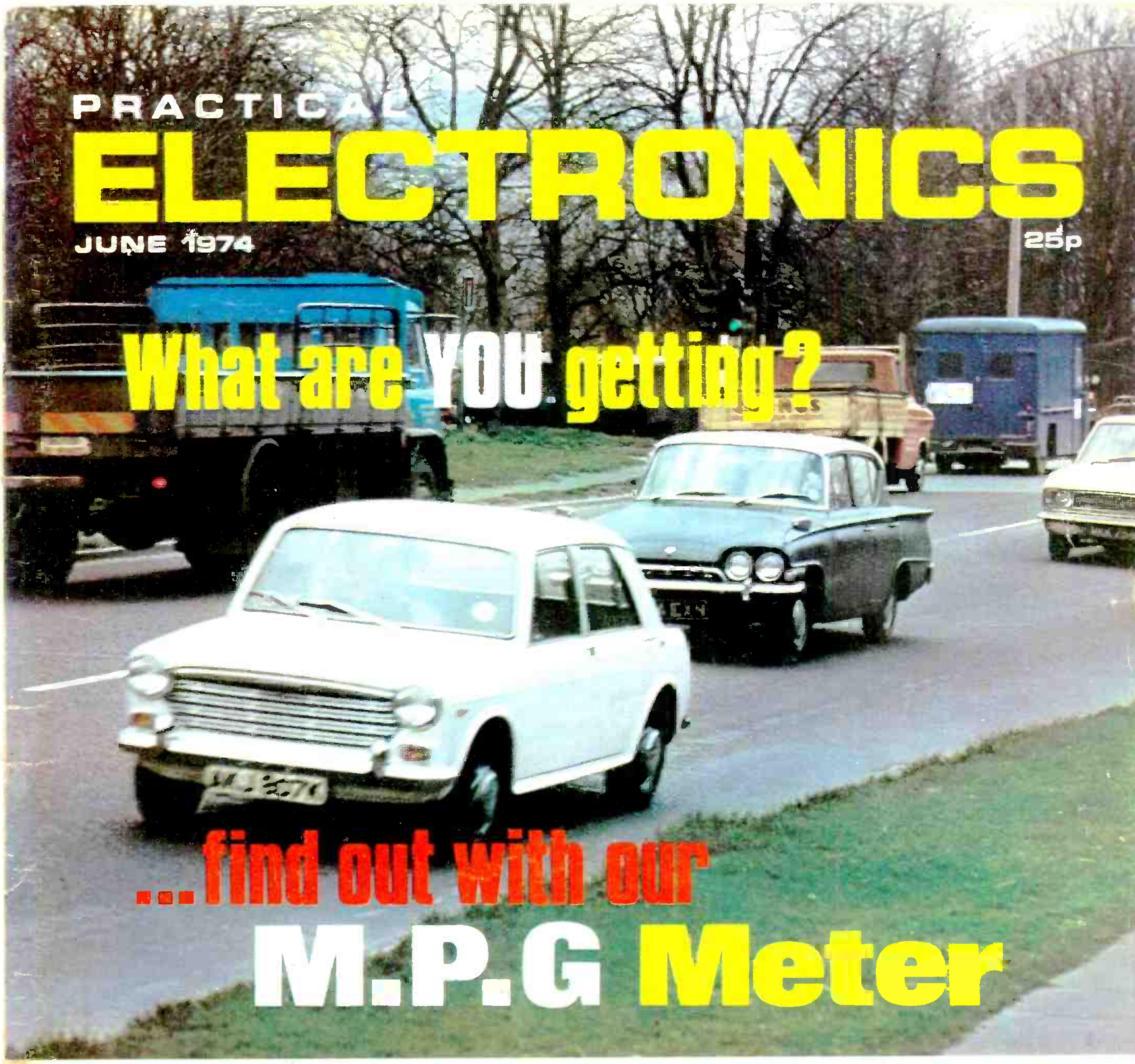
PRACTICAL
ELECTRONICS

JUNE 1974

25p



NEW EDU-KIT MAJOR

COMPLETELY SOLDERLESS ELECTRONIC CONSTRUCTION KIT
BUILD THESE PROJECTS WITHOUT SOLDERING IRON OR SOLDER

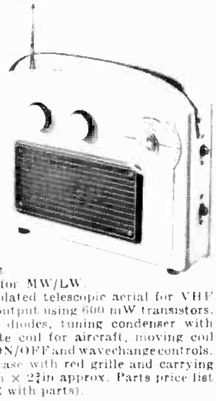
- 4 Transistor Earpiece Radio
- Signal Tracer
- Signal Injector
- Transistor Tester NPN-PNP
- 4 Transistor Push Pull Amplifier
- 5 Transistor Push Pull Amplifier
- 7 Transistor Loudspeaker Radio MW/LW.
- 5 Transistor Short Wave Radio
- Electronic Metronome
- Electronic Noise Generator
- Batteryless Crystal Radio.
- One Transistor Radio
- 2 Transistor Regenerative Radio
- 3 Transistor Regenerative Radio
- Audible Continuity Tester
- Sensitive Pre-Amplifier

TOTAL BUILDING COSTS
£7·23 P.P. & INS. 44p (Overseas P.P. £1·85p)
(+10% VAT 72p)

Components include:
- 24 Resistors • 21 Capacitors • 10 Transistors • 3½" Loudspeaker • Earpiece • Mica Baseboard • 3 12-way Connectors • 2 Volume Controls • 2 Slider Switches • 1 Tuning Condenser • 3 Knobs • Ready Wound MW/LW/SW Coils • Ferrite Rod • 6½ yards of wire • 1 yard of sleeving, etc.
- Parts price list and plans 50p (free with parts)

NEW ROAMER NINE

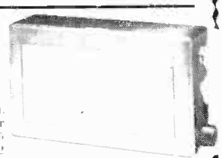
WITH V.H.F. INCLUDING AIRCRAFT



Nine Transistors. 9 Tunable wavebands as Roamer Ten. Built in ferrite rod aerial for MW/LW. Retractable chrome plated telescopic aerial for VHF and SW. Push Pull output using 600 mW transistors. 9 Transistors and 3 diodes, tuning condenser with VHF section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange controls. Attractive all white case with red grille and carrying strap. Size 9½in × 7in × 2¾in approx. Parts price list and plans 30p (FREE with parts).

TOTAL BUILDING COSTS £6·95 (+10% VAT 69p) P.P. & INS. 44p (OVERSEAS P. & P. £1·85)

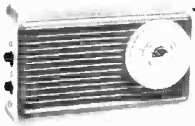
POCKET FIVE



3 Tunable wavebands. MW/LW and Trawler Band. 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, moving coil loudspeaker, attractive Black and Gold Case. Size 5½in × 1¼in × 3½in approx. Plans and parts price list 15p (FREE with parts).

Total Building Costs **£2·28** (+10% VAT 22p) P.P. & Ins. 26p (Overseas P. P. £1·25)

TRANSONA FIVE



Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and parts price list 15p (FREE with parts).

Total Building Costs **£2·50** P.P. & Ins. 26p (+10% VAT 25p) (Overseas P. & P. £1·25)

NEW EVERYDAY SERIES

Build this exciting New series of designs

EV5 5 Transistors and 2 diodes. MW/LW. Powered by 4½ volt Battery. Ferrite rod aerial, tuning condenser, volume control, and loudspeaker. Attractive case with red speaker grille. Size 9in × 5½in × 2¾in approx. Parts price list and plans 15p (FREE with parts).

TOTAL BUILDING COSTS £2·73 (+10% VAT 27p) P.P. & INS. 30p (OVERSEAS P. & P. £1·25)

EV6 Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt Battery. Ferrite rod aerial, 3" loudspeaker, etc., MW/LW coverage. Push Pull Output. Parts price list and plans 15p (FREE with parts.)

TOTAL BUILDING COSTS £3·60 (+10% VAT 36p) P.P. & INS. 30p (OVERSEAS P. & P. £1·25)

EV7 Case and looks as above. 7 transistors and 3 diodes. Six wavebands. MW/LW, Trawler Band, SW1, SW2, SW3, powered by 9 volt Battery Push Pull Output. Telescopic Aerial for Short Waves. 3" Loudspeaker. Parts price list and easy build plans 20p. Free with parts.

TOTAL BUILDING COSTS £4·08 (+10% VAT 40p) P.P. & INS. 31p (OVERSEAS P. & P. £1·85p)

ROAMER EIGHT Mk. I

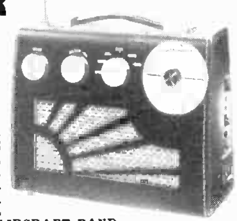
NOW WITH VARIABLE TONE CONTROL

7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND. Built-in ferrite rod aerial for MW and LW. Retractable chrome plated telescopic aerial for short waves. Push-pull output using 600mW transistors. Car aerial and tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Latest 4" 2 watt Ferrite Magnet loudspeaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9in × 7in × 4in approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).

TOTAL BUILDING COSTS £6·98 (+10% VAT 69p) P.P. & INS. 47p (OVERSEAS P. & P. £1·85)

ROAMER TEN

WITH VHF INCLUDING AIRCRAFT



10 TRANSISTORS. 9 TUNABLE WAVEBANDS, MW1, MW2, LW, SW1, SW2, SW3, TRAWLER BAND, VHF AND LOCAL STATIONS. ALSO AIRCRAFT BAND Latest 4" 2 watt Ferrite Magnet Loudspeaker. Built-in ferrite rod aerial for MW/LW. Retractable, chrome plated 7 section telescopic aerial, can be angled and rotated for peak short wave and VHF listening. Push-pull output using 600mW transistors. Car Aerial and tape record sockets. 10 transistors plus 3 diodes. Ganged tuning condenser with VHF section. Separate coil for Aircraft Band. Volume/on/off, wave change and tone controls. Attractive case in black with silver blocking. Size 9in × 7in × 4in. Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts).

TOTAL BUILDING COSTS £8·50 (+10% VAT 85p) P.P. & INS. 52p (OVERSEAS P. & P. £1·85)

EDU-KIT

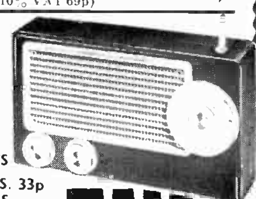
Build Radios Amplifiers, etc., from easy stage, diagrams.

Five units including master unit to construct.

Components include: Tuning Condenser; 2 Volume Controls; 2 Slider Switches; Fine tone 3" moving coil Speaker; Terminal Strip; Ferrite Rod Aerial; Battery Clips; 4 Tag Boards; 10 Transistors; 4 Diodes; Resistors; Capacitors; Three ½in Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction. Parts price list and plans 25p (FREE with parts).

TOTAL BUILDING COSTS £5·50 (+10% VAT 55p) P.P. & INS. 33p (OVERSEAS P. & P. £1·85)

TRANS EIGHT 8 TRANSISTORS AND 3 DIODES



6 TUNABLE WAVEBANDS, MW, LW, SW1, SW2, SW3 AND TRAWLER BAND. Sensitive ferrite rod aerial for MW. and LW. Telescopic aerial for short waves. 3in speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9in × 5½in × 2¾in approx. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 25p (FREE with parts).

TOTAL BUILDING COSTS £4·48 (+10% VAT 44p) P.P. & INS. 33p (OVERSEAS P. & P. £1·25)

ROAMER SIX

CASE AND LOOKS AS TRANS EIGHT 6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, TRAWLER BAND PLUS AN EXTRA MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. Sensitive ferrite rod aerial and telescopic aerial for short waves. 3in speaker. 8 stages 6 transistors and 2 diodes, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9in × 5½in × 2¾in approx. Plans and parts price list 25p (FREE with parts).

TOTAL BUILDING COSTS £3·98 (+10% VAT 39p) P.P. & IN. 31p (OVERSEAS P. & P. £1·85)

RADIO EXCHANGE LTD

*Callers side entrance "Lavells" shop
*Open 10-1, 2.30-4.30. Mon.-Fri. 9-12 Sat.

To RADIO EXCHANGE CO., 61a HIGH STREET, BEDFORD MK40 1SA
Tel. 0234 52367 Reg. No. 788372

I enclose £ .... for ....

Name ....

Address ....

PE6

PRACTICAL ELECTRONICS

VOLUME 10 No. 6 JUNE 1974

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our July issue will be published on Friday June 14, 1974.

RTVC FOR AUDIO ON A BUDGET

PUSH BUTTON(*) CAR RADIO KIT

The first time **Motor *magazine have nominated a push button car radio for their Top Ten Accessory Awards***

NOW BUILD YOUR OWN AWARD WINNING PUSH BUTTON CAR RADIO

Technical specification:
1.) **Output** 2.5 watts R.M.S. into 8 ohms. For 12 volt operation on negative or positive earth.
2.) **Integrated circuit** output stage, pre built three stage IF Module.
Controls Volume, manual tuning and five push buttons for station selection, illuminated tuning scale covering full medium and long wave bands.
Size Chassis 7 ins. wide, 2 ins. high and 4$\frac{5}{16}$ ins. deep approx.

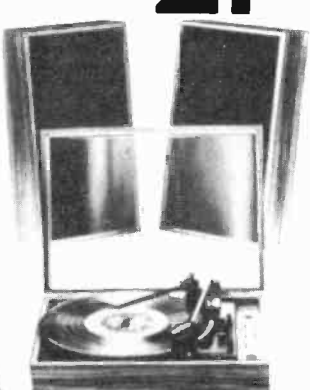
NOTE: The ability to solder on a printed circuitboard is necessary to complete this kit successfully. Circuit diagram and comprehensive instructions 55p free with kit.

Car Radio Kit
£6.60 + 55p. postage & packing.

Speaker including baffle and fixing strips
£1.65 + 23p. postage & packing.

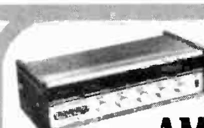
Recommended **Car Aerial** - fully retractable and locking.
£1.35 post paid.

STEREO 21



QUALITY SOUND(*) FOR LESS THAN £19·00

Stereo 21 easy to assemble audio system kit, - no soldering required. Includes:—
BSR 3 speed deck, automatic, manual facilities together with ceramic cartridge.
Two speakers with cabinets.
Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.
For the technically minded:—
Specifications:
Input sensitivity 600mV; Aux. input sensitivity 120mV: Power output 2.7 watts per channel: Output impedance 8–15 ohms. Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs - radio, tape, etc., and outputs for taping discs. **Overall Dimensions.** Speakers approx. 15$\frac{1}{2}$" × 8" × 4". Complete deck and cover in closed position approx. 15$\frac{1}{2}$" × 12" × 6". **Complete only £18.95** +£1.60 p & p.
Extras if required.
Optional Diamond Styli **£1.37**
Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance, **£3.85.**



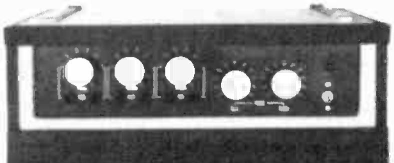
DISCO AMPLIFIER

Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties.
Outputs 20 watts R.M.S. into 8 ohms (suitable for 15 ohms).
Inputs *5 Electrically Mixed Inputs. *3 Individual Mixing controls. *Separate bass and treble controls common to all 5 inputs. *Mixer employing F.E.T. (Field Effect Transistors). *Solid State Circuitry. *Attractive Styling.

INPUT SENSITIVITIES

1) Crystal Mic or Guitar 9mV. 2) Moving coil Mic or Guitar 8mV. 3), 4), 5) Medium output equipment (Gram. Tuner, Monitor, Organ, etc.) - all 250mV sensitivity.
AC Mains 240V. operation.
Size approx. 12$\frac{1}{2}$ ins × 6 ins × 3$\frac{1}{2}$ ins
£15.00 + 60p. postage & packing

DISCO 50



45 WATT R.M.S. MONO DISCOTHEQUE AMPLIFIER
Ideal for Disco Work. Output Power: 45 watts R.M.S. Frequency Response 3dB points 30Hz and 18KHz. Total Distortion: less than 2% at rated output. Signal to noise ratio: better than 60dB. Bass Control Range: 13dB at 60Hz. Treble Control Range: 12dB at 10KHz. Inputs: 4 inputs at 5mV into 470K. Each pair of inputs controlled by separate volume control. 2 inputs at 200mV into 470K. Size: 19$\frac{1}{4}$ × 10$\frac{1}{2}$ × 8ins. approx. Amplifier **£27.50 + £1.50 p. & p**

Special Offer: Disco 50 plus two 15" E.M.I. speakers type 14A/780 (as illustrated on opposite page). **Complete £57.00 + £4.00 p&p.**

COMPLETE(*) STEREO SYSTEM

£51·00

40 Watt Amplifier.
Viscount III – R102 now 20 watts per channel.
System I includes.
Viscount III amplifier – volume, bass, treble and balance controls, plus switches for mono/stereo on/off function and bass and treble filters. Plus headphone socket.
Specification
20 watts per channel into 8 ohms.
Total distortion @ 10W @ 1kHz 0·1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K. equalised within ± 1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to –17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to –12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max.) –58dB.
Crosstalk better than 35dB on all inputs.
Overload characteristics better than 26dB on all inputs. Size approx. 13¾″ × 9″ × 3¾″.
Garrard SP25 deck, with magnetic cartridge, de luxe plinth and hinged cover.
Two Duo Type II matched speakers – Enclosure size approx. 17½″ × 10¾″ × 6″ in simulated teak. Drive unit 13″ × 8″ with parasitic tweeter

Complete System £51.00

£69·00

System II
Viscount III amplifier (As System I)
Garrard SP. 25 (As System I)
Two Duo Type IIIA matched speakers– Enclosure size approx. 31″ × 13″ × 11½″. Finished in teak veneer. Drive units approx. 13½″ × 8¼″ with 3¼″ HF speaker. Max. power 20 watts, 8 ohms. Freq. range 20Hz to 20kHz.

Complete System £69.00

PRICES: SYSTEM 1

Viscount III R 102 amplifier	£24·20 + £1 p & p	
2 Duo Type II speakers	£14·00 + £2·20 p & p	
Garrard SP25 with MAG. cartridge de luxe plinth and hinged cover	£21.00 + £1.75 p & p.	
total	£59.20	

Available complete for only £51.00 + £3·50 p. & p.

PRICES: SYSTEM 2

Viscount R102 amplifier	£24·20	£1·00 p. & p.
2 Duo Type IIIA speakers	£39·00	£4·00 p. & p.
Garrard SP25 with MAG cartridge de luxe plinth and hinged cover	£21·00	£1·75 p. & p.
total	£84·20	

Available complete for only £69.00 + £4 p. & p.

EMI SPEAKERS AT FANTASTIC REDUCTIONS

THE ULTIMATE COMPLETE SPEAKER SYSTEM EMI LE 315. List Price £86·00

A professional standard five way speaker system with enclosure giving top quality performance.
Enclosure Dimensions
approx. (3ft × 2ft × 1ft.)
Drive Units
Hand built – 15″ diameter bass with 3″ voice coil, – two 5″ diameter Mid Range units, – two 3¼″ HF units, plus matching crossover panel with two variable potentiometers for mid and high frequency adjustment.
Power Handling
Continuous rating 35 W rms., Peak power rating 70 W.
Frequency Response
20 Hz 20,000 Hz. Imp. 8 ohms.

Our price £45·00 + £3·50 p. & p.

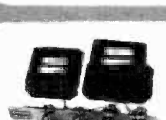
15″ 14A/780 BASS UNIT

Bass unit on a rigid diecast chassis. Superior cone material handles up to 50 watts RMS, and is treated to give a smooth frequency response. Resonance 30 Hz. flux density 360,000 Maxwells. Impedance at 1 kHz is 8 ohms. 3″ voice coil.

Recommended retail price £40·80.
OUR PRICE £18·70 + £1·50 p & p

950 KIT

Five matched speakers and crossover unit for handling up to 45 watts, frequency response from 20 to 20,000 Hz.
Huge 19″ × 14″ (approx.) high efficiency Bass-Speaker with 16,500-gauss magnet built on a heavy diecast frame.
The four 10,000 gauss tweeters, each 3¼″ dia. approx., are fed by the crossover which critically adjusts signal for maximum fidelity. Impedance at 1 kHz is 8 ohms. Bass coil 2″, others 0·5″. Recommended list price £44·00 **OUR PRICE £19.50 + £1·50 p & p Special Offer.**



BUILD YOUR OWN STEREO AMPLIFIER(*)

For the man who wants to design his own stereo — here's your chance to start, with Unisound — pre-amp, power amplifier and control panel. No soldering — just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum. 240V. AC only.

£7·64 + 55p. p& p

8 TRACK CARTRIDGE PLAYER(*)

Elegant self selector push button player for use with your stereo system. Compatible with Viscount III system, Unisound module and the Stereo 21. Technical specification Mains input, 240V, Output sensitivity 125mV. Comparable unit sold elsewhere at £24·00 approx.

Yours for only £10.95 + 90p. p & p

Just write your order giving your credit card number
DO NOT SEND YOUR CARD

- **Mail orders to Acton. Terms C.W.O. All enquires Stamped Addressed Envelope. Goods not despatched outside U.K.**
- **Leaflets available for all items listed thus (*) Send stamped addressed envelope.**

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VARIABLE VOLTAGE TRANSFORMERS

INPUT 230/240V a.c. 50/60 OUTPUT VARIABLE 0–260V

All Types

SHROUDED TYPE

0·5 KVA (2½ amp) (MAX) **£10·00**
1 KVA (5 amp) (MAX) **£14·70**
2 KVA (10 amp) (MAX) **£28·10**
3 KVA (15 amp) (MAX) **£31·25**
4 KVA (20 amp) (MAX) **£72·50**
37·5 amp (MAX) **£102·50**

CARRIAGE AND PACKING EXTRA

L.T. TRANSFORMERS

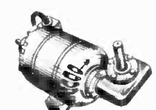
All primaries 220–240V

Type No.	Sec. Taps	Price Post
1	30, 32, 34, 36V at 5A	£6·90 + 45p
2	30, 40, 50V at 5A	£9·15 + 60p
3	10, 17, 18V at 10A	£7·20 + 50p
4	6, 12V at 20A	£8·60 + 60p
5	17, 18, 20V at 20A	£9·15 + 60p
6	6, 12, 20V at 20A	£8·65 + 60p
7	12, 20, 24V at 10A	£6·75 + 50p
8	4, 6, 24, 32V at 12A	£8·60 + 60p
9	6 and 12V at 10A	£4·30 + 40p

VOLTAGE CHANGING TRANSFORMER

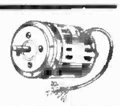
M.f.g. to highest W.D. spec. Auto wound, and tapped 0–130–160–200–250 at least 2kVA. Can also be used as 230–240V input. 115V out for U.S.A. equipment, or reverse to obtain 240V from 115V. The ideal transformer for making up solid state constant voltage unit, by use of taps the following voltages may be obtained 30–40–50–70–90V at 10 amps. Weight 40lb, length, 260mm, height 190mm, width 230mm. In original maker's wooden case, **£8.** Carr. **£1.**

PARVALUX TYPE SD19 230/250 VOLT A.C. REVERSIBLE GEARED MOTORS



30 r.p.m. 40 lb. ins. Position of drive spindle adjustable to 3 different angles. Ex-equipment. Tested and in first-class running order. A really powerful motor offered at a fraction of makers' price. **£6·30.** Post 60p.

A.C. MOTOR 'Mfg. by AEI.'



Smooth running, powerful, continuously rated, reversible motor. 230/250V a.c., 50 cycle 1/50 H.P., RPM 900, 0·25A. **£3·50** post 50p.

METERS NEW! 2½in. Flush round. Available in D.C. Amps 1, 5, 10, 15, 20 or A.C. Amps 1, 5, 10, 15, 20, Voltmeter 0–300V A.C. All types **£2.** Post 15p.

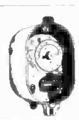
600 WATT DIMMER SWITCH

Easily fitted. Fully guaranteed by makers. Will control up to 600W of lighting except fluorescent at mains voltage. Complete with simple instructions. **£2·75.** Post 25p.

2000 WATT POWER CONTROL

For Power tools, Heating, Sewing Machines, Lighting, etc **£8·00.** Post 27p.

VENNER TIME SWITCH TYPE MSQP

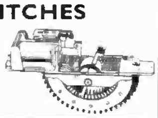


200/250 Volt 2-ON/2-OFF every 24 hours at any manually pre-set time. 20 amp contacts. Fitted diecast case. Tested and in perfect condition **£4·75.** Post 25p.

FOOT SWITCH

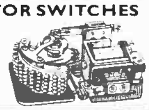
Suitable for Motors, Drills, etc., etc. 5 amp. 250 volt. Price **75p.** Post 15p.

UNISELECTOR SWITCHES



***NEW* 4 Bank 25 Way,** 24V d.c. operation. **£6·90.** Post 30p. **6 Bank 25 Way,** 24V d.c. **£7·90.** Post 30p. **8 Bank 25 Way,** 24V d.c. operation. **£9·50.** Post 40p.

MINIATURE UNISELECTOR SWITCHES



2 Bank, 12 position, 24 volt D.C. operation, full wiper with ancillary contacts. NEW Price **£2·50.** Post 20p. As above but with 5 Bank, 12 position. Price **£3·50.** Post 20p.

STROBE! STROBE! STROBE!

Build a Strobe Unit, using the latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/250V a.c. operation.

EXPERIMENTERS' ECONOMY KIT

Speed adjustable 1 to 30 flash per sec. All electronic components including Xenon Tube and instructions **£6·30.** Post 30p.

INDUSTRIAL KIT

Ideally suitable for schools, laboratories, etc. Speed adjustable 1–80 f.p.s. Approx. ½ output of Hy-Lyght. Price **£12·00.** Post 50p.

HY-LYGHT STROBE MK III

For use in large rooms, halls and utilises a silica tube, printed circuit. Speed adjustable 0–20 f.p.s. Light output greater than many (so called 4 Joule) strobes. **£12.** Post 50p.

THE 'SUPER' HY-LYGHT KIT

Approx. four times the light output of our well proven Hy-Lyght strobe.

- Variable speed from 1–13 flash per sec.
- Reactor control circuit producing an intense white light. ONLY **£20.** Post 75p.

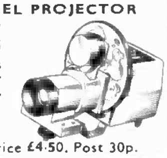
ROBUST, FULLY VENTILATED METAL CASE. For Hy-Lyght Kit including reflector **£5·75.** Post 25p.

Super Hy-Lyght case including reflector **£8.** Post 60p.

7-inch POLISHED REFLECTOR

Ideally suited for above Strobe kits. Price **55p.** Post 15p.

COLOUR WHEEL PROJECTOR



Complete with oil-filled colour wheel. 100 watt lamp. 200/240V AC. Features extremely efficient optical system. **£18·50.** Post 50p.

6 INCH COLOUR WHEEL

As used for Disco lighting effects, etc. Price **£4·50.** Post 30p.

BIG BLACK LIGHT

400Watt. Mercury vapour ultra violet lamp. Powerful source of u.v. Innumerable industrial applications also ideal for stage, display, discos, etc. P.F. ballast is essential with these bulbs. Price of matched ballast and bulb **£16.** Post **£1.** Spare bulb **£7.** Post 40p.

BLACK LIGHT FLUORESCENT U.V. TUBES

4ft 40 watt. Price **£5·50.** Post 30p. **2ft 20 watt, £4·25.** Post 25p. (For use in standard bi-pin fittings.)

MINI. **12in 8 watt, £1·60.** Post 15p. **9in 6 watt, £1·30.** Post 15p. Complete ballast unit and holders for 9in and 12in tube, **£1·70.** Post 25p. (9in and 12in measures approx.)

AUTO FADE COLOUR BLEND MODULE

Will control up to 750W. of lighting. Automatic fade-up, fade-down at a manually pre-selected timing, which may be varied between 1 second to 1 minute. Based on 10 amp triac for maximum reliability. Ready built with switch and Time Control, on 4½" × 5" glass P.C. board. Three modules or more can be sequenced to obtain fantastic colour blending effects. Price **£12·50.** Post 30p per module.

PROGRAMME TIMERS

230/240V a.c. 15 r.p.m. Motors. Each cam operates a c/o micro switch. Ideal for lighting effects, animated displays, etc. Ex equipment tested.

4 cam model. **£2·50** post 30p.
6 cam model. **£3·25** post 30p.
12 cam model. **£4·00** post 35p.

TRIACS

GENERAL ELECTRIC POWER-GLAS TRIACS

10 amp. Glass passivated plastic triac. Latest device from U.S.A. Long term reliability. Type SC146D 10 amp, 400 PIV, **£1.** Post 5p. Type SC146E 10 amp, 500 PIV, **£1·30.** Post 5p. (Inclusive of data and application sheet.) Suitable Diac 18p.

All prices are subject to **10% VAT.** (10p in the £)
To all orders add 10% VAT to total value of goods including carriage/packaging.

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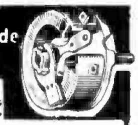


New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.

25 WATT 10/25/50/100/250/300/500/1k/ohm **£1·15.** Post 10p.
50 WATT 1/5/10/25/50/100/250/500/1k/1·5k/ohm **£1·60.** Post 10p.
100 WATT 1/5/10/25/50/100/250/500/1k/1·5k/2·5k/3·5k/5k ohm **£2·35.** Post 15p.

Black Silver, Skirted knob calibrated in Nos. 1–9. 1½in. dia. brass bush. Ideal for above Rheostats, **22p each.**

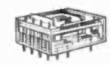
RELAYS SIEMENS, PLESSEY, Etc. MINIATURE RELAYS

Col.(1) Coil ohms; Col. (2) Working d.c. volts; Col. 3 Contracts; Col. (4) Price; HD = Heavy duty; *Incl. Base; All prices incl. P. & P.

1	2	3	4
52	4–6	6M	60p*
58	5–9	6 c/o	80p
150	4–9	2 c/o	70p*
185	8–12	6M	60p*
308	9–14	4 c/o	75p*
700	16–24	4M 2B	60p*
700	16–24	4 c/o	80p*
700	6–12	1 c/o HD	70p*
700	20–30	6 c/o	50p*
2,500	31–43	2 c/o HD	60p*
2,500	36–45	6M	60p*
2,400	30–48	4 c/o	60p
5,800	24–26	2 c/o	60p*
9,000	40–70	2 c/o	60p*
15k	85–110	6M	60p*

6 VOLT D.C. 1 make contacts **35p.** Post 5p.
6 VOLT D.C. 2 make contacts **75p.** Post 5p.
9 VOLT D.C. RELAY
3 c/o 5 amp contacts. 70 ohm coil. **75p.** Post 5p.
12 VOLT D.C. RELAY
3 c/o 5 amp contacts. 120 ohm coil. **75p.** Post 5p.
24 VOLT D.C. 3 c/o **75p.** Post 5p.

ITT LOW PROFILE RELAY



500 ohm coil, 12–24 volts D.C., 4 c/o. Price **85p.** Post 5p each.

CLARE-ELLIOTT TYPE RP7641 G8

Miniature relay. 675 ohm coil. 24 Volt D.C. 2 c/o. **70p** post paid.

100 VOLT A.C. 2 c/o sealed type, octal base **£1.** Post 10p.

24 VOLT A.C. Mfg. by ITT. 2 h.d. c/o contacts. **55p.** Post 5p.

240 VOLT A.C. RELAY. Mfg. by ITT. 240V A.C. 10 amp h.d. c/o contacts. Octal plug in base. (Similar to illustration below). Price **75p.** Post 5p.

HEAVY DUTY A.C. SEALED RELAYS

230/240 V. 2 c/o. 20 amp contacts. 110 Volt. 2 c/o 20 amp contacts. Either type **£1·25.** Post 10p.

DRY REED RELAYS

Mfg. by ERG, 12 volt d.c. encapsulated. Single c/o **65p,** post paid. Two c/o **85p,** post paid. **STC** 280 ohm coil 6/12V d.c. 3 make metal shrouded. **60p** post paid.
Other types available, state your requirement.

"HONEYWELL" PUSH BUTTON, PANEL MOUNTING MICRO SWITCH ASSEMBLY

Each bank comprises a c/o rated at 10 amps 240V. A.C. Black knob 1 in. Fixing hole ⅞ in. ONE bank **30p;** TWO bank **40p;** THREE bank **50p.** Quote for quantity.

HIGH VISIBILITY PANEL MOUNTING LED's. 0·25 inch mounting, 0·16 inch lens. Typical parameters 2V, 20M amps all type. Supplied complete with snap in mountings and data. Red 4 for **£1,** Green 3 for **£1,** Yellow 3 for **£1.** Post 5p. (in order) (£1).

'HONEYWELL' LEVER OPERATED MICROSWITCH

10 amps 250 volt A.C. c/contacts. In maker's carton. PRICE: 10 for **£1·90.** Post 15p.

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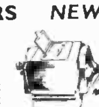

Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L.8in, W.4in, H.6in, weight 6lb. **1,000V,** 1,000 megohms, **£34.** Post 60p. **500V,** 500 megohms, **£28.** Post 60p.

24 VOLT DC SOLENOIDS

Unit containing 1 heavy duty solenoid approx. 25lb pull 1 inch travel. Two × approx. 1lb pull ¼ inch travel. 6 × approx. 4oz. pull ⅛ inch travel. One 24 volt d.c., 1 heavy duty single make relay. Price **£2·50** P + p 60p. **ABSOLUTE BARGAIN.**

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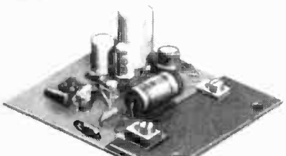
AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.
The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f = 1KHz	0·25%
LOAD IMPEDANCE	—	8–16 Ω
INPUT IMPEDANCE	f = 1KHz	100 k Ω
FREQUENCY RESPONSE —3dB	Po = 2 WATTS	50 Hz–25KHz
SENSITIVITY for RATED O/P	Vs=25V. Rl=8Ω f=1KHz	75mV. RMS
DIMENSIONS	—	3″ × 2½″ = 1″

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power out for 2% T.H.D. (RL = 8Ω f = 1KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

AUDIO AMPLIFIER MODULES

AL 10. 3 watts £2·19
AL 20. 5 watts £2·59
AL 30. 10 watts £3·01

POWER SUPPLIES

PS 12. (Use with AL10 & AL20) 88p
SPM 80. (Use with also AL30 & AL50) £3·25
FRONT PANELS PA 12 with Knobs £1·00

PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20) £4·35
PA 100. (Use with AL30 & AL50) £13·15

TRANSFORMERS

T461 (Use with AL10) £1·38 P & P 15p
T538 (Use with AL20) £1·93 P & P 15p
BMT80 (Use with AL30 & AL50) £2·15 P & P 25p

PA12 PRE-AMPLIFIER SPECIFICATION

The PA12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm × 84mm × 35mm.

Frequency response—20Hz–50KHz (−3dB)
Bass control— ± 12dB at 60Hz
Treble control— ± 14dB at 14KHz
*Input 1. Impedance 1 Meg. ohm Sensitivity 300mV
†Input 2. Impedance 30 K ohms Sensitivity 4mV

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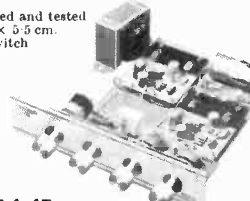
ALL PRICES INCLUDE VAT

The STEREO 20

The "Stereo 20" amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm × 14 cm × 5·5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls. Transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The "Stereo 20" has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ± 12dB at 60Hz typically 0·25% at 1 watt. Treble con. ± 14dB at 14kHz.



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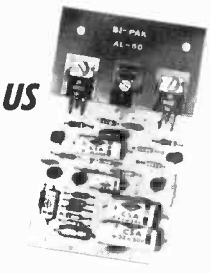
NOW WE GIVE YOU 50w PEAK (25w R.M.S.) *PLUS* THERMAL PROTECTION! The *NEW* AL60 Hi-Fi Audio Amplifier FOR ONLY £3·95

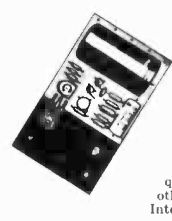


- Max Heat Sink temp 90°C.
- Frequency Response 20Hz to 100KHz
- 0·1% Distortion
- Distortion better than 1% at 1KHz
- Supply voltage 10–35 volts
- Thermal Feedback
- Latest Design Improvements
- Load — 3, 4, 8 or 16 ohms
- Signal to noise ratio 80dB
- Overall size 63mm × 105mm × 13mm

Especially designed to a strict specification. Only the finest components have been used and the latest solid state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

FULLY BUILT — TESTED and GUARANTEED

STABILISED POWER MODULE SPM80

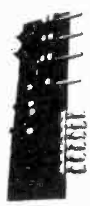


AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm × 105mm × 30mm.
These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available 10p **PRICE £3·25**

TRANSFORMER BMT80 £2·15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.



SPECIFICATION

Frequency Response	20Hz—20KHz ± 1dB
Harmonic Distortion	better than 0·1%
Inputs: 1. Tape Head	1·25 mV into 50K Ω
2. Radio, Tuner	35 mV into 50K Ω
3. Magnetic P.U.	1·5 mV into 50K Ω

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.

Bass Control	± 15dB at 20Hz
Treble Control	± 15dB at 20KHz
Filters: Rumble (High Pass)	100Hz
Scratch (Low Pass)	8KHz
Signal/Noise Ratio	better than −65dB
Input overload	+ 26dB
Supply	+ 35 volts at 20mA
Dimensions	292mm × 82mm × 35mm

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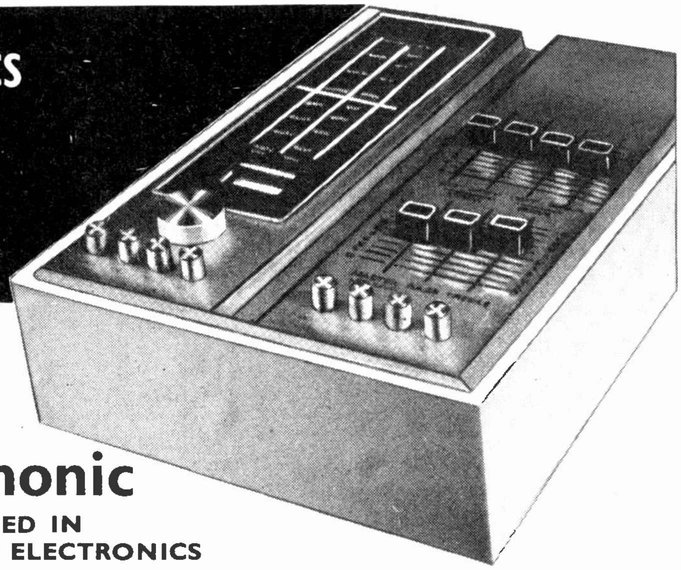

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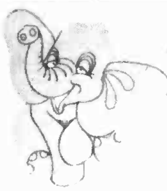

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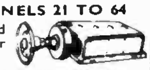

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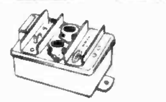

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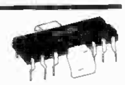

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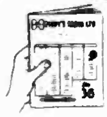

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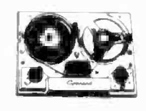

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20VA version uncoated, no fuse	£2·52	£0·30

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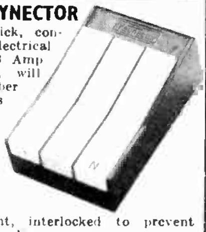

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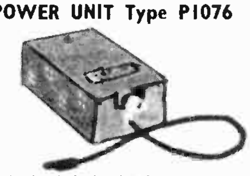

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350	153	14·00	11·44	0·80
500	154	15·80	13·20	1·00
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2000	158	60·95	55·44	
3000	159	79·53	72·49	

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Amps 12V	Amps 24V	Type No.	Price £	P. & P. £
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0·5	0·25	111	1·34	0·22
1	0·5	213	1·59	0·22
2	1	71	2·09	0·22
4	2	18	2·75	0·38
6	3	70	3·56	0·42
8	4	108	3·96	0·52
10	5	72	4·67	0·52
12	6	116	5·67	0·52
16	8	17	6·64	0·52
20	10	115	10·23	0·69
30	15	187	13·75	0·97
40	20	232	18·26	1·00
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Amps	Type	Price	P. & P.
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2	3	3·19	0·38
3	20	3·96	0·42
4	21	4·68	0·52
5	51	5·80	0·52
6	117	6·93	0·52
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Prim. 200–240V.
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Amps	Type	Price	P. & P.
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3	105	5·77	0·52
4	106	7·48	0·52
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10	119	17·60	0·97

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4	123	9·35	0·67
5	40	11·55	0·67
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0–6	0–6	500	500	234	1·30	0·10
0–6	0–6	1000	1000	212	1·68	0·22
9–0–9	—	100	—	13	1·23	0·10
0–9	0–9	330	330	235	1·43	0·10
0–8–9	0–8–9	500	500	207	2·28	0·22
0–8–9	0–8–9	1000	1000	208	3·03	0·30
15–0–15	—	40	—	240	1·23	0·10
0–15	0–15	200	200	236	1·30	0·10
20–0–20	—	30	—	241	1·23	0·10
0–20	0–20	150	150	237	1·30	0·10
0–15–20	0–15–20	500	500	205	2·97	0·38
0–20	0–20	300	300	214	1·76	0·22
0–20	—	3500	(No screen)	1116	3·00	0·40
20–12–0–12–20	—	700 (D/C)	—	221	1·55	0·30
0–15–20	0–15–20	1000	1000	206	3·80	0·38
0–15–27	0–15–27	500	500	203	3·08	0·38
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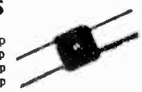

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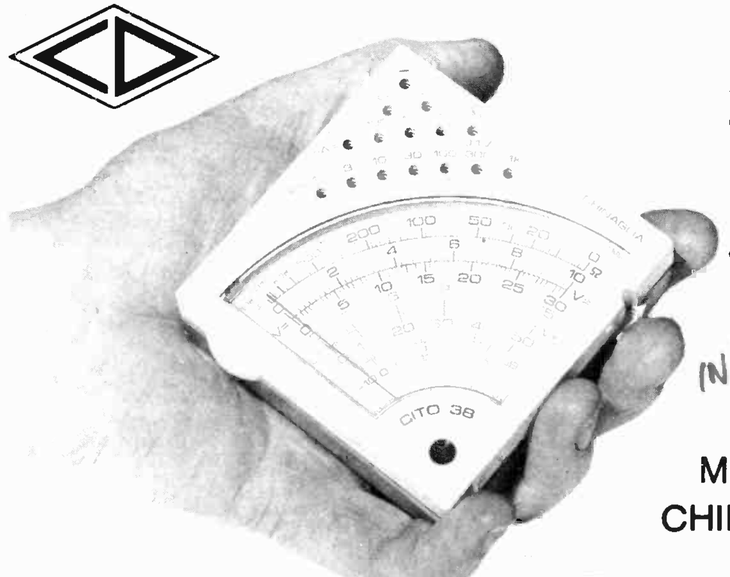

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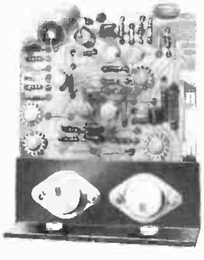

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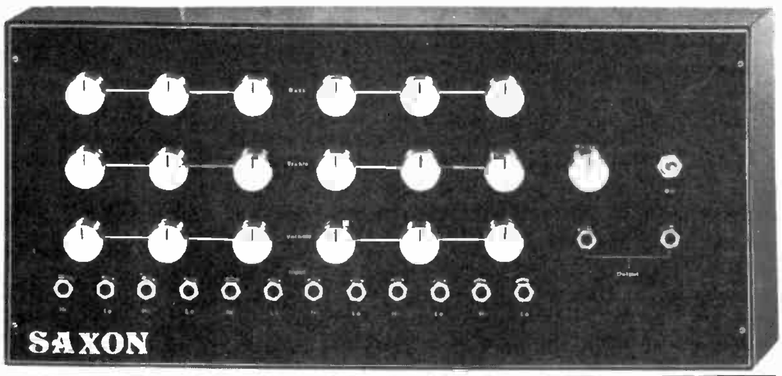

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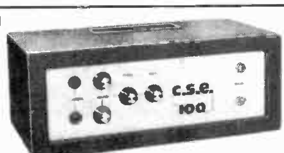

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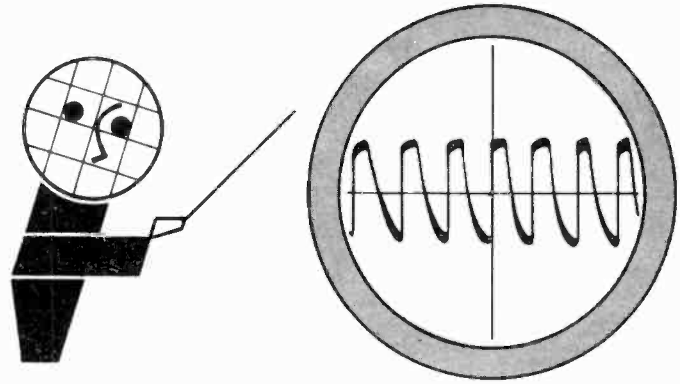

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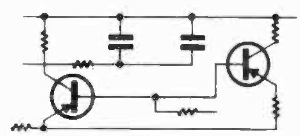

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MIND OVER MATTER

FOR long it has been customary to attribute all manner of so-called mystic powers to electro-magnetic forces generated within living bodies by bio-chemical processes. The intangible nature of electricity does of course make it an obvious choice when searching for an explanation of certain strange phenomena that cannot be accounted for by any mechanism within our normal range of experience and perception.

Knowledge of the electrical nature of all matter makes credible the proposition that an individual's personality radiates beyond the physical bounds of the body in some form of electro-magnetic energy. Nor does this idea have to be restricted to the animal world, but it can be applied to all biological systems including plants.

Is it therefore so very difficult and fanciful to take this line of argument yet a stage further and suggest that inanimate objects could also be endowed with some extraordinary abilities, that enable them (for example) to accept and respond to external, non-physical influences emanating from living bodies? Researches into psychical matters recognise this kind of phenomenon, and they call it psychokinesis.

If the medium for thought-transference is electro-magnetic radiation, then electronic circuits must indeed be high on the list of promising candidates for psychokinesis investigations. Especially those circuits designed to be susceptible to extremely minute signals. What an interesting thought—but what a nightmare for custodians of top security electronic installations!

This leads us to the reason why we consider such esoteric matters have a legitimate place in a magazine devoted to materialistic practicalities of electronics. The discussion is particularly timely because the writer of our *ESP, etc.* feature offers this month a circuit he has devised in order to conduct some simple "mind over matter" experiments.

Psychical investigations are, inevitably, largely influenced by the subjective responses of the individuals involved. But if electronic techniques can help in such investigations, for example in connection with psychokinesis, they ought to be tried out wherever possible—with a completely open mind. Through the sensible and carefully controlled use of electronic instruments by technically knoweldgeable operators, a significant element of objectivity could be injected into the interpretation of the experiments.

Such persons are not likely to be confused or mislead by such red herrings as spurious radiations and fortuitous rectification produced by random metallic contacts, or other effects "strange" to the uninitiated. Undoubtedly many reputed strange phenomena can be explained away as merely the manifestation of some well known law of physics. On the other hand variations in meter readings or in audio signals are not to be lightly dismissed as figments of the imagination. Such changes or responses have to be accounted for—malfunctioning of the equipment itself can be identified and so discounted.

All things being considered, it seems undeniable that there are certain phenomena deserving detailed and cautious investigation by the unprejudiced. To those who are intrigued by this subject there is a further challenge in developing special circuits to permit particular lines of investigation to be carried out.

F.E.B.

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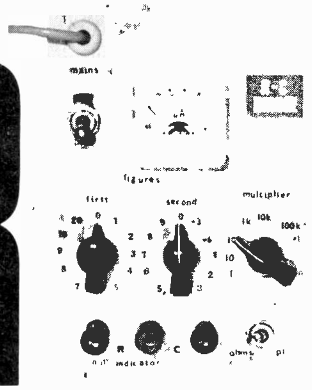
BRIDGE R C



By D. W. EASTERLING

It is always useful to be able to confirm the value of a component, particularly these days when "job lot" packets of devices can be bought for low prices. Markings can be suspect and indeed in the case of capacitors can be obliterated.

Thus any instrument which is capable of measuring resistance and capacitance to a reasonable degree of accuracy is always welcome.

The R/C Bridge presented here is simple in construction and operation, and is capable of indicating resistance and capacitance over a sufficiently wide range to meet most needs. It does not set out to be either highly accurate or sophisticated, giving indication to two significant figures only and with accuracy figures of about 5 per cent on ohms and picofarads and 20 per cent on microfarads.

RANGES

The actual capacitance range covered is from 10pF to 1,090μF with indication from below 10pF and up to 2,000μF. Resistance can be measured from 0·3Ω up to 10·9MΩ, with indication up to 20MΩ. Resolution is two significant figures from 10Ω and 100pF.

The use of a switched digital readout in conjunction with a null-indicating meter avoids the calibration difficulties found with the normal analogue control system used in most bridges.

In fact, it is possible to carry out transformer ratio measurements and some inductance measurements with this instrument.

OPERATION

Operation is simple. Resistors are connected across a pair of input terminals R, as shown in Fig. 2 and capacitors across a further pair of terminals C. The centre terminal is common to both ranges. A mains switch is turned on, and the range toggle switch in line with the terminals is set to the appropriate position. Usually the approximate value of the component being tested is known, allowing the bridge to be set roughly before finally adjusting it to the precise value. For example, suppose a 27kΩ resistor is being measured, the multiplier is set to 1k (3 noughts), the first figure switch to 2, and the second figure to 7.

Typical resistors may be a little more or a little less than the claimed value, and so the bridge is balanced by adjusting the second figure for minimum meter reading. If the meter is still tending to fall when the second figure is 0·3 or 9, the first figure should be set 1 or 3 as appropriate, and the second figure again adjusted for minimum meter reading.

Capacitors are similarly measured. A 0·47μF capacitor (470,000pF) should balance the bridge with the multiplier at 10k (4 noughts), the first figure at 4, and the second figure at 7. Slight variations can be expected according to the tolerance of the component being tested.

The actual value of a 10 per cent 27kΩ resistor would lie somewhere between 24 and 30kΩ.

If the value of the component being measured is completely unknown the bridge is balanced by moving the first figure and multiplier switches progressively through all combinations until a setting is found where the meter reading is tending to fall, and then make the final adjustment on the second figure switch as already described.

THE DESIGN

The measuring circuit is based upon the well known Wheatstone Bridge illustrated in Fig. 1. The applied voltage is common to both arms R_a, R_b and R_x, R_y, of the bridge with a null indicator connected across the centre points. The null indicator is used only to detect any potential difference between these points.

When the potential difference is zero or a minimum the bridge is said to be balanced, and in this condition $\frac{R_a}{R_b}=\frac{R_x}{R_y}$. It will be noted that it is unnecessary for both arms to have the same resistance values in order to satisfy the equation, only the ratios have to be the same.

When the bridge is used as a measuring device one branch is regarded as being the component under test; say R_x. The other branches are then made known values, then the equation can be rewritten $R_x = \frac{R_y.R_a}{R_b}$.

For convenience in balancing the bridge it is normal to make one or more of the known branches adjustable. The advantages of this arrangement over an ohmmeter is that it is possible to produce a linear scale, and accuracy is then dependent on the known resistors, not the applied voltage or meter calibration.

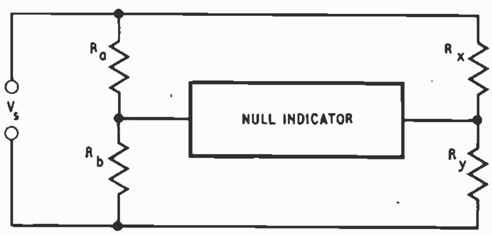


Fig. 1. The basic Wheatstone bridge circuit used in the present equipment

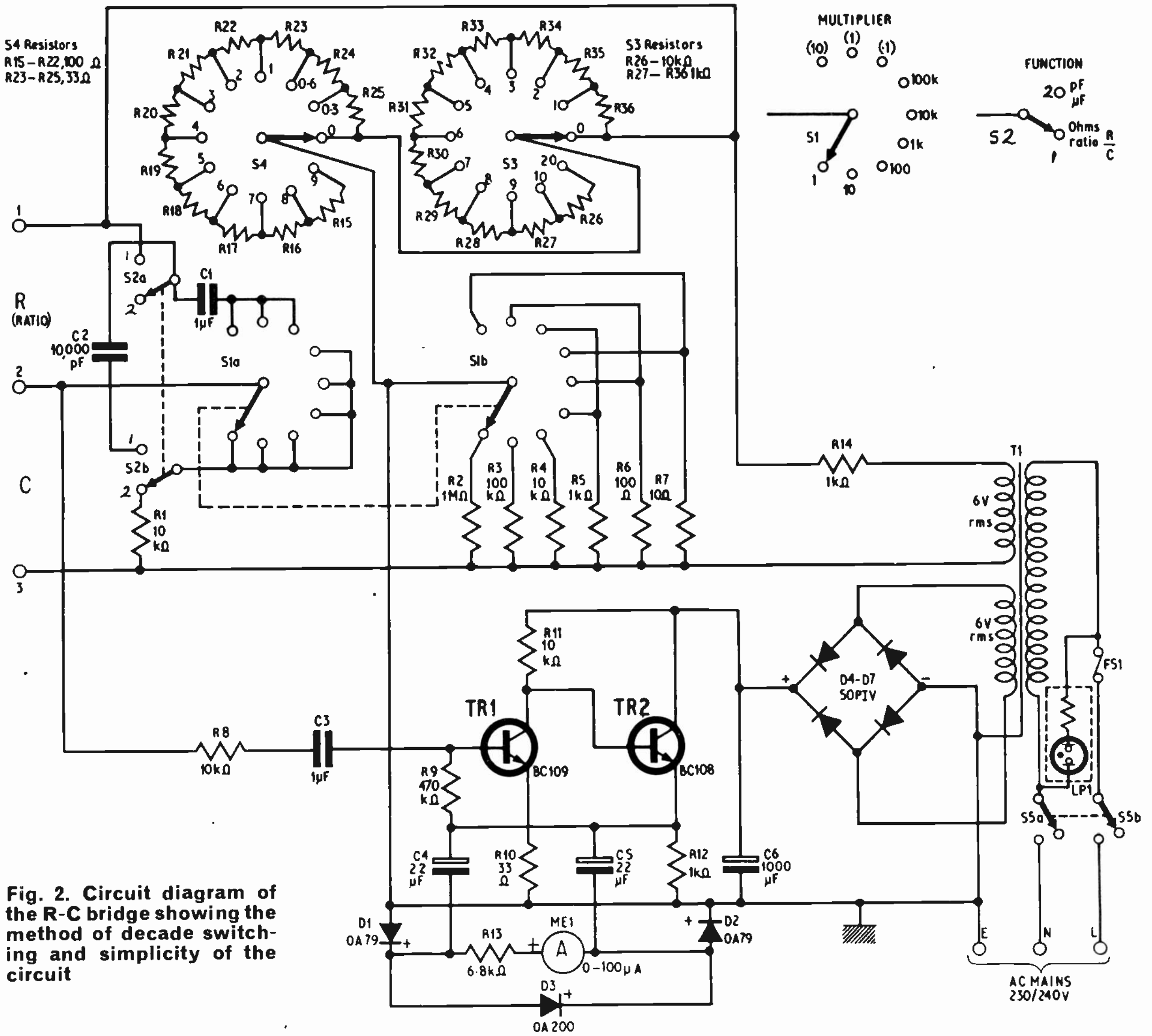


Fig. 2. Circuit diagram of the R-C bridge showing the method of decade switching and simplicity of the circuit

A further advantage is that the circuit is readily adapted to measure capacitance. In this case two capacitors, one the component under test, and the other a known standard, replace resistors R_x and R_y.

V_s must now be an alternating voltage, and the null indicator must be able to operate on a.c.

The bridge equation now becomes $\frac{R_a}{R_b} = \frac{X_{cx}}{X_{cy}} = \frac{C_y.2\pi f}{C_x.2\pi f} = \frac{C_y}{C_x}$ since the reactance of a capacitor equals $\frac{1}{C2\pi f}$, and $2\pi f$ being the same for both capacitors cancels out.

PRACTICAL CIRCUIT

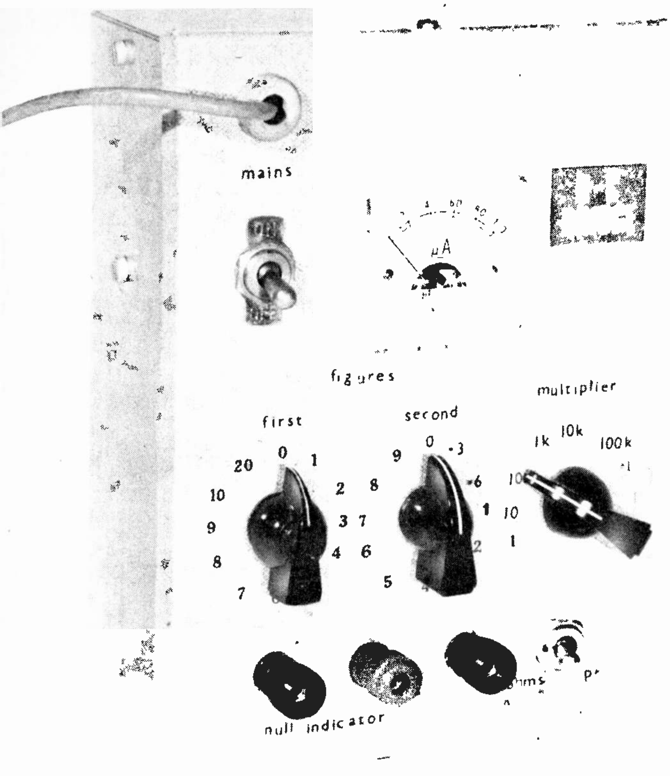
In the practical circuit illustrated in Fig. 2 the bridge includes the resistor being measured across terminals 1 and 2, the standard resistor R1, the multiplier resistor selected by switch wafer S1b, and the first and second figure variable resistors S4 and S3.

When capacitance is being measured it is placed across terminals 2 and 3, and toggle switch S2a/b is set to replace R1 by either C1 or C2 depending on whether the pF or μF ranges are selected by wafer S1a. Wafers S1a and S1b are of course mounted on the same switch assembly.

Switches S3 and S4 are detailed here and in Fig. 3 where it will be seen that they each consist of a 12-way single-pole switch arranged to select the appropriate resistance. Both assemblies start at 0 or zero resistance. The first figure S3 then increases in 1kΩ increments to 10kΩ plus a final jump of 10kΩ making a maximum value of 20kΩ.

This last step makes it easier to sense whether the multiplier should be increased, and also serves to push up the extreme range of the instrument to 20MΩ and 2,000μF.

The second figure S4 first increases in 33Ω steps to a nominal 100Ω, and then in 100Ω steps to 900Ω. The 33Ω steps makes it easier to sense whether the multiplier should be reduced, and also serves to push the lowest range of the instrument down to 0·33Ω.



COMPONENTS . . .

Resistors

R1*	10k Ω	R7*	10 Ω	R13†	6·8k Ω
R2*	1M Ω	R8†	10k Ω	R14†	1k Ω
R3*	100k Ω	R9†	470k Ω	R15–22*	100 Ω (8 off)
R4*	10k Ω	R10†	33 Ω	R23–25*	33 Ω (3 off)
R5*	1k Ω	R11†	10k Ω	R26	10k Ω
R6*	100 Ω	R12†	1k Ω	R27–36	1k Ω (10 off)

* ½W 2% Electrosil   † ½W 5% Carbon

Capacitors
C1 1μF Tubular polyester 160V 10%
C2 10,000pF Polystyrene 160V 2%
C3 1μF Tubular polyester 160V 10%
C4 22μF Electrolytic 25V Wkg
C5 22μF Electrolytic 25V Wkg
C6 1,000μF Electrolytic 25V Wkg

Transistors
TR1 BC109   TR2 BC108

Diodes
D1 OA79   D2 OA79   D3 OA200
D4 to D7 Rectifier Bridge 50 p.i.v. ½A

Switches
S1 2-Pole 9-Way
S2 2-Pole Changeover Toggle Switch
S3 1-Pole 12-Way
S4 1-Pole 12-Way
S5 2-Pole on-off Toggle Switch

Miscellaneous
Transformer T1 Eagle MT6 Primary 230/240V, Secondary 1, 6V ½A, Sec 2, 6V ½A
Meter M1 SEW MR38P 1 21/32 inches square 100μA
Aluminium box 7 × 5 × 2½ inches
Qty 3 Terminals 4mm with top socket
Qty 3 Pointer knobs
Qty 2 Miniature tag boards 12 tag each side
Nuts, bolts, spacers, washers, solder tag, wire and Contact or Fablon.

ENERGISATION

The bridge energising voltage for both resistance and capacitance measurements is derived from a six volt winding on the mains transformer T1 via limiting resistor R14. The disadvantage of using a.c. for resistance measurements is that it limits the bridge to testing non-inductive components, although it does simplify the bridge circuitry. In practical terms the value of resistors can be measured, but not the d.c. resistance of transformers, chokes, and motors.

With no component on test the terminal voltage can rise to 6·3V r.m.s., or 10V peak. This may be thought to be an embarrassment when measuring electrolytic capacitors especially as no d.c. polarising voltage is provided. In practice this is not a problem because R14 together with the bridge impedance and the component under test effectively reduces the terminal voltage to 0·5V r.m.s. or less.

Modern electrolytic capacitors retain their dielectric characteristic long after the polarising voltage is removed, as was found when capacitors which had lain on the shelf for years still measured to their stated capacity.

This circuit differs from many published designs in that ratios as high as 2,000 : 1 are used instead of the more normal 10 : 1. This enables 2,000μF to be measured using a non-electrolytic 1μF capacitor as a standard. Electrolytic capacitors require a polarising voltage for constant use and are insufficiently accurate and stable for measurement work.

NULL INDICATION

The null indicator consists of a two transistor amplifier feeding a 100μA moving coil meter via diode detectors. The signal is passed from the bridge to the null detector via a limiting resistor R8 and isolating capacitor C3. Transistor TR1 is a common emitter voltage amplifier directly coupled to TR2, an emitter follower. The circuit is stabilised by the feedback loop R9 and emitter resistor R10.

The a.c. output from the null indicator is converted to d.c. by the full wave detector circuit C4/D1 and C5/D2 in order to drive the moving coil meter ME1. R13 in series with the meter produces a full scale deflection of 0·75V, but this combination is also shunted by a forward biased silicon diode D3 which starts to pass current at about 0·5V.

The result is that although the pointer can never go beyond the top end of the scale, maximum sensitivity is still available at the bottom end where the critical null point occurs. Such a non-linear response is of course ideal in this application.

POWER SUPPLY

The null indicator requires 9V d.c., and this is derived from a second 6V winding on the mains transformer via the bridge rectifier D4–7 and smoothing capacitor C6. It should be noted that this second winding on the transformer has to be completely isolated from that driving the bridge, because the earthy side of the null indicator is taken back to the junction of S4 and S1b as well as to the metal case. The mains transformer has a standard 230/240V primary which is connected to the live and neutral conductors of the mains lead via a double pole toggle switch. The earth conductor of the mains lead is taken direct to the metal case.

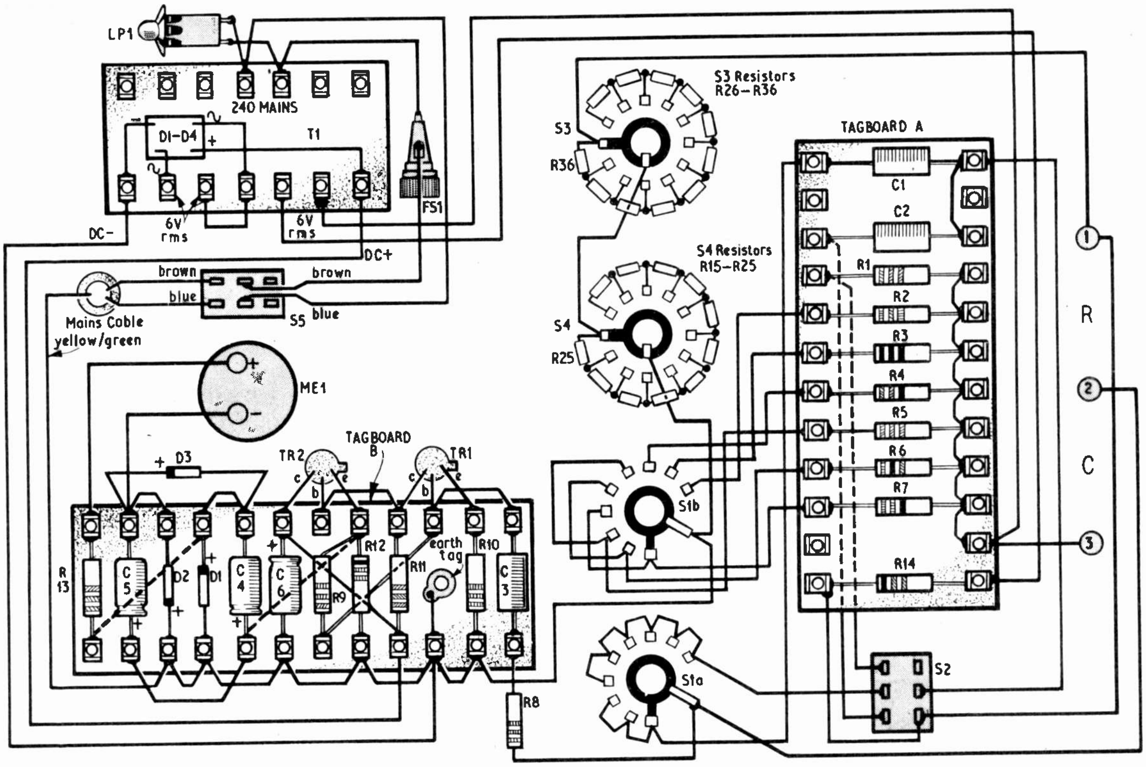


Fig. 3. Wiring diagram of the bridge illustrating the use of tag strips. Remember that S1a and S1b are mounted on the same shaft

CONSTRUCTION

The unit is housed in a standard aluminium box measuring 7 × 5 × 2½ inches. All components except for the mains transformer and rectifier are mounted in the lid which becomes the front panel.

In order to provide a suitable background for the switch and terminal legends the front panel is covered with self adhesive vinyl sheet such as "Contact" or "Fablon". This material will take transfers and instant dry print lettering such as "Blick".

The lettering will rub off with a dry cloth, but is easily made permanent by applying a coat of varnish. Clear fingernail varnish is ideal. The vinyl sheet is applied after drilling the holes, but before the components are mounted. The whole panel including the holes is covered and the creases smoothed out. Finally the parts covering the holes are removed by working a half-round file along the edge of the hole. The lettering is applied after the components are mounted and the knobs fixed.

Care should be taken when fitting the terminals and switches to ensure that the securing nuts do not pucker the vinyl sheet. This can be avoided by using plain washers under the nuts, and the shakeproof washer under the front panel. The switches should be so oriented that the knob point positions conform to the layout shown.

The tagboards are mounted using 6BA bolts. Three-quarter inch spacers are used with tagboard A (see Fig. 3) so that it clears the terminals which it overlaps. The thickness of a full 4BA nut is sufficient for tagboard B to prevent the tags shorting out on the front panel. The bolt at the terminal end of this tagboard is fitted with an earthing solder tag and so provides connection to the metal case.

WIRING

The wiring diagram is shown in Fig. 3. The mains transformer is not mounted on the front panel but in the main box, and has to be connected to the front panel by flexible leads long enough to allow the box to be opened..

During the initial testing procedure it is a good idea not to wire the mains lead via S5 on the front panel, but to connect it direct to the transformer. The mains supply will then have to be controlled by the wall switch and only the low voltage supplies will come to the front panel which will receive the most handling.

Wiring the first and second figure switches S4 and S3 should present no difficulty. The main point to watch is that the component sequence starts at the correct tag. Fig. 3 shows the switch wipers at zero, the resistance value increasing as the wiper moves in a counter clockwise direction (clockwise when viewed from the front of the panel).

The high stability resistors used for these assemblies are fairly fragile, and the leads should not be bent or soldered within ¼in of the resistor body. A heat sink such as the nose of a pliars should be used between the resistor and the joint being soldered.

To clarify the wiring diagram Fig. 3 shows wafers S1a and S1b as two separate switches. They are in fact mounted on the same switch assembly, and with the switch used by the writer they are actually two swiches on the same wafer. Care should be taken to identify the tags clearly before the connections are made. The components associated with S1 are mounted on tagboard "A." The null indicator which is built as a separate assembly is on tagboard "B."

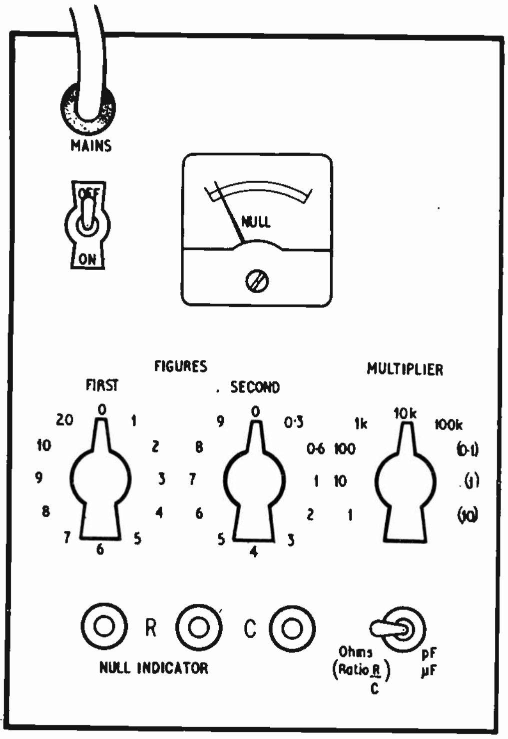


Fig. 4. The front panel showing the lettering used and general layout

Having checked the front panel wiring, the low voltage connections to the transformer may be made, and the unit assembled in its case for test. With the CR terminals unconnected and S2 switched to "ohms", the meter should read just below full scale at all positions of S1, S3 and S4, except when S1 is at (10), when the reading will be lower and drop to zero as S3/S4 are increased. Recommencing with S2 at pF and S3/S4 at maximum, the reading should again be just below maximum, falling when S1 is on 1, or as S3/S4 are decreased.

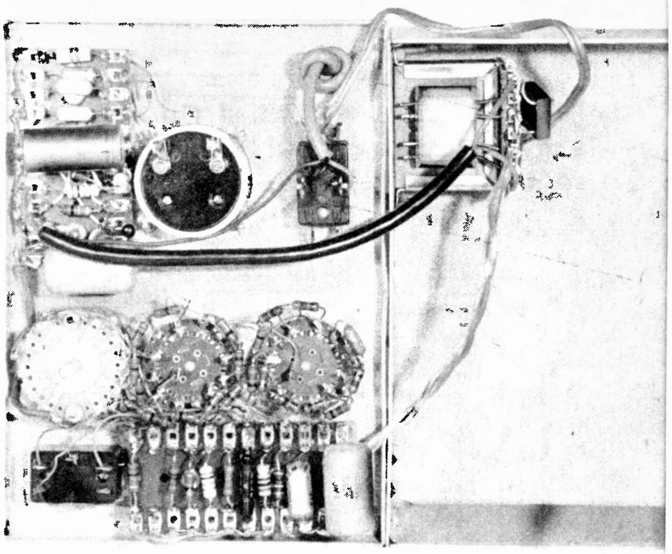
If the meter tends to go above full scale check R13, R14, and D3. If all is well try increasing R13 to 8·2kΩ. If the meter never exceeds 80µA, but otherwise appears to be working satisfactory, try decreasing R13 to 5·6kΩ. If all is now well try measuring a known component.

OPERATION

The following additional notes on operation may be of interest.

Resistance measurements can only be made with S2 on "ohms", and S1 in the first six ranges. The ranges in brackets refer to ratio measurements in this case.

Suppose the turns ratio of an output transformer is to be measured, the high impedance winding is connected across the R terminals, and the low impedance across C, the centre terminal being common to both. The bridge may then be balanced in the usual way. For example a turns ratio of 80 : 1 would be indicated with the multiplier on (1), S4 on 8, and S3 on zero. The correct ratio is that with the windings in phase. Out of phase connections give lower ratio readings.



Component positioning in the prototype. The front panel is to the left and case to the right

INDUCTANCE

The ratio facility may sometimes be used to determine inductance. An unknown inductance across the C terminals can be expressed in terms of a known inductance across the R terminals. There are a number of problems associated with measuring inductance, and the particular bridge configuration used in this design is far from ideal. For instance both standard and unknown inductors may pick up hum and so invalidate the null reading.

Practical inductors have d.c. resistance which in this design is not balanced out. Stray capacitance across the windings may also have an effect. Additionally the inductance of iron cored components vary to some extent according to the d.c. current flowing through the winding, and no provision has been made for this in the equipment described.

CAPACITANCE

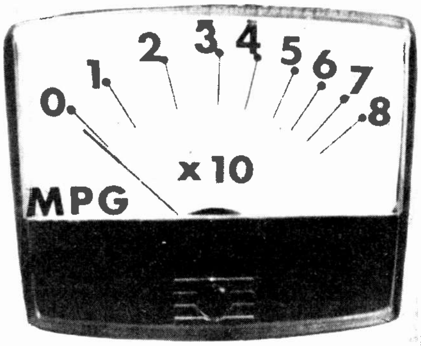
Capacitance measurements are made with S2 switched to "pF (µF)". This means that the first six ranges of S1 relate to picofarads and the last three ranges shown in brackets to microfarads. It will be noticed that the 100k pF range is duplicated by the 0·1µF range. This arrangement is really due to the multiplier range being required for ratio measurements when S2 is on "ohms".

Nevertheless it is available and has the advantage that one range can be checked against the other using any external capacitor within the range 1µF to 10µF. It should be noted that the terminal voltage on the 100k pF range is less than when S1 is on (0·1) µF, and is a consideration when checking very low voltage working capacitors.

One final note is that the unit may be employed simply as a null indicator for use with some other type bridge or test equipment. For this purpose S1 is set to (10), S2 to "ohms", and S4/S3 to zero. Under these conditions the frequency response is flat from below 20Hz to above 30kHz, and the sensitivity for a mid range reading of 50µA is 12·5mV r.m.s. The input voltage should not be allowed to exceed 6V r.m.s. ★

Provided your car has an electric fuel pump, this meter can be fitted to give a continuous reading of fuel consumption so that speed can be adjusted for greatest economy

M.P.G METER



By S. JONES

THE CIRCUIT to be described counts the number of rotations of the rear wheels in the time it takes the fuel pump to complete one pumping cycle. The greater the number of wheel revolutions during one pumping cycle, the higher the "miles per gallon" figure.

To count the revolutions of the rear wheel a diode pump counter is used, being operated by a reed relay and two magnets in the rear wheel.

CIRCUIT DESCRIPTION

The circuit diagram of the Miles per Gallon Meter is shown in Fig. 1. Capacitor C2 charges up via R2, D2 and C3.

When the reed relay contacts RLA1 are closed by a magnet on the rear wheel, C2 is discharged via D3 but the charge on C3 remains.

After contacts RLA1 are released by the magnet, C2 is again charged and the voltage on C3 increased by a step almost equal to its original voltage. The voltage on C3 increases in equal steps each time RLA1 is operated and continues to increase until the fuel pump operates which momentarily discharges C3 via D4 and D5.

This maximum voltage reached by C3 is a measure of the miles per gallon. It can be seen from Fig. 2 that twice the fuel consumption and twice the speed results in the same peak value on C3 and hence the same meter reading.

Transistor TR1 forms an emitter follower, the voltage across the meter being virtually equal to that across C3. Diodes D4 and D5, being silicon diodes, short C3 to their forward voltage of about 0·7V and this compensates for the base to emitter voltage drop of TR1; two diodes are used to ensure a low forward resistance.

Capacitor C4 is incorporated to ensure that readings do not fluctuate wildly as C3 is charged and discharged. However, it must be small enough to

COMPONENTS . . .

Resistors
R1 56Ω
R2 47Ω
R3 4·7kΩ
R4 2·2kΩ
All ±10% ½W carbon

Potentiometer
VR1 5kΩ skeleton preset

Capacitors
C1 1000μF 12V elect.
C2 12·5μF 64V elect.
C3 470μF 10V elect.
C4 1000μF 12V elect.

Diodes and Transistor
D1 10V 1W Zener diode
D2, D3 OA81 (2 off)
D4, D5 1N4001 (2 off)
TR1 2N2926 (−ve earth) 2N3702 (+ve earth)

Miscellaneous
ME1 1mA f.s.d. meter
RLA1 1in reed relay
½in dia button magnets (Eclipse) (2 off)

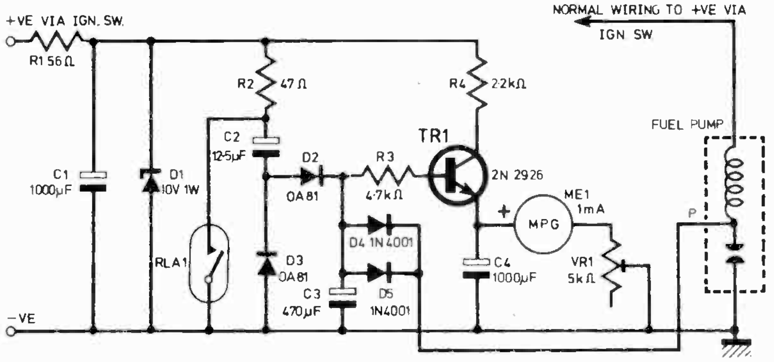
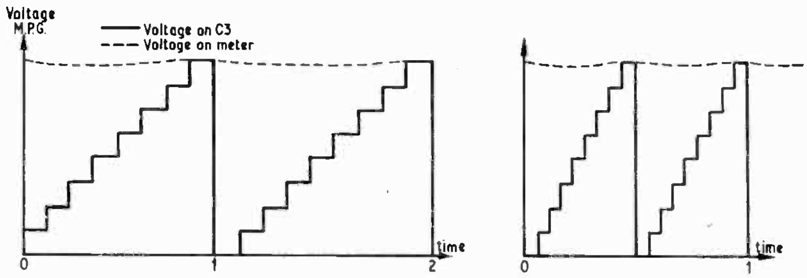


Fig. 1. Complete circuit diagram of the Miles per Gallon Meter. The circuit shown here is for the negative earth system. TR1 should be altered to a 2N3702 and all diodes and capacitors reversed for positive earth

Fig. 2. Doubling the speed and doubling the fuel consumption keeps the m.p.g. reading the same



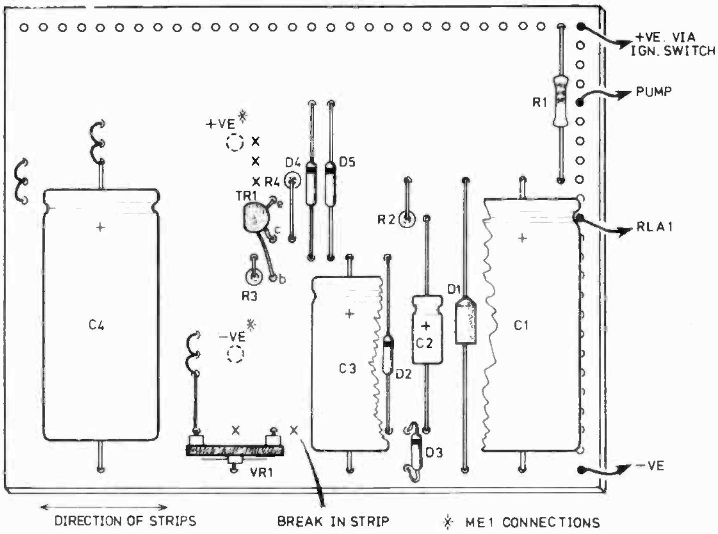
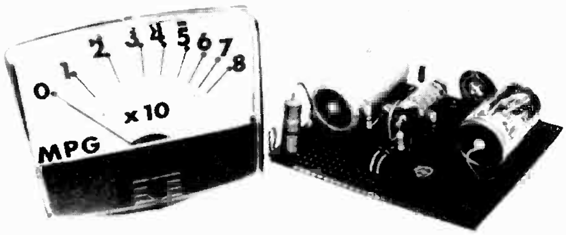


Fig. 3. Layout of the components on the Veroboard. This panel is mounted directly on the meter. Holes should be drilled to suit meter



Photograph of the completed Miles per Gallon Meter.

allow the meter reading to fall to a higher consumption value in a reasonable time. The values indicated proved to be the most satisfactory, readings below 30 m.p.g. being steady ±1 m.p.g., while those above 30 m.p.g. are in themselves only temporary during gear changing, braking, etc.

