250V	1A	12p
BZY10	800V	6A	25p
BZY13	200V	6A	20p
IN4001	50V	1A	7p
IN4004	400V	1A	8p
IN4007	1000V	1A	12p

SIGNAL

OA85	7p
OA90	5p
OA91	5p
OA202	7p
IN4148	5p
BA114	8p

BRUSHED ALUMINIUM PANELS

12in x 6in=25p; 12in x 2½in=10p; 9in x 2in=7p.

SLIDER POTENTIOMETERS

86mm x 9mm x 16mm, length of track 59mm.
SINGLE 10K, 25K, 100K log. or lin. 40p.
DUAL GANG, 10K + 10K etc. log. or lin. 60p.
KNOB FOR ABOVE 12p.
FRONT PANEL 65p
18 Gauge panel 12" x 4" with slots cut for use with slider pots. Grey or matt black finish complete with fixings for 4 pots.

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MYLAR FILM CAPACITORS 100V.

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2½ x 3¾	22p	17p
2½ x 5	24p	21p
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3¾ x 5	28p	28p
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17 x 3¾	100p	78p
17 x 5 (plain)	—	82p
17 x 3¾ (plain)	—	60p
17 x 2½ (plain)	—	42p
2½ x 5 (plain)	—	12p
2½ x 3¾ (plain)	—	11p
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Stereo socket	18p	3·5mm socket	8p

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2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin
Plug 12p. Socket 8p.
4 way screened cable 15p/metre
6 way screened cable 22p/metre

BATTERY ELIMINATOR — £1·50

9V mains power supply. Same size as PP9 battery.

THERMISTORS

VA1055S 15p VA1066S 15p VA1077 15p R53 £1·35

COMPACT CASSETTES—IN PLASTIC LIBRARY BOX

C90 65p C120 85p

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1600μF	64V	74p	3200μF	16V	50p
2500μF	40V	74p	4500μF	16V	50p
2500μF	50V	58p	4500μF	25V	£1·68
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2800μF	100V	£3·00			

HIGH VOLTAGE TUBULAR CAPACITORS—1,000 VOLT

0·01μF	10p	0·047μF	13p	0·22μF	20p
0·022μF	12p	0·1μF	16p	0·47μF	22p

POLYSTYRENE CAPACITORS 160V 2½%

10pF to 1,000pF E12 Series values 4p each.

Peerless HIGH FIDELITY LOUDSPEAKERS

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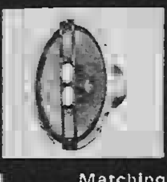
Chassis Units (Dual Cone, Coaxial, Woofers, Tweeters, etc.) plus Multi-unit systems in Kit Form from Scandinavia's largest manufacturer.



Matching Cabinet Kits also available.

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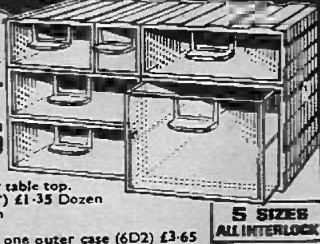
I-N-T-E-R-L-O-C-K-I-N-G PLASTIC STORAGE DRAWERS

Newest, neatest system ever devised for storing small parts and components: resistors, capacitors, diodes, transistors, etc. Rigid plastic units, interlock together in vertical and horizontal combinations. Transparent plastic drawers have label slots / removable space dividers. Build up any size cabinet for wall, bench or table top.

NEAT! HANDY! TIDY!

DISCOUNT PRICES



5 SIZES ALL INTERLOCK

SINGLE UNITS (5"x2¼"x2¼") £1·35 Dozen
DOUBLE UNITS £2·25 Dozen
TREBLE (3D) £2·35 for 8
DOUBLE TREBLE 2 draws in one outer case (6D2) £3·65 for 8 extra large size (6D1) £3·30 for 8.

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BRAND NEW SPACE AGE model —SO FAR AHEAD OF ITS TIME IT WILL STILL BE MAKING MANY LOOK OUT OF DATE IN 1984!

THE FABULOUS ASTRAD 17 PORTABLE RADIO & COMMUNICATIONS RECEIVER

This OFFER ONLY FROM US

WORLD WIDE RECEPTION THOUSANDS OF RADIO TRANSMISSIONS & STATIONS POUR IN FROM THE FOUR CORNERS OF THE EARTH!

28 TRANSISTORS AND DIODES!

WAVEBANDS:

STANDARD LONG and MEDIUM
Plus 5 SHORT WAVEBANDS
Plus ULTRA SHORT WAVES
(V.H.F. AM. FM. MW. LW. USW.)

*COMPARE ITS PERFORMANCE with £80 RADIOS!

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Think of 1984 and what might be produced then—now get the ASTRAD 17 and SEE that the Russians have done it all NOW! This one supersedes all earlier Models! It will probably make your present radio seem like a 'crystal set'! Complete with optional battery eliminator for both battery and mains use! We're almost giving them away at only £20·75—a fraction of today's Russian price! Compare performance with £80 radios! *Refund if not astounded. Black and chrome finish facia, set in Cabinet built case—constructed of fine Russian hardwood in beautiful Teak Veneer finish—prevents vibration, ensures sweeter tone than ever! Volume controlled from a whisper to a roar. Wider band spread, for "pin-point" station selection! Plus "MAGIC EYE" tuning level indicator for ultra perfect tuning sensitivity! Yes, the Russians have surpassed themselves, proving again their fantastic ability in spaceship and satellite communications. Yes, EVERY WAVEBAND instantly at your fingertips including Standard Long, Medium, Short and Ultra Short Waves to cover the four corners of the Earth, including all normal transmissions, VHF, AM, FM, MW, LW, USW, plus local and new stations not yet operational, and messages from all over the world! Expensive TURRET TUNER side control waveband selection unit (as used on expensive TVs!) Every waveband clicks into position, incredible ease of tuning! Genuine push-pull output! ON/OFF volume and separate Treble and Bass tone controls for utter perfection of tone! Press-button illumination! Take it anywhere—runs on batteries on through battery eliminator from 220/240v. AC mains supply. Internal ferrite rod plus built-in "rotatable" telescopic aerial extending to 39ins. approx. It's also a fabulous CAR RADIO. Can be used through extension amplifier, tape recorder or public address. SIZE $14 \times 10\frac{3}{4} \times 4\frac{1}{4}$ins. approx. Made to give years of perfect service. U.K. facilities and spares available for years to come! With WRITTEN G'TEE, manual with instructions and circuit diagram. ONLY £20·75 (with mains/battery eliminator £1·48 extra). BOX, POST, ETC., 50p. *BUT WAIT, for only 55p extra you get the "COMPUTERISED" WORLD TUNING GUIDE. (It enables you to time, pinpoint and get transmissions the whole world over—it even lets you know when to tune into the U.K. when abroad). PLUS "longlife" batteries. PLUS earphone for personal listening. (Sorry—We cannot change these new radios for any earlier model purchased). SHOPERTUNITIES FOR BARGAINS! Send today or call

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Combined

V.H.F AM/FM RADIO and CASSETTE TAPE RECORDER & PLAYER

RECOMMENDED RETAIL PRICE £44

OUR PRICE £23·75 CARR ETC. 35p

Latest sensation in the world of sound! Fabulous VHF, AM/FM Radio AND Cassette Tape Recorder & Player combined & it runs off batteries or mains. (Plug in the 220/240v. AC line cord). Record and play back anything, anywhere! Even tape direct from the Radio as you listen! RECOMMENDED RETAIL PRICE GENUINELY £44! WE OFFER AT ALMOST HALF PRICE! Wonderful features: ★ Press-button Keyboard Control Panel or latest MASTER SWITCH CONTROL! ★ "MAGIC EYE" Visual Battery check/recording level indicator or built-in automatic Leveller! ★ Separate ON/OFF and HI-LO volume controls! ★ Heavy duty built-in speaker! ★ Earphone (for personal listening or "monitoring") and extension speaker sockets! ★ Remote control microphone! ★ Built-in swivel telescopic extension aerial (24in approx.)! Magnificently made case with carry handle. (DESIGNS VARY SLIGHTLY.) Takes standard 30, 60, 90 or 120-minute Cassette Tapes obtainable everywhere). The built-in full circuit VHF, AM/FM Radio gives superb clarity of tone, incredible station selection. Rotating Selector Dial—get all local and regional stations in every part of the country plus B.B.C. National, VHF. Picks up dozens of foreign stations. Fabulous in car! You could pay more for a Car Radio or Car Cassette player ALONE! £23·75. CARR. ETC. 35p. With instructions, remote control microphone with on/off switch and stand. WRITTEN G'TEE. BONUS: Batteries and Cassette tape 25p.

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Iskra Miniature High Stability carbon Film Resistors with negligible noise factor.
All Resistors ± 5% (except values over 4·7 Meg). These Resistors are even lower in price than most 10% and older carbon composition types.

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POLYCARBONATE AND POLYESTER			ELECTROLYTIC		
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100v	0·47 μF	10p	25v	100 μF	9p
100v	0·68 μF	15p	25v	220 μF	11p
250v	0·01 μF	5p	25v	470 μF	14p
250v	0·015 μF	5p	25v	1000 μF	22p
250v	0·022 μF	5p	25v	2200 μF	42p
250v	0·033 μF	6p	35v	4·7 μF	7p
250v	0·047 μF	6p	35v	220 μF	14p
250v	0·068 μF	6p	100v	10 μF	8p
250v	0·1 μF	6p	100v	22 μF	9p
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FREE with all orders value £5 or over we will give absolutely free one GSPK P.C. Kit for making your own printed circuits (normal retail price £1·95). Hurry! Offer valid for limited period only.

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BC148	8p	7p	NKT224	21p	19p	2N1304	21p	20p
BC149	8p	7p	NKT242	14p	12p	2N1613	14p	13p
BCY70	14p	13p	NKT243	51p	44p	2N1711	15p	14p
BCY71	20p	19p	NKT401	70p	56p	2N2904	29p	28p
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BDY20	91p	73p	NKT403	64p	50p	2N2906	19p	18p
BFX29	24p	23p	NKT453	41p	33p	2N2907	22p	21p
BFX30	24p	23p	OA47	6p	5p	2N3053	17p	16p
BFY50	19p	18p	OA79	6p	5p	2N3054	49p	47p
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Copper laminate and all materials available to make your own printed circuit boards.
Lamps and lampholders for every requirement. Ready Built Circuits and Modules.
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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 × 11¼in. Above motor board 3¼in. below motor board 2½in. with STEREO and MONO XTAL **£8·75** Post 25p.
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Plays all records

RCS DE-LUXE 3 WATT AMPLIFIER. Ready made tested. Printed circuit. Pentode valve EL84. 3 watts output Tone and volume controls. Metal rectifier. Complete with two knobs, output transformer and high performance loudspeaker. Response 50-12,000 cps. Sensitivity 300mV **£4** Post 25p.

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Really smart appearance with space for R.C.S. Amplifiers and most modern autochangers. Size 18 × 15 × 8in. Metal fittings. Carrying handle. Popular Colours. Two-tone rexine covered. **£4** Post 25p.

GARRARD DISCO DECK TA Mk II

4 speeds. Plays all sizes of records. 4 pole heavy duty motor. 9in. steel turntable. Plug in head complete with stereo/mono cartridge. Adjustable stylus pressure. Auto-stop. Brown and Cream finish. AC mains 110/240v. Base plate size 12in. × 8in. Operating area 14in. × 12½in. Above motor board 3in., below motor board 2½in. Ideal for Home Hi-Fi or Discotheque. **£10** Post free.

GARRARD AUTOCHANGERS with Sonotone Cartridges Stereo Diamond and Mono Sapphire. Model 1025 £10. Model 3500 Stereo and Mono Autochanger £14. Post 25p.

BSR JUNIOR SINGLE PLAYER **£4·50**
Turntable, 4-speed motor and separate pick-up

HI-FI PICK-UP CARTRIDGES. Diamond LP/Stereo Stereo/Mono 9TA £2·50; GP94 £2·50; GP93 £2·00; Sapphire Mono GP91 £1·50; Power-point LP/78 60p.

E.M.I. WOOFER AND TWEETER KIT

£5·75 Post 25p

Comprising a fine example of a Woofer 10¾ × 6½in. with a massive Ceramic Magnet, 44oz, Gauss 13,000 lines. Aluminium Cone centre to improve middle and top response. Also the E.M.I. Tweeter 3½in. square has a special light-weight paper cone and magnet flux 10,000 lines. Crossover condenser included.

Impedance Standard	8 ohms
Maximum Power	12 watts
Useful Response	35 to 18,000 cps
Base Resonance	45 cps

SUITABLE ENCLOSURE 20 x 13 x 9in, £9 POST 25p
MODERN TEAK DESIGN

WEYRAD P50—TRANSISTOR COILS

RA2W Ferrite Aerial	72p	Spare Cores	3p
Osc. P50/1AC	33p	Driver Trans. LFDT4	58p
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P51/1 or P51/2	36p	Weyrad Booklet	10p
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Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 15p. D.P. 25p. STEREO L/S 55p. D.P. 75p. Edge 5K. S.P. Transistor 25p

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BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd. £1·40; 60 yd. £2
FRINGE LOW LOSS Ideal 625 and colour. **10p** yd

8in ELAC HI-FI SPEAKERS

Dual cone plasticised roll surround. Large ceramic magnet. 50-16,000 cps. Bass resonance 55 cps. 8 ohm impedance. 10 watts music power. **£4·80**

BLANK ALUMINIUM CHASSIS 18 s.w.g. 2in. sides. 7 × 4in. 45p; 9 × 7in. 60p; 11 × 7in. 70p; 13 × 9in. 90p; 14 × 11in. 85p; 15 × 14in. 99p; 11 × 8in. 50p; 16 × 10in. £1.
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1¼ inch DIAMETER WAVE-CHANGE SWITCHES 25p. 2 p. 2-way. or 2 p. 6-way or 3 p. 4-way 25p each. 1 p. 12-way. or 4 p. 2-way. or 4 p. 3-way 25p.
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"THE INSTANT" BULK TAPE ERASER & HEAD DEMAGNETISER

200/250v. A.C. Leaflet S.A.E. **£2·35** Post 15p

R.C.S. STABILISED POWER PACK KITS

All parts and instructions with Zener Diode. Printed Circuit, Bridge Rectifiers and Double Wound Mains Transformer input 200/240v. AC. Output voltages available 6 or 9 or 12 or 15 or 18 or 20v. DC at 100mA or less.
PLEASE STATE VOLTAGE REQUIRED. **£2** POST FREE
Details S.A.E. Size 3½ × 1½ × 1¼in.

GENERAL PURPOSE TRANSISTOR PRE-AMPLIFIER BRITISH MADE

Ideal for Mike, Tape, P.U., Guitar. Can be used with Battery 9-12v. or H.T. line 200-300v. D.C. operation. Size 1¾" × 1¼" × ½". Response 25 c.p.s. to 25 Kc/s. 26db gain. For use with valve or transistor equipment. Full instructions supplied. Details S.A.E. **90p** Post 10p

NEW TUBULAR ELECTROLYTICS				CAN TYPES	
2/350V	14p	250/25V	14p	50+50/350V	35p
4/350V	14p	500/25V	20p	60+100/350V	58p
8/450V	14p	100/25V	35p	32+32/250V	18p
16/450V	15p	100/50V	47p	32+32/450V	33p
32/450V	20p	8+8/450V	18p	350+50/325V	50p
25/25V	10p	8+16/450V	20p	32+32+32/350V	48p
50/50V	10p	16+16/450V	25p	100+50+50/350V	48p
100/25V	10p	32+32/350V	25p		

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500mF. 12V. 15p; 25V. 20p; 50V. 30p.
1000mF. 12V. 17p; 25V. 35p; 50V. 47p; 100V. 70p.
2000mF. 6V. 25p; 25V. 42p; 50V. 57p.
2500mF. 50V. 62p; 3000mF. 25V. 47p; 50V. 65p.
5000mF. 6V. 25p; 12V. 42p; 25V. 75p; 35V. 85p; 50V. 95p

CERAMIC 1pF to 0·01mF, 4p. Silver Mica 2 to 5000pF. 4p.
PAPER 350V-0·1 4p. 0·5 12p; 1mF 15p; 2mF 150V 15p.
500V-0·001 to 0·05 4p; 0·1 5p; 0·25 8p; 0·47 25p.
SILVER MICA. Close tolerance 1% 2·2-500pF 8p; 500-2·200 pF 10p; 2,700-5,600pF 20p; 6,800pF-0·01, mfd 30p; each.
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NEON PANEL INDICATORS 250V AC/DC Red or Amber 20p.
RESISTORS, ¼ w., ½ w., 20% 1p; 2 w. 5p 10 ohms to 10 meg
HIGH STABILITY. ½ w. 2%, 10 ohms to 1 meg., 10p.
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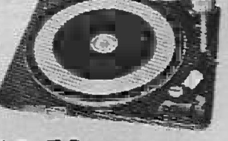
DECCA DECCADEC GARRARD MOTOR UNIT MKII



Single play Stereo Mono Deram transcription head and arm Four speeds. 10½in. turntable. Anti-rumble filter Bias compensation. Laboratory motor.

SPECIAL PRICE **£18·50** Post 25p

METAL PLINTH & PLASTIC COVER

Cut out for most Garrard or B.S.R. Will play with cover in position. Latest design. Covered in black leatherette. Antimagnetic. 12½ × 14¾ × 7½in. **£5·50** POST 25p

ALSO AVAILABLE IN SOLID NATURAL MAHOGANY WAX POLISHED FINISH AT SAME PRICE

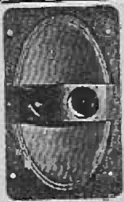
MAINS TRANSFORMERS

ALL POST 25p each

250-0-250 80 mA. 6·3v. 4 amp	£1·50
250-0-250 80 mA. 6·3v. 3·5a. 6·3v. 1a or 5v. 2a.	£2·50
350-0-350 80 mA. 6·3v. 3·5a. 6·3v. 1a. or 5v. 2a.	£3·00
300-0-300v. 120mA., 6·3v. 4a. C.T.; 6·3v. 2a	£3·25
MINIATURE 200v. 200mA., 6·3v. 1a. 2½ × 2½ × 2in.	75p
MIDGET 220v. 45 mA., 6·3v. 2a. 2½ × 2½ × 2in.	90p
MINI-MAINS 20v. 100mA. 1½ × 1½ × 1½in.	50p
HEATER TRANS. 6·3v. 3 a.	80p
Ditto tapped sec. 1·4 v., 2, 3, 4, 5, 6·3 v. 1½ amp	80p

GENERAL PURPOSE LOW VOLTAGE. Tapped Outputs at 2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. £2·25
1 amp., 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60. £2·25
2 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60. £3·25
5 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60. £8·75
AUTO TRANSFORMERS 115v. to 230v. or 230v. to 115v. 150w. £2·25; 500w. £6·25; 750w. £10; 100w. £14.
CHARGER TRANSFORMERS. Input 200/250v. for 6 or 12v., 1½ amp., £1·50; 2 amp £1·80; 4 amp. £2·50.
FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12v. outputs, 1½ amp. 40p; 2 amp. 55p; 4 amp. 85p
LUCAS 2DS500 Bridge 70V 5 amp £1.

E.M.I. 13½ × 8in. LOUDSPEAKERS



With twin tweeters and crossover, 10 watt State 3 or 8 or 15 ohm. (As illustrated) **£4·25** Post 15p

With flared tweeter cone and ceramic magnet, 10 watts. Bass res. 45-60 cps. Flux 10,000 gauss. State 3 or 8 or 15 ohm. **£2·75** Post 15p

£5 Teak Cabinet Size 16 × 10 × 9in. Post 25p

ALL MODELS "BAKER SPEAKERS" IN STOCK
Hi-Fi Enclosure Manual containing 20 plans, crossover data and cubic tables. 42p Post Free.

BAKER 12in. MAJOR £9

30-14,500 c.p.s., 12in. double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c.p.s. Rated 20 watts. Voice coils 3 or 8 or 15 ohms. Post Free

Module kit, 30-17,000 c.p.s. with tweeter, crossover, baffle and instructions. **£11·50**

BAKER "BIG—SOUND" SPEAKERS

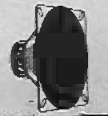
'Group 25'	'Group 35'	'Group 50'
12 inch 25 watt 3 or 8 or 15 ohm **£7**	12 inch 35 watt 3 or 8 or 15 ohm **£9**	15 inch 50 watt 8 or 15 ohm **£19**

TEAK HI-FI SPEAKER CABINETS. Fluted wood front
For 12in. or 10in. dia. speaker 20 × 13 × 9in. £9. Post 25p
For 13 × 8in. or 8in. speaker 16 × 10 × 9in. £5. Post 25p
For 10 × 6in. or 6in. speaker 16 × 8 × 6in. £4. Post 25p
LOUDSPEAKER CABINET WADDING 18in. wide, 15p ft

GOODMANS 6½ in. HI-FI WOOFER

8 ohm, 10 watt. Large ceramic magnet. Special Cambric cone surround. Frequency response 30-12,000 cps. Ideal P.A. Columns. Hi-Fi Enclosures Systems, etc. **£4**

ELAC CONE TWEETER



The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 cps to 18,000 cps. Size 3½ × 3½ × 2in. deep. Rating 10 watts. 3 ohm or 15 ohm models. **£1·90** Post 10p

SPEAKER COVERING MATERIALS. Samples Large S.A.E.
Horn Tweeters 2-16kc/s, 10W 8 ohm or 15 ohm £1·50.
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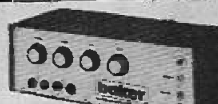
TWO-WAY 3000cps CROSSOVERS 3 or 8 or 15 ohm 95p.
SPECIAL OFFER! 80 ohm 2½in.; 2½in.; 35 ohm, 2in.; 3in. 25 ohm, 2½in. dia.; 3in. dia.; 6 × 4in.; 8 × 5in. 15 ohm. 3½in. dia.; 6 × 4in.; 7 × 4in.; 3 ohm. 2½in. 3in. 5 × 3in. **£1** EACH TYPE
LOUDSPEAKERS P.M. 3 OHMS. 7 × 4in. £1·25; 6½in. £1·50; 8 × 5in. £1·60; 8 × 2½in. 90p 8 in. £1·75; 10 × 6in. £1 90.
RICHARD ALLAN TWIN CONE LOUDSPEAKERS. 8in. dia. 4 watt; 10in. dia. 5 watt; 12in. dia. 6 watt 3 or 8 or 15 ohm models £2·00 each. Post 15p.
VALVE OUTPUT TRANS. 25p; MIKE TRANS. 50:1 25p.
5 WATT MULTI-RATIO, 3, 8 and 15 ohms 80p.

BAKER 100 WATT ALL PURPOSE TRANSISTOR AMPLIFIER



4 Inputs speech and music. Mixing facilities. Response 10-30,000 cps. Matches all loudspeakers. A.C. 200/250V. Separate Treble and Bass Controls. Guaranteed. Details S.A.E. **£39** Post Free

BARGAIN AM TUNER. Medium Wave. Transistor Superhet. Ferrite aerial. 9 volt. **£4·50**

BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt. STEREO VERSION OF ABOVE £4·50 **£3·50**

BARGAIN FM TUNER 88-108 Mc/s Six Transistor. 9 volt Printed Circuit. Calibrated slide dial tuning. Walnut Cabinet. Size 7 × 5 × 4inch **£12·50**
BARGAIN FM TUNER as above less cabinet **£8·85**

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built, with volume control. 9v. **£3·50**

COAXIAL PLUG 6p. PANEL SOCKETS 6p. LINE 18p
OUTLET BOXES, SURFACE OR FLUSH 25p.
BALANCED TWIN FEEDERS 5p yd. 80 ohms or 300 ohms.
JACK SOCKET Std. open-circuit 14p, closed circuit 23p; Chrome Lead Socket 40p. Phono Plugs 5p. Phono Socket 5p. JACK PLUGS Std. Chrome 15p; 3·5mm Chrome 14p. DIN SOCKETS Chassis 3-pin 10p; 5-pin 10p. DIN SOCKETS Lead 3-pin 18p; 5-pin 25p. DIN PLUGS 3-pin 18p; 5-pin 25p.
VALVE HOLDERS, 5p; CERAMIC 8p; CANS 5p.

E.M.I. TAPE MOTORS Post 15p.
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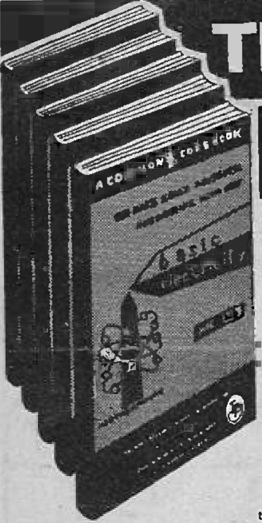

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1	25	2½p	500	10	5p
1	50	3p	500	12	8p
2	10	2½p	500	25	10p
2	15	2½p	640	10	8p
2.5	50	3p	1000	3	6p
4	10	3p	1000	6	8p
6.4	50	3p	1000	12	10p
8	25	3p	1000	25	15p
10	6	3p	1000	50	35p
10	15	3p	2000	12	10p
10	25	3p	2000	25	15p
10	40	4p	2500	12	10p
10	50	4p	2500	25	30p
16	15	3p			
16	25	3p			
20	25	3p			
25	15	3p			
25	25	3p			
25	50	4p			
32	50	4p			
40	6	3p			
50	10	3p			
50	50	7p			
64	10	4p			
64	15	4p			
64	25	4p			
64	40	5p			
100	6	3p			
100	25	4p			
100	50	8p			
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250	6	4p			
250	10	4p			
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OC36	43p
μL914	30p
7400/01/10/30	15p
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5	750	2p
10	750	2p
20	750	2p
25	750	2p
40	750	2p
60	750	2p
75	750	2p
100	750	2p
120	750	2p
220	750	2p

pF	V	
1000	50	2½p
4700	30	2p
0.01	30	3p
0.01	350	2p
0.022	30	2p
0.047	30	2p
0.1	25	3p

Polyester

mF	V	
0.001	400	2p
0.01	200	3p
0.068	160	3p
0.12	150	3p
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PROJECTS
THEORY...

SURREPTITIOUS SURVEILLANCE

The term "unlawful surreptitious surveillance" describes, most succinctly, the repugnant anti-social practice of snooping or eavesdropping upon private conversations with the aid of technical devices. This subject has received widespread attention recently following the publication of the report by the Committee On Privacy.

There is, however, another quite different form of "surreptitious surveillance" that one can perform quite legitimately and without giving offence to any innocent party. This is in order to protect one's property or premises from uninvited "visitors".

BURGLAR ALARM

It is a regrettable fact that intruder surveillance systems are becoming increasingly necessary items of equipment for the ordinary home, just as for business premises.

There are of course many kinds of electronic burglar alarms in existence and they utilise various electronic properties in order to detect the presence of an intruder. Choice of a system is not always easy, and the environment in which it is required to function can play a large part in determining the effectiveness of a given system.

This month's burglar alarm design provides an inexpensive yet effective form of protection against the marauder. It exploits the sensitiveness of certain semiconductor devices to quite weak beams of invisible light (infra-red radiation) and has a range adequate for many purposes. Another practical application of simple electronics to meet a real and serious everyday need.

EVENING CLASSES

Further proof of the spreading interest in d.i.y. electronics comes from the increasing number of non-vocational courses dealing with this subject, conducted up and down the country by local educational authorities. Many of these courses combine instruction in basic theory with practical demonstration, and also offer opportunities for students to build simple projects under expert guidance.

Evening courses start, generally, around mid-September, so if you are interested in extending your activities in this way during the coming winter months make enquiries in your area without delay.

Local educational authorities who organise non-vocational courses for adults are usually responsive to genuine demands for specialist subjects—providing a suitable instructor is at hand.

Fred Bennett.

*Our October issue will be published on **Friday, September 15***

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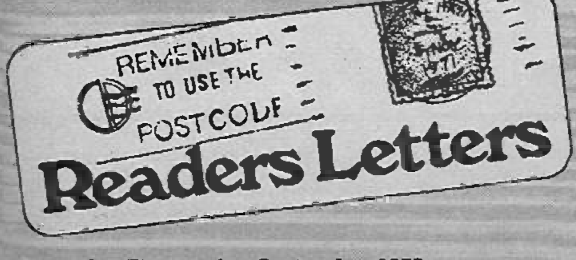
VOL. I NO. 11 SEPTEMBER 1972

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES



We are always interested in receiving readers' news and views of all items concerning this magazine and electronics in general; however if you write to us for advice would you please note the following.

We are unable to provide assistance on subjects not relating to published articles, and we cannot undertake to answer letters that do not include a s.a.e.

Infra-Red Burglar Alarm

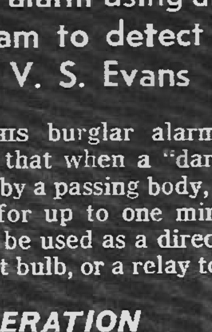
An alarm using an invisible, reflected beam to detect intruders.

By V. S. Evans

THIS burglar alarm works on the principle that when a "dark light" beam is interrupted by a passing body, a power output is switched on for up to one minute duration. This output can be used as a direct power source for a small light bulb, or a relay to operate an alarm system.

OPERATION

A miniature bulb supplies the beam, which passes through a screen to filter out all the light spectrum except infra-red. Although the beam is now invisible it behaves like ordinary light and is focused by a lens, over the distance required, onto a mirror, where it is reflected back onto a second lens focused on a light sensor.



Approximate cost of components £3·50 excluding case

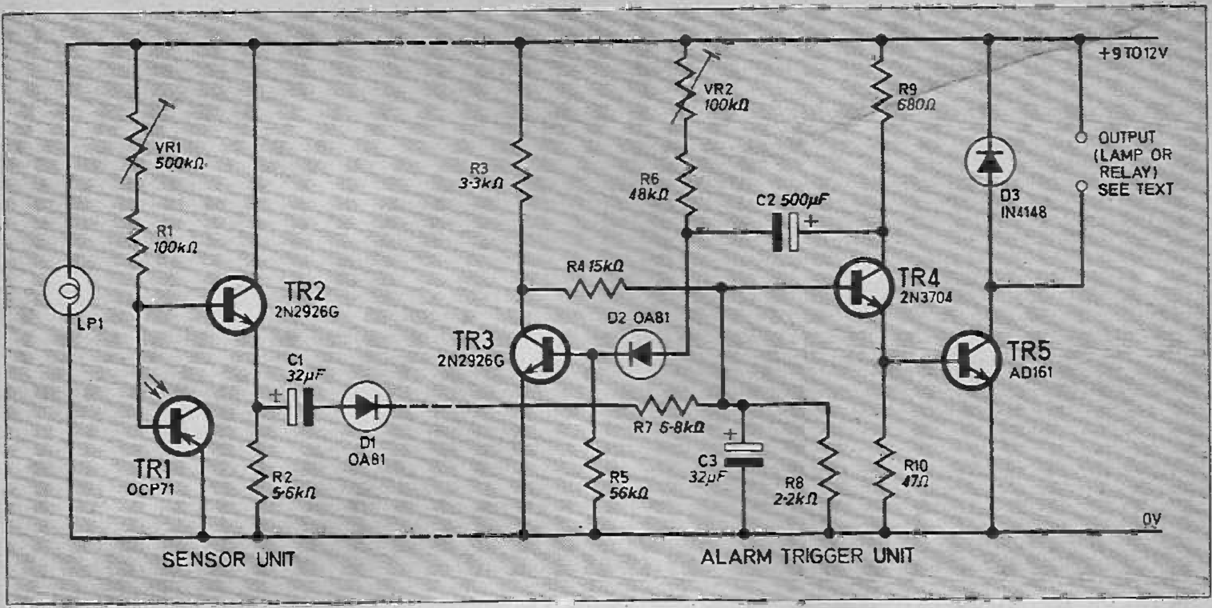


Fig. 1. Complete circuit diagram of the Infra-red Burglar Alarm.

The sensor generates current when the infra-red beam is present, and this current is used to keep open an electronic switch. When the path of the beam is momentarily interrupted and cut off from the sensor by an interposing body, the sensor ceases to generate current and the electronic switch instantly closes, switching on power at the output, to operate the chosen alarm.

The switch remains closed, with the alarm operating, for a pre-determined period of time, then automatically opens and the system reverts to the "on guard" state.

THE SENSOR

The beam sensor is a photo transistor (TR1) which is actually used as a photo diode, the collector not being connected. This device produces a current of 100 microamps or so when subjected to a simple light beam provided by LP1 as described above. This is sufficient to put a negative bias on the base of TR2 thus holding it in the "off" state until the current inducing beam is withdrawn (see Fig. 1).

Although the interruption may be for only a fraction of a second in duration it is sufficient for TR2 to momentarily switch on and deliver a pulse through C1 and D1 to the next stage—the monostable. Preset VR1 and R1 are used to set the level of standing current through TR2, so that the small change actioned by TR1 will switch TR2.

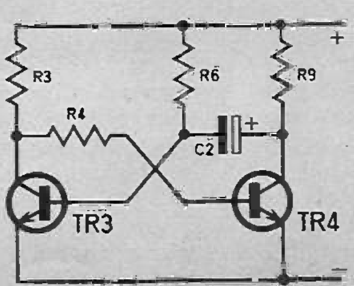
THE MONOSTABLE

The monostable is one of a class of circuits known as multivibrators which change electronically between two states. The monostable, as its name implies, is normally dormant in one state. If it is electronically activated into its second state it will remain changed for a pre-determined period of time and then automatically return to its dormant state.

The circuit of the basic monostable is shown in Fig. 2. It will be seen that TR3 is "on" due to a positive bias being applied to the base via R6. In this state its collector is near zero voltage, and through R4, applies this potential to the base of TR4, thus holding this transistor "off". In this state TR4 collector will be at near the positive line potential. It follows that capacitor C2 will have its positive side at near the positive line voltage and its negative side very much less so. It is therefore charged.

Now, if a positive pulse is delivered to the base of TR4, this transistor will switch "on," its collector voltage will drop to near zero and C2 will be forced to discharge at a rate controlled by the value of R6. During the period of discharge through R6, TR3 will be "off" and TR4 will remain "on". After discharge the circuit returns to its original state. This simple circuit can now be related to the circuit shown in Fig. 1. It will be seen that a variable resistor (VR2)

Fig. 2. Circuit to show the basic operation of a monostable.



has been included in series with R6 so that the time period of the monostable can be adjusted.

POWER OUTPUT

In the circuit of Fig. 1, it will be seen that the emitter of TR4 feeds the base of the power output transistor TR5, consequently they work together, i.e. both "on" or both "off". The output transistor is a commonly available *npn* germanium type and should be up to grade with a low leakage rating, not a manufacturers reject or secondhand type. Resistor R10 is purposely of low value to minimize any leakage that may nevertheless occur across the output. The diode D3 across the output is only required if the load is an inductive one, such as a relay or solenoid. It protects TR5 from reverse current caused at "switch off" by the field surrounding the coil, collapsing.

FINAL CIRCUIT

Some of the components shown in Fig. 1 have not yet been explained; VR1 is a preset resistor used as instructed later to set up the correct current in TR2. Diode D2 blocks the surge discharge from C2 applying a heavy reverse bias to TR3 base. Resistor R5 is the lower leg of the base bias potential divider to TR3. Diode D1 blocks any positive d.c. from interfering with the polarisation of C1. Resistor R7 and capacitor C3 form a filter which prevents any spurious pulse, which may be picked up inductively on the input line, from triggering the alarm.

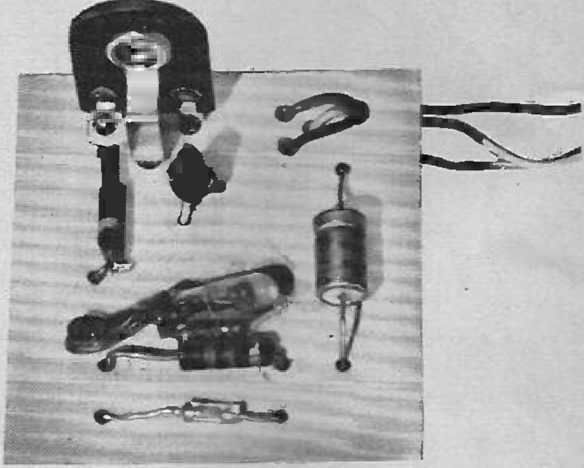
POWER SUPPLY

The unit will operate on a supply voltage from 9 to 12 volts, and this voltage will appear across the output when the alarm is triggered. For experimental purposes a large type of dry battery will suffice—as used for electric bells or lamps. For permanent installation an accumulator as used for scooters and cars is preferable. The unit will then operate even if the mains supply is off.

SENSOR CONSTRUCTION

The beam and detector unit is shown in Fig. 3; this should be made up first. When completed this stage can be tested and put into operation. It should be solidly constructed and all parts firm. The dimensions shown are for the specified lenses. Infra-red gelatine sheet can be obtained from main photographic dealers or alternative materials can be found. Dark coloured polystyrene $\frac{1}{16}$inch sheet has proved successful and the author has been told that resin bonded paper (0·015 inch Paxolin) can be used. However, the screen does not affect the working of the unit and can be left out until all testing and setting up has been done.

The sensor unit board is constructed as shown in Fig.4. Take care when soldering TR1, TR2 and D1 and use a heat shunt on the wires being soldered. Make sure that VR1 is mounted in such a position that it can easily be adjusted when the board is fixed in the case.



Photograph of the sensor circuit board.

Commence construction by drilling the board as shown and inserting the component wires through the holes.

The two Paxolin or s.r.b.p. insert panels, shown in Fig. 3, should be a tight fit, and are placed so that the bulb and photodiode are at the focal length from their respective lenses. This is the distance at which an image through the lens is at best definition on the panel and will be about $2\frac{3}{4}$ inches with the lenses specified. (The light from a window or a room light will provide the required image.)

The phototransistor has a light sensitive zone which must be located and placed at the front when mounting on the circuit panel. An initial location of this spot can be made by connecting the diode across a multimeter—say 500 microamp scale, and shining a pocket torch fairly close to and around the diode. This procedure will also show whether the device is a good one. The polarity is important when wiring up.

ALIGNMENT

The unit has now to be aligned and this is best carried out in nearly dark conditions. Place it on a firm table or work bench and if possible it is best secured or clamped. The 12 volt supply is connected to the bulb only and the beam then directed at a flat surface 7 to 10 feet distant where the image of the bulb filament will show. Adjust the distance from lens to bulb for sharpest definition.

The beam should now be directed at a mirror (this can be as small as 1 inch square—Fig. 5 shows a suitable design) which can be angled so that the reflected light is made to cover the lens

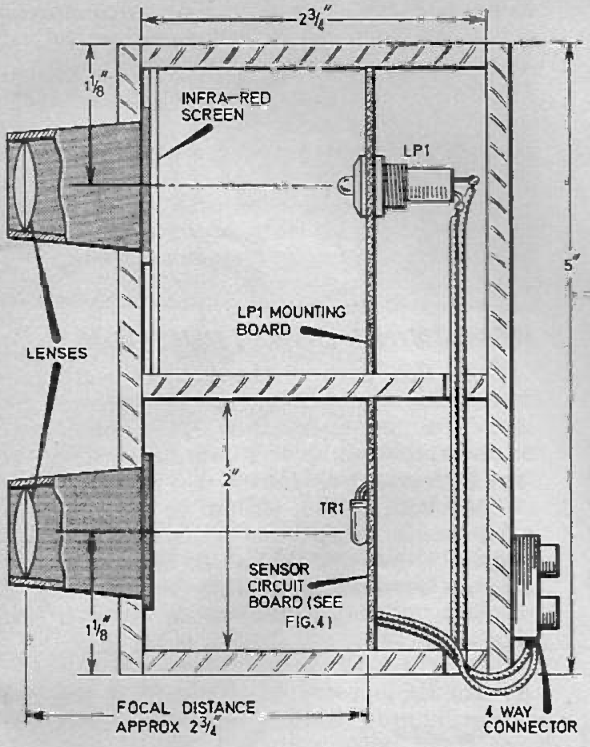


Fig. 3. Construction of the beam and detector unit.

Infra-Red Burglar Alarm

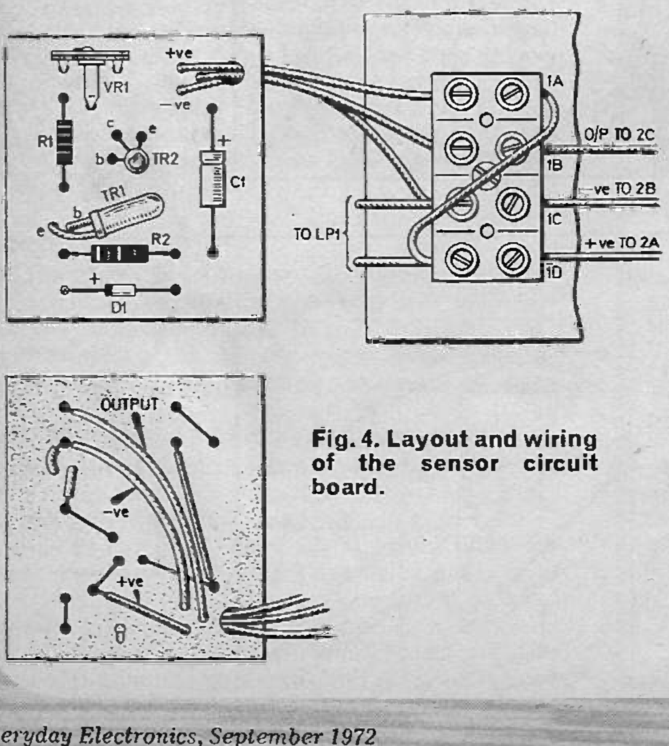
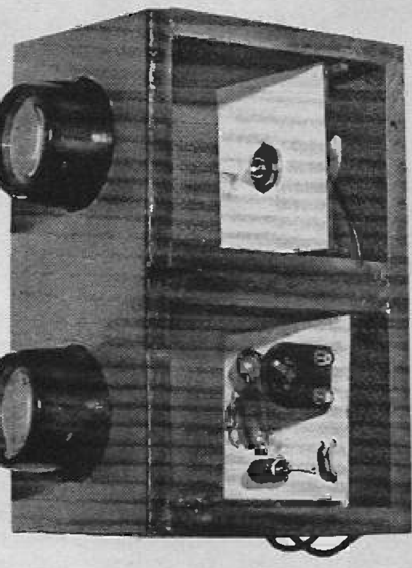


Fig. 4. Layout and wiring of the sensor circuit board.



Photograph of the beam and detector unit.

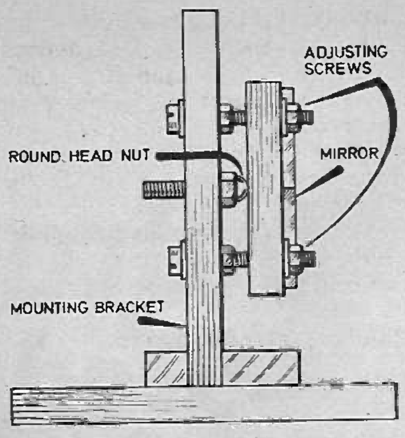


Fig. 5. Basic design for an adjustable mirror.

focused on TR1. The phototransistor is then eased into a position which produces the highest reading on a meter connected across it, typically 100 to 150 microamps. With this achieved a few small drops of quick drying adhesive (clear Bostik or Uhu etc.) should be carefully placed each side of the diode to fix it.

SENSOR TESTING

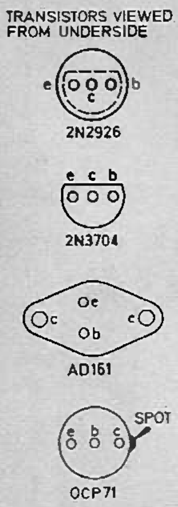
The next stage is to prove the functioning of TR2. With power connected (but not to the bulb) and a milliameter in the positive lead, adjust VR1 to give a reading of 1 to 1·5 milliamps. Connect the bulb directly to the power source (not through the meter) and if all is correctly lined up the reading should drop considerably.

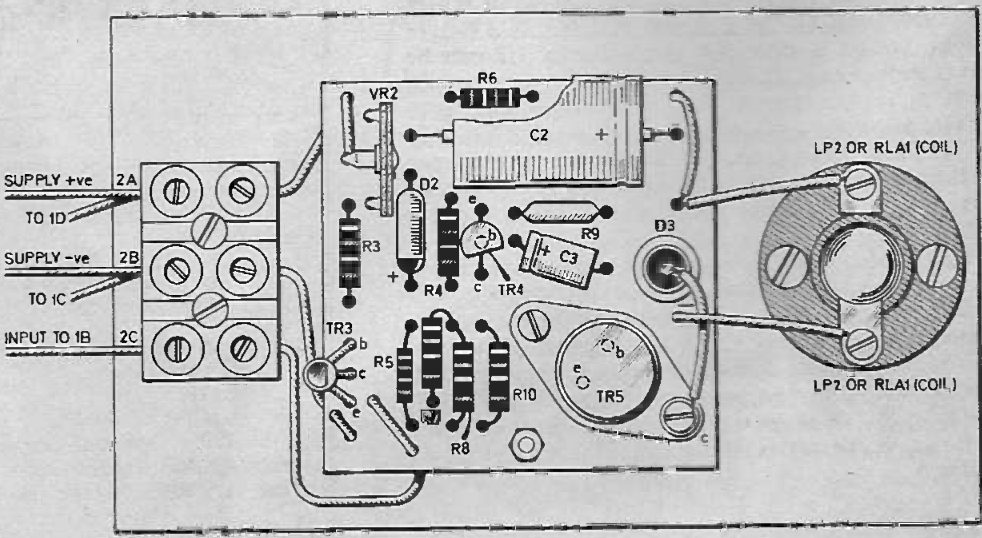
Preset VR1 is then adjusted to give a standing current, in this state, of between 100 and 200 microamps. If the beam is now interrupted the reading should smartly rise to 1mA.

REMAINING CONSTRUCTION

With this part of the project working correctly, the construction of the second circuit board can be undertaken. This comprises the monostable and power output—wiring being straightforward as shown in Fig. 6.

The board is thin s.r.b.p. or Paxolin. All the components except the transistors and diodes should be mounted and wired up as shown. Once this has been done, carefully solder in the semiconductors using a heat shunt on each lead as





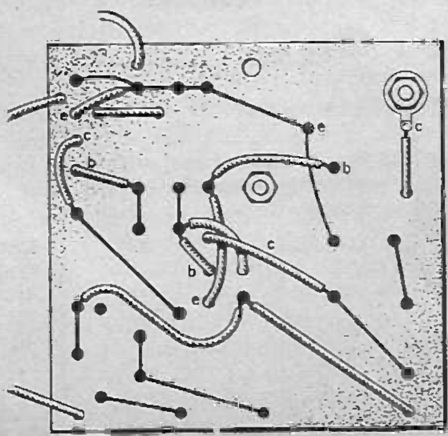
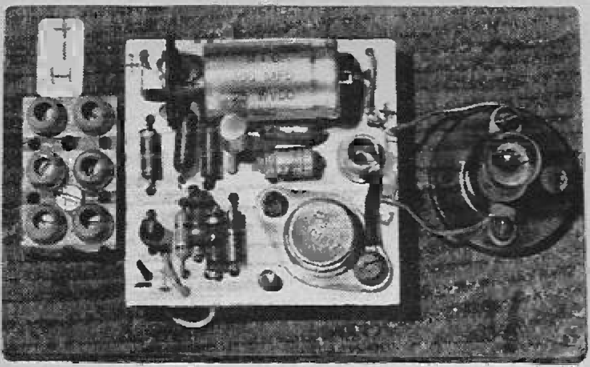


Fig. 6. Layout and wiring of the monostable and power output circuit board.



Photograph of the alarm trigger unit.

it is soldered. Once again make sure the preset potentiometer (VR2) can be easily adjusted. Finally mount the board in a suitable case or on a supporting block. For test purposes a 12 volt bulb should be connected across the output. This should be a 2·2 watt 12V type.

With power on, a 5 kilohm resistor placed briefly between the input and the positive lead, should bring the monostable into action and the bulb will light for a period, the length of which is controlled by the position of VR2. If a longer time period is required the value of C2 can be increased, but there is a limit beyond which leakage can trigger the monostable and give false alarms.

It is important that at no time is the output short circuited as this would result in the output transistor overheating and probably destroying itself.

All being well the two units can be linked and proved functional. The main circuit board can be enclosed in any small box with the bulb or alarm mounted outside, or it can be enclosed with whatever alarm system the constructor chooses. A 9 or 12 volt relay (depending on the supply used) with a coil resistance of about 100 ohms or more can be wired up, as shown in Fig.7, to switch an alarm.

USE

If the alarm is to be put into permanent use, it is essential that the beam/sensor unit and the reflecting mirror are fixed to solid supports and are absolutely rigid. Any slackness or movement will move the focal point of the beam off the sensitive spot of the phototransistor, the result being erratic performance and false alarms.

In installations of this kind it is sometimes recommended that screened cable should be used. In the prototype this was not found to be necessary and the connecting cables were cheap plastic covered wire twisted together for their full length of some 50 feet.

To provide protection around a room or building more than one mirror can be used to reflect the beam around the area as shown in Fig.8. ■

Fig. 7. Wiring used for a relay and alarm.

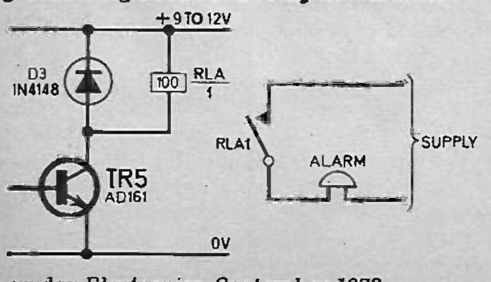
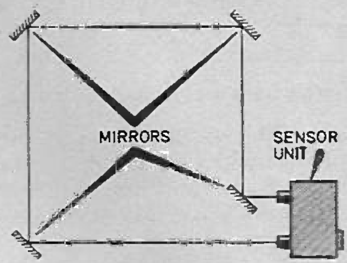


Fig. 8. Method of protecting an area.



Components....

Resistors

R1	100kΩ	R6	47kΩ
R2	5·6kΩ	R7	6·8kΩ
R3	3·3kΩ	R8	2·2kΩ
R4	15kΩ	R9	680Ω
R5	56kΩ	R10	47Ω

All ¼W ±5% carbon

Capacitors

C1 32μF elect. 15V
C2 500μF elect. 15V
C3 32μF elect. 15V

SEE **SHOP TALK**

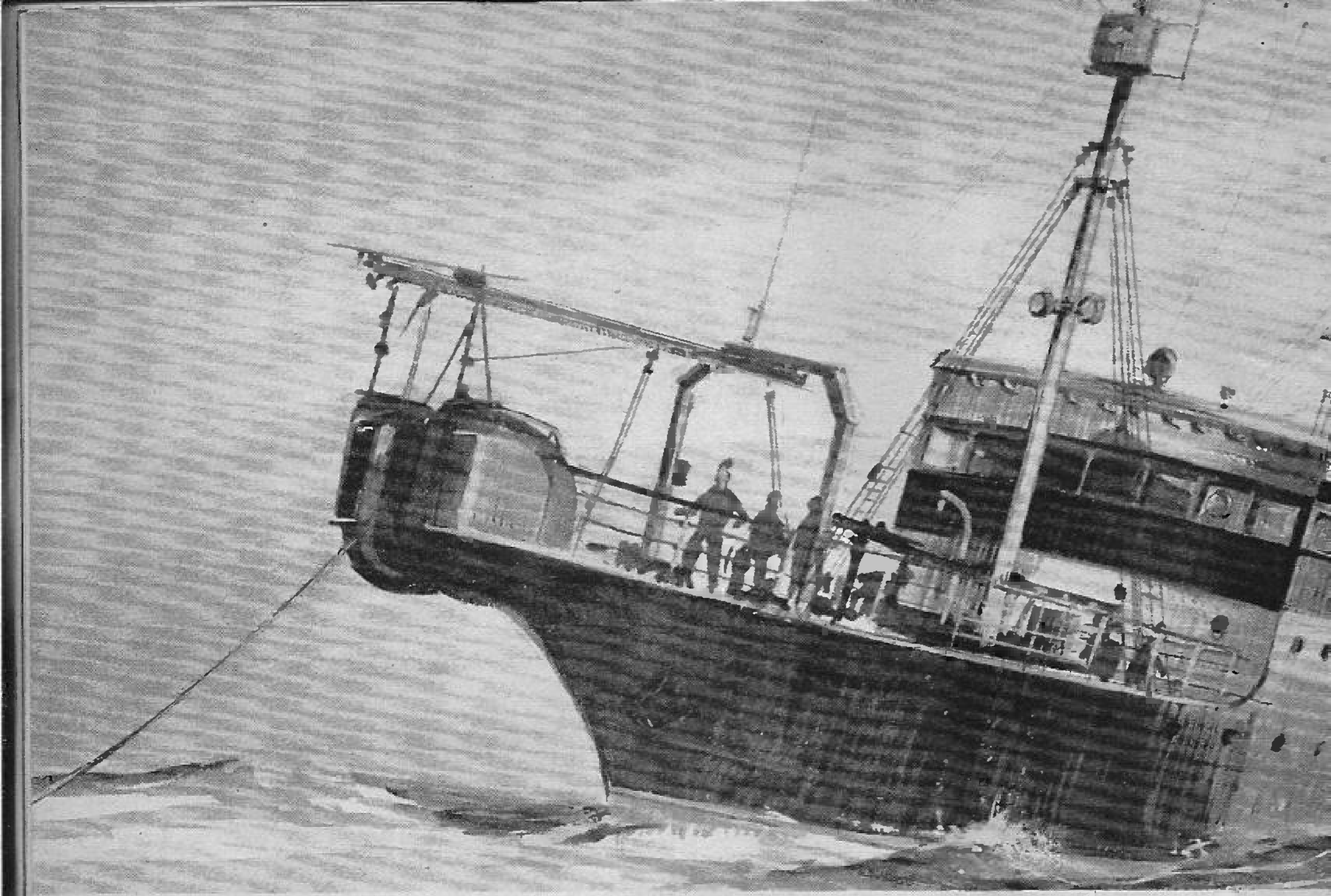
Semiconductors

D1 OA81
D2 OA81
D3 1N4148 or similar
TR1 OCP71 germanium *pnp*
TR2 2N2926G silicon *npn*
TR3 2N2926G silicon *npn*
TR4 2N3704 silicon *npn*
TR5 AD161 germanium *npn*

Miscellaneous

LP1 Miniature 12V, 0·2A bulb and holder
VR1 500kΩ skeleton preset potentiometer
VR2 100kΩ skeleton preset potentiometer
LP2 12V 2·2W bulb (for alarm signal or testing only—see text)
RLA1 100Ω or greater 12 or 9V relay with one set of normally open contacts (to operate alarm system—bell etc. —see text)

Lenses—two jewellers eye glass magnifiers, one four way and one three way connection block, s.r.b.p. or Paxolin sheet (three pieces, 2in x 2in), materials for cases (see text), 4BA fixings, wire, small mirror and materials for mirror mounting (see text). Infra-red screen (see text)



ALTHOUGH satellites are providing a growing proportion of transatlantic communications links, the more down to earth system of undersea cables is undergoing exciting developments of its own.

Improvements in the technology of undersea cables—reduction in the loss per unit length of both the armoured and unarmoured cables and the use of semiconductors—are making a significant impact on the cost of laying trans-ocean cables. For example, the Cantat 1 transatlantic cable was laid between Canada and Britain in 1961 at a cost of £100,000 a circuit, but a new cable, Cantat 2, to be laid in 1973-74 will cost just £16,500 a circuit.

The principal reason for such a dramatic improvement in economy is the increased number of circuits which the latest types of cable can carry. Cantat 1 has 80 circnits but Cantat 2 will have more than 1,800 circuits—more circuits, in fact, than all existing transatlantic cables combined.

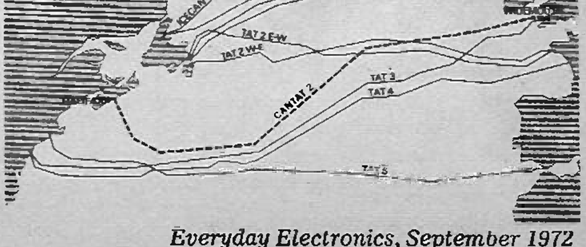
PAST AND PRESENT

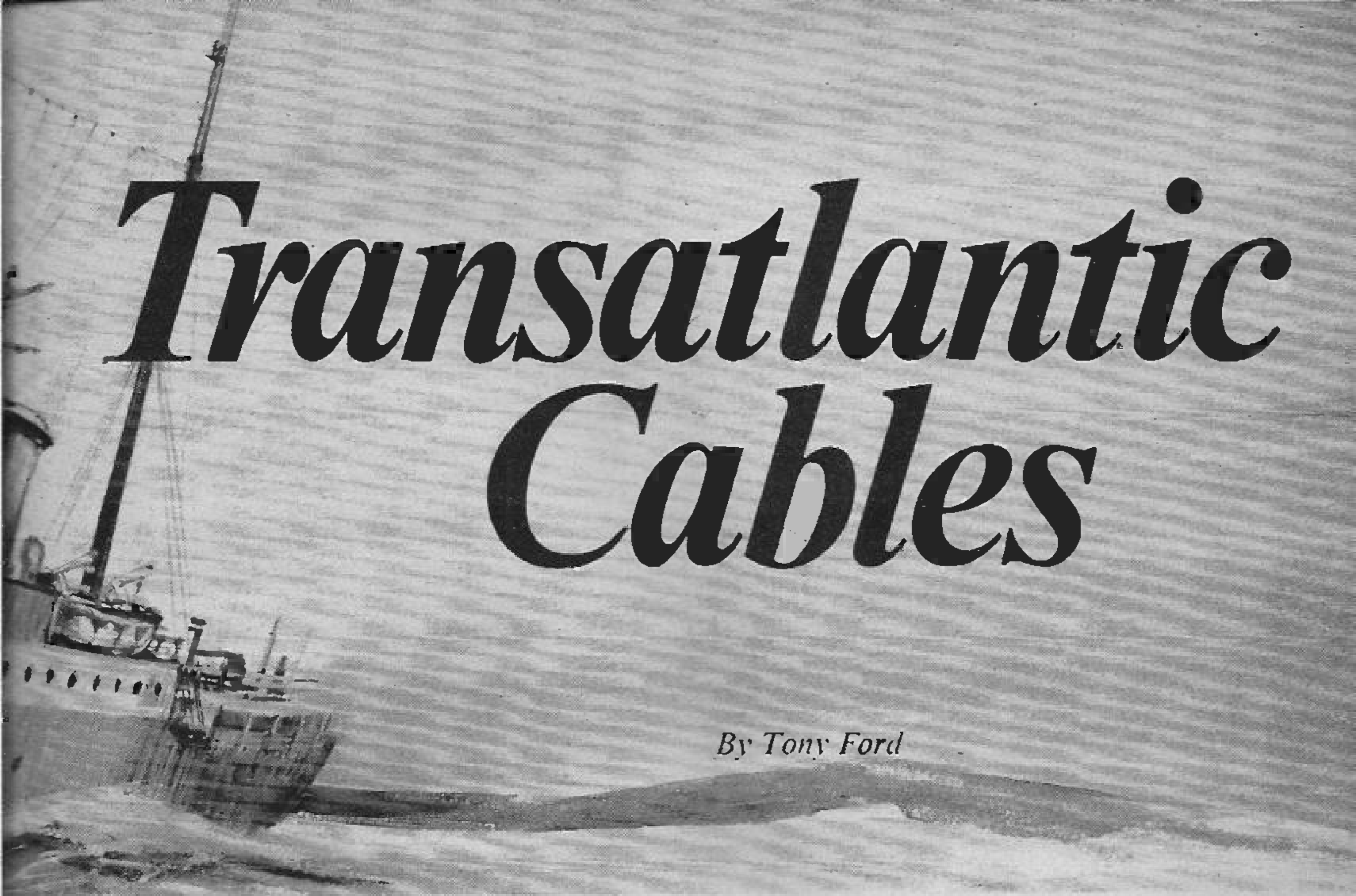
Cantat 2 will be the third undersea cable between the UK and Canada. The first transatlantic telephone cable—TAT1 from Oban, Scotland to Clarenville, Newfoundland—was opened in 1956. Cantat 1 was laid between Oban and Hampden, Newfoundland and was the first section of the Commonwealth cable network designed to carry calls between the UK and Canada and on to New Zealand, Australia and the Far East over Pacific and South East Asia cable systems.

Cantat 2 is primarily intended for Britain's communications with North America to meet a rising demand. Since Cantat 1 was laid the annual total of telephone calls from North America account for nearly 13½ million minutes a year (compared to less than two million in 1960) and calls to North America from Britain occupy more than 10½ million minutes (compared to 1½ million in 1960).

In addition to telephone calls, Cantat 2 will handle telex, telegrams and data transmission.

The existing transatlantic cables and the route of Cantat 2.





Transatlantic Cables

By Tony Ford

TRANSISTORS

The key to Cantat 2 and the continuing future of long distance undersea cables as a practical and economic means of intercontinental communication lies in transistors which have been developed at the Post Office research establishment at Dollis Hill in North London. The transistors which replace thermionic valves, are able to operate with guaranteed reliability and performance to the higher bandwidths of submarine cable—13·7MHz in the case of Cantat 2.

Built into the 2,840 nautical miles of Cantat 2 will be 473 repeaters each of which amplifies the signals and boosts them along their journey. Looking rather like torpedoes in their cylindrical steel housings and each weighing about a ton the repeaters will contain transistorised circuits which must have outstanding reliability.

In some places the cable will lie three miles deep and where pressure on the cable will be four tons per square inch. Apart from the cost of locating and raising the cable for repairs there would be a loss of operating revenue which, for Cantat 2, will be some £60,000 an hour at full capacity.

Each of the 2,838 transistors contained in the cable has been designed to give a trouble-free life of more than 25 years. It is a standard of reliability that is unique and could be com-

This device creates the pressure condition the cable will encounter on the sea bed—up to three tons per square inch. The photograph shows part of the Cantat 2 cable being prepared for testing.

pared to switching on almost 500 transistor radios and expecting them to all work non-stop and perfectly for a quarter of a century.

DESIGN ADVANCES

A further and simple indication of the advances made in undersea cable design in recent years is shown by comparing details of the Cantat 1 cable in 1961 with Cantat 2 with the latter's figures in brackets: number of speech channels 80 (1,840); number of repeaters 90 (473); length in nautical miles 2,072 (2,840); active elements 540 Post Office type 10P valves (2,838 Post Office type 4A and 10A transistors); principal types of cable, 0·99 inch unarmoured over 1,518 nautical miles (1·47 inch unarmoured over 2,425 nautical miles), 0·62 inch armoured over 554 nautical miles (1·47 inch armoured over 370 nautical miles); power, 9·5kV and 415mA (12·34kV and 500mA).

Bringing Cantat 2 into service will cost about £30,500,000. This covers production, survey and development work and laying operations. The cost will be shared by the British Post Office and the Canadian Overseas Telecommunications Corporation but some rights of use will be sold to the authorised carriers in Europe and the USA.

The need to increase the gain-bandwidth, while at the same time keeping the amplifier voltage low, resulted in a change from thermionic valves in the Cantat 1 cable in 1961 to transistors for Cantat 2 which will become operational in 1974. This change precluded the use of parallel amplifiers which has improved the reliability of the early valve systems. Nevertheless the greater potential reliability of the transistor, compared to the hot cathode thermionic valve, more than compensated for the change.

In physical terms the gain-bandwidth product of the transistor increases as the transistor dimensions decrease. The trend is, therefore towards smaller devices.

TRANSISTOR TYPES

The 4A type transistor developed by the Post Office and produced by both the Post Office and Standard Telephones and Cables Limited, provides 640 circuits in submarine use. However, the smaller types, known as the 10A2 and 10A10 designs, for input and output use respectively, allow an increase in circuit capacity to 1,840—as in Cantat 2. Here the 4A type is used in the low frequency amplifier and the 10A types in the high frequency amplifier. This arrangement is also being used in a series of high capacity cables being laid in the North Sea linking Britain with Europe. The 10A2 was developed by the Post Office and the 10A10 jointly by the Post Office and STC.

The 10A type, being smaller, requires a more

A technician lifts a batch of transistor "headers"—tiny gold-plated beds on which the transistors will eventually rest—from an alcohol bath. This is part of a process which ensures that components are as clinically clean as possible. After being washed in alcohol, the "headers" are baked in a vacuum.

advanced technology than was needed for the 4A type. In particular, improved methods of diffusion have been developed for the 10A to give a base-width of 0·5 micron compared to the 4A base width of 1·2 microns.

RELIABILITY

The impressive reliability of the transistors stems from the method of bonding, by thermocompression, aluminium wires to aluminium contacts in each device. The standard of testing and inspection is such that of every 10,000 transistors made only 1,000 find their way into a cable system. The remainder are tested to destruction or do not meet the stringent standards required.

During the production of Cantat 2 some 20,000 transistors will be exhaustively tested. Already during the development of the transistors for submarine cable use 40,000 have been tested in production and 6,000 are in use in other cables on the sea bed. No failures have been found during these tests.

Although the provision of such reliability obviously becomes very expensive for trans-ocean cable systems, the cost is more than balanced by the increased circuit capacity made possible by the improved design of solid state devices and which has reduced the cost per circuit nautical mile by a factor of 30 in 15 years.

A further aspect of the development work are the elaborate precautions taken to protect the transistors in the main amplifying path from the effects of electrical surges which occur if the cable itself is cut or damaged. This protection is provided by the use of diodes, which themselves must be highly reliable, to absorb the surges in both the power feed paths.

CLEAN ATMOSPHERE

Apart from the advanced and highly skilled technology involved in producing the transistors themselves, the most important requirement is a perfectly clean atmosphere. Even the tiniest speck of dust will contaminate the transistor on which it settles.

The Post Office and STC, therefore, produce transistors and assemble the repeaters in "superclean" laboratory conditions where staff dress like surgeons. They often need microscopes to see their work and breathe the purest air. Sophisticated air conditioning systems filter and remove from the atmosphere the tiniest traces of dirt and dust.

So critical is the standard of cleanliness required that a member of the staff could create unwanted particles of dust simply by scratching his head. In fact the air in the laboratories is filtered and purified to such a degree that by comparison the air in a hospital operating theatre seems dirty.

NAVIGATION

The precision which goes into the manufacture of the cable's components is continued when the cable is actually laid. To select the best possible route for the cable and to establish its location with pin-point accuracy should repairs be necessary, the survey vessels and the laying vessels must be able to navigate with extreme accuracy.

The normal methods of navigation used in commercial vessels do not meet these requirements and special arrangements are necessary; these largely involve the use of satellites.

Ships engaged in preliminary surveys and the actual lay will, therefore, use the Decca Hi-Fix system when covering the approaches to the terminals on both sides of the Atlantic—at Widemouth Bay, Cornwall and near Halifax, Nova Scotia. For the main part of the route across the Atlantic the ship's positions will be fixed by means of satellite navigation backed up by the Omega and Loran "C" navigation systems.

All these radio-navigational systems have a high standard of accuracy and are independent of weather conditions. Hi-Fix is a very accurate short-range system with the twin virtues, for the cable ship, of repeatability and predictable accuracy.

The first, which ensures the ability to return to a previously visited point, is important from the maintenance aspect in an area, such as the approach to a cable terminal point, where existing cables are likely to be close together as they converge on the land station.

The second, predictable accuracy, allows the ship to be taken to a pre-determined point so that the cable can be laid along the route previously surveyed and where all obstacles have been mapped. This is vitally important where the cable, as in the case of Cantat 2, is routed along valleys and through passes when crossing the undersea "mountain range" known as the Mid-Atlantic Ridge. Hi-fix can only be used close to the shore otherwise the satellite system must be used.

Positions obtained by satellite navigation are extremely accurate but, at present, can only be obtained at varying intervals of time. The other radio-navigational aids, Loran "C" and Omega are not in themselves fully able to meet the exacting navigational demands of the project but provide a valuable back-up system. By careful observation they can be used to give information in the intervals between satellite fixes.

CABLE LAYING

The increase in diameter and the closer repeater spacing needed in modern cables to handle the rise in circuit capacity, has led to

Continued on page 609

Throughout its life the cable will be subjected to incredible natural pressures, in shallow water the pull of tides and currents will create huge stresses. Additionally during laying and recovery for maintenance it is subjected to very heavy bending stresses. These two large rotating wheels simulate such stresses in the laboratory.

A simple radio tuner for use with almost any amplifier. By F. C. Judd

THIS very simple radio tuner will operate with a few feet of wire for an aerial and tunes to the medium and long wave bands. Sensitivity is sufficient to bring in local stations such as BBC Radio 1 and Radio 4 on medium wave and Radio 2 (200 metres) on long wave.

The tuner is ideal for tape recording and has an output of around 100mV, depending on the strength of received signals, and so can be directly coupled to the radio input of any tape recorder. It is suitable of course for use with any amplifier having an input sensitivity of around 100 to 200mV.

Reception strength does depend on location and it would be unreasonable, for example, to expect strong signals from the 200 metre BBC long wave Radio 2 in remote parts of the country. On the other hand both sensitivity and selectivity do to some extent depend on the length of the aerial which may be any thin insulated wire about 10 to 15 feet long and as high in the room as possible.

If, for example, location is close to local stations such as the BBC Brookmans Park medium wave Radio 1 and 4, then a much shorter aerial would be needed to achieve complete separation of the signals. (The Brookmans Park station aerials are shown on the front cover and on this page.)

THE CIRCUIT

As shown in Fig. 1 the circuit consists of a tuned radio frequency amplifier (TR1). The inductor L2 provides a high resistance to the r.f. signals which pass through C5 to the diode detector. The main tuning capacitor (C2) is a

Approximate cost of components £2·50 plus case

Medium & Long Wave Radio Tuner

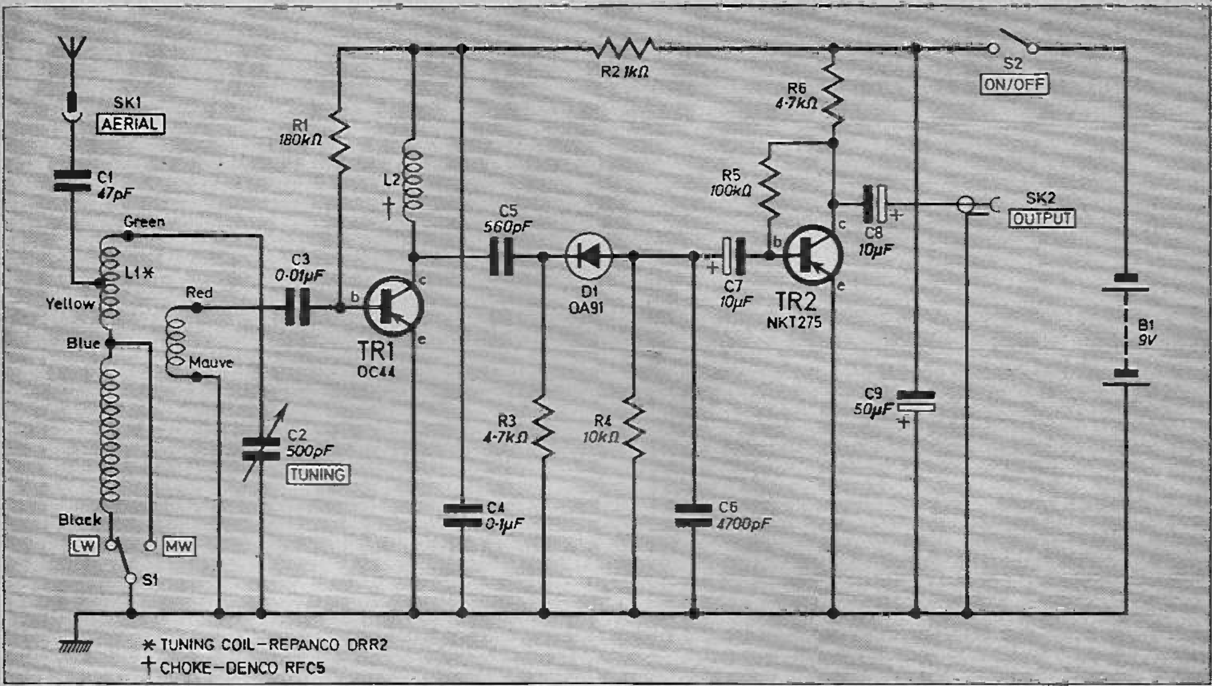


Fig. 1. Complete circuit diagram of the LW/MW Radio Tuner.

mica dielectric type and the tuning coil a Repanco type DRR2 which has a tapped winding for medium and long wave tuning plus a secondary winding suitable for coupling to the low impedance input of TR1.

The output from the diode detector is taken to TR2 which operates as an audio signal amplifier. Radio frequency signals are removed by the capacitor C6, leaving the audio signal to be amplified by TR2.

CONSTRUCTION

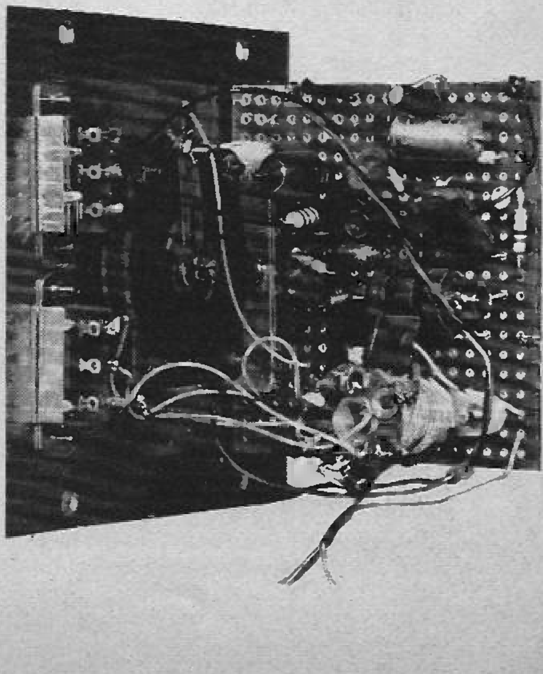
The prototype, as shown in the photographs, was constructed on a piece of plain circuit board and housed within a metal box. The box should be large enough to accommodate a PP6 type 9V battery as well as the radio tuner circuit board, etc.

Details for the component board layout and wiring are given in Fig. 2 and the aerial socket, output signal socket and wiring to the remaining components are shown in Fig. 3. Note that the connections of the OC44 are located by the red spot (next to the collector lead) whilst those to the NKT 274 are according to position as in the inset of Fig. 2.

Commence construction by cutting the component board to size and drilling the board for the mounting bracket and L1. Fit L1 to the board making sure it is the right way round (this makes the wiring neater). Next fit the remaining components, except the transistors and diodes and wire up as shown in Fig. 2. Check the layout and then wire in TR1, TR2 and D1 observing the correct connections.

Mount the circuit board on the front panel as shown together with the remaining components and wire up the complete tuner as shown in Fig. 3. We advise readers to follow the layout shown as alteration could cause instability.

Photograph showing the construction of the Radio Tuner. The aerial and output socket can be mounted on the side or back panels.



Medium & Long Wave Radio Tuner

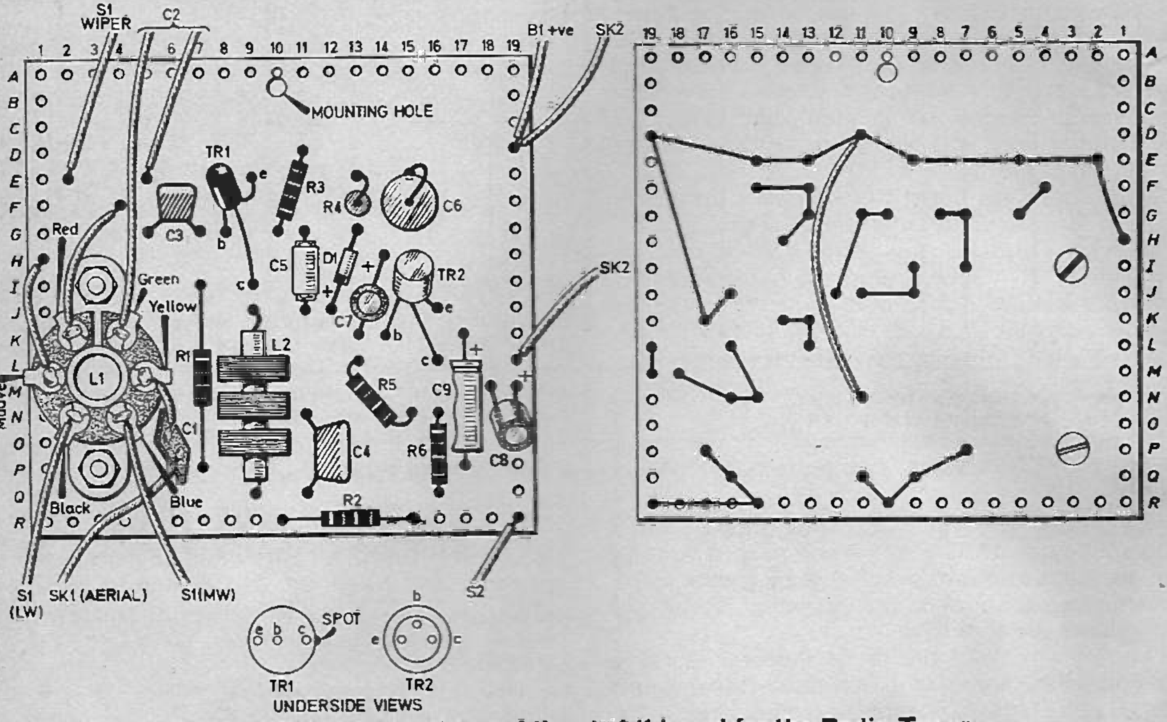


Fig. 2 Layout and wiring of the circuit board for the Radio Tuner.

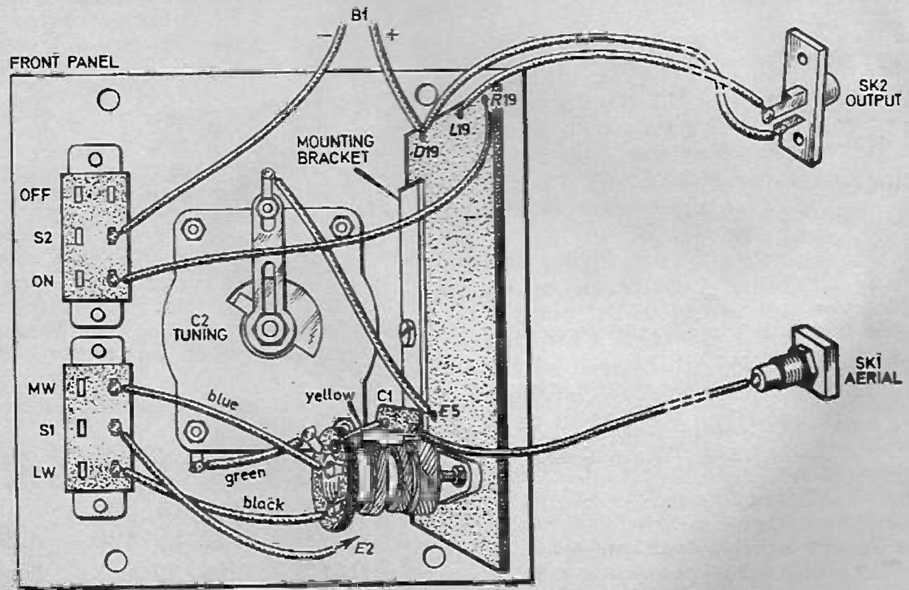


Fig. 3. Connection of the circuit board to the remaining components. In the prototype the aerial and output sockets were mounted on the back of the case.

SETTING UP

With a 9V supply the tuner takes a little under 2mA so if a milliammeter is available this could be checked to ensure correct operation of the two transistors. The DRR2 tuning coil may be supplied with a tuning core and if so, this must be removed completely; it is not needed. Couple up about 10 feet of insulated wire for an aerial and connect the output of the tuner to an amplifier, or to a tape recorder with through monitoring, so that signals are audible. The tuning points of local stations on medium waves will depend on location but those for the London area will be similar to those shown on the cover photograph.

If the received signals are strong they may overlap on medium waves. If this happens, reduce the length of the aerial until separation is obtained. No earth is necessary as the tuner will be automatically earthed via the amplifier or tape recorder to which it is connected. ▣

Components....

SEE **SHOP TALK**

Resistors

R1	180kΩ
R2	1kΩ
R3	4·7kΩ
R4	10kΩ
R5	100kΩ
R6	4·7kΩ

All ¼W ±10% carbon

Capacitors

C1	47pF
C2	500pF variable (mica dielectric type)
C3	0·01μF
C4	0·1μF
C5	560pF
C6	4,700pF
C7	10μF elect. 12V
C8	10μF elect. 12V
C9	50μF elect. 12V

Semiconductors

TR1	OC44	germanium *pnp*
TR2	NKT 275	germanium *pnp*
D1	OA 91	

Miscellaneous

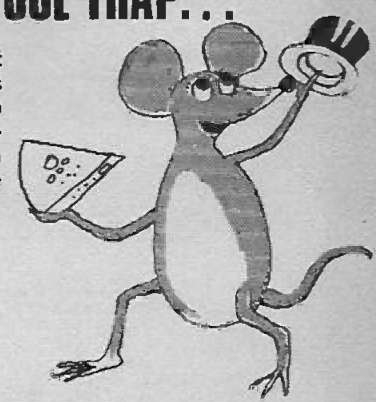
L1	Repanco type DRR2 (medium and long wave coil)
L2	Denco RFC 5 radio frequency choke (inductor)
SK1	Single insulated socket
SK2	Insulated phono socket
B1	9V PP6 battery
S1	S.p.d.t. slide or toggle switch
S2	S.p.s.t. slide or toggle switch

Metal case (or any suitable case, minimum size 4in x 4in x 3in), tuning knob, aluminium angle ½in x ½in x 2in (for mounting the circuit board), plain perforated Veroboard 3in x 2⅞in x 0·15in matrix, material for tuning dial, 6BA fixings, battery connectors.

Cassette tape POWER SUPPLIES

Have you ever wanted to use your cassette recorder in the car or home and wished that you could power it from the car battery or mains supply? Well now you can, we will show you how to build two separate power supplies to cope with these requirements.

ELECTRONIC MOUSE TRAP...



Why kill the mice that plague your home? This "humane" mouse trap catches the mice unharmed so that you can release them outside your home.

REACTOMATIC...

Test your reflexes against other peoples! When the timed light comes on press your button first and your opponent is blocked—your light shows the winner. The Reactomatic can be developed for TV-type quiz game answering.

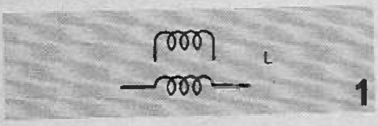
Next month's feature article... ELECTRONICS IN MEASUREMENT

All in the October issue.

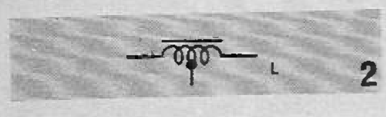
On sale Friday, September 15

guide to circuit

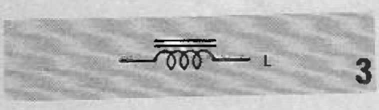
Inductors



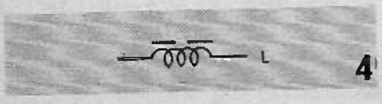
1 Winding of an inductor, coil, choke or transformer



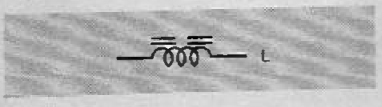
2 Winding with a solid ferrite or dust iron core with a single tapping



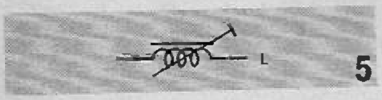
3 Winding with a laminated core



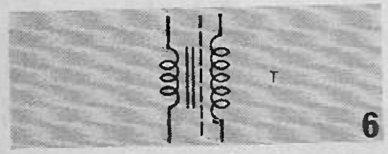
4 Winding with ferrite or dust iron gapped core



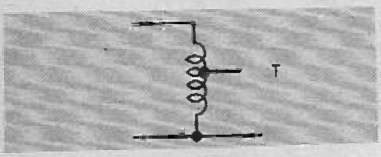
Winding with laminated gapped core



5 Inductor with variable inductance, for example, tuning coil or solenoid with moving core

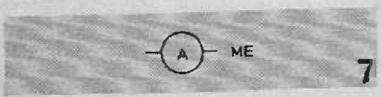


6 Transformer with two windings, a laminated core and a screen between the windings, no tappings

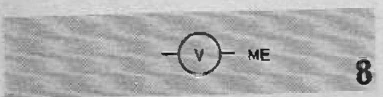


Auto transformer with one winding

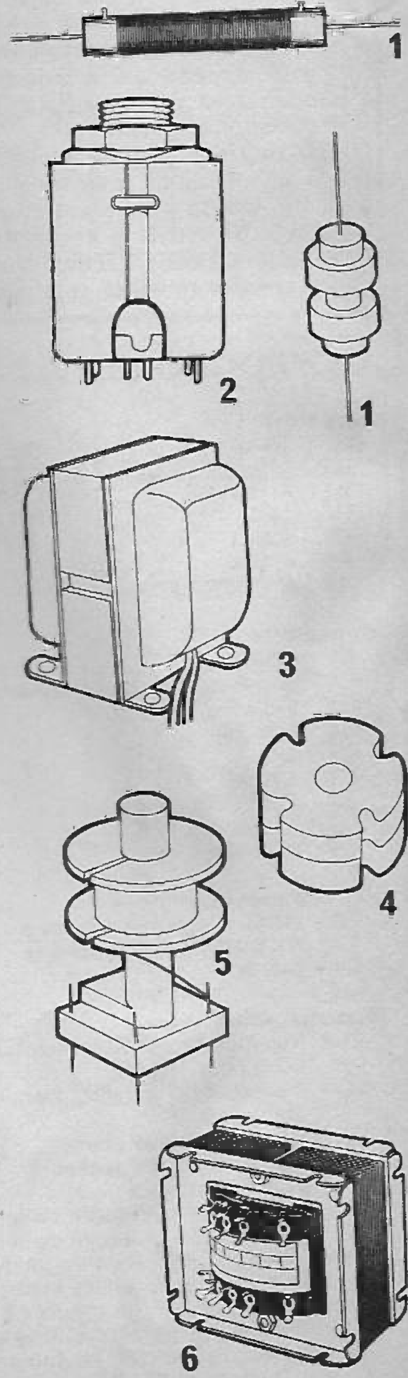
Meters



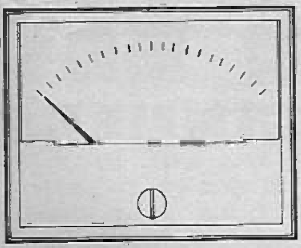
7 Ammeter or milliammeter



8 Voltmeter or millivoltmeter



symbols . . . part 4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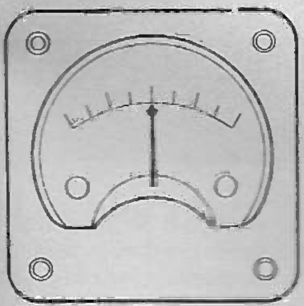
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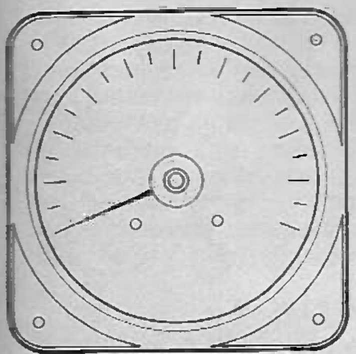
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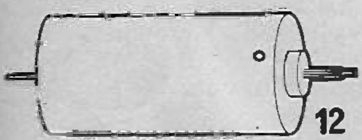
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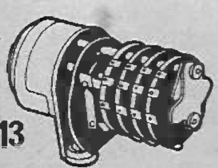
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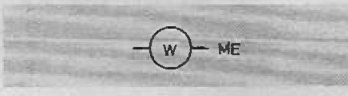
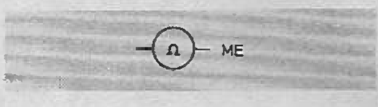
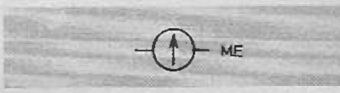


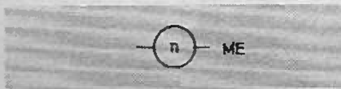
9 Wattmeter or milliwattmeter



Ohmmeter

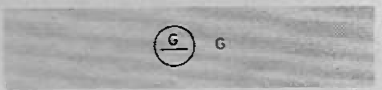


10 Galvanometer

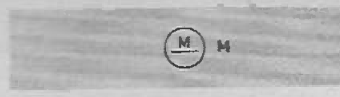


11 Tachometer (revs per minute etc.)

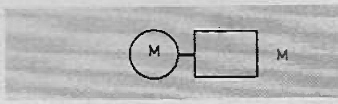
Motors and Generators



Rotating d.c. generator

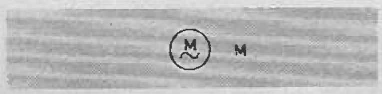


12 Rotating d.c. motor

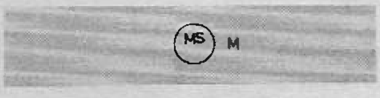


13 Motorised switch or valve mechanism

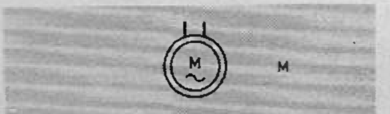
Rotating a.c. generator



Rotating a.c. motor



Synchronous motor



Squirrel cage induction motor

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

TEACH-IN
...FOR BEGINNERS

By Mike Hughes M.A.

11 AMPLIFICATION

WITHOUT doubt, the most popular application of electronics is to produce audible sounds from a loudspeaker. In most instances, we hear the necessity of using an amplifier to produce the end product. However, it is not always so obvious why we need amplification or, indeed, what form it should take.

We have already produced quite a reasonable level of sound from a loudspeaker without recourse to amplification—i.e., the multivibrator in Part 8.

The reason why we needed no amplifier was because we had comparatively large voltage swings (9V) and reasonably high currents available in the collector circuit of the multivibrator. To produce the audible sound we had to feed these currents to a loudspeaker.

POWER LEVELS

To obtain sufficient current we had to produce a high enough voltage swing to make this current flow through the impedance of the loudspeaker coil. It would be more correct to say we needed power to produce a sound of acceptable level.

The multivibrator was capable of delivering a power of about 125mW to the 35 ohm loudspeaker. The power required by a loudspeaker to produce audible sounds depends on the efficiency of the loudspeaker and also on what we require in the way of volume.

We can describe the subjective effects of different power levels by saying that the output of a typical transistor portable radio would be about 1W. The lowest power that will produce an easily recognisable sound (without putting the ear right up to the loudspeaker cone) would be about 10mW and, of course, at the other extreme "pop" groups frequently delight the ear with powers greatly in excess of 50W per amplifier.

To get maximum power dissipated in a loudspeaker we must apply the same reasoning that we arrived at in Part 4, i.e., the impedance (we are now dealing with alternating currents) of the circuit producing the current, should, as far as possible, equal the impedance of the loudspeaker. Most loudspeakers have very low impedances ranging typically from 3 to 35 ohm.

POWER AMPLIFICATION

An amplifier serves two purposes. The first is most easily understood and is simply to increase the voltage swings that the source (e.g., microphone, pick-up, or radio tuner) produces. The second, and not so obvious role of an amplifier is to take these voltage swings and increase the amount of current produced.

We could say we are amplifying the current, although in practice we are using voltage swings in high impedance circuits, to produce equal voltage swings in low impedance circuits. Going from high to low impedance circuits without changing voltage levels, is the same as saying "current amplification"—going from low to high impedance is usually "voltage amplification." Combine the two together and one gets "power amplification."

CRYSTAL MICROPHONE

Let's take the case of a crystal microphone. This is a device that converts air pressure waves into electrical voltages. The pressure waves impinge on a light diaphragm that is connected to a crystal made of "piezoelectric" material. This material has the property of producing minute voltages when it is mechanically deformed.

The level of signal produced by a normal voice about 6 inches from a crystal microphone is seldom much more than 10mV. Unfortunately the piezoelectric crystal is a very poor conductor of electricity; so poor in fact that it behaves rather like a low value capacitor, the electrodes making contact to it acting as the plates.

Different types have widely varying characteristics but typically the capacitance is in the order of a few hundred picofarads. At 1kHz this gives an impedance greater than 100 kilohm.

The frequency range of the human voice is from about 100Hz to about 3,000Hz, so you can see that at low voice frequencies the microphone has extremely high impedance, and as the frequency increases its impedance falls, but nevertheless is still very high and will probably be around 50,000 ohms.

POWER IN LOAD

We run up against this "non constant" problem all the time in audio work so it is usual to talk in terms of a fixed frequency of 1kHz unless otherwise stated.

Let's assume, then, that we have a microphone giving an output of 10mV at 1kHz and it has an impedance of 100 kilohm. What is the maximum power we can expect to obtain in the load "Z" shown in Fig. 1a?

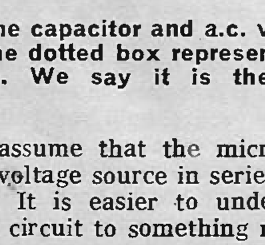


Fig. 1(a). The capacitor and a.c. voltage source shown in the dotted box represents the crystal microphone. We say it is the "equivalent circuit".

We will assume that the microphone is an alternating voltage source in series with its own capacitance. It is easier to understand if we convert this circuit to something more familiar, see Fig. 1b.

The battery represents the voltage generated by the microphane (10mV), R1 is the impedance of the microphone (100 kilohm) and R2 is the impedance of the "ideal" load (equal to value

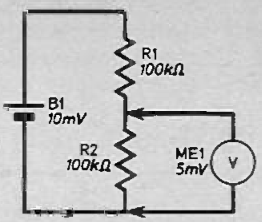


Fig. 1(b). The simple d.c. equivalent of Fig. 1(a) where R1 represents the impedance of the microphone, B1 its typical output voltage and R2 the ideal load for maximum power coupling.

of R1) for maximum power coupling. The power in the load will be

$$P = \frac{V^2}{R2} = \frac{0{\cdot}005 \times 0{\cdot}005}{100{,}000} = 0{\cdot}00000000025 \text{ watts}$$

It looks a bit better if we say 0·00025 microwatts, but still it is minute and if fed directly to a loudspeaker, would produce no reaction whatsoever.

BIASING FOR A.C.

We shall use a transistor to give us voltage and current amplification at the same time. It will use the minute current available from the crystal microphone to control its collector current which, of course, should be higher.

The current from the microphone will be fed to the transistor's base/emitter circuit. The trouble is that the output from the microphone is an alternating current going both positive and negative about zero and typically it will not exceed 10mV peak. We already know that we have to make the base of an *npn* transistor at least 600mV positive w.r.t. the emitter before any base current is passed, therefore the output from the microphone will not have any effect at all when it is on a positive half cycle—let alone when it is on a negative half cycle. We have to put the transistor into a "partial" state of conduction before we consider the effect of the microphone. This we call "biasing."

We usually try to bias a transistor so that the current flowing through the collector load resistor causes the voltage at the collector to be about half the supply voltage. Any small variations in base current ultimately caused by signals from the microphone will then cause the voltage at the collector to move either more positive, or down towards zero, depending on whether the microphone is producing positive or negative half cycles.

The first thing we have to do is set the biasing so that the output of the collector is approximately half the supply—we call this the "quiescent" condition. To make matters simple for ourselves let's assume we want a quiescent current of 0·5mA to flow in the collector of TR1 in Fig. 2a (there are various factors which control the choice of this current, but we will ignore these at this point).

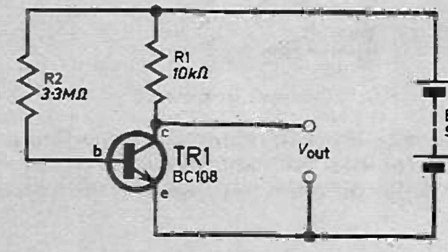


Fig. 2(a). If h_{FE} for TRI was exactly 200, V_{out} would be approximately +5·0volts. In practice this is most unlikely as h_{FE} can vary considerably from device to device.

To set the collector voltage at 4·5V with 0·5mA flowing, the drop across R1 must equally be 4·5V, thus we can calculate the value of R1 using Ohm's law (V=IR).

$$R1 = \frac{4 \cdot 5}{0 \cdot 0005} = 9{,}000 \text{ ohms}$$

Let's say 10,000 ohms (10 kilohms) as the nearest convenient value. This will modify the voltage at the collector to +5V (relative to the emitter line) but this is near enough for our purposes.

To pass a current of 0·5mA in the collector circuit, we must pass a base current of $0 \cdot 5/h_{FE}$ mA.

Using a BC108 the h_{FE} will be around 200, therefore I_b will be 0·0025mA—we must provide this through our bias circuit.

If we use the positive rail as the source of base current we must limit it through a resistor (R2) and this will have a value given by 9V minus 0·6V, divided by the base current (I_b). Therefore,

$$R2 = \frac{9 - 0 \cdot 6}{0 \cdot 0000025} = 3{,}360{,}000 \text{ ohms (say 3·3 megohm)}$$

EXPERIMENTAL CHECK

Wire up this circuit on the Demo Deck and measure the potential at TR1 collector. The chances are that it will not be the +5V as calculated because we have made the assumption that h_{FE} was 200, and this is not necessarily the case as it varies considerably from one device to another (use a 20,000 ohm per volt voltmeter for this and other measurements).

We can "cheat" a bit at this stage and adjust the quiescent base current to give us the output level we require as shown in Fig. 2b. Wire up this circuit on the Demo Deck, VR1 is the 100 ohm potentiometer of the Demo Deck which we will use to set the drive voltage for the base

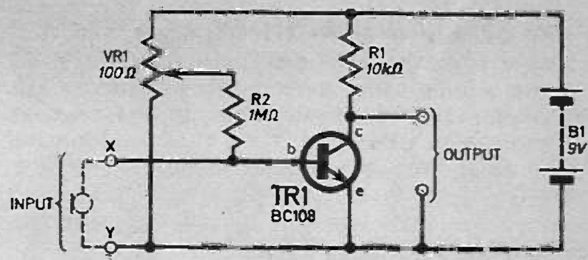


Fig. 2(b). Variations in h_{FE} can be overcome by adjusting the bias with VR1 until the quiescent output voltage is + 4·5V.

current, and R2 is now made 1 megohm. Adjust the setting of VR1 until the collector voltage is exactly midway (+4·5V).

Having set the d.c. state of our circuit we can now inject the signal from our microphone. Connect the pair of wires from the microphone between base and emitter. This should not affect the 4·5V at the collector because the microphone is virtually a capacitor and will not modify the d.c. current in the base circuit. Any signal from the microphone will now add to or subtract from the standing base current.

Try speaking close to the microphone and you might just see a slight flicker on your voltmeter; probably not much because you are trying to measure a high frequency voltage on top of a reasonably high d.c. level. We can get rid of the d.c. level and at the same time rectify the alternating current by the complete circuit shown in Fig. 3.

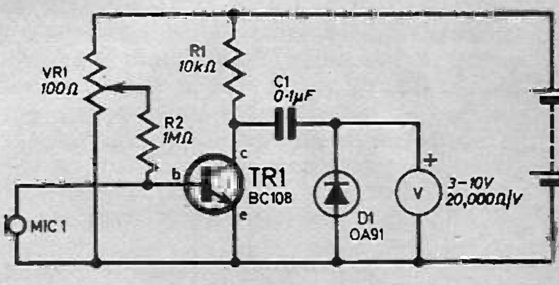


Fig. 3. Complete common emitter amplifier stage with output voltage metering circuit.

Capacitor C1 will pass the a.c. while blocking d.c. and diode D1 shorts out negative half cycles. You can now set your meter to a lower d.c. range and when you talk fairly loudly and close to the microphone, you should see voltage swings of about 1 volt.

Obviously we have amplified the approximate 10mV output of the microphone, but what current swings do we now get? The 1V swings are occurring across a 10 kilohm resistor, therefore the current must be varying by about 0·1mA. Thus the power in R1 is being varied by at least 1V x 0·1mA=0·1mW and this is caused purely by the current injected by the microphone.

We still cannot apply 0·1 milliwatts to a loudspeaker and expect to hear anything, but at least we are talking about a level only one hundredth of the minimum desirable level and this is a vast improvement compared with the fractions of microwatts we have been talking about previously.

GROUNDED EMITTER

The circuit wc have made is called a **grounded emitter amplifier** stage because the emitter is connected directly to the negative power rail. Sometimes it is called a **common emitter** stage because the input source used the emitter line as one of the connection points, and we measured the output relative to the same emitter line.

The method of biasing is somewhat unconventional, but in this case is used to demonstrate the principle involved. We will later come across some more sophisticated ways of biasing.

HIGHER POWER

Now let's press on and see if we can produce sufficient power from the microphone to drive a loudspeaker. We now have a signal level of 1 volt at low current. Assume we had unlimited current available; 1 volt across a loudseaker of 35 ohms impedance (as is that in the Demo Deck) would dissipate a power of

$$\frac{V^2}{R} = \frac{1 \times 1}{35} = 29\text{mW (approximately)}$$

This would be ample to produce an audible sound. Therefore 1 volt is sufficient, but we need more current. Now we shall use another transistor in a current amplifier circuit that does not change the voltage swings.

The simplest circuit to do this is called an **emitter follower** or **grounded collector** stage. The basic circuit is shown in Fig. 4a.

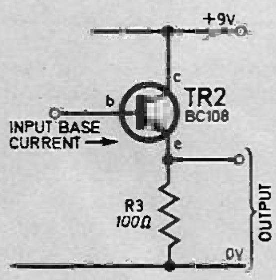


Fig. 4(a). Basic emitter follower circuit.

Notice that the 100 ohm resistor (R3) is in the emitter circuit. In the absence of any base current, the potential at the emitter will be zero. We can now do another simple experiment on the Demo Deck using the circuit diagram of Fig. 4b.

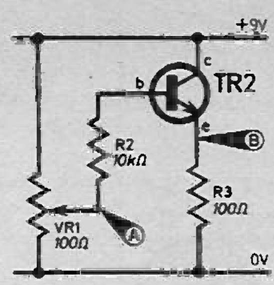


Fig. 4(b). Experimental circuit to show the working of an emitter follower stage. Measure voltages at B for different settings of voltages at A.

Connect a 10 kilohm resistor to the base of TR2 and take the other end to a 100 ohm potentiometer—used as a potential divider. Monitor the voltage at the emitter of TR2 and slowly increase the voltage at the wiper of VR1. At each setting of VR1 you should find that the potential at the emitter is the same, less about 600mV.

The reason for this is that base current is drawn by the transistor as soon as the base becomes 600mV more positive than the emitter, but this base current causes collector current to flow and this causes the potential at the emitter to rise. The ratio of base to collector current (which is almost the same as emitter current) is again h_{FE}.

The voltage at the emitter will rise until it nears 600mV below the base voltage, and then the rise will stop; the emitter cannot rise more positive than the base—or even reach the same value—because if it did, base current would cease to flow, and hence the collector current would fall. Thus apart from the initial 600mV difference, we say the emitter voltage "follows" the base voltage.

There is an important difference though in these two voltages. The one at the base is produced through a 10,000 ohm resistor, while that at the emitter is across 100 ohms. Notice we have in effect reduced circuit resistance (or impedance) across the transistor.

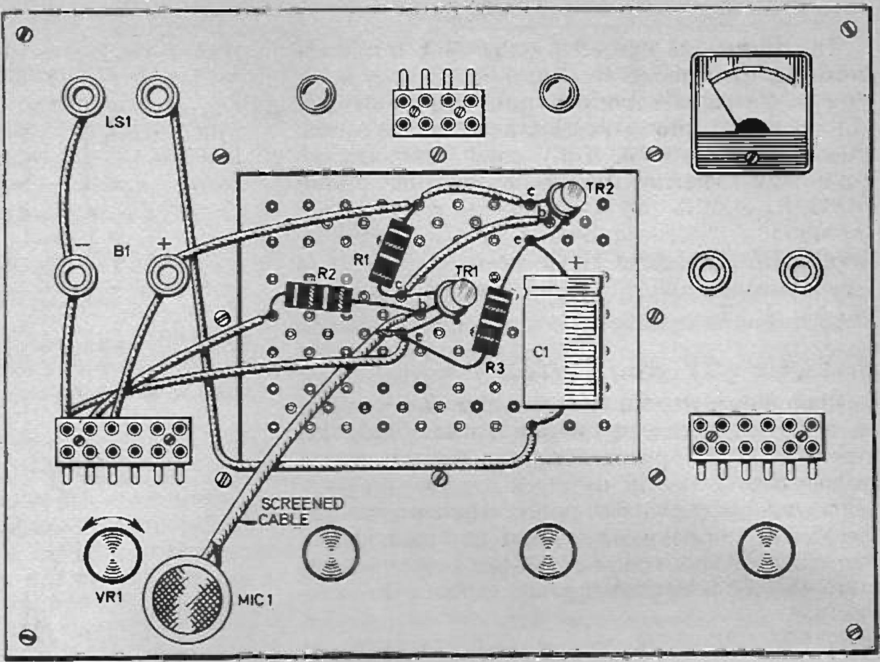
A voltage causing a low current to flow through a high resistor in the base circuit causes a similar voltage to appear across a much lower resistor, hence the current must be much higher. We can work out what the maximum current we can control in the emitter circuit will be by simply multiplying the available base current by h_{FE}.

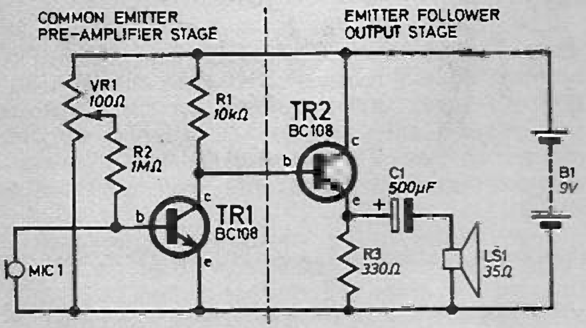
TWO-STAGE AMPLIFIER

Instead of connecting the base of TR2 to the wiper of a potentiometer through a resistor, we will connect it straight to the collector of TR1, see Fig. 5. All the voltage measurements we saw before will appear at the emitter of TR2 apart

Fig. 5(a) (below). Complete microphone amplifier giving a reasonable output into a 35 ohm loudspeaker. The effect of excessive or insufficient bias current can be experienced by adjusting VR1.

Fig. 5(b) (right). The microphone amplifier of Fig. 5(a) wired up on the Demo Deck.





from a 600mV constant drop, but the currents flowing will be considerably higher.

A small proportion of the current flowing through R1 is sufficient to provide the base current for TR2 without affecting the collector levels of TR1 too much.

Wire up the circuit of Fig. 5a on the Demo Deck (Fig. 5b). The 35 ohm loudspeaker of the Demo Deck is connected through a 500μF capacitor. The potential at the emitter will be about +3·9V (caused by the quiescent potential at the collector of TR1).

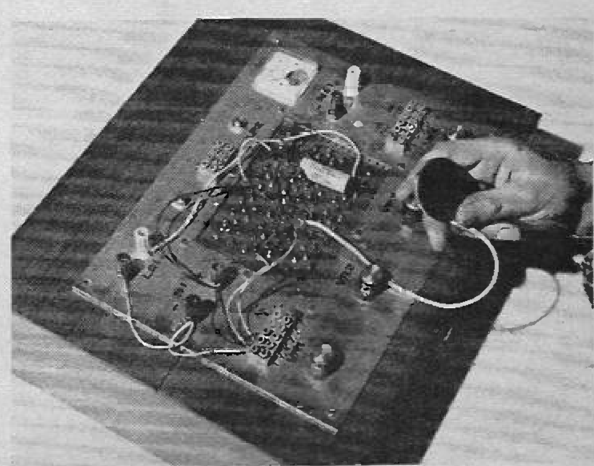
In the absence of signal from the microphone no d.c. will flow through the capacitor and loudspeaker, but if we speak into the microphone the fluctuations in emitter current will pass through the capacitor into the coil of the loudspeaker and produce quite a reasonable audio output.

The capacitor presents very low impedance to the path of a.c. and the small a.c. currents (compared with the quiescent current) are fed directly to the loudspeaker with only a small proportion being shunted by R3.

You will probably find that the circuit is so sensitive that you will encounter acoustic feedback. This shows itself in the form of a "howl." It is caused by the sound from the speaker being picked up by the microphone, being re-amplified and fed back to the speaker—only to repeat the same cycle over and over again. The best way to prevent this is to separate the microphone and the loudspeaker by a reasonable distance.

VARYING THE BIAS

Remember the bias is still set by VR1 right at the front end. Try varying the bias in both extremes. By reducing the bias current to zero, you will find that the gain of the system reduces to zero; by increasing it you will notice, first of all, distortion which gets worse and worse until there is again virtually no output.



Photograph of the microphone amplifier connected up on the Demo Deck.

The former is caused by the first transistor refusing to conduct at all, while the second is due to the signals from the microphone driving the transistor into saturation until the bias itself makes the transistor fully conducting all the time. Try experimenting with different values of R1, R2 and R3 and see if you can arrive at any deductions regarding output levels or biasing levels. Do not make these resistors less than the following values: R1 1 kilohm, R2 10 kilohm, R3 100 ohms.

FREQUENCY RESPONSE

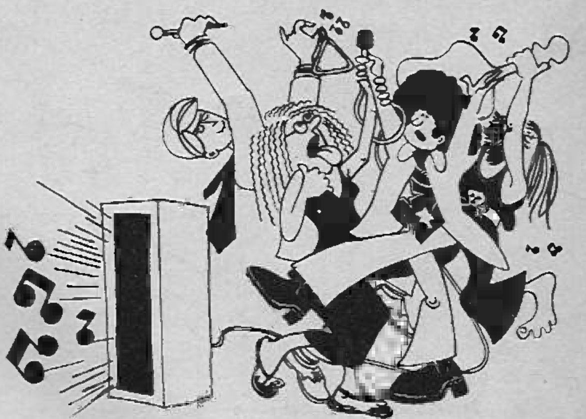
Remember we said that the impedance of the microphone increased for low frequencies? This means that the amount of base current it can supply into TR1 will decrease for low frequencies and increase for high frequencies. Try "crooning" into the microphone and then whistling a high note (both at about the same volume) and you will hear that the output from the loudspeaker is very much greater for the higher whistled note. You can, in fact, measure the differences in amplitude if you go back to the metered experiment shown in Fig. 3.

We say that this amplifier does *not* have a "flat response" and hence does not reproduce the original signal to perfection—the fidelity is therefore poor.

In the case of, say, an intercom, this does not matter but it is a terrible fault to have if we are trying to obtain hi-fi. In quality designs, steps are taken to reduce this effect of amplitude "roll-off" at low frequencies.

Next month we shall show you two better ways of biasing the first transistor that will do away with the necessity for VR1 and also a better impedance matching stage that will give us more power output at higher efficiency.

Next month: Amplification. Components required in addition to those already obtained: resistors, 2.2kΩ, 22kΩ, 150kΩ, 470kΩ, 560kΩ, 1MΩ (all $\frac{1}{4}$W ±10%, 1 off each). Capacitors, 2,000pF (1 off), 50μF elect. 15V (2 off). Transistors, BC 108, 2N3702 (1 off each).



Ruminations
By Sensor

Other People's Jobs

While waiting to turn into a main road the other day, my car came to rest opposite one of those Post Office Telephones "tents" erected over a hole in the pavement. I peered into the tent just as a man climbed out of the hole; our eyes met. "Not a bad day for camping," I said, he considered my remark for a while then agreed, good naturedly, that it wasn't at all bad.

Later, I wondered what I would have said if he had leaned over my shoulder in the electronics lab and said, "Not much on the telly today," as I gazed into the oscilloscope. I hope that I would have been as agreeable as he was.

Other peoples jobs fascinate me. Fortunately, I find that most people are willing to talk about their work if they believe that the enquirer is really interested. Sometimes, if pressures of work are not too great, one may be invited to "have a go" and the experience can be most satisfying. I enjoyed, particularly, an opportunity to try my hand (and mouth) at glass blowing.

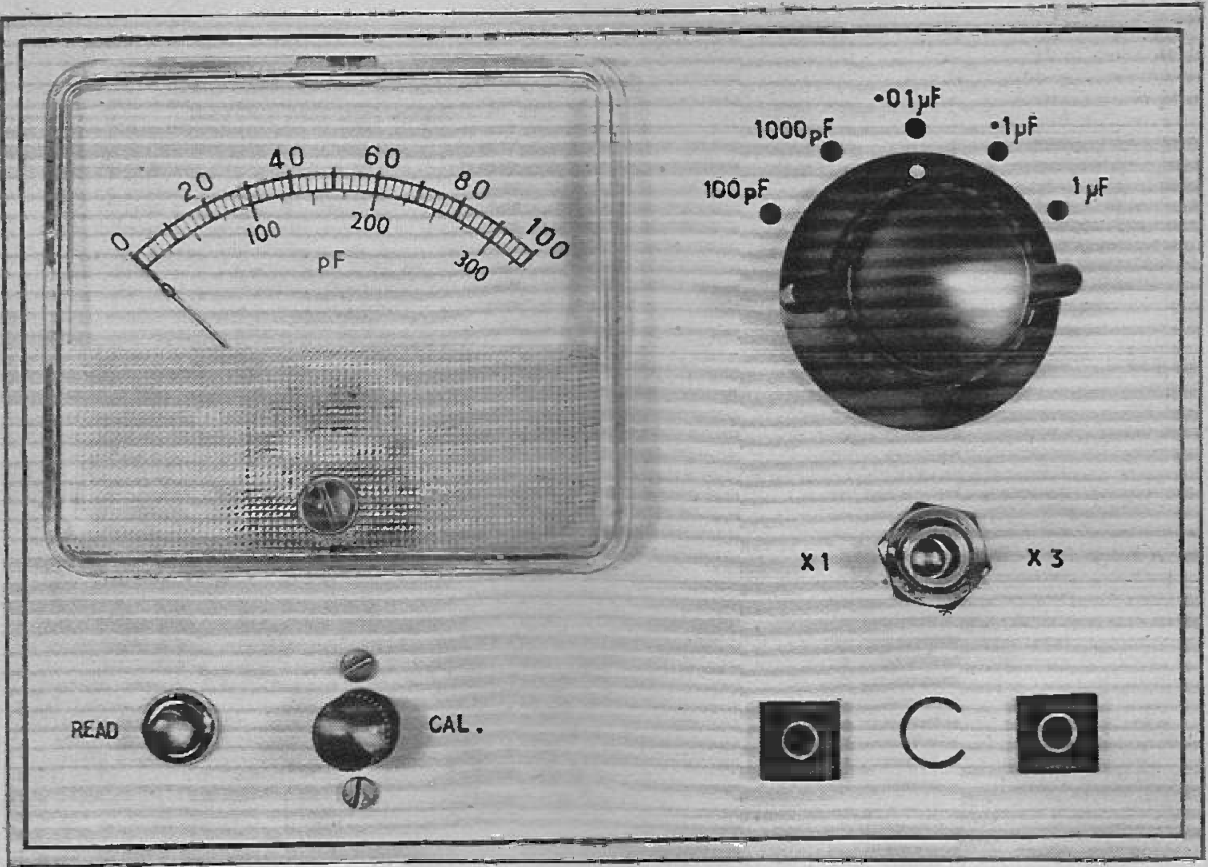
A Little Knowledge

One frosty morning, the sink fitted in the electronics laboratory in which I was working, became blocked. By the time we had all rinsed our tea cups the water was an inch or so deep, and eager to play the plumber, I unscrewed the plug from the trap. The water drained into the bin that I had placed beneath, but the sink was found to be still blocked when the plug was replaced. I admitted defeat and returned to my 'scope and "breadboard".

Later, someone else decided to "have a go". He connected a hose from the compressed air supply to the sink outlet and turned on the compressed air—the water disappeared and did not return. "Well done," we said, and he took up his soldering iron again with a happy smile. A few minutes later, a man from the lab above came in. "You ought to have been in our lab, just now," he said. "A great jet of water shot out of the sink and went all over the ceiling!"

We expressed our sympathy, and the right amount of incredulity, and sent for the plumber.

Electronics engineers are a pretty dedicated lot on the whole, but like everyone else they enjoy a bit of fun. On one occasion we noticed a wire dangling from the lab above, "Ah, someone is building a radio" we said. We fished the wire through our window and connected it via a 0·1μF capacitor to a signal generator, while someone from our lab went up to "help" them to cure their oscillating radio!



CAPACITANCE

THE value of many fixed capacitors is merely printed on the side of the body, and this can be rubbed off by contact with fingers, or when components are stored loose in a tray.

Unmarked variables and trimmers can also be quite difficult to identify on occasions.

Anonymous capacitors can be reclaimed with the aid of a capacitance bridge—if one is available—but this will entail time consuming dial adjustments. It would obviously be much easier to use a direct reading instrument, similar to an ohmmeter, to measure capacitance.

Notable features of the meter described here are good coverage of picofarad values and a simple circuit based on two transistors. Capacitance from 100 picofarad—1 microfarad full-scale is covered by five switched ranges, plus an additional times three multiplier.

Accuracy depends on the tolerance of components used for meter construction, and on available calibration standards, but it is possible to achieve ±2 per cent on individually calibrated ranges if a ±1 per cent meter movement is used.

BASIC CIRCUIT

An electronic switch and an a.c. reading meter form the basic circuit of the Capacitance Meter (see Fig. 1).

With the switch operating at a fixed frequency from a battery of stable voltage, the average current passed by the unknown capacitor is proportional to its value, and widely differing values can be accommodated if the electronic switch is made to function at selected frequencies.

Maximum attainable switching frequency and stray capacitance due to wiring, etc., places a limit on the smallest value that can be measured, in this case about 3 picofarad.

At the other extreme, meter pointer vibration at the lowest switching frequencies encountered

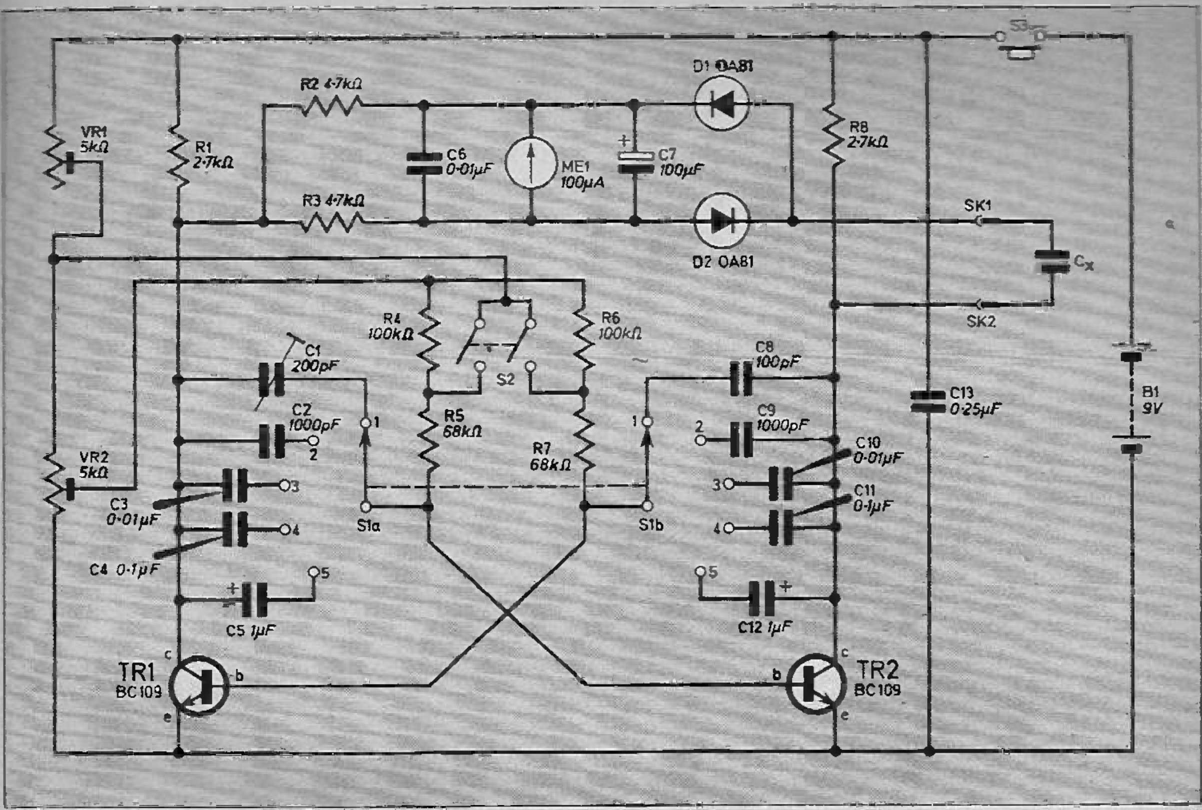


Fig. 2. The complete circuit diagram of the Capacitance Meter.

METER

A direct reading capacitance meter for non-polarised low value capacitors.

by D. Bollen

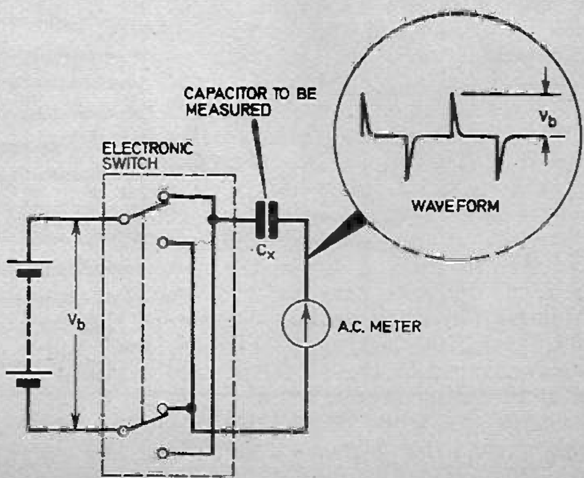
Approximate cost of components £5·50 plus case

will restrict the largest measurable value to 3 microfarad.

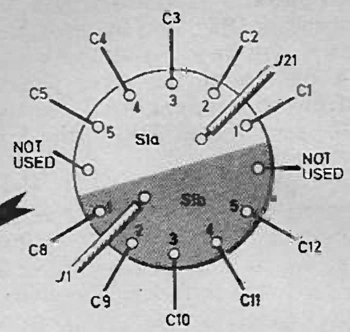
MULTIVIBRATOR SWITCH

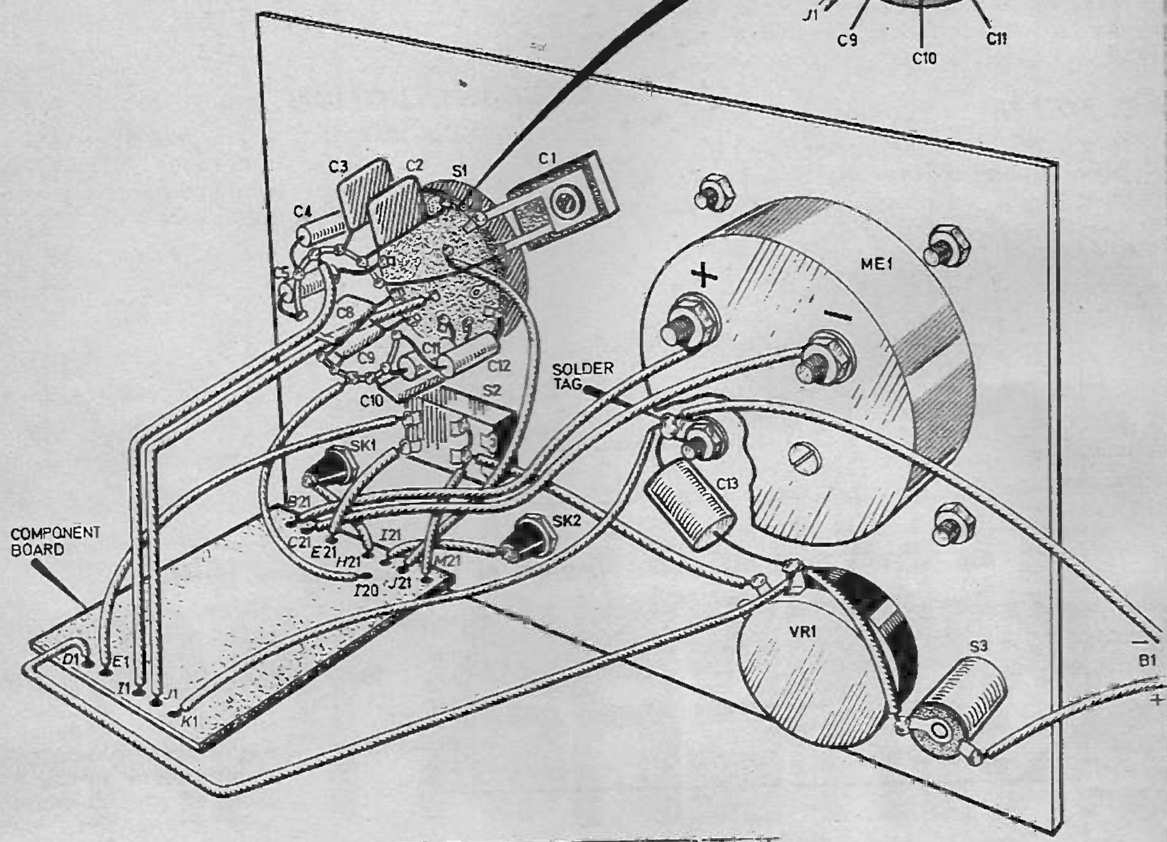
The electronic switch used in the Capacitance Meter is an astable multivibrator. Looking at the complete circuit, Fig. 2, the multivibrator switching frequency is determined by switch

Fig. 1. The basic circuit of the Capacitance Meter.



CAPACITANCE METER





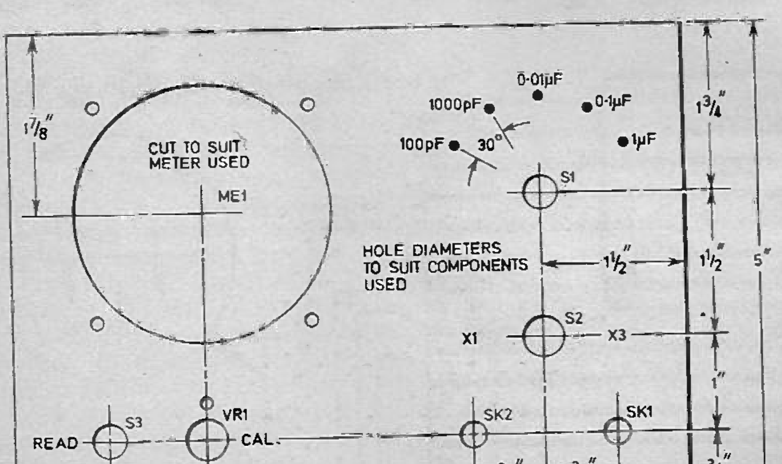


Fig. 3. The complete wiring diagram of the Capacitance Meter. Everything is connected to the back of the front panel.

Fig. 4. Suggested dimensions for the front panel, made from Paxolin, Formica or Perspex.

selected pairs of capacitors (S1a, S1b), switched base resistors (S2), and by an adjustable voltage applied to the base resistors (VR1, VR2).

With S2 closed, S1 gives decadal frequency steps from approximately 10Hz to 100kHz, and with S2 open 3Hz to 30kHz, the latter being the times three ranges.

Preset potentiometer VR1 provides a fine adjustment of frequency for both S2 settings, and thus acts as an overall calibration control to cater for falling battery voltage, while VR2 serves only for initial calibration of the times three multiplier.

A.C. METER

The a.c. reading meter, made from R2, R3, C6, C7, MEI, DI, and D2 (see Fig. 2) is connected in series with the unknown capacitor C_x between the collectors of TR1 and TR2.

Because of the steep sided exponential waveform fed by C_x to the rectifier diodes D1 and D2, and a multivibrator output of more than 15V peak to peak, errors due to diode non-linearity are small. Tests with a large ±1 per cent meter showed a non-linearity of less than 0·5 per cent over 98 per cent of the scale.

Battery drain of the circuit is only 5mA, and the push to read button S3 will ensure that the meter is not accidentally left on after use, so battery life will be almost as good as shelf-life.

CONSTRUCTION

Fig. 3 gives drilling details and dimensions of a 7in x 5in s.r.b.p., Formica or Perspex front panel. A metal panel is avoided because it would tend to increase stray capacitance on the 0-100 picofarad range.

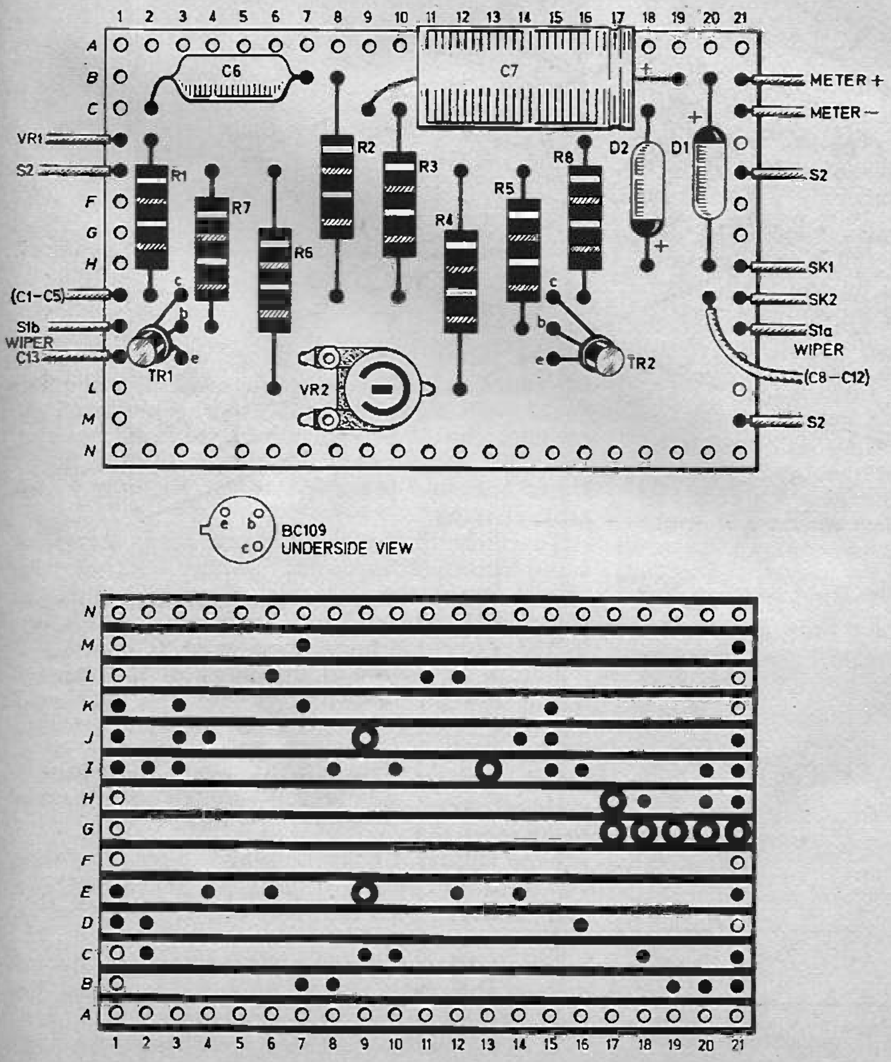
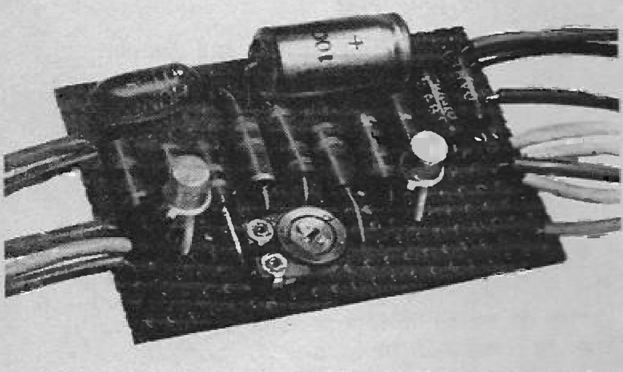


Fig. 5. The layout of the components on the top side of the Veroboard with flying lead connections. Below is shown the regions of copper strip to be removed from the underside.

After lettering the front panel, mount VR1, S2, S3, ME1, SK1, and SK2, as shown in the general wiring and layout diagram shown in Fig. 4.

Switch S1 should be pre-assembled with capacitors C1-C5 and C8-C12 before mounting on the panel.

Next, solder the components to a 2·1in x 1·4in piece of 0·1in matrix Veroboard, as shown in Fig. 5. The Veroboard cut-outs at positions H17, G17, 18, 19, 20 and 21, have been made to minimise stray capacitance between the copper strips.



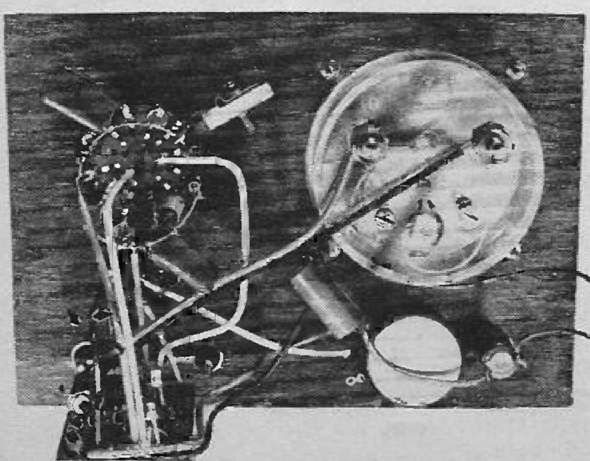
Photograph of the top side of the Veroboard with all components in position.

The transistors and diodes should be the last components to be soldered in position and a heat shunt must be used on the leads when soldering, otherwise permanent damage may be done to these components.

Attach lengths of 22 s.w.g. tinned copper wire to the ends of the panel to form leads.

When the circuit panel is complete, offer it up to the front panel as close as possible to SK1 and SK2, and then cut the leads, insulate with sleeving, and solder the 22 s.w.g. leads to the front panel components.

The wiring on the back of the front panel of the prototype.

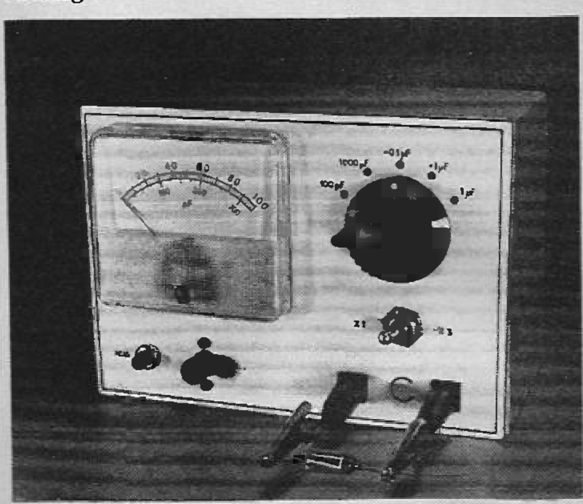


When this wiring is completed it will be found that the circuit panel is held quite firmly and will need no additional support.

Complete the wiring by interconnecting the front panel components, not forgetting C13.

CALIBRATION

To check that the instrument is working on all ranges, temporarily connect a 33 kilohm resistor in series with a capacitor of about 0·5 microfarad between SK1 and SK2, and press S3. A meter reading should be obtained at all range settings.



The prototype in use.

Two silver mica capacitors of ± 1 per cent tolerance, a 100 picofarad and a 10,000 picofarad, will serve to calibrate the meter. First connect the 10,000 picofarad standard to SK1 and SK2, set S1 to 0·01 microfarad and S2 to times one, and press S3; adjust VR1 for a full scale reading.

To calibrate the times three range with the same standard capacitor, rotate VR2 on the circuit panel fully clockwise, set S2 to times three, and then adjust VR2 carefully until the meter reads 0·01 microfarad when S3 is pressed.

Return S2 to the times one position and set S1 to 100 picofarad. Place the 100 picofarad standard capacitor across SK1 and SK2 and trim C1 for a full scale reading. Remove the 100 picofarad standard capacitor and observe the residual stray capacitance reading, this should be no more than 3 picofarad.

Now adjust C1 again while measuring the 100 picofarad standard, to make the meter read 100 picofarad plus the stray capacitance, that is, slightly more than full scale.

When using the 100 picofarad range, always deduct the stray capacitance value from the indicated value to obtain the true value.

If it is found that there is excessive pointer vibration with the particular meter movement used for ME1, on the 3 microfarad range, a capacitor of about 300-500 microfarads can be wired across the meter terminals in series with a switch, to give additional smoothing on this range.

The capacitance meter is only suitable for measuring non-polarised capacitors with a rating of 15V or more. A shorted capacitor will show up as a more than full scale reading on all ranges, while an open circuit component will give no reading at all. ▣

Components....

SEE SHOP TALK

Resistors

R1 2·7kΩ
R2 4·7kΩ
R3 4·7kΩ
R4 100kΩ
R5 68kΩ
R6 100kΩ
R7 68kΩ
R8 2·7kΩ
All ½ watt ±10% carbon

Potentiometers

VR1 5kΩ linear carbon, T.V. preset type
VR2 5kΩ miniature preset, horizontal mounting

Capacitors

C1 200pF compression trimmer
C2 1,000pF ±1% silver mica
C3 10,000pF ±1% silver mica
C4 0·1μF polycarbonate or polyester ±10% or better
C5 1μF polycarbonate, tantalum, or polyester ±10% or better
C6 0·01μF polyester ±20%
C7 100μF elect. 15V
C8 100pF ±1% silver mica
C9 1,000pF ±1% silver mica
C10 10,000pF ±1% silver mica
C11 0·1μF polycarbonate or polyester ±10% or better
C12 1μF polycarbonate, tantalum or polyester ±10% or better
C13 0·25μF polyester ±20%

Transistors

TR1, TR2 BC 109 silicon *npn* (2 off)

Diodes

D1, D2 OA81

Switches

S1 Two-pole six-way wafer
S2 Double-pole changeover toggle
S3 Single-pole push button

Miscellaneous

ME1 100μA (with 0–3, 0–10 scales) ±2% or better
B1 9V battery PP3
4mm plugs and sockets; 7in x 5in s.r.b.p., Perspex or Formica front panel; 2·1in x 1·4in Veroboard 0·1in matrix; knob; 22 s.w.g. tinned copper wire; two crocodile clips.

Continued from page 591

further advances being made in cable laying methods. This includes a new type of cable laying "engine" designed by the Post Office. The new engine was first used to lay the UK-Spain cable in 1970.

A modified design of the engine will be fitted to the Canadian cable ship and ice breaker *John Cabot* which will be used to bury the Cantat 2 cable and repeaters in the shallow waters of less than 300 fathoms off the Nova Scotia coast to protect the cable from damage by trawlers.

The cable and repeaters are laid through a plough-type device and the *John Cabot* is at present the only ship available powerful enough, because of her other activity as an ice breaker, to pull the plough. Remote TV cameras are fitted to the plough and linked to monitors in a control room on board. More TV monitors and indicators showing cable tensions and ground speed of the plough are also mounted on the ship's bridge.

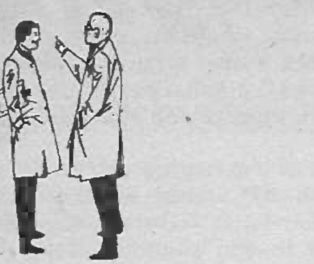
The plough is capable of cutting a furrow in the sea floor allowing the cable to be buried to a depth of up to 26 inches. The other ship which will be engaged in laying 95 per cent of the cable is the Cable and Wireless ship, *Mercury*, which is also to be fitted with a linear laying engine.

After all the work of the electronic experts in developing today's trans-ocean cables and the use of the latest scientific navigation and monitoring devices nature must still be accounted for. Storms are still a hazard to the cable ships. Photographs taken from the bridge of a Post Office cable ship are used by the Meteorological Office as a standard reference to illustrate sea conditions in a hurricane. ▣

ADDENDUM

Since this article was written the Post Office's Research Department at Dollis Hill has received the Queen's Award for Industry, given for "Technological Innovation" in the development and production of high quality transistors for use in undersea telephone cables.

Cable Ship *Alert* lying to final splice at Kennack Sands, Cornwall during the laying of a U.K.—Spain cable.



SHOP TALK

By Mike Kenward

A NUMBER of readers have written to us regarding the supply and use of Veroboard, since we feel that there may be a great number of readers who are not fully aware of the types, we will try and clarify the situation.

Firstly, there are three fairly common types and we use the following terms to describe them; Veroboard—by this single name we mean perforated board with lines of copper on one side only, this is probably the most common and the one we usually use; plain Veroboard—this is perforated board with no copper strips on it; double sided Veroboard — perforated board with copper strips on both sides, we have never yet used this type of board and it is doubtful if we ever will, as it is not necessary for the type of projects we describe.

We usually use 0·15 inch matrix, this means that the rows of holes are 0·15 inches apart, there are other sizes (0·1 inch and 0·2 inch) so make sure you get the right one.

Infra-Red Burglar Alarm

The main buying problems for the *Burglar Alarm* are more likely to concern the non electronic parts, in particular the infra-red screen and the two eye glass magnifiers. The screen should be obtainable from most large photographic suppliers but in case of difficulty some alternatives have been given in the text.

The two lenses used do not have to be exactly the same as those shown on the prototype but they do give a neat finish to the unit. You should be able to obtain them from some watchmenders but you may have to hunt around.

Alarm requirements will decide if RLA 1 is to be used, the main point when buying this is that the contacts can switch the load applied by the alarm.

If you have an old OC 71 you could try scraping the black paint off it to use it as TR1 (OCP 71). The old types were filled with an almost clear jelly-like substance which allows light to get at the junction inside—newer ones use an opaque substance which does not allow enough light to pass.

Capacitance Meter

When buying for the *Capacitance Meter* you must make sure that the capacitors you get are the correct type and that the tolerances are within those specified. You will probably have to pay a little more for the better tolerance but the resultant accuracy of the meter is worth the extra.

A two-pole six-way wafer switch has been used in the prototype although only five ways are used, this is because the six way type is easier to obtain.

Once again with this project the meter will be the most expensive part, but it is worth buying a fairly good one for the sake of accuracy. You should be able to buy one marked with 0-10 and 0-3 scales.

It is of course, possible to recalibrate your own meter, using Letraset, if you carefully dismantle the case and remove the scale.

LW/MW Radio Tuner

There should be no buying problems for the Radio Tuner, the only items that could possibly cause trouble are the two coils. If you cannot get them in your area write to one of the larger London based suppliers—most of them are able to supply.

New Products

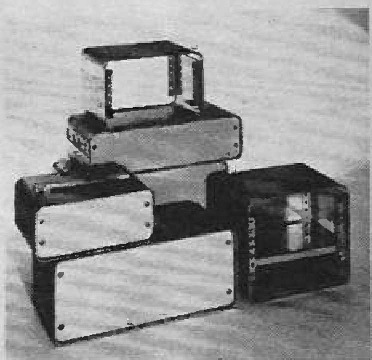
Having written about the Linear 505 amplifier last month, and complained about the poor specification quoted, we then received news of another new amplifier from Linear—the 606! Linear say that the 606 is believed to be the lowest priced stereo amplifier, designed for a magnetic cartridge, to ever become available through the normal wholesale—retail channels. The recommended retail price is £22·50.

The specifications quoted are rather better than for the 505: output, 6W music power into 15Ω (that's about 3W continuous r.m.s. [our estimate]); input sensitivity, 3·5mV magnetic, 35mV ceramic, 100mV tape and 400mV tuner; total harmonic distortion 0·1 per cent at 1 watt; frequency response range (whatever that means) 20Hz to 65kHz.

We said the specifications quoted are rather better, by this we mean the way they are quoted, not the actual figures. Since most of the figures are qualified in some way it is a pity that a proper frequency response figure is not quoted, but at the price, one must not expect the highest quality.

Another new product this month is the Mod-3 case from West Hyde Developments Ltd, Ryefield Crescent, Northwood Hills, Middx. HA6 1NN. West Hyde have long provided a professionally finished case (the Mod-2) and they have now introduced this new case design.

Mod-3 cases are provided in a variety of sizes, the smallest being $7 \times 3 \times 5\frac{1}{4}$ inches deep and the largest $11 \times 6 \times 5\frac{1}{4}$ inches deep, they are finished in blue and grey p.v.c. covered metal (outside blue, panels grey) and cost from £2·25 to £4·25.



Bi-Pre-Pak Ltd.

Due to a printer's error in our August issue an incorrect price was quoted for the Complete Telephone as offered for sale by the above company. The correct price should have read 95p. We offer our apologies to Bi-Pre-Pak Ltd., and to any readers who may have been inconvenienced by this error.

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GARLAND BROS. LTD,
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TRANSFORMERS
all with 0–250 Volt primaries
Miniature
MM6 6V, 500mA + 6V, 500mA
MM12 12V, 250mA + 12V, 250mA
MM20 20V, 150mA + 20V, 150mA
£1·29 plus 13p p. & p.

L.T.
LT1 6·3V, 1·5A—75p plus 18p p. & p.
LT2 6·3V, 3A—80p plus 26p p. & p.
LT3 12V, 1·5A—80p plus 26p p. & p.
LT4 12V, 3A—£1·32 plus 30p p. & p.
LT5 9–0–9V, 0·5A—75p plus 21p p. & p.
LT6 12–0–12V, 1A—95p plus 26p p. & p.
LT7 30–0–30V, 1A—£1·87 plus 30p p. & p.

Multi-tapped
MT30/2 0–12–15–20–24–30V, 2A—£1·95 plus 30p p. & p.
MT60/1 0–5–20–30–40–60V, 1A—£1·97 plus 30p p. & p.
MT60/2 0–5–20–30–40–60V, 2A—£2·90 plus 34p p. & p.

Charger
CT/01 1A—£1 plus 26p p. & p.
CT/02 2A—£1·25 plus 30p p. & p.
CT/03 4A—£1·50 plus 30p p. & p.
Secondaries—0–5–11–17V.

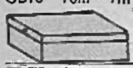
Auto-transformers
AT30 30W—£1·18 plus 30p p. & p.
AT75 75W—£1·85 plus 30p p. & p.
AT150 150W—£2·55 plus 34p p. & p.
AT300 300W—£4·75 plus 42p p. & p.
AT1000 1000W—£8·90 plus 62p p. & p.
All shrouded with terminal blocks. AT30 0–110–240V. All others 0–110–200–220–240V.

Speaker isolating transformer
1 : 1 ratio for 3–15Ω, 2W—86p plus 13p p. & p.

Speaker matching transformer
Tapped 3, 8, 16Ω. Will match almost any speakers to any amplifier. 15W max.—90p plus 20p p. & p.

ALUMINIUM BOXES
with lids and screws

Type	L.	W.	D.	Price	p. & p.
GB7 *	5¼in	2¼in	1½in	38p	15p
GB8 *	4in	4in	1½in	38p	15p
GB9 *	4in	2¾in	1½in	38p	13p
GB10*	5¼in	4in	1½in	44p	18p
GB11	4in	2½in	2in	38p	13p
GB12	3in	2in	1in	33p	13p
GB13	6in	4in	2in	52p	18p
GB14	7in	5in	2½in	63p	19p
GB15	8in	6in	3in	81p	26p
GB16	10in	7in	3in	92p	26p

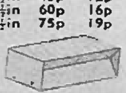


* These sizes fit standard veroboards

EQUIPMENT CASES
with sloping front panel

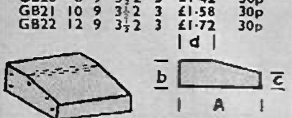
Type	H.	W.	D.	Price	p. & p.
SF1	2in	5¾in	2½in	45p	12p
SF2	2in	7¾in	3½in	60p	16p
SF3	2in	9¾in	4½in	75p	19p

Plain aluminium. Stove - enamelled silver-grey hammer finished, 20p extra.



CONSOLE CASES
in plain aluminium, ideal for mixers, instruments, etc.

Type	W. in	A in	B in	C in	D in	Price	p. & p.
GB20	8	9	3½	2	3	£1·42	30p
GB21	10	9	3½	2	3	£1·58	30p
GB22	12	9	3½	2	3	£1·72	30p



VEROBOARD

Size	0·1 matrix	0·15 matrix
2½in × 3¾in	22p	16p
2½in × 5in	24p	25p
3¾in × 3¾in	24p	25p
3¾in × 5in	27p	29p
17in × 2½in	75p	57p
17in × 3¾in	£1	75p

Pins—either size; packet of 36, 18p

ELECTROLYTICS

1µF	450V	19p	1,000µF	25V	27p
2µF	500V	20p	1,000µF	50V	39p
4µF	350V	14p	2,000µF	25V	36p
8µF	450V	16p	2,000µF	50V	53p
16µF	450V	17p	2,500µF	25V	45p
25µF	25V	7p	2,500µF	50V	60p
25µF	50V	8p	3,000µF	25V	48p
32µF	450V	24p	5,000µF	25V	55p
50µF	50V	10p	5,000µF	50V	98p
100µF	25V	10p	8–8µF	450V	18p
100µF	50V	10p	8–16µF	450V	20p
250µF	25V	12p	16–16µF	450V	27p
250µF	50V	17p	16–32µF	450V	63p
500µF	25V	18p	32–32µF	450V	49p
500µF	50V	25p	50–50µF	350V	38p

MINIATURE ELECTROLYTICS

1µF	63V	6p	10µF	64V	7p
2·2µF	63V	6p	16µF	40V	7p
4µF	40V	7p	30µF	15V	7p
4·7µF	63V	6p	47µF	16V	7p
8µF	15V	7p	47µF	25V	6p
8µF	40V	7p	68µF	16V	6p
10µF	25V	6p	100µF	10V	6p

ENTIRE MULLARD 015 016 017 RANGE ALSO STOCKED

CASSETTE OWNERS!
For Philips and similar cassette recorders.
PU12 Power unit for connection to 12V + or — E car electrical systems, giving 7½V. stabilised output. **£3·25**
PU14 As above but switched for 6V, 7½V or 9V output. **£5·10**
PP75 Mains power supply, output 7½V d.c. **£1·95**
All units are complete with cable and plug.

VARIABLE POWER SUPPLY
Input: 240V, a.c.
Output: Switched 3, 4·5, 6, 7·5, 9, 12 volts d.c. at 500mA **£4·20**

BATTERY ELIMINATORS
suitable for transistor radios and similar light current equipment
PP6 Input 240V a.c. Output 6V d.c.
PP9 Input 240V a.c. Output 9V d.c.
Price £1·50 plus 12p p. & p.

NEW NEW
ILLUSTRATED 1972-73 CATALOGUE
Post Free 15p

CONTROLS, Log. or Lin.
Single, less switch, 15p
Single, D.P. switch, 24p
Tandem, less switch, 40p
5kΩ, 10kΩ, 25kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ, 1MΩ, 2MΩ

SLIDER CONTROLS, 87mm.
complete with knobs.
Single, 44p; Tandem, 55p. 10kΩ, 25kΩ, 50kΩ, 100kΩ, log. or lin.

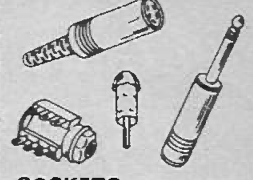
RESISTORS
Carbon
All 5%, high-stability, E12 values. ¼W, 1p; ½W, 1½p; 1W, 4p; 2W, 6p
Wire-wound
5W, 10p; 10W, 12p

LOUDSPEAKERS
7in × 4in, 3Ω—£1·12, 8Ω—£1·12, 15Ω—£1·40.
8in × 5in, 3Ω—£1·85, 8Ω—£1·77, 15Ω—£1·70.
10in × 6in, 3Ω—£2·32, 8Ω—£2·32, 15Ω—£2·32.
8in round, 3Ω—£2·10, 8Ω—£2·50, 15Ω—£2·10.
Adastra "Hi-Ten", 10in, 10W, 8 or 15Ω—£3·40.
Please add 20p p. & p. to all speakers.

BONDED ACRYLIC FIBRE
B.A.F. wadding, 18in wide, 1in thick. The ideal lining for speaker enclosures. 25p per yard.

PLUGS

Car aerial	14p
Co-axial	9p
D.I.N. 2 pin (speaker)	10p
D.I.N. 3 pin	13p
D.I.N. 4 pin	14p
D.I.N. 5 pin, 180°	13p
D.I.N. 5 pin, 240°	15p
D.I.N. 6 pin	15p
Jack, 2½mm unscreened	9p
Jack, 2½mm screened	10p
Jack, 3½mm unscreened	8p
Jack, 3½mm screened	12p
Jack, ¼in unscreened	12p
Jack, ¼in screened	20p
Jack, stereo, unscreened	20p
Jack, stereo, screened	35p
Phono, plastic top	5p
Phono, plated metal	12p
Phono, fitted 4 ft lead	8p
Wander, red or black	3p
Banana 4mm, red or black	6p



LINE SOCKETS

Car aerial	14p
Co-axial	17p
D.I.N. 2 pin (speaker)	15p
D.I.N. 3 pin	16p
D.I.N. 5 pin, 180°	16p
D.I.N. 5 pin, 240°	16p
Jack, 3½mm	15p
Jack, ¼in screened	49p
Jack, stereo, screened	30p
Phono, plated metal	14p

SOCKETS

Car aerial	8p
Co-axial, surface	8p
Co-axial, flush	9p
D.I.N. 2 pin (speaker)	10p
D.I.N. 3 pin	9p
D.I.N. 5 pin, 180°	9p
D.I.N. 5 pin, 240°	9p
Jack, 2½mm	10p
Jack, 3½mm	10p
Jack, ¼in unswitched	15p
Jack, ¼in switched	17p
Jack, stereo, switched	24p
Phono, single	5p
Phono, 2 on a strip	7p
Phono, 3 on a strip	9p
Phono, 4 on a strip	10p
Wander, single, red or black	5p
Wander, twin strip	7p
Banana 4mm red, or black	6p

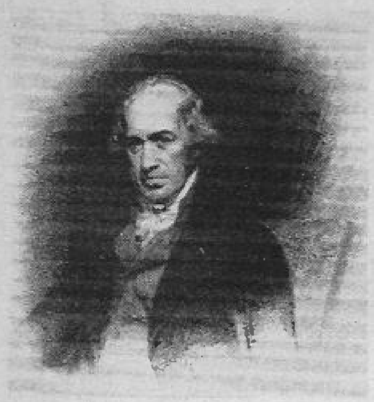
CAPACITORS

2·2pF	500V	S/M	7½p
3·3pF	500V	S/M	7½p
5pF	500V	S/M	7½p
10pF	125V	P.S.	5p
10pF	500V	S/M	7½p
15pF	125V	P.S.	5p
15pF	500V	Cer.	4p
18pF	500V	S/M	7½p
22pF	125V	P.S.	5p
22pF	500V	S/M	7½p
25pF	500V	S/M	7½p
27pF	500V	Cer.	4p
33pF	125V	P.S.	5p
33pF	500V	S/M	7½p
39pF	500V	S/M	7½p
47pF	125V	P.S.	5p
47pF	500V	Cer.	4p
50pF	500V	S/M	7½p
56pF	500V	S/M	7½p
68pF	125V	P.S.	5p
68pF	500V	S/M	7½p
75pF	500V	S/M	7½p
82pF	500V	S/M	7½p
100pF	125V	P.S.	5p
100pF	500V	S/M	7½p
100pF	500V	Cer.	5p
120pF	500V	S/M	7½p
150pF	125V	P.S.	5p
150pF	500V	S/M	7½p
150pF	500V	Cer.	5p
180pF	500V	S/M	7½p
200pF	500V	S/M	7½p
220pF	125V	P.S.	5p
220pF	500V	Cer.	5p
250pF	500V	S/M	8p
270pF	500V	Cer.	5p
300pF	500V	S/M	8p
330pF	125V	P.S.	5p
330pF	500V	S/M	8p
390pF	500V	S/M	8p
470pF	125V	P.S.	5p
470pF	750V	Disc	5p
500pF	500V	S/M	8p
560pF	500V	S/M	8p
680pF	125V	P.S.	6p
680pF	500V	S/M	8p
820pF	500V	S/M	8p
0·001µF	100V	Mylar	3p
0·001µF	125V	P.S.	6p
0·001µF	400V	Poly.	3p
0·001µF	500V	S/M	10p
0·001µF	500V	Cer.	5p
0·001µF	1,000V	MDC	6p
0·0015µF	400V	Poly.	3p
0·0015µF	500V	S/M	10p
0·0015µF	500V	Cer.	5p
0·0018µF	500V	S/M	10p
0·002µF	100V	Mylar	3p
0·002µF	500V	Cer.	5p
0·0022µF	125V	P.S.	6p
0·0022µF	500V	S/M	10p
0·0022µF	1,000V	MDC	6p

0·0027µF	500V	S/M	15p
0·003µF	500V	Cer.	5p
0·0033µF	125V	P.S.	6p
0·0033µF	500V	Poly.	6p
0·0033µF	1,000V	MDC	6p
0·0036µF	500V	S/M	15p
0·0047µF	125V	P.S.	9p
0·0047µF	500V	Poly.	6p
0·0047µF	500V	S/M	20p
0·0047µF	1,000V	MDC	6p
0·005µF	100V	Mylar	3p
0·005µF	500V	Cer.	5p
0·0068µF	125V	P.S.	10½p
0·0068µF	500V	S/M	30p
0·0068µF	500V	Poly.	6p
0·0082µF	125V	P.S.	10½p
0·0082µF	500V	S/M	30p
0·01µF	18V	Disc	4p
0·01µF	125V	P.S.	10½p
0·01µF	160V	Poly.	4p
0·01µF	250V	M.F.	3p
0·01µF	400V	Poly.	3p
0·01µF	500V	Cer.	5p
0·01µF	500V	S/M	30p
0·01µF	600V	MDC	7p
0·01µF	1,000V	MDC	9p
0·015µF	160V	Poly.	3p
0·015µF	400V	Poly.	3p
0·02µF	100V	Mylar	3p
0·022µF	18V	Disc	5p
0·022µF	250V	M.F.	3p
0·022µF	400V	Poly.	3p
0·022µF	600V	MDC	7½p
0·022µF	1,000V	MDC	9p
0·033µF	250V	M.F.	4p
0·033µF	400V	Poly.	4p
0·047µF	12V	Disc	6p
0·047µF	160V	Poly.	3p
0·047µF	250V	M.F.	3p
0·047µF	400V	Poly.	4p
0·047µF	600V	MDC	8p
0·047µF	1,000V	MDC	10p
0·1µF	30V	Disc	6p
0·1µF	250V	M.F.	4p
0·1µF	400V	Poly.	5p
0·1µF	600V	MDC	10p
0·1µF	1,000V	MDC	13p
0·15µF	250V	M.F.	5p
0·22µF	160V	Poly.	6p
0·22µF	250V	M.F.	5p
0·22µF	400V	Foil	10p
0·22µF	1,000V	MDC	15p
0·33µF	250V	M.F.	8p
0·47µF	250V	Foil	8p
0·47µF	400V	Foil	15p
0·47µF	1,000V	MDC	20p
1·0µF	250V	M.F.	15p

Note:
S/M = silver mica 1% tol.
P.S. = polystyrene 2½% tol.
MDC—a.c. rating = 300V.
M.F. = Mullard min. foil.
Cer. = ceramic.

MAIL ORDERS: Some items have a post and packing charge shown against them. Where p. & p. is not shown the charge is 12p for any selection. When both classes of goods are ordered the charge is 12p plus any p. & p. charges shown. (Overseas extra.) Telephone 01-692 4412



Photograpgh: Science Museum, London.

THEY MADE THEIR MARK

No.5 Watt

By J. E. Gregory

Table 1: WATT (W)

The watt might be termed the "horse-power" unit of electronics, in fact 746 watts are equal to 1 h.p. The power needed to maintain a current of one ampere through a conductor, and a potential of one volt across its ends is equal to one watt.

The unit was first proposed by C. W. Siemens in his presidential address to the British Association in 1889.

We come now to our first British pioneer, but as he was not a physicist nor engaged in proving any electrical theory he may be termed "a stranger in our midst". James Watt inventor extraordinary; the man after whom the unit of electronic power is named (see Table 1).

The year is 1755; the place Greenock on the Clyde. Nineteen-year-old James Watt said goodbye to his family and set off for London, the hard way, by horseback to look for work. His father a small merchant had lost his trade and fortune through bad speculation. Because of this and ill health, Watt had been unable to go to school regularly and was therefore largely self taught.

Arriving in London some twelve days later, the young James obtained employment at the instrument works of John Morgan. After twelve months he returned home but was forbidden by the Glasgow City Guild to start a business as an instrument maker because he had not served a full apprenticeship.

NEWCOMEN'S ENGINE

Watt obtained work with the college of Glasgow in a model making and repair shop. The college asked him to repair their model of Newcomen's engine which had been invented some sixty years earlier and had since been used to pump water out of coal mines.

Having got the model working Watt was amazed to find the great consumption of steam; he reasoned that he could produce a better version. In 1765 he made a large scale engine, which was erected at Kinneil near Linlithgow. This gave Watt the opportunity to go into the construction in more detail.

Large scale trials and patent fees took what little money he had, and Watt was forced to agree to Dr. John Roebuck founder of the Carron Ironworks, taking two thirds of any profits from the invention in return for bearing costs, but the two partners did not get on well together and after a few years of uneasy collaboration they parted. Once again shortage of money prevented Watt from bringing his invention before the public.

BOULTON AND WATT

In 1768 Watt met Matthew Boulton, a man of considerable vision who could see that steam engines need not be confined to pumping machines and that they had a great future. Boulton, a Birmingham manufacturer, was owner of one of the most modern engineering works in Great Britain. He agreed to take Roebuck's share in the invention and a new and famous partnership was born. Then in 1769, Watt obtained his first patent, his machine produced more power for its size than Newcomen's and used less fuel but was still only usable as a steam pump.

In 1781 he patented his second engine which converted the reciprocating motion of the piston rod into a rotary motion and "drove a wheel round". This opened up new frontiers and was the start of the real steam age; it set Britain on the road as a great manufacturing power.

The Watt family built Heathfield Hall, a mansion on Handsworth Heath, Staffs, on a forty acre site. Although by now wealthy and famous, Watt worked constantly in his garret workshop. His restless brain invented a sculpture copying machine, a machine for drawing in perspective, and a press for copying manuscripts.

Watt died at Heathfield on August 19, 1819.

James Watt, garret workshop

Photograph: Crown copyright Science Museum, London.

Readers Letters

Knotted

A serious error was made by somebody when he knotted the mains input cable, illustrated twice (on Pages 530 and 531) in the article on the *Drill Speed Controller*.

This can be very dangerous and is specifically outlawed by the Institute of Electrical Engineers in their published regulations.

If a cable is rapidly bent from a straight to a highly twisted configuration, as often occurs when an item is knotted and the knot pulled tight rapidly, the core material may suffer from local fatigue causing cracking of the material. This occurs very readily with copper core, but less so with the more resistant steel ones. The cracking acts as a resistance to the current flowing through the appliances, hence local heating occurs. At the 200 watt (0·9amps) being drawn by a domestic drill this heating may be only a few degrees, but if the same knotted lead were used to feed say a three kilowatt fan heater the temperature may rise 100 degrees above ambient temperature, melting the cable insulation and possibly doing damage to someone or thing but at least blowing the fuse.

Hence although this may appear to be excusable in this instance I believe that it would be a good idea if a few words of caution were published in a future edition of your publication to "head off" anybody gaining the general impression that this is accepted safe practice which it most certainly is not.

The error, though dangerous, is so common that the writer could be excused it, provided the suggested warning is printed.

K. R. Kinsella,
Aylesbury.

We thank you for pointing out our mistake, we would suggest that readers use one of the plastic cable clamps available, to secure mains leads.

For the Drill Speed Controller *this could be screwed to the base of the MK box.*

Radio Amateurs

I write to ask that a brief item be inserted in EVERYDAY ELECTRONICS magazine re. the amateur radio course run by Northumberland Education Dept. at Gosforth, very near Newcastle-upon-Tyne.

The course is designed to prepare students for the Radio Amateurs Examination in May/June 1973. It will be run at the Gosforth Evening Institute, Gosforth Secondary School, Regent Avenue, Gosforth, Northumberland, commencing in September 1972.

Designed specifically for the R.A.E. the course is also ideal for anyone wanting to get an insight into radio theory, having just taken up radio or electronics generally as a hobby or professionally.

Held on Tuesday/Wednesday of each week from 7p.m. to 9p.m. candidates may sit the R.A.E. at the school.

Enquiries should be addressed to, The Principle, Gosforth Evening Institute at the above address who will forward a prospectus by return, or further information can be had from myself by telephoning Newcastle-upon-Tyne 668439.

As you will have gathered, I take the class and your co-operation in this matter would be greatly appreciated.

D. R. Loveday,
Newcastle-upon-Tyne.

Too Slow

I have just built the *Electronome* from the circuit as described in the July issue of EVERYDAY ELECTRONICS. I have used all the correct component values, and have checked all wiring. You say that this circuit should give 40-225 beats per minute. I only get 18-100 beats per minute.

Could you please advise me what may have gone wrong.

N. Matheson,
Newcastle-upon-Tyne.

The reason for your Electronome *not giving the correct range of beats per minute is almost certainly that the capacitors are too high in value. This is quite common as electrolytic capacitors have very poor tolerances, e.g. −20% to +100% of the nominal value. We suggest that you reduce the value of C2.*

Soldering Irons

Could you please help me in buying a soldering iron? I am a beginner to electronics and before the end of the year the firm I work for will be going over to electronic calculators from mechanical types.

I have managed to get all the issues of EVERYDAY ELECTRONICS to date in order to get myself used to electronics; I have a *Demo Deck* and plan to try some of your projects, but I can't make my mind up which would be the best soldering iron for the projects in your books and for future use on other projects.

Could you please explain the connection between the iron's leakage current to the electronic components, and the damage that can occur.

Finally, the bits for the iron are available "nickel plated," "Ferraclad" and "Triple coated," which do you use for what job?

I would like to thank you on behalf of us beginners for bringing out a magazine which we can understand. I only hope that you don't take too much notice of some of the letters that you have published from people who want you to turn into the same type of magazine as all the others, leaving us beginners once again on the outside.

There is always a new generation of beginners coming along who need a magazine like this as a stepping stone before going to the more experienced magazines with all the technical jargon.

G. Hayes,
Hackney, London.

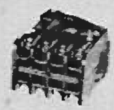
Provided you are soldering to a circuit that is not connected to a supply or to earth no damage can result from iron leakage. When the circuit is live and part of it is earthed or connected, via a transformer to the mains supply a low leakage iron should be used to avoid possible damage to semiconductors.

The more expensive coated bits are made to last longer—they are designed not to corrode as much as a normal copper bit. Coated bits are generally used on assembly lines but they are good if you tend to leave the iron

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 & p.

MAINS OPERATED CONTACTOR

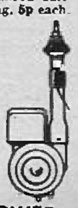


220/240v. 50 cycle solenoid with laminated core so very silent in operation. Closes 4 circuits each rated at 10 amps. Extremely well made by a German Electrical Company. Overall size 2½ × 2 × 2in. £1·50 each.

NEED A SPECIAL SWITCH?

Double Leaf Contact. Very slight pressure closes both contacts. 8p each, 60p doz. Plastic pushrod suitable for operating. 5p each. 45p doz.

AUTO—ELECTRIC CAR AERIAL



with dashboard control switch—fully extendable to 40in or fully retractable. Suitable for 12V positive or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch. £5·75 plus 25p post and insurance.

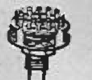
MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only £1, plus 18p postage.

MICRO SWITCH

5 amp. changeover contacts, 9p each, £1 doz. 15 amp. Model 10p each or £1·05 doz.

MINIATURE WAFER SWITCHES



2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 20p each £1·80 for ten, your assortment.

KITS FOR PREVIOUS PROJECTS

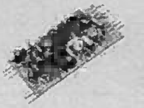
Unless otherwise stated, kits contain electronic parts only. The case and special items can be obtained locally. Also batteries are not included. Kits may be returned for refund if construction has not been started. We reserve the right to substitute components should deliveries be protracted so as to avoid undue delay.

HOME SENTINEL INTRUDER ALARM	£3·75
SNAP INDICATOR	75p
WINDSCREEN WIPER CONTROL	£2·00
RECORD PLAYER (amplifier components only)	£5·50
DEMO DEC	£6·75
FUZZ BOX	£1·85
PHOTOGRAPHIC COLOUR TEMPERATURE METER	£2·65
ASTRON RADIO	£3
REMOTE TEMPERATURE COMPARATOR	£4·25
ELECTRO LAUGH	£2
RAIN WARNING ALARM	£1·80
WA-WA PEDAL	£2·90
SIGNAL INJECTOR	80p
SOIL MOISTURE METER	£3·00
SIMPLE CALCULATOR	£2·20
DC POWER SUPPLY	£5·00
BABY ALARM	£4·00
AUDIO TONE GENERATOR	£2·60
METAL LOCATOR	£4·00
LIGHT TO SOUND CONVERTER	£1·70
THRU LENS LIGHTMETER	£3·00
DRILL SPEED CONTROLLER	£2·00

BAKELITE INSTRUMENT CASE

Size approx. 6½" × 3½" × 2" deep with brass inserts in four corners and bakelite panel. This is a very strong case suitable to house instruments and special rigs, etc. Price 45p each.

MULLARD I.F. MODULE



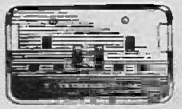
This is a fully screened intermediate frequency module for amplification and detection of f.m. signals at 10·7MHz and a.m. signals at 470kHz. The first stage is used as an i.f. amplifier for f.m. and a self-oscillating mixer for a.m. operation, in conjunction with an external oscillator coil. 75p each. 10 for £6·75. 100 for £62·50p. With connection dig.

STANDARD WAFER SWITCHES

Standard size 1¼" wafer—silver-plated 5-amp contact standard ¼" spindle 2" long—with locking washer and nut.

No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10 way	12 way
1 pole	40p	40p	40p	40p	40p	40p	40p	40p	40p
2 poles	40p	40p	40p	40p	40p	40p	40p	70p	70p
3 poles	40p	40p	40p	40p	70p	70p	70p	95p	95p
4 poles	40p	40p	40p	70p	70p	70p	70p	£1·20	£1·20
5 poles	40p	40p	70p	70p	95p	95p	95p	£1·45	£1·45
6 poles	40p	70p	70p	70p	95p	95p	95p	£1·70	£1·70
7 poles	70p	70p	70p	95p	£1·20	£1·20	£1·20	£1·95	£1·95
8 poles	70p	70p	70p	95p	£1·20	£1·20	£1·20	£2·20	£2·20
9 poles	70p	70p	95p	95p	£1·45	£1·45	£1·45	£2·45	£2·45
10 poles	70p	70p	95p	£1·20	£1·45	£1·45	£1·45	£2·70	£2·70
11 poles	70p	95p	95p	£1·20	£1·70	£1·70	£1·70	£2·95	£2·95
12 poles	70p	95p	95p	£1·20	£1·70	£1·70	£1·70	£3·20	£3·20

13 AMP TWIN GANG SOCKETS

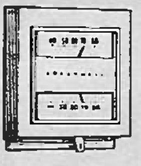


Offered at less than wholesale price your opportunity to replace those dangerous adaptors—brown bakelite flush mounting—standard fitting. Unswitched 20p each, separately switched 30p each. Separately switched and with neon on/off indicators 45p each. Less 10% ten or more + 20p postage if order under £5.

THIS MONTH'S SNIP

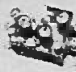
YOUR TIME is the most precious thing you have. Do you waste it waiting for the soldering iron to heat up? You can be soldering in a few seconds with the E.T.P. Solder Gun which we offer at a specially keen price. It is in fact this month's snip. A well made lightweight unit with flash lamp to illuminate the work. Has 100 watt double insulated mains Transformer and is built into a shockproof Thermo-plastic case. Suitable for 240volt, 50 c.p.s. This comes complete with 5 spare tips and is offered at a special snip price £2·25 plus 20p post and insurance.

THERMOSTAT WITH THERMOMETER



Made by Honeywell for normal air temperature 40°-80°F. (5-25°C.). This is a precision instrument with a differential which can be adjusted to better than 1·5°F. A mercury switch breaks on temp. rise—the switch is operated by coiled bi-metal element and an adjustable heater is incorporated for heat anticipation. Elegantly styled and encased in an ivory plastic case with clear plastic windows, thermometer above and switch setting scale below. Size approx. 3·8" × 3·2" × 1·4" deep. Can be mounted on conduit box or directly on wall. Price £1·25 each or 10 for £11·25.

MULLARD AUDIO AMPLIFIER MODULE



Uses 4 transistors, and has an output of 500mW into 8 ohms speakers. Input suitable for crystal mic. or pick-up. 9 volt battery operated. Size 2" long × 1¼" wide × 1" high. SPECIAL SNIP PRICE 60p each. 20 for £5·40

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. £2·25 less plug; £2·50 with fitted 13 amp plug; £2·65 with fitted 15 amp plug, plus 23p P. & P.

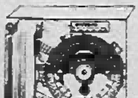
1 HOUR MINUTE TIMER

Made by Smiths. Complete with control knob and calibrated dial. This month's special bargain at 50p. Useful in the kitchen, office and dark-room etc.

INFRA RED BURGLAR ALARM
CAPACITANCE METER
LW/MW RADIO TUNER

To receive prices for these and other featured projects send the estimated cost any difference will be adjusted.

ELECTRIC TIME SWITCH

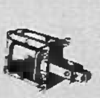


Made by Smiths these are A.C. mains operated. NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods per 24 hours. 5 amp change-over contacts will switch circuit on or off during these periods £2·50 post and ins. 23p. Additional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

50 MICRO AMMETER

Square, panel mounting type. £2

MAINS OPERATED SOLENOIDS

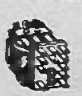


Model 772 — small but powerful 1" pull —approx. size 1¼ × 1¼ × 1¼" 60p.

Model 400/1 ¾" pull Size 2¼" × 2 × 1¾" 75p.

Model TT10 1¼" pull size 3 × 2½ × 2" £1·80 plus 20p post and insurance.

MAINS RELAY BARGAIN



Special this month are some single, double and treble pole change-over relays. Contacts rated at 15 amps. Operating coil wound for 240V A.C. Good British Make. Unused. Size approx. 1½" × 1". Open construction.

Single pole 25p each — 10 for £2·25
Treble pole 35p each — 10 for £3·15

CD CAR IGNITION

This system which has proved to be amazingly efficient. We offer kit of parts as P.W. Circuit £5·95 plus 20p p. & p. Deluxe model with prepared circuit board £6·95. When ordering please state whether for positive or negative systems.

22 POS. SOLENOID OPERATED STUD SWITCH Mains operated, each current pulse to switch solenoid moves switch arm through one position on to the next contact stud—current to release solenoid brings back switch arm to position one. These are ex-equipment but in good working order. Any not so would be replaced. Price 50p each.

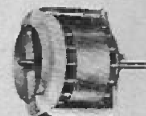
TIMED 'ON' SWITCHES

Made by Smiths for washing machines etc. Centre spindle closes double pole 15 amp switch directly it is turned. A full 360° turn or only a part turn winds the clockwork mechanism and keeps the switch closed until the spindle returns to the 'off' position. A dial therefore could be fitted to indicate hours and minutes and the switch on period could be set quite accurately. 3 models available—90 minutes, —120 minutes and 360 minutes. Price 95p each. Metal clad pointer knob 15p. Suitable relay to make the switch 'on' instead of 'off' 35p.

MOTOR GENERATOR

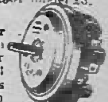
Ex Admiralty—24 volt D.C. input—240v 50 cps output. Admiralty rating 80 watt but we have tested this to 50% overload voltage regulated so suitable to operate TV or instrument. In case with metal cover—controls on front include voltmeter. Probably cost £200 each to make. Our price only £25 each plus carriage. £2 up to 200 miles £4 up to 400 miles.

PAPST MOTORS



Est. 1/40th h.p. Made for 110–120 volt working, but two of these work ideally together off our standard 240 volt mains. A really beautiful motor, extremely quiet running and reversible. £1·50 each. Postage one 23p, two 33p, 230v model £3.

PRESSURE SWITCH



Containing a 15 amp. change over switch operated by a diaphragm which in turn is operated by air pressure through a small metal tube. The operating pressure is adjustable but is set to operate in approx. 10 in. of water. These are quite low pressure devices and can in fact be operated simply by blowing into the inlet tube. Original use was for washing machines to turn off water when tub has reached correct level but no doubt has many other applications. 75p each. 10 for £6·75.

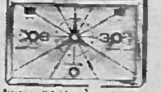
TAPE HEADS

Miniature size. Front $\frac{5}{16}$" × $\frac{5}{16}$"—depth ⅜" made for Truvox, separate heads for record and erase—2 track 45p pair. 4 track 75p pair.

LEVER SWITCH REF. H52/4

Ideal for intercom or similar. Pressing the lever down operates 6 pairs of change-over contacts, pressing the lever up operates 4 pairs of change-over contacts. The switch is spring loaded and normally returns to the off or centre position. Size approximately 1¼" long × 2½" deep × ½" thick. 40p each.

15 AMP ELECTRICAL PROGRAMMER



Wake up gently with radio playing and kettle boiling—switch lights on to ward off intruders—have warm house to come home to. These and other things you can do with the help of an Electrical Programmer Clock by famous maker with 15 amp. on/off switch. Switch on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price £1·85 + 20p. p. & p. or with glass front chrome bezel 75p extra.

2 POS. ROTARY MAINS SWITCH

Rated 15 amp at 230v. 4 circuits. Position A—all circuits open. Position B—circuit 1 closed. Position C—circuit closed. Position D, circuits 2, 3 & 4 closed Postion E—2 & 3 circuits closed. Position F—1, 2, 3 & 4 circuits closed. Position G—2 & 4 circuits closed. 15p each or 10 for £1·35.

EDGE CONNECTORS

32 way for £1·50 strip boards. Gold plated contacts. 50p each or 10 for £4·50.

VEROBOARD

Offcuts—10 pieces—·1—·15 & ·2 matrix. All good useful sizes. Total not less than 150 sq. ins very useful for circuit building. Regular price value at least £2. Price £1 the lot.

8 AMP VARIACS

These are variable voltage transformers. British made by the famous Zenith Co. Fully enclosed for bench use and fitted with Calibrated scale and control knob. Zenith Model No. 100 LM. 220–240 A.C. output 0-240 volt up to 8 amps. This model is listed at nearly £20. We have a limited quantity only, absolutely brand new, still in makers cartons, offered to you at £12·50 each plus £1 carriage and insurance up to 400 miles.

Where postage is not stated then orders over £5 are post free. Below £5 add 20p. Semi-conductors 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 1YD
Callers to: 102/3 Tamworth Road, CROYDON

BRAND NEW GUARANTEED

LARGEST SELECTION OF SEMICONDUCTORS COMPONENTS

RETURN OF POST SERVICE

TRANSISTORS

2G301	0·15
2G302	0·15
2G303	0·25
2G306	0·30
2G309	0·30
2G371	0·15
2G374	0·15
2G381	0·25
2N404	0·28
2N696	0·15
2N697	0·15
2N698	0·25
2N706	0·10
2N708	0·13
2N709	0·38
2N718	0·21
2N914	0·15
2N916	0·17
2N918	0·30
2N929	0·14
2N930	0·14
2N1090	0·30
2N1091	0·32
2N1131	0·20
2N1132	0·20
2N1184	1·27
2N1302	0·16
2N1303	0·16
2N1304	0·20
2N1305	0·20
2N1306	0·22
2N1307	0·22
2N1308	0·25
2N1309	0·25
2N1507	0·30
2N1613	0·20
2N1631	0·88
2N1637	0·36
2N1638	0·32
2N1711	0·17
2N1893	0·34
2N2147	0·70
2N2148	0·60
2N2193	0·58
2N2193A	0·61
2N2194A	0·30
2N2219	0·20
2N2220	0·20
2N2221	0·20
2N2222	0·20
2N2222A	0·32
2N2368	0·11
2N2369	0·12
2N2369A	0·17
2N2046	0·45
2N2711	0·12
2N2712	0·12
2N2713	0·17
2N2714	0·17
2N2904	0·18
2N2904A	0·29
2N2905	0·28
2N2905A	0·28
2N2906	0·18
2N2906A	0·23
2N2907	0·18
2N2923	0·12
2N2924	0·12
2N2925	0·12
2N2926	
Green	0·10
Yellow	0·10
Orange	0·10
2N3053	0·15
2N3054	0·47
2N3055	0·60
2N3390	0·20
2N3391	0·20
2N3391A	0·22
2N3392	0·13
2N3393	0·12
2N3394	0·12
2N3402	0·17
2N3403	0·19
2N3404	0·24
2N3405	0·27
2N3414	0·10
2N3415	0·10
2N3416	0·15
2N3417	0·21
2N3570	1·25
2N3572	0·97
2N3702	0·11
2N3703	0·10
2N3704	0·11
2N3705	0·10
2N3706	0·90
2N3707	0·11
2N3708	0·70
2N3709	0·90
2N3710	0·90
2N3711	0·90
2N3715	1·23
2N3716	1·30
2N3791	2·06
2N3819	0·28
2N3823	0·62

2N3854	0·16
2N3854A	0·16
2N3855	0·18
2N3855A	0·16
2N3856	0·16
2N3856A	0·16
2N3858	0·16
2N3858A	0·16
2N3859	0·16
2N3859A	0·16
2N3860	0·16
2N3866	0·70
2N3877	0·25
2N3877A	0·26
2N3900	0·20
2N3900A	0·21
2N3901	0·32
2N3903	0·22
2N3904	0·22
2N3905	0·21
2N3906	0·22
2N4058	0·12
2N4059	0·90
2N4060	0·11
2N4061	0·11
2N4062	0·11
2N4303	0·32
2N5172	0·09
2N5174	0·22
2N5175	0·26
2N5176	0·32
2N5245	0·43
2N5459	0·33
3N128	0·63
3N140	0·76
3N141	0·69
3N142	0·54
3N143	0·64
3N152	0·79
40050	0·50
40251	0·58
40309	0·26
40310	0·37
40360	0·35
40361	0·37
40362	0·40
40406	0·40
40407	0·31
40408	0·41
40410	0·53
40467A	0·57
40468A	0·35
AC107	0·35
AC126	0·20
AC127	0·20
AC128	0·20
AC154	0·20
AC176	0·16
ACY17	0·25
ACY18	0·15
ACY19	0·20
ACY20	0·20
ACY21	0·18
ACY22	0·13
ACY28	0·18
ACY40	0·17
ACY41	0·17
AD140	0·55
AD149V	1·23
AD150	0·55
AD161	0·33
AD162	0·38
AD161 } PR	
AD162 }	0·60
AF106	0·24
AF114	0·25
AF115	0·25
AF116	0·25
AF117	0·20
AF118	0·50
AF124	0·24
AF125	0·20
AF126	0·20
AF127	0·20
AF139	0·33
AF178	0·55
AF179	0·65
AF180	0·50
AF211	0·55
AF239	0·36
AF279	0·47
AF280	0·47
ASY26	0·25
ASY27	0·30
ASY28	0·25
ASY29	0·30
ASY50	0·20
ASY55	0·35
ASZ21	0·55
AU103	1·25
BC107	0·12

BC108	0·11
BC109	0·12
BC113	0·18
BC115	0·15
BC116	0·15
BC116A	0·18
BC118	0·11
BC121	0·20
BC125	0·15
BC126	0·20
BC140	0·30
BC147	0·10
BC148	0·09
BC149	0·11
BC157	0·09
BC158	0·10
BC159	0·10
BC160	0·11
BC167B	0·11
BC168B	0·10
BC168C	0·10
BC169B	0·11
BC169C	0·11
BC170	0·11
BC171	0·13
BC172	0·11
BC182	0·10
BC183	0·09
BC184	0·11
BC212L	0·12
BCY30	0·35
BCY31	0·40
BCY32	0·60
BCY33	0·30
BCY34	0·35
BCY38	0·40
BCY39	0·80
BCY40	0·50
BCY42	0·15
BCY43	0·15
BCY58	0·18
BCY59	0·19
BCY70	0·17
BCY71	0·22
BCY72	0·13
BCZ10	0·35
BCZ11	0·50
BD116	0·75
BD121	0·75
BD123	0·82
BD124	0·60
BD121	0·75
BD132	0·75
BDY10	1·25
BDY11	1·50
BDY17	1·50
BDY18	1·75
BDY19	1·97
BDY20	1·00
BDY38	0·65
BDY60	0·90
BDY61	0·85
BDY62	0·75
BF115	0·25
BF117	0·43
BF163	0·20
BF166	0·35
BF167	0·18
BF173	0·19
BF177	0·25
BF178	0·31
BF179	0·38
BF180	0·35
BF181	0·34
BF184	0·17
BF185	0·17
BF194	0·14
BF195	0·15
BF196	0·15
BF197	0·15
BF198	0·18
BF200	0·40
BF224J	0·14
BF255J	0·19
BF237	0·22
BF238	0·22
BF244	0·16
BFX13	0·23
BFX29	0·25
BFX30	0·25
BFX44	0·33
BFX68	0·30
BFX84	0·24
BFX85	0·29
BFX86	0·24
BFX87	0·27
BFX88	0·25
BFX89	0·45
BFY10	0·35
BFY11	0·45
BFY17	0·90
BFY18	0·35
BFY19	0·35
BFY20	0·50
BFY29	0·40
BFY41	0·43
BFY43	0·65

BFY50	0·16
BFY51	0·16
BFY52	0·16
BFY53	0·15
BFY56	0·34
BFY75	0·40
BFY76	0·22
BFY77	0·24
BFY90	0·65
BFY39	0·38
BSX19	0·13
BSX20	0·14
BSX21	0·20
BSX26	0·34
BSX27	0·34
BSX28	0·25
BSX60	0·54
BSX61	0·42
BSX76	0·15
BSX77	0·20
BSX78	0·25
BSW70	0·28
BSY24	0·20
BSY25	0·20
BSY26	0·20
BSY27	0·15
BSY28	0·15
BSY38	0·15
BSY39	0·16
BSY51	0·25
BSY52	0·25
BSY53	0·25
BSY54	0·30
BSY56	0·79
BSY78	0·40
BSY79	0·40
BSY90	0·45
BSY95A	0·09
C111	0·53
C424	0·15
C425	0·36
C426	0·25
C428	0·25
GET113	0·25
GET114	0·20
GET119	0·35
GET120	0·40
GET873	0·15
GET880	0·35
GET887	0·20
GET890	0·35
MJ400	0·78
MJ420	0·86
MJ421	0·88
MJ430	0·75
MJ440	0·71
MJ480	0·75
MJ481	0·85
MJ490	0·94
MJ491	1·10
MJE340	0·47
MJE520	0·59
MPF102	0·25
MPF103	0·33
MPF104	0·33
MPF105	0·33
NKT124	0·42
NKT125	0·40
NKT126	0·38
NKT128	0·48
NKT135	0·28
NKT137	0·32
NKT210	0·25
NKT211	0·25
NKT212	0·25
NKT213	0·25
NKT214	0·15
NKT215	0·21
NKT216	0·46
NKT217	0·50
NKT219	0·25
NKT223	0·17
NKT224	0·25
NKT225	0·21
NKT229	0·29
NKT237	0·31
NKT238	0·18
NKT240	0·19
NKT241	0·20
NKT242	0·15
NKT243	0·63
NKT244	0·17
NKT246	0·18
NKT261	0·21
NKT262	0·19
NKT264	0·21
NKT271	0·18
NKT272	0·18
NKT274	0·18
NKT275	0·23
NKT401	0·70
NKT402	0·76
NKT403	0·65
NKT404	0·61
NKT405	0·80
NKT406	0·63
NKT603F	0·30

NKT613F	0·30
NKT674F	0·24
NKT677F	0·22
NKT713	0·30
NKT717	0·44
NKT781	0·20
NKT10419	0·20
NKT10439	0·27
NKT10519	0·23
NKT20329	0·32
NKT20339	0·36
NKT80111	0·67
NKT80112	0·84
NKT80113	1·00
NKT80211	0·75
NKT80212	0·75
NKT80213	0·75
NKT80214	0·75
NKT80215	0·75
NKT80216	0·75
OC20	0·85
OC22	0·50
OC23	0·50
OC24	0·60
OC25	0·50
OC26	0·25
OC28	0·65
OC29	0·60
OC35	0·50
OC36	0·65
OC41	0·30
OC42	0·35
OC44	0·15
OC45	0·12
OC46	0·27
OC70	0·12
OC71	0·12
OC72	0·12
OC74	0·25
OC75	0·22
OC76	0·22
OC77	0·40
OC81	0·20
OC81D	0·20
OC82D	0·25
OC83	0·20
OC84	0·20
OC139	0·25
OC140	0·30
OC170	0·25
OC171	0·30
OC200	0·40
OC201	0·65
OC202	0·65
OC203	0·42
OC204	0·42
OC205	0·85
P346A	0·18
TIP29A	0·49
TIP30A	0·58
TIP31A	0·62
TIP32A	0·74
TIP33A	1·01
TIP34A	1·51
TIP35A	2·90
TIP36A	3·70
TIS34	0·50
TIS43	0·21
TIS44	0·07
TIS45	0·10
TIS46	0·11
TIS47	0·11
TIS48	0·11
TIS49	0·11
TIS50	0·17
TIS51	0·11
TIS52	0·13
TIS53	0·23

Post & Packing 13p per order. Europe 25p. Commonwealth (Air) 65p (MIN.)
Matching charge (audio transistors only) 15p extra per pair.
Prices subject to alteration without prior notice.

TTL LOGIC I.C. NEW PRICES

	1-11 £p	12-24 £p		1-11 £p	12-24 £p		1-11 £p	12-24 £p
SN7400	0·20	0·18	SN7433	0·80	0·75	SN7472	0·32	0·30
SN7401	0·20	0·18	SN7437	0·64	0·06	SN7473	0·43	0·41
SN7402	0·20	0·18	SN7438	0·64	0·60	SN7474	0·43	0·41
SN7403	0·20	0·18	SN7440	0·23	0·21	SN7475	0·45	0·44
SN7405	0·20	0·18	SN7441AN	0·87	0·88	SN7476	0·45	0·44
SN7406	0·80	0·75	SN7442	0·85	0·81	SN7480	0·70	0·65
SN7407	0·80	0·75	SN7443	2·86	2·70	SN7481	1·40	1·38
SN7408	0·20	0·18	SN7444	2·86	2·70	SN7482	0·87	0·82
SN7409	0·20	0·18	SN7445	2·50	2·40	SN7483	0·87	0·82
SN7410	0·20	0·18	SN7446	1·00	0·95	SN7484	2·00	1·85
SN7411	0·23	0·21	SN7447	1·00	0·95	SN7485	3·62	3·40
SN7412	0·48	0·46	SN7448	1·00	0·95	SN7486	0·33	0·30
SN7413	0·40	0·38	SN7449	1·00	0·95	SN7490	0·87	0·84
SN7420	0·20	0·18	SN7450	0·20	0·18	SN7491AN	1·21	1·10
SN7423	0·51	0·47	SN7451	0·20	0·18	SN7492	0·87	0·84
SN7427	0·48	0·45	SN7453	0·20	0·18	SN7493	0·87	0·84
SN7428	0·80	0·75	SN7454	0·20	0·18	SN7494	0·87	0·84
SN7430	0·23	0·15	SN7460	0·20	0·18	SN7495	0·87	0·84
SN7432	0·48	0·42	SN7470	0·40	0·38	SN7496	0·87	0·84

SUB-MIN ELECTROLYTIC

range axial lead — 6p each
Values: μF/V): 0·64/64; 1/40; 1·6/25; 2·5/16; 3·2/63; 4/10; 4/40; 6·4/6·4; 6·4/25; 10/16; 10/64; 16/40; 20/16; 20/64; 25/6·4; 25/25; 32/10; 32/40; 32/64; 40/16; 50/6·4; 50/25; 50/40; 64/10; 80/16; 80/25; 100/6·4; 125/10; 125/16; 320/6·4.

SILICON RECTIFIERS

PIV	50	100	200	400	600	800	1000	1200
1A	8p	9p	10p	11p	12p	15p	20p	—
3A	15p	17p	20p	22p	25p	27p	30p	35p
6A	—	—	25p	30p	32½p	35p	—	—
10A	30p	35p	40p	47p	56p	66p	75p	—
15A	36p	45p	48p	55p	65p	75p	87p	—
35A	70p	80p	90p	£1·00	£1·40	£1·70	£2·75	—

1 amp and 3 amp are plastic encapsulation.

DIODES & RECTIFIERS

IN34A	10p	AA119	7p	BAX16	12½p	FST3/4	22½p
IN914	7p	AA129	15p	BAY18	17½p	OA5	17p
IN916	7p	AAZ13	12p	BAY31	7p	OA10	20p
IN4007	20p	AAZ15	12p	BAY38	25p	OA9	10p
IS44	7p	AAZ17	10p	BY100	15p	OA47	8p
IS113	15p	BA100	15p	BY103	22p	OA70	7p
IS120	12p	BA102	25p	BY122	47½p	OA73	10p
IS121	14p	BA110	25p	BY124	15p	OA79	7p
IS130	8p	BA114	15p	BY126	15p	OA81	8p
IS131	10p	BA115	7p	BY127	17p	OA85	10p
IS132	12p	BA141	17p	BY164	57p	OA90	7p
IS920	7p	BA142	17p	BYX10	22p	OA91	7p
IS922	8p	BA144	12p	BYZ10	35p	OA95	7p
IS923	12p	BA145	17p	BYZ11	32p	OA200	7p
IS940	5p	BA154	12p	BYZ12	30p	OA202	10p
		BAX13	5p	BYZ13	25p	TIV307	50p

"SCORPIO" CAP DISCHARGE IGNITION SYSTEM
(As printed in P.E. Nov. '71). Complete kit £10·00
P. & P. 50p.

BRIDGE RECTIFIERS

A.	PIV		A.	PIV	
1	100	37p	4	50	60p
1.4	140	57p	4	100	70p
2	50	32p	4	400	80p
2	200	41p	6	50	62p
2	400	46p	6	200	80p
			6	400	£1·10

THYRISTORS (SCR)

PIV	50	100	200	300	400
1A	25p	27½p	37½p	40p	47½p
4A	40p	45p	55p	—	60p
7A	82p	87p	92p	—	£1·12p

TIC47 0.6 amp. 200 PIV 55p.
Also 12 amp. 100 PIV 75p
2N3525 at 85p

VEROBOARD

	0·15 Matrix	0·1 Matrix
2½ × 3¾in	17p	23p
2½ × 5in	25p	25p
3¾ × 3¾in	25p	25p
3¾ × 5in	30p	29p
5 × 17in (Plain)	83p	—

Vero Pins (Bag of 36) 20p
Vero Cutter 45p
Pin Insertion Tools (·1 and ·15 matrix) at 55p.

OPTOELECTRONICS
MINITRON 3015F SEVEN SEGMENT INDICATOR £2·00
TIL 209 LIGHT EMITTING DIODE (RED) 35p.
B9900 PHOTORESISTOR 38p

RESISTORS

Carbon Film
⅛ watt 5%, 1p.
¼ watt 5%, 1p. — ⅛W, 1W & 2W E24 Series.
½ watt 5%, 1½p.
½ w 2% M/O 4p.
1 watt 10%, 2½p. — ¼W & ½W E12 Series.
2 watt 10%, 6p.

MULLARD C280 M/FOIL CAPACITORS

0·01, 0·022, 0·033, 0·047 .. 3p each
0·068, 0·10 .. .. 4p each
0.15, 0·22, 0·33 .. .. 5p each
0·47 .. .. .. 9p
0·68 .. .. .. 11p
1μF 14p
1·5μF 21p
2·2μF 25p

WIRE-WOUND RESISTORS

2·5 watt 5% (up to 270 ohms only). 7p
5 watts 5% (up to 6·2kΩ only), 9p
10 watt 5% (up to 25kΩ only), 10p

POTENTIOMETERS

Carbon:
Log. and Lin., less switch, 16p.
Log. and Lin., with switch, 25p.
Wire-wound Pots (3W), 38p.
Twin Ganged Stereo Pots, Log. and Lin., 40p.

PRESETS (CARBON)

0·1 Watt 6p
0·2 Watt 6p
0·3 Watt 7½p
VERTICAL OR HORIZONTAL

THERMISTORS

R53 (STC) £1·20 — VA3705 95p
K151 (1k) 12p — VA1077 20p
Mullard Thermistors also in stock. Please enquire.

Tel. 01-452 0161/2/3 Telex 21492

A. MARSHALL & SON
28 CRICKLEWOOD BROADWAY, LONDON, N.W.2

CALLERS WELCOME
HRS. 9–5.30 MON.-FRI.
9–5.0 SAT.

on for long periods without making any joints. Iron manufacturers will be able to provide you with more information on particular types of bits.

Bug Report

Four months ago you published some of my reflections on how I was feeling as a recently infected victim of the "Electronics Bug", so perhaps you may be interested to hear something of the post-infection period.

At the present time temperature is now back to normal, or at least I don't get quite so hot under the collar trying to follow some of the more complicated theoretical items, such as how an actual circuit performs. You see I have now resigned myself to the fact that it is perhaps a little late in the day to really learn thoroughly how and why it all happens.

With only a limited amount of time to devote to a hobby which is after all to some a very full-time occupation; I have decided that maximum pleasure will be obtained if I cease puzzling *how* a particular circuit functions, and just get on with, what is for me the most enjoyable part of the activity, the actual construction of a project.

No doubt some of the more erudite purists among your readers and contributors will throw up their hands in horror at this "short cut" attitude. My defence is that each of us must know best how much time and effort we can afford to devote to a hobby, and the criterion is surely the amount of pleasurable relaxation that can be derived from it.

In my own case the main pleasure is the construction of the housing of radio receivers, I find a great deal of satisfaction out of designing a suitable cabinet, in the main using plywood either varnished, or covered with self-adhesive plastic of which a huge variety can be very easily obtained almost anywhere. The latter method does of course have the advantage of speed, as you don't have to wait between the several coats of varnish that are necessary to obtain a really pleasing finish.

For the *Astron* (which incidentally really did "work first time" as you forecast!) I didn't consider I could make a good job of the perspex case featured in your article, also I was anxious to get on with it and so looked around for something quickly available. It was felt necessary to keep to the spirit of the project, I finally selected a transparent rigid plastic lunch box and managed to fit everything neatly with only very minor alterations to the suggested lay-out.

There are several sizes of rigid plastic containers available in most hardware and chain stores, usually intended for food storage, picnics, etc., and are worth considering when one is searching for something quick and easy.

Naturally, for those who require something even easier there are plenty of diecast boxes and instrument cases to be had in all shapes and sizes from many of the component suppliers who advertise regularly in your columns.

As this progress report has become more of a case history (ugh!) perhaps I could continue by referring to the excellent article in March E.E. namely *Cases from Chassis* which appeared just as I was contemplating construction of the *Electro Laugh* so this seemed an ideal time to put the method into operation.

I sent off my £2 to the supplier who regularly offers a kit of parts for your projects and was delighted to find the order was dealt with very promptly indeed. I was especially pleased to find that not only was the approximate cost quoted in your article an apparently realistic one but that the kit also contained the extra parts to include the optional blanking gate. Full marks all round!

All the components and circuit board were fixed directly to a panel (you've guessed it—plastic covered ply-wood!) cut to fit the open side of an 8 inch x 6 inch aluminium chassis all as per the *Cases from Chassis* article.

With perseverence, I am sure the smaller size chassis could have been utilised, but as size was not an important factor this time I found it simpler to use the larger case which gave more scope for planning a pleasing layout, bearing in mind this project uses two 6 volt batteries.

The "speaker" supplied with the kit, a $2\frac{1}{2}$-inch diameter telephone ear-piece was found to give excellent volume, much better than various impedance mini-speakers I experimented with, so this was mounted centrally on the front panel, the moulded flange on the ear-piece making fixing a simple matter of cutting a circular hole in the panel, and applying a little contact adhesive.

The blanking gate was wired via a second push switch, so the type of "laugh" produced depends on whether one presses one, or two buttons, and can of course be varied as the mood takes you.

In actual fact the sound produced is not really very much like laughter, or at least it isn't on my model. It is more like a cross between a wailing banshee, and a soul in torment, with police siren overtones. However it certainly makes me laugh, also those friends and colleagues who are still speaking to me after exposure to its somewhat strident tones.

To sum up, an interesting unusual project, of no real practical value other than a (end of!) conversation piece. As a laughter simulator: 5 out of 10; but as a laughter *stimulator*—full marks!

J. G. Richards
Sale.

We must point out that we are unable to supply the back issues mentioned in this letter. Nor are we able to supply copies of individual circuits or articles.

PLEASE TAKE NOTE

The approximate cost of components for the *Weather Station* (featured last month) should have been given as £7·50, excluding the two cases but including the vanes and rotor kit. Also in this article D1 is a 3·3V, 400mW Zener diode.

Drill Speed Controller **(featured last month) see page 614.**

CRESCENT RADIO LTD

11 & 40 MAYES ROAD. LONDON N22 6TL 888 3206

MAIL ORDER DEPT.
No. 11 MAYES RD. LONDON N22 6TL

COMPONENTS AND HI FI FOR THE HOME CONSTRUCTOR

OUR SHOPS ARE OPEN ALL DAY FROM 9 A.M. TO 6 P.M. 6.30 P.M. ON FRIDAY (WE CLOSE ALL DAY THURSDAY)

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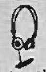

S. G. BROWN "DIPLOMAT" MONO/STEREO. HEADSET

Finest quality British made Lightweight Headphones.
Incorporate ceramic piezo electric transducers.
Specification:—
Frequency—20–17,500 CPS.
Impedance — Predominantly capacitive, at ·001MFD per earpiece can be regarded as 150K at 1kcs.
Weight—3·5oz. (98 grams).
A Bargain at **£2·50p** each set
Please include 10p per set P.P.

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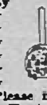
24 Hour Nixie Digital Clock Kit We Supply:
★ A complete set of components
★ A complete set of easy to follow instructions
★ Printed circuits made to make construction as simple as possible
★ A cabinet and front panel to give a professional finish.
All for the price of the components. £22·50.+50p. P. & P.
Please send S.A.E. for more information.

TRI-VOLT BATTERY ELIMINATOR

Enables you to work your transistor radio, amplifier, or cassette, etc. from A.C. mains through this compact eliminator. Just by moving a plug you can select the voltage you require — 6v, 7½v or 9 volts. This means all your transistor power pack applications can be handled by this one unit. Approx. size: 2¾" x 2½" x 3¼". OUR PRICE — £2·75p + 10p. P. & P. Same model suitably wired for the Philips Cassette — £3·00 + 10p. P. & P.

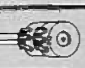
TRI-VOLT CAR CONVERTER

Enables you to work your Transistor Radio, Amplifier or Cassette etc. from the 12 volt car supply positive or neg. earth.
This converter supplies 6, 7½ or 9 volts and is transistor regulated. Approx. size 2½" × 3¼" × 2" Very easy to fit and a real monny saving device for £2·50 + 10p. P. & P.



WAFER SWITCHES

1 pole 12 way
2 pole 2 way
2 pole 3 way
2 pole 4 way
2 pole 6 way
3 pole 4 way
4 pole 3 way
18p each. Please inc. 5p P. & P. Up to 3 switches.



POTENTIOMETERS

All types 1" and less diameter.

SINGLES		DUAL	
5K	Log or	5K	
10K	Lin Less	10K	
25K	Switch	25K	Less
50K	12p ea,	50K	Switch
100K		100K	40p.
250K	Double	250K	each
500K	Pole	500K	
1M	Switch	1M	
2M	24p ea,	2M	

Up to 3 Pots. Please add 5p. P. & P.

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Made from 18 gauge aluminium 4 sided chassis with corner brackets. All are 2½" depth.

6×3—41p	12×3—58p	14× 9—94p
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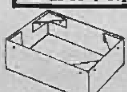
8×6—53p	12×8—83p	16×10—1·06p
10×7—63p	14×3—60p	

Please send 10p per chassis P. & P.



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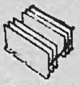

2N3055 POPULAR POWER TRANSISTOR

Now at our Low Price 50p each
Please include 5p P. & P.

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Everything for producing your own printed circuits.
£1·40p plus 10p. P. & P.

HIGH QUALITY IMPORTED HEADPHONES TTC G1105

1,000 Ω per phone 95p
2,000 Ω per phone .. 105p
Plus 10p P. & P. per pair.

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TESTED THYRISTOR 400 volt. 3 amp.
45p each 5 for £2·00
Please include 5p P. & P.

PRINTED CIRCUIT BOARD

8×6—10p 10× 8—15p
9×5—10p 12×12—30p
Please inc. 3p. per board P. & P.

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Brand new range of British made Relays.
Size—1½" × 1" × ⅞"
All two changeovers with 250V. 1·5A contacts and suitable for fitting on ·1m Veroboard.

Type	Volts	Current	Ohms.
27/A	12v	17M/A	700 Ω
21/A	12v	28M/A	430 Ω
12/A	6v	33M/A	185 Ω

80p each.
Please include 5p P & P up to 3 Relays.

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Veroboard Offcuts ·2m. 3½" × 5½" 17p
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Standard Toggle Switch, DPDT 18p
D.P.D.T. Slide Switch .. 13p
Experimental Transistor Holders, 3-pin and 4-pin 7p
I.C. Holders for 14 or 16 pin 20p
Please include 3p p. & p. per 3 items

10,000MFD @ 16V CAPACITOR

A few only at this price. 3½" long. 1½" diameter. Screw Terminals. 40p each. Please include 5p p. & p.

SINGLE EARPIECES

Crystal or Magnetic 3·5mm or 2·5mm (please state which type you require. Complete with lead. 20p plus 3p p. & p.

LOUDSPEAKER BARGAINS

E.M.I. 450 set 3. 8. 15 ohm
£3·25 plus 38p. P. & P.
E.M.I. 350 set 8 ohm.
£7·00 plus 38p. P. & P.

MINI LOUDSPEAKERS

2¼" (57mm) 8ohm — 50p each
2¼" (57mm) 40ohm — 50p each
2¼" (57mm) 80ohm — 50p each
Please include 5p. P. & P. up to 3 Mini-Loudspeakers

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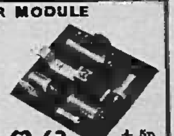
An Audio Amplifier designed around the TAA621 Linear I.C.:—
Supply Voltage 9–24V
Speaker Imp. .. .. 8–16 ohm
Frequency 50hZ–25kHz
Overall Size .. .. 2in × 8in × ⅞in
Ideal Amplifier for radios, record players, stereo units, etc.
Full technical data and diagrams with each module. All guaranteed and a bargain at **£2·63** + 5p P. & P.



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24, WOODHILL, HARLOW, ESSEX

Add 5p P. & P. Price list S.A.E. No callers please.

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AC107	15p	AL102	59p	BD116	79p	OC14	18p	TIP33A	95p	2N3711	10p
AC126	11p	AL103	49p	BD121	50p	OC45	13p	TIP34A	£1·80	40251	49p
AC127	11p	AU103	85p	BD130	46p	OC71	12p	2N697	18p	40636	65p
AC128	11p	AU111	95p	BD131	59p	OC72	12p	2N1171	24p		
AC176	25p	BC107	8p	BF194	15p	OC81	13p	2N1304	25p		
AC141K	20p	BC108	8p	BFY50	15p	OC81D	13p	2N1305	25p		
AC142K	20p	BC109	8p	BFY51	12p	OC83	20p	2N2646	47p		
AD14	40p	BC154	20p	BSY95A	15p	OC170	24p	2N2926	10p		
AD150	44p	BC168	10p	ME0402	18p	OC200	25p	2N3053	20p		
AD161	M/P55p	BC169	11p	ME0404	14p	OC201	25p	2N3055	48p		
AD162		BC182L	8p	ME4401	10p	OC25	25p	2N3702	12p		
AF114	15p	BC183L	8p	ME4103	12p	OC28	30p	2N3703	12p		
AF115	15p	BC184L	8p	ME6002	14p	OC29	38p	2N3704	12p		
AF116	15p	BC212L	8p	ME6101	14p	OC35	25p	2N3705	12p		
AF117	15p	BC214L	8p	ME6102	15p	OC36	38p	2N3706	10p		
				MP8111	32p	TIP29A	48p	2N3707	10p		
				MP8511	34p	TIP30A	65p	2N3708	9p		
				MP8513	45p	TIP31A	58p	2N3709	10p		
				OC41	13p	TIP32A	69p	2N3710	10p		

DIODES

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IN4002	4p
IN4003	5p
IN4004	7p
OA90	6p
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MULLARD POLYESTER CAPACITORS C280 SERIES

250V P.C. mounting: 0·01μF. 0·015μF, 0·022μF, 3p. 0·033μF. 0·047μF, 0·068μF, 3½p. 0·1μF, 4p. 0·15μF, 0·22μF, 5p. 0·33μF, 6½p. 0·47μF, 8½p. 0·68μF, 11p. 1·0μF, 13p. 1·5μF, 20p. 2·2μF, 24p.

MULLARD POLYESTER CAPACITORS C296 SERIES

400V: 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, 2½p. 0·0068μF, 0·01μF, 0·015μF. 0·022μF, 0·033μF, 3p. 0·047μF, 0·068μF, 0·1μF, 4p. 0·15μF, 6p. 0·22μF, 7½p. 0·33μF, 11p. 0·47μF, 13p.
160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, 3p. 0·1μF 3½p. 0·15μF, 4½p. 0·22μF, 5p. 0·33μF, 6p. 0·47μF, 7½p. 0·68μF, 11p. 1·0μF, 13p.

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(μF/V) 10/2·5, 20/2·5, 80/2·5, 160/2·5, 320/2·5, 500/2·5, 8/4, 32/4, 64/4, 125/4, 250/4, 400/4, 6·4/6·4, 25/6·4, 50/6·4, 100/6·4, 200/6·4, 320/6·4, 4/10, 16/10, 32/10, 64/10, 125/10, 200/10, 2·5/16, 10/16, 20/16, 40/16, 80/16, 125/16, 1·6/25, 6·4/25, 12·5/25, 25/25, 50/25, 80/25, 1/40, 4/40, 8/40, 16/40, 32/40, 50/40, 0·64/64, 2·5/64, 5/64, 10/64, 20/64, 32/64.

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Miniature Fixed Ceramic Plate 2½p each.
Preferred values from 1·8pf to 10,000 pf.

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Reads 0–9 and decimals (Data Sheet on request)

ONLY £1·50
for one month only

16 DIL Socket 30p
Driven by 7447 95p

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301A	To99	49p
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Potentiometers
Carbon track 500 Ω to 2·2M Ω
Log or Linear
Single 12p. Dual gang (stereo) 40p.
Any type with D.P. switch 12p extra.

RESISTORS

½ watt 5% carbon 1p each
¼ watt 10% carbon 1p each
range 2·7 Ω to 10 M Ω type TR5 triple rated ½-¼-⅛, tin oxide ×2% range 10 Ω to 1 M Ω. 3p each

SLIDE SWITCH

3 SST 10p each
SP Three Position 12p each

MINIATURE NEON LAMPS

240v or 110v 1–4 5p. 5 plus 4½p each.

CARBON SKELETON PRE-SETS

Small high quality, type PR, linear only: 100 Ω, 220 Ω, 470 Ω, 1K, 2K2, 4K7, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M2, 4M7, 10M Ω. Vertical or horizontal mounting, 5p each.

BARGAIN TTL'S

	£p		£p
=SN7400	0·15	=SN7470	0·29
=SN7401	0·15	=SN7472	0·29
=SN7402	0·15	=SN7473	0·37
=SN7403	0·15	=SN7474	0·37
=SN7404	0·15	=SN7475	0·47
=SN7405	0·15	=SN7476	0·43
=SN7407	0·18	=SN7480	0·67
=SN7408	0·18	=SN7481	0·97
=SN7409	0·15	=SN7482	0·97
=SN7410	0·15	=SN7483	1·10
=SN7413	0·29	=SN7486	0·82
=SN7416	0·43	=SN7490	0·67
=SN7417	0·43	=SN7491AN	0·87
=SN7420	0·15	=SN7492	0·67
=SN7430	0·15	=SN7493	0·67
=SN7440	0·15	=SN7494	0·77
=SN7441	0·67	=SN7495	0·77
=SN7442	0·67	=SN7496	0·77
=SN7443	1·85	=SN74100	1·75
=SN7444	1·85	=SN74104	0·97
=SN7445	1·85	=SN74105	0·97
=SN7446	0·97	=SN74107	0·40
=SN7447	0·97	=SN74110	0·55
=SN7448	0·97	=SN74111	1·25
=SN7450	0·15	=SN74118	1·00
=SN7451	0·15	=SN74119	1·35
=SN7453	0·15	=SN74121	0·67
=SN7454	0·15	=SN74141	0·67
=SN7460	0·15	=SN74145	1·50
		=SN74150	1·80

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1–9 13p
10 plus 11p
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unbranded but tested

Unmarked but fully tested 2N3055
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1–9 8p
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100 plus 6p

BC 182L:-3-4-212-4
1–9 8p
10 plus 7p

TBA800
5 watt AF power Amp. £1·40 each

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USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES, ETC.

● LOW COST ● QUICK DELIVERY ● OVER 200 RANGES IN STOCK ● OTHER RANGES TO ORDER

NEW "SEW" DESIGNS!

CLEAR PLASTIC METERS

TYPE SW.100
100 x 80 mm.

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

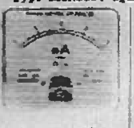
BAKELITE PANEL METERS

TYPE S-80
80 mm.
square fronts

50µA	£3·20		
50–0–50µA	£3·16	50V. D.C. ..	£2·60
100µA	£3·10	300V. D.C.	£2·60
100–0–100µA	£3·00	1 amp. D.C.	£2·60
500µA	£2·75	5 amp. D.C.	£2·60
1mA	[illegible]	300V. A.C.	£2·60
20V. D.C. ..	[illegible]	VU Meter ..	£3·37

"SEW" CLEAR PLASTIC METERS

Type MR.85P. 4½in. × 4¼in. 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 ..	£3·50
500–0–500µA	£2·80	1 amp. A.C.*	[illegible]
1mA	£2·80	5 amp. A.C.*	[illegible]
1-0-1mA ..	£2·80	10 amp. A.C.*	[illegible]
5mA	£2·80	20 amp. A.C.*	[illegible]
10mA	£2·80	30 amp. A.C.*	[illegible]

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

		[illegible]	£1·60
		200mA	£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	[illegible]	3V. D.C. ..	£1·50
50–0–50µA	[illegible]	10V. D.C. ..	[illegible]
100µA	[illegible]	25V. D.C. ..	[illegible]
100–0–100µA	£1·75	50V. D.C. ..	[illegible]
200µA	£1·75	100V. D.C.	[illegible]
500µA	£1·65	150V. D.C.	£1·60
500–0–500µA	[illegible]	300V. D.C.	£1·60
1mA	£1·60	500V. D.C.	£1·60
1–0–1mA ..	£1·60	750V. D.C.	£1·60
2mA	£1·60	25V. A.C. ..	£1·70
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.52P. 2½in. square fronts.

50µA	£3·10	10V. D.C. ..	[illegible]
50–0–50µA	£2·60	20V. D.C. ..	[illegible]
100µA	£2·60	50V. D.C. ..	[illegible]
100-0-100µA	£2·50	300V. D.C.	[illegible]
500µA	£2·30	15V. A.C. ..	[illegible]
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.45P. 2in. square fronts.

50µA	£2·25	5 amp.	£1·70
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

Type MR.65P. 3½in. × 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	£2·87
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
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"SEW" BAKELITE PANEL METERS

Type MR.65. 3½in. square fronts.

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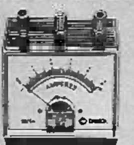
500mA	£1·95	VU Meter ..	£3·10

*MOVING IRON—
ALL OTHERS MOVING COIL

Please add postage

SEW EDUCATIONAL METERS



Type ED.107. Size overall 100mm × 90mm × 108mm. A new range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The meter movement is easily accessible to demonstrate internal working. Available in the following ranges:

50µA	£5·00	20V d.c.	£4·40
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50-0-50µA ...	£4·65		
1-0-1mA.....	£4·40	Dual range	
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5A d.c.	£4·40	5V/50V d.c. ..	£4·65
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EDGWISE METERS

Type PE.70. 3 17/32in. × 1 15/32in. × 2¾ in. deep.

50µA	£3·10	500µA	£2·75
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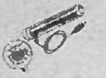
100µA	£3·00	300V. A.C.	£2·45
100–0–100µA	£2·90	VU Meter ..	£3·40
200µA	£2·90		

Send for illustrated brochure on SEW Panel Meters—discounts for quantities.

MULTIMETERS for EVERY purpose!

ROUND SCALE TYPE PENCIL TESTER MODEL TS.68



Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V AC and DC at 2,000 o.p.v. Resistance 0-20K ohms. ONLY £1·97 P. & P. 13p.

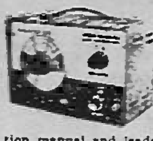
SKYWOOD SW-500

50KΩ/Volt. Mirror scale DC Volts 0.6/3/12/30/300/600. DC Current 20uA/6/600mA Resistance 10K/100K/1 Meg/10 Meg. Decibels — 20 to +57 db. £7·50. P. & P. 15p.

MODEL 5025

57 Ranges, Giant 5½in. Meter. Polarity Reverse Switch. Sensitivity: 50K/Volt D.C. 5K/Volt A.C. D.C. Volts: ·125, ·25, 1·25, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.C. Volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.C. Current: 25, 50IA, 2·5, 5, 25, 50, 250, 500mA, 5, 10 amp. Resistance: 2K, 10K, 100K, 1MEG, 10MEG. Decibels: −20 to +85 dB. £12·50. P. & P. 17½p.

TE22 SINE SQUARE WAVE AUDIO GENERATORS

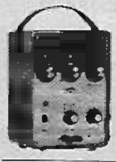


Sine: 20cps to 200 kc/s on 4 bands. Square: 20cps to 30 kc/s. Output impedance 5,000 ohms, 200/250V. A.C. operation. Supplied brand new and guaranteed with instruction manual and leads. £17·50. Carr. 37½p

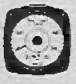
TE-20D RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 Kc/s–500 Mc/s on 6 bands. Directly calibrated Variable R.F attenuator, audio output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions. £15. Carr. 37½p. Size 140 × 215 × 170 mm.

BELCO DA-20 SOLID STATE DECADE AUDIO OSCILLATOR



New high quality portable instrument. Sine 1 Hz to 100 KHz. Square 20 Hz to 20 KHz. Output max + 10 dB (10 K ohms). Operation 220/240v. A.C. Size 215mm x 150mm x 120mm.
Price £27·50. Carr. 25p.

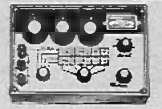


240° Wide Angle 1mA Meters

MW1-6 60mm square	£3·97½
MW1-8 80mm square	£4·97½

P. & P. extra

TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE



A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω–11·1 megΩ 6 Ranges ±1% L.1 µ H - 111 HENRYS 6 Ranges 2% C.10pF±1110mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000–1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100µA. Meter indication. Attractive 2 tone metal case. Size 7¾ × 5 × 2in. £20. P. & P. 25p

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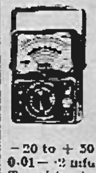
Built in gearbox. All brand new and boxed 60 RPM CW: 30 RPH CW; 2R/HR ACW; 2R/HR CW: 8R/DAY CW: 10 RPM CW; 50p each, Post 12p.

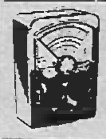
HIOKI MODEL 720X

20,000 O.P.V. Overload protection. 5/25/100/500/1000 VDC. 10/50/250/1000 VAC. 50 uA/250 mA. 20K/2 meg ohm. −5 to + 62db. £4·97. P. & P. 15p.



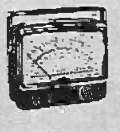
Model 8-100TR MULTI-METER TRANSISTOR TESTER 100,000 o.p.v. MIRROR SCALE OVER-LOAD PROTECTION

0/-12—6/3/12/30/120/600 V DC. 0/6/30/120/600 V. AC. 0/12/600uA/12/300 MA /12 Amp. DC. 0/10K/1 MEG/100 MEG. −20 to + 50 db. 0.01—2 mfd. Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads. £13·50. P.P. 25p.



MODEL 500 30,000 O.P.V

with overload protection mirror scale 0/·5/2·5/10/25/100/250/500/1,000 V. 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 Meg Ω. £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 3¼in. £18·90. P. & P. 25p.

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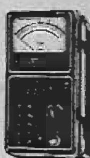

TO-3 PORTABLE OSCILLOSCOPE

3in. tube. Y amp. Sensitivity 0·1v p-p/CM. Bandwidth 1·5 cps–1·5 MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0·9v. p-p/CM. Bandwidth 1.5 cps –800KHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10 cps–300 KHz. Synchronization. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½ lb. 220/240V. A.C. Supplied brand new with handbook. £40·00. Carr. 50p

HONEYWELL DIGITAL VOLTMETER VT.100

Can be panel or bench mounted. Basic meter measures 1 volt D.C. but can be used to measure a wide range of AC and DC volt, current and ohms with optional plug in cards. Specification: Accuracy: ± 0·2, ± 1 digit. Resolution: 1mV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1·999). Input impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100v. D.C. Input: Fully floating (3 poles). Input power: 110-230v. A.C. 50/60 cycles. Overall size: 5¼in. x 2 13/16in. x 8 3/16in. AVAILABLE BRAND NEW AND FULLY GUARANTEED AT APPROX. HALF PRICE. £49·97½. Carr. 50p.

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2N706A	12p
2N708	15p
2N709	62p
2N718	25p
2N718A	80p
2N726	30p
2N727	30p
2N914	17p
2N916	17p
2N918	30p
2N929	22p
2N930	20p
2N987	40p
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2N1639	27p
2N1701	162p
2N1711	24p
2N1889	32p
2N1893	37p
2N2147	72p
2N2160	57p
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2N2194A	30p
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2N2218	20p
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2N2220	25p
2N2221	25p
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2N2222A	25p
2N2297	30p
2N2368	15p
2N2369	15p
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2N3716	130p
2N3773	240p
2N3791	206p
2N3819	34p
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2S102	25p
2S103	25p
2S104	25p
2S301	50p
2S302	50p
2S303	60p
2S304	75p
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2S502	35p
2S503	27p
3N83	40p
3N128	70p
3N140	77p
3N141	72p
3N142	55p
3N143	67p
3N152	87p
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40468A	35p
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40603	50p
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AC126	20p
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ASY86	32p
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BC178	20p
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BC183L	9p
BC184	11p
BC184L	11p
BC186	25p
BC187	27p
BC212L	12p
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BC214L	15p
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BCY42	15p
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BCY54	32p
BCY58	22p
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BCY60	97p
BCY70	15p
BCY71	20p
BCY72	15p
BCY78	30p
BCY79	30p
BCZ10	27p
BCZ11	40p
BD112	30p
BD116	112p
BD121	65p
BD123	80p
BD124	60p
BD131	75p
BD132	80p
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BDY20	105p
BDY61	125p
BDY62	100p
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BF117	47p
BF152	28p
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BF224	14p
BF225	19p
BF237	22p
BF238	22p
BF244	23p
BFW61	47p
BFW87	25p
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BFW-9	20p

BFW90	22p
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BFX12	22p
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BFX37	30p
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BFX86	25p
BFX87	25p
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BFY29	40p
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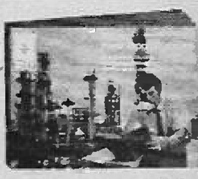

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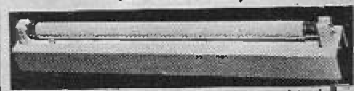

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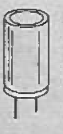

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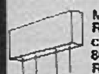

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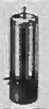

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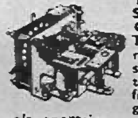

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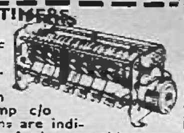

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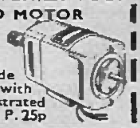

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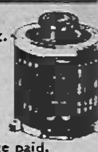

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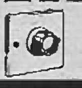

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