PRACTICAL

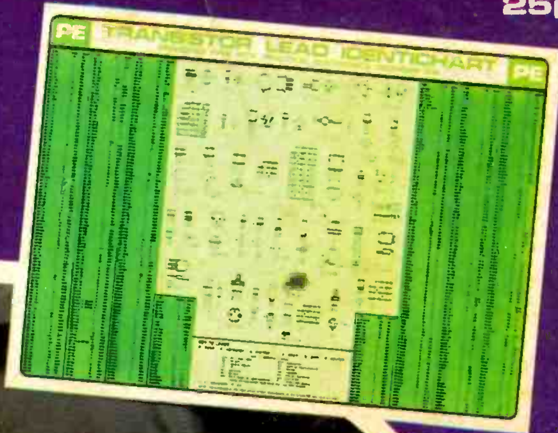
ELECTRONICS

DECEMBER 1974

25p

FREE! *in this issue*

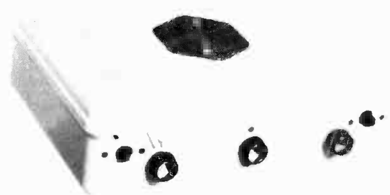
TRANSISTOR LEAD IDENTICHART



CORRECT SETTING WITH OUR

DWELL METER

FOR IMPROVED ENGINE PERFORMANCE



NEW EDU-KIT MAJOR

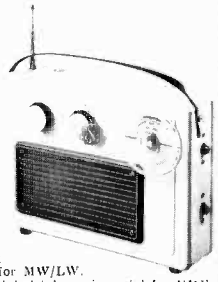
COMPLETELY SOLDERLESS ELECTRONIC CONSTRUCTION KIT
BUILD THESE PROJECTS WITHOUT SOLDERING IRON OR SOLDER

- 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 (+8% VAT 57p) **P.P. & INS. 44p (Overseas P.P. £1·85p)**

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

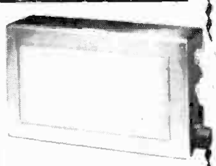


WITH V.H.F. INCLUDING AIRCRAFT

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 9¼in × 7in × 2¾in approx. Parts price list and plans 30p (FREE with parts).

TOTAL BUILDING COSTS £6·95 (+8% VAT 55p) **P.P. & INS. 44p (OVERSEAS P. & P. £1·85)**

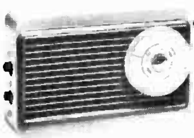
POCKET FIVE



NOW WITH 3" LOUDSPEAKER

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

Total Building Costs £2·50 (+8% VAT 20p) **P.P. & Ins. 26p (Overseas P. P. £1·25)**



TRANSONA FIVE NOW WITH 3" LOUDSPEAKER

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 £2·75 **P.P. & Ins. 26p** (+8% VAT 21p) **(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 now with 3" loudspeaker. Attractive case with red speaker grille. Size 9in × 5¼in × 2½in approx. Parts price list and plans 15p (FREE with parts).

TOTAL BUILDING COSTS £2·95 (+8% VAT 23p) **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 (+8% VAT 29p) **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 (+8% VAT 32p) **P.P. & INS. 31p (OVERSEAS P. & P. £1·85p)**

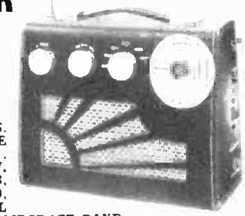
ROAMER EIGHT Mk. I

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. Chrome plated telescopic aerial can be angled and rotated for peak short-wave listening. 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 (+8% VAT 56p) **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. 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 (+8% VAT 68p) **P.P. & INS. 52p (OVERSEAS P. & P. £1·85)**

EDU-KIT

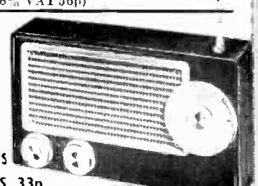
Build Radios Amplifiers, etc., from easy stage, diagrams.

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 (+8% VAT 44p) **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 × 2½in 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 (+8% VAT 36p) **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 × 2½in approx. Plans and parts price list 25p (FREE with parts).

TOTAL BUILDING COSTS £3·98 (+8% VAT 32p) **P.P. & IN. 31p (OVERSEAS P. & P. £1·85)**

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PE12

PRACTICAL
ELECTRONICS

VOLUME 10 No. 12 DECEMBER 1974

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

SPECIAL DATA SHEET FREE INSIDE THIS ISSUE

TRANSISTOR LEAD IDENTICHART

At-a-glance details on over 700 transistors

Our January 1975 issue will be published on Friday, December 13, 1974

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- ROBUST DIODE PROTECTED PRECISION MOVEMENT.
- 33 RANGES D.C. VOLTS 0–100mV, 1·5V, 5V, 15V, 50V, 150V, 500V, 1,500V. D.C. CURRENT 0–50μA, 5mA, 50mA, 500mA, 2·5A. A.C. VOLTS, 0·7·5V, 25V, 75V, 250V, 750V, 1,500V, A.C. CURRENT 0–25mA, 250mA, 2·5A, 12·5A. dB RANGES, −10 to +69. AF VOLTS RANGES 0–1,500V. RESISTANCE RANGES 10kΩ, 10MΩ F.S.D. CAPACITANCE RANGES 100μF, IF F.S.D.
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- RESISTANCE RANGES POWERED BY INTERNAL BATTERIES.
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- CLEARLY CALIBRATED DIAL WITH ANTI-PARALLAX MIRROR.
- PROFESSIONAL QUALITY COMPONENTS EMPLOYED THROUGHOUT.
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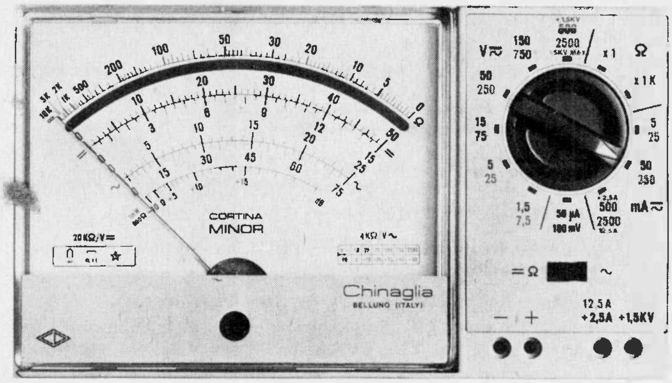

METER PRICE £15·40 (p & p 80p) PROBE £8·80 inclusive of V.A.T.

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Input: 12–24V d.c. (not centre tapped). 18V input giving 10V constant amplitude output.
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300 VA ISOLATING TRANSFORMER

115/230-230/230 volts. Screened. Primary two separate 0-115V for 115 or 230 volt. Secondary two 115V at 150 VA each for 115 or 230 volt output. Can be used in series or parallel connections. Fully tropicalised. Length 13·5 cm. Width 11 cm. Height 13·5 cm. Weight 15 lb.
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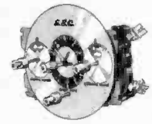

Based on an electric clock, with 25 amp. single pole switch, which can be preset for any period up to 12 hrs. ahead to switch on for any length of time, from 10 mins. to 6 hrs. then switch off. An additional 60 min. audible timer is also incorporated. Ideal for Tape Recorders, Lights, Electric Blankets, etc. Attractive satin copper finish. Size 135 mm × 130 mm × 60 mm. Price £2. Post 20p. (Total incl. VAT and Post £2·38).

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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.
2 cam model. £2·00 post 30p.
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2 Bank, 11 position, 24 volt D.C. operation, full wiper with ancillary contacts. NEW Price £2·50. Post 20p. As above but with 5 Bank, 11 position. Price £3·50. Post 20p.

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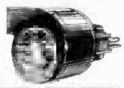

Mfg. Airflow Developments Ltd. Heavy Duty continuously rated, smooth running, 230/240V a.c. motor. Size: 16 × 14cm (case only). OAL 15cm. Aperture 6 × 6cm. £6·50. Post 50p.

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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.

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

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Approx. four times the light output of our well proven Hy-Lyght strobe.
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ROBUST, FULLY VENTILATED METAL CASE. For Hy-Lyght Kit including reflector £5·75. Post 25p.
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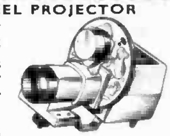
7-inch POLISHED REFLECTOR
Ideally suited for above Strobe kits. Price 55p. Post 15p.

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
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400Watt. Mercury vapour ultra violet lamp. Powerful source of u.v. P.F. ballast is essential Price of matched ballast and bulb £16. Post £1. Spare bulb £7. Post 40p.

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750W Solid State Fader, with three functions. Manual fade; Auto fade-up; Auto fade-down. Automatic cycling up and down. Functions selected with 'three-position' rocker switch. Two ranges of cycling for 'Flashing' or 'Slow blending'. Ready built module 6" × 3" glass fibre board incorporating 10 amp TRIAC. Two or more modules for top quality colour blending and flashing effects. PRICE £15. Post 30p.

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Easy to build. Solid State. Two full octaves (less sharps and flats). Fitted hardwood case. Powered by two penlite 1½V batteries. Complete set of parts including speaker, etc., together with full instructions and 10 tunes. Price £3·25. Post 35p.

50 in 1 ELECTRONIC PROJECT KIT
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All prices are subject to 8% VAT. (8p in the £)
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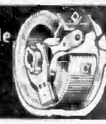

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150	4–9	2 c/o	70p*
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410	12–20	4 c/o	80p*
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700	16–24	4 c/o	80p*
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2,500	31–43	2 c/o HD	60p*
2,500	36–45	6M	60p
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15k	85–110	6M	60p*

*Incl. Base All prices incl. P. & P.

6 VOLT D.C. 1 make contacts **35p.** Post 10p.
6 VOLT D.C. 2 make contacts **75p.** Post 10p.
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3 c/o 5 amp contacts. 70 ohm coil. **75p.** Post 10p.
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230/240V a.c. 2 c/o, 25 amp RES. at 250V a.c. **£2.** Post 10p.
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Miniature relay. 675 ohm coil. 24 Volt D.C. 2 c/o. 70p post paid.
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24 VOLT A.C. 3 c/o. **75p.** Post 10p.
24 VOLT A.C. Mfg. by ITT. 2 h.d. c/o contacts. **55p.** Post 10p.
240 VOLT A.C. RELAY. Mfg. by ITT. 240V A.C. 10 amp h.d. c/o contacts. Octal plug in base. Price **75p.** Post 10p.
230/240 VOLT A.C. RELAY. Mfg. by Arrow 2 h.d. 15 amp c/o contacts. Amp connectors. Price **£1.** Post 10p.
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HEAVY DUTY A.C. SEALED RELAYS
110V. 2 c/o. 20 amp contacts. **£1·25.** Post 10p.

VERY SPECIAL OFFER

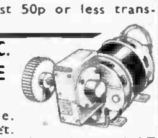
MINIATURE ROLLER MICRO SWITCH. 5 amp. c/o contacts. Mfg. BONNELLA. NEW. Price 10 for **£1·50.** Post 10p. (Min. order 10).
AS above WITHOUT ROLLER. 20 for **£2.** Post 10p.

230/240 VOLT A.C. MINIATURE MOTOR. 20 R.P.M. Price £1. Post 10p.

BODINE TYPE N.C.I. GEARED MOTOR

(Type J) 71 r.p.m. torque 10 lb. in. **Reversible** 1/70th h.p. cycle 0·38 amp. **(Type 2) 28 r.p.m. torque** 20 lb. in **Reversible** 1/80th h.p. 50 cycle 0·28 amp. The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115v A.C. Supplied complete with transformer for **230/240v A.C. input.**
Price, either type **£6·25.** Post 50p or less transformer £3·75. Post 40p.

'FRACMO' 240 VOLT A.C. 50 cycle SINGLE PHASE GEARED MOTOR



33 r.p.m. 30 lb. ins. Reversible. Fitted with mounting feet.
Brand New. **£14.** Post 60p. (Total price incl. VAT **£15·77**).

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PUSH BUTTON CAR RADIO KIT

The Tourist II

NO SOLDERING REQUIRED!

NOW BUILD YOUR OWN PUSH BUTTON CAR RADIO

Easy to assemble construction kit comprising fully completed and tested printed circuit board on which no soldering is required. All connections are simple push fit type making for easy assembly.
Fine tuning push button mechanism is fully built and tested to mate with printed circuit board.

Car Radio Kit £7.70 + 55p p & p

The Tourist I Kit For the experienced constructor
If you can solder on a printed circuit board you can build this model.
Same technical specification as Tourist II
Price £6.60 + 55p p & p.

Technical specification:
(1) **Output** 4 watts R.M.S. output. For 12 volt operation on negative or positive earth.
(2) **Integrated circuit** output stage, pre-built three stage IF Module.

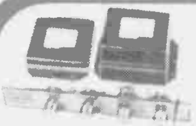
Controls volume manual tuning and five push buttons for station selection, illuminated tuning scale covering full, medium and long wave bands.
Size chassis 7″ wide, 2″ high and 4¾″ deep approx

Speaker including baffle and fixing strip **£1.65+23p. p&p.**
Car Aerial Recommended — fully retractable
£1.37+20p. postage & packing

*STEREO 21 QUALITY SOUND FOR LESS THAN £20·00

Stereo 21, easy to assemble audio system kit. No soldering required. The unit is finished in white P.V.C. and the acrylic top presents an unusually interesting variation on the modern deck plinth.

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.
Specifications: For the technically minded:—
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. 15½″ × 8″ × 4″. Complete deck and cover in closed position approx. 15½″ × 12″ × 6″.
Complete only **£19·95** + £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.**



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 HOME 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 eleswhere at £24.00 approx. Yours for only
£11.95 + 90p p & p.

COMPLETE * STEREO SYSTEM

System 1. £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. $13\frac{3}{4}'' \times 9'' \times 3\frac{3}{4}''$.
Garrard SP 25 Mk III deck with magnetic cartridge, de luxe plinth and hinged cover.
Two Duo Type II matched speakers – Enclosure size approx. $17\frac{1}{2}'' \times 10\frac{3}{4}'' \times 6''$ in simulated teak. Drive unit 13″ × 8″ with parasitic tweeter. 10 watts handling.

Complete System £51·00

System 2. £69·00

Viscount III amplifier (As System I)
Garrard SP 25 Mk III deck (As System I)
Two Duo Type III matched speakers – Enclosure size approx. 27″ x 13″ x $11\frac{1}{2}''$
Finished in teak veneer. Drive units 13″ x 8″ bass driver, and two 3″ (approx.) tweeters.
20 watts R.M.S., 8 ohms frequency range — 20 Hz to 18,000 Hz.

Complete System £69·00

PRICES: SYSTEM 1	
Viscount III R102 amplifier	£24.20 + £1 p & p
2 Duo Type II speakers	£14.00 + £2.20 p & p
Garrard SP 25 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 III R102 amplifier	£24.20 + £1 p & p
2 Duo Type III speakers	£39.00 + £4.00 p & p
Garrard SP 25 with Mag. cartridge de luxe plinth and hinged cover	£21.00 + £1.75 p & p
total: £84.20	

Available complete for only: **£69·00** + £4.00 p & p

EMI SPEAKERS AT FANTASTIC REDUCTIONS

20 WATT SPEAKER SYSTEM

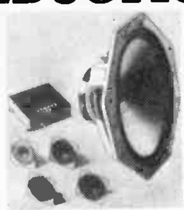
System consists of a 13″ × 8″ (approx) eliptical woofer unit with a 8″ × 5″ (approx.) mid range unit incorporating parasitic tweeter and crossover components.
Technical Specification:
Bass Unit
Flux density–100 K, speech coil–$1\frac{1}{2}$
Cone, Triple laminated paper with P.V.C. surround.
Mid Range Unit
Flux density-33K, speech coil-1″ with parasitic tweeter.
Power Handling
20 watts R.M.S., impedance – 8 ohms, frequency response – 20 Hz to 18,000 Hz.

OUR PRICE £6.60. Complete + 90p 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 $3\frac{1}{4}''$ 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.

Special Offer
OUR PRICE £19.50 + £1·50 p&p

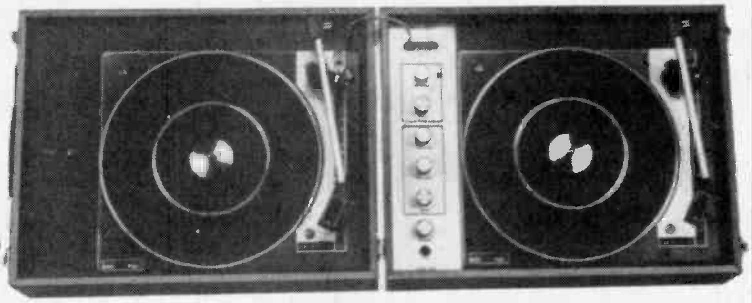
FOR DISCO PAGE AND DETAILS OF HOW TO ORDER – TURN OVER...

PORTABLE DISCO CONSOLE

INCORPORATES: Pre-Amp with full mixing facilities, including switched input for mic with volume control, switched input for auxiliary with volume control, bass and treble controls, volume control and blend control for turntables.

Two B.S.R. single play professional series decks, fitted with crystal cartridges.

The turntables are designed and precision engineered. They combine clean modern styling with superb reproduction. Their many special features include square section aluminium tonearms, (high precision low mass design fully counterbalanced, with calibrated stylus pressure control for perfect tracking), and conveniently grouped easy to read linear controls. The turntables have viscous cueing devices which allows the tonearms to be placed or lifted at any point on the record.
The two lightweight cartridge shells have slide-in-holders to facilitate easy inspection of needles and cartridges.