A scale to 80 m.p.g. was required with a 1,600cc *Capri,* though under heavy braking some overloading of the meter movement occurs as the pointer attempts to reach perhaps 100 m.p.g.

CONSTRUCTION

Construction is on 0·1in matrix Veroboard, 24 holes by 31 as shown in Fig. 3. This was mounted directly onto the meter in the original, and sufficient room has been left to move the mounting holes to suite individual meters. The board may of course be mounted separately from the meter.

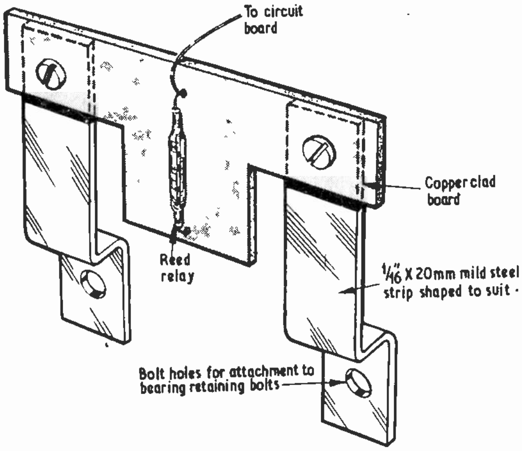
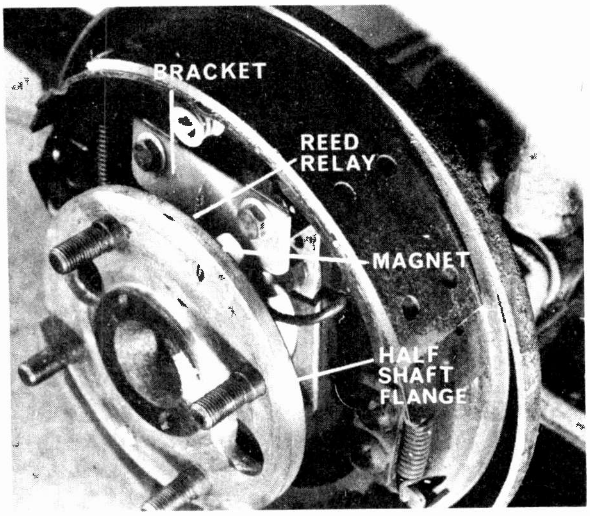


Fig. 4. Mounting details for the reed relays



Photograph of the reed relays mounted on the half shaft flange

POSITIVE EARTH VEHICLES

The same Veroboard can be used for positive earth vehicles, although all the capacitors and diodes (including D1) must be reversed in polarity and TR1 changed for a 2N3702.

The pump and reed connections are identical, though the positive and negative supply connections to the Veroboard must be reversed.

WHEEL MAGNETS

A reed relay inside a rear brake drum is closed twice every revolution (every 0·037 sec at 60 m.p.h.), by two magnets bolted to the inside of the half shaft flange. The photograph shows how they are arranged. (The half shaft flange is the disc to which the wheel bolts are attached.)

Many cars will already have one hole drilled in the flange and this can be utilised—the steel is soft and can be easily drilled with a sharp 5/32in drill. Use countersunk 4BA bolts with nylock nuts to hold the magnets, as they must not shake loose to impede the brake action. No deterioration of the magnets has been noticed despite the temperatures inside the drum.

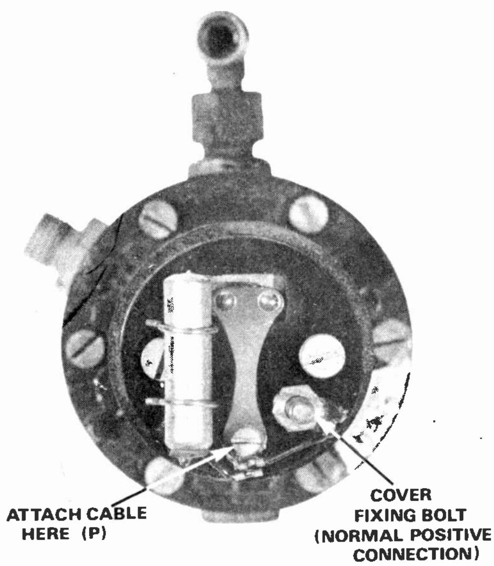
Four nuts retaining the wheel bearing will be noticed behind the half shaft flange—two of these can be removed through the two large holes in the half shaft flange and used to attach a strong bracket (see Fig. 4) which holds the reed vertically about 15 thousandths of an inch from the magnet.

Check the operation of the reed, ensuring that it closes twice only per revolution, and then earth one connection, and passing a wire through a small hole in the backplate, connect the other to the electronics inside the vehicle. Allow plenty of slack for rear axle movement.

FUEL PUMP

This component requires little modification. Attach a wire to the internal upper fixed contact (see photograph) and lead out the wire through a small hole

Photograph of an SU fuel pump with the cover removed showing the new connection which has to be made



in the case. When the pump is in normal use this wire will be connected to earth via the pump contacts each time the pump completes a pumping stroke.

Cars normally fitted with mechanical pumps will require the fitting of an electric type, but this need not be expensive if one is purchased from a breakers' yard.

The mechanical pump can be left on the car for emergency use, should the electric pump fail.

TESTING AND CALIBRATION

Before testing, fit a normally open switch between the RLA1 terminal of the Veroboard and earth and the "PUMP" terminal and earth. These switches will simulate the operation of pump and reed during calibration and testing.

Connect to a suitable voltage supply and with VR1 set to its maximum, operate the "reed" test switch a few times—the meter needle should deflect and return very shortly to zero. Operate the RLA1 test switch until half full scale deflection occurs, and then operate the "PUMP" test switch. The meter needle should return to zero quite quickly.

It is now necessary to calculate the number of miles per gallon indicated by each step of the diode pump counter:

$$\text{m.p.g. per step} = \frac{\text{fuel pump strokes per gallon}}{\text{revolution of wheel per mile} \times \text{number of wheel magnets}}$$

The number of fuel pump strokes per gallon depends on the pump used, but will be in the range 2,500 to 3,500.

MEASURING FUEL CONSUMPTION

Connect the pump to the battery and restrict the outlet from the pump so that the strokes are slow enough to be counted. If the pump cannot be removed, disconnect at the carburettor.

Allow the pump to deliver one pint of fuel, counting the strokes, and multiply this number by eight. Paraffin is easier to handle than petrol, particularly if the pump is not yet fitted to the car.

Wheel revolutions per mile are shown below—do not try to measure the circumference of the tyre with string—a true rolling circumference is required as shown in Table 1.

Table 1: TYRE CIRCUMFERENCES

Wheel Diameter (in)	RADIAL Rev/mile	CROSSPLY Rev/mile
10	1082	1080
12	955	954
13	889	866
14	871	820
15	820	800
16	758	748

Once the calculation has been completed it is easy to adjust VR1 so that the required number of steps gives a full scale deflection of 80 m.p.g. Halve the number of steps to calibrate for 40, 20 and 10, etc.

It will be noticed that the scale is non linear; however, this is an advantage as accurate readings are of more use at low miles per gallon.

The meter can now be installed and will require no further adjustment. ★

POINTS ARISING

ANYONE AT HOME? (*April 1974*)

In the Veroboard diagram, Fig. 6, there should be no breaks at D29 or F21, and there should be a break at F19.

AUTO CHARGER-REGULATOR (*February 1974*)

In Fig. 2, the power supply pins to IC1, pins 7 and 4 should be transposed so that pin 4 goes to negative and 7 to positive.

BOOLEAN ALGEBRA—Part 2 (*April 1974*)

In Fig. 2.5, in the second row of integrated circuits from the left, the bottom left pin should go to the 5V line.

On the strip side two breaks are missing (a) in the ninth row from the top, between the short wire link and the capacitor body (b) in the ninth row from the bottom between the leftmost pair of diode bodies.

In Figs. 2.5 and 2.6 wires running from panel to Veroboard should be re-routed thus: wire D (panel) to ground line (Veroboard); wire R (panel) to Q (Veroboard); wire Q (panel) to D (Veroboard).

SLOW TIME BASE OSCILLATOR (*Ingenuity, March 1974*)

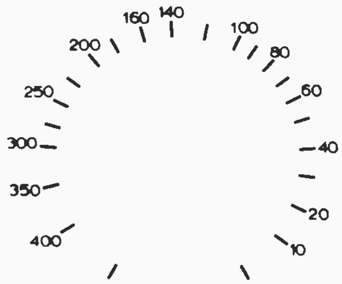
Resistor R3 should be connected between R4 and R5, and not between R1 and R4 as shown. This error causes non-linearity in the ramp output slope at lower frequencies.

SEMICONDUCTOR TESTER (*October, November 1973*)

R12 in the components list may be made up from 5·1Ω, 5·1Ω, and 8·2Ω in parallel.

In the components list R17 should have been 10kΩ as in the circuit diagram.

We reproduce here a scale suitable for the "*h*" potentiometer which gives reasonable accuracy.



9V BATTERY ELIMINATOR (*December 1973*)

C1 in Fig. 1 should be 1,000μF as in the components list.

POWER SUPPLY FOR I.C.s (*January 1974*)

For use at currents greater than 40mA an MJE520 should be substituted for the BFY50 output transistor.

RHYTHM GENERATOR (*March 1974*)

In Fig. 3 the diagram showing the pin connections for IC1-IC3 is incorrect. GND should go to pin 11 and 4·7V to pin 4. IC4-IC5 is as shown.

In Fig. 4 the diagram of LP1 should show pin 10 connected to 4·7V not common.

INGENUITY UNLIMITED

A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.
This is YOUR page and any idea published will be awarded payment according to its merits.

LOGIC CIRCUIT TESTER

When experimenting with logic circuits, a source of individual pulses or series of pulses is often required. The circuit in Fig. 1 was built for low speed testing of TTL in breadboard circuits. It generates either a continual train of 10 millisecond pulses at the rate of 1 p.p.s. or 1 to 10 pulses via a telephone dial. Positive or negative going outputs are available.

The pulse generator is an SN74121 monostable multivibrator. The duration of the output pulse is governed by the timing components R3 and C2. R3 should not exceed 40 kilohms.

The pulse is generated whenever the input signal on pin 5 goes positive. With the switch in the "Dial" position, this point is held to ground via the intermittent contacts in the dial mechanism. When a number is dialled, these contacts open that number of times and generate the required number of pulses. With the switch in the "Osc" position, the input is held to ground via the output load of a unijunction oscillator. When the timing capacitor C1 discharges through the transistor, a positive pulse of about 2·5 volts appears across the load resistor and this operates the pulse generator. With the values shown, the frequency will be about 1 pulse per second.

Note that a spurious pulse is generated when the switch is operated. Each output of the device has a fan-out of 10.

A. Langton
Aberdeen.

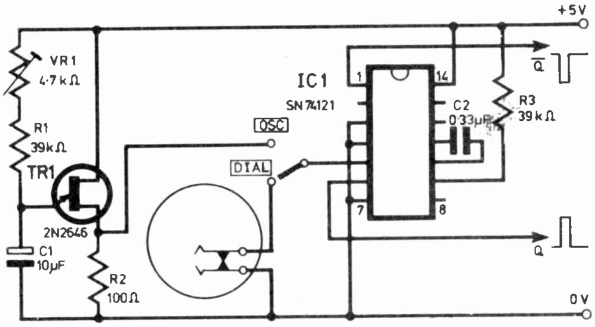


Fig. 1. Circuit diagram for the logic tester

TOUCH SWITCH WITH DELAYED SWITCH-OFF

The circuit shown in Fig. 1 was originally designed as a "gimmick" to light a bulb when an "Aladdin's Lamp" was rubbed. It will doubtless find many other uses, the most obvious being an enlarger timer.

The circuit operates in the following way. Normally CSR2 is off and RLA de-energised, thus CSR3 is also off as contacts RLA2 are open. When the plate is touched a small current flows through R1 and R2 triggering the silicon controlled switch CSR1. This brings on thyristor CSR2 and hence RLA. As thyristor CSR2 is supplied with smoothed d.c. from D2, D3, it latches on. Contacts RLA2 close and d.c. is applied to the timing network R6, R7, VR2 and C2. As C2 charges it eventually reaches a potential close to that set by the divider R9 and R10. In this condition CSR4 is triggered which brings on thyristor CSR3, whose anode is suddenly brought close to its cathode potential and the resulting signal is fed to the anode of CSR2 via C3 switching it off.

The cycle can be repeated by once more touching R1.

The sensitivity of the circuit is determined by VR1. Diac D1 clamps the potential at which CSR1 fires, ensuring that triggering occurs early in the mains cycle. This also reduces mains interference.

The length of the delay time is set by VR2 and longer delays can be achieved by increasing VR2 and C2. If R9 is increased extra delay time at the expense of range can be obtained.

A. J. Woollard,
Devon.

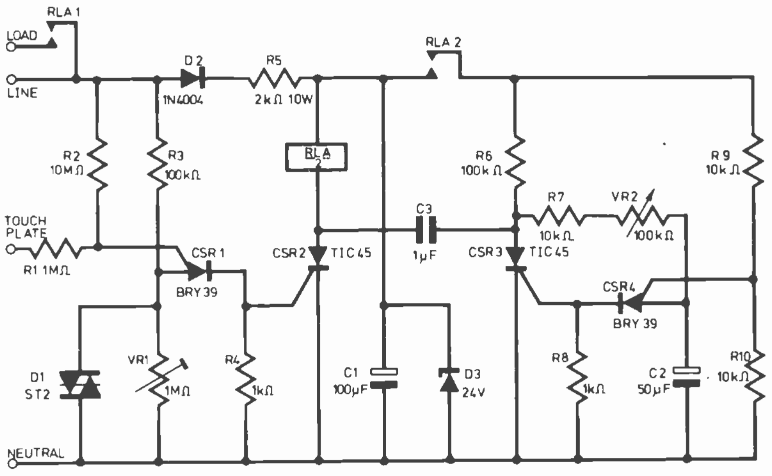


Fig. 1. Circuit of touch switch with delayed switch-off

VOLTAGE SHARING IN STABILISED POWER SUPPLIES

ONE OF the problems associated with stabilised supplies is the amount of heat dissipated in the series transistors. The usual solution to this problem is to use a parallel combination of two or more devices to share the current.

This presents a difficulty as transistors used in this manner usually need matched characteristics, with large wattage resistors in the emitters to make the current sharing as equal as possible.

The method described here does not require matched devices but is still very effective.

Instead of current sharing, voltage sharing is used. The circuit is shown in Fig. 1. Assume to begin with that TR1 is saturated so that the input voltage (V_{in}) minus the output voltage (V_{out}) will be dropped across TR2.

This voltage is fed back via a Zener diode and resistor to TR1 in such a way as to turn off TR1. This means that TR1 begins to turn off when the voltage across TR2 reaches a voltage determined by the Zener diode and the two resistors R1 and R2. The values in the diagram were chosen to give near equal sharing with 5V output, 35V input and 1A of current.

The graph of Fig. 2 shows how the power is shared between the two transistors.

To establish the voltage across TR1, use the formula

$$V_{CE(TR1)} = \frac{R_1}{R_1 + R_2}(V_{in} - V_{out} - V_z).$$

This means that only TR2 will be effective until the voltage causes the Zener diode to conduct, i.e. when $V_{in} - V_{out} \geqslant V_z$. R1 must be sufficiently small to supply enough base current to TR1 to saturate it at maximum current.

D. W. Lloyd,
Biggleswade.

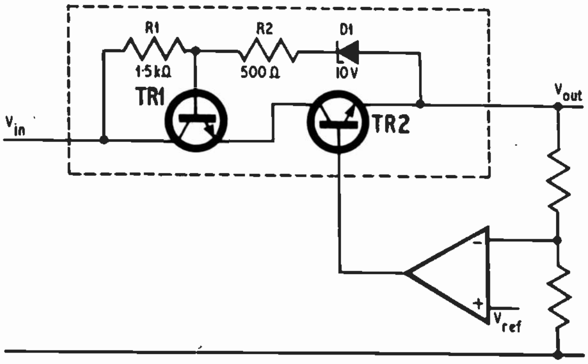


Fig. 1. Circuit diagram for a voltage sharing power supply

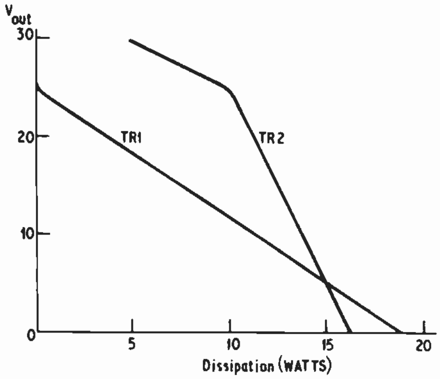


Fig. 2. Graph showing how the power is shared between TR1 and TR2

CIRCUIT BOARD PREPARATION

IT TAKES some time to prepare a printed circuit board so Veroboard is the usual answer. Veroboard is quite expensive and not always to hand. The narrow width of the strips is not always convenient.

Two simple tools which make is possible to prepare a printed circuit board in a short time will be described.

A clamp is made from two pieces of flat iron $1\frac{1}{2}$in × $\frac{1}{8}$in × 8in. Drill a hole in each end for a $\frac{3}{16}$in screw.

The second tool is a wooden handle with a slot in it so that a piece of used hacksaw blade, 4in long and ground on each side, can be fitted.

To prepare a circuit board, put a piece of copper clad board in the clamp, tightening both screws, leaving a strip the required width protruding (Fig. 1). With a slow movement, scribe a slot in the copper, checking to see that no shorts are left at the end of the process. After this, drill holes only where you need them.

E. Koren,
Israel.

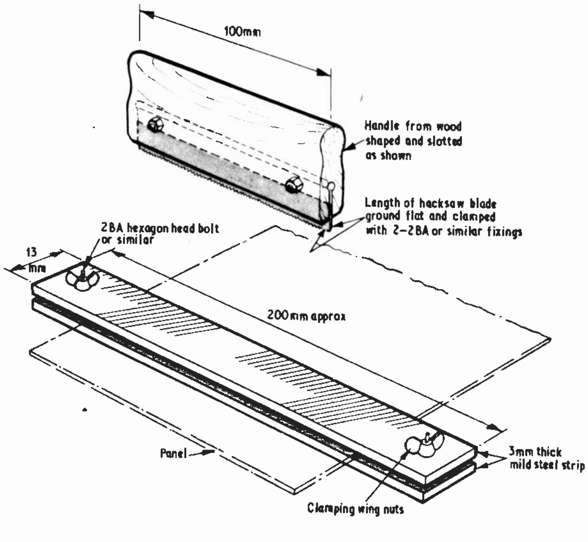


Fig. 1. Two aids for making circuit boards

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MULLARD POLYESTER CAPACITORS C296 SERIES
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160V: 0·01μF, 0·015μF, 0·02μF, **3p**. 0·047μF, 0·068μF, **3½p**. 0·1μF, **4½p**. 0·15μF, **5p**. 0·22μF, **5½p**. 0·33μF, **6½p**. 0·47μF, **8½p**. 0·68μF, **12p**. 1μF, **14p**.

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NOVEL TIMEBASE MARKER CIRCUIT

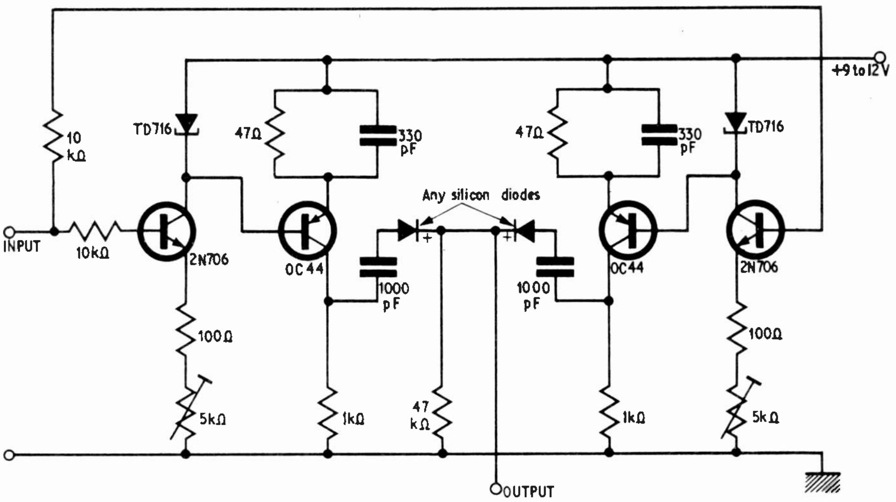


Fig. 1. Novel timebase marker circuit

A NOVEL timebase marker circuit is shown in Fig. 1. It consists of two Schmitt triggers which are set by VR1 and VR2 to fire at different input voltages. The two output pulses are fed through C2 and C3 into D1 and D2 which combines the pulses to give single output.

If the positive timebase ramp output from an oscilloscope is fed into the Schmitt triggers (marked "input" on the diagram), and the output is fed to the *Y* input two pips will appear on the screen.

The pip positions on the screen can be adjusted by adjustment of the input voltage controlling potentiometers VR1 and VR2 as indicated in Fig. 2. Their relative positions are not affected, however, by the timebase speed.

Therefore if your oscilloscope does not have a graticule you can still do frequency comparisons using and positioning the pips as markers.

S. H. Alsop,
Sheffield.

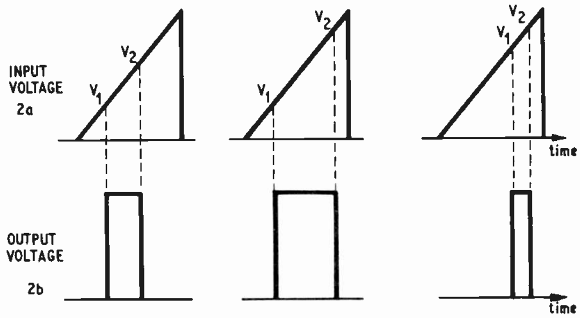


Fig. 2. (a) Input from timebase ramp showing trigger voltages of the Schmitt triggers at V_1 and V_2. (b) output pulse to the Y input of the oscilloscope

TUNNEL DIODE IN A SCHMITT TRIGGER

THE circuit diagram shown in Fig. 1 uses a tunnel diode as part of a Schmitt trigger.

When the input voltage is at zero volts TR1 is OFF and therefore no collector current flows. As the input voltage is increased the base current of TR1 increases. When TR1 collector current reaches 4·7mA, the voltage across the tunnel diode suddenly increases. This is amplified by TR2, a germanium transistor, which switches ON when the base-emitter potential reaches 0·2V, giving a positive pulse through C1.

The input voltage can be set by the variable resistor to give the positive pulse; with lower resistance value causing a pulse at a lower input voltage and a higher resistance raising the input voltage required for a pulse.

Typical values are zero ohms for pulsing at 1·5V input and 5kΩ for pulsing at 26V input.

S. H. Alsop,
Sheffield.

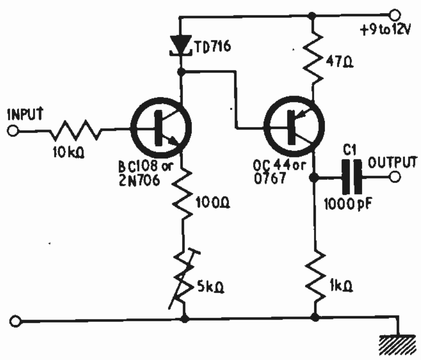


Fig. 1. Tunnel diode in a Schmitt trigger

SHUTTLE SERVICE REGULATOR

IN this circuit the 555 timer is used to regulate an automatic shuttle service in which one vehicle passes back and forth along a single track line, with predetermined waiting periods at each terminus. The 555 is used in the astable mode with a relay as the load. The relay contacts control the rail current supply.

On the track itself, terminal rails X and Y are isolated at J and K respectively from main rails A and B by insulated rail-joiners, which are however by-passed for one direction of current only by diodes D2 and D3.

The cycle of operations is as follows. Suppose a vehicle to be travelling on main rails A and B towards Y; when its wheels have completely passed K it will halt because of the blocking action of D3. The model will stay at Y until the 555 timer next causes the relay to change state; direction of track current will thereby be reversed, D3 will conduct and the model will return along the track towards X, until it is stopped beyond J by D2, to await the next change of the 555 and its next trip towards Y.

Using the component values shown in the diagram, RLA is in its off state for 85 seconds, then on for

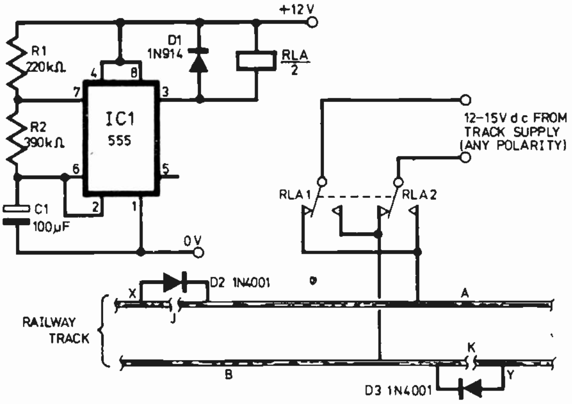


Fig. 1. Model railway track control circuit

55 seconds. These values can of course be varied, or made variable, within reasonable ranges.

Supply to the 555 should be completely independent of track supply. The orientation of diodes D2 and D3 should be verified experimentally for individual layouts.

J. Duffill,
Southam, Glos.

A SIMPLE OSCILLATOR

THE circuit introduced here is one of several types of oscillator developed by the writer for specialised purposes. Where a number of audio frequencies is required from a single oscillator, and/or where a special waveform is not required, the circuit shown in Fig. 1 is offered as a more economic proposition than the standard astable multivibrator since it uses only one capacitor. The circuit produces a pulse followed by a relatively long, quiescent interval.

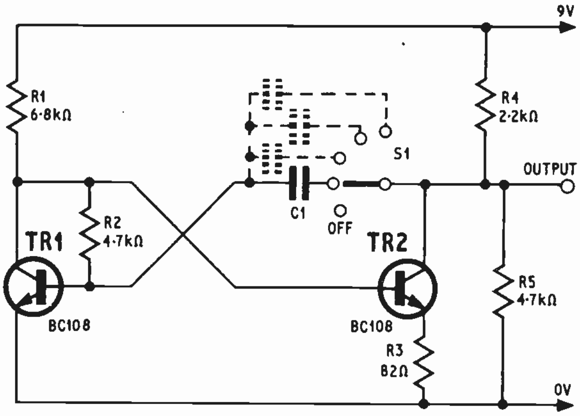
This oscillator is perhaps best understood by first considering S1 in the OFF position. In the resulting static conditions, TR1 conducts and its V_{ce} is such that TR2 is also turned on.

The emitter resistor R3 makes the TR2 collector voltage more positive than V_{be} of TR1 and it also serves to limit TR2 base drive. The base current of TR1 is derived via R2 from TR1 collector so that negative feedback to TR1 base stabilises the d.c. operating point and compensates for varying factors of TR1 h_{fe}.

If C1 is now switched in circuit it will begin to charge up to the voltage between TR2 collector and the base of TR1. But the initially high charging current will flow through the b/e junction of TR1 and the resulting increase of base current causes the V_{ce} of TR1 to fall to a level where TR2 turns off.

C1 therefore charges up to a voltage something less than the value fixed by the potential divider R4, R5, but when charging current ceases to flow (or nearly so) the base current of TR1 reverts back almost to its static value and TR2 again turns on.

Thus, the positively charged side of C1 is effectively connected to the OV rail via TR2, R3 and the negatively charged side rapidly turns off TR1. The capacitor then discharges at a rate largely determined by the time constant C1 (R1 + R2), but after it has discharged, TR1 will again turn on and C1 will re-start the cycle by re-charging.



The static value of TR2 V_{ce} is not at all critical and the purpose of the potential divider is simply to limit the C1 charge voltage to the TR1 b/e max safe reverse value. This technique avoids certain disadvantages which would result from including a protective diode at TR1 base.

The unloaded output is sensibly constant at all frequencies and, where necessary, this characteristic can be preserved by resistive d.c. coupling to an emitter follower. An expression for determining frequency is somewhat problematical since the discharge time constant is modified by the changing drive on TR2 base during the relaxation period—thus, the h_{fe} of TR2 becomes involved. However, very roughly:

$$f \simeq \frac{1}{C_1(R_1 + R_2) + C_1R_4}$$

But using low-leakage types of transistors, the value of R1 will not be too critical and by making part of it variable, a useful degree of tuning can be introduced.

N. Naughton,
Manchester.

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Working voltage 500V d.c.
Values in pF—2·2 to 820 in 32 stages, **6p** each; 1,000, 1,500, **7p** each; 1,800, **8p**; 2,200, **10p**; 2,700, 3,600, **12p** each; 4,700, 5,000, **15p** each; 6,800, **20p**; 8,200, 10,000, **25p** each.

TANTALUM BEAD
0·1, 0·22, 0·47, 1·0mF/35V, **13p** each. 2·2/16V, 2·2/35V, 4·7/16V, 10/6·3V, **13p** each. 4·7/35V, 10/16V, 22/6·3V, **16p** each. 10/25V, 22/16V, 47/6·3V, 100/3V, **18p** each.

POLYCARBONATE TYPE B32540
Working Voltage 250V.
Values in mF: 0·0047, 0·0068, 0·0082, 0·01, 0·012, 0·015, **3p** each. 0·018, 0·022, 0·027, 0·033, 0·039, 0·047, 0·056, 0·068, 0·082, 0·1, **4p** each.

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C	1/2	4·7–10M	1·3	1·1	0·9 nett
C	3/4	4·7–10M	1·5	1·2	0·9 nett
C	1	4·7–10M	3·2	2·5	1·9 nett
MO	1/2	10–1M	4	3·3	2·3 nett
WW	1	0·22–3·9	9	9	8
WW	3	1–10K	7	7	6
WW	7	1–10K	9	9	8

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E24: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.
Tolerances:
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0·47	—	—	—	—	—	—	11p	8p
1·0	—	—	—	—	—	11p	—	8p
2·2	—	—	—	—	11p	—	8p	9p
4·7	—	—	—	11p	—	8p	9p	9p
10	—	—	—	—	8p	9p	8p	8p
22	—	—	8p	—	9p	8p	8p	10p
47	8p	—	9p	8p	8p	8p	10p	13p
100	9p	8p	8p	8p	9p	10p	12p	19p
220	8p	8p	9p	10p	10p	11p	17p	28p
470	9p	10p	10p	11p	13p	17p	24p	45p
1,000	11p	13p	13p	17p	20p	25p	41p	—
2,200	15p	18p	23p	26p	37p	41p	—	—
4,700	26p	30p	39p	44p	58p	—	—	—
10,000	42p	46p	—	—	—	—	—	—

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½	10%	3·3M Ω–10M Ω	E12	1·3p	1·1p
½	2%	10 Ω–1M Ω	E24	3·5p	3p
⅓	10%	1 Ω–3·9 Ω	E12	1·3p	1·1p
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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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0·001μF, 0·002μF, 0·005μF, 0·01μF, 0·02μF, **3p.** 0·04μF, 0·05μF, 0·068μF, 0·1μF, **4p.**

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0·47μF 35V	6·8μF 25V	47μF 6·3V
1·0μF 35V	10μF 25V	100μF 3V

VEROBOARD

	0·1	0·15
2½ × 3¾	24p	20p
2½ × 5	28p	28p
3¾ × 3¾	28p	28p
3¾ × 5	32p	32p
17 × 2½	85p	67p
17 × 3¾	120p	108p
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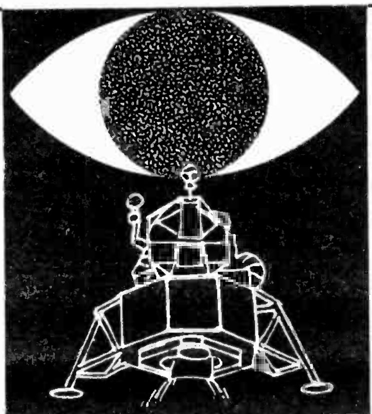


SPACEWATCH

BY FRANK W. HYDE

CULLED FROM KOHOUTEK

Though the observations of the comet Kohoutek were disappointing in the United Kingdom, other places had better luck. From New Mexico it was visible to the naked eye as late as January 20. On January 10 observers were recording a tail 17° long.

The *Skylab* scientists were the first to see Kohoutek emerge from perihelion.

From Tokyo came the observations of Z. Sekanina who said that there was a high state of dust activity (before perihelion) and asserted that this was the cause of the spike. He estimated that the dust activity must have begun about October. He also said that the particles gathered round the head of the comet were as large as one millimetre.

Other observers reported that there was a gas and dust trail in the direction away from the Sun and that on January 16 a wavy motion of the gas was seen extending from 10° to 15° from the head. The tail and coma showed a silicate structure and the spike had a black body spectrum. All this is consistent with a gritty or perhaps sandy structure. Measurements were made by infrared techniques as a dusty content radiates thermally.

Spectroscopy has revealed some 200 emission lines not previously known. Optically C_2, C_3, CN, NH_3, CO, and Na emission have been recorded. Some of the lines not identified are probably from singly ionised water molecules. Radio astronomers have recorded Methyl Cyanide, Hydrogen Cyanide, CH and OH. Rockets carrying ultra violet equipment detected radiation from the gaseous trail extending millions of kilometres round the comet. This is similar to that which appeared with comet Bennett and could be common to certain comets.

One thing is certain, from the remarkable amount of data already processed, that the direct observation of bright comets is very desirable. This makes a rendezvous with Halley's comet a worthwhile project.

TITAN-CENTAUR

It is not often the case that failure has to be reported in Spacewatch, but it does happen from time to time. In dealing with the failure of the *Titan 3E/Centaur* system it has to be admitted that this has been a major disaster for NASA.

A great deal of the future projects were to be related to this system as a launch vehicle. The far reaching effects involve the Mars unmanned landings for there was much faith put in the *Titan/Centaur* vehicle for this project. One of the objects of the launch that failed was to test out a number of modifications, simulate some of the sections of the new missions that were to be undertaken, and the site launching facilities which had also been modified.

It was intended that the vehicle should be a sort of intermediate carrier of heavier unmanned loads into orbit and also into interplanetary trajectories until the space shuttle was ready. The fact that the guidance system failed because of vibration effects is particularly disquieting because long journeys such as the Mars landing require that extreme stability is mandatory.

The failure was in the *Centaur* section only; all systems in the *Titan* stages being quite satisfactory. It is unfortunate that the number of missions is limited and there is not much time or vehicles available if a high rate of abortive action takes place.

The modifications that were made involved two important areas of *Centaur*, the control systems, and the heat shield. The computerised control systems handling the guidance, navigation, control of fuel and telemetry, was extended to include the initiation of vehicle activity. This would have included the rocket "burns".

The time of the failure was at the moment when the rocket burn should have taken place. This did not signal an affirmative to the control centre and it had to be assumed that no "burn" had taken place, so that, following procedure, the safety officer ordered "destruct".

The heat shield modification was an important one, for the new three layer sandwich, of aluminised Mylar and Dacron, would have improved fuel losses during long term missions. Conservation of fuel combined with the ability of the vehicle to "coast" would be of great value on long missions where zero gravity was involved. Also, coasting is important in synchronous orbits.

In the case of the aborted mission the flight plan it was set to follow was a seven hour programme. This was to include an initial launch trajectory which would be the same as for the *Viking* mission, from this it was to have entered a parking orbit and coast for twelve minutes. A next burn would have transferred the vehicle to an orbit similar to the end of the *Viking* plan. The actual burn would be shorter than the *Viking* mission.

During the intermediate orbit a coasting of 80 minutes would have taken place allowing a check of fuel handling systems in conditions of zero gravity. The next transition was to be to a third burn into a transfer orbit. Ten minutes later the *Sphinx* satellite would have been ejected. The vehicle was to do a five hour coasting in the transfer orbit. The whole sequence was to test the three burn facility.

The purpose of the *Sphinx* (space plasma high voltage interaction experiment) satellite was to check the high voltage equipment. So far, space missions have used mainly low voltage solar cells for power; in the long duration missions a greater amount of power is required so that other methods are important.

The higher output solar cells would enable the heavy inboard power sources to be removed and replaced with more payload. There is a difficulty, however, and that is that as yet no one knows for sure how the high voltage cells will react. There is a possibility that there would be reaction due to particles which are charged and possible short circuits or arcing leading to loss of power. The *Sphinx* project would have been able to make a long period study.

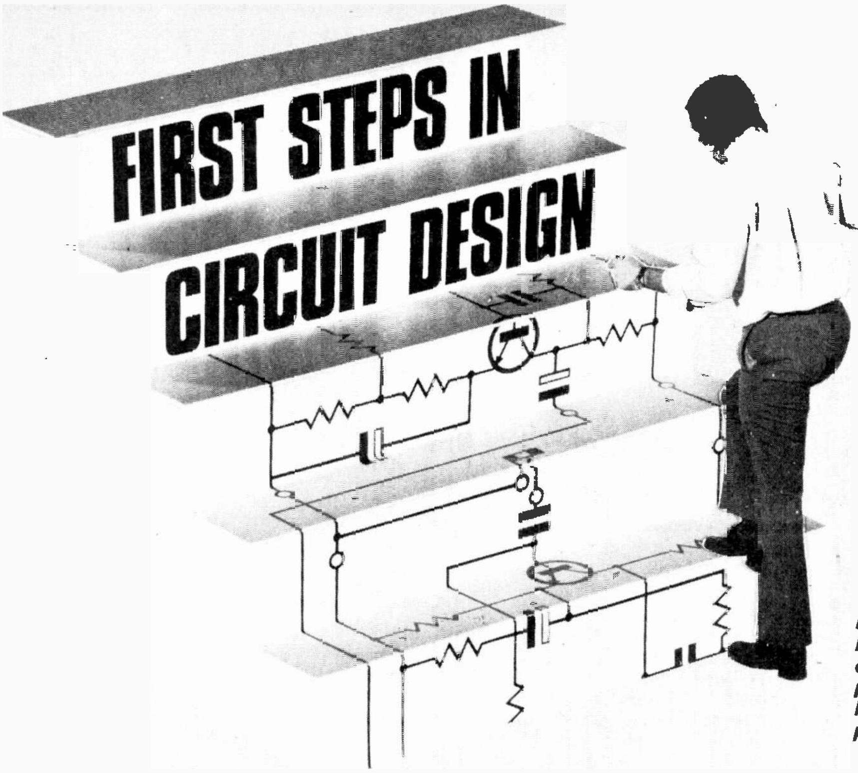
There are some who think that a much higher orbit may be necessary for satellites equipped with high voltage cells. The effect of plasma, however, is important as also the manner in which insulation and cell layouts, which could be rolled up like blinds, would survive. With array voltages at 16kV prolonged operation may be necessary before decisions can be finally made.

WHICH CANDIDATE

The black hole problem still occupies attention and the latest candidate is now the X-1 object in Cygnus and not X-3. The reason for this is that X-1 has shown very rapid fluctuations in X-ray emissions, with periods as fast as one twentieth of a second. This is at the threshold of the instrument aboard the satellite *Uhuru* undertaking these present observations.

Larger instruments are required to extend observation and these need to have detection limits capable of measuring fluctuations of a few millionths of a second.

FIRST STEPS IN CIRCUIT DESIGN



3

By A. P. Stephenson

This series, specially written for the beginner, takes you step-by-step through transistor circuit design in a simple, non-mathematical way.

Design of a small signal amplifier will be followed by a Class B amplifier and the series will conclude with a constructional project so that your theoretical knowledge can be put into practice.

LAST MONTH we saw how the characteristics of the transistor must control our circuit design. Now that the parameters of the transistor are more fully understood we can get down to the real business of choosing the components so that the transistor behaves just the way we want it to.

An example of bad design will be given so that the impatient beginner does not fall into the more obvious traps.

As well as choosing components, there is also the supply rail voltage to be defined. This is often of major importance to successful circuits.

3.1. RELEVANT EQUATIONS TO VOLTAGE AMPLIFYING STAGE

There are four equations which must be considered as absolutely essential to the design of a simple amplifying stage. These are shown in Fig. 3.1 in a way that should immediately suggest their use.

These equations should be copied onto paper and chanted over and over in the mind before going to sleep.

Note how the variables interact with one another The choice of collector current will affect r_e which in turn will affect the voltage gain A and the input resistance of the stage R_{IN}.

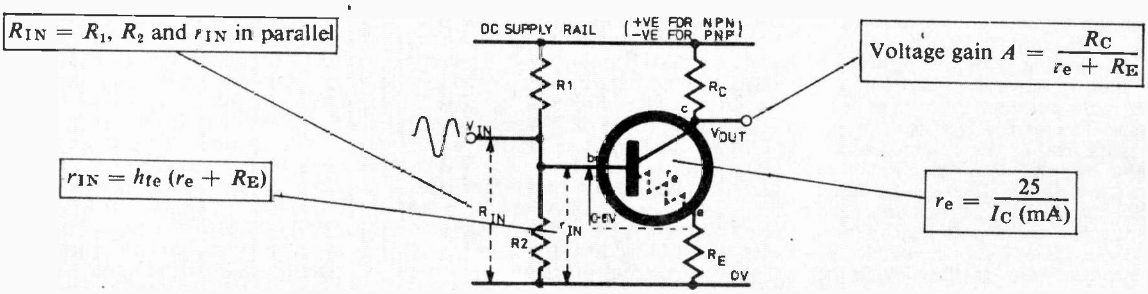


Fig. 3.1. This circuit shows how the four equations essential to amplifier design are related

3.2. CHOICE OF COLLECTOR CURRENT AND RAIL VOLTAGE

With any particular transistor there are obvious limits at both ends of the collector current scale.

The limit at the lower end is due to the reduced h_{FE} and also to the encroachment of the base current onto the leakage area. For small silicon transistors similar to the BC108, the lower limit may be taken as around ten microamps.

UPPER LIMIT

At the other end of the scale, there is the absolute limit imposed by the manufacturers known as $I_{c(max)}$, which, again quoting the BC108, is 200mA. There is a hidden danger in this figure however, unless the maximum power dissipation ($P_{(max)}$) is also examined.

The BC108 claims 300mW for $P_{(max)}$, therefore if the designer does attempt to use 200mA collector current, he had better make sure that he never allows the collector voltage to be more than *one volt*, or the poor thing will protest warmly.

Except for pulse circuitry, where large currents can be tolerated, the practical maximum for amplifier stages will be lower than $I_{c(max)}$. Ten milliamps is the recommended maximum for the BC108; beyond this, the h_{FE} starts to fall again.

CHOOSING COLLECTOR CURRENT

Having established the range as 10μA to 10mA, there is still the particular value to be decided upon when designing an amplifying stage.

Other things being equal, a choice of low I_c will:

(a) Enable the stage input resistance to be higher because R_{IN} is the parallel combination of the base bias resistors R1, R2 and the transistor input resistance r_{IN}. R1, R2 will be higher because the base current will be small. Also r_{IN} will be higher because $r_{IN} = h_{fe} (r_e + R_E)$ and both r_e and R_E can be high if I_c is low.

(b) The output resistance R_{out} of the stage will be high because R_c will tend to be high. This is not good.

SUPPLY RAIL VOLTAGE

The higher the supply voltage the easier the circuit is to design. There is a greater freedom of choice—more breathing space, since voltage can always be dropped but not so easily increased. The limit is, of course, $V_{CE(max)}$ which, in the case of the BC108, is around 20 volts.

3.3. DESIGN PITFALLS

The beginner to the art of design is soon face to face with a frustrating problem: how to meet the conflicting demands of satisfying both the signal and the d.c. bias requirements.

To illustrate this let us assume a simple voltage amplifier is to be designed having a gain of 100. This is a harmless specification, with no mention of input resistances, supply rail voltages, etc., and the beginner might be excused for underestimating the job.

His reasoning might proceed as follows:

1. Look up the equation for voltage gain

$$A = R_C/(r_e + R_E)$$

2. Note that R_E appears a nuisance so why not leave it out altogether?

$$A = R_C/r_e$$

(This will save a resistor and make the equation easier)

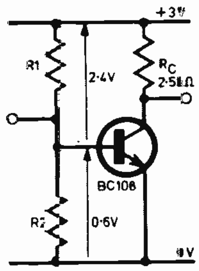


Fig. 3.2. Circuit diagram of the example in the text

3. Look up the equation for r_e

$$r_e = 25/I_c(\text{mA})$$

and note that choosing a nice figure of 1mA will make r_e = 25 ohms.

R_C can then be found by $R_C = 1000 \times 25 = 2{\cdot}5\text{k}\Omega$.

4. The circuit may now be drawn with as much data as possible included (see Fig. 3.2). The 3V rail is handy because the small family torch has a 3V battery.

5. Look up h_{FE} of a BC108 which will be 300 (typically) which means that the base current will be $I_c/300$ = 1mA/300 = 0·003mA (approx). Since the divider chain should carry a much larger current than the base, let this be 0·03mA.

Allowing the regulation 0·6V across R2, R2 = 0·6V/0·03mA = 20kΩ.

6. R1 must drop the remaining 2·4V therefore R1 = 2·4V/0·03mA = 80kΩ.

The paper work is now finished and the designer can now rig up the circuit and try it out.

What a bitter disappointment he is in for!

Voltage checks will soon reveal that:

(a) The 0·6V may be disturbingly out, and may drift downwards slowly.

(b) The transistor is almost or even completely saturated. The output terminal has no room to move since it is grovelling at almost ground voltage.

In short, it is a shocking example of bad design.

3.4. THE IMPORTANCE OF R_E

A familiar component in most small signal amplifiers is the resistor R_E connected between emitter and ground. The primary reason for its presence is to provide a simple self-adjusting mechanism for forward bias on the base.

It may be remembered that the transistor will only amplify correctly if the base voltage is held at a mean value of about 0·6V higher than its emitter (at normal temperature).

Not only is it difficult to tap off such a precise, small voltage from a divider chain, there is also the added complication of the change in this voltage when the temperature changes (remember that V_{BE} falls by about 2mV per degree C rise in temperature).

The inclusion of R_E will compensate for these effects (see Fig. 3.3).

Suppose R1, R2 values were a little out, due to tolerance errors resulting in a voltage of say 1·5V instead of 1·6V. This would produce only 0·5V across base and emitter *if the collector current remained the same*, but of course it will not.

The collector current must fall and the 1V drop across R_E must then fall to say 0·9V.

This means that the voltage difference between base and emitter would be back again to 0·6V.

The system is thus almost completely self-regulating—if the temperature rises, more current would tend to flow which would increase the 1V across R_E to say 1·1V and that would reduce the forward bias in the base to 0·5V which holds the current back again.

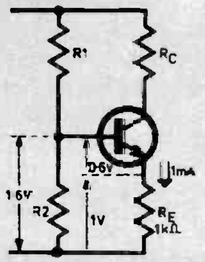


Fig. 3.3. Circuit to show the stabilising effect of R_E upon the V_{BE}

With regard to the design equation, how big should R_E be?

Compromise as usual! The higher it is the better the stabilisation action, but the more volts are "wasted" across R_E.

A good rule of thumb is:

> Make R_E at least five, but preferably ten times greater than r_e.

3.5. THE EFFECT OF R_E ON VOLTAGE GAIN AND DISTORTION

Apart from stabilising the d.c. bias conditions, R_E causes the voltage gain to fall.

This can be understood by re-examining the equation for voltage gain $A = R_C/(r_e + R_E)$.

A more convincing way of understanding the effect is to consider the effect of a signal applied between base and ground (see Fig. 3.4).

Consider first the action with the switch closed, i.e. R_E not in circuit.

If a positive-going signal of say 2mV is applied, the whole of the signal is across the base to emitter junction.

With the switch open, the 2mW signal between base and ground would cause an increase of collector current (as before) but the volts drop across R_E would cause the emitter to rise as well as the signal. Thus the effective value of the signal between base and emitter would be less than in the case above.

For example, if the base signal rises by 2mV and the emitter voltage also rises to say 1·5mV, then the effective signal between base and emitter is only 0·5mV.

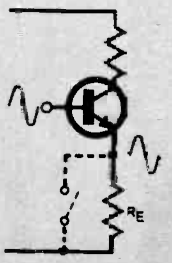


Fig. 3.4. The divider to feed base bias is irrelevant to this circuit which demonstrates the effect of R_E

From the point of view of voltage gain, it appears that R_E has in this case, reduced the effectiveness of the signal by a factor of four which means the gain is reduced by a factor of four.

This gain reduction, caused by a signal voltage, appearing across R_E is an example of negative current feedback.

ADVANTAGES OF NEGATIVE FEEDBACK

Although the gain is reduced, there are certain advantages in this kind of feedback:

1. The input resistance r_{IN} is increased, since $r_{IN} = h_{fe}(r_e + R_E)$.
2. The distortion, inevitable to some degree in all transistors, is much less. In fact the distortion is reduced by the same factor as the gain.
   In the above example distortion would be reduced by four times by the inclusion of R_E.
3. The reduced gain now tends to be less dependent on the actual transistor causing the circuit performance to be determined without worrying about tolerance variations in the *h*-parameters.

If a high gain is more important than these advantages R_E can be "by-passed" with a capacitor which will provide a signal short to ground.

The capacitor's reactance X_c should be smaller than R_E at the lowest frequency, a rough and ready equation being $C = 1/(f \times R_E)$ where C is in microfarads, f in kHz and R_E in kilohms.

3.6. SETTING THE D.C. OUTPUT VOLTAGE

The output terminal of the stage should, wherever practical, rest somewhere about the middle of the available voltage swing. This will ensure that signal variations will have freedom to move in both directions without hitting the supply rail at the top, or the saturation area at the bottom.

The above remarks still apply even if the signal variations are known to be small. The percentage distortion introduced by the slight non-linearity in transistor curves is always proportional to the size of the swing.

For example, a signal swing of one volt superimposed on the output will introduce less distortion if the available limit of swing is 10 volts than if it were five.

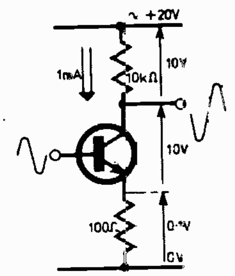


Fig. 3.6. *Example B:*

Gain = 100 (r_e still almost swamped by R_E)
Maximum allowable input signal = 0·1V

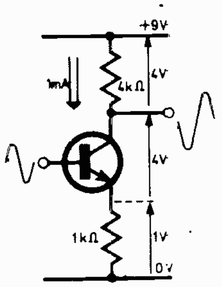


Fig. 3.5. *Example A.*

Gain = 4 (r_e swamped by R_E)
Maximum allowable input signal = 1V

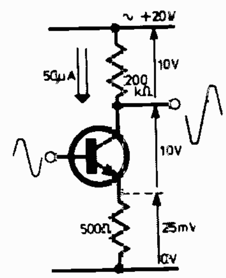


Fig. 3.7. *Example C.*

This gives high gain but will not obey the full equation $A = R_C (r_e + R_E)$ very accurately because (a) R_E does not swamp r_e; in fact $R_E = r_e$ and (b) the value of R_C is not negligible in relation to the internal collector resistance. Hence don't expect the gain to be 400.

3.7. SETTING THE BIAS VOLTAGE

The setting of the output voltage should normally be tackled first. If R_{IN} is important, however, some preliminary doodling is required.

Afterwards, the required voltage drops across the divider chain, the desired base current, the divider chain current and finally the values for R1 and R2 (in that order) should be determined.

Suppose, for example, that we have decided on the output circuit shown in Fig. 3.8.

BASE CURRENT

Before we can calculate the bias resistors the base current must be estimated. Don't be too fussy about this; instead be pessimistic!

Assume you will be unlucky enough to pick the worse sample of a BC108, i.e. h_{FE} only about 100. This would demand a base current of 1mA ÷ 100 = 10μA.

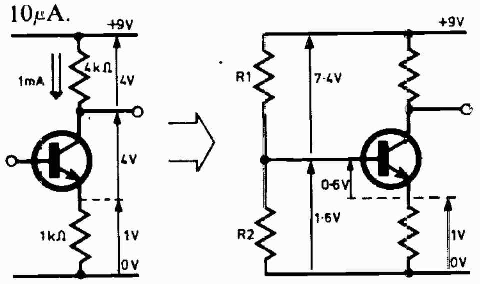


Fig. 3.8. Assuming the voltage drops and current shown in (a) the bias voltage drops must then be as in (b)

In case this reasoning appears very rough and ready, remember that the only thing of importance about the current down the divider chain is that it should be much larger than the base current.

If we use the "ten times rule" and make the current in R2 = 100μA when the worse transistor is used, then the current stability will always be good enough, and often better, than necessary.

$$R2 = \frac{1·6V}{0·1mA} = 16k\Omega$$ (note that changing 100μA to 0·1mA keeps that arithmetic easy).

R1 should be 11 times the base current:

$$R1 = \frac{7·4V}{0·11mA} = 67k\Omega$$

The nearest preferred values may be used because the emitter resistor R_E will always ensure that the 0·6V V_{BE} is maintained within reasonable limits.

STAGE INPUT RESISTANCE

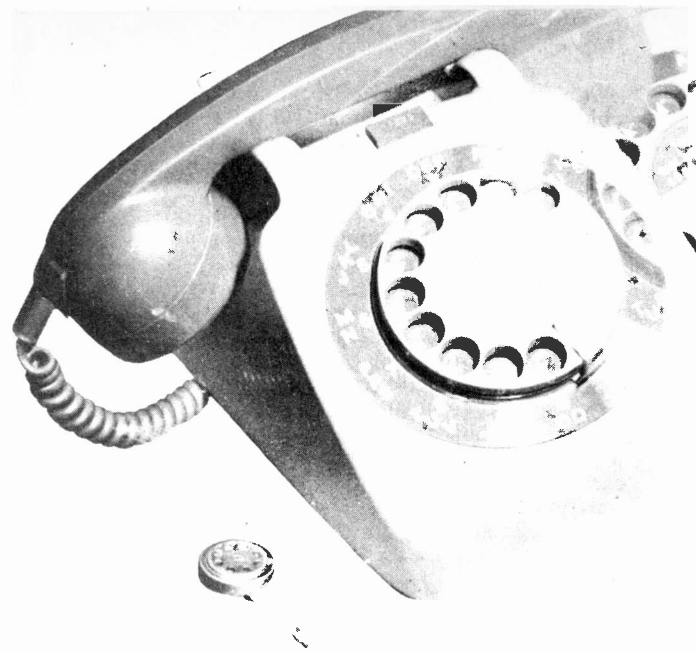
It may be interesting at this point to calculate the input resistance of the stage (R_{IN}).

First R1 and R2 in parallel have a resistance of 13kΩ. The transistor itself presents an r_{IN} of h_{fe} ($r_e + R_E$) which equals 100 (25 + 1000) = 100kΩ.

Since we have again assumed the worse case value of 100 for h_{fe}, it is clear that r_{IN} will probably be much higher.

It is safe to assume therefore that r_{IN} in parallel with 13kΩ will have little effect on the R_{IN} of the stage which is therefore around 13kΩ.

Continued next month



TELEBELL ... REPEATS ANYWHERE

BY J.N. WATT

THE TELEBELL is a compact phone bell repeater unit that provides remote indication that a telephone bell is ringing without having to be connected to the Post Office line. It is driven by self-contained batteries and as it has low stand-by power requirements, these have a very long life.

Useful to anyone who has ever been busy some distance from their telephone and has stopped to wonder whether it was ringing or not, the Telebell will also be extremely helpful to the hard of hearing when in another room away from the telephone.

POST OFFICE

It is of course possible to have an extension bell fitted by the Post Office, but this does have drawbacks as it costs money in the form of extra rental and is usually fitted permanently in one place, so reducing the number of places where it can be heard, compared to the unit described here, which can have its repeater bell placed anywhere at will.

Under existing Post Office regulations, no electrical connection may be made by the hirer to a telephone. How, then, can an extension bell be made to function?

The answer is to use acoustic coupling. A microphone, mounted close to the telephone, picks up the sound of the bell. The resultant electrical signal is amplified and used to trigger a thyristor, which operates the extension bell; this latter can be at almost any distance and can be placed in any particular position found convenient. The unit is battery operated and is thus completely safe, yet the current drawn in the stand-by condition is so low that batteries last for many months.

The author understands that such an arrangement does not contravene any Post Office regulations.

THE CIRCUIT

The complete circuit diagram is shown in Fig. 1. The first transistor, by means of its high value collector and emitter resistors, R2 and R3, and correspondingly high value collector-base resistor, R1, draws only 50μA when there is no input from the microphone.

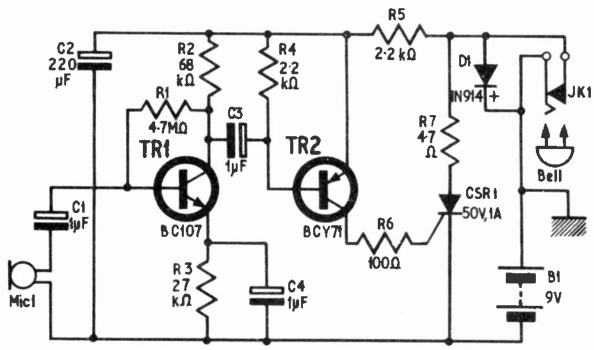


Fig. 1. Basic circuit diagram of the low-current ringing detector/bell

At the same time, transistor TR2 is held non-conducting by R4, so that the thyristor CSR1 has no gate drive and passes only a very small leakage current. Thus the total current drawn is about 50μA and this, flowing through the bell coil, is far short of that required to operate it.

When the telephone bell sounds the crystal microphone MIC1 gives an output of about 100mV and this signal is amplified by TR1 to a sufficiently high level to cause TR2 to pass current; this current is fed to CSR1 gate. Thyristors have the property that if sufficient current is fed to the gate, the device conducts and will continue to do so, even without further gate current, until the current passed falls to a few mA or less.

In this instance the thyristor current is of course the bell operating current; shortly after it starts to flow it is interrupted by the action of bell circuit breaker and this interruption prevents further thyristor current passing.

However, if there is continuing microphone output the circuit operation described will continue and consequently the bell acts as a repeater of the telephone bell.

Resistor R5 and capacitor C2 isolate the amplifier stages from the transient voltages present due to the bell current changing rapidly, while R6 limits thyristor gate current to a safe value. Diode D1 eliminates reverse voltages caused by operation of the circuit breaker in the bell, which could otherwise damage the thyristor.

The battery voltage required for best operation of TR1 is 9V, while most bells call for about 4 to 5V. Thus R7 has been included to drop the voltage to ensure that no more than the correct voltage appears across the bell coil.

It will be seen that all the current drawn by the unit flows through the bell. This has been done so that disconnection of the bell also disconnects the battery from the remaining circuitry at the same time, so eliminating the need for an on-off switch.

CONSTRUCTION

Practical details are straightforward. Two 4·5V flat batteries and all else except for the bell and microphone are mounted in a small die-cast box. Connections to the bell are made by means of a 3·5mm jack, to make connection and disconnection easy.

The crystal microphone can be obtained as a "crystal microphone insert", and in the prototype is about ¾in in diameter with leads about 2in long. These should be carefully extended (taking care to insulate the joints so made), to about 18in, so that the unit can be situated out of sight with the microphone insert placed under the telephone, where it will pick up the sound of the bell. A little experimenting may be called for to locate the best position for the microphone, but no difficulty should be experienced.

An alternative method of locating the microphone would be to fix it to a small rubber sucker with a suitable cement, such as impact adhesive, and then to attach it to the side or rear of the telephone.

The components, except for the diode D1, are mounted on a piece of 0·15in pitch Veroboard, 2¾in × 1¼in; the Veroboard and component layouts used are shown in Figs. 2 and 3. Two holes are drilled in the board for fixing to the box. When drilling these, start from the copper side and use a piece of scrap wood as a backing to prevent splintering of the board as the drill breaks through.

Two 6BA screws are fixed to the base of the box in the appropriate place by means of nylon nuts, and the Veroboard dropped on top, to be secured by two steel or brass nuts. A piece of scrap cardboard, the same size as the Veroboard, is used as insulation underneath it. The protection diode, D1, can be located on the 3·5mm jack itself.

Four Veropins are located as shown on the circuit board to provide two connections for the microphone, one for battery negative and one for connection to the bell, via the jack centre contact. The

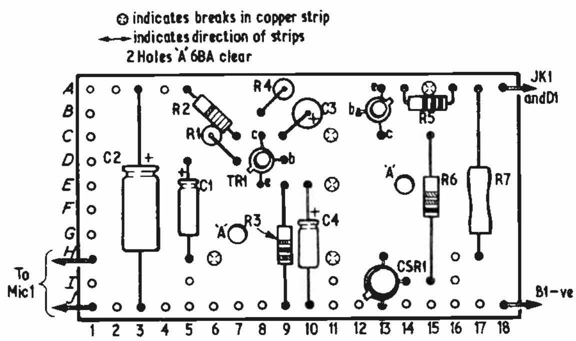


Fig. 2. Veroboard and component layout

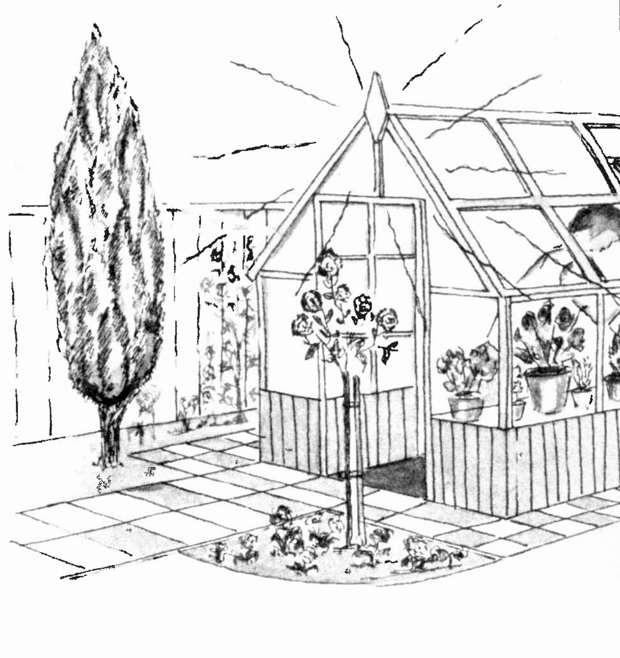
COMPONENTS . . .

Resistors
R1 4·7MΩ
R2 68kΩ
R3 27kΩ
R4 2·2kΩ
R5 2·2kΩ
R6 100Ω
R7 4·7Ω 3W, W.W.
All ¼W, 10% unless otherwise stated

Capacitors
C1 1μF, 16V, elect.
C2 220μF, 16V, elect.
C3 1μF, 16V, elect.
C4 1μF, 16V, elect.

Semiconductors
TR1 BC107
TR2 BCY71
CSR1 50V 1A device
D1 1N914

Miscellaneous
Batteries, 4·5V (2 off). Diecast box 4¾ × 3¾ × 2in. Jack plug and socket. (3·5mm). Crystal microphone insert. Bell, 4 to 5V. Veroboard 0·15in pitch, 2¾ × 1¼in. Veropins. Grommet.



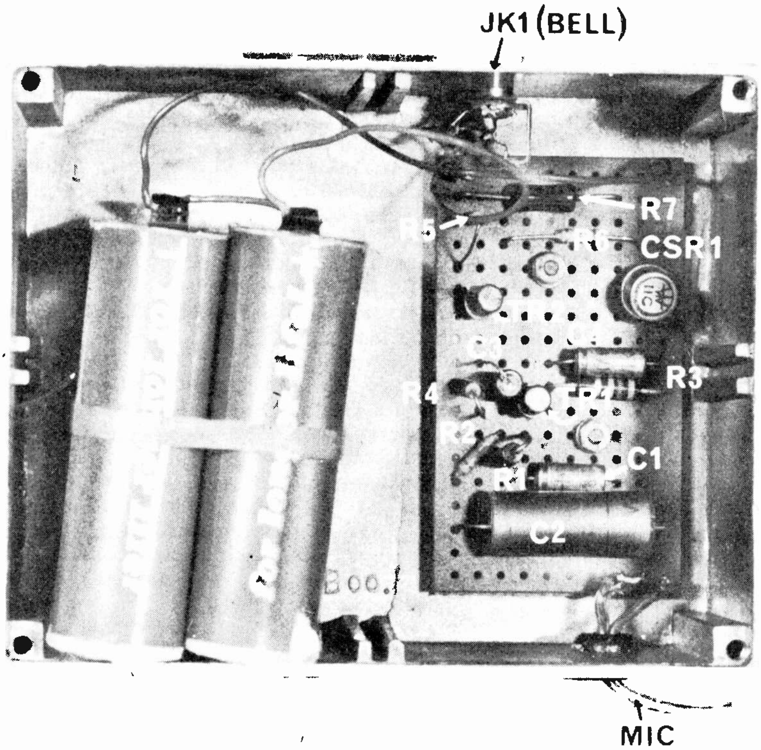


Fig. 3. Interior view of the Telebell case complete with batteries

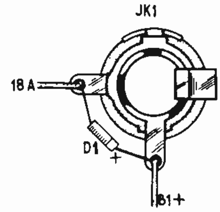


Fig. 4. Detail of the bell jack socket (JK1) showing the mounting of D1

other jack contact goes to battery positive; note that this is also joined to the box itself, so make sure that nothing else comes into contact with the case.

When inserting the Veropins, push through from the copper side and solder in place.

Leads to the batteries, from the Veroboard and jack, are best made about 5in long so that they can be made up before the batteries are dropped in. The latter are held together with a stout rubber band, and then held in place by the clamping action of the box lid, a thick piece of foam plastic being interposed to ensure that there is no movement.

The microphone leads are simply fed in through a small grommet and soldered directly to the appropriate Veropins.

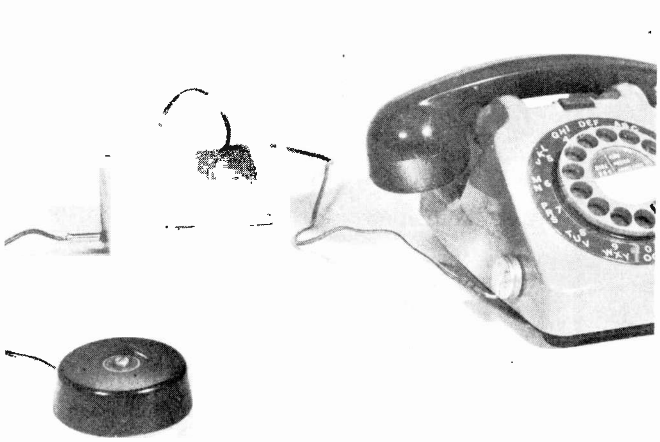
When all the holes have been drilled in the box, temporarily blank them off on the inside with adhesive tape and spray the box a suitable colour, using a car touch-up or household paint aerosol. Then carry out final assembly of the unit as already described.

In use, it will be found that battery life will depend very largely on the frequency of incoming telephone calls, as the stand-by current consumption is very low. Even so, it is best to withdraw the jack plug (so eliminating all current drain) when the unit is not required, for example, when the house is unoccupied for a few hours or more.

Users may find it convenient to have a number of bells, with one located at each remote point, and to plug in which ever is required at a particular time. The use of a small jack facilitates this scheme considerably.

Some external noises can trigger the bell. For example a knock on the telephone or the like. However, the results are very brief and easily identified.

If a gain control is felt to be necessary a 25kΩ variable resistor in series with 4·7μF electrolytic capacitor can be connected between TR1 collector and the negative rail. The lower the setting of the variable resistor the lower the gain. ★



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The first of a series describing a family of four, high quality, dual channel amplifiers providing outputs of 20, 40, 65 and 100 watts r.m.s. per channel. All versions are based on a common circuit configuration.
Low distortion figures make them ideally suited for use with high fidelity pre-amplifiers, P.A. systems, studio monitoring, electronic organs, electric guitars and servo systems.

Plus

CAR SYSTEMS MONITOR

Avoid unnecessary damage to your car with this simple electronic "black box" which gives alarm at sudden temperature or other gauge changes.

RANDOM LIGHT DISPLAY

Brighten up your life with the Random Light Display! Small enough to place on a shelf or table, yet capable of producing an endlessly varying and unpredictable pattern of colours.

Starting this month–

PE RONDO STEREO DECODER & F.M. TUNER

PRACTICAL

ELECTRONICS

JULY ISSUE ON SALE JUNE 14, 1974

PE RONDO PART 7

AUDIO ROUND-UP

BY R.A. COLE

THE RONDO Quadraphonic system has proved to be of interest to many readers. As a result of work which has now been carried out by the author, various constructors and other correspondents, we are able to publish some suggestions and amendments of use to current and would-be constructors. The following includes updated information, corrections of errors which have willy-nilly crept into the various parts of this complex system and some suggestions on items such as earthing and switching.

Taking the simpler points first, in Part 1, page 757 the value of 0·7 noted in Fig. 1.10 should perhaps have been given in full as 0·707 since some readers might not have readily identified the accepted equivalent.

In the parts list on page 764 the capacitor C1 is given as 0·47μF when it should have been 0·047μF.

When setting up the amplifiers the preset VR8 should be slowly rotated clockwise until a reading of approximately 20mV is obtained. This reading corresponds to approximately 20mA.

POWER SUPPLY

The power supply board in Part 3, page 956, shows C26 as in a shaded portion of the circuit when in fact it should have been shown in the clear since it is mounted on the board as shown in Fig. 3.3. In this latter figure the components D15, C22, R34, and the components D14, C21, R33 are transposed. This does not cause circuit trouble since the circuit is symmetrical but it has proved confusing.

In the same figure the +ve and −ve 25V terminals to the right of the upper 0V terminal should be transposed + for −. The lowermost terminal to the right of this board shown as 24V a.c. should be shown as 20V a.c.

On the power board, TR6 can be replaced with an MJE3055 mounted with its metal face towards D9 to 12 and not towards C23 if one wished.

Also C23 is noted as 35V working but can be 30V working if desired. An additional hole is required for the positive end of D13 in the board.

In Fig. 3.1 the transformer winding feeding D9 to 12 should be shown as a 20V winding to agree with the earlier correction.

INPUTS

By some strange quirk of fate the input to the system from a gram. deck for stereo, SQ or QS was not shown in the original wiring or harness. In fact the input socket can be positioned to suit taste although perhaps a suitable location is at the unit "front" adjacent the tape input/output sockets.

It will, of course, be appreciated that the CD4 decode sysem is expected to be an add-on unit in view of the size and complexity problems involved. Hence the wired-in socket. Here it is expected that the CD4 unit will have its own tone controls and will accept 4-channel input from tape. Of course, 4-channel output is already available at the tape outputs in either coded matrix 2-channel or 4 discrete channels.

A simple modification which has been incorporated in later Rondos is the inclusion of a microswitch as the mains switch, actuated by the slider of the master volume control. The switch is a press-to-open unit located at the low volume end of the control and actuated by the slider bar. Indication of system "on" is by means of panel illumination or perhaps an indicator lamp if needed.

In Part 4, Fig. 4.4, as in the power supply circuit, the 24V winding on the transformer should of course be 20V and again the + and −25V terminals should be transposed.

The headphone sockets in this figure were originally identified as Left and Right to conform with stereo practice but they should perhaps be annotated Rear and Front to conform to recently adopted quadraphonic practice.

POWER TRANSISTORS

There are a variety of power transistors suited to use in the Rondo power amplifier at TR4 and TR5 in Fig. 2.6. Using the p.c.b. layout given in the Fig. 2.12 TR4 may be a TIP2955 or an MJE2955K and TR5 may be a TIP3055 or an MJE3055K.

On the market there are now equivalent devices with different pin connections and to accommodate these we show in Fig. 7.1 a p.c.b. master which is electrically the equivalent of Fig. 2.12 but is capable of accepting MJE2955 for TR4 and MJE3055 for TR5.

This further board has an identical component layout and will in addition accept BC350 and BC347 from Motorola in place of BC212L and BC182L from Texas.

One or two readers have queried the power ratings in the speaker assemblies, January 1974 issue. It should be remembered that the total power output is shared between the four speaker units in each assembly, roughly in the proportions indicated in the diagram of Fig. 5.3. Thus about 50 per cent of the power appears in the lower register up to 300Hz, about 30 per cent in the zone from 300Hz to 5kHz, and the remainder in the upper register.

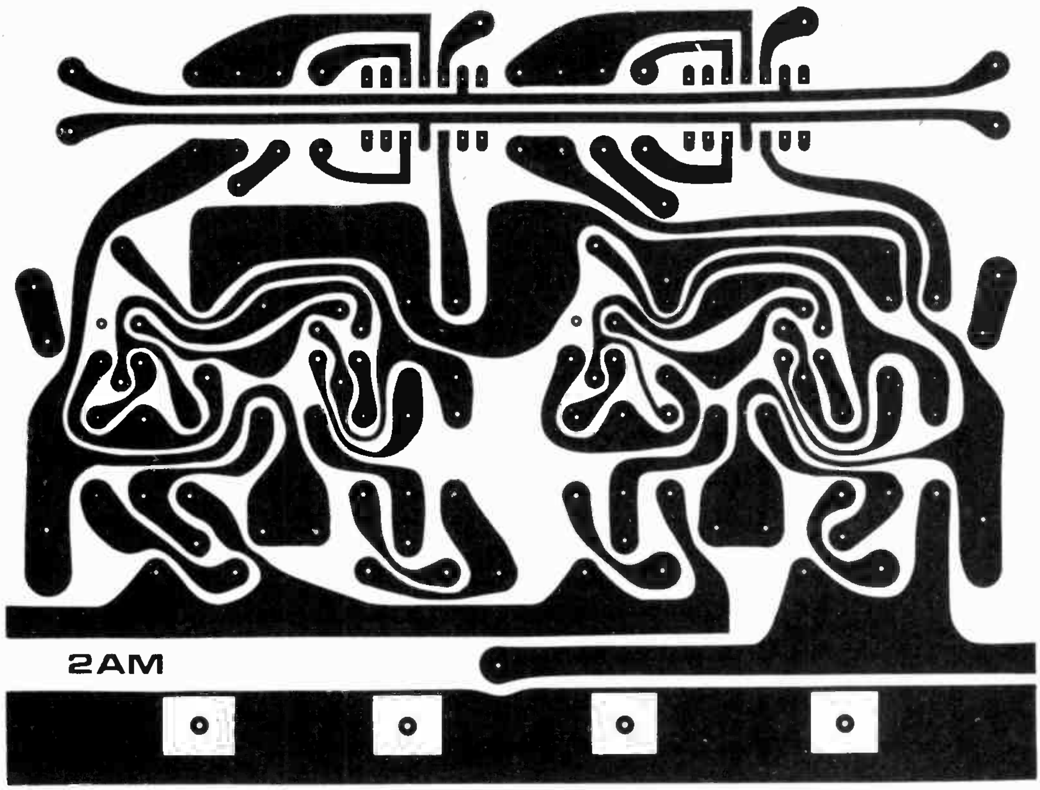


Fig. 7.1. Printed circuit master for a main amplifier stereo pair using output transistors with altered pin connections

EARTHING

It will be appreciated that in a system such as the Rondo, with four 20W channels and all the associated pre-amplifier and mixer circuitry, the avoidance of earth loops and stray pick-up is critical. Thus Fig. 7.2 shows the arrangement of earth and power links adopted for the power amplifier boards. This layout has proved useful in avoiding hum problems.

The link marked *A* in Fig. 7.2 can be made up from 16 s.w.g. wire which is passed through the board and a clearance hole cut in the heatsink so as to avoid chassis earth loops. The links from each board are joined and one is bent to go to the 0V power bus.

It should be noted that the power supply to the main amplifier boards is taken from the capacitors C19 and C20, not from the board tags, in order to reduce hum.

Other steps which can be taken include connecting the loudspeaker earths directly and individually back to the junction of C19 and C20.

If the earth connection between the pre-amplifier and tone control board is made via the screen of the signal lead, this will help. The earth from the tone to the main amplifier boards should be a separate 32/0·2mm wire of about 0·4m length which can subsequently be used to hum-buck by movement round the chassis when wired-in and in operation to a position of lowest hum value.

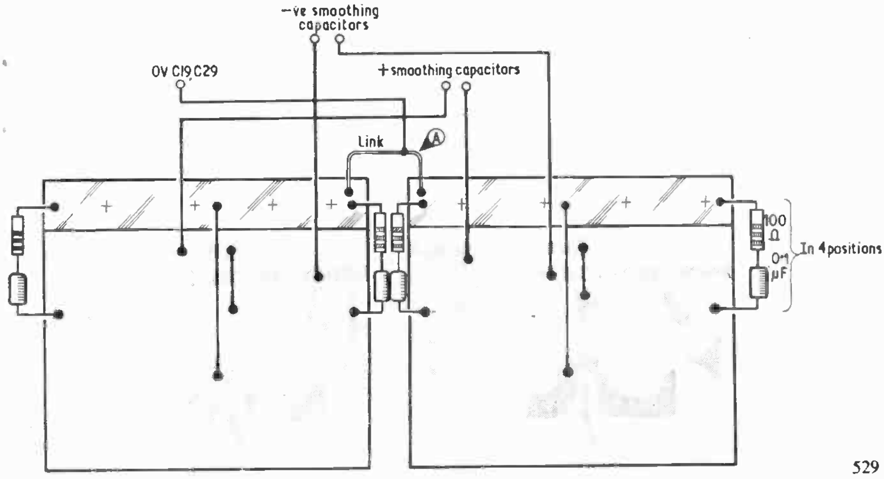
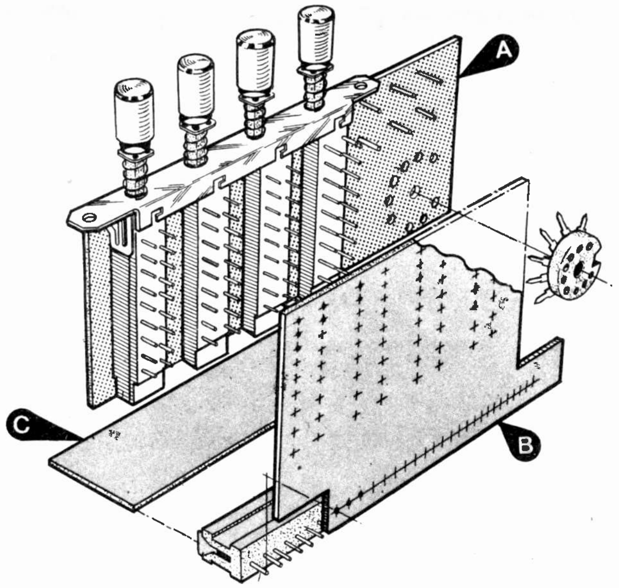
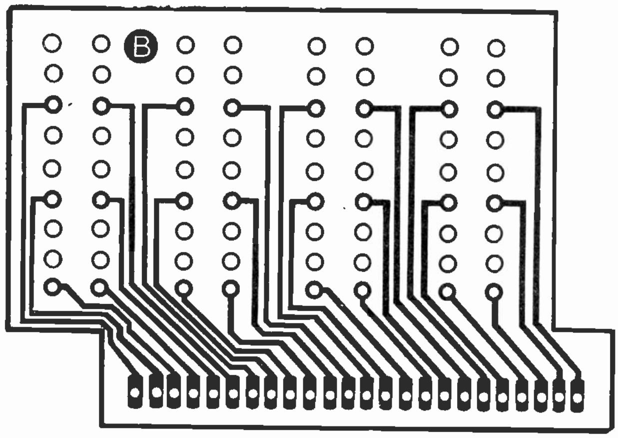
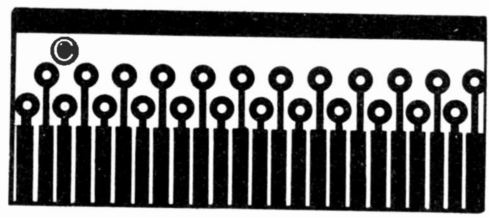


Fig. 7.2. Earth and power supply links used to avoid hum







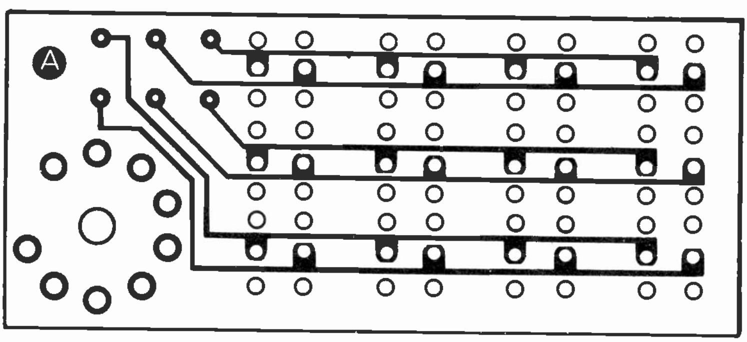


Fig. 7.3. The three items of p.c.b. and their assembly with the mode switch for simplicity of interwiring

As noted earlier, try to avoid any connection between the output transistors and the heatsinks. In fact it helps to isolate the sinks altogether if possible.

For simplicity of wiring it is possibly best not to earth all the Quad paths between the SQ socket and the selector switch. Earth only both ends of the LT and RT paths. The remainder should be earthed at the switch end only.

Apparently one or two readers have experienced difficulty in following through the circuit diagrams in relation to the inter-board wiring and input/output connections to the pre-amplifier. The following may help.

The pre-amplifier module is shown in Fig. 2.10 with the board layout at the top of the page. Output 1 from this board goes to the master tone/volume control board Left input and, via a 0·22μF capacitor, to the Left tape output. Output 11 in symmetry goes to the Right input of the one board and, via a further 0·22μF capacitor, to the Right tape output.

The inputs to the board may be connected to the pins projecting from the various parts of S1 either from above or below the board. Thus looking at the component layout of Fig. 2.10 and identifying the switch sections as A, B, C and D from left to right, and the pins from 1 to 3 in the first column of section A and 4 to 6 in the second, from top to bottom (with corresponding numbering of the remainder) we have the tape Left input to pin A2 and Right to pin A5. Mono goes to pins 2 and 5 of B. Gram. Right goes to pin D2 whilst Left goes to D8.

In the circuit some of these switch contacts are inter-connected and the links are as follows. A3, C3 and D9 are connected together. Finally A6, B3 and C6 are connected together.

SWITCH INTERWIRING

For those who perhaps found the system interwiring diagram of Fig. 4.4 in the December issue a little overbearing, the author has developed two "back-wiring" p.c.b. panels and a "fanning strip" which can be used with the mode switches to simplify interwiring and any subsequent dissembly/assembly of a completed system.

The back-wiring p.c.b.c. and the assembly of them with the switch units is as in Fig. 7.3. The switch button to the left in Fig. 7.3 corresponds to the lowermost button in Fig 4.4.

The p.c.b. A accepts a B9G valvebase which can be used as a socket for interwiring to the master tone control board, stereo decoder, and other fascia-mounted items, the connections to these being taken from the rear of the p.c.b. The switch interwiring is brought out to 6 Harwin pins which are similarly interwired. That deals with the interwiring "across" the switches.

The wiring "down" the switches is catered for with p.c.b. B which acts in co-operation with the fanning strip C. The p.c.b. carries a 24-way edge-connector into which the fanning strip plugs with the copper side underneath when the whole is assembled to a facia.

Loom interconnections to the fanning strip are made as in Fig. 7.4 which also shows the strip zones for the systems not yet discussed.

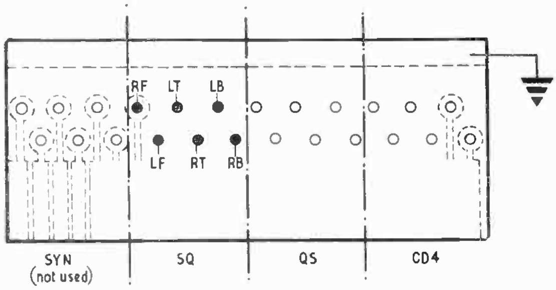


Fig. 7.4. Loom interconnections to the fanning strip C of Fig. 7.3

INPUT SENSITIVITY

The basic sensitivity of the Rondo with RIAA correction is 3mV with S1 in the "Gram" position. In the linear positions it is 45mV with the circuit as shown. This should, of course, cover most requirements for external equipment which will be met.

However, requirements can in fact extend from 3mV up to 2V when dealing with magnetic pick-ups and microphones at one end and external tape equipment at the other.

To accommodate such a range it is necessary to adjust the feedback resistor R8 (Fig. 2.3, October issue) if an increased sensitivity is required and to select suitable values of R1, 2 or 3 for lower sensitivities. As a guide, a value of R8 of 22kΩ gives a sensitivity of around 4–5mV.

If R1, 2 or 3 is 22kΩ with an R8 of 1·2kΩ a sensitivity of 100mV is obtained. For much lower sensitivities a simple attenuator including a series resistor as well as R1, 2 or 3 can be used. The values of the series R and R1, 2 or 3 can be selected to give the correct matching impedance to the feeding source and the correct ratio of voltage reduction to the Rondo equipment.

Finally, one or two components are not shown mounted on p.c.b., for example C5 and C105, the tape output decoupling capacitors. These are mounted at suitable locations in the assembly wiring. Thus C5 and C105 can be mounted at the DIN sockets.

Next month: In the July issue we will commence the Stereo decoder and f.m. tuner description.

NEWS BRIEFS

Light Modulator enables Laser Beam to carry 25,000 Phone Calls

It has long been realised that laser beams have the capability of carrying a vast amount of information, but, so far, the modulators (i.e. the devices for getting the information onto the beam) have been large, costly and consumed many hundreds of watts.

Now, scientists at RCA have made what they regard as a major electronics advance in the form of the first electro-optic modulator truly compatible with integrated circuits.

The new modulator has an active volume of only 0·12 × 0·02 × 0·02ins. It uses a thin film of lithium niobate tantalate sandwiched between minute interleaving metal fingers. The materials used have the property of changing the speed of the photons through them when a voltage is applied.

The new device is capable of 80 per cent modulation of red light with only six volts. The power needed to drive it at even the highest frequencies is only a few watts.

Though still in the research stage RCA claim that this device will give laser beams the capability of carrying 25,000 telephone calls or 20 TV channels simultaneously.

Micromotors Miniaturise Medical Logging Device

The development of reliable micromotors by Portescap has made possible portable data logging systems small enough to fit in the pocket.

The Oxford Instruments' "Medilog" is capable of 24-hour continuous monitoring of four separate data channels, though it uses only a standard low-cost magnetic tape cassette and measures only 112 × 86 × 36mm overall.

Because the unit is so small it can be easily and unobtrusively carried by a patient whose condition is to be monitored. The batteries last up to 30 hours, so for continuous monitoring all that needs to be done is to change the batteries and the cassette.

One of the main problems in relatively slow speed recorders is the maintenance of constant speed. This was achieved by electronically controlling the speed of the motors and accurately aligning the gearbox with the capstan spindle.

Non-medical applications include use in oceanography, vehicle vibration and noise level monitoring.

Paging Down Under

The new Sydney Opera House has been equipped with a radio pocket paging system designed by the London based firm of Multitone Electric Co. Ltd.

Because of the unique structure of the building, specially designed aerials had to be positioned to obtain complete coverage throughout all areas of the Opera House complex. Positioning of the transmitters was another problem, some being hidden in the ceiling of the concert hall and one even in the ceiling of the "gentlemen of the chorus" dressing room.

A total of 40 lightweight receivers are used by the staff. There is a special alarm facility in the system which enables group calling to be used to alert such groups as fire fighters instantaneously.

THEATRE CUEING LIGHTS

By S. H. DAVIES

Make sure the curtain goes up on time with this versatile signalling unit

THIS system was constructed to fulfil the need for a unit which could communicate with up to four remote stations using the following light signals:

1. A red and a green light on both master and remote units to signal "standby" and "go", the lights to remain illuminated until cancelled either by the master unit or by the remote unit acknowledging the signal.
2. An amber light on the master unit only, for the remote station to attract the attention of the master unit. This would also light when the remote station acknowledged the signal from the master.
3. A flash facility on red and green lights for pre-arranged emergency signals. (In one show a flashing red light to the pianist meant "keep on playing"!)

The final unit was designed to be strong, have room for additional facilities and to look reasonably presentable. It has the added advantage that if a cable breaks or becomes open circuit the appropriate lamps on the master unit will not light, giving warning of the fault.

The unit requires only three wires per channel between the master and remote terminals, enabling ordinary three-core mains cable to be used.

We would like to thank the Petts Wood and District Operatic Society for the loan of the unit

COMPONENTS . . .

FOR ONE CHANNEL

Resistors

R1, R7 4·7kΩ (2 off) R3, R8 470Ω (2 off)
R2, R6 1kΩ (2 off) R4, R5 1kΩ (2 off)
All ± 10% ¼W carbon

Capacitors

C1, C2 25μF 25V elect. (2 off)

Diodes

D1–D4 1N4001 (4 off)

Thyristors

CSR1–CSR4 C6U (Jermyn Industries, 120 Vestry Estate, Sevenoaks, Kent) (4 off)

Lamps

LP2–LP6 6·3V 0·3A m.e.s. with holders (5 off)

Switches

S2 D.P.D.T. miniature toggle
S3, S4 Push-to-make, release-to-break push-button (2 off)
S5 Push-to-changeover pushbutton

Plugs and Sockets

PL1, SK1 3-pin mains plug and socket (Bulgin)

Miscellaneous

3in × 2in × 1½in aluminium case

FOR COMPLETE UNIT

Transformer

T1 Mains primary, 0–6·3V, 0–6·3V secondary (see text)

Miscellaneous

S1 D.P.D.T. mains switch
FS1 1A fuse and holder
LP1 Mains neon and holder

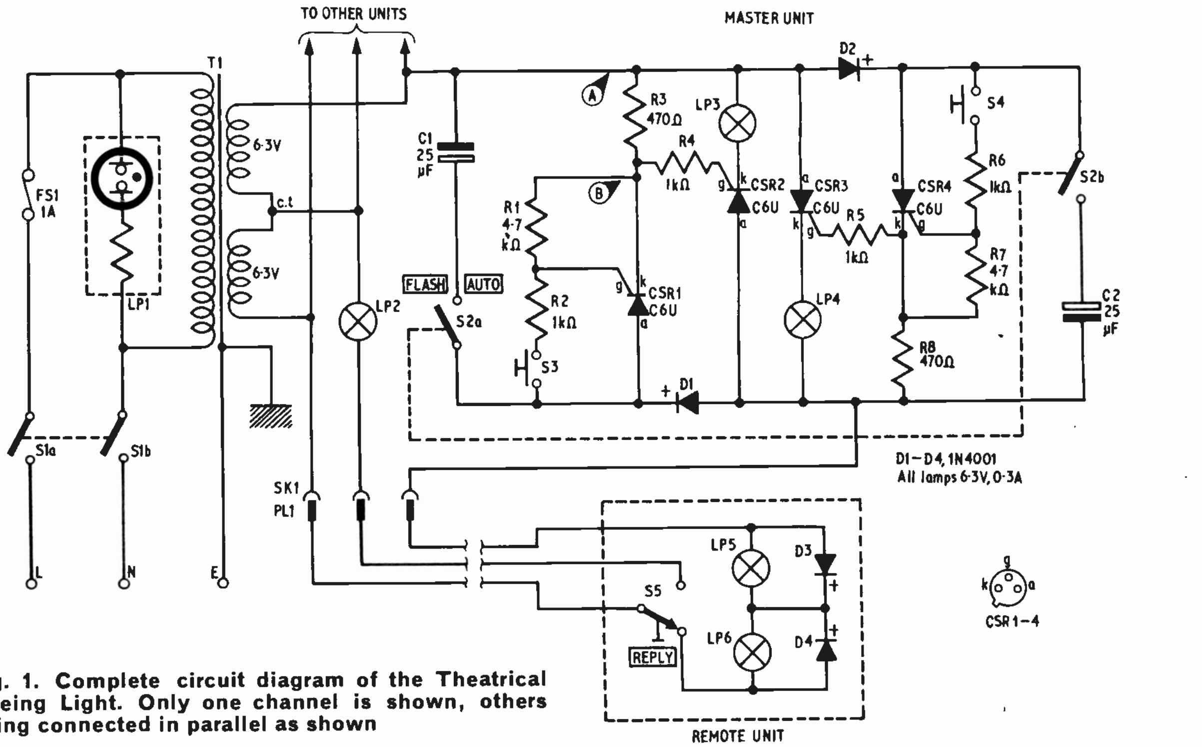


Fig. 1. Complete circuit diagram of the Theatrical Cueing Light. Only one channel is shown, others being connected in parallel as shown

CIRCUIT PRINCIPLES

The circuit of the Cueing Light is shown in Fig. 1.

Considerable use is made of the fact that a thyristor will stay conducting once switched on, and will only cease conducting when the current through it falls below a certain value, called the holding current.

In the circuit the positive and negative going portions of the a.c. supply are used to power different bulbs (the thyristors also act as diodes when switched on).

First, consider what happens when S2 is open, i.e. in the "flash" position. Pressing S3 supplies gate current to CSR1 switching it on until S3 is released.

Switching on CSR1 causes the voltage at B to become sufficiently positive with respect to A to switch on CSR2, lighting LP3 in the master, and LP5 in the remote units. Once S3 is released both lights will extinguish. Hence the "flash" facility.

With S2 closed (in the "auto" position), diode D1 rectifies the a.c. and C1 smooths it, giving smooth d.c. across CSR1. Providing R3 is small enough to pass the holding current, CSR1 will stay on after S3 is released and therefore CSR2 will also stay on.

Lamps LP3 and LP5 will stay on after S3 is pressed and can be switched off either by pressing S5 in the remote unit (which illuminates LP2 in the master), or by S2 which removes the smoothing capacitor causing the voltage to fall below the holding level fifty times a second.

The other half of the circuit (CSR3 and CSR4) works in exactly the same way except that it operates on the opposite half cycles of the a.c.

CONSTRUCTION

The components in the master unit were mounted directly on the panel, no board being felt necessary (see Fig. 2). Ensure that all leads are sleeved to prevent accidental short circuits, and cover the thyristor cans with insulating tape.

The case will obviously depend on individual needs so no overall dimensions are given. The transformer should be of sufficient current rating to drive the number of units required, each taking about 300mA.

A fuse and neon indicator should be fitted, as many theatres still use unfused plugs.

The master and remote units are connected by the three-core cable fitted with a three-pin plug which fits into a socket in the back of the master.

Constructional details for only one channel are shown, others being connected in parallel with the power supply as indicated in Fig. 1.

Continued on page 541

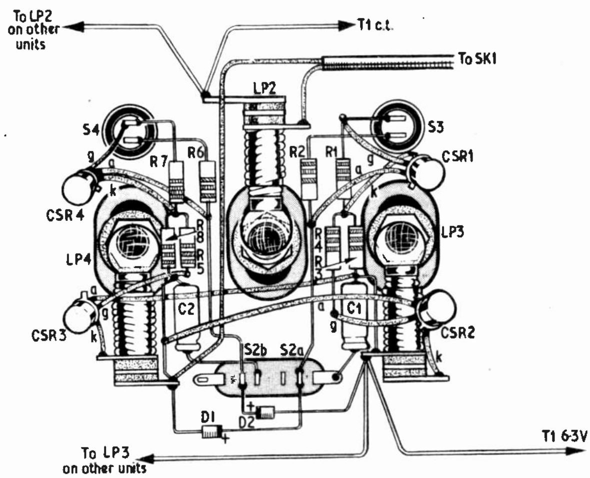


Fig. 2. Layout of the components on the master unit front panel

OSCILLOSCOPE KIT

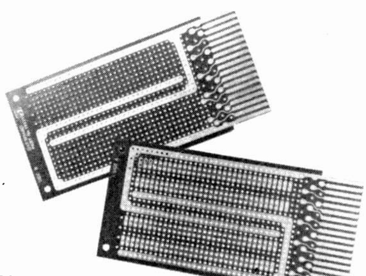
A new oscilloscope kit specially designed for use on 2-channel and 4-channel stereo systems has been announced by **Heath (Gloucester) Ltd.** Designated type AD-1013 Audio Scope, the instrument is ideal for visual checking and monitoring of such parameters as channel separation, phasing, relative signal strengths, multipath reception and centre-tuning of receivers and tuners.

A built-in four channel decoder gives independent or simultaneous visual indication of all four channels. It is claimed that by using a triggered sweep circuit a stable, jitter free signal trace is obtained.

Inputs are provided on the rear panel for Left-Front, Left-Back, Right-Front, Right-Back and Multipath. Any of these inputs can be switched and observed on the screen, independently or in combination. Illuminated function indicators on the front panel show what function is being displayed.

An input, on the front panel, is provided for observing any external signal, permitting the equipment to be used as a conventional oscilloscope for checking out equipment malfunctions. A built-in independent 20Hz to 20kHz low distortion audio oscillator provides a convenient means of adjusting and checking any stereo system. Front panel controls are provided for frequency selection of the audio oscillator as well as controlling the amplitude of the generated signal.

Most of the components are mounted on a single circuit board and point-to-point wiring is kept to a minimum to aid construction. The price of the Heathkit AD-1013 Audio Scope is £99·55 mail order, carriage extra. More information is obtainable from Heath (Gloucester) Ltd., Bristol Road, Gloucester.



Vero printed wiring boards

MARKET PLACE

Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned.

NEW OSCILLOSCOPES

Two new low cost, high performance oscilloscopes have been introduced on the market by **Advance Electronics.** Intended for industrial or educational use, the OS140 and OS240 have a 10MHz bandwidth, input sensitivity of 5mV/0·8cm (the smaller tube face size of 10cm dictated a graticule division of 0·8cm) and a triggered time base.

The OS240 has a double beam facility implemented by i.c. switching.

A design philosophy aimed at economy in price and construction without degrading a high performance specification has resulted in relatively few piece parts and, very noticeable, a complete absence of cable looms.

Most of the circuitry is contained on three plug-in printed boards. Plug-in mounting of these boards means easy availability for servicing.

Both instruments measure 132 × 270 × 317mm and weigh approximately 5kg. Prices of the OS140 and OS240 are £107 and £125 respectively. Full technical specification for the oscilloscopes can be obtained from Advance Electronics Ltd., Roebuck Road, Hainault, Essex.

PRINTED CIRCUIT KIT

With the increasing complexity of many of the published circuits it seems that the popularity of making printed circuits to aid the ease of construction is on the increase. Readers may be interested in the new printed circuit kit from **Daturr Ltd.,** which provides all the requirements for etching circuit boards.

A feature of the kit is a plastics hole template which allows for transistor and i.c. configurations to be easily scribed onto the copper laminate.

Also contained in the kit are three boards, resist pen, scriber, plastics tongs and funnel, and large bottles of resist remover and etchant. The large plastics case also doubles as an etching bath.

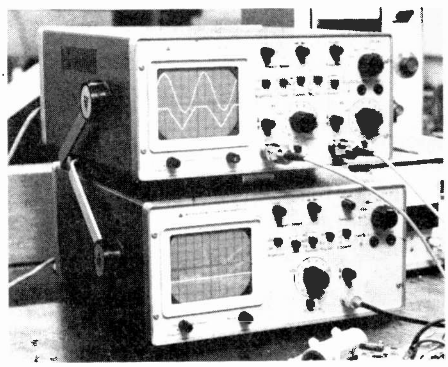
The kit retails at £7·95 and is available from Daturr Ltd., Market Road, Richmond, Surrey.

D.I.P. BOARD

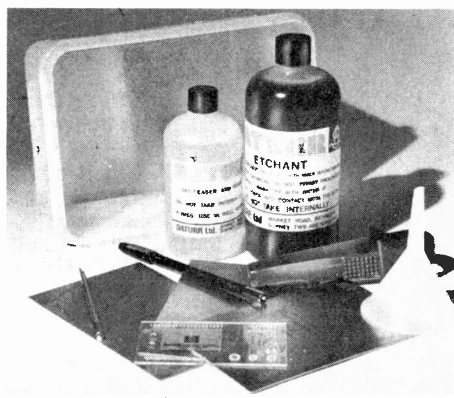
Two special d.i.p. boards have recently been introduced by **Vero Electronics.** These have a 0·1in pitch hole matrix and are designed to mate with standard D.E.C. connectors.

Initially available in two sizes, both five inches long, one being of single height and the other of double height. Readers who are commencing building the "Rhythm Generator", recently published in P.E., should find that the board is suitable for mounting the logic circuitry.

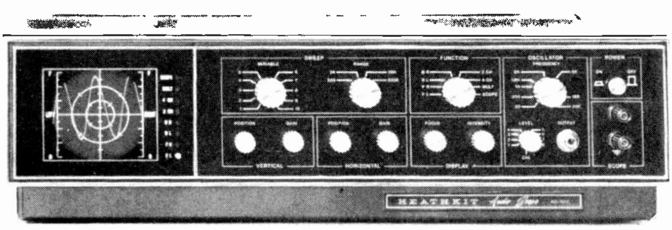
Full details of the boards can be obtained from Vero Electronics Ltd., Industrial Estate, Chandlers Ford, Eastleigh, Hants.



New Advance oscilloscopes



Printed circuit kit by Daturr



Four channel audio oscilloscope from Heath

NEW DEVICES ...APPLICATIONS

PROGRAMMABLE TIMER/COUNTER

AN INTEGRATED circuit capable of producing programmable time delays ranging from microseconds up to five days has been produced by Exar Integrated Systems.

Accuracy is such that the device is a viable replacement for mechanical or electromechanical timers. With two devices in cascade the timing period can be increased up to five years!

CIRCUIT DESCRIPTION

A simplified circuit diagram of the device, designated XR-2240 or, in a less accurate version, XR-2340, is shown in Fig. 1. It can be seen to consist of three main sections: a time base; an eight stage binary counter; and a control bistable.

The time base circuit needs two external timing components (R and C) to produce an accurate clock oscillator.

The timing cycle is initiated by applying a positive-going trigger pulse to the TRIGGER input of the control bistable. This trigger pulse starts the time base oscillator, clears the counter stages back to zero and makes the counter ready to accept an input.

The time base oscillator produces timing pulses with a period T equal to the product of the timing components $T = CR$. The pulses from the time base are counted by the eight bistables forming the binary counter, the output from each being available.

The timing period is ended when a reset pulse is applied to pin 10.

GENERAL PURPOSE TIMING

In most timing applications one or more of the counter outputs are connected back to the reset terminal as shown in Fig. 2, with S1 closed. This causes the timing period to start with the trigger pulse and to end when a preprogrammed count is reached.

The counter outputs are open collector types and the timing period is determined by which particular outputs are connected to the load resistor R_L and the reset input.

For instance, if a timing period of 100T was desired then pins 3 (4T), 6 (32T) and 7 (64T) would be connected to R_L (since $4T + 32T + 64T = 100T$).

LONG DELAYS

For extremely long delays with low power consumption, two XR-2240 i.c.s may be cascaded as in Fig. 3. Referring back to Fig. 1 it will be seen that a regulated voltage is available at pin 15 and it is this voltage which is fed to the second i.c.

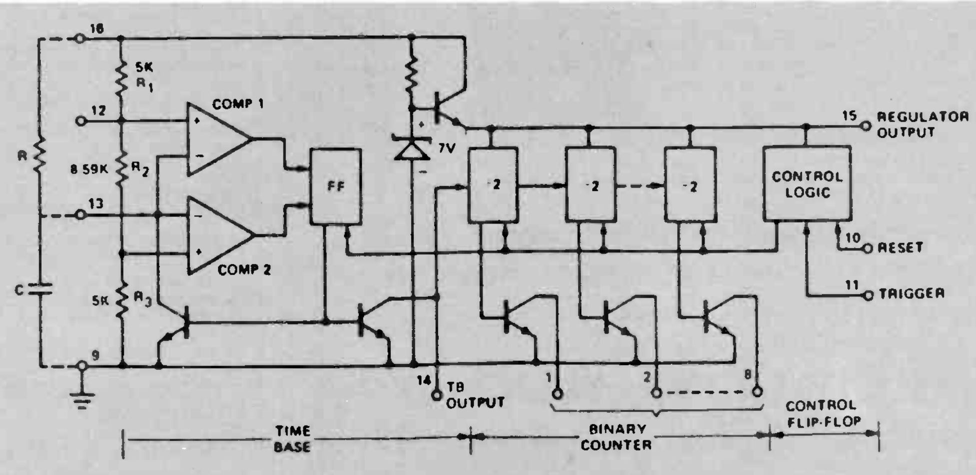
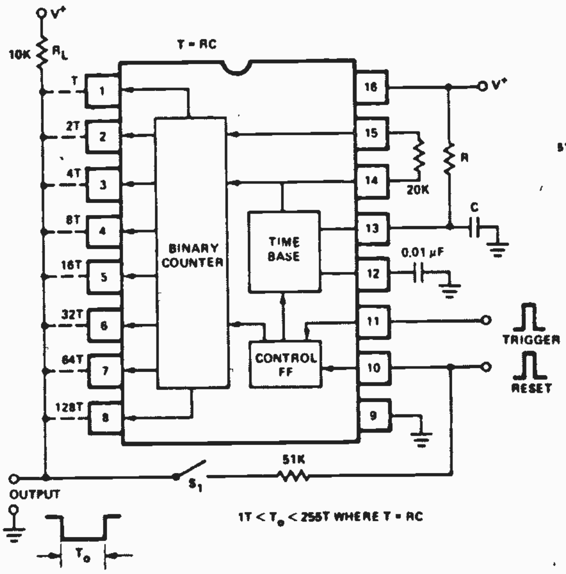


Fig. 1. Simplified circuit diagram of the XR-2240/2340 integrated circuit



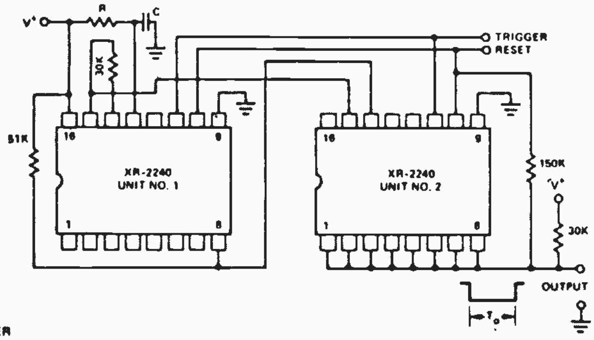


Fig. 2. Generalised circuit connection for timing applications. With S1 open the circuit operates in astable mode; with it closed, in monostable mode (left)

Fig. 3. Two devices connected in cascade for low-power, long time delay operation (above)

FREQUENCY SYNTHESIS

The programmable counter section of the XR-2240 can be used to generate 255 discrete frequencies from a given time base setting using the circuit shown in Fig. 4. The output of the circuit is a positive pulse train, the pulses being *T* seconds wide, and occurring at a period of $(N+1)T$ seconds, where *N* is the programmed count in the counter.

Thus by changing the value of *N* (by shorting different outputs together) 255 frequencies are generated.

ANALOGUE-TO-DIGITAL CONVERTER

Fig. 5 shows a simple eight-bit analogue-to-digital converter using the XR-2240.

When a strobe pulse is applied, the counter is reset to zero. The time base oscillator is started and the counter begins counting. The eight resistors are connected to the counter outputs and are of values which produce a staircase waveform at the output of the operational amplifier (op amp).

This ascending staircase is compared with the input voltage by the comparator, and, as soon as the input is exceeded, the bistable latch is set, the count stopped, and the digital equivalent of the input is available at the counter outputs.

OTHER FEATURES

The supply voltage can lie anywhere between 4V and 15V, power dissipation being less than 750mW. All outputs are TTL and DTL compatible.

The device comes in a standard 16-pin dual-in-line package.

The price of the cheapest version of this programmable timer/counter (the XR-2340CP) is £3·90 subject to availability though the XR-2240N which is the same device with a smaller timing error (2% as compared with 5%) is £8·55 (add 14p postage and VAT).

These devices or further data are available from Rastra Electronics, 275-281 King Street, Hammersmith, London W6 9NF.

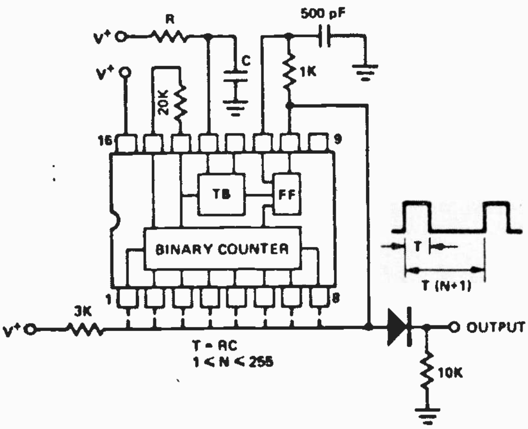


Fig. 4. Frequency synthesis using the internal time base. The frequency is altered by changing the programmed count in the counter

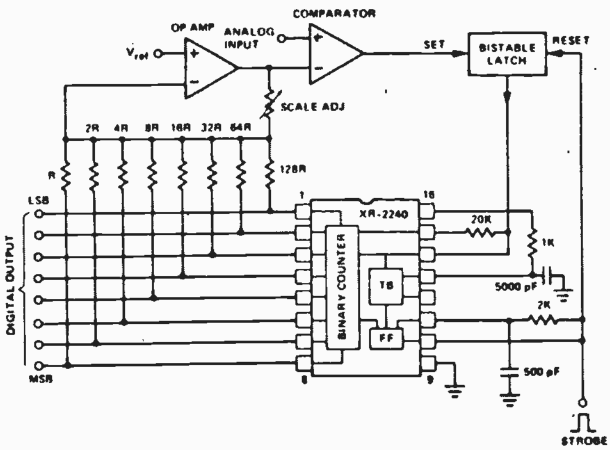


Fig. 5. An eight-bit analogue-to-digital converter using the XR-2240

ESP etc

By Brian Baily...

Time Gentlemen, Please . . .

As mentioned earlier in this series, the realm of ESP and other difficult-to-explain phenomena is wide and varied. The thinking mind fairly boggles as it tries to find some underlying common factor, to which some, if not all such happenings can be attributed. Alas, there seems little one can find to fill the bill, apart from such descriptions "very odd", "coincidental", or "let's get out out here!"

Let's have a brief look at one or two types of ESP-ery and see what develops. Take the classical example of the dream that comes true, a most eerie experience, if ever you find it happening to you. Often, the content of such dreams is most trivial, though, in the best examples, concerns incidents which the dreamer would not normally have "dreamed of happening".

At this point, whilst our sceptic friends are still with us, I had better assure them that I am fully in support of their views on such subjects as dreams, and that I, too, am highly sceptical of anyone else's experiences, and even my own sometimes. But the strange "coincidences" of dreams is one of the earlier experiences I had which opened my scientifically-motivated mind. So please stay with us, and continue to disbelieve: that is your prerogative . . . until it happens to you . . . more than three times.

If, then, we take the happening of an unlikely event identical in detail to the dreamed event, and we are forced to suppose that the dreamer *did* foresee it in sleep, then there are two possibilities to my way of thinking. Either the dreamer somehow "leaped forward" in time, returning to the "present" a little later, or part of his mind (maybe not his brain?) managed to compress part of his appreciation of time so that he was able to "see" more than he would normally.

Anyone who has used a good oscilloscope will have noticed the effect of using the Expand Trace control. If the trace is compressed, it is possible to see parts of a waveform normally occurring too early in time to be seen on the screen, i.e. normally too far to the left.

Psychometrists

So much for dreams. Time is again the only variable when we consider prediction in waking life. There are some who are good at this, despite the charlatans. Then there are the "psychometrists", people who can handle an inanimate object and then tell you all about the events in the lives of people who may have owned it over the years. (I have scientifically tested two such people more than once and I am convinced of the validity of their claims; one subject even related the basic content of a lecture recorded on a spool of magnetic tape, without even unwinding it!) Again, then, in psychometry, there seems to be some sort of "time recording". If not, what else?

Some years ago (about 8 years) Benson Herbert, M.Sc., of the Paraphysical Laboratory, Downton, Wilts, used a randomly-flashing electric lamp as a detector to establish whether it was possible to predict correctly how long the interval would be between consecutive flashes. Careful precautions were taken to prevent temperature changes affecting timing, and elaborate measures taken to establish exact timing accuracy, using a multi-channel pen recorder. I saw the resulting traces and success in predicting flash intervals proved to be phenomenally high, and very much higher than chance.

Years Later

Some years later, I watched the same subject (a young lady) sit by the same flashing light to "tell" it (reading instructions of fast or slow from a table composed from a book of random numbers, where odd ones were interpreted as, say, long, and even numbers as short). The lamp, in most instances, obeyed her wish. I watched, fascinated. All wiring was exposed, and there were no tricks: even though those present were genuinely interested scientifically, we have to ensure there is no room for error, deliberate or otherwise.

It would appear that the subject was able, by thought process, to interfere with normal randomness of the flashing lamp. This phenomenon is called "psycho-kinesis", or PK. My own feelings are that if anything can be changed by thought, then by far the easiest task must surely be interference with the rate of random sequences, since the resulting "bunching" is readily recognised when present, and in the case of the flashing lamp, the influence of moving one flash forward results in the interval following it to be made longer, so increasing the effect twofold.

Incidentally, experiments using the flashing of a geiger counter proved that the cosmically generated events were *not* influenced by any tested subject.

Random Timer

I am embarking on a series of experiments using a specially-designed random event timer, one version of which is described in the article on page 540 in this issue. At the time of writing results are not to hand, but I am already very hopeful, as during development tests the circuit showed surprising tendencies to display "bunching" effect, despite the special precautions I had taken to ensure no synchronisation between the two timer elements. Careful analysis of figures over hundreds of operations, and of voltages in the circuit, showed no clue to the odd behaviour.

Readers may care to construct a circuit along the lines of the example and see if they get unexpected results (say a run of 7 second intervals) when certain people are asked to concentrate on the flashing lamp or speaker "click".

One way of looking for paranormal effects is to let the timer cycle on for a while unobserved. Then grab a stopwatch and start timing, resetting the watch and logging figures while you concentrate on obtaining high readings. After some ten results, change your concentration to obtaining low reading, for the next ten times. Then add up the seconds for each group and compare the total! The result will surprise or even shock you, if my findings are anything to go by.

Next month . . . preliminary findings on Random PK Timer plus news from other countries

RANDOM TIMER

By Brian Baily

A circuit developed for the investigation of psycho-kinesis phenomena

THE reason for the development of this circuit is described in the *ESP etc.* feature elsewhere in this issue.

The production of randomly-timed events is not an easy task, and for true randomness to be achieved very much more circuitry than that shown would be required. However, the circuit illustrated serves its purpose to produce fairly random timing when set to run from 2 to 20 seconds. Free-running oscillators were rejected from the selection because of the danger of accidental synchronisation effects, which may upset randomness and could at best result in discrete units of time being introduced, created by the repetition rate of such an oscillator.

CIRCUIT

The block schematic Fig. 1 shows the main blocks of the circuit. A metronome-like circuit drives a speaker to produce a series of clicks. Its timing is determined by a randomising circuit, which is triggered and made to change timing information every time the metronome fires. TR4 is a unijunction transistor which uses the charging of capacitor C3 to produce the intervals between clicks. When C3 charge reaches a certain positive value, TR4 emitter becomes conductive and the capacitor is discharged through the lower base connection of TR4 producing a click in the speaker (Fig. 2).

The charging of a capacitor through a resistance is not linear, but is exponential, i.e. for the first part of the charging the voltage across the capacitor increases quite quickly, but as it gets closer to the aiming potential the rate of ascent decreases, and so the voltage stays at nearly the same level for a relatively long time. If we try to alter the timing of TR4/C3 circuit when this exponential law is in operation, most of the effect we shall have will be in the first few seconds and this leaves about half of the time available unchanged, i.e. the part of the charge curve that is nearly horizontal. So it was necessary to change the curve of the C3 charge line by charging C3—instead of through a resistor—through a transistor, TR5, which would supply a constant charging current to C3, so that the voltage on C3 climbs at uniform rate with time. The rate of charge being set by VR1.

When C3 charge reaches the critical voltage for TR4 to conduct, the lower base conducts the charge through the speaker. At the same time, the emitter voltage falls rapidly towards zero volts. This fall discharges C2 with it, via limiting resistor R5, causing the *pnp* transistor TR2 to conduct. The conduction is only momentary, as C2 charges quickly due to the base current taken by TR2.

Transistor TR2 forms a variable current source in a charge circuit for C1, which is in a very similar circuit in appearance to the metronome circuit TR4. However, TR1 circuit is not free-running, and C1 may not reach a charge voltage sufficient to fire TR1 in the time that TR2 conducts. But whatever voltage is attained on C1, remains, as there is no leak path for it to drain away, because the f.e.t. (TR3) gate draws virtually no current. However, a certain voltage, proportional to that on C1, but not equal to it, is produced across R3. By this time C3 charge would have fallen almost to zero, but because of the voltage across R3, and because D1 polarity is the way that it is, C3 is allowed to fall only to the level across R3 (less about 0·5V which polarises the diode).

Hence, when C3 charges next time, it has a head start, since it already has R3 voltage across it. So, C3 reaches TR4 firing voltage earlier than before. Next time TR4 fires, the same events occur, and more voltage is applied to C1, which may, this time, reach the firing voltage of TR1 emitter. If this occurs, C1 will discharge completely to 0 volts, but, if TR2 is still conducting when this happens, C1 will begin to charge again until the short conduction of TR2 ceases. Hence, it is most likely, in all

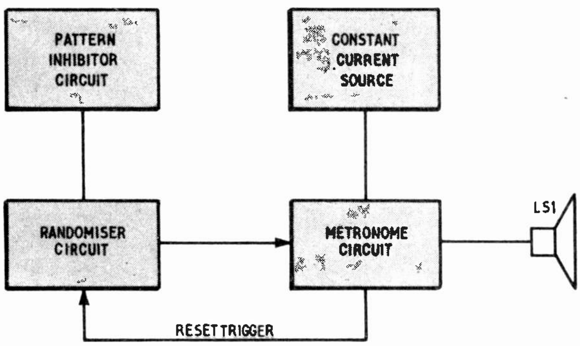


Fig. 1. Block diagram for a random timer

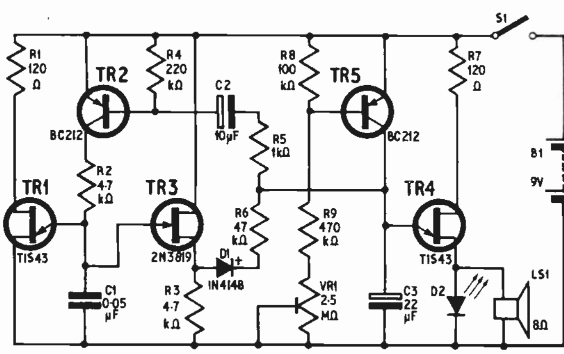


Fig. 2. Suggested circuit for the random timer

events, that C1 will reach a different charge voltage each time TR4 produces a click in the speaker.

PATTERN INHIBITOR

Originally, a diode was used to discharge C2 between pulses, but it was found that when the timer results were examined over a period of many events, a recognisable pattern was discernable. The pattern was often several cycles long or more. So it was decided to introduce a non-linear function into the circuit. This was done by using R4 as the discharge path for C2.

As explained earlier, when TR4 emitter fires and C1 charge falls rapidly, C2 charges by drawing current through TR2 base. But when C3 voltage rises again, during charge, C2 discharges much more slowly through the relatively high resistance of R4. Now, if C3 charges slowly, the discharge of C2 would be completed in the time, but when C3 charges quickly, R4 is too high to allow C2 to completely discharge.

The amount by which C2 has discharged, when next TR4 fires, has a large effect on the duration of TR2's conduction, and therefore on the amount of charge applied to C1. The time-constant of C2 and R4 ensures that, at higher repetition rates a much smaller amount of charge is allowed to be fed to C1 than at lower rates, so introducing a very non-linear function into the system. As you will remember, a capacitor and resistor produce an exponential voltage function. As soon as this small alteration was made to the circuit, the timer showed no further evidence of repetitive pattern "runs", but behaved extremely randomly. For instance, instead of a five-second interval always being followed by (say) a 15-second interval, there was no correlation on any timing.

Current consumption of the circuit was 2mA, making a PP3 battery quite adequate.

SETTING UP

The values in the circuit were those arrived at in the author's particular circuit. Unfortunately, the manufacturers' grading of unijunctions allows a wide spread of characteristics, and there can be no guarantee that these values will apply in other cases, but the circuit itself can be modified here and there to obtain a working result.

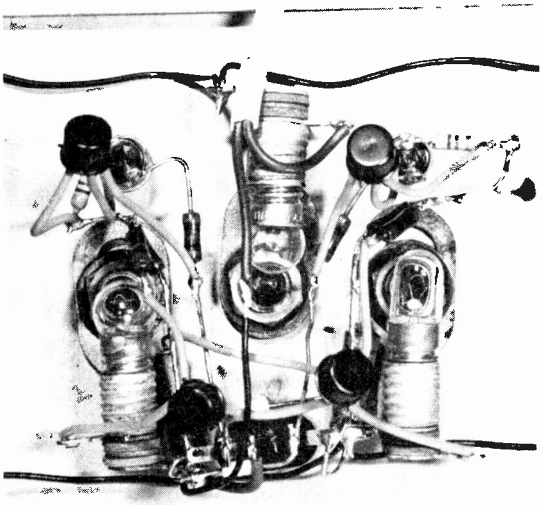
Test the circuit by first short-circuiting C1. Then set VR1 carefully until speaker clicks once every 15 or 20 seconds. Next, remove short from C1 and place a voltmeter (10V range) across R3. Note the reading each time speaker clicks, and see that reading varies each time, and does not remain the sâme for more than two clicks, and if at all, only occasionally. Adjustment of this is effected by value of R4, C2 and R2.

Note, tantalum capacitors were used in the prototype, and these have low leakage levels, so considerable differences would be expected using ordinary electrolytics.

The inclusion of a light-emitting diode, D2, and substitution of an earphone for the speaker make the author's version particularly suitable where it was required to limit the observations to one person. This is because in some experiments it is best for a subject not to know of failures they may have during a prolonged experiment, because of the discouragement factor. ★

THEATRE CUEING LIGHTS

Continued from page 533



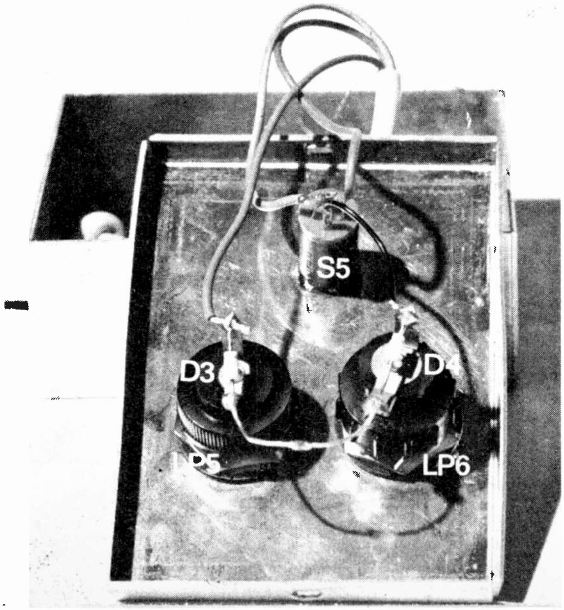
The remote units were built in small aluminium boxes as shown in the photograph. Large lampholders were used to make the lights more noticeable.

COMPONENTS

None of the components are particularly critical. The thyristors specified are readily available but 1A 50V types will do. Wire ended types are most convenient.

If different thyristors are used they may need more gate current. This can be produced by reducing R2 (down to 150Ω if necessary). If the thyristors light but fail to stay on increase the value of the smoothing capacitors and decrease R3 (not below 100Ω).

The toggle switches should preferably be miniature types as the normal size make rather a noise when flicked over on metal panels. ★



Photograph showing the construction of the remote unit. The two diodes are mounted on the lampholders as shown

INDUSTRY NOTEBOOK

By Nexus

C'EST SI BON!

The Paris Components Show staged at the beginning of April is one of the dwindling number of giant events which still, apparently, has universal appeal. Britain's IEA (Instruments, Electronics, Automation) show, to be held in late May at Olympia, is a shadow of its former self, suffering from a bout of last-minute cancellations (accompanied by suitably heavy penalty clauses) by a number of leading companies.

Not so at Paris, despite it being just about the most expensive place in the world to exhibit. This year there were the usual 1,000 exhibitors from 25 countries with some 80 UK companies exhibiting.

And the French, themselves, have never had it so good. Well may they be cheeky to Dr. Kissinger, go their own way in oil deals with the Arabs, run their own defence arrangements outside NATO, and lay down the law on the Common Agricultural Policy.

For the French, 1973 was a fine year with 6·5 per cent overall growth which, with only a fairly modest level of inflation, gave everyone a real gain in standard of living. And the biggest success story of all at the Paris Show was the performance of the French electronic components industry.

For the past ten years it has averaged 13·2 per cent growth a year and exports have grown even more steeply so that this year total output will be worth a billion US dollars with 40 per cent of production going for export. An astonishing performance. And the pace shows no sign of slackening. What is stoking the French fire of ambition is the race to beat the Germans into top spot in Europe as an industrial and technological power. Britain was well ahead of France ten years ago. Now the French are abreast.

THE POOR BRITISH

One solid reason why the Germans and French are doing so well is because the incentives are good. In a 1973 salary survey it was revealed that a British company director with a nominal salary of £12,500 would, in fact, receive only £7,000 after tax. His French opposite number would get £14,350 in salary and keep £11,075 net, and his German equivalent would get £20,200 and keep a thumping £13,400, nearly twice that of the British director.

In recent months three British managing directors have confessed to me that in setting up sales and service operations on the European mainland they have had to start their European managers on a salary greater than their own, even though the European manager has only a fraction of the staff of the parent company.

AFTERMATH

The three-day week did little damage to the electronics industry. After the return to normal my own personal survey revealed no company admitting to less than 80 per cent of normal production and one company actually achieved 110 per cent—a production gain.

The smaller companies with their greater flexibility did best of all. Dear old Mavis, Flo, Alice and Betty and hundreds more like them stuffed their shopping bags with PCBs and components and carried on assembly work at home. The old concept of a cottage industry was revived. One aspect was enormous loyalty. One manager told me that timekeeping improved at his plant and absenteeism was lower. The "temporary difficulty" made people think more about the value of their jobs. It can hardly be said that the enforced three-day week was good but some good did come out of it.

Best of all was that order intake was not impaired. The fear that overseas customers would start cancelling unfulfilled export orders or cease to place new orders was not realised.

IN THE BALANCE

Hardly a day passes without some new application of electronics. When Ludwig Oertling started manufacturing analytical balances in Britain 127 years ago the steam engine was the big technological achievement of the day and the discovery of Hertzian waves was still 40 years ahead in the future. Oertling is still making fine balances (see the Guinness Book of Records for the world's most accurate balance which measures one tenth of one millionth of a gram) and is making them all the finer with the addition of electronics.

Latest top-pan Oertling balances have digital outputs for direct electronic read-out from an LED display, recording of weights on a printer, or coded on paper tape for computer analysis. These are not the fragile balances we remember from our days in the school lab but rugged yet sensitive machines for industry and commerce.

The electronic models use a moire fringe optical counting system with a 10-element self-scanning photo-diode array. The subsequent electronics employ over 70 TTL integrated circuits. Heading up Oertling's electronics design team is Rodric Dalitz, a physics graduate from Oxford University.

Oertling's sales director tells me that by the end of this decade he expects sales of electronic read-out balances to be one third of total output. But the fundamental measuring system in Oertling instruments will still be the lever system with built-in weights, a principle dating back 5,000 years which certainly may be said to have stood the test of time.

STRATEGY

Big companies need to plan for the '80s now. That's why Plessey has teamed up with French CIT-Alcatel on development of a new electronic telecommunications system to meet the £500 million market which will start in the late '70s.

The plan is to marry Plessey's System 250 stored program central processor (already developed for the British Ptarmigan military telephone switching network) with CIT's E10 digital switch, now in use on a small scale in France. The combination is a powerful new system which, when refined further, will be an attractive option for not only the British and French Post Offices but for many other countries.

In the UK the Post Office is looking to TXE4 as an interim measure before moving to a fully electronic system for which GEC's Mark 2BL processor is the front runner although still only in the development phase.

Last June GEC and STC agreed to co-operate on the TXE4 and later systems, apparently leaving Plessey out in the cold. What we didn't know then was that Plessey had been talking to CIT long before then and may well have taken the wiser course in refusing the invitation to join STC in a co-operative project. As Sir John Clark, Plessey's Chairman, commented, "We never saw that an association with an American-dominated company (STC is owned by the U.S. ITT) would be a satisfactory solution for the vast majority of European countries".

Is Sir John being a good European or just a good businessman? I suspect he's both.

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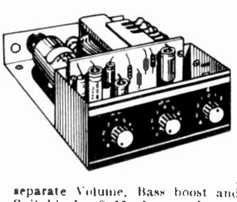

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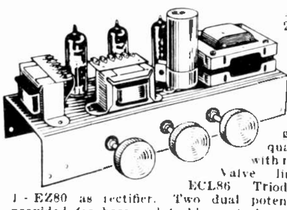

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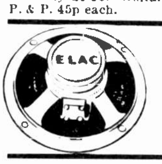

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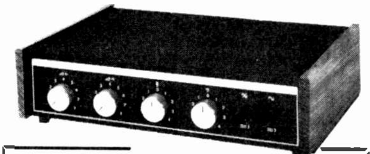
Size 11¾in × 14¾in × 1 7/16in deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz-20kHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details. Only **£6·55** each. P. & P. 34p.

HI-FI STEREO HEADPHONES

Adjustable headband with comfortable flexifoam ear-muffs. Wired and fitted with standard stereo ¼in jack plug. Frequency response 30-15,000Hz. Matching impedance 8-16 ohms. Easily converted for mono. PRICE **£3·30.** P. & P. 25p.

HAVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



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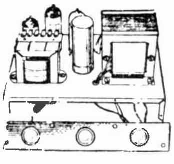
Fully detailed 7-page construction manual and parts list free with kit or send 18p plus large S.A.E.

PRICES AMPLIFIER KIT, **£11·55** P. & P. 25p.
(Magnetic input components 33p extra)
POWER PACK KIT, **£3.50** P. & P. 35p.
CABINET, **£3 50** P. & P. 35p.

(Post Free if all units purchased at same time). Full after sales service. Also available ready built and tested, **£25·10.** Post Free.
Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

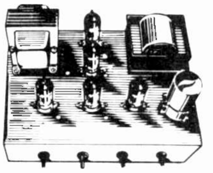
3-VALVE AUDIO AMP. HA34 MK II



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in w. × 4in. d. × 4½in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£6·00.** P. & P. 45p.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **£5·00.** P. & P. 45p.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet **15p** plus S.A.E. (Free with parts). **All parts sold separately.** ONLY **£9·00.** P. & P. 60p. Also available ready built and tested **£13·00.** P. & P. 70p.

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PATENTS REVIEW...

NOISE MAKING CIRCUIT

Audible alarms for battery operated clocks and film cameras must provide loud sounds at low voltages (often in the order of 1 or 1½V). Feedback circuits using silicon devices have been tried, but there is a crippling loss of drive voltage for the transducer.

In BP 1 333 644 P. R. Mallory & Co Inc of Indianapolis, USA, describes a sound producing piezo-electric transducer of novel construction incorporated in a feedback circuit.

Fig. 1 shows a part of the transducer in section. The piezo-electric crystal is bonded to the substrate and the electrodes T1 and T3 are isolated from the crystal; electrode T2 is mounted on the substrate. The crystal can be a lead, zirconium or titanium composite.

Electrodes T1 and T2 provide the drive for the transducer and T3 provides feedback.

In the circuit of Fig. 2 the amplifying transistors TR1 and TR2 are biased by resistors R1, R2 and R3. Transistor TR2 is connected to electrodes T1 and T2 with the collector of TR1 connected to the base of TR2. The emitter of TR1 is connected to the emitter of TR2 to provide a common emitter amplifier.

The feedback electrode T3 is connected to the base of TR1 and by selecting the correct polarity at T1 and T2 (which depends on the initial polarisation direction of the crystal) for connection to the collector and emitter of TR2 the feedback voltage at T3 can be put in phase and oscillations created. These will be maintained at the resonant frequency of the transducer.

It is claimed that under such circumstances substantial noise is produced with low supply voltage.

BP 1 333 644

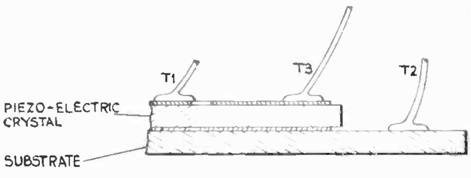

Fig. 1

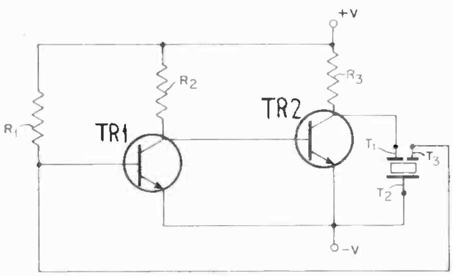

Fig. 2

DISTANCE MEASURING

The Japanese National Railways and Sumitomo Electric Industries Ltd., jointly describe in BP 1 337 088 an extremely clever new use for coaxial cable.

The object of the exercise is to produce a means for accurately recording the distance travelled by a moving object along a predetermined path. This may be on a large scale, as for instance a train moving along a track, or on a small scale; a scientific instrument moving along a programmed route. Whatever the scale of the operation, spurious revolutions, e.g. due to slippage, make it impossible to achieve this accurately simply by counting the revolutions on a wheel.

What the Japanese propose is that a coaxial cable be modified

BP 1 337 088

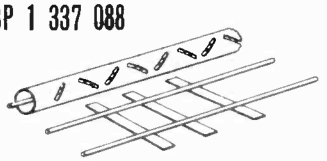

Fig. 1

to deliberately produce field leaks along its length, see Fig. 1. This they do by cutting slots through the outer coaxial conductor at regular intervals along its length. The slots are so angled, one with respect to the next, as to produce alternately reverse polarised magnetic fields from a current flowing along the cable central conductor.

A leaky coaxial cable of this type is laid along the route to be followed and the central conductor fed with a current having a wavelength longer than the interval between adjacent slits. The moving object is provided with an on-board aerial which couples with the alternating magnetic fields which occur at the discrete points of the leaks and digital counters are used to tot up the number of successive field occurrences encountered during travel.

The distance travelled is detected by counting the occurrences of the field and the speed of the moving object by measuring the ratio between the travelling distance and time.

Copies of Patents can be obtained from the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price 25p each

Readout—

A SELECTION FROM OUR POSTBAG

Scorpio Transformer

Sir,—Recently I experienced some difficulty in obtaining the recommended ferrite cups for the transformer core. Rather than wait delivery I wound the transformer on a line output transformer core from a scrapped T.V. set. This works perfectly well and the only disadvantage I found was that the finished transformer is larger than the recommended one.

First I cut away the old windings, then dismantled the clamping assembly until I was left with the bare core which was in two pieces, *C*-shaped and *I*-shaped.

Using stiff card to protect the wire from the sharp square edges, I wound the h.t. secondary (400 turns) directly onto the *C*-core. The primary windings (12T + 12T) were wound onto the *I*-core and the feedback windings over these p.v.c. insulating tapes was used as insulation between layers of windings.

With the transformer that I used the original core-clamps were impractical but it was a simple job to fabricate alternatives.

D. Gennard,
Rotherham,
York.

P.E. Synthesiser

Sir,—Having added this above project to my other synthesiser, and having spent some time building your circuit, I feel I must point out some difficulties encountered which may be of some use to other readers:

1. Excessive noise on output of ring modulator.

2. C3 on sample-hold/noise generator board too low to trigger IC2; I used 0·01μF sufflex.

3. TR1 on sample-hold/noise board shown as *npn*, this should be *pnp*.

4. Tone-control — the following modifications had to be made, due to non-operation of circuit as shown. R1 made 120kΩ. Junction of R2/R4 taken to 0V instead of −15V line as shown.

5. D5 on keyboard envelope shaper has not been valued. This should be 11V.

6. Keyboard hold, mod amps and mixer circuit—IC3 is shown with R68 to pin 3. The non invert input of IC3 and C1 to pin 2, these leads should be reversed for sample/hold function, otherwise circuit will oscillate.

7. Keyboard hold—although when setting up VR4/VR5 out of circuit, the hold time is fair, when actually connected to keyboard contacts the leakage which can be experienced from contacts to keyboard frame is enough to upset the hold circuit. I suggest a gate be interposed between C1 and R66–62, this is normally open but closes when gated from keyboard −ve busbar.

Mr. Campbell's synthesiser

My two main criticisms are the difficulty experienced in setting up the sine-shaper of the log oscillators and the lack of a good voltage controlled low pass filter. Otherwise a brilliant piece of design work especially on keyboard and log v.c.o.s.

N. Campbell,
Liverpool.

ELECTRONICS FOR SCHOOL TEACHERS

The University of Essex are holding their third Electronics Summer School for teachers on July 8-12.

Further details may be obtained from Mr. R. J. Mack, Department of Electrical Engineering Science, University of Essex, Wivenhoe Park, Colchester CO4 3SQ, phone Colchester 44144, Ext. 2408 (or 2299).

BACK NUMBERS WANTED

Anyone who can supply the undermentioned are asked to communicate directly with the reader.

We regret that back numbers of Practical Electronics can no longer be supplied. We will try to publish announcements of readers' requirements (without a guaranteed date) free of charge.

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U4341 Multimeter & Transistor Tester

27 ranges. 16,700opv. Overload protected. Ranges: 0.3/1.5/6/30/60/150/300/900V DC. 1.5/7.5/30/150/300/750V AC. Current: 0.06/0.6/6/60/600mA DC. 0.3/3/30/300mA AC. Resistance: 0.06/0.6/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.

OUR PRICE £10.50 P&P 20p

AUDIOTRONIC Model ATM1

Top value 1,000 opv pocket multimeter. Ranges:– 0/10/50/250/1,000 volt AC and DC. DC current 0 1mA/100mA. Resistance: 0/150k ohms. Decibels: –10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.

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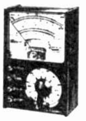
AUDIOTRONIC Model ATM5

Jewel movement, attractively moulded case with edgwise ohms adjustment. Ranges: 0-3/15/150/300/1200V AC, (2500 opv). 0-6/30/300/600V DC, (5000 opv). 0-300 uA/0-300mA DC. Resistance: x 10 & x 100. –10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 29mm.

OUR PRICE £3.50 P&P 15p

MODEL C1092 MULTIMETER



Features 5,000 opv jewel movement and a good selection of range functions. Edgwise ohms adjustment. Ranges:– 0–3/15/150/300/1,200V AC (2,500 opv). 0–6/30/300/600 V DC (5,000 opv). DC current. 0–300uA/300mA. Resistance: R x 10, R x 1,000. –10 to +16dB. Complete with battery, test leads and data booklet. Size: 120 x 73 x 28mm.

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MODEL TH12

20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/50/150/1000V DC. 0/10/50/250/1000V AC. 0/50uA/25/250mA DC. 0/3k/30k/300k/3 Megohms. –20 to +50dB.

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HIOKI Model 720X VOM

A versatile, accurate measuring instrument. 20,000 opv. 0/5/25/100/500/1000V DC. 0/10/50/250/1000V AC. 0–50uA/250mA. 0–20k/2 Megohms.

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MODEL PL436

20,000 opv DC. 8000 opv AC. Mirror scale 6/3/12/30/120/600V DC. 3/30/120/600V DC. 60/600μA/600mA. 10/100K/1 Meg/10 Meg Ohm. 20 to 46 dB.

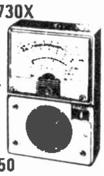
OUR PRICE £6.97 P&P 15p.

U4323 MULTIMETER

20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance: 5/50/500 ohms/5/10/100k ohms/1Meg. Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.

OUR PRICE £7.00 P&P 20p

MODEL HIOKI 730X



30,000 opv. Overload protection. 6/30/60/300/600/1200V DC. 12/60/120/600/1200V AC. 60/μA/30mA/300mA. 2K/200K/2 Meg Ohm. 10 to 63 dB.

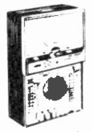
OUR PRICE £7.50 P&P 15p.

MODEL TE300

30,000opv. Mirror scale. Overload protection. 0/0.6/3/15/60/300/1200V DC. 0/6/30/120/600/1200V AC. 0/30uA/6mA/60mA/300mA/600mA. 0/8k/80k/800k/8 Meg ohms. –20 to +63dB.

OUR PRICE £7.50 P&P 15p

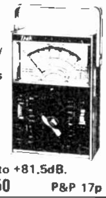
U4324 MULTIMETER



High sensitivity, overload protected. 20,000opv. Ranges: 0.6/1.2/3/12/30/60/120/600/1200V DC. 3/6/15/60/150/300/600/900V AC. Current: 0.06/0.6/6/60/600mA/3A DC. 0.3/30/300mA/3A AC. Resistence: 25/500 ohms/0.5/5/50/500k ohms/5 Mohms. Decibels: –10 to +12dB. Size 167 x 98 x 63mm. Supplied comp lete with test leads, spare diode and instructions.

OUR PRICE £8.00 P&P 20p

TMK MODEL TW50K



46 ranges, mirror scale. 50k/V DC 50k/V AC. DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistance: 10k/100k/1 Meg/10 Meg ohms. –20 to +81.5dB.

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U435 MULTIMETER

20,000opv. Overload protected. Ranges: 75mV/2.5/10/25/100/250/500/1000V DC. 2.5/10/25/100/250/500/1000V AC. Current: 50uA/1/5/25/100mA/0.5/2.5A DC. 5/25/100mA/0.5/2.5A AC. Resistance: 0.3/3/30/300k ohms. Size: 205 x 110 x 84mm. Supplied complete with leads, crocodile clips and steel carrying case.

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U91 Clamp VOLT AMMETER

For measuring AC voltage and current without breaking circuit. Ranges: 300/600V AC. Current: 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 36mm. Complete with carrying case, leads and fuses.

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U4312 MULTIMETER

extremely sturdy instrument for general electrical use. 667opv. 0/0.3/1.5/7.5/30/60/150/300/600/900V DC & 75mV. 0/0.3/1.5/7.5/30/60/150/300/600/900V AC. 0/300uA/1.5/6/15/150/60/600mA/1/1.5/6A DC. 0/1.5/6/15/60/150/600mA/1.5/6A AC. 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.

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MODEL 500

30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC. 0/50uA/5/50/500mA. 12A DC. 0/60k/6 meg/60 megohms.

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Leather case for above £1.75

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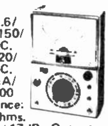
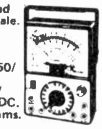


43 ranges: 0–0.3/0.6/1.5/3/6/12/30/60/150/300/600/1,200V DC. 0–3/6/15/30/60/120/300/600/1,200V AC. Current: 0–30/60uA/1.5/3/15/30/150/300mA/6/12A. Resistence: 0–3/300k/3/30Mohms. Decibels: –10 to +17dB. Output:– 0–3/6/15/30/60/120/300V. Accuracy ± 3% DC, ± 4% AC. Sensitivity: 50,000 opv DC, 5,000 opv AC. 4 inch meter. Built in protection. Size: 57 x 102 x 153mm.

OUR PRICE £11.95 P&P 40p

HIOKI MODEL 700X



100,000opv. Overload protection. Mirror scale. 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC. 1.5/3/6/12/30/60/150/300/600/1200V AC. 15/30uA/3/6/30/60/150/500mA/6/12A DC. 2k/200k/2M/20MOhms. –20 to +63dB.

OUR PRICE £14.95 P&P 20p

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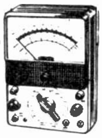
100,000 opv. Mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600V AC. 0/10μA/6/60/300mA/12 Amp. 0/2K/200K/2M/200 Meg Ohm. 20 to 17dB.

OUR PRICE £17.50 P&P 20p.

KAMODEN HM720B FET VOM



Input impedence 10 Megohms. Ranges:– 0/.25/1/2.5/10/50/1000V DC. 0/2.5/10/50/250/1000V AC. 0/25uA/2.5/25/250mA DC. 0/5k/50k/500k/5 M 500 Megohms

OUR PRICE £21.00 P&P 30p

KAMODEN 72.200 Multitester

High sensitivity tester. 200,000 opv Overload protected. Mirror scale. Ranges:–0/.06/.3/3/30/120/600/1200V DC. 0/3/12/60/300/1/1200 V AC. 0/6uA/1.2mA/120mA/600mA/12A DC 0/12A AC. –20 to +63dB. 0/2k/200k/2 Meg/200 Megohms.

OUR PRICE £22.50 P&P 30p

U4317 MULTIMETER

High sensitivity instrument for field and laboratory work. Knife edge pointer, 86mm. mirror scale. Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000 V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: –5 to +10dB Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.

OUR PRICE £15.00 P&P 20p

MODEL U4311 Sub-standard Multi-range Volt-Ammeter

Sensitivity 330 Ohms/Volt AC and DC. Accuracy 0.5% DC. 1% AC. Scale length: 165mm. 0/300/750uA/1.5/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A DC. 0/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A AC. 0/75/150/300/750mV/1.5/3/7.5/15/30/75/150/300/750V DC. 0/750mV/1.5/3 /7.5/15/30/75/150/300/750V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificates.

OUR PRICE £49.00 P&P 50p

TE40 HIGH SENSITIVITY AC VOLTMETER

10 Meg input. 10 ranges: 0.001/0.03/0.1/0.3/1/3/11/30/100/300V RMS. 5cps–1.2MHz. –40 to +50dB supplied complete with leads and instructions.

OUR PRICE £17.50 P&P 25p

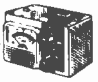
TE65 VALVE VOLTMETER

28 ranges. DC volts 1.5–1500V. AC volts 1.5–1500V. Resistance up to 1000 Megohms. 200/240V AC operation. Complete with probe and instructions.

OUR PRICE £17.50 P&P 30p

Additional probes available: RF £2.12, HV £2.50

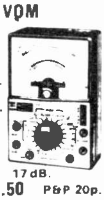
L83 TRANSISTOR TESTER



Tests ICO and B. PNP/NPN. Operates from 9V battery. Instructions supplied.

OUR PRICE £3.95 P&P 20p

MODEL AF.105 VOM



50,000 opv. Mirror scale. Meter protection. 0/3/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600/1200V DC. 0/30μA/6/60/300 mA/12 Amp. 0/10K 1m/10m/100 Meg Ohms. 20 to 17dB.

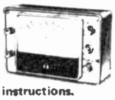
OUR PRICE £12.50 P&P 20p.

LB4 TRANSISTOR TESTER

Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.

OUR PRICE £4.50 P&P 20p

KAMODEN HMG500 insulation resistance tester



Range 0–1,000 Megohms, 500V. Battery operated. Wide range clear meter 4"x 4¾". Complete with deluxe carrying case, batteries and instructions.

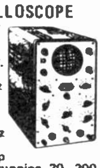
OUR PRICE £19.95 P&P 30p

S100TR MULTIMETER TRANSISTOR TESTER

100,000opv. Mirror scale. Overload protection. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600V AC. 0/12/600uA/12/300mA/6/12A DC 0/10k/1 Meg/100 Meg. –20 to +50dB. 0.01–0.2MFD Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.

OUR PRICE £15.95 P&P 25p

CI5 PULSE OSCILLOSCOPE



For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth: 10MHz. Sensitivity at 100kHz VRMS/mm: 0.1–25; HOR. AMP. Bandwidth: 500kHz. Sensitivity ay 100kHz VRMS/mm: 0.3–25 Preset triggered sweep 1–3000usec. Free running 20–200 kHz in nine ranges. Calibrator pips. 220 x 360 x 430mm. 115–230V AC.

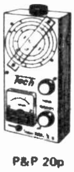
OUR PRICE £39.00 Carr. paid

RUSSIAN CI16 Double Beam OSCILLOSCOPE

5 MHz pass band. Separate Y1 and Y2 amplifiers. Rectangular 5" x 4" CRT. Calibrated triggered sweep from 0.2usec. to 100 milli-sec/cm. Free running time base. 50Hz–1MHz. Built-in time base Calibrator and amplitude Calibrator. Supplied complete with all accessories and instruction manual.

OUR PRICE £87.00 Carr. paid

MODEL TE15 GRID DIP METER



Transistorised. Operates as Grid Dip, Oscillator, Absorbtion Wave Meter and Oscillating Detector. Frequency range 440kHz–280MHz in six coils. 500uA meter. 9V battery operation. Size: 180 x 80 x 40mm.

OUR PRICE £19.95 P&P 20p

SWR METER Model SWR3

Handy SWR meter for transmitter antenna alignment, with built-in field strength meter. Accuracy 5%, Impedence 52' Indicator 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.

OUR PRICE £4.25 P&P 25p

AT201 Decade ATTENUATOR

Frequency range 0–200kHz. Attenuator 0–111dB, 0.1dB steps. Impedence 600 ohms. Input power maximum 30dBm. Size: 180 x 90 x 55mm.

OUR PRICE £12.50 P&P 37p

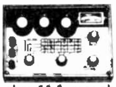
Also see following pages

ALL PRICES EXCLUDE VAT

LASKYS

Also see previous page

TRANSISTORISED L.C.R. A.C. BR/8 MEASURING BRIDGE

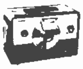


A new portable bridge offering excellent range and accuracy at low cost. Resistance 6 ranges: 0.1 ohm-11.1 megohm ± 1%. Inductance: 6 ranges: 1 microhenry-111 henries ± 2%. Capacity 6 ranges: 10pf-1110 mfd ± 2%. Turns Ratio 6 ranges: 1:1/1000-1 11100 ± 1%. Bridge Voltage at 1,000cps. Operated from 9-volt battery. 100 micro-amp meter indication. Size 7¾" x 5" x 2". OUR PRICE £25.00 P&P 25p

TE16A TRANSISTORISED SIGNAL GENERATOR

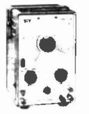
5 ranges, 400kHz to 30 MHz. An inexpensive instrument for the handy-man. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. Size: 149 x 149 x 92mm. Complete with instructions and leads.
OUR PRICE £8.97 P&P 25p

MODEL TE20 RF SIGNAL GENERATOR



Six bands. 120kHz–260MHz. Dual output RF terminals. Separate variable audio output. Accuracy ± 2%. Audio output to 8V. Power requirements: 105–125V, 220–240V AC. Size: 193 x 265 x 150mm. Complete with test leads etc.
OUR PRICE £17.50 P&P 40p

TE-200 RF SIGNAL GENERATOR



Accurate wide range signal generator covering 120 kHz-500 MHz on 6 bands. Directly calibrated. Variable R.F. attenuator audio output. Xtal socket for calibration 220/240V a c. Brand new with instructions. Size 140mm x 215mm x 170mm
OUR PRICE £17.50 P&P 30p

ARF 300 AF/RF SIGNAL GENERATOR

All transistorised compact fully portable. AF sine-wave 18Hz to 220 kHz. AF square wave 18Hz to 100k Hz. Output Square/Sine wave 10V. P-P RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads.
OUR PRICE £29.95 P&P 50p

MODEL MG100 SINE SQUARE WAVE AUDIO GENERATOR

Range 19-220,000Hz Sine Wave 19–100,000 Hz Square Wave Output Sine or Square wave 10v P to P Size 180 x 90 x 90mm Operation 220/240v. A.C.
OUR PRICE £19.95 P&P 37p

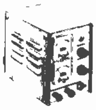
MCA220 Automatic Voltage Stabiliser

Input 88–125V AC or 176–250V AC. Output 120V AC or 240V AC. 200V/A rating. P&P 50p
OUR PRICE £11.97

PS100B Regulated POWER SUPPLY UNIT

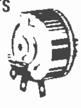
Solid state. Output 6, 9 or 12V DC up to 3 Amp. Meter to monitor current. Input 220/240V AC. Size: 100 x 82 x 159mm.
OUR PRICE £11.97 P&P 25p

PS200 Regulated POWER SUPPLY UNIT



Solid state. Variable output 5–20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size: 190 x 136 x 98mm.
OUR PRICE £19.95 P&P25p

POWER RHEOSTATS



High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range available ex-stock. Single hole fixing. ¼" diameter shafts. Bulk quantities available.

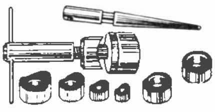
25 WATT 10/25/50/100/250/500/1000/2500 Ohms £1.15 P&P 10p
50 WATT 10/25/50/100/250/500/1000/2500/5000 Ohms. £1.62 P&P 10p
100 WATT 1/5/10/25/50/100/250/500/1000/2500 Ohms £2.34 P&P 15p

AUTO TRANSFORMERS

0/115/250V. Step up or step down. Fully shrouded.

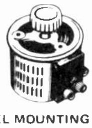
80 WATTS	£2.75	P&P 18p
150 WATTS	£3.50	P&P 18p
300 WATTS	£4.50	P&P 23p
500 WATTS	£6.95	P&P 33p
1000 WATTS	£9.50	P&P 38p
1500 WATTS	£12.50	P&P 43p
2250 WATTS	£20.95	P&P 50p
5000 WATTS	£44.95	P&P £1

CP110 CHASSIS PUNCH SET



Carefully machined top grade steel. Contains 1/2", 5/8", 3/4", 1" and 1 1/8" punches complete with gripper and accessories.
OUR PRICE £3.00 P&P 40p

YAMABISHI VARIABLE VOLTAGE TRANSFORMERS



Excellent quality at low cost. Input. 230V 50/60Hz. Output 0–260V.

MODEL S260 BENCH MOUNTING

		P&P
1A	£10.50	30p
2.5A	£12.00	35p
5A	£17.50	37p
8A	£30.35	50p
10A	£33.75	75p
12A	£29.50	75p
20A	£85.00	125p
25A	£95.00	130p
40A	£120.00	150p

MODEL S260B PANEL MOUNTING

1A	£10.00	30p
2.5A	£12.00	35p

240° Wide Angle 1mA METERS

MW 1–6 60x60mm
£6.50 P&P 15p
MW 1–8 80x80mm
£6.90 P&P 15p

BV05 Vernier TUNING DIAL

App. 7:1 ratio planetary drive vernier dial. Log scale 0–180 degrees. Blank scales 1–5. Dial size 128 x 76mm. Overall size 190 x 117 x 41mm. deep including knob and coupling. ¼" diam. shaft
OUR PRICE £1.62 P&P 15p

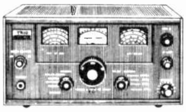
WALKIE TALKIES

SKYFON 100mW
OUR PRICE £24.95 per pair
P302 Two Channel 300mW
OUR PRICE £52.50 per pair
P1003 Three Channel 1 Watt
OUR PRICE £71.25 per pair
P&P 50p per pair
NB. Licence required for use in UK

RUH6 Reflex Horn Speaker

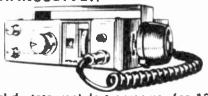
Built-in driver unit. Impedence 16 ohms. Power rating 10W. Response 380–7000Hz. Size app. 6" x 6". Weather and shock protected.
OUR PRICE £4.97 P&P 30p

TRIO 9R59DS RECEIVER



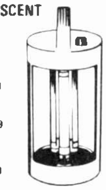
Four bands covering 550kHz to 30 MHz continuous and electrical bandspread on 10, 15, 20, 40,and 80 mtrs. 8 valve plus 7 diode circuit. 4 to 8 ohm output and phone jack. SSB–CW, ANL, variable BFO, S Meter and separate band spread dial. IF frequency 445kHz, audio output 1½ watt. Variable RF and AF gain controls. 115/250V AC, with instructions.
Our Price £42.50 CARR. PAID

BELTEK W5400 CAR TRANSCEIVER



Solid state mobile transceiver for 12 volt DC neg. Transmits and receives on any 12 of 28 channels between 144 and 146MHz. Power output 10W and 1W switchable. Controls: On/off/volume, squelch and channel selector. Internal 3" speaker. Complete with dynamic mic. PTT switch, three sets of crystals for 144.48, 144.6 and 145MHz, mounting bracket and instructions. Size: 150 x 70 x 220mm.
OUR PRICE £75.00 P&P 50p

HITACHI FLUORESCENT LANTERN L1901

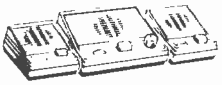


A portable battery operated lantern ideal for home, motoring, camping etc Approx 10" tall Provides brilliant light from 9 1 5v batteries (not supplied)
OUR PRICE £7 90
P&P 25p

DT55G DIGITAL CLOCK MECHANISM

Features 24 hour alarm setting, on/off and auto alarm 'sleep' switch. Illuminated rotary dial with hours, minutes and seconds. Automatically turns off radio, TV, light etc. and with auto-switching will turn on again when required. 240V AC operation. Switch rating 250V–3 Amp.
OUR PRICE £5.95 P&P 30p

KE630 3 Station INTERCOM



Master and two sub-stations. Can be used on desk or wall mounted. Complete with cable and batteries
OUR PRICE £5.25 P&P 50p

LH02S STEREO HEADPHONES

Light weight headphones with padded ear pieces. 4/16 ohms 20–20,000Hz. Complete with 6' lead and plug.
OUR PRICE £1.97 P&P 30p

TE1018 Deluxe Mono High Impedence Headset.

Sensitive magnetic headset with soft ear pads. Impedence 2,600 ohms (600 ohms DC). Frequency response: 200–4,000Hz.
OUR PRICE £2.25 P&P 30p

OH02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedence 8 ohms. 20–12,000Hz. Complete with lead and plug.
OUR PRICE £2.50 P&P 30p

TE1035 Stereo HEADPHONES

Low cost with excellent response. Foam rubber earcups. Adjustable headband. 8 ohms impedence. Frequency response 25Hz–18kHz. Complete with cable and stereo jack plug.
OUR PRICE £2.60 P&P 30p

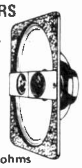
SH8DV MONO/STEREO HEADPHONES

Volume control for each channel. 4/16 ohms impedence. Frequency response 20Hz–18kHz. Complete with 10ft. coiled lead and jack plug.
OUR PRICE £4.97 P&P 30p

BH001 HEADSET and Boom Microphone

Moving coil. Ideal for language teaching, communications etc. Headphone impedence 16 ohms. Microphone impedence 200 ohms.
OUR PRICE £5.95 P&P 30p

EMI LOUDSPEAKERS



Model 350 13 x 8" with single tweeter/crossover. 20–20,000Hz. 15 watts RMS. Available 8 or 15 ohms.
OUR PRICE £7.50 each P&P 37p
Model 450 13 x 8" with twin tweeter/crossover. 55–13,000Hz. 8 watts RMS. Available 8 or 15 ohms
OUR PRICE £3.62 each P&P 25p

SPECIAL PURCHASE LIMITED QUANTITY! Tannoy 12" DR/8 Bass Speakers

8 ohms 30 watt Heavy duty ideal for Hi Fi P A Group
OUR PRICE £12 50
P&P 50p

HIGH QUALITY CONSTRUCTION KITS

JOSTY KIT

WE ARE APPOINTED STOCKISTS AT ALL BRANCHES

All kits are complete with comprehensive easy to follow instructions and covered by full guarantee.
Post and Packing 15p per kit.

AF20 Mono amplifier	£4.80
AF25 Mixer	£3.60
AF30 Mono pre-amplifier	£2.61
AF35 Emitter amplifier	£2.27
AF80 0.5W mic. amplifier	£4.22
AF305 Intercom	£9.52
AF310 Mono amplifier	£5.91
AT5 Automatic light control	£2.58
AT25 Window wiper robot	£5.82
AT30 Photo cell switch unit	£5.70
AT50 400W triac light dimmer/speed control	£4.80
AT56 2,200W triac light dimmer/speed control	£6.90
AT60 1 channel light control	£7.80
AT65 3 channel light control	£14.55
GP304 Circuit board	£4.94
GP310 Stereo pre-amplifier for use with 2 x AF310	£21.27
GP312 Circuit board	£11.45
GU330 Tremolo unit	£7.50
HF61 Diode detector	£3.32
HF65 FM transmitter	£2.70
HF75 FM receiver	£2.87
HF310 FM tuner	£15.81
HF325 Deluxe FM tuner	£24.12
HF330 Decoder (HF310/325)	£9.96
HF380 lw/vhf aerial amplifier	£4.94
HF395 broadband aerial amp.	£1.77
LF380 Quadraphonic device	£11.36
M160 Multi-vibrator	£1.71
M191 VU Meter	£4.55
M192 Stereo balance meter	£4.97
M1302 Transistor tester	£8.45
NT10 Stabilised power supply 100mA, 9V	£6.15
NT300 Stabilised p. supply	£12.51
NT305 Voltage converter	£4.50
NT315 Power supply 240V AC to4,5/15V DC, 500mA	£9.57

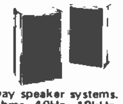
Amateur Electronics by Josty-Kit, the professional book for the amateur —covers the subject from basic principals to advanced electronic techniques. Complete with circuit board for AE1 to AE10.
OUR PRICE £3.30 (No VAT)
P&P 25p plus VAT.

AE1 100mW output stage	£1.50
AE2 Pre-amplifier	£1.15
AE3 Diode receiver	£1.82
AE4 Flasher	99p
AE5 Astable multi-vibrator	96p
AE6 Monostable multi-vibrator	93p
AE7 RC generator	97p
AE8 Bass filter	90p
AE9 Treble filter	90p
AE10 CCIR filter	90p

SPECIAL BARGAIN !! STEREOSOUND SPEAKERS

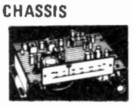
Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 368 x 229 x 190mm. 8 ohms. 8 watts RMS, 16 watts peak. Complete with Din lead.
OUR PRICE £12.95 P&P 50p

SPECIAL BARGAIN! FERGUSON 3406 HI-FI SPEAKERS



High quality 2 way speaker systems. 25 Watts. 4–8 ohms. 40Hz–18kHz. Size: 560 x 340 x 255mm. approx. Wood grain finish with black fronts.
OUR PRICE £26.95 PR. P&P £1

FM TUNER CHASSIS



6 transistor high quality tuner. Size only 153 x 101 x 63mm 3 IF stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Covers 88–108MHz. Ready built, ready for use. Fantastic value for money.
OUR PRICE £5.95 P&P 20p

Model A1018 FM TUNER

6 transistor high quality unit—3 IF stages and double tuned discriminator. For use with most amplifiers. Covers 88–108MHz. Powered by 9V battery.
OUR PRICE £13.50 P&P 30p
Stereo multiplex adapter £5 95 extra.

ALL PRICES EXCLUDE VAT

SEW CLEAR PLASTIC PANEL METERS

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

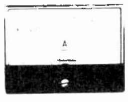
Over 200 ranges in stock—other ranges to order. Quantity discounts available. Send for fully illustrated brochure.

*Items with asterisk are Moving Iron type, all others are Moving Coil

CLEAR PLASTIC MODEL SD640
Size: 85 x 64mm

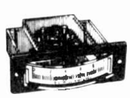
50uA	£3.80		
100uA	£3 75		
200uA	£3 70		
500uA	£3 65		
50-0-50uA	£3.75		
100-0-100uA	£3 70		
1mA	£3.65		
5mA	£3 65		
10mA	£3.65		
50mA	£3.65	10V DC	£3.65
100mA	£3.65	20V DC	£3 65
500mA	£3.65	50V DC	£3.65
1A DC	£3.65	300V DC	£3 65
5A DC	£3.65	15V AC	£3 75
10A DC	£3.65	300V AC	£3 75
5V DC	£3 65	VU Meter	£3 90

CLEAR PLASTIC MODEL SW100
Size: 100 x 80mm



50uA	£4.60		
100uA	£4.50		
500uA	£4 30		
50-0-50uA	£4 50		
100-0-100uA	£4 45		
1mA	£4 30		
1A DC	£4 30		
5A DC	£4 30		
20V DC	£4 30	150V AC	£4.45
50V DC	£4.30	300V AC	£4 45
300V DC	£4.30	VU Meter	£4 90

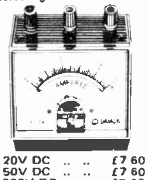
EDGWISE MODEL PE70
Size: 90 x 34mm



50uA	£4.15
100uA	£4 10
200uA	£4 05
500uA	£3 90
50-0-50uA	£4 10
100-0-100uA	£4.05
1mA	£3 85
300V AC	£3.95
VU Meter	£4 30

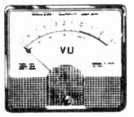
MODEL ED107 EDUCATIONAL METER
Size: 100 x 90 x 150mm including terminals

A 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.



50uA	£8 50		
100uA	£7 90		
50-0-50uA	£7 90	20V DC	£7 60
1mA	£7.60	50V DC	£7 60
1-0-1mA	£7 60	300V DC	£7 60
1A DC	£7 60	500mA/5A DC	£8 60
5A DC	£7 60	5V/50V DC	£8.60
5V DC	£7.60	5V/15V DC	£8 60
10V DC	£7 60	1/5A DC	£8.60
15V DC	£7 60	1A/15A DC	£8 60

CLEAR PLASTIC MODEL MR 85P
Size: 120 x 110mm

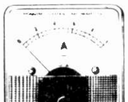


50uA	£5 45		
100uA	£5 40		
200uA	£5 35		
500uA	£5 25		
50-0-50uA	£5 40		
100-0-100uA	£5 35		
500-0-500uA	£5.20		
1mA	£5 20		
1-0-1mA	£5 20		
5mA	£5 20		
10mA	£5.20		
50mA	£5 20		
100mA	£5 20	300V DC	£5 20
500mA	£5 20	15V AC	£5 30
1A DC	£5.20	300V AC	£5 30
5A DC	£5.20	S Meter 1mA	£5 20
15A DC	£5 20	VU Meter	£5 55
30A DC	£5.40	1A AC	*£5 20
10V DC	£5.20	5A AC	*£5 20
20V DC	£5.20	10A AC	*£5 20
50V DC	£5 20	20A AC	*£5.20
150V DC	£5 20	30A AC	*£5 20

CLEAR PLASTIC MODEL SD830
Size: 110 x 83mm

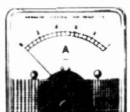
50uA	£4 30		
100uA	£4 25		
200uA	£4 20		
500uA	£4 15		
50-0-50uA	£4 25		
100 0 100uA	£4 20		
1mA	£4 10		
5mA	£4 10		
10mA	£4 10		
50mA	£4 10	10V DC	£4 10
100mA	£4 10	20V DC	£4 10
500mA	£4 10	50V DC	£4 10
1A DC	£4 10	300V DC	£4 10
5A DC	£4 10	15V AC	£4 20
10A DC	£4 10	300V AC	£4 20
5V DC	£4 10	VU Meter	£4 40

CLEAR PLASTIC MODEL MR 45P
Size: 50 x 50mm



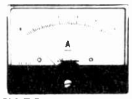
50uA	£3 20		
100uA	£3 15		
200uA	£3 10		
500uA	£3 00		
50-0-50uA	£3 15		
100-0 100uA	£3 10		
500-0-500uA	£2 95		
1mA	£2 95		
5mA	£2 95		
10mA	£2 95		
50mA	£2 95		
100mA	£2 95		
500mA	£2 95	300V AC	£3 05
1A DC	£2 95	S Meter 1mA	£2 95
5A DC	£2 95	VU Meter	£3 40
10V DC	£2 95	1A AC	*£2.95
20V DC	£2 95	5A AC	*£2 95
50V DC	£2 95	10A AC	*£2 95
300V DC	£2 95	20A AC	*£2 95
15V AC	£3 05	30A AC	*£2 95

CLEAR PLASTIC MODEL MR 38P
Size: 42 x 42mm



50uA	£3 10		
100uA	£3 05		
200uA	£3 00		
500uA	£2 85		
50-0-50uA	£3 05		
100-0 100uA	£3 00		
500-0-500uA	£2.80		
1mA	£2 80		
1-0-1mA	£2 80		
2mA	£2 80		
5mA	£2 80		
10mA	£2 80		
20mA	£2 80		
50mA	£2 80	20V DC	£2 80
100mA	£2 80	50V DC	£2 80
150mA	£2.80	100V DC	£2 80
200mA	£2 80	150V DC	£2 80
300mA	£2 80	300V DC	£2 85
500mA	£2 80	500V DC	£2 85
750mA	£2 80	750V DC	£2 90
1A DC	£2.80	15V AC	£2 90
2A DC	£2.80	50V AC	£2 90
5A DC	£2 80	150V AC	£2 90
10A DC	£2.80	300V AC	£2 90
3V DC	£2.80	500V AC	£3 00
10V DC	£2.80	S Meter 1mA	£2 80
15V DC	£2 80	VU Meter	£3 20

CLEAR PLASTIC MODEL SD460
Size: 59 x 46mm



50uA	£3 50		
100uA	£3 45		
200uA	£3 40		
500uA	£3 35		
50-0-50uA	£3 45		
100-0-100uA	£3.40		
1mA	£3 30		
5mA	£3 30		
10mA	£3 30		
50mA	£3 30	10V DC	£3 30
100mA	£3 30	20V DC	£3.30
500mA	£3.30	50V DC	£3 30
1A DC	£3 30	300V DC	£3 30
5A DC	£3 30	15V AC	£3 45
10A DC	£3 30	300V AC	£3 45
5V DC	£3 30	VU Meter	£3 65

POSTAGE & PACKING 15p

CLEAR PLASTIC MODEL MR 65P
Size: 86 x 78mm

50uA	£3 95		
100uA	£3 85		
200uA	£3 80		
500uA	£3 75		
50-0-50uA	£3 85		
100-0-100uA	£3 80		
500-0-500uA	£3 70		
1mA	£3 70		
1-0-1mA	£3.70		
5mA	£3 70		
10mA	£3 70	300V DC	£3.70
50mA	£3 70	15V AC	£3 80
100mA	£3 70	50V AC	£3.80
500mA	£3 70	150V AC	£3 80
1A DC	£3 70	300V AC	£3 90
5A DC	£3.70	500V AC	£3.80
10A DC	£3 70	S Meter 1mA	£4 10
15A DC	£3 70	VU Meter	£3 70
20A DC	£3 80	1A AC	*£3 70
30A DC	£3 85	5A AC	*£3 70
50A DC	£4 05	10A AC	*£3.70
5V DC	£3 70	20A AC	*£3 70
10V DC	£3 70	30A AC	*£3 70
15V DC	£3.70	50mA AC	*£3 70
20V DC	£3 70	100mA AC	*£3 70
50V DC	£3 70	200mA AC	*£3 70
150V DC	£3.70	500mA AC	*£3 70

BAKELITE MODEL S80 Enlarged Window
Size: 80 x 80mm

50uA	£4 50
100uA	£4 45
500uA	£4 20
50-0-50uA	£4 45
100-0-100uA	£4 40
1mA	£4.20
1A DC	£4 20
5A DC	£4 20
20V DC	£4 20
50V DC	£4 20
300V DC	£4 20
300V AC	£4.30
VU Meter	£4.70

CLEAR PLASTIC MODEL MR 52P
Size: 60 x 60mm

50uA	£3 70		
100uA	£3 50		
500uA	£3 35		
50-0-50uA	£3 50		
100-0 100uA	£3 45		
1mA	£3 30		
5mA	£3 30		
10mA	£3 30		
50mA	£3 30		
100mA	£3 30		
500mA	£3 30		
1A DC	£3 30		
5A DC	£3 30	S Meter 1mA	£3 30
10V DC	£3 30	VU Meter	£3 80
20V DC	£3 30	1A AC	*£3 30
50V DC	£3 30	5A AC	*£3 30
300V DC	£3 30	10A AC	*£3 30
15V AC	£3 40	20A AC	*£3 30
300V AC	£3 40	30A AC	*£3 30

BAKELITE MODEL MR 65 Size: 80 x 80mm

25uA	£5 25		
50uA	£4 00		
100uA	£3 95		
500uA	£3 65		
50-0-50uA	£3 95		
100-0-100uA	£3 90		
500-0-500uA	£3 60		
1mA	£3 60		
1-0-1mA	£3 60		
5mA	£3 60		
10mA	£3.60		
50mA	£3.60	300V DC	£3.60
100mA	£3 60	30V AC	*£3.60
500mA	£3 60	50V AC	*£3 60
1A DC	£3 60	150V AC	*£3 60
2A DC	£3 60	300V AC	*£3 60
5A DC	£3 60	500V AC	*£3.60
10A DC	£3.60	VU Meter	£4 10
15A DC	£3 60	1A AC	*£3 60
30A DC	£3.60	5A AC	*£3 60
50A DC	£3 80	10A AC	*£3 60
5V DC	£3 60	20A AC	*£3 60
10V DC	£3.60	30A AC	*£3 60
15V DC	£3.60	50A AC	*£3 60
20V DC	£3 60	500mA AC	*£3 60
50V DC	£3 60	50mV DC	£3.75
150V DC	£3 60	100mV DC	£3 75

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PZ6 Power Supply	£7.98
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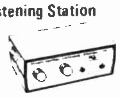
1021 Stereo Listening Station



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TYPE	5	10	25
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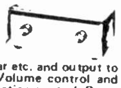

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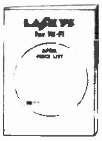

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2G306	0·30	2N3402	0·18	40050	0·78	BC107	0·16	BCY89	0·97	BFY19	0·35
2G309	0·30	2N3403	0·19	40251	0·81	BC108	0·15	BCZ10	0·35	BFY20	0·50
2G345B	0·25	2N3404	0·24	40309	0·30	BC109	0·19	BCZ11	0·50	BFY29	0·40
2G371	0·15	2N3405	0·27	40310	0·50	BC113	0·13	BD115	0·75	BFY37	0·20
2G374	0·15	2N3414	0·10	40313	0·92	BC114	0·12	BD116	0·75	BFY41	0·43
2N174	1·40	2N3415	0·10	40316	0·50	BC115	0·15	BD121	0·75	BFY43	0·65
2N404	0·43	2N3416	0·15	40318	0·92	BC116	0·15	BD123	0·82	BFY50	0·22½
2N456	0·75	2N3417	0·21	40360	0·46	BC116A	0·18	BD124	0·67	BFY51	0·18½
2N456A	0·75	2N3570	1·25	40361	0·48	BC117	0·21	BD131	0·40	BFY52	0·20½
2N457A	0·80	2N3571	1·12½	40362	0·50	BC118	0·11	BD132	0·50	BFY53	0·16
2N491	3·58	2N3572	0·97	40363	0·61	BC119	0·29	BD135	0·43	BFY56	0·34
2N696	0·15	2N3702	0·11	40389	0·46	BC121	0·23	BD136	0·49	BFY64	0·41½
2N697	0·15	2N3703	0·12	40394	0·56	BC125	0·15	BD137	0·55	BFY75	0·40
2N698	0·25	2N3704	0·14	40395	0·65	BC126	0·20	BD138	0·63	BFY76	0·22
2N699	0·29	2N3705	0·12	40406	0·44	BC132	0·30	BD139	0·71	BFY77	0·24
2N706	0·16	2N3706	0·09	40407	0·33	BC134	0·11	BD140	0·87	BFY78	0·36
2N706A	0·18	2N3707	0·13	40408	0·50	BC135	0·11	BDY10	1·25	BFY90	0·60
2N708	0·14½	2N3708	0·70	40409	0·52	BC136	0·15	BDY11	1·50	BRY39	0·28
2N709	0·38	2N3709	0·11	40410	0·52	BC137	0·15	BDY17	1·50	BSX19	0·13
2N711	0·30	2N3710	0·12	40411	2·25	BC138	0·24	BDY18	1·75	BSX20	0·20½
2N718	0·21	2N3711	0·11	40414	3·55	BC140	0·34	BDY19	1·97	BSX21	0·20½
2N718A	0·49	2N3712	0·96	40467	0·69	BC141	0·29	BDY20	1·05	BSX26	0·49
2N720	0·50	2N3713	1·20	40468A	0·44	BC142	0·23½	BDY38	0·65	BSX27	0·34
2N721	0·55	2N3714	1·38	40600	0·69	BC143	0·21	BDY60	0·85	BSX28	0·25
2N914	0·22	2N3715	1·50	40601	0·67	BC144	0·24	BDY61	1·25	BSX29	0·47
2N916	0·41	2N3716	1·80	40602	0·46	BC145	0·21	BDY62	1·00	BSX60	0·54
2N918	0·47	2N3773	2·65	40603	0·58	BC147	0·12	BF115	0·25	BSX61	0·42
2N929	0·30	2N3779	3·15	40604	0·56	BC148	0·13	BF116	0·23	BSX76	0·15
2N930	0·48	2N3790	2·40	40636	1·10	BC149	0·12	BF117	0·43	BSX77	0·20
2N1090	0·30	2N3791	2·35	40673	0·70	BC153	0·18	BF119	0·58	BSX78	0·25
2N1091	0·32	2N3792	2·69	AC107	0·25	BC154	0·18	BF121	0·25	BSW70	0·28
2N1132	0·54	2N3794	0·10	AC113	0·16	BC157	0·14	BF123	0·27	BSY24	0·20
2N1302	0·18½	2N3819	0·37	AC117	0·20	BC158	0·13	BF125	0·25	BSY25	0·20
2N1303	0·18½	2N3820	0·38	AC121	0·13	BC159	0·14	BF152	0·20	BSY26	0·20
2N1304	0·24	2N3823	1·42	AC126	0·25	BC160	0·37	BF153	0·21	BSY27	0·15
2N1305	0·24	2N3824	1·33	AC127	0·25	BC167B	0·13	BF154	0·16	BSY28	0·15
2N1306	0·31	2N3826	0·23	AC128	0·25	BC168B	0·13	BF158	0·23	BSY38	0·19½
2N1307	0·22	2N3854	0·18	AC141K	0·30	BC168C	0·11	BF159	0·27	BSY39	0·19½
2N1308	0·25	2N3854A	0·16	AC142K	0·25	BC169B	0·13	BF160	0·23	BSY51	0·25
2N1309	0·35½	2N3855	0·19	AC151V	0·14	BC169C	0·13	BF161	0·41½	BSY52	0·25
2N1483	0·90	2N3855A	0·20	AC152V	0·17	BC170	0·11	BF163	0·31½	BSY53	0·25
2N1507	0·30	2N3856	0·19	AC153	0·25	BC171	0·13	BF166	0·31½	BSY54	0·30
2N1613	0·33	2N3856A	0·20	AC153K	0·25	BC172	0·11	BF167	0·21	BSY56	0·79
2N1631	0·38	2N3858	0·16	AC154	0·20	BC182	0·12	BF173	0·24	BSY65	0·15
2N1637	0·36	2N3858A	0·19	AC176	0·18	BC182L	0·12	BF177	0·29	BSY78	0·40
2N1638	0·32	2N3859	0·14	AC176K	0·25	BC183	0·09	BF178	0·35	BSY79	0·40
2N1701	1·19	2N3859A	0·19	AC187K	0·28	BC183L	0·09	BF179	0·43	BSY790	0·45
2N1702	2·15	2N3860	0·19	AC188K	0·34	BC184	0·11	BF180	0·35	BSY95A	0·10½
2N1711	0·45	2N3866	1·09	ACY17	0·35½	BC184L	0·11	BF181	0·34	BU104	1·42
2N1893	0·81	2N3877	0·25	ACY18	0·24	BC186	0·25	BF182	0·40	BU105	2·25
2N2102	0·30	2N3877A	0·26	ACY19	0·27	BC187	0·27½	BF183	0·40	C111	0·53
2N2147	0·70	2N3900	0·21	ACY20	0·22	BC207	0·12	BF184	0·30	D40N3	0·55
2N2148	0·94	2N3900A	0·21	ACY21	0·26	BC208	0·11	BF185	0·17	GET111	0·45
2N2192	0·40	2N3901	0·32	ACY22	0·17	BC212K	0·10	BF194	0·16	GET113	0·25
2N2192A	0·40	2N3903	0·24	ACY28	0·20	BC212L	0·16	BF195	0·17	GET114	0·20
2N2913	0·40	2N3904	0·27	ACY30	0·42	BC214L	0·21	BF196	0·15	GET115	0·50
2N2193A	0·61	2N3905	0·24	ACY39	0·65½	BC237	0·09	BF197	0·15	GET119	0·35
2N2194	0·73	2N3906	0·27	ACY40	0·17	BC238	0·09	BF198	0·18	GET120	0·40
2N2194A	0·30	2N4036	0·62½	ACY41	0·17	BC239	0·09	BF199	0·18	GET535	0·20
2N2218A	0·86	2N4037	0·42	ACY44	0·31	BC251	0·20	BF200	0·40	GET536	0·20
2N2219	0·57	2N4058	0·16	AD136V	0·96	BC252	0·18	BF224J	0·14	GET538	0·20
2N2219A	0·86	2N4059	0·09	AD142	0·50	BC253	0·23	BF225J	0·19	GET873	0·12
2N2220	0·45	2N4060	0·11	AD143	0·45	BC257	0·09	BF237	0·22	GET875	0·15
2N2221	0·41	2N4061	0·11	AD149V	0·66	BC258	0·09	BF238	0·22	GET880	0·35
2N2221A	0·83	2N4062	0·11	AD150	0·63	BC259	0·13	BF244	0·16	GET883	0·20
2N2222	0·60	2N4302	0·25	AD161	0·45	BC261	0·20	BF245	0·33	GET887	0·20
2N2222A	0·91	2N4303	0·47	AD162	0·45	BC262	0·18	BF246	0·43	GET890	0·25
2N2368	0·31	2N4916	0·11	AD161 }	Pr.	BC263	0·23	BF247	0·49	GET895	0·25
2N2369	0·37	2N4917	0·17	AD162 }	1·05	BC300	2·12	BF254	0·16	TIP29A	0·49
2N2369A	0·41	2N4918	0·73	AF109R	0·40	BC301	0·34	BF255	0·17	TIP30A	0·58
2N2646	0·77	2N4919	0·84	AF114	0·25	BC302	0·29	BF257	0·47	TIP31A	0·62
2N2647	1·12	2N4920	0·99	AF115	0·24	BC303	0·54	BF258	0·59	TIP32A	0·74
2N2711	0·13	2N4921	0·73	AF116	0·25	BC307	0·10	BF259	0·55	TIP33A	1·01
2N2712	0·12	2N4922	0·84	AF117	0·20	BC307A	0·10	BF270	0·21	TIP34A	1·51
2N2713	0·17	2N4923	0·83	AF118	0·50	BC308	0·09	BF272	0·53	TIP35A	2·90
2N2714	0·18	2N5172	0·12	AF121	0·22	BC308A	0·12	BF273	0·15	TIP36A	3·70
2N2904	0·55	2N5174	0·22	AF124	0·24	BC308B	0·09	BF274	0·17	TIP41A	0·79
2N2904A	0·70	2N5175	0·26	AF125	0·20	BC309	0·10	BF457	0·53	TIP42A	0·90
2N2905	0·71	2N5176	0·32	AF126	0·19	BC309A	0·10	BF458	0·65	TIP2955	0·98
2N2905A	0·88	2N5190	0·92	AF127	0·20	BC309B	0·10	BF821A	2·30	TIP3055	0·60
2N2906	0·65	2N5191	0·95	AF139	0·38	BC327	0·21	BF828	0·92	ME0401	0·18
2N2906A	0·70	2N5192	1·24	AF170	0·25	BC328	0·19	BF861	0·27	ME0402	0·20
2N2907	0·38	2N5195	1·46	AF172	0·25	BC337	0·19	BF898	0·20	ME0404	0·13
2N2907A	0·41	2N5245	0·43	AF178	0·55	BC338	0·19	BFW11	0·61	ME0411	0·17
2N2923	0·12	2N5457	0·49	AF179	0·65	BCY30	0·43	BFX13	0·23	ME0412	0·18
2N2924	0·14	2N5458	0·45	AF180	0·50	BCY31	0·51½	BFX29	0·30	ME0413	0·14
2N2925	0·17	2N5459	0·49	AF186	0·40	BCY32	1·15	BFX30	0·25	ME1120	0·25
2N2926		3N128	0·73	AF200	0·35	BCY33	0·34	BFX37	0·33	ME4001	0·09
Green	0·12	3N138	1·65	AF239	0·51	BCY34	0·36½	BFX44	0·33	ME4002	0·11
Yellow	0·11	3N139	1·42	AF240	0·72	BCY38	0·52½	BFX63	2·48	ME4003	0·14
Orange		3N140	0·92	AF279	0·54	BCY39	1·05	BFX68	0·30	ME6101	0·10
	0·11	3N141	0·81	AF280	0·54	BCY40	0·87	BFX84	0·24	ME4102	0·11
2N3053	0·32	3N142	0·58	AFY42	0·74	BCY42	0·15	BFX85	0·30	ME4103	0·10
2N3054	0·86	3N143	0·75	AL102	0·75	BCY43	0·15	BFX86	0·25½	ME4104	0·11
2N3055	0·75	3N152	0·92	AL103	0·70	BCY58	0·21	BFX87	0·28	ME4101	0·14
2N3390	0·26	3N153	0·81	ASY26	0·30	BCY59	0·22	BFX88	0·25	ME6102	0·16
2N3391	0·28	3N154	0·84	ASY27	0·36	BCY70	0·17	BFX89	0·45	ME8002	0·17
2N3391A	0·29	3N159	1·17	ASY28	0·28	BCY71	0·22	BFY10	0·35	ME8003	0·16

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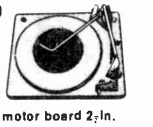

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SILVER MICA. Close tolerance 1%. 2·2–500pF 8p; 560–2,200pF 10p; 2,700–5,600 pF 20p; 6,800pF–0·01, mfd 30p each.
TWIN GANG, "0–0" 208pF + 176pF, 65p; 500pF standard 45p. 365pF + 365pF with 25pF + 25pF, Slow motion drive 50p.
SHORT WAVE SINGLE. 10pF, 30p, 25pF, 55p, 50pF, 55p.
NEON PANEL INDICATORS 250V AC/DC. Amber 20p.
RESISTORS. ¼W, ½W, 1W, 20% 1p; 2W, 5p. 10Ω to 10M.
HIGH STABILITY. ½W 2% 10 ohms to 6 meg., 10p.
Ditto 5%. Preferred values 10 ohms to 10 meg., 4p.
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt, 10 ohms to 100K 10p each; 0·5 ohm to 8·2 ohms 10p.
TAPE OSCILLATOR COIL Valve type 35p.

NEW MODEL "BAKER LOUDSPEAKER", 12IN 50 WATT. GROUP 50/12. 8 OR 15 OHM HIGH POWER. FULL RANGE PROFESSIONAL QUALITY. £17·60

BAKER MAJOR 12" £9·90

Post free

30–14,500 c/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/s. Rated 20W. NOTE: 3 or 8 or 15 ohms must be stated.

Module kit, 30-17,000 c/s with tweeter, crossover, baffle and instructions. £12·50
Please state 3 or 8 or 15 ohms. Post free

BAKER "BIG-SOUND" SPEAKERS Post free

'Group 25'	'Group 35'	'Group 50'
12in. 25W £8·80	12in. 35W £9·90	15in. 50W £22
3 or 8 or 15 ohm	3 or 8 or 15 ohm	8 or 15 ohm

TEAK VENEERED HI-FI SPEAKER & CABINETS

For 12in or 10in dia. speaker	20 × 13 × 9in. £10·00.	Post 50p
For 13 × 8in or 8 in speaker	16 × 10 × 9in. £6·60.	Post 35p
For 8 × 5in speaker	16 × 8 × 6in. £5·00.	Post 25p
For 6in and Tweeter	12 × 8 × 6in. £4·00.	Post 25p

LOUDSPEAKER CABINET WADDING 18in wide, 15p ft.

GOODMANS 6½in. HI-FI WOOFER

8 ohm. 10W. Large ceramic magnet. Special Cambric cone surround. Frequency response. 30–12,000 c/s. Ideal P.A. Columns. Hi-Fi Enclosure Systems, etc. £4
Suitable Cabinet 12 × 8 × 6 £4 Suitable Tweeter £2

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 c/s to 18,000 c/s. Size 3¼ × 3¼ × 2in deep. Rating 10W. 3 ohm. Crossover £1·25 £1·90 Post 20p.

SPEAKER COVERING MATERIALS. Samples Large S.A.E.
Horn Tweeters 2-16kc/s. 10W 8 ohm or 15 ohm £2·25.
De Luxe Horn Tweeters 2-18kc/s, 15W, £3·50.
CROSSOVERS, TWO-WAY 3,000 c/s 3 or 8 or 15 ohm £1·25.
LOUDSPEAKERS P.M. 3 OHMS. 7 × 4in., £1·25; 6½in., £1·50; 8 × 5in, £1·60; 10in, £2·00; 8in, £1·75; 10 × 6in, £1·90.
SPECIAL OFFER! 80 ohm, 2½in, 2¾in; 35 ohm, 2in, 3in, 25 ohm, 2½in dia., 3in dia., 5in dia.
15 ohm, 3½in dia, 6 × 4in, 7 × 4in, 8 × 5in.
3 ohm, 2½in, 2¾in, 3½in, 5in dia. (6 × 4in 8 ohms £1·50.)
RICHARD ALLAN TWIN CONE LOUDSPEAKERS.
8in diameter 4W £2·50. 10in diameter 5W £2·50;
12in diameter 6W £2·95. 3/8/15 ohms, please state.
VALVE OUTPUT TRANS. 40p; MIKE TRANS. 50:1 40p.
Mike trans. mu metal 100:1 £1·25.

MAJOR 100 WATT ALL PURPOSE GROUP AMPLIFIER

All purpose transistorised. Ideal for Groups, Disco and P.A. 4 inputs speech and music. 4 way mixing. Output 8/15 ohm. a.c. Mains. Separate treble and bass controls. Guaranteed. Details SAE. £49 Carr. £1·00
PROFESSIONAL VALVE MODEL, 100W, callers only, £69.

BARGAIN AM TUNER. Medium Wave. Transistor Superhet, Ferrite aerial. 9 volt. £4·95

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. 9V. £4·50
TWO CHANNEL STEREO VERSION £5·95

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built, with volume. Treble and bass controls. 18 volt d.c. £4·50

COAXIAL PLUG 10p. PANEL SOCKETS 10p. LINE 18p.
OUTLET BOXES, SURFACE 25p. FLUSH 60p. TWIN 85p.
BALANCED TWIN RIBBON FEEDER 300 ohms. 5p yd.
JACK SOCKET Std. open-circuit 14p, closed circuit 23p;
Chrome Lead-Socket 45p. Phono Plugs 5p. Phono Socket 5p.
JACK PLUGS Std. Chrome 20p; 3·5mm Chrome 12p. DIN SOCKETS Chassis 3-pin 10p. 5-pin 10p. DIN SOCKETS lead 3-pin 18p; 5-pin 15p. DIN PLUGS 3-pin 18p; 5-pin 25p.
VALVE HOLDERS, 5p; CERAMICS 10p; CANS 5p.

REVERSIBLE 4 POLE MOTOR

1,400 r.p.m. Reversible 42 Watt, spindle 1½" × 5/16", size 3½" × 3", As illustrated. With Cooling Fan. a.c. 240V. £2·20 Post 25p

E.M.I. GRAM. MOTOR.

120V or 240V a.c. 2,400 r.p.m. 2 pole 70mA. Size 2¼ × 2¼ × 2½in. £1 Post 25p.

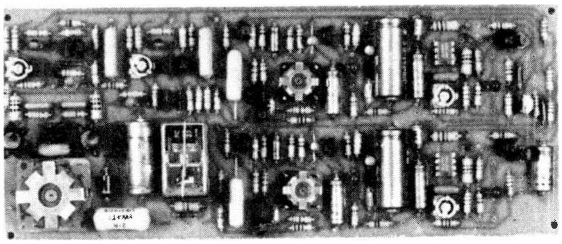
SPECIAL OFFER

100 ohm 20W Rheostat 2½in diam. Ceramic Former, screw terminals, ¼in diam. spindle. 95p, post 25p.

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, CROYDON
Open 9–6, Wed. 9–1, Sat. 9–5 (Closed for lunch 1.15–2.30)
Buses 50, 68, 159. Rail Selhurst. Tel. 01-684 1665

Radio Books and Component Lists 10p. (Minimum posting charge 20p.)



PHONOSONICS
PCB's AND KITS

HI-FI TAPE LINK
(PE Mar./Apr. 73) S/c's. i.c's. Rs. Cs. Relay and pc-base. Pot Cores and pc-bases Sw s. Pots. Panel Lamp—Mono. £12·78; Stereo. £20·41. PSU. £3·58. Main Circuit PCB (3¼in × 9in) Stereo (also holds relay and cores). £2·10. Sub-assembly PCB (2¼in × 6¼in). Stereo 80p.

BIOLOGICAL AMPLIFIER
(PE Jan./Feb. 73). P/A Set—S/c's. i.c s. Rs. Cs. Pots. PCB. £3·46. Output Stages—S/c's. Rs. Cs. Pots. Rotary Sw's and PCBs for Alphaphone, Cardio, Freq-Meter, Vis-Feed. £4·96. Audio Amps PC7. £5·20; EA1000. £3·30.

ENLARGER EXPOSURE METER AND THERMOMETER
(PE Sept. 73). S/c's. Thermistor. LDR Rs. Pots. PCB. £3·90.

ELECTRONIC PIANO
(PE Sept 72/Jan 73) Details in lists.

GEMINI STEREO AMPLIFIER
(PE Nov 70/Mar 71) Stereo Sets and PCBs Pre-amp—Rs. Cs. Pots. Sw s—with ½W MO Rs £14·18—with ½W CF Rs. £10·40. PCB as published. £2·20. Main Amp—Rs. Cs. Pots. £5·88. PCB (3¼in × 5in). £1·28. Power supply—Rs. Cs. Pot. £4·56. PCB (2in × 4in). 65p.

AUDIO MILLIVOLTMETER
(PE Feb 74) S/c's. Rs. Cs. Pots. Sw s. PCBs. £4·95.

MICROPHONE MIXER
(PE Apr 69) S/c's. Rs. Cs. Pots. PCB (also holds pots). £4·12. While Stocks Last

8 WATT AMPLIFIER
(PW Nov./Dec. 72) Pre-amp—S/c s. Rs. Cs. Pots. Sw—Mono. £2·50; Stereo. £6·03. PCB (3¼in × 7¼in) (Stereo) also holds rotary or slider pots. and Sw. £1·66. Main Amp—S/c's. Rs. Cs. Pot—Mono. £4·18. Stereo. £8·36. PCB (2¼in × 3in) (Mono). 60p. PSU. £3·90.

SOUND SYNTHESISER
(PE Feb. 73/Feb. 74)
RHYTHM GENERATOR
(PE Mar./June 74)
SOUND BENDER
(PE May 74)
Details of all these in List

REVERBERATION UNIT
(PW Nov./Dec. 72) S/c s. Rs. Cs. T/former—with Rotary Pots. £6·44—with Slider Pots. £7·28. PCB (2in × 11½in) also holds sliders. £1·20. 9in Spring Unit. £4·50.

LOUDHAILER AND SIREN
(PW Dec. 72) Pre-amp and Siren Generator—S/c's. Rs. Cs. Pot. PCB (2¼in × 2¼in). £2·20. While Stocks Last Main Amp Module PC5. £6·25.

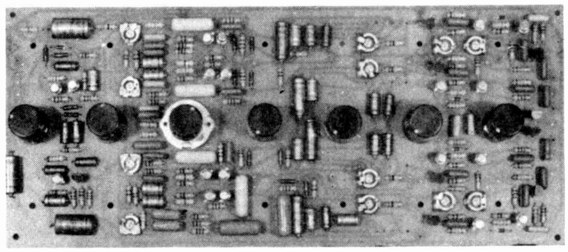
MISCELLANEOUS PCBs (While Stocks Last)
LOGICAL RADIO CONTROL (PE Dec 71/Jan. 72) PCBs '2A', '2B'. Decoder 50p each
MODEL SERVO CONTROL (PE Feb./Mar 72) PCBs 'B', Fail-safe. 33p each
DIGICAL PSU PCB (PE Aug. 72). 50p. OSCILLOSCOPE P/A PCB (PE Aug 72). 33p.
GEMINI STEREO TUNER PCB (PE Apr 72). £1·50. TRIFFID PCB (PE Feb. 73). 60p.
(The above PCBs are as published)
DIGITRONIC (PW Mar 73) Read-out PCB (1½in × 3½in). 50p. CALLERCORD (PE Jul. 72) Main Control PCB (4in × 7¼in)

PHOTOPRINT PROCESS CONTROL
(PE Jan./Feb 72) For Colour and B & W—finds exposure, controls timing, stabilises mains voltage. S/c's. SCR LDR Rs. Cs. Pots. Relay. Keyswitch. T/fmr. £7·98. PCB (3¼in × 5¼in) also holds pots. Sw. relay. £1·60.

PROJECT Q4
(PW Oct 73/Jan 74) Multisystem Quadraphonic Decoder S/c s. I/c s. Rs. Cs. Pots. Makeswitches. £12 48 PSU. £3·17. Set of PCBs. £2·60.

RONDO
(PE Sept 73/Feb. 74) Details in List

PHASING UNIT
(PE Sept 73) S/c's. Rs. Cs. Pots. PCB (1¼in × 2¼in). £2·20.



AURORA
(PE Apr./Aug 71) Multichannel Sound Controlled Light S/c's (Excl SCRs). Rs. Cs. Pots. Cores—Pre-amp. Sync Generator and 4 Chans. £10·97; 4 extra chans.. £8·35. Reg PSU. £3·95. PCB (4¼in × 10¼in) for Pre-amp and 4 Chans (also holds pots). £2·50. PCB (4¼in × 5in) for Sync Gen. PSU. 8 cores. 8 SCRs. £1·30.

AURORA AUXILIARY CONTROL UNIT
2 Variable Frequency Strobe Generators and 4 Variable Amplitude Frequency Generators S/c's. Rs. Cs. Pots. PCB (3¼in × 5¼in). £4·87.

SEMICONDUCTOR TESTER
(PE Oct 73). S/c's. Rs. Cs. Pots. Makaswitches. Sub-assembly PCB. £5·30.

TAPE NOISE LIMITER
(PE Feb 72). S/c's. Rs. Cs. Pot. Sw. PCB (1¼in × 3in). £2·30. Reg PSU and PCB (1¼in × 2¼in). £3·40.

ULTRASONIC TRANSMITTER-RECEIVER
(PE May 72) S/c's. Rs. Cs. Pot. Relay. Dual PCB (2in × 5¼in). £4·40. Transducers excluded

VERSATILE LIGHT EFFECTS UNIT
Single Channel Sound Controlled Light with built-in variable strobe (PE Jun 72). S/c s. Rs. Cs. Pots. T/fmrs. Keyswitch. £11·28. PCB (3¼in × 7¼in) also holds pots and switch. £1·70. SCRs excluded

VIBRASONIC GUITAR PRE-AMP
(PW Sept. 70). Incl. Mic P/A. 2-Guitar P/A. Trem and Tone Controls. Master Volume. S/c's. Rs. Cs. LDR. Rotary Pots. Lamps. Coupling T/fmr. £7·64. PCB (3¼in × 10¼in) also holds pots. £1·92. Power Supply. £3·90.

VOICE OPERATED FADER
(PE Dec 73) S/c's. Rs. Cs. Pot. PCB (1¼in × 3¼in). £2·95.

WIND AND RAIN EFFECTS
(PE Oct. 73). S/c's (incl special noise diode). Rs. Cs. Pots. £1·95.

RESISTORS
¼W and ½W
CARBON FILM
MANUFACTURED BY
AEI TO DEF 6112A
E24 SERIES
¼W 5% 4E7 to 1M
½W 5% 4E7
to 2M2 then 10% to
10M
COMPREHENSIVE
STOCKS
FACILITATE RAPID
PROCESSING
AS APPOINTED
DISTRIBUTORS
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SEMICONDUCTORS

AC128	20p	2N2905	27p
AC176	20p	2N2907	22p
AD161	40p	2N3702	12p
BC107	13p	2N3703	12p
BC108	13p	2N3704	12p
BC109	13p	2N3819	35p
BC147	12p	2N3823E	39p
BC148	12p	2N4871	36p
BC149	12p		
BC157	12p		
BC158	12p		
BC159	12p		
BC182L	12p		
BC204	14p		
BC209c	14p		
BC212L	15p		
BCY71	22p		
BFY50	22p		
BFY52	23p		
BSY95A	12p		
MJE2955	110p		
MJE3055	75p		
NKT0033	112p		
OC28	65p		
OC71	14p		
OC84	25p		
ORP12	55p		
TIS43	30p		
2N706	13p		
2N914	22p		
2N1304	22p		
2N2219	27p		

DIODES

1N916	4p
1N4001	6p
1N4002	7p
1N4004	8p
1N4005	8p
BA145	23p
OA91	7p
OA200	8p
1GP7	12p
1SJ50	11p

INTEGRATED CIRCUITS

709 TO5	40p	7447	175p
723 TO5	95p	7473	44p
741 8P DIL	40p	7489	432p
747 14P DIL	115p	7815 TO220	220p
748 TO5	63p	CA3046	69p
7400	20p	PA263	168p
7402	20p	SG3402N	169p
7420	20p		

ELECTROLYTIC (µF/V)

0 47 63	6p	100 10	6p
1 0 63	6p	100 25	6p
2 2 63	6p	100 40	7p
4 7 35	6p	100 63	12p
4 7 63	6p	150 16	6p
6 8 40	6p	150 63	12p
10 25	6p	220 10	6p
10 63	6p	220 16	6p
15 40	6p	220 25	10p
22 10	6p	220 40	14p
22 25	6p	220 63	21p
33 6 3	6p	330 10	8p
33 16	6p	470 6 3	6p
33 40	6p	470 10	10p
33 50	6p	470 25	14p
47 25	6p	470 40	20p
47 40	6p	500 64	46p
47 63	7p	680 6 3	10p
50 6 4	6p	680 25	20p
		680 40	25p
		1000 10	14p
		1000 16	25p
		1000 25	25p
		1000 40	40p
		2200 25	45p
		2200 40	50p
		2800 100	350p
		3300/63	133p
		3300 100	350p
		4700 16	60p
		4700 25	75p
		4700 40	93p

POLYESTER (µF)

0 01	3p
0 015	3p
0 022	3p
0 033	3½p
0 047	3½p
0 068	3½p
0 1	4p
0 15	5p
0 22	5p
0 33	7p
0 47	9p
0 68	11p
1 0	14p

TANTALUM BEAD (µF/V)

0 1 35	12p
0 22 35	12p
0 47 35	12p
1 0 35	12p
1 5 35	16p
2 2 35	12p
4 7 35	12p
10 16	12p
10 25	16p
15 6 3	16p
22 16	16p
47 6 3	16p
100 3	16p

ADD 15p P. & P.
ADD 10% VAT to total cost (including P & P)
SEND S A E (Stamped Addressed Envelope) for Free Itemised List (and with all enquiries please)
OVERSEAS COSTS P &P will be charged at cost (most kit weights and postal rates are shown in list) Send International Reply Coupon for Free List & with all enquiries
VAT does not apply to exports. EXPORT ORDERS ARE ALWAYS WELCOME
MAILING LIST SERVICE—details with list
COLOUR CODE identification supplied with most kits and as part of list
PCBs are Fibreglass. Drilled. Tinned. and designed by Phonosonics unless stated 'as published'
PCB Layout and Circuit Diagram supplied free with Phonosonics-designed PCBs
POTS are rotary unless stated as slider.
PRICES correct at time of press E & OE
DELIVERIES subject to availability

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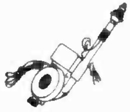
WITH A MOTOR DRIVEN CAR AERIAL
Spec.: 5 Section
Extended Length 100cm
Length under Fender 40cm
Cable Length 120cm
Supplied complete with Fixing Bracket and Control Switch **£6·75** plus 25p P. & P.



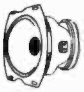
"CRESCENT BEAT BRITE" SINGLE CHANNEL SOUND TO LIGHT UNIT
This fantastic little box approx. 4" × 3" × 2½" when connected to the output of a sound source from 1 to 100 watts produces a psychedelic light display of up to 1000 watts. Complete with a sensitive level control the unit is fused and cannot harm your amplifier.
A Bargain at £7·50 plus 10p.

"CRESCENT" BUBBLE LIGHT SHOW

A new and exciting feature for the professional disc jockey or to give the private party an electric atmosphere, a projected kaleidoscope of colour.
Specification Projector: 100W, convection cooled, at 30ft the projected image = 16ft; Motor: 1 rev per 2 min. Liquid Wheel: 6in diameter multicolour.
The Motor is fitted to the Projector and can only be purchased as a single unit. The Liquid Wheel, however, is our very popular standard model & may be purchased separately. A bargain—Projector with Motor ready for instant use, £15; 6in Liquid Wheel, £5 = £20 + 75p carr.

TRI-VOLT BATTERY ELIMINATOR
Enables you to work your Transistor Radio, Amplifier or Cassette, etc., from the a.c. mains through this compact Eliminator. Just by moving a plug you can select the voltage you require. 6, 7½ or 9 volt. This means all your transistor power pack applications can be handled by this one unit. Approx. size 2¾in × 2¼in × 3¼in. Our Price £2·75 plus 10p P. & P. Same model suitably wired for the Philips Cassette £3 plus 10p P. & P.

7in × 4in LOUDSPEAKER



A top quality speaker ideal where small size is important. Manufactured by E.M.I. for a well-known hi-fi set maker. Size: 7in × 4in. Impedance: 8 ohms. Flux: 38,000. Max. Free range: 90Hz to 12kHz. Power handling: 5W. Unbeatable. Price: £1·60. Free postage on this item.

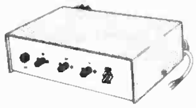
AMTRON KITS

UK65	Transistor Tester	£1·66
UK92	Telephone Amp	£8·26
UK115	Hi-Fi Amp—8W	£4·50
UK130	Mono Control Unit	£4·15
UK145	Amp—1·5W	£3·81
UK165	RIAA Equalised Stereo Amp	£5·30
UK195	Mini-Amp—2W	£3·66
UK220	Signal Injector	£2·65
UK230	AM-FM Aer. Amp	£3·29
UK275	Mike Pre-Amp	£6·98
UK300	4 Channel Radio Control T.X.	£6·61
UK310	Radio Control Receiver	£3·29
UK515	MW Radio Receiver	£7·92
UK520	AM Tuner	£4·60
UK710	4 Channel A.F. Mixer	£12·59
UK715	Photoelectric Cell Switch	£8·97
UK835	Guitar Pre-Amp	£4·98
UK875	Cap. Discharge Ignition	£13·19
UK915	R.F. Amp 12-170MHz	£2·66
UK935	Wide Band Amp 20Hz to 150MHz	£2·66

TRI-VOLT CAR SUPPLY
Enables you to work your Transistor Radio, Amplifier or Cassette, etc. from the 12 volt car supply. Positive or negative earth. Approx. size = 2in × 3¼in × 1¼in. This converter supplies 6, 7½ or 9 volts and is transistor regulated. A real money saving device for £2·50. 10p P. & P.

"C.300" DISCO CONTROL PACK
A control Unit which when connected to twin decks makes a disco of professional quality. We supply a smart front panel which incorporates controls, switch and input sockets. The control module, I.C. construction incorporating mixing, pre-amp and headphone listening amplifier. The power pack enables this unit to work from the standard mains. * Inputs include Mic., Tape/Cassette and Twin Decks. * Controls include Mic., Tape, Each Deck, Mono. £14. Stereo, £17 plus 20p carr.

3 KILOWATTS PSYCHEDELIC LIGHT CONTROL UNIT



Three Channel: Bass—Middle—Treble. Each channel has its own sensitivity control. Just connect the input of this unit to the loudspeaker terminals of an amplifier, and connect three 250V up to 1000W lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed)
£18·50 plus 38p P. & P.

LOW VOLTAGE AMPLIFIER

5 transistor amplifier complete with volume control, is suitable for 9V d.c. and a.c. supplies. Will give about 1W at 8 ohm output.
With high IMP input this amplifier will work as a record player, baby alarm, etc., amplifier.
£1·75 plus 13p P. & P.

200/250V MAINS RELAY

Heavy duty contacts. 2,500Ω coil. All new and unused D.P.D.T. mains relays 50p + V.A.T. Carr. Free. Special quantity price: £40 per 100 relays.

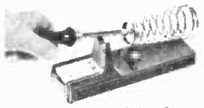
MINI LOUDSPEAKERS

2¼in 80 ohm, 50p; 2¼in 40 ohm, 50p. Please include 5p P. & P. on each L.S.

CRESCENT CATALOGUE
If you construct you should own one. Send 20p inc. carriage.

★ **VAT**
Please include 10% VAT on goods plus carriage.

The new Oryx 50 is temperature controlled, light, small, easy to handle, rapid heating and high performance. It has a temperature control within ±2°C and adjusted in seconds whilst running to any value between 200°C and 400°C. Long life iron coated tip as standard (11 sizes available).
Oryx De-Soldering Irons—small model SR3A instantly removes solder from printed circuits etc., accurate, reliable, simple. PTFE nozzle. Larger instrument SR2 gives more suck, less recoil as only piston moves.



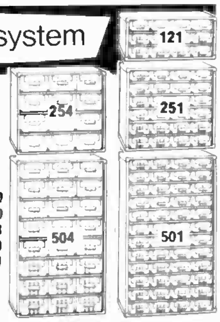
Safety Stand £2·44

De-Soldering Tools
SR3A £5·06
SR2 £6·65
Oryx 50 Iron
1 at £6·60

Lower prices for quantities

Prices Correct May 1974
Prices include P. & P. and 10% VAT

WH·MK spacemiser storage system



Cabinets have stove enamelled steel frames in three heights all of equal width and depth. The frames are strong and rigid, fitted with top and bottom locating pegs and rear slots making stacking, wall or frame mounting positive and simple.

	1 off	4 off
121, 122, 123, 124	£4·07	£3·70
251, 252, 253	£6·16	£5·50
501, 502, 503	£10·67	£9·68
254, 257, 258	£5·83	£5·30
504, 507, 508	£10·01	£9·08

Less for quantities
All prices include P. & P. and 10% VAT. Prices correct May 1974.

Contil Mod-3 cases are in six sizes and offer the manufacturer of small instruments an attractive low cost case available ex stock. Made in blue PVC coated steel and complete with front and rear panels and chassis, they are light, strong and rigid. PCE and PSU mounting systems available.

		Width	Height	Depth
Mod-301	£3·54	7"	3"	5"
Mod-302	£3·71	7"	4½"	5"
Mod-303	£4·20	7"	6"	5"
Mod-304	£4·20	11"	3"	5"
Mod-305	£5·21	11"	4½"	5"
Mod-306	£5·77	11"	6"	5"

Less for quantities. Prices correct May 31. Prices include P. & P. 10% VAT, feet and screws.

BRADRAD DRILLING AND DEBURRING TOOL equals eleven drills. One cut drills and deburrs the normal run of steels, aluminium, brass, copper and all types of plastics, perspex, fibre glass etc. and hardboard should the need arise it is designed to overcome all the problems associated with drilling thin materials—it drills interlocking holes for instance.
⅛"–2⅛" in ⅛" steps or 6–36mm in 3mm steps. Both with ¼" shanks. £10·75. Also 1⅛"–2⅛" and 36–60 mm. £27·88.

All prices include P. & P. and 10% VAT. Prices correct May 31.

Q.MAX PUNCHES

½"	£1·18
⅝" or ¾"	£1·38
⅞" or 1"	£1·47
1", 1⅛", 1¼"	£1·88
1½"	£2·22

ADEL
The Adel cuts holes of virtually any shape and size starting from a ⅜" hole, cutting cleanly like a punch and die. Ideal for notching clearances on flanges of cabinets or chassis. £4·81.

Available in a range of six sizes in 21 gauge Zintec with blue Acrylic texture. Front panels white Zintec steel or PVC Aluminium.

Width	Depth	Height	No	Case	Extra for cost alu. panel
7"	5"	5"	755	£5·59	23p
8"	6"	7"	867	£6·12	19p
9"	7"	5"	975	£6·12	19p
12"	7"	7"	1277	£6·73	18p
12"	7"	7"	1277	£5·56*	—
16"	12"	7"	16127	£9·55	50p
19"	10"	10"	191010	£13·17	—

*unpainted

Less for quantities. Prices include steel panel with feet and screws. P. & P. and 10% VAT. Prices correct May 31.

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WEST HYDE DEVELOPMENTS LTD, Ryefield Cres., Northwood Hills, Northwood, Middx HA6 1NN. Tel. Northwood 24941/26732. Telex: 923231
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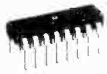

* 100 plus less 10% on the 25+ column

No's	1+ £	25+ £	No's	1+ £	25+ £	No's	1+ £	25+ £
			7447	1·48	1·39	74123	3·35	3·28
			7448	1·98	1·81	74141	1·10	0·99
7400	0·20	0·18	7450	0·20	0·16	74145	1·65	1·48
7401	0·20	0·18	7451	0·20	0·19	74150	3·30	2·75
7402	0·20	0·18	7453	0·20	0·19	74151	1·21	1·15
7403	0·20	0·18	7454	0·20	0·18	74153	1·32	1·15
7404	0·21	0·19	7460	0·20	0·18	74154	2·20	1·87
7405	0·21	0·19	7470	0·33	0·27	74155	1·65	1·21
7406	0·54	0·49	7472	0·33	0·30	74156	1·65	1·21
7407	0·54	0·48	7473	0·46	0·42	74157	1·54	1·43
7408	0·29	0·24	7474	0·44	0·40	74160	2·18	2·05
7409	0·29	0·24	7475	0·63	0·57	74161	2·18	2·05
7410	0·20	0·18	7476	0·55	0·51	74162	4·84	4·54
7411	0·23	0·21	7480	1·10	0·99	74163	4·84	4·54
7412	0·40	0·33	7481	1·37	1·26	74164	2·73	2·63
7413	0·31	0·29	7482	1·10	0·99	74165	2·73	2·63
7416	0·49	0·47	7483	1·32	1·29	74166	4·28	3·94
7417	0·57	0·53	7484	1·32	1·21	74174	2·78	2·66
7420	0·20	0·18	7485	2·75	2·64	74175	1·94	1·81
7422	0·60	0·58	7486	0·49	0·41	74176	1·99	1·87
7423	0·60	0·58	7489	4·95	4·29	74177	2·75	2·64
7425	0·60	0·53	7490	0·82	0·71	74180	2·75	2·64
7426	0·35	0·31	7492	0·84	0·65	74181	6·49	6·05
7427	0·55	0·51	7493	0·82	0·66	74182	2·16	2·02
7428	0·85	0·79	7494	1·04	0·93	74184	2·69	2·42
7430	0·20	0·18	7495	1·14	1·03	74190	3·08	2·69
7432	0·42	0·33	7496	1·25	1·15	74191	2·30	2·24
7433	0·97	0·91	74100	2·75	2·58	74192	2·53	2·30
7437	0·77	0·74	74104	1·18	1·14	74193	2·53	2·30
7438	0·77	0·74	74105	1·18	1·14	74194	3·27	3·15
7440	0·20	0·18	74107	0·48	0·46	74195	2·42	2·30
7441	0·81	0·78	74110	0·67	0·65	74196	2·18	2·06
7442	0·81	0·78	74111	1·52	1·40	74197	2·18	2·06
7443	1·40	1·32	74118	1·10	0·80	74198	6·65	6·05
7444	1·57	1·52	74119	1·64	1·54	74199	6·65	6·05
7445	2·31	2·18	74121	0·47	0·42	74200	26·40	21·12
7446	2·31	2·18	74122	1·70	1·59			

Linear Integrated Circuits

		£
301	DIL	0·50
301	TO99	0·55
301	8 PIN DIL	0·46
301A	DIL	0·69
301A	TO99	0·69
301A	8 PIN DIL	0·66
307	DIL	0·69
307	TO99	0·69
307	8 PIN DIL	0·66
308	TO99	6·45
308A	TO99	6·40
709c	DIL	0·35
709c	TO99	0·31
723c	DIL	0·99
723c	TO99	0·95
741c	8 PIN DIL	0·38
741c	14 PIN DIL	0·39
741c	TO99	0·41
747c	DIL	0·46
748c	DIL	0·39
748c	TO99	0·41
ZN414		1·38
MC1310P		3·38

Resistors

¼ watt 5% carbon	1p
½ watt 5% carbon	1p
1 watt 10% carbon	2½p
range 10 ohms to 4·7 megohms.	
½ watt m/o 2%	4p
range 10 ohms to 1 megohms.	

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2½ × 3¾	24p	19p
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3¾ × 5	31p	31p
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17 × 3¾	£1·10	87p
17 × 5 (Plain)		90p
Pin insertion tool	57p	57p
Spot face cutter	46p	46p
Pk 36 Pins	20p	20p

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4 VOLT		16 VOLT		40 VOLT	
47µF	6½p	15µF	6½p	47µF	6½p
100µF	6½p	33µF	6½p	68µF	10p
200µF	6½p	150µF	6½p	100µF	9p
320µF	6½p	150µF	8p	220µF	11p
1000µF	13p	220µF	9p	470µF	19p
4700µF	29p	680µF	17p	680µF	25p
		1000µF	17p	1000µF	25p
6·3 VOLT		1500µF	25p	2200µF	44p
33µF	6½p	2000µF	43p		
68µF	6½p	**25 VOLT**			
150µF	6½p	10µF	6½p		
470µF	11p	22µF	6½p		
680µF	13p	47µF	6½p	**63 VOLT**	
1500µF	18p	100µF	8p	1µF	6½p
2200µF	18p	150µF	8p	2·2µF	6½p
3300µF	26p	220µF	10p	4·7µF	6½p
10 VOLT		470µF	13p	6·8µF	6½p
22µF	6½p	680µF	20p	10µF	6½p
47µF	6½p	1000µF	22p	22µF	6½p
100µF	6½p	2200µF	39p	68µF	10p
220µF	8p	5000µF	68p	100µF	11p
330µF	10p			150µF	18p
470µF	10p	**40 VOLT**		220µF	19p
1000µF	11p	6·8µF	6½p	330µF	22p
1500µF	20p	15µF	6½p	470µF	26p
2200µF	24p	33µF	6½p	1000µF	44p

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Carbon track 500Ω to 2·2MΩ. Log or Linear.
Single 13p. Dual gang (stereo) 44p.
Single type with D.P. switch 13p extra.

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Small high quality type (linear only). All valves 100·5 meg ohms.
—1 watt 6p each
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SP8T 11p each. D.P.D.T. 13p each.

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250V P.C. mounting: 0·01µF, 0·015, 0·022 3½p. 0·033, 0·047, 0·068 4p. 0·1 4½p. 0·15, 0·22 5½p. 0·33 7p. 0·47 9½p. 0·68 12p. 1µF 14p. 1·5µF 22p. 2·2µF 27p.

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£1 BARGAIN PACKS

- £1 10 Silicon *npn* power transistors (2N3055), tested/unmarked.
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- £1 20 TO5 transistors *npn* 2 to 5A, untested/unmarked.
- £1 20 TO18 transistors *pnp* like BC178, BC179, etc., untested/unmarked.
- £1 30 Plastic 2N3055, unmarked/untested. TO220 case.
- £1 10 General purpose, fully tested FET's.

★ Any 5 pack £4·50 ★

P.E. RONDO KIT available Send for list

Transformers

Primary 200-220-240V.

			£	P./P.
MT111	12V	0·5A	1·11	16p
MT111/3	24V	0·25A	1·35	20p
MT71	12V	2A	1·76	22p
MT71/B	24V	1A	1·76	22p
MT18	12V	4A	2·47	36p
MT18/8	24V	2A	2·47	36p

30V transformers

Prim. 200–220–240V. Secondary voltage, 12, 15, 20, 24, 30V or 12–0–12V or 15–0–15V.

		£	P./P.
MT112	0·5A	1·32	22p
MT79	1A	1·80	36p
MT3	2A	2·96	36p
MT20	3A	3·30	42p
MT51	5A	4·84	49p

50V transformers

Prim. 200–220–240V. Secondary voltage, 19, 25, 33, 40, 50V or 25–0–25V.

		£	P./P.
MT102	0·5A	1·76	30p
MT103	1A	2·58	38p
MT105	3A	4·84	52p
MT106	4A	6·02	22p

60V transformers

Prim. 200–220–240V. Secondary voltage, 24, 30, 40, 48, 60V or 24–0–24V or 30–0–30V.

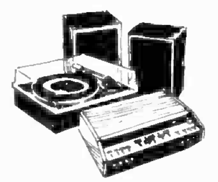
		£	P./P.
MT124AT	0·5A	1·76	38p
MT126AT	1A	2·47	34p
MT127	2	3·90	44p

Miniature transformers

Prim. 220V			£	P./P.
BT606	100mA	6–0–6V	0·98	15p
BT909	100mA	9–0–9V	0·98	15p
BT12012	100mA	12–0–12V	1·08	15p
BT24024	100mA	24–0–24V	1·95	15p

Semicndctrs.				Bridge Rect.	
AC126	14p	OC36	50p	*1 amp*	
AC127	16p	OC44	16p	100V	22p
AC128	15p	OC45	10p	200V	24p
AC141K	26p	OC71	11p	600V	27p
AC142K	26p	OC81	12p		
AC176	18p	2N706	14p	**Thyristors**	
AC187	24p	2N1131	24p	*1 amp*	
AC188	24p	2N1132	28p	50V	29p
AC187K	28p	2N2904	20p	100V	32p
AC188K	28p	2N2926	11p	200V	34p
AD149	49p	2N3053	26p	400V	44p
AD161	38p	2N3054	55p	*3 amp*	
AD162	40p	2N3055	49p	50V	39p
AF114	20p	2N3702	14p	100V	44p
AF115	20p	2N3703	13p	200V	48p
AF116	20p	2N3704	14p	400V	66p
AF117	20p	2N3705	13p	*5 amp*	
BC107	13p	2N3706	12p	50V	46p
BC108	13p	2N3707	13p	100V	57p
BC109	13p	2N3708	11p	200V	66p
BC147	13p	2N3709	12p	400V	77p
BC148	13p	2N3710	12p		
BC149	13p	2N3711	12p	**Triacs**	
BC182	13p	2N3819	35p	*2 amp*	
BC183	11p	40361	55p	100V	33p
BC184	14p	40362	55p	200V	55p
BC212	13p	40636	69p	400V	77p
BC213	13p	1N914	8p	*6 amp*	
BC214	13p	1N916	8p	100V	66p
BD131	68p	1N4001	7p	200V	88p
BD132	90p	1N4002	8p	400V	99p
BF194	16p	1N4003	10p	*10 amp*	
BF195	17p	1N4004	10p	100V	99p
BF244	27p	1N4006	15p	200V	£1·32
BFY50	18p	1N4148	6p	400V	£1·43
BFY51	18p	1N5400	16p		
BFY52	17p	1N5401	17p	**400mW Zener Diodes**	
MP8111	36p	1N5402	19p	3·3 to 33V	
OC28	50p	1N5404	24p		11p each
		1N5406	28p		

BIG DISCOUNTS



PLUS full 12 months' guarantee and after sales service.

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★ Callers welcome — listen and look at our new retail premises.

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Includes IC 4000 amp 12 watt RMS, Hiltone speakers, Garrard SP25 Mk. IV turntable, G800 cartridge. P and C.
R.R.P. £112
Our Price £69·80 (carr £1·50)
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Our Price £84·20 (carr £1·50)
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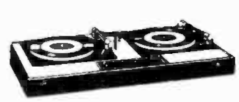
Includes Hiltone 10 watt RMS amp, Hiltone speakers, Garrard 2025TC turntable complete cartridge. P and C.
R.R.P. £83
Our Price £54·80 (carr £1·50)
or £1·32 weekly for 52 weeks

Hiltone 20 + 20 System
Includes Hiltone 20 watt RMS amp, Hiltone speakers, SP25 Mk. IV turntable, G800 cartridge. P and C.
R.R.P. £104
Our Price £79·60 (carr £1·80)
or £1·03 weekly for 104 weeks

Hiltone TA100 Systems
Hiltone 10 watt tuner amp, Hiltone speakers. Garrard 2025TC turntable with cartridge and P and C.
R.R.P. £114
Our Price £84·50 (carr £1·80)
or £1·21 weekly for 52 weeks

TRANNIES DISCO UNIT

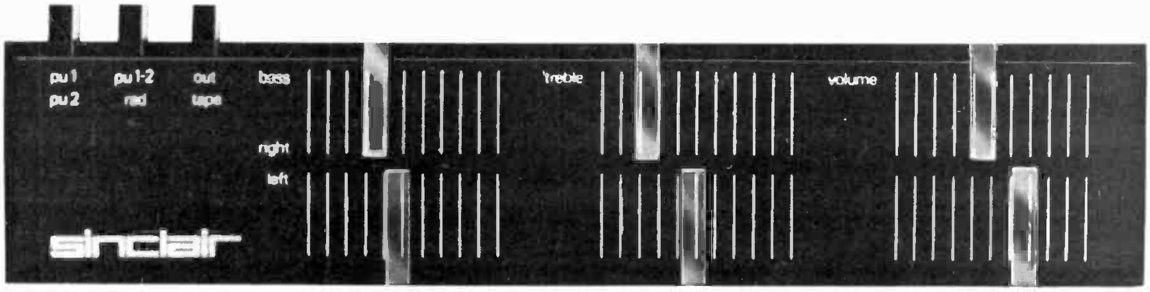


Includes

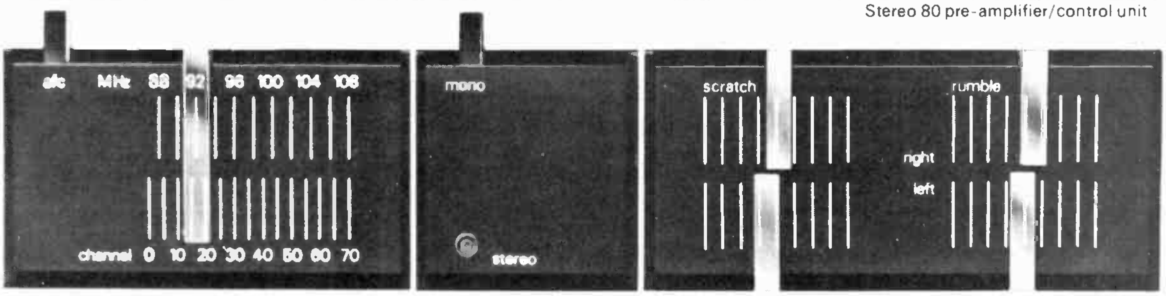
- ★ DJ 100 watt discotheque amp with full mixing and PFL facilities. **£90·75**
- ★ Stereo headphones with boom microphone. **£9·90**
- ★ Trannies Disco Console—with 2 Garrard SP25 Mk. IV turntables with G850 cartridges. **£57·50**
- ★ Pair 50 watt speakers. **£43**

or Complete System **£182·50** carr £3
★ terms £2·38 weekly over two years (total £225) ★
We stock a full range of Disco Equipment. Send for list or pay us a visit.

Sinclair Project 80
exciting



Stereo 80 pre-amplifier/control unit



Project 80 tuner Stereo decoder Project 80 Active Filter Unit (AFU)

only $\frac{3}{4}$'' deep x 2'' high

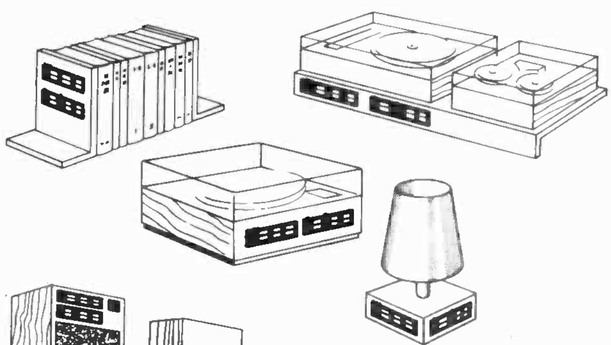
Living with hi-fi takes on new meaning with Sinclair Project 80. The electronics of these revolutionary new modules are all contained within elegantly designed matching cases no more than three-quarters of an inch deep. They are designed for mounting on any appropriate flat surface by means of 6BA bolts extending from the rear of each module and which pass through suitably drilled holes. Connections are taken away out of sight in a similar manner. The possibilities opened up by Project 80 are endless – superb hi-fi systems can be installed in ways hitherto only dreamed about and never before made practical. No more cutting out and shaping to put modules in position. A few holes drilled with the aid of templates supplied and the job is done. Now you need never again be faced with problems of keeping the hi-fi from clashing with carefully thought-out furnishing schemes. (That will surely please wives!) Slider controls have been introduced in place of knobs and all modules in the range incorporate new up-dated circuitry with emphasis on performance standards and built-in protection against overload and shorting. The aim was to re-think modular construction completely – to make it infinitely more versatile, even simpler and more reliable – the result – Project 80 – another triumph for Sinclair, and the most exciting construction modules ever.

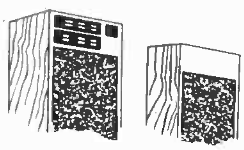
the slimmest, most elegant hi-fi modules ever made

Typical Project 80 applications

System	The Units to use	Units cost
Simple battery record player	Z.40	£5·45 + 54p V.A.T.
Mains powered record player	Z.40, PZ.5	£10·43 + £1.04 V.A.T.
30W. RMS continuous sine wave stereo amp.	2 × Z.40s, Stereo 80; PZ.6	£30·83 + £3.08 V.A.T.
50W (8 Ω) RMS continuous sine wave de luxe stereo amp.	2 × Z.60s, Stereo 80; PZ.8	£33·83 + £3.38 V.A.T.
Indoor P.A.	Z.60, PZ.8	£14·93 + £1.49 V.A.T.

Project 80 FM tuner, decoder, and A.F.U. may be added as required

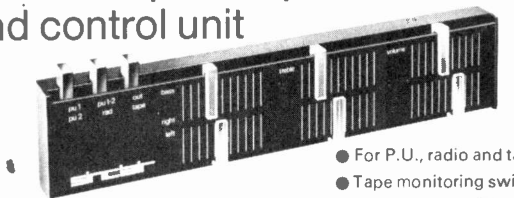




Mount Project 80 on a bookshelf, a loudspeaker, a lampshade base a false wall with two Q.16 loudspeakers . . . almost anywhere.

new thinking in modular hi-fi

Stereo 80 pre-amplifier and control unit



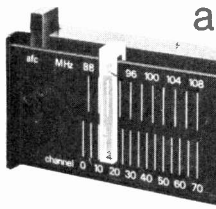
- For P.U., radio and tape
- Tape monitoring switch
- Simplest ever fixing

Each channel has its own separate tone and volume controls operated by slicers, enabling ideal environmental matching to be obtained. A virtual earth input stage forms part of the up-dated circuitry that ensures the finest possible quality from all signal sources. Generous overload margins are allowed on all inputs. Clear instructions with template are supplied.

TECHNICAL SPECIFICATIONS
Size – 260 × 50 × 20mm (10¼ × 2 × ¾ins)
Finish – Black with white indicators and transparent Sliders
Inputs – Magnetic pick-up 3mV RIAA corrected. Ceramic pick-up 300mV
Radio 300mV; Tape 30mV
Signal/noise ratio – 60dB
Frequency range – 20Hz to 15KHz ± 1dB. 10Hz to 25KHz ± 3dB
Power requirements – 20 to 35 volts
Outputs – 100mV + AB monitoring for tape
Controls – Press button for tape radio and P.U. Sliders for volume, bass (+ 12dB to – 14dB at 100Hz) treble (+ 11dB to – 12dB at 10KHz)

R.R.P. **£11.95** +£1·19 V.A.T.

Project 80 FM tuner and stereo decoder



- Twin dual varicap tuning: 4 pole ceramic filter: switchable A.F.C.
- On the decoder, solid state stereo indicating beacon.

Making the Project 80 F.M. tuner and decoder available separately gives a wider choice of systems and saves money where stereo reception may not be required. The tuner is a triumph of electronic design and assures excellent performance. The decoder gives a 40dB channel separation with 150mV output per channel. Both units may be used with other than Project 80 systems.

TECHNICAL SPECIFICATIONS OF TUNER
Size – 85 × 50 × 20mm (3⅜ × 2 × ¾ins)
Tuning range – 87·5 to 108 MHz
Detector – I.C. balanced coincidence for good A.M. rejection
One I.C. equal to 26 transistors
Distortion – 0·2% at 1KHz for 30% modulation
4 pole ceramic filter in I.F. section
Aerial impedance – 75 Ω or 240-300 Ω
Sensitivity – 4 microvolts for 30dB quieting
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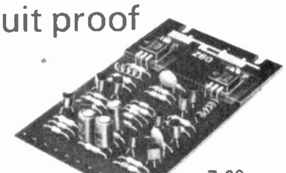

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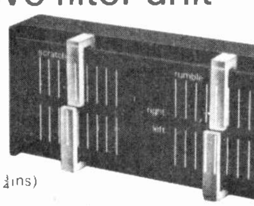

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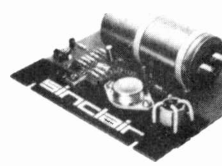

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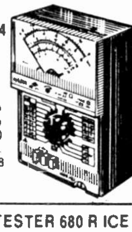

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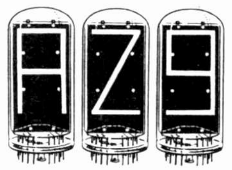

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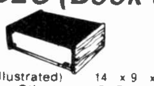

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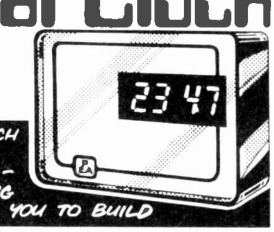

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