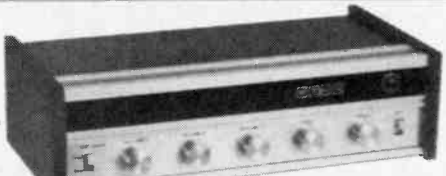
TECHNICAL SPECIFICATION:
Pre-amp – Output – 200mV. Auxiliary inputs – 200mV and 750mV into 1 meg. Mic input – 6mV into 100K. 240 volt operation.
Turntables capacity – 7", 10" or 12" records.
Rumble, wow and flutter – Rumble – Better than –35dB. Wow – Better than 0.2%. Flutter – Better than 0.06% (Gaumont kalee meter).
Finish – Satin black mainplate with black turntable mat inlaid with brushed aluminium trim. Tonearm and controls in black and brushed aluminium.

Console size – Unit Closed – 17¾"×13¾"×8¾" (approx.)
Unit Open – 35¾"×13¾"×4⅞" (approx.)
This disco console is ideally matched for the Reliant IV and Disco 50 or any other quality amplifier.
The unit is finished in black PVC with contrasting simulated teak edging diamond spun control knobs with matching control panel.

Yours for only £45.00 + £3.50 P. & P.

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: 19¼"×10½"×8" (approx.) Amplifier **£27.50 + £1.50 p. & p.**



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 *4 electrically mixed inputs. *3 individual mixing controls.
*Separate bass and treble controls common to all 4 inputs.
*Mixer employing F.E.T. (Field Effect Transistors) *Solid State circuitry.
*Attractive styling.

INPUT SENSITIVITIES
–Input – 1.) Crystal mic. guitar or moving coil mic, 2 and 10mV.
(Selector switch for desired sensitivity).
–Inputs – 2), 3), 4). Medium output equipment – ceramic cartridge, tuner, tape recorder, organs, etc. – all 250mV sensitivity. AC Mains, 240V operation.
Size approx: 12½"×6"×3½".

£15.00 + 60p. post & pack.

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SPARKRITE Mk II

Electronic Ignition... Better on all points

Because you keep your points!

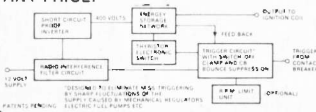
The SPARKRITE MK.2 is a full capacitive discharge electronic system. Specifically designed to retain the points assembly – with all the advantages and none of the disadvantages. No misfire because contact breaker bounce is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high rpm. Contact breaker burn is eliminated by reducing the current to about 1/50th of norm, thus avoiding arcing. But you can still revert to normal ignition if need be. In seconds. If points go (very unlikely) you can get replacements anywhere. All these advantages.

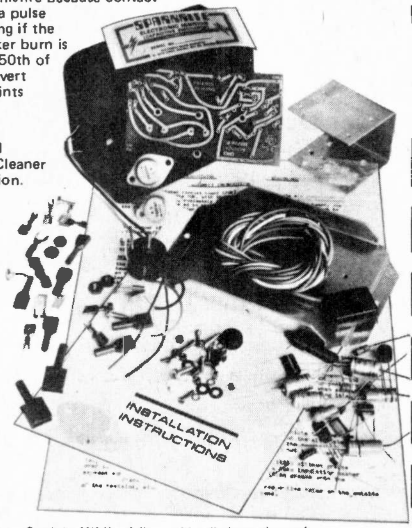
● Fitted in 15 minutes. ● Up to 20% better fuel consumption. ● Instant all weather starting. ● Cleaner plugs – they last 5 times longer without attention. ● Faster acceleration. ● Faster top speeds. ● Coil and battery last longer. ● Efficient fuel burning with less air pollution.

The kit comprises everything needed

Ready drilled scratch and rust resistant case, metalwork, cables, coil connectors, printed circuit board, top quality 5 year guaranteed transformer and components, full instructions to make positive or negative earth system, and 6 page installation instruction leaflet.

WE SAY IT IS THE BEST SYSTEM AT ANY PRICE!





Sparkrite MK II – full capacitive discharge electronic system – not just a transistorised inductive discharge booster.

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D.I.Y. Kit only £10·93 incl VAT and P & P
Ready Built Unit £13·86 incl VAT and P & P
(Both to fit all cars with coil/distributor ignition up to 8 cylinders).
We can supply units for any petrol-engined vehicle (boat, motorcycle etc) with coil/contact breaker ignition. Details on request. Call in and see us for a demonstration.

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Please supply
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AC141	18p	BC148	7p	BF173	25p	MJE371	84p	ZTX301	14p	2N2904	20p	2N4059	10p
AC142	18p	BC149C	8p	BF177	26p	MJE520	68p	ZTX302	18p	2N2905	18p	2N4060	13p
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AC187	12p	BC158	12p	BF179	33p	MJE2555	90p	ZTX304	24p	2N2926RB	7p	2N4444	180p
AC188	11p	BC159	14p	BF180	33p	MJE3055	65p	ZTX500	15p	2N2926O	8p	2N5457	38p
AD140	46p	BC169C	11p	BF181	33p	MPF102	31p	ZTX501	15p	2N2926YG	9p	2N5458	35p
AD142	55p	BC182	10p	BF184	22p	MPF103	31p	ZTX502	19p	2N3053	18p	2N5459	35p
AD143	50p	BC183	10p	BF185	22p	MPF104	31p	ZTX503	45p	2N3054	45p	3N140	100p
AD149	43p	BC184	11p	BF194	11p	MPF105	31p	2N404	26p	2N3055	40p	3N141	90p
AD161	33p	BC212	11p	BF195	12p	OC26	43p	2N696	15p	2N3441	80p	40360	35p
AD162	33p	BC213	10p	BF196	14p	OC28	48p	2N697	13p	2N3442	120p	40361	35p
AF114	13p	BC214	12p	BF197	15p	OC35	45p	2N698	30p	2N3525	80p	40362	38p
AF115	13p	BC307	11p	BF200	32p	OC36	52p	2N706	12p	2N3702 3	11p	40409	50p
AF116	13p	BC308	11p	BF244	38p	OC41	15p	2N708	18p	2N3704	11p	40410	50p
AF117	13p	BC309	12p	BFX29	30p	OC42	15p	2N914	18p	2N3705 6	10p	40411	200p
AF118	50p	BCY70	18p	BFX30	30p	OC44	11p	2N918	40p	2N3707	11p	40594	85p
AF121	33p	BCY71	22p	BFY50	15p	OC45	11p	2N929	20p	2N3708 9	9p	40595	75p
AF124	30p	BD115	45p	BFY51	15p	OC70	11p	2N930	18p	2N3771	170p	40600	69p
AF125	30p	BD121	100p	BFY52	15p	OC71	11p	2N1131	18p	2N3772	180p	40603	58p
AF126	30p	BD123	100p	BFX87	15p	OC72	11p	2N1132	18p				
AF127	30p	BD124	65p	BFX88	24p	OC73	50p	2N1302 3	17p				
AF139	33p	BD131	40p	BSX19	16p	OC74	30p	2N1303 4	21p				
AF181	45p	BD132	45p	BSX20	16p	OC81	12p	2N1306 7	28p				
AF186	48p	BD153	65p	BSX21	22p	OC82	12p	2N1308 9	28p				
AF239	38p	BD156	60p	BT106	95p	OC83	18p	2N1613	20p				
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250mA	14p	—	—
1A	20p	25p	25p
2A	30p	45p	45p
4A	48p	60p	70p
6A	50p	78p	95p

SCR-THYRISTORS

	50V	100V	400V	600V
1A	42p	48p	60p	78p
3A	43p	50p	78p	96p
7A	—	60p	84p	114p
16A	—	78p	96p	—

TRIACS

	30V	50V	400V	500V
800mA	52p	58p	—	—
3A	—	85p	99p	120p
6A	—	88p	120p	150p
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OA79	7p
OA81	7p
OA85	9p
OA90	6p
OA91	6p
OA95	7p
OA200	6p
OA202	7p
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3·3V to 33V ± 5%

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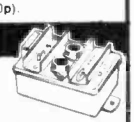

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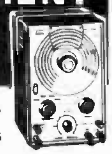

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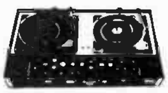

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AC142	20
AC142K	28
AC151	17
AC154	22
AC155	22
AC156	22
AC157	27
AC165	22
AC166	22
AC167	22
AC168	27
AC169	16
AC176	22
AC177	27
AC178	31
AC179	31
AC180	22
AC180K	32
AC181	22
AC181K	32
AC187	24
AC187K	25
AC188	24
AC188K	25
ACY17	28
ACY18	22
ACY19	22
ACY20	22
ACY21	22
ACY22	18
ACY27	20
ACY28	21
ACY29	39
ACY30	31
ACY31	31
ACY34	23
ACY35	23
ACY36	31
ACY40	19
ACY41	20
ACY44	39
AD130	42
AD140	53
AD142	53
AD143	42
AD149	55
AD161	39
AD162	39
AD161 and AD162MP	75
ADT140	55
AF114	27
AF115	27
AF116	27
AF117	27
AF118	39
AF124	33
AF125	33
AF126	31
AF127	31
AF139	33
AF178	55
AF179	55
AF180	55
AF181	55
AF186	55
AF239	41
AL102	72
AL103	72
ASY26	28
ASY27	33
ASY28	28
ASY29	28
ASY50	28
ASY51	28
ASY52	28
ASY54	28
ASY55	28
ASY56	28
ASY57	28
ASY58	28
ASY73	28
ASZ21	44
BC107	14
BC108	14
BC109	15
BC113	11
BC114	17
BC115	17
BC116	17
BC117	20
BC118	11
BC119	33
BC120	88
BC125	13
BC126	20
BC132	13
BC134	20
BC135	13
BC136	17
BC137	17
BC139	44
BC140	33
BC141	33
BC142	33
BC143	33
BC145	50
BC147	11
BC148	11
BC149	13
BC150	20
BC151	22
BC152	19
BC153	31
BC154	33
BC157	20
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BC160	50
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BC170	13
BC171	16
BC172	16
BC173	16
BC174	16
BC175	24
BC177	21
BC178	21
BC179	21
BC180	27
BC181	27
BC182	16
BC182L	16
BC183	16
BC183L	16
BC184	22
BC184L	22
BC186	31
BC187	31
BC207	12
BC208	12
BC209	13
BC212L	14
BC213L	14
BC214L	18
BC225	28
BC226	39
BC301	30
BC302	27
BC303	35
BC304	40
BC440	34
BC460	40
BCY30	27
BCY31	29
BCY32	33
BCY33	24
BCY34	28
BCY70	16
BCY71	22
BCY72	16
BCZ10	22
BCZ11	28
BCZ12	28
BD115	68
BD116	88
BD121	66
BD123	72
BD124	76
BD131	55
BD132	66
BD133	72
BD135	44
BD136	44
BD137	50
BD138	55
BD139	61
BD140	66
BD155	88
BD175	66
BD176	66
BD177	72
BD178	72
BD179	72
BD180	77
BD185	72
BD186	72
BD187	77
BD188	77
BD189	83
BD190	83
BD195	94
BD196	94
BD197	99
BD198	99
BD199	£1·05
BD199	£1·05
BD200	£1·05
BD205	88
BD206	88
BD207	£1·05
BD208	£1·05
BDY20	£1·10
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BF115	27
BF117	50
BF118	77
BF119	77
BF121	50
BF123	55
BF125	50
BF127	55
BF152	61
BF153	50
BF154	50
BF155	77
BF156	53
BF157	61
BF158	61
BF159	66
BF160	44
BF162	44
BF163	44
BF164	44
BF165	44
BF167	24
BF173	24
BF176	39
BF177	39
BF148	33
BF179	33
BF180	33
BF181	33
BF182	44
BF183	44
BF184	28
BF185	33
BF187	30
BF188	44
BF194	18
BF195	18
BF196	16
BF197	16
BF200	50
BF222	£1·05
BF257	50
BF258	66
BF259	94
BF262	61
BF263	61
BF270	39
BF271	33
BF272	88
BF273	39
BF274	39
BFW10	66
BFX29	30
BFX84	24
BFX85	33
BFX86	24
BFX87	27
BFX88	24
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BFY53	19
BSX19	17
BSX20	17
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BSY26	17
BSY27	17
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C428	22
C441	33
C442	33
C444	39
C450	24
MAT100	21
MAT101	22
MAT120	21
MAT121	22
MJE2955	95
MJE3055	62
MJE3440	55
MPF102	46
MPF104	41
MPF105	41
OC19	39
OC20	70
OC22	52
OC23	54
OC24	62
OC25	42
OC26	32
OC28	55
OC29	55
OC35	46
OC36	55
OC41	22
OC42	27
OC44	17
OC45	14
OC70	11
OC71	11
OC72	16
OC74	16
OC75	17
OC76	17
OC77	28
OC81	17
OC81D	17
OC82	17
OC82D	17
OC83	22
OC139	22
OC140	22
OC169	28
OC170	28
OC171	28
OC200	28
OC201	31
OC202	31
OC203	28
OC204	28
OC205	39
OC309	44
OCP71	48
ORP12	48
ORP60	44
ORP61	44
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2G302	21
2G303	21
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2G309	39
2G339	22
2G339A	18
2G344	20
2G345	18
2G371	18
2G371B	13
2G373	19
2G374	19
2G377	33
2G378	18
2G381	18
2G382	18
2G401	33
2G414	33
2G417	28
2N388	39
2N388A	61
2N404	22
2N404A	31
2N524	46
2N527	54
2N598	46
2N599	50
2N696	14
2N697	15
2N698	27
2N699	39
2N706	09
2N706A	10
2N708	18
2N711	33
2N717	39
2N718	27
2N718A	55
2N726	31
2N727	31
2N743	22
2N744	22
2N914	16
2N918	33
2N929	23
2N930	23
2N1131	22
2N1132	24
2N1302	16
2N1303	16
2N1304	19
2N1305	19
2N1306	23
2N1307	23
2N1308	26
2N1309	26
2N1613	22
2N1711	22
2N1889	35
2N1890	50
2N1893	41
2N2147	79
2N2148	63
2N2160	66
2N2192	39
2N2193	39
2N2194	39
2N2217	24
2N2218	22
2N2219	22
2N2220	24
2N2221	22
2N2222	22
2N2368	19
2N2369	16
2N2369A	16
2N2411	27
2N2412	27
2N2646	52
2N2711	23
2N2712	23
2N2714	23
2N2904	19
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2N2905	23
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2N2907	22
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2N2923	16
2N2924	16
2N2925	16
2N2926G	14
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2N2926B	11
2N3010	77
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2N3054	51
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2N3392	16
2N3393	16
2N3394	16
2N3395	19
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2N3525	83
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2N3646	10
2N3702	13
2N3703	13
2N3704	14
2N3705	13
2N3706	13
2N3707	14
2N3708	09
2N3709	10
2N3710	10
2N3711	10
2N3819	31
2N3820	55
2N3821	39
2N3823	31
2N3903	31
2N3904	33
2N3905	31
2N3906	30
2N4058	13
2N4059	11
2N4060	13
2N4061	13
2N4062	13
2N4284	19
2N4285	19
2N4286	19
2N4287	19
2N4288	19
2N4289	19
2N4290	19
2N4291	19
2N4292	19
2N4293	19
2N5172	13
2N5294	60
2N5457	35
2N5458	35
2N5459	44
2N6121	75
28301	55
28302A	46
28302	46
28303	61
28304	77
28305	86
28306	86
28307	86
28321	62
28322	46
28322A	46
28323	62
28324	77
28325	77
28326	77
28327	77
28701	46
40361	44
40362	50

DIODES AND RECTIFIERS

Type	Price p
AA119	9
AA120	9
AA129	9
AAY30	10
AAZ13	11
BA100	11
BA116	23
BA126	24
BA148	16
BA154	13
BA155	16
BA156	15
BA173	16
BY100	17
BY101	13
BY105	19
BY114	13
BY124	13
BY126	16
BY127	17
BY128	17
BY130	18
BY133	23
BY164	55
BYX38/30	46
BYZ10	39
BYZ11	33
BYZ12	33
BYZ13	28
BYZ16	44
BYZ17	39
BYZ18	39
BYZ19	31
CG62 (OA91Eq)	6
CG651 (OA70-OA79)	7
OA5	39
OA5 short leads	23
OA10	15
OA47	8
OA70	8
OA79	8
OA81	8
OA85	10
OA90	7
OA91	7
OA95	8

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Type No.	1	25	100+
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72710	45p	43p	40p
72741	40p	38p	35p
72741C	45p	43p	40p
72741P	38p	36p	34p
72748P	38p	36p	34p
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SL702C	50p	45p	40p
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BP935	16p	15p	14p
BP936	16p	15p	14p
BP944	16p	15p	14p
BP945	30p	28p	25p
BP946	15p	14p	13p
BP948	30p	28p	25p
BP951	70p	65p	60p
BP962	15p	14p	13p
BP9093	45p	43p	40p
BP9094	45p	43p	40p
BP9097	45p	43p	40p
BP9099	45p	43p	40p

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7407	0·39	0·34	0·31	7476	0·44	0·43	0·42	74153	1·20	1·10	1·00
7408	0·25	0·24	0·23	7480	0·74	0·71	0·64	74154	1·98	1·90	1·75
7409	0·25	0·24	0·23	7481	1·30	1·25	1·20	74155	1·20	1·15	1·10
7411	0·28	0·27	0·26	7482	0·90	0·85	0·80	74156	1·20	1·15	1·10
7412	0·30	0·29	0·28	7483	1·20	1·15	1·05	74157	1·20	1·15	1·10
7413	0·32	0·31	0·30	7484	1·10	1·05	1·00	74160	1·73	1·70	1·65
7416	0·40	0·39	0·38	7485	2·00	1·90	1·80	74161	1·73	1·70	1·65
7417	0·40	0·39	0·38	7486	0·35	0·34	0·33	74162	1·73	1·70	1·65
7422	0·30	0·29	0·28	7489	4·00	3·75	3·50	74163	1·73	1·70	1·65
7423	0·40	0·39	0·38	7490	0·74	0·71	0·64	74164	2·20	2·10	2·00
7425	0·40	0·39	0·38	7491	1·10	1·05	1·00	74165	2·20	2·10	2·00
7426	0·40	0·38	0·36	7492	0·74	0·71	0·64	74166	2·35	2·30	2·25
7427	0·40	0·38	0·36	7493	0·74	0·71	0·64	74174	2·00	1·95	1·90
7428	0·45	0·42	0·40	7494	0·85	0·82	0·75	74175	1·40	1·35	1·30
7432	0·40	0·38	0·36	7495	0·85	0·82	0·75	74176	1·60	1·55	1·50
7433	0·42	0·40	0·38	7496	0·96	0·93	0·86	74177	1·60	1·55	1·50
7437	0·45	0·42	0·40	74100	1·50	1·45	1·40	74180	1·60	1·55	1·50
7438	0·45	0·42	0·40	74104	0·70	0·68	0·66	74181	5·00	4·50	4·00
7441	0·74	0·71	0·64	74105	0·70	0·68	0·66	74182	1·50	1·45	1·40
7442	0·74	0·71	0·64	74107	0·44	0·42	0·40	74184	2·40	2·30	2·20
7443	1·20	1·15	1·10	74110	0·60	0·55	0·50	74190	2·15	2·10	2·00
7444	1·20	1·15	1·10	74111	0·95	0·92	0·90	74191	2·15	2·10	2·00
7445	1·98	1·95	1·90	74118	1·10	1·05	1·00	74192	2·15	2·10	2·00
7446	1·20	1·15	1·10	74119	1·50	1·40	1·30	74193	2·15	2·10	2·00
7447	1·10	1·07	1·05	74121	0·50	0·48	0·45	74194	1·90	1·80	1·70
7448	1·10	1·07	1·05	74122	0·88	0·86	0·84	74195	1·60	1·50	1·40
7470	0·32	0·29	0·27	74123	1·58	1·54	1·50	74196	1·73	1·70	1·65
7472	0·32	0·29	0·27	74141	0·85	0·82	0·79	74197	1·73	1·70	1·65
7473	0·41	0·39	0·35	74145	1·58	1·54	1·50	74198	3·45	3·35	3·20
7474	0·41	0·39	0·35	74150	2·50	2·40	2·30	74199	3·10	3·00	2·90

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T6	8	2G344B	OC44
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100	05	07	1N4002	06	10	17	23	75
200	06	10	1N4003	07	12	22	25	1·00
400	08	15	1N4004	08	15	30	38	1·35
600	09	17	1N4005	10	18	36	45	1·90
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5A	TO64	0·39	0·52	0·54	0·62	0·75	0·88
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10A	TO48	0·55	0·63	0·67	0·83	1·07	1·32
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UIC02=12×7402	0·55	UIC50=12×7450	0·55	UIC91=5×7491	0·55
UIC03=12×7403	0·55	UIC51=12×7451	0·55	UIC92=5×7492	0·55
UIC04=12×7404	0·55	UIC53=12×7453	0·55	UIC93=5×7493	0·55
UIC05=12×7405	0·55	UIC54=12×7454	0·55	UIC94=5×7494	0·55
UIC06=8×7406	0·55	UIC60=12×7460	0·55	UIC95=5×7495	0·55
UIC07=8×7407	0·55	UIC70=8×7470	0·55	UIC96=5×7496	0·55
UIC10=12×7410	0·55	UIC72=8×7472	0·55	UIC100=5×74100	0·55
UIC20=12×7420	0·55	UIC73=8×7473	0·55	UIC121=5×74121	0·55
UIC30=12×7430	0·55	UIC74=8×7474	0·55	UIC141=5×74141	0·55
UIC40=12×7440	0·55	UIC76=8×7476	0·55	UIC151=5×74151	0·55
UIC41=5×7441	0·55	UIC80=5×7480	0·55	UIC154=5×74154	0·55
UIC42=5×7442	0·55	UIC81=5×7481	0·55	UIC193=5×74193	0·55
UIC43=5×7443	0·55	UIC82=5×7482	0·55	UIC199=5×74199	0·55
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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
¼	10%	1 Ω–3·9 Ω	E12	1·3p	1·1p
¼	5%	4·7 Ω–1M Ω	E12	1·3p	1·1p
4	10%	1 Ω–10 Ω	E12	8p	7p

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

DEVELOPMENT PACK

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

POTENTIOMETERS

Carbon track 5k Ω to 2M Ω, log or linear (log ¼W, lin ½W).
Single, **14p.** Dual gang (stereo), **49p.** Single D.P. switch, **29p.**

SKELETON PRESET POTENTIOMETERS

Linear: 100, 250, 500 Ω and decades to 5M Ω. Horizontal or vertical P.C. mounting (0·1 matrix).
Sub-miniature 0·1W, **6p** each. Miniature 0·25W, **7p** each.

TRANSISTORS

AC107	16p	BC109	14p	BD115	75p	BF337	46p	ZTX300	18p
AC126	18p	BC115	16p	BD116	60p	BFY50	22p	ZTX302	20p
AC127	18p	BC116	15p	BD124	81p	BFY51	22p	ZTX341	18p
AC128	18p	BC117	23p	BD131	60p	BFY52	22p	ZTX500	18p
AC141K	22p	BC125	15p	BD132	64p	BRY39	41p	ZTX503	25p
AC142	25p	BC142	24p	BD140	66p	MJE340	47p	2N2646	60p
AC165	20p	BC143	21p	BDY32	57p	MJE370	68p	2N2904	28p
AC176	18p	BC147	12p	BF115	32p	OC26	90p	2N2905	32p
AC187	22p	BC148	12p	BF158	22p	OC28	90p	2N2926	12p
AC188	22p	BC149	12p	BF159	22p	OC35	90p	2N3053	31p
AC193K	28p	BC153	18p	BF160	23p	OC42	16p	2N3054	60p
AD140	53p	BC154	18p	BF161	26p	OC44	12p	2N3055	60p
AD143	73p	BC157	15p	BF164	22p	OC45	12p	2N3702	15p
AD149	70p	BC158	15p	BF173	28p	OC70	12p	2N3703	14p
AD161	42p	BC159	14p	BF177	29p	OC71	12p	2N3704	20p
AD162	42p	BC169	15p	BF178	43p	OC72	12p	2N3705	20p
AF114	25p	BC171	13p	BF179	41p	OC75	12p	2N3706	19p
AF115	25p	BC172	22p	BF180	42p	OC81	12p	2N3707	20p
AF116	25p	BC177	20p	BF181	32p	OC82	12p	2N3708	20p
AF117	25p	BC182	15p	BF182	41p	OCP71	35p	2N3709	19p
AF118	50p	BC182L	16p	BF183	43p	ORP12	65p	2N3710	19p
AF121	50p	BC183	15p	BF184	32p	TIP29A	49p	2N3711	19p
AF126	50p	BC183L	16p	BF185	32p	TIP30A	58p	2N3819	32p
AF127	50p	BC184	18p	BF194	14p	TIP31A	62p	2N4062	25p
AF139	53p	BC186	25p	BF195	17p	TIP32A	74p	40360	46p
AF178	48p	BC187	25p	BF196	15p	TIP33A	98p	40361	43p
AF180	50p	BC212	13p	BF197	16p	TIP34A	148p	40362	45p
AF186	[illegible]9p	BC212L	15p	BF200	40p	TIP41A	79p	40363	88p
AF239	48p	BC214L	19p	BF259	25p	TIP42A	90p	40406	44p
BC107	13p	BCY70	21p	BF262	26p	TIP43	35p	40486	90p
BC108	13p	BD112	52p	BF263	26p	ZTX108	18p		

ZENER DIODES

400mW 5% 3·3V to 30V, 12p.

WIREWOUND POTS.

3W, 10, 25, 50 Ω and decades to 100k Ω, 50p.

DIODES

RECTIFIER

BY127	1250V	1A	12p
1N4001	50V	1A	7p
IN4002	100V	1A	8p
1N4004	400V	1A	8p
1N4006	800V	1A	10p
1N4007	1000V	1A	10p

SIGNAL

OA85	7p
OA90	5p
OA91	5p
OA202	7p
1N4148	5p
BA114	8p

SLIDER POTENTIOMETERS

86mm × 9mm × 16mm, length of track 59mm.

SINGLE 10K, 25K, 100K log. or lin. **50p.**

DUAL GANG, 10K + 10K etc. log. or lin. **60p.**

KNOB FOR ABOVE, **12p.**

FRONT PANEL, **90p.**

18 Gauge panel 12in × 4in with slots cut for use with slider pots. Grey or matt black finish complete with fixings for 4 pots.

BRUSHED ALUMINIUM PANELS

12in × 6in, **37p**
12in × 2½in, **14p**
9in × 2in, **12p**

THYRISTORS

2N5060	50V	0·8A	65p
2N5064	200V	0·8A	80p
106F	50V	5A	55p
106D	200V	5A	80p

HEATSINKS—REDPOINT

2W	24p	4W	45p	TO5	Clip	5p	TO1	Single	5p
3W	36p	6W	60p	TO18	Clip	5p	TO1	Double	8p

TRANSFORMERS All have 240V primary

MT30/2	0–12–15–20–24–30V	2A	£3·85
MT50/½	0–19–25–33–40–50V	½A	£2·50
MT50/1	0–19–25–33–40–50V	1A	£3·15
MT50/2	0–19–25–33–40–50V	2A	£4·20
MT60/½	0–24–30–40–48–60V	½A	£3·30
MT60/1	0–24–30–40–48–60V	1A	£4·80
MT60/2	0–24–30–40–48–60V	2A	£6·80

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250V P.C. mounting: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, **3½p**; 0·068μF, **4p**; 0·1μF, **4½p**; 0·15μF, **5p**; 0·22μF, **5½p**; 0·33μF, **7p**; 0·47μF, **9p**; 0·68μF, **12p**; 1·0μF, **14½p**; 1·5μF, **22p**; 2·2μF, **26p.**

MYLAR FILM CAPACITORS 100V

0·001μF, 0·002μF, 0·005μF, 0·01μF, 0·02μF, **3p.** 0·04μF, 0·05μF, 0·068μF, 0·1μF, **6p.**

CERAMIC DISC CAPACITORS

100pF to 10,000pF, **2p** each.

ELECTROLYTIC CAPACITORS

(μF/v) 1/63, 1·5/63, 2·2/63, 3·3/63, 4·7/63, 6·8/40, 6·8/63, 10/25, 10/63, 15/16, 15/40; 15/63, 22/10, 22/25, 22/63, 33/6·3, 33/16, 33/40, 47/4, 47/10, 47/25, 47/40, 68/6·3, 68/16, 100/4, 100/10, 100/25, 150/6·3, 150/16, 220/4, 220/6·3, 220/16, 330/4, **6p.** 47/63, 100/40, 150/25, 220/25, 330/10, 470/6·3, **7p.** 68/63, 150/40, 220/40, 330/16, 1000/4, **10p.** 470/10, 680/6·3, **11p.** 100/63, 150/63, 220/63, 1000/10, **12p.** 470/25, 680/16, 1500/6·3, **13p.** 470/40, 680/25, 1000/16, 1500/10, 2200/6·3, **18p.** 330/63, 680/40, 1000/25, 1500/16, 2200/10, 3300/6·3, 4700/4, **21p.**

SOLID TANTALUM BEAD CAPACITORS **12p**

0·1μF	35V	2·2μF	35V	22μF	16V
0·22μF	35V	4·7μF	35V	33μF	10V
0·47μF	35V	6·8μF	25V	47μF	6·3V
1·0μF	35V	10μF	25V	100μF	3V

VEROBOARD

	0·1	0·15
2½ × 3¾	26p	28p
2½ × 5	28p	28p
3¾ × 3¾	28p	28p
3¾ × 5	34p	34p
17 × 2½	95p	77p
17 × 3¾	130p	108p
17 × 3¾ (plain)	86p	72p
17 × 2½ (plain)	—	51p
2½ × 5 (plain)	—	18p
2½ × 3¾ (plain)	—	15p
Pin insertion tool	62p	62p
Spot face cutter	52p	52p
Pkt. 50 pins	20p	20p

JACK PLUGS AND SOCKETS

Standard screened	32p	2·5mm insulated	13p
Standard insulated	18p	3·5mm insulated	13p
Stereo screened	44p	3·5mm screened	22p
Standard socket	15p	2·5mm socket	14p
Stereo socket	22p	3·5mm socket	14p

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2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin
Plug 12p. Socket 8p.
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6 way screened cable, 31p/metre.

BATTERY ELIMINATOR **£1·70**

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

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0·01μF	12p	0·047μF	16p	0·22μF	28p
0·022μF	14p	0·1μF	20p	0·47μF	36p

POLYSTYRENE CAPACITORS 160V 2½%

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

SMOKE AND COMBUSTIBLE GAS DETECTOR—GDI

The GDI is the world's first semiconductor that can convert a concentration of gas or smoke into an electrical signal. The sensor decreases its electrical resistance when it absorbs deoxidizing or combustible gases such as hydrogen, carbon monoxide, methane, propane, alcohol, North Sea gas, as well as carbon-dust containing air or smoke. This decrease is usually large enough to be utilized without amplification. Full details and circuits are supplied with each detector. Detector GDI **£2.** Smoke and Gas Detector Kits, mains operated with audible alarm **£5·60.** Mains operated Meter Indicator **£7·90.** Mains/Battery Gas Leak Detector **£12·60.** 12/24V Battery operated **£8·40.** 12V Battery operated Two Remote Sensors **£12·80.** NOTE. The battery operated kits incorporate our patented circuit to minimise battery drain. Typically 120mA for 12V. These kits contain all parts required with the exception of case. Suitable case mains operated kit **£1·60.** Battery operated kits **£5.**

PRINTED BOARD MARKER **97p**

Draw the planned circuit onto a copper laminate board with the P.C. Pen, allow to dry, and immerse the board in the etchant. On removal the circuit remains in high relief.

METERS

2" Scale-500μA, 1mA, 10mA, 100mA **£3·30**

BULGIN MAINS CONNECTORS

3 Pin	1½A	Chassis Plug	18p
		Line Socket	22p
3 Pin	3A	Chassis Plug	24p
		Line Socket	28p
3 Pin	5A	Chassis Plug	24p
		Line Socket	32p
3 Pin	1½A	Chassis Socket	30p
		Line Plug	24p
3 Pin	3A	Chassis Socket	34p
		Line Plug	40p
2 Pin	5A	Line Plug	20p

THERMISTORS

VA1005	15p
VA1026	15p
VA1033	15p
VA1055S	15p
VA1066S	15p
VA1077	15p
R53	£1·35

WAVECHANGE SWITCH 33p

1p 12W, 3p 4W, 2p 2W, 2p 6W, 4p 3W

ROTARY MAINS SWITCH

D.P. 2A **35p**

LINEAR IC's

709	14 pin DIL	40p
741	8 pin DIL	40p
741	14 pin DIL	38p
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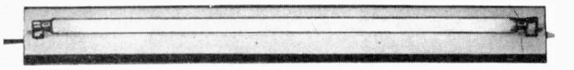
747	14 pin DIL	85p
748	8 pin DIL	45p

DIL Sockets 14 pin and 16 pin **16p**

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

12 VOLT FLUORESCENT LIGHTING



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(SHORT LEAD)	20p PAIR
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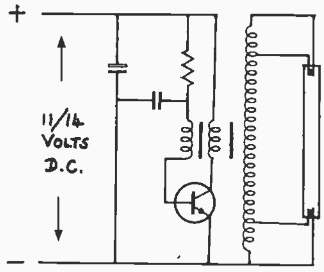
TUBE, 18in-15W or 21in-13W	45p

(NOTE: TUBE ONLY SUPPLIED IF CASE ORDERED, TO PREVENT POSTAL DAMAGE)

13W FITTING READY BUILT AND TESTED—INCLUDING TUBE (POSTAGE 30p) £3·75

POST/PACKING, 25p PER ORDER EXCEPT WHERE SHOWN



NEW IMPROVED CIRCUIT!

Drives 21in 13W
18in 15W
or adaptable for
2 × 12in 8W

SMALL ELECTROLYTICS

Ref No.	Capacity	Voltage	Price
H8/3	3µF	50V	4p
H8/3A	4µF	50V	4p
H8/5	5µF	10V	4p
H8/6A	10µF	10V	4p
H8/8A	16µF	16V	4p
H8/9A	20µF	70V	4p
H810	22µF	50V	4p
H8/11	25µF	12V	4p
H8/12A	30µF	10V	4p
H8/13A	32µF	50V	4p
H8/14	40µF	25V	5p
H8/14A	40µF	16V	4p
H8/15A	40µF	35V	4p
H7/1A	50µF	10V	4p
H7/2A	64µF	2·5V	2p
H7/4	64µF	15V	4p
H7/9A	125µF	4V	4p
H7/10A	160µF	2 5V	3p
H7/11	160µF	25V	6p
H7/11A	150µF	16V	5p
H7/14	220µF	50V	10p
H7/14A	220µF	16V	6p
H7/15	220µF	25V	5p
H7/15A	220µF	35V	10p
H6/1A	250µF	4V	3p
H6 3A	320µF	2·5V	3p
H6/4	320µF	10V	4p
H6/5	330µF	25V	10p
H6/5A	330µF	35V	15p
H6/8A	470µF	35V	20p

Postage 25p per order

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SELF SERVICE

It is a healthy sign that the throw-away philosophy which has pervaded so many aspects of life is now being questioned, mainly because of the disregard for conservation of natural resources it encourages. The uncontrolled and thoughtless exploitation of irreplaceable materials has finally become a major concern, throughout the world.

In this connection, the role of electronics cannot escape some censure. The vast growth of electronic products has been paralleled by a fall-off in servicing facilities generally available. Clearly many of the cheaper consumer products are not intended to receive any drastic servicing treatment in the course of their normal life. When they prove troublesome their destination, all too commonly, is the dustbin. On a commercial basis this makes sense, it must be admitted, for the cost of a skilled repairman's time would very quickly exceed the market value of the article. It is only the non-profit orientated private enthusiast who is likely to undertake such uneconomical work.

With larger and more expensive equipment, e.g. colour television sets, servicing still remains an indispensable feature during the normal working life of the product. Modular construction aids rapid on-the-spot servicing, although an element of the throw-away philosophy undoubtedly persists at the individual module level.

It has always been claimed that the increased use of i.c.'s will enhance the reliability factor and so reduce the number of failures in electronic equipment. This should help ease the demand upon the overtaxed service technicians. Yet, as in other branches of engineering, the supply of competent service technicians is likely to continue to lag far behind the demand.

One consequence of this shortage of skilled professionals and the accompanying rise in labour charges is the growth of do-it-yourself enterprise, in many different fields. The private motorist offers perhaps the most obvious example of the greatly increasing application of "self service". Car maintenance depends upon specialist knowledge and working experience. It is also a field where electronic instruments can play quite an important part—not least for the amateur. In many instances the electronics constructor can apply his interest in this subject to help out if or when he is compelled to undertake his own car maintenance. The Dwell Meter described in this issue is another valuable instrument that seems destined to repay its cost over and over again in the austere times which we have been warned lay immediately ahead.

F.E.B.

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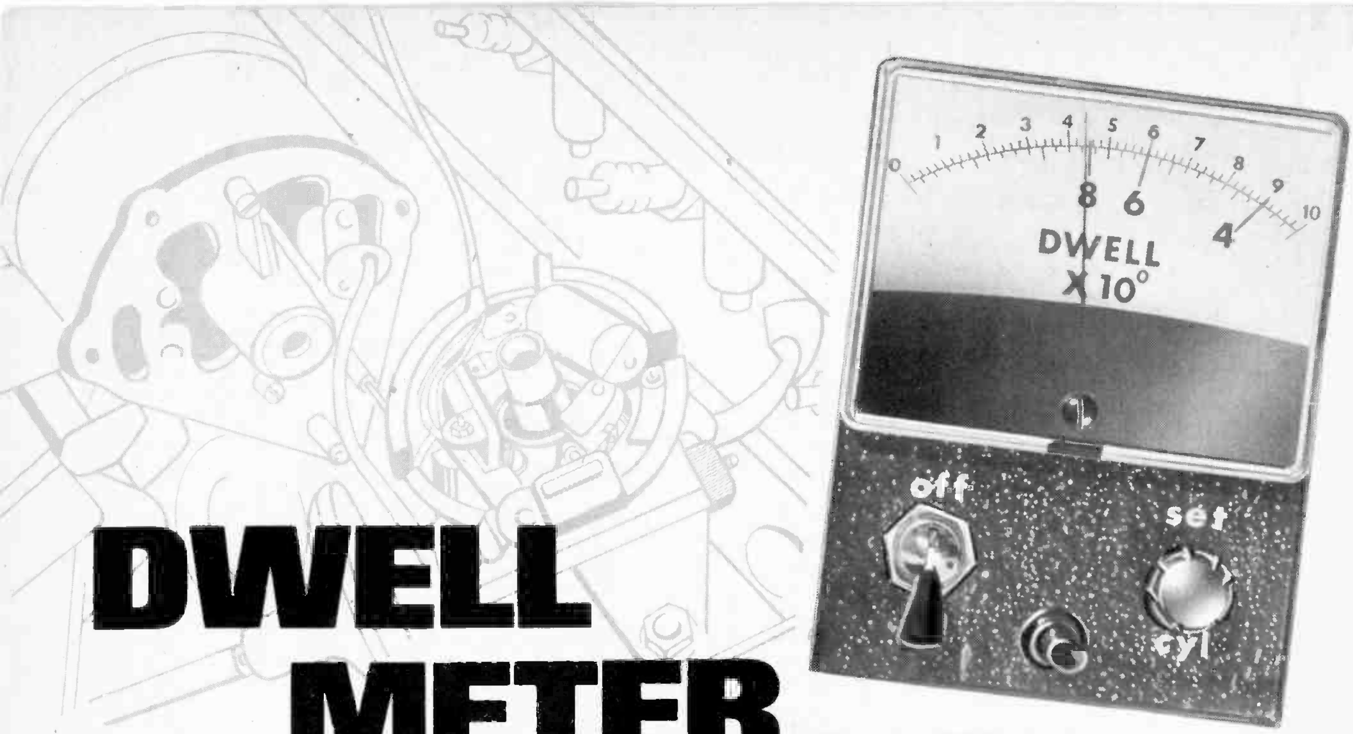


DWELL METER

BY S. JONES

This dwell meter was designed to facilitate automobile contact breaker adjustments without the use of feeler gauges. In this way worn contact breaker points can be adjusted, a task not otherwise possible.

Distributor mechanical wear and vacuum advance operation can also be checked. The prototype was checked against the most expensive commercial dwell meters available and no variation between them could be detected.

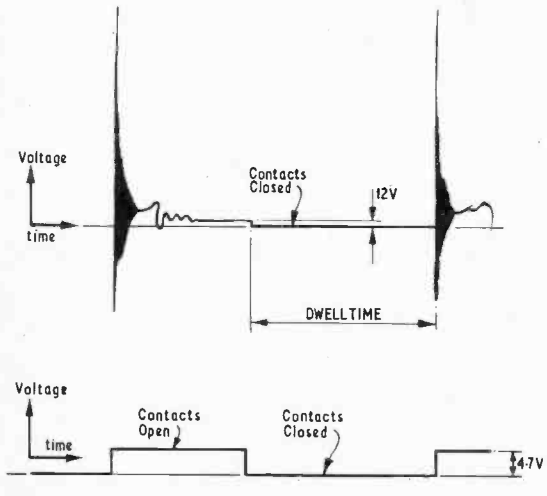


Fig. 1. The waveform at the contact breaker points shown here in the upper graph. The voltage level during the closed-points period is only 12V just to give an idea of scale. The lower graph shows the output from the bridge rectifier used in the following circuit diagram

WHAT IS DWELL ANGLE?

During the time when the points are closed, called the dwell time, the primary current through the coil builds up producing a magnetic field around the coil. If this magnetic field does not reach sufficient strength, due to too short a dwell time, its collapse when the points open may not produce sufficient voltage to cause a spark at the plug.

Dwell time is therefore very important. However, measuring it is difficult as obviously it decreases with increasing engine speed. Thus the angle for which the points remain closed is used and this remains constant through the speed range provided that the points are not moved.

This measurement can be made by examining the potential across the points during their operation.

DESIGN PROBLEMS

Although most ignition systems work on a 6V or 12V supply, an alternating voltage with a peak of up to 300V is produced across the points when they open (see Fig. 1). If this 300V were applied to a transistorised circuit without some modification it is unlikely that the transistors would survive the voltage peaks and for this reason the voltage across the contacts is first rectified and stabilised to produce a voltage suitable for transistor switching as in Fig. 1, lower curve.

CIRCUIT

A full wave rectifier formed by diodes D1 to 4 (Fig. 2) is fed with the signal from the points under test; this rectifies the oscillations shown in the upper part of Fig. 1 to give the lower waveform. R1 limits the current flow to Zener D5 which stabilises the output from the rectifier at 4·7V.

The voltage developed across R3 when the contacts are open makes the base of TR1 positive, turning it on. This in turn switches off TR2 and no current flows through the meter ME1.

COMPONENTS . . .

Resistors
R1 1kΩ
R2 1kΩ
R3 1kΩ
R4 3·3kΩ
All 10% $\frac{1}{10}$W carbon

Potentiometer
VR1 4·7kΩ Lin

Diodes
D1 1N4001
D2 1N4001
D3 1N4001
D4 1N4001
D5 4·7V, 1W Zener

Transistors
TR1 2N2926 (Orange)
TR2 2N2926 (Orange)

Miscellaneous
ME1 1mA or see text
S1 SPST on/off
B1 1·5V battery (Alkaline cell size AA preferable)
Veroboard, 0·1in matrix, 29 × 24 hole rows. Case, 4 × 6 × 1·5in.
Wire, solder, nuts, screws etc.

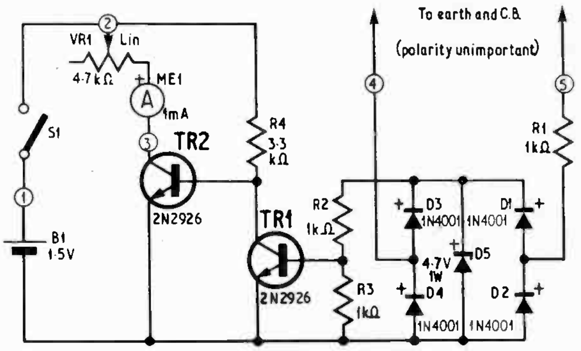


Fig. 2. The circuit diagram of the dwell meter showing the simplicity of the arrangement

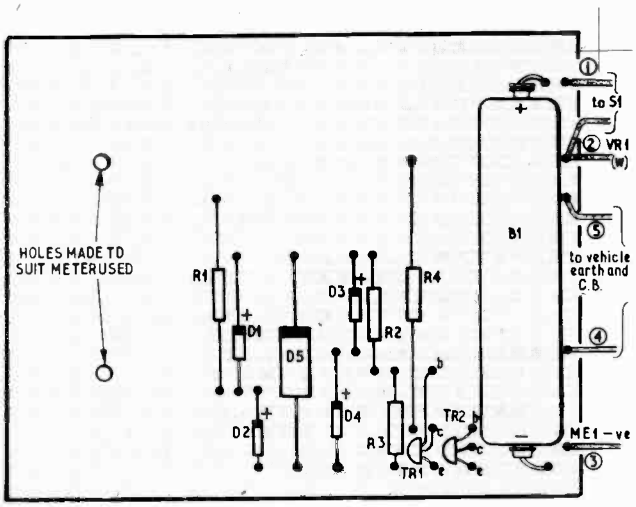


Fig. 3. Component layout and Veroboard cut details for the dwell meter

The Dwell Meter together with the starter switch push unit. Of course, they are not connected electrically, one going to the starter solenoid whilst the other goes to the points

When the contacts close the input to the rectifier is short-circuited by the contacts and the voltage across R3 falls, causing TR1 to be turned off and TR2 on. Current now flows through the meter via VR1.

The "earth" of the vehicle is unimportant as the input to the dwell meter is via a full wave rectifier and for the same reason it is unimportant which way round the input wires are connected across the contacts.

The ratio of on to off periods of TR2 determines the average current through ME1 and this is used to assess the actual dwell angle.

The use of the vehicle battery as a power source, even if stabilised, has been found unsatisfactory and so a 1·5V alkaline cell is recommended. This has a shelf life of 2 years and is totally leak-proof. A standard pen cell could be used, but leakage could be a problem.

The meter ME1 can be almost any value, both 1mA and 100μA have been used and VR1 set accordingly.

CONSTRUCTION

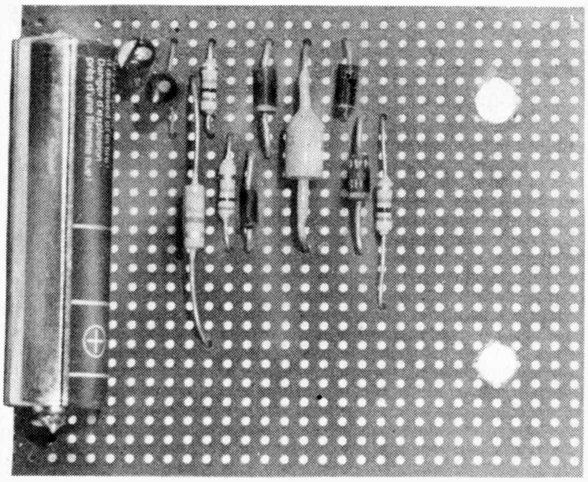
All components are mounted on 0·1in matrix Veroboard 3in × 2·5in which can, if desired, be mounted direct onto the meter terminals. A board layout is shown in Fig. 3. Holes may be drilled anywhere in the last inch of the board as this has been isolated from the rest of the circuit.

The board can be mounted with the copper side outwards if a shallow case is to be used, but the case itself, if metal, must not be connected to the circuitry as the case will no doubt come into contact with the vehicle chassis during normal use.

The battery is soldered direct to the Veroboard though if preferred small clips could be used, or the battery mounted separately.

CALIBRATION

With a normal 0 to 10 scaled meter, all that is required is to change the figures to 0° to 100°. Then zero the meter needle on to 90° for a 4-cylinder engine using VR1. The meter is then ready for use reading dwell angle from 0 to 90° with a linear scale. For 6-cylinder engines set the needle to 60°, 8-cylinder to 45°, 12-cylinder to 30°, i.e. 360 divided by the number of cylinders. These zero marks can be put onto the scale for future reference as can be seen in the photographs.



Component layout on the Veroboard used in the prototype. Note the use of the alkaline cell power source

USING THE DWELL METER

Switch on and zero the dwell meter as explained above to suit the engine being examined. Connect one of the input cables to a good earth and the other to the terminal on the coil which is connected to the distributor contacts; this may be marked CB, positive or negative, depending on the age and "earth" of the vehicle.

Remove the distributor cap and rotor arm and loosen the contact breaker fixing screws so that with a screwdriver in the adjusting slot the points can be adjusted but are not loose. Switch on the ignition and while the starter motor turns over the engine, move the contact breakers with the screwdriver in the adjusting slot until the dwell is correct for your vehicle.

Tighten the screws, replace the rotor arm and distributor cap. The points are now adjusted. It is now advisable to time the engine using the timing lamp in the January issue. Always dwell then time, not the other way about.

Whilst this is a normal procedure in commercial workshops, some owners might prefer to remove the spark-plugs before turning the engine over so as to reduce the load on the starter.

DWELL ANGLES

If the dwell angle only requires checking then connect the dwell meter as described above, but run the engine at idle speed and read the dwell angle in the normal way.

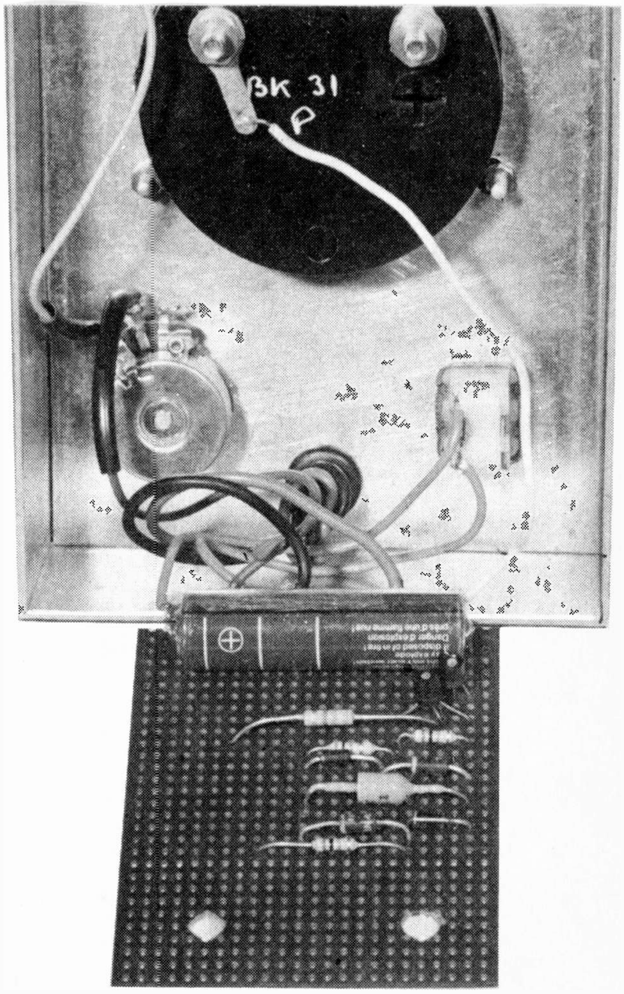
The dwell angles for 4-cylinder engines are as follows:

Autolite distributor	40°	Vauxhall/Bedford
Lucas distributor	60	B.L.M.C.
A.C. Delco distributor	37°	Ford

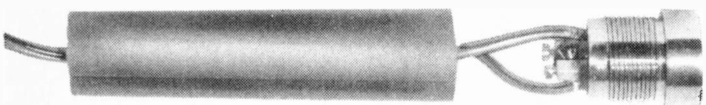
With the Autolite and Delco 4-cylinder distributors the dwell angle will increase when the vacuum advance mechanism operates. This is normal.

The great variety of distributors fitted to 6, 8 and 12-cylinder engines makes listing dwell angles difficult, but most libraries now carry a good selection of manuals as do book shops and they will be only too glad to let you peruse the relevant pages.

To check distributor wear, disconnect the vacuum unit and note the dwell angle at idle speed. Increase speed to 3,000 r.p.m., noting the dwell angle again. A variation of more than 3 indicates distributor bearing wear which may, depending on the exact nature of the wear, affect the running of the engine.



View inside the prototype Dwell Meter showing the simple interwiring between the meter, board and external vehicle circuit



The manual starter switch is simply a push-switch which is itself a push fit in a length of plastic tube to make a comfortable handle. The cable can be locked in position using wax or sealing compound

REMOTE STARTER

Some readers may have considerable difficulty in operating the starter, as in the case where it is actuated by the ignition switch, and at the same time moving the contacts. Where the starter solenoid is not operable mechanically, a remote starter overcomes the problem.

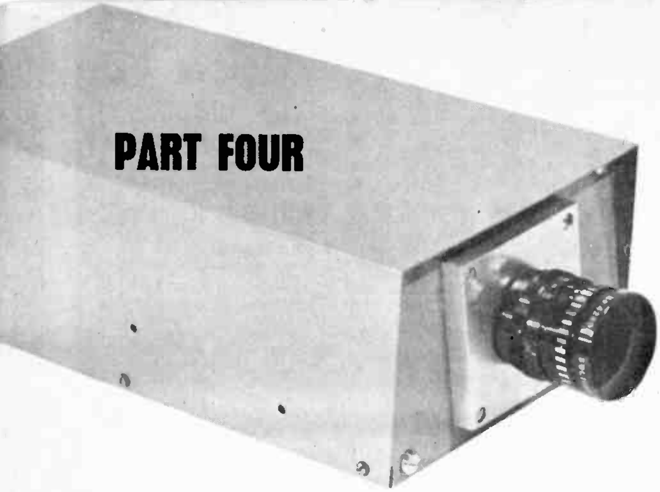
Obtain a length of stout cable, to one end fit a crocodile clip and to the other a ¼in Lucar connector. At the centre break the cable and fit a push-to-make switch rated at at least 5A. In the version shown here a Bulgin switch was pushed into a length of plastic tube for convenience.

Locate the starter motor solenoid, which may be mounted on top of the starter motor or elsewhere in the engine compartment, and look for a single wire feeding to an isolated Lucar spade. Remove the distributor cap and then have someone turn the engine over briefly with the ignition key and disconnect this cable, the starter motor should stop if the correct cable has been selected.

If you are confronted by two small Lucar spades, one on either side of the solenoid, remove each in turn until the starter motor stops. The other forms part of the ignition system and should be left in place.

Now attach the crocodile clip to the unearthed battery terminal and the Lucar connector to the solenoid operating terminal previously located. Push the button and the starter will operate. On no account remove or make a connection to the two bolt connections of the solenoid or any wire attached to them.

Turning the engine over with the starter for what may seem quite lengthy periods to some readers is normal in the garage trade when setting tappets for instance. No damage will be caused unless the time taken for adjustment is excessive, but for those who wish, the load may be considerably lightened by removing the spark plugs. ★



PART FOUR

PE CCTV MONOCHROME CAMERA

By G. D. BISHOP

U.H.F. MODULATORS: *A CHOICE OF TWO*

A CCTV system normally consists of a camera or group of cameras connected via a fade or switch unit to a CCTV monitor. The monitor is merely a cathode ray tube which is driven by a video amplifier and the normal scan coils and timebase circuits as would be found in a domestic television receiver. A domestic TV set can, therefore, be used as a monitor in one of two ways; the CCTV camera signal can be fed to the video amplifier input direct necessitating internal modifications to the TV set, or the camera signal can be modulated onto the normal u.h.f. carrier frequencies and applied to the usual aerial socket.

No modifications to the receiver are needed if the latter method is adopted and this article describes the construction of such a modulator using a standard domestic receiver u.h.f. tuner as the modulating circuit. The CCTV signal could be applied direct to the modulator but to avoid any distortion of the signal a small video amplifier is included, together with a low voltage power supply.

For those constructors who would prefer to build from a simple kit with instructions, an excellent modulator is available from Crofton Electronics for £7·30. Details are given in Fig. 4.5.

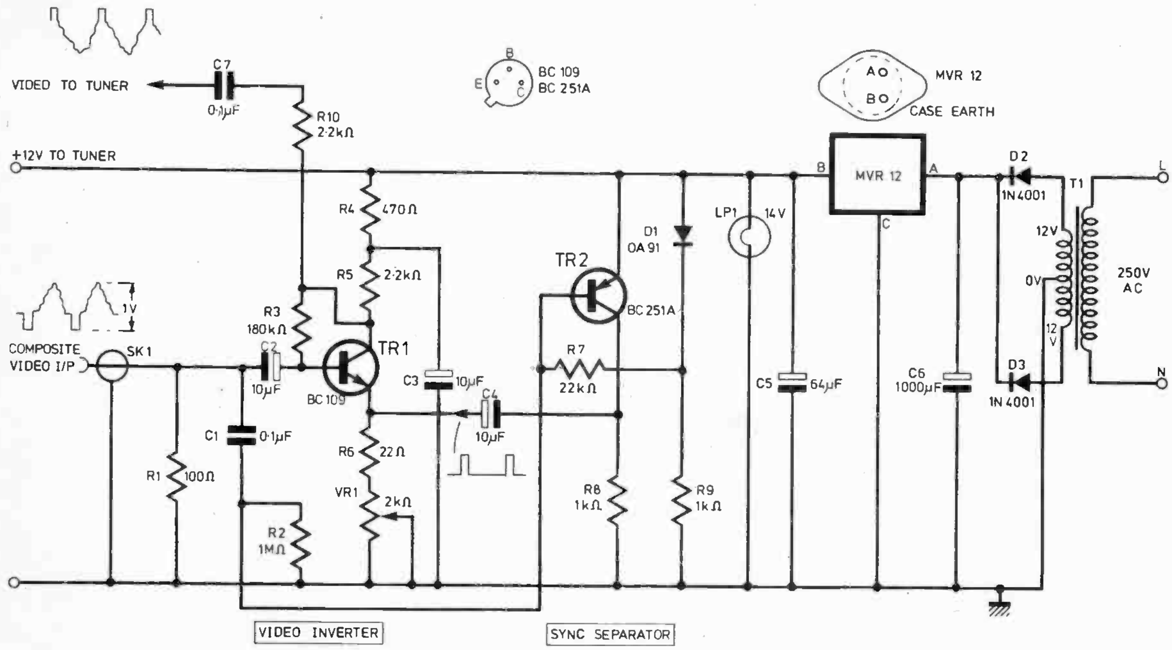


Fig. 4.1. Circuit diagram of sync separator and video inverter

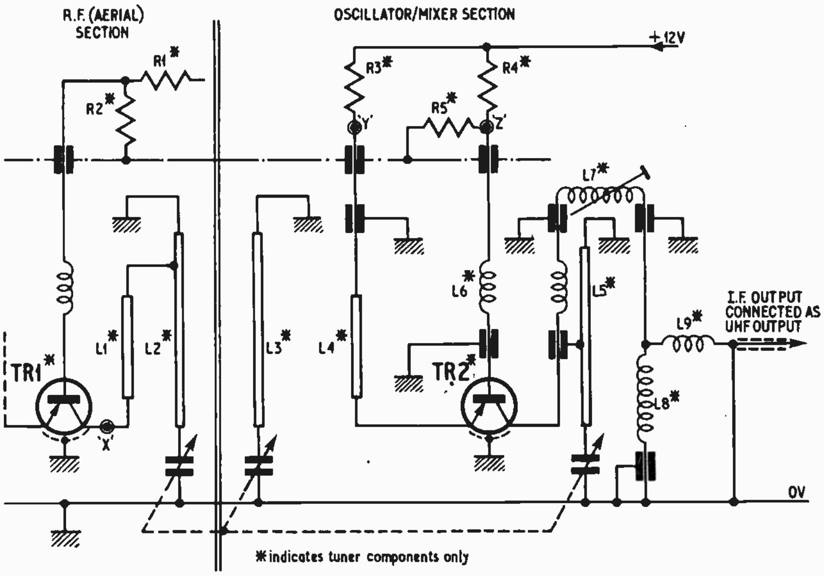


Fig. 4.2. Showing modifications and connections to typical u.h.f. tuner. All straight line inductances are lecher bars

BASIC PRINCIPLES

Part of the modulator (the modified oscillator section of a u.h.f. tuner) comprises a grounded base *pnp* or *npn* transistor connected as a regenerative ultra-high-frequency oscillator and mixer circuit. In this design the aerial signal which would normally be fed to this transistor to mix with the oscillator sinewave is disconnected and replaced by the CCTV signal. The signal is applied to the transistor emitter (grounded base input) and in order to generate negative modulation, identical with normal u.h.f. transmissions an inverted signal must be provided. Camera signal outputs are usually positive video signals and so a single transistor inverter precedes the tuner input.

THE CIRCUIT

Fig. 4.1 shows the video inverter and sync separator with a conventional power supply centred around a 12 volt regulator unit MVR-12, providing +12V to the tuner, TR1, TR2 and an indicator lamp. The input CCTV signal is correctly matched at 75 ohms by R1 and the transistor input impedance and is amplified with approximately unity gain in TR1. The video gain can be adjusted with VR1, a front-panel control, which with R6 provides negative feedback to increase the bandwidth. R4 and C3 decouple TR1 and the output signal is taken via R10 and C7 to the tuner.

The input signal is also taken via C1 to TR2, connected as a sync separator which is switched on only by the negative sync pulses at its base, this being a *pnp* transistor in common emitter connection. D1 provides constant bias to the base and the amplified inverted sync pulses are fed through C4 to TR1 emitter where they add to the video signal at the collector. Any *pnp* transistor which is silicon planar will suffice.

TUNER MODIFICATIONS

Before any u.h.f. tuner modifications are undertaken a few words on general tuner construction might enable prospective constructors to approach this task with more confidence.

The tuner, like many other radio/TV tuners comprises an r.f. section where the aerial signal is selected and amplified, and an oscillator/mixer stage where a generated sinewave is mixed with the r.f. to produce a constant carrier frequency i.f. of 39·5MHz in the case of 625-line TV.

Tuning is carried out with very small inductances called lecher bars which are strips of metal as seen in Fig. 4.3. Each lecher bar is tuned with one section of the tuning gang capacitance in parallel with a small trimmer capacitor. The tuner casing is split into four or five mechanical sections, each of which is a resonant cavity and which is critically tuned to the required frequency. The placing of every component is critical and no component other than those indicated must be touched.

The r.f. section is disconnected by cutting TR1 collector at point X in Fig 4.2. The next step is to

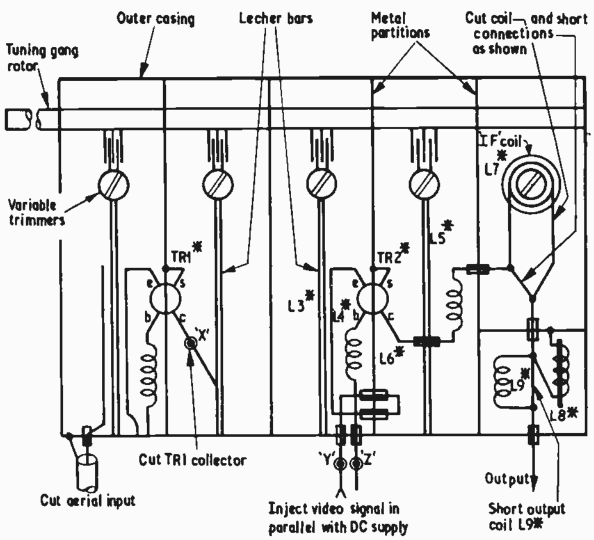
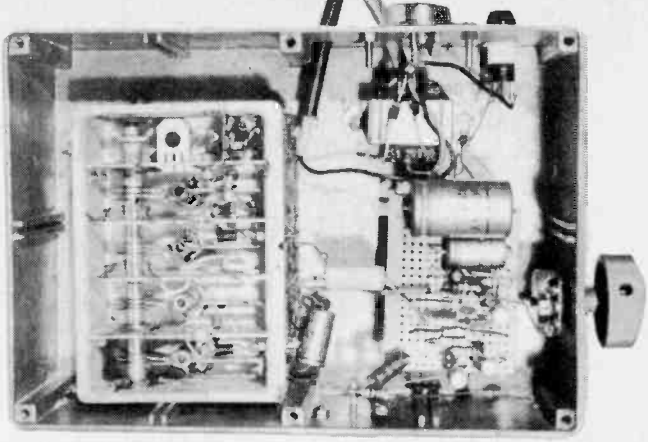


Fig. 4.3. Physical details of modifications and connections to typical tuners

disconnect the output tuned circuits which, if still tuned to 39·5MHz, would attenuate the u.h.f. signal on 450 to 850MHz approximately. The i.f. coil L7 is cut and its place taken by a shorting link. Similarly the output coil L9 is shorted out. No other modifications are necessary inside the tuner casing.

The shorting links are of tinned 20s.w.g. or 22s.w.g. copper wire and are as short as possible and not grounding to chassis.

The aerial input coaxial lead is cut or desoldered and a coaxial lead is soldered on the output connection where the i.f. lead was situated, making the braiding as short as possible. Position Y is then located on the circuit diagram and on the component layout as in Fig. 4.2 and 4.3, this being the point which is to be connected to the video amplifier of Fig. 4.3. There will be d.c. voltage on this point of about 6 volts from R3*. If difficulty is experienced in



COMPONENTS . . .

Resistors

- R1 100 Ω
- R2 1M Ω
- R3 180k Ω
- R4 470 Ω
- R5 2·2k Ω
- R6 22 Ω
- R7 22k Ω
- R8, R9 1k Ω
- R10 2·2k Ω
- All ¼ watt 10% carbon

Capacitors

- C1 0·1μF polyester
- C2–C4 10μF elect. 10V (3 off)
- C5 64μF elect. 25V
- C6 1,000μF elect. 25V

Potentiometer

- VR1 2k Ω lin.

Transistors

- TR1 BC109
- TR2 BC251A *or* BC477

Diodes

- D1 OA91
- D2, D3 IN4001

Transformer

- T1 Mains transformer 240V pri. 12–0–12V, 50mA sec.

Miscellaneous

Transistor u.h.f. tuner assembly (type immaterial) SK1—75 Ω coaxial chassis mounting socket LP1—14V miniature indicator lamp, Veroboard 0·1in matrix, 4cm × 5cm, metal case 12cm × 17cm × 4cm.

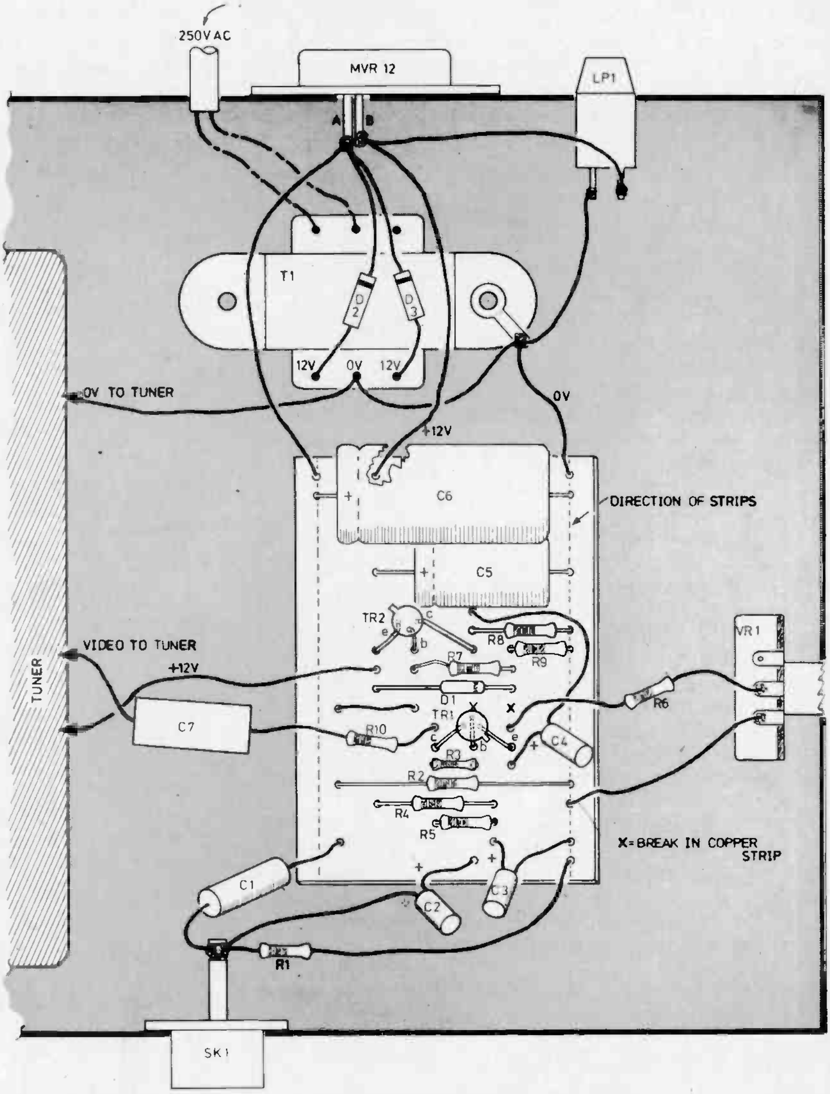


Fig. 4.4. Component layout of sync separator, video inverter and power supply. Tuner unit is adjacent

obtaining good results from point Y, point Z can be substituted this time there being phase inversion in TR2*. (components with an asterisk merely refer to those components in a typical tuner). The cause of the trouble possibly being the fact that the tuner chosen has a negative supply voltage or the CCTV input is inverted.

SCREENING ESSENTIAL

The push-button switch assembly is not required for the tuner but the copper screening cover is essential to avoid interference pick-up. Most transistor tuners require a 12 volt supply with the casing connected to the negative (earth) potential as in Fig 4.2. Location of this 12 volt rail must be carried out with reference to the circuit diagram of the tuner used.

On many receivers, this is obtained via a suitable dropper resistor (10 kilohms or thereabouts) from the 200V valve supply in the i.f. strip. If this is the case then bypass this dropper resistor together with any r.f. gain control, a.f.c. connection or a.g.c. connections which can be ignored or disconnected.

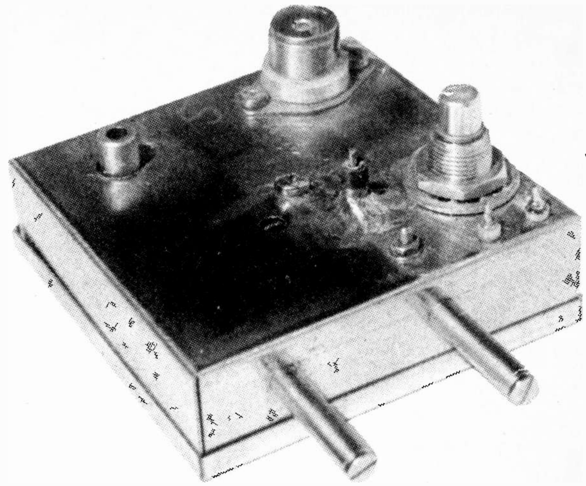
A varicap tuner can also be used as a modulator, similar modifications being necessary using the correct circuit diagram. Two points to mention on varicap tuners are the absence of mechanical tuning gang capacitors and small internal size. If a carrier frequency control is used therefore a potentiometer must be taken to the outside case which will vary the varicap tuning voltage. Due to the small size, great care must be taken when shorting the coils L7* and L9*.

Finally, all TV transistor tuners are different in appearance and their circuits are not identical, their operations, however, are similar and it is not a difficult task for the experienced electronics constructor to relate the circuit and layout of Fig 4.2 and 4.3 to the tuner in question.

Any tuner from a monochrome or colour receiver, single standard in preference, will be suitable. Integrated tuners with u.h.f./v.h.f. combined are too complex and cannot be used, also valve tuners cannot be used.

CONSTRUCTION

The tuner, video printed veroboard panel and power supply will fit into a metal case of dimensions 12cm by 17cm by 4cm deep and are laid out as



The completed Crofton unit

seen in Fig. 4.4. The power supply leads must be kept as short as possible to prevent hum pick-up and the video leads to and from the video panel should be short to avoid interference pick-up. The tuner spindle is passed through a hole in the case so that a knob can be screwed on for carrier frequency adjustment, similarly the video gain potentiometer is screwed onto the case as shown. The power supply regulator is screwed to the chassis after drilling 4mm holes for the input and output leads, the case of the MVR-12 is earthed.

TESTING

The camera is connected to the input socket and the output plugged into a TV aerial socket. A picture should appear on the screen when the carrier frequencies are adjusted to be the same. Adjustment of the gain control will give 'contrast' control and loss of sync when very high or very low. If trouble is experienced in obtaining good results it might be advisable to check the tuner modifications, the polarity of the input video signal or move the carrier frequency up or down the band since the

continued on page 1074

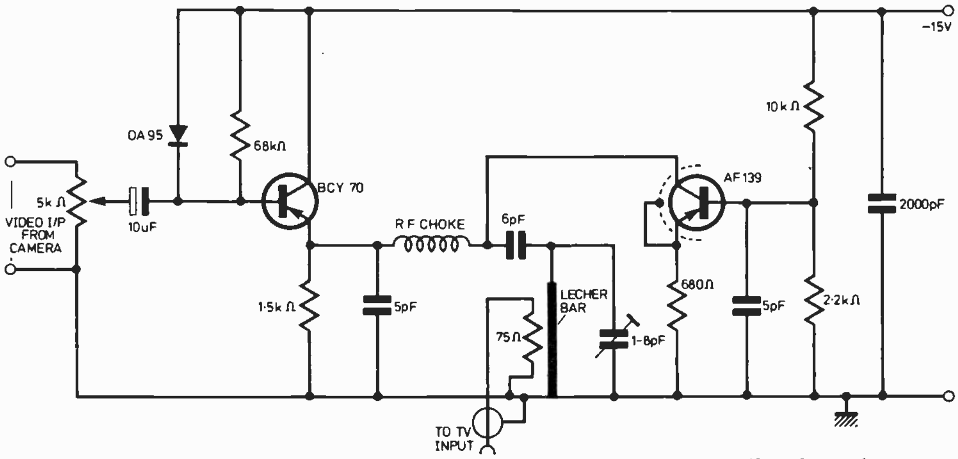
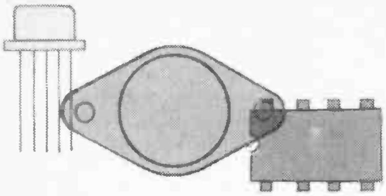


Fig. 4.5. Circuit of Crofton Modulator. For effective operation layout is critical



THE NEXT DECADE ?

Tomorrow's world of electronics as our readers see it . . .

PULSING AHEAD

IT IS the cheapness of integrated circuits and their ability to produce and manipulate pulses that has given the filip to computers and produced the calculator market. Coded systems (pulse code modulation) have already started taking over the telephone system and we shall see the existing network used for other purposes: vision phones, document transmission, remote reading of gas and electricity meters, etc. An inexpensive print-out device would add a new dimension to the phone service and then amateurs would send photos and letters to each other by phone and P.E. will print the results!

Nor are we limited to telephone lines. The national grid could also be used to carry additional information. A start might be made by having an extension speaker system that simply plugs into any mains outlet in the home. This is feasible now.

We could well see sound and vision broadcasts change to a pulse code system so that our receivers will be minicomputers receiving and decoding pulses. This will keep us busy so we may first have time to build our own video tape recorder using present techniques before it becomes obsolete!

In the home those unreliable timing devices on washing machines, etc. will be replaced by an electronic package. Any mechanical function that can be performed electronically will be fair game and this leads us to motor cars, where manufacturers have already made a start. The lighting harness could be replaced by a ring main operated by pulses. An l.e.d. display could give a direct indication of speed, braking, fuel consumption, visibility and other hazards ahead. Scope here for the enthusiastic constructor to keep his banger up to the same standard (electronically) as the most expensive in the land!

William A. L. Smith

BUY BRITISH

THE increasing use of quadraphonic high fidelity sound reproduction and the decreasing quality of the contents so that we end up listening to quadraphonic silence.

The first Megawatt discotheque amplifier goes on sale. A computer process is developed to produce colour information from monochrome films of video recordings enabling all television programmes ever made to be repeated in pseudo-colour.

TV personalities and recording stars are elected Gods by electronic vote counting. Suits are made with more pockets to cater for pocket telephone, pocket television, pocket computer, pocket stereo/quadraphonic receiver, pocket aspirin dispenser.

The BBC announces that the experimental octophonic broadcasts will not become a regular feature.

A new electronic timer is developed for sports events and is adopted for the 1984 Olympics. It enables timing to a nanosecond.

I.c. chips become so small that Mullard issue a photograph of one being engulfed by a bacterium.

British viewers now have a choice of six television channels during the 1984 Olympics; this enables them to watch a different event on each channel.

Sony, National Panasonic, Hitachi, having built factories in this country, urge people to "buy British".

January 1984 issue of Practical Electronics carries the announcement that with effect from February 1984 price will go up to £2·50.

R. N. Soar

GOOD HEALTH

THE following indicates an approach to good health which is positive, as compared with the present system which treats lack of good health, i.e. illness, as the positive factor. When an electrical machine is regularly monitored for its insulation resistance, a progressive lowering of the resistance figure (taking the weather into account) can indicate approaching trouble before disaster actually occurs, and suggest the need for inspection and repair.

It is reasonable to suppose that human beings could be monitored in a similar manner, not for their insulation resistance, but as regards temperature, pulse rate, weight, and as many other biological parameters as are quickly measurable by today's techniques, many of which employ electronic means. These measurements could be fed into a computer, say once a month, and changes over a period compared with the changes expected for a standard person of the age, sex, weight and blood group concerned, probably also taking into account such factors as environment, weight, food intake and type of occupation.

Any unexpected changes developing over the period would then indicate the approach of trouble. After enough experience has been gained with the technique, and if enough biological factors were included in the measurements, it might even be possible to indicate the imminent susceptibility of an individual to a particular disease, and steps taken to counter this.

The great advantage of this method of treatment would be that the patient need not actually become "ill" before treatment is undertaken, and so treatment should be that much easier. Another point is that the biological measurements referred to could be made by technicians, thereby freeing doctors for more urgent tasks. On the one hand, whilst subjects would hopefully be kept in peak condition, on the other the cost of the nation's medical service would be reduced.

W. Higson

OLD AND NEW

POSSIBLY the one sure thing that anyone could predict for electronics in the next ten years would be that the production of valves will cease. Although even the home constructor uses i.c.'s it is suprising to know that valves are still moderately common. When the transistor was first released professional men stuck to the valve. For this reason the valve has hung on and on and so too will the transistor now, and in its turn the i.c.

I would like to see massive efforts (particularly from the Government) in the direction of solar energy control. Alas it will be 50 years or so before the householder hires his "solar energy generator" from the M.E.B. instead of his two-part tarrifmeter!

Could it be that periodicals will act as an interface between the old and new, providing the "old timer" with information to help him understand the new techniques and provide food for thought and ideas for the more advanced readers.

I would like to see more modern test equipment being designed, giving top priority to producing an oscilloscope with the capability of a Tektronix or Hewlett Packard, which might be able to deal with the more advanced projects that you might come up with.

G. R. Wates

NO BOUNDARIES

WHEN making auguries for the next decade, one's imagination must take flight because of what has been born from l.s.i. electronics. Solid state TV is a reality with large scale chip miniaturisations now replacing discretes. Plausibly one could predict a standardised chip TV in the near future just like the standard a.m. discrete superhet of today. Predictions in this area include three dimensional pictures using laser display techniques. This is not just pie-in-the-sky but a possibility raised in a recent RTRA/RRI Conference.

Ceefax and Oracle are words which have insinuated themselves into the language now bristling with electronic acronyms. The U.K. leads the world in this field and recent Government approval of a two year experimental period promises much. This would mean up-to-the-minute print-outs of national and international news providing continuously revised news items, blow-by-blow accounts of stock market dealing, sports news, local news and weather forecasts, all displayed in page form on the screen at the flick of a switch.

In radio, quadraphonic reception will be a certainty since pioneering spadework is already underway.

As a sop to the inevitable neurosis all this surfeit of goodies will cause, electronics will slavishly function as an unpaid locum with the dial-a-complaint computer; another feasibility which will take the mundane work load from the G.P., returning him to his true role of family counsellor and N.H.S. clerk.

In automobiles, digital metering of fuel, temperature, speed, etc. is a certainty since l.e.d. displays are becoming cheaper than their analogue counterparts.

Electronics is a science which has, of necessity, crossed the boundaries of so many disciplines, such as medicine, chemistry, automobile engineering, etc. that it is inevitable that its effects or spin-off in ideas must increase to the benefit of humanity.

G. Rapson

INFORMATION DESK

THE public's requirement to be kept up to date with such things as public services, entertainment and general information creates a market for message systems and information retrieval.

To enable this market to be satisfied the minicomputer in the form of a desk top model completely self-contained will supply the service. The computer will be fully programmable by either cassette tape or disposable read only memories (ROM) with visual display output (VDU) and or permanent copy by thermal printing for availability of users' information.

In order that the public can make use of the service the computers will be located at such places as libraries and railway stations and the service will work in the following way.

As the computer is completely pre-programmed by use of either disposable ROM's or cassette tapes programmed at a central bureau, the programme material will include such things as the entertainment available in the area served by the library, updated monthly on the basis of disposable programmed devices.

Other services offered could be timetables of buses, trains serving that area, hours of opening for public buildings, half day shopping, hotels and many other services.

For more than one user a number of displays will be available driven from the computer using time sharing techniques; also a number of inquiry points will be accommodated. The systems can be further extended to such places as large supermarkets giving information on best buys, present prices and availability of items.

R. Cepa

IT'S ALL CHEMISTRY

WHEN thinking of the future one must take into consideration, that although a decade is not long, it is sufficient time for major development or cultivation of a revolutionary idea.

For example, ten years ago the transistor was making its debut for home constructors; now it is an indispensible component. Similarly the laser was invented a little over ten years ago; now it holds a definite place in industry and technology.

Although not fully conversant with the intricacies of modern electronics, I feel that changes are inevitable and possibly will involve chemistry, where the exploitation of the heavy metal compound crystals (i.e. the rarer ones, e.g. Neodymium) is by no means exhausted.

As components become more intricate and delicate, soldering will lose its popularity. The introduction of a conductive heat resistant adhesive/resin for securing components may prove suitable. "Deresinification" (desoldering) would be carried out using a non corrosive solvent (actuated at time of use to prevent spillage the consequences of such an accident can be imagined).

Similarly the copper strips on Vero or p.c. boards could be replaced with electrically conductive plastic. (The price of copper rarely fluctuates from the steady rise.)

Laser development will advance to the high degree of household necessity, for some inappropriate capability.

T.V.s will change for the commercial market. All colour, quad or stereo (personal preference), even the collaboration of holography and T.V. for 3D viewing.

B. Theiss

MATURITY

OUR TECHNOLOGY has been developing exponentially for a century, and is now approaching maturity.

The significance of maturity in technology lies in the freedom from standardisation that it brings; it allows a huge increase in the range of goods available without an equivalent rise in cost at the end of the production line.

At first sight, such abundance might gladden the electronics constructor. The range of projects open to him would widen dramatically, and the price of short-run chips, anti-log pots and other expensive oddities would be decimated. Design and performance would be near-perfect; integration of circuitry would be combined with flexibility of application. But the home constructor enjoys his hobby because it tests his skill, and the hobby magazines reflect this fact, suggesting projects that (a) are not available in the shops (or not so cheaply), (b) involve some skill in construction and "tuning" and (c) give enjoyment through the intelligent use of the latest technological developments. A maturing technology combined with an aggressive electronics industry will force the home constructor into beyond-the-fringe gadgetry if he wants to retain any of these features.

The start of this trend is already evident. If the history of other technology-based hobbies can be trusted to repeat itself, the electronics constructor will soon be tempted to return to the comfortable past when his radio needed him. Like a vintage car enthusiast a plate photographer, or a steam fanatic, he will gladly exchange the boring best for the challenge and involvement that previous eras provided.

D. Beattie.

IDEAS IN INK

IT IS my opinion that the next ten years will bring a much wider application of plastics within the field of electronics. I envisage the development of synthetic materials with various electronic properties.

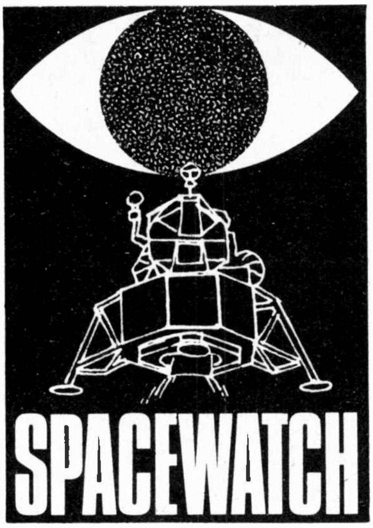
Not only will this include the simple properties of conductivity, resistivity, capacitance, etc. but it seems quite possible that a substitute for silicon and germanium could be produced.

Taking this idea a little further, it is easy to imagine the evolution of kits containing special resins and "inks" with templates and equipment for printing one's own "giant size" integrated circuits on little more than sheets of paper.

The key factor here of course is the price of the plastics involved. If they are to be particularly expensive this might more than compensate for the cheap production of i.c.s and put them out of reach of the home constructor. However, if this is not to be so then the potential of the amateur could be greatly extended.

D. Gowe

. . . a further selection of readers' predictions will appear next month



BY FRANK W. HYDE

THE NEW JUPITER

An analysis of the data provided by *Pioneer 10* reveals some startling facts. Many of the previous conjectures about the constitution and structure of the giant planet will have to be abandoned. No doubt the first findings will be confirmed by *Pioneer 11*, which will fly past the planet in the first week of December, a year from the time that *Pioneer 10* collected the initial data.

One of the puzzles of Jupiter has been the great Red Spot. For something like three hundred years there have been many observations and almost as many theories. These range from the possibility of a submerged satellite, suggested by Firsoff, to the Taylor column. This is an effect that could take place if there was a high projection of, say, a mountain and the consequence of hydrodynamic waves in the atmosphere. In fact it does appear that the red spot might be caused by an updraught of hurricane force. The red spot would be the vortex centre. The size of the spot, some 40,000km (25,000m), could be the visible evidence of this. If such is the case then the views of Professor Raymond Hide would be relevant.

The severe atmospheric effects would be expected on the new facts. From the analysis of the gravity sensing experiment, Dr J. Henderson of the Jet Propulsion Laboratory and Dr W. B. Hubbard of the University of Arizona, it appears that Jupiter is largely liquid. If there is a core at all, it would be molten and very small. The temperature would be very high and pressures would be high. It is worth remembering that the late B. M. Peek in his book "The Planet Jupiter" discusses these early models in detail.

COLOURED BELTS

The coloured belts have been a continuous study particularly by the amateur astronomers. The periods of revolution of some of the white and grey areas have resulted in thousands of sketches of great accuracy by members of the Jupiter section of the Astronomical Association.

The new thoughts on this subject are that the white and grey areas are in fact cloud tops only some 240km (150m) below the upper limit of the planet's atmosphere. The brown and orange areas would be troughs. It would appear that the clouds on Jupiter are stretched round the planet, rather than in circular groups as they are in the Earth's atmosphere. The stretching out round Jupiter is most likely due to the rapid rotation of Jupiter on its axis, some 9 hours 55 minutes. The actual speed at the equatorial belt is of the order of 35,000km (22,000m) an hour.

Another problem that has been the subject of conjecture is the excess of heat radiated by Jupiter. This level is some two and one half times that which Jupiter receives from the Sun. The new model of the planet suggests that it is cooling off and growing smaller, this would account for the high level of heat being given off. The model of the planet which now emerges is that of a body of four conditions. The first is the possible core which would have a temperature of 29,000°C. Next there is a level extending for many thousands of kilometres where the hydrogen has become metallic with a temperature in the region of 11,000°C. In this area pressures could be as high as 45,000,000 lbs/sq.in. The next region which starts at about 1,000km into the atmosphere is a transitional zone where there is liquid hydrogen.

The magnetic field has already been described in *Spacewatch* (Sept. '74) with considerable detail. One new point to be added is that as a result of the high level of the radiation belts, which are of a similar configuration to those surrounding the Earth, high energy particles have been radiated and detected on Earth.

The four large satellites, almost of planetary size, all appear to have atmospheres of their own. The densities are proportional to the distance between them and the planet. Pictures were obtained of the satellite Ganymede, these are being processed but first findings do indicate that there are highlands and lowlands similar to Mars and the Moon. The composition of the satellites do indicate the possible combination of ice and rock, in the case of Ganymede and Callisto. Io and Europa are certainly rock.

After *Pioneer 11* has made its fly-past it will be on the way to Saturn. It will pass between the main body of Saturn and the innermost ring.

LARGEST KNOWN OBJECTS

Two radio galaxies of immense size have been discovered by A. G. Willis, R. Strom and A. Wilson, using the Westerbork radio telescope.

One of these, the largest object so far known in the universe is 3C 236. The radio components of this galaxy are spread over the vast distance of 18 million light years. The second object is DA 240 and is 6.6 light years across.

The measurements were made by the synthesis telescope which comprises 12 parabolic reflectors working in a linear base line of 1·5km. This provides a beam of resolution of 1·0 arc minute, with a field of 1·5°. The frequency of operation is 49cm.

It is certain that more of these objects will be found. They are on such a vast scale and the density as low as 30 atoms per cubic centimetre, that is almost the mean density of the universe. The energy in these extensive objects must be so high that there are electrons moving at almost the speed of light.

One thing is certain and that is that if more of these objects exist, then rather drastic remodelling will need to take place. With objects like these the radio clouds will have spread relativistic plasma throughout a volume of space equal to that of large galaxies or even clusters of galaxies. Estimates of the age of these radio sources is increased by a factor of ten. Obviously some re-thinking is likely to be extensive, for the effect on cosmological theory will be profound.

MOVEMENTS OF THE CRUST OF THE EARTH

A project by NASA called Astronomical Radio Interferometric Earth Surveying (ARIES) will provide information about continental drift and improve earthquake prediction.

The technique is to receive radio emissions from extra-galactic sources at two places, and time the arrival differences. In practice this means that the antenna at Goldstone and the antenna at the Jet Propulsion Laboratory are focused on a quasar. The difference of the time of the arrival of the signals at the two places can be measured to 0·1 of a billionth of a second. These data can then be resolved in terms of distance between the two stations. This can be done at the moment with an accuracy of 10cm; later it will reach an accuracy of 2cm. Any difference in the measurements will indicate movement and strain.

It will be possible to use portable antennas for this work so that by changing the position of any two an almost three dimensional picture can be built up. Thus the movement and strain along the San Andreas fault can be detected.

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Strictly Instrumental

by K. Lenton-Smith

WITH many electronic projects, there are no half measures—they either work or fail when first tested. Where audio applications are concerned, the project could work but only after a fashion and then some very critical faculties (sic) will come into play!

The listener with anything approaching perfect pitch will find tuning discrepancies particularly objectionable. He will stomach single note melodies, perhaps, but sustained chords produce violently noticeable beats—even to those that are tone deaf: the more upper harmonics in the chord, the worse the effect.

VOLTAGE

The last article in this series dealt with tuning generally and its main purpose was to warn the constructor to take great care in choosing his generator system. That article prompted a letter from a reader experiencing tuning drift, due to mains voltage fluctuation, with a commercially made electronic accordion. The instrument concerned uses astable multivibrators as master oscillators, followed by bi-stable multivibrator dividers. I decided to confirm the comments about R/C oscillators in the previous article by making up the accordion's master oscillator to see how voltage changes affected it. Using a frequency meter, a one volt change in supply in either direction caused a frequency change of about 6 per cent —or a semitone in musical terms.

If such an instrument was only played solo, very few listeners would object. After all, the key of C sharp sounds better than C—provided the whole system is in tune with itself! But the problems arise when playing with other instruments and the player will find himself at odds with a well-tuned piano. Nothing will throw a small band into confusion quicker than this type of problem—or encountering a continental pitch piano!

SPACE PROBLEMS

It is essential that any electronic instrument can be accurately tuned and will stay that way. The keen amateur may be itching to get with the problem, but commercial instruments may present difficulties because of lack of space due to the use of i.c.s, and general condensation of circuitry. Reorganisation of master oscillators may have to be ruled out, therefore.

As we have seen, R/C oscillators require a precise supply voltage to stay in tune, so it might pay to look carefully at the power pack. There will probably be an array of voltages for generators, keying, pre-amplifiers, power amplifier, etc. but the most important supply is that to the generators and in particular the master oscillators. Regulation should be checked with the instrument in operation and, if this is found lacking, one of the TO3 encapsulated regulators (MVR type) might be incorporated. Both load and line regulation of these devices are better than a fraction of one per cent, if their output voltages match the circuit's requirements.

MAINS REGULATOR

If it can be proved that mains voltage fluctuation is the root cause of tuning instability, the simplest course would be to fit a mains voltage stabiliser between the a.c. supply and the instrument. If the load is fairly light, the type sold by photographic shops (for stabilising brightness and colour temperature of enlarging lamps) might be one solution.

No apologies are due for labouring the point concerning tuning: building a polyphonic keyboard instrument is a major operation. It is as well to be absolutely sure that the home constructed instrument will not require an expensive and time consuming modification after completion because the back has to be taken off every week to re-tune it.

TREMULANT

Tremulant is an amplitude modulation effect, and should not be confused with vibrato which is frequency modulation. It is fairly easy to arrange by connecting the signal across an l.d.r. and modulating this resistor by means of a lamp. The lamp could form part of the collector load of a multivibrator, or it could be a miniature neon in a relaxation oscillator circuit. Whilst the filament lamp is best suited for tremulant effect, the more precise pulsing of a neon enables it to be used for higher speed chopping—repeat effects such as mandolin and banjo.

In early instruments, tremulant was often obtained by using a motor driven variable resistor across the signal source, but these were noisy and tended to wear rapidly. Devices such as the ORP12 l.d.r. have since come on the market and are both dependable and noiseless.

VIBRATO

Good vibrato is by no means easy to obtain, especially if the oscillators are really stable. The fact is that, if you have a stable oscillator, you must expect stability! When the oscillator refuses to be modulated by an electronic vibrato, the effect is best obtained by mechanical means—such as the Leslie speaker.

The vibrato oscillator should ideally produce a sine wave, although multivibrators are often used commercially. A fair amount of drive will be required, in some cases of almost medium power proportions, to the base of the oscillator transistor. A good deal of care is required in setting up, too much signal making the oscillator fail on peaks and too little producing nothing more than a mild tremulant.

DELAY LINE

Electronic vibrato often sounds uninteresting as its effect is similar for all frequencies. The Hammond delay line system overcomes this problem as its effect is more prominent at higher frequencies. The line consists of some 18 L/C sections and, according to the vibrato depth chosen by the player, sections are switched to the stators of a multi-element variable capacitor whose rotor picks up the modulated signal. By scanning back and forth along the line, phase differences are converted to frequency differences: this contributes to chorus effect as modulation takes place per section of the line according to frequency.

PE MINISONIC

By D. SHAW

PART TWO

- Voltage Controlled Oscillators
- Voltage Controlled Filter and Envelope Shaper
- Voltage Controlled Amplifiers

THIS month we begin the circuit construction of the P.E. Minisonic series by detailing the VCO's, VCF and Envelope Shaper/VCA's.

BATTERY LIFE

The average current drawn by the P.E. Minisonic is about 62mA, so it is estimated that a pair of PP9 batteries will provide up to 50 hours of useful life. Much depends, of course, on the length of the periods during which the instrument is switched on. When usage is restriced to around two to four hours per day then maximum battery life can be expected.

On the current price of PP9's, therefore, the running costs of the P.E. Minisonic are likely to vary between 1·4p per hour and 2·33p per hour depending on usage and this seems, on the basis of comparison with other forms of entertainment, to represent pretty good value for money.

One of the drawbacks of battery operation is that the voltage falls in a manner proportional to the drain and to the charge remaining, and thus circuits which are voltage sensitive could begin to perform in an erratic and unreliable manner.

In the P.E. Minisonic this problem has been overcome by the establishment of voltage reference rails, considerably below nominal battery potential, in order to serve those circuits which are particularly voltage sensitive.

In practical terms the VCO's and VCF will operate without any change in performance down to ±7·5 volts and, indeed, will tolerate supply voltages up to ±12 volts also without change in performance.

The worst effect of falling battery voltage on these circuits not served by the reference rail is that the gain/attenuation ratio of the VCA's diminishes by between 6 to 8dB and the noise generator will cease to operate at about ±7·8 volts.

The great advantage of battery operation is that the instrument becomes a perfectly safe proposition for the younger enthusiast who can dabble about to his heart's content without the attendant fear of electrocution.

COMPONENTS . . .

VOLTAGE CONTROLLED OSCILLATOR
(2 required)

Resistors

R1, R2	6·8kΩ (2 off)
R3–R6	47kΩ (4 off)
R7	22kΩ
R8	1·2kΩ
R9	1kΩ
R10	2·7kΩ
R11	1kΩ (see text)
R12	750Ω
R13	22kΩ
R14	82kΩ (see text)
R15, R16	10kΩ (2 off)

All ±5% ¼W or ⅛W carbon

Potentiometers

VR1	10kΩ skeleton horizontal preset
VR2	10kΩ linear carbon
VR3	100kΩ skeleton horizontal preset
VR4	10kΩ linear carbon

Capacitors

C1	0·1μF
C2	22μF 16V tantalum
C3	3·3pF

Semiconductors

D1	1N914
TR1	BC184
TR2	BC213
IC1, IC2	Type 741 8-pin d.i.l. (2 off)
IC3	Type 748 8-pin d.i.l.

Miscellaneous

JK1	3.5mm jack socket
SK1, SK2	2mm sockets (2 off)
0·1in	Veroboard, 115 × 34 holes (This board also carries Keyboard Control, Mixers and Ring Modulator)

LOGARITHMIC LAW

Both the VCO's and the VCF have a logarithmic—or, more accurately—an exponential relationship between the applied control voltage and the control current which, in turn, prescribes the frequency of the VCO and the pass-band of the VCF.

The so-called "log-law" has been adopted because it allows for a considerable simplification in the keyboard and pitch determining systems—an important factor in an instrument which is to be used for musical purposes and which, hopefully, is to remain in tune over relatively long periods.

In simple terms the "log-law" enables linear increments of control voltage to cause frequency changes of one octave in the case of the VCO or passband variations of one octave in the case of the VCF.

In the P.E. Minisonic the control voltage increment required is 600mV per octave but there is provision for adjusting this from about 220mV per octave to 1·2V per octave in order that the instrument may be matched to other synthesiser systems.

Since the control voltage increment is the same value for both VCO and VCF this enables the control node for both circuits to be identical save for two minor variations.

THE CONTROL NODE

The circuit of the control node is shown in Fig. 2.1, which shows the VCO but an almost identical control node is used in the VCF. IC1 is a four-input summing inverter in which two inputs are committed to providing bias and manual control voltages while the remaining two can be coupled to external programming sources.

The overall gain of the inverter is prescribed by VR3 which is used to set the so-called "law" of the system, i.e.—the relation of frequency or pass-band to voltage. VR1 provides a fixed bias to the inverter which serves to set the minimum frequency, or to position the overall frequency range in manual control, while VR2 provides the voltage swing, in manual, required to give a nominal ten octave range.

The input via R5 is coupled through the normally-closed contacts of JK1 to the keyboard controller "hold" circuit (which will be described next month).

Insertion of an open circuit jack plug will override the "hold" input or, alternatively, an external signal wired in to a jack plug may be routed into this input.

The input via R6 is wired to a 2mm socket so that an external programming signal may be employed in combination with the keyboard.

The output of IC1 drives a divider, R7-R8, which sets the bias on transistor TR1—a constant current generator. It is in TR1 that the exponential relationship between control voltage and control current is derived.

TRANSISTOR CHARACTERISTICS

Reference to the characteristic curves of almost any small signal transistor in which V_{be} is plotted against I_C will show that there is a fixed relationship between these factors which extends over a range of three or four decades.

V.C.O.

PERFORMANCE

Frequency Range	10 octaves, nominally 5Hz to 5kHz in manual control
Control Voltage Law	600mV per octave
Waveform	Sawtooth, 400mV p-p
Current Drain	5mA

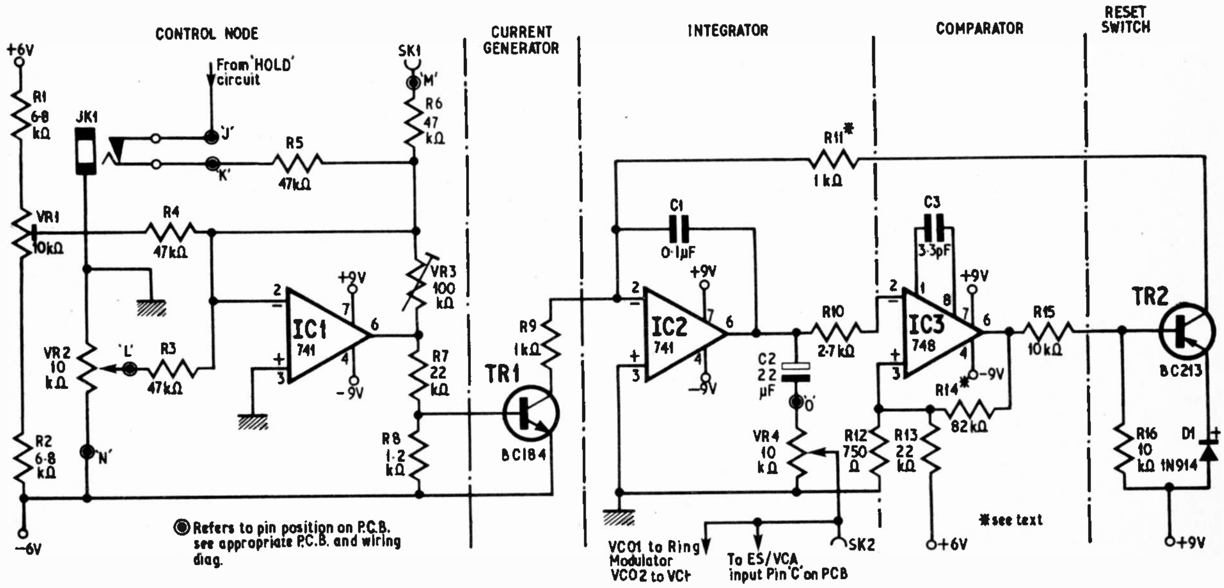
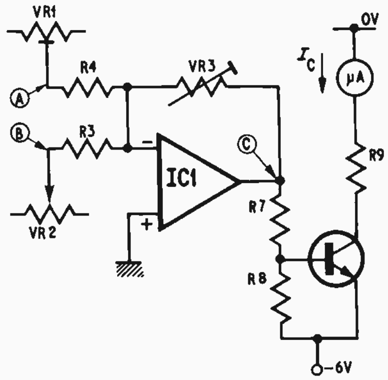


Fig. 2.1. Circuit diagram of the Voltage Controlled Oscillator. Letters in inverted commas refer to connections from the Veroboard panel to the front panel



Voltage readings with A at —1·4V and C at 0·95V

B(−V)	0	0·6	1·2	1·8	2·4	3·0	3·6	4·2	4·8	5·4	6·0
I_C(μA)	—	—	0·5	1·0	2·0	4·0	8·0	16·0	35·0	82·0	190·0

Fig. 2.2. Simplified circuit of the control node used in both the VCO and the VCF. The table shows typical current readings for different settings of VR2. Note that tolerance on R7 and R8 can cause significant departures from values shown. These may be compensated by adjustment of VR1. The important relationship is between the voltage at B and I_C

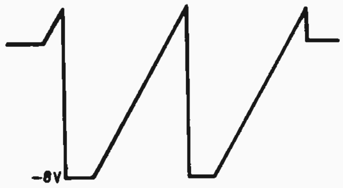


Fig. 2.3a. The integrator output with resistor R11 removed

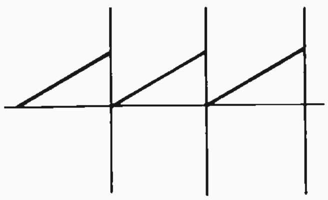


Fig. 2.3b. Output of the integrator showing, large spikes during the reset period. These are too fast to be audible

Above a minimum level of V_{be}, the collector current will double for each successive increment in V_{be} of the order of 20 to 25mV. Over the straight line portion of the curve, if it is assumed that the V_{be} increment is 24mV, then increments of 2mV will cause the collector current to increase successively in the ratio $1:\sqrt[12]{2}$ — which musicians will immediately recognise as being identical to the ratio in pitch between any two consecutive notes in an equal tempered scale. Indeed, this relationship serves to explain why the "log-law" circuit is so much more useful in a musical sense than its linear counterpart.

SETTING-UP PROCEDURE

The efficiency with which the vco's and vcf function relative to their respective control voltages is entirely dependent upon the accuracy with which the setting-up of the control node is accomplished.

The principal aim is to ensure that successive increments of 600mV supplied by VR2 result in successive doublings of the current through the constant current generator TR1. Fig. 2.2. illustrates a simplified control node together with a table of typical results obtained with the prototype instrument.

With the wiper of VR2 at ground potential, VR1 should be adjusted so that the wiper is at −1·4V. VR3 should now be adjusted so that the output of IC1 is at +0·95V. These adjustments will set the operating points of the control node to within close limits of the required values.

A multimeter switched to the microamp range should now be connected between R9 and the 0V rail and VR2 swung through the range of values shown in the table.

It should be noted that the current readings recorded will not necessarily correspond exactly with those quoted in the table since tolerance variations in R7 and R8 can cause significant differences.

During the first swing of VR2 it is almost certain that errors will be present and it is important, at this stage, to determine whether the current through TR1 is greater or less than the doubling required for each increment of 600mV at the wiper of VR2.

For this purpose it is best to carefully record the current readings obtained over a range of input voltages—say from 1·2V to 4·8V—in order to establish whether the error is consistent.

If the current through TR1 is greater than the doubling required for each 600mV increment then the gain of IC1 has to be reduced by adjustment of VR3. Conversely for less than the required doubling.

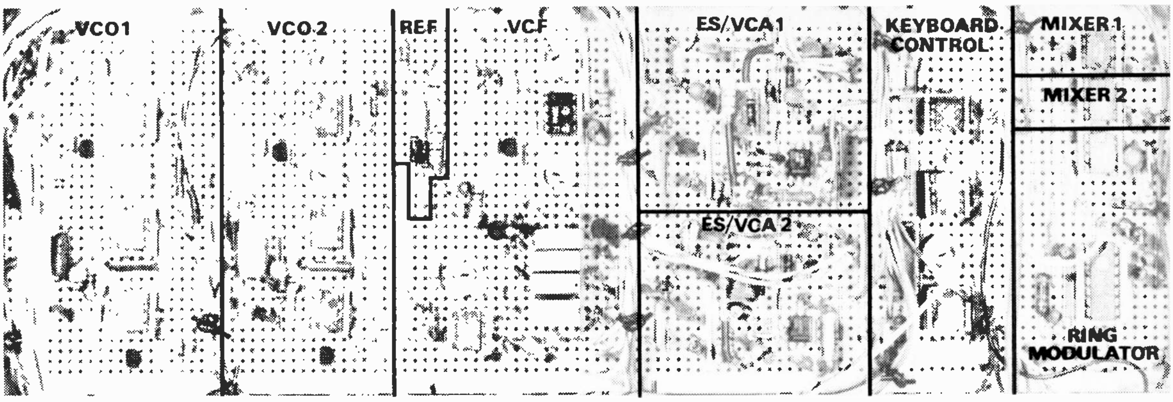
When the required relationship has been established the control nodes for the vco's may be matched by making a further adjustment to VR1 so that, for a given voltage supplied by VR2, the current through TR1 is identical in both nodes.

It should be noted that the current/voltage relationship in the control nodes need not be precisely 600mV per current doubling. Indeed the range of adjustment afforded by VR3 allows that the relationship may be set at any value lying between aproximately 220mV and 1·2V. What is important however is that the relationship adopted should be *exactly* the same for all control nodes. If it is not then the circuits will not track accurately and the overall performance of the instrument will be marred.

The design of the Keyboard Controller is such that it can accommodate any voltage/current relationship which it is possible to set up with the component values given for the control nodes.

THE VOLTAGE CONTROLLED OSCILLATOR

The complete circuit of the vco is illustrated in Fig. 2.1. Apart from the control node and current generator the vco comprises a linear integrator around IC2, a comparator around IC3 and a reset switch TR2.



Photograph of complete board on which VCO's, VCF, Voltage Reference and ES/VCA's are mounted. (Note: some minor changes have been made to this layout)

HOW IT WORKS

If we assume that the reset cycle has just completed, the output of IC2 will be zero volts, the output of IC3 will be positive due to the voltage applied by divider R12-R13, and TR2 will be hard off. C1 although nominally uncharged will, in fact, have a charge in relation to the negative rail and thus TR1 will draw on that charge at a constant rate thereby causing the output of IC2 to ramp in a positive direction.

The maximum positive level of the ramp is determined by two factors. Firstly there is a positive threshold voltage set by divider R12-R13 which is equal to:

$$\frac{750}{22750} \times 6 = 200\text{mV}$$

Secondly there is a positive feedback factor applied to IC3 by R14. This has the effect of determining a further threshold value on the basis of the currents applied differentially to IC3 through R10 and R14.

If x be a voltage at the output of IC2 then the secondary threshold value is determined by:

$$I_{R10} = \frac{x}{2700} = \frac{8}{82000} - I_{R14}$$

i.e. approximately 250mV.

The overall threshold value is thus theoretically 450mV. Although the 450mV threshold could be derived from divider R12-R13 alone the adopted method is preferable because it has the effect of speeding up the switching process.

When the output of IC2 reaches the threshold value the output of IC3 will try to go negative. However, the biasing on TR2 is such that when the output of IC3 has moved about 200mV, TR2 turns on and sends a relatively large pulse of current into C1 in order to restore the original state.

At this point the output of IC2 moves rapidly in a negative direction and when it falls to below 200mV, i.e. below the minimum threshold value on IC3, then IC3 will switch to positive saturation again before the output of IC2 actually reaches its minimum level. At this point the cycle repeats.

The overall effect is to provide a very rapid reset which results, in relation to the integrating rates employed, in a sawtooth waveform of almost perfect shape.

The reset time occupies a period of approximately 8μs. On most oscilloscopes the reset pulse will be invisible at low frequencies and its presence will generally only be detectable at frequencies of the order of 5kHz and greater.

RESET TIME

Resistor R11 sets a limit on the reset current supplied by TR2 and thus has an effect on the reset time. With R11 significantly greater than 1kΩ it will be found that the reset will terminate at a point about +100mV or so above zero volts, at which point integration will re-commence.

With R11 removed altogether the output of IC2 will go hard negative at each reset resulting in an output waveform as shown in Fig. 2.3a and a very slow rate of oscillation.

The ideal situation is when the value of R11 is such that the reset, as measured at the output of IC2, terminates on the zero volt rail. The output waveform of the integrator is shown in Fig. 2.3b.

Resistor tolerances being what they are there could, in a worse case, be as much as 20 per cent variation in the integrator output waveform peak-to-peak value between oscillators. This means that, with matched control nodes and for a given control voltage, the vco with the greater amplitude waveform will run at a proportionately lower frequency.

Fortunately this error is constant over the whole frequency range and may thus be compensated for by adjustment of the bias control VR1. It is more elegant however to make the adjustment on the vco itself so that the greater level in output waveform will not introduce any impairment of performance in relation to the sound treatment circuits.

Resistor R14, in view of its value and position on the circuit board is the most convenient resistor to adjust. Any adjustment should be directly proportional to the error variation in output waveform level, i.e. if the output waveform is 10 per cent high in relation to the other vco then the value of R14 should be increased by 10 per cent—to 91kΩ say—and vice versa.

From Fig. 2.3b it will be seen that the integrator output waveform exhibits a substantial positive and negative going spike at the reset point. This is due to the differentiation of the reset pulse by C1.

Although rather unsightly, the spike is too fast to have any effect on the audio output.

V.C.F.

PERFORMANCE

Passband	3Hz to 15kHz (—6dB)
Dynamic Range	—54dB (referred to peak output signal)
Resonance Range	5kHz to 25kHz
Current Drain	4mA (min), 8mA (max)

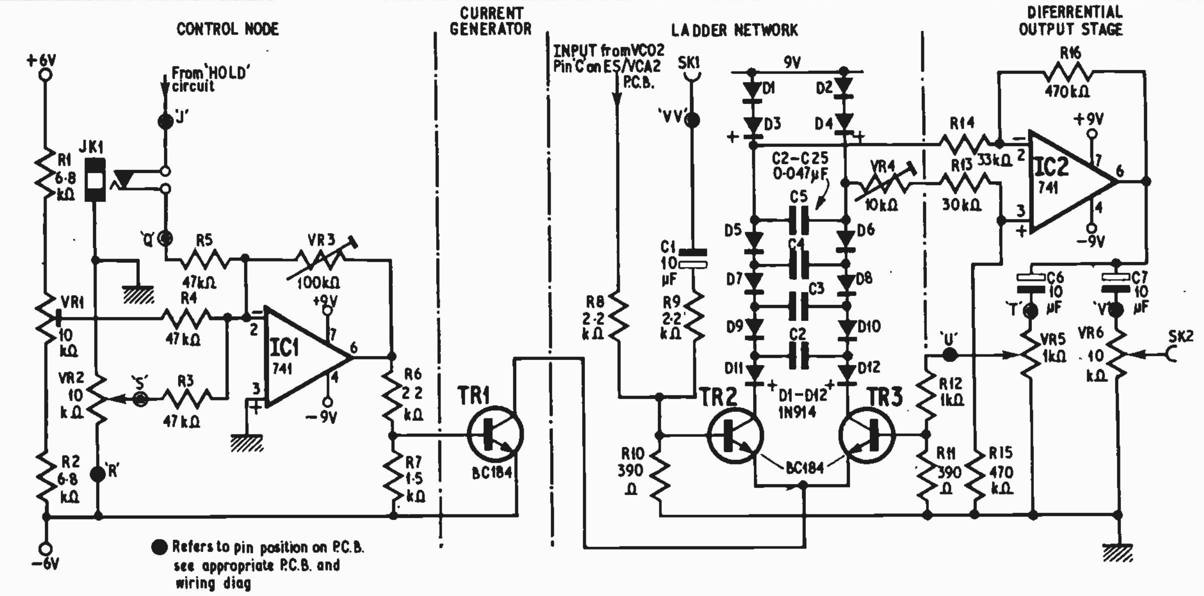


Fig. 2.4. Complete circuit diagram of the Voltage Controlled Low-pass Filter

VOLTAGE CONTROLLED LOW-PASS FILTER

The complete circuit of the filter is shown in Fig. 2.4 and comprises, in addition to the control node and current generator, a ladder network and a differential output stage. The ladder network, in which the filtering action takes place, is based on the design by Dr R. A. Moog.

The diode may be considered to be an impedance which varies inversely as the current through it, i.e. at low currents the impedance is high and vice versa. The a.c. signal is superimposed on to the diode current flow as shown in Fig. 2.5 which represents the lower half of the ladder network.

The ladder terminates in transistors TR2 and TR3 which are effectively biased on by referring their bases to the 0V rail. Thus any current drawn through the network by means of the constant current generator passes, without restriction, through these transistors.

If an a.c. signal is now applied to the base of TR2 there will be a proportional variation in the current through the transistor and thus also a voltage variation at each diode junction in the ladder.

This applies over virtually any current drawn by the constant current generator so that, for a given level of a.c. signal, the smaller the current through the network, the smaller will be the proportional variation induced by the signal. Thus the concept of variable impedance is, in fact, due to the combined effect of diode, transistor and current generator.

FILTER PERFORMANCE

The range extends over several decades and, in the circuit given, the -6dB passband at maximum is from 3Hz to 15kHz.

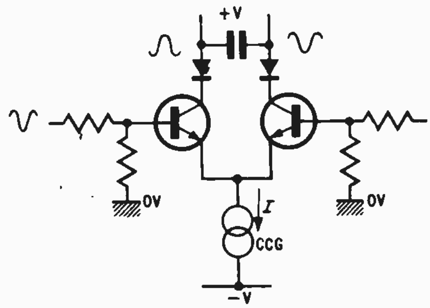


Fig. 2.5. Simplified circuit diagram of the lower section of the VCF showing how the a.c. signal is superimposed on the ladder current

Four filter stages are cascaded in the ladder network and since each stage has a theoretical roll-off of 6dB per octave the maximum roll-off of the filter should be 24dB per octave. Efficiency in this respect can only be achieved, however, if every precaution is taken to prevent loading the network both at the point of entry of the a.c. signal and also at the point of extraction.

In the interests of simplicity and economy the buffer stages have not been included in the circuit but, even so, the roll-off possible is around 12 to 15dB per octave and, for the majority of purposes, this will be found to be quite sufficient.

FEEDBACK

The output from the filter network is amplified differentially by IC2, with VR4 being employed to cancel out any d.c. imbalance due to variations in

COMPONENTS . . .

VOLTAGE CONTROLLED FILTER

Resistors

R1, R2	6·8kΩ (2 off)
R3–R5	47kΩ (3 off)
R6	22kΩ
R7	1·5kΩ
R8, R9	2·2kΩ (2 off)
R10, R11	390Ω (2 off)
R12	1kΩ
R13	30kΩ
R14	33kΩ
R15, R16	470kΩ (2 off)

All ±5% ¼W or ⅛W carbon

Potentiometers

VR1	10kΩ skeleton horizontal preset
VR2	10kΩ linear carbon
VR3	100kΩ skeleton horizontal preset
VR4	10kΩ skeleton horizontal preset
VR5	1kΩ linear carbon
VR6	10kΩ linear carbon

Capacitors

C1	10μF 6·3V tantalum
C2–C5	0·047μF (4 off)
C6, C7	10μF 6·3V tantalum (2 off)

Semiconductors

D1–D12	1N914 (12 off)
TR1–TR3	BC184 (3 off)
IC1, IC2	Type 741 8-pin d.i.l. (2 off)

Miscellaneous

JK1	3·5mm jack socket
SK1, SK2	2mm socket (2 off)

diode characteristics. The output signal from IC2 is capacitatively coupled into two potentiometers. VR6 is simply the output level control while VR5 is the feedback or Q control.

With the Q control at zero the base of TR3 is referred closely to the 0V rail and thus TR2 and TR3 behave essentially as a differential pair. The output of IC2 is therefore nominally in phase with the input signal at the base of TR2.

As VR5 is advanced from zero a proportion of the output signal appears at the base of TR3 thereby tending to induce a signal in the collector circuit which is 180 out of phase with the signal which is already there due to the effect of the signal on TR2. The result is that the output signal will become significantly attenuated except at the frequency whose period is equal to the adjusted time-constant of the network.

At this critical frequency the output of the filter will peak up, the bandwidth of the signal depending on the degree of feedback applied.

Further application of feedback will cause the filter to oscillate. The frequency of oscillation is proportional to the current through the ladder network and the oscillation, which is of sine form, will be superimposed on the filter output signal. The P.E. Minisonic filter oscillates over the range 5kHz to 25kHz.

The filter may be operated in a number of modes each of which finds a place in the tone colour spectrum of the synthesiser. An outline of the various possibilities will be given in a later part of the series.

SETTING-UP THE VCF

The setting up of the control node for the VCF should follow exactly the same procedure as the VCO with the exception that, having established the correct voltage/current relationship, VR1 is adjusted so that the maximum current through TR1 with an applied voltage of −6V at VR2 should be of the order of 3mA instead of the 190μA quoted in the table shown in Fig. 2.2.

In order to achieve this result the value of R7 in the VCF is 1·5kΩ instead of the 1·2kΩ specified for R8 in the VCO control nodes. Increasing the value of R7 requires that the gain setting of IC1 be reduced by adjustment of VR3 and, in relation to an initial setting at VR1 of −1·4V, the output of IC1 should be approximately +0·84V at the commencement of the setting-up procedure.

The setting-up of the filter proper is essentially concerned only with providing the optimum balance between extreme d.c. conditions arising in the ladder due to current variations. With a high resistance voltmeter directly monitoring the output of IC2, VR5 at zero, and with the audio inputs uncommitted, the frequency control (VR2) should be moved from one extreme to the other.

The meter readings at extreme settings of VR2 should be noted and VR4 adjusted to reduce the voltage swing at the output of IC2 to a minimum. It may require several iterative adjustments to get the best possible balance.

This adjustment is not too critical since the output of IC2 is capacitatively coupled although, if the filter is being programmed by a fairly rapid envelope, any significant change in d.c. level at the output of IC2 can be differentiated by the coupling capacitor and induce an unpleasant click on to the audio signal.

THE ENVELOPE SHAPER AND VOLTAGE CONTROLLED AMPLIFIER

Two distinct but very closely related circuits are covered by this section. The first is the envelope shaper which is of considerable importance in the scheme of the synthesiser since, by variation of just two controls, a whole range of differing characteristics can be imparted to an otherwise uninteresting sound.

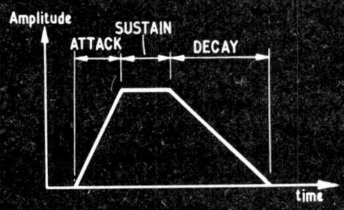


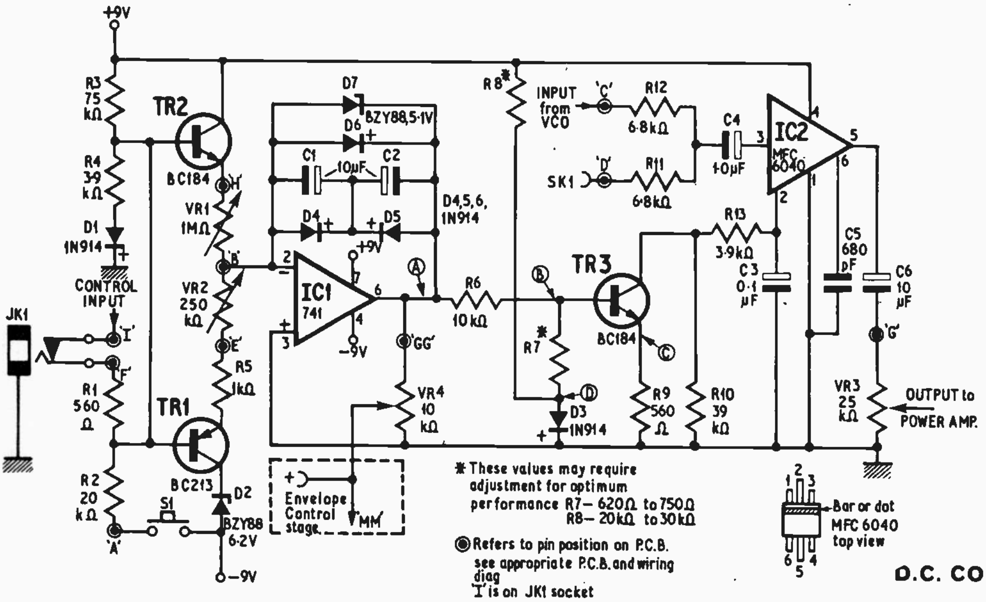
Fig. 2.6a. Typical Envelope Shaper output waveform showing the three variable parameters: attack, sustain and decay

Fig. 2.6b. A selection of envelope formats

E.S./V.C.A.

PERFORMANCE

Attack	Variable 30ms to 4s
Decay	Variable 100ms to 16s
Attenuation Range	48 to 54dB (referred to peak output)
Nominal Input	400mV p-p
Nominal Output	1·25V p-p
Operating Voltage Range	±9V to ±7·5V



D.C. CONDITIONS (volts)

	A	B	C	D
TR3 off	−0·5	0·6	0·01	0·65
TR3 on	4·5	0·8	0·24	0·65

Fig. 2.7. Complete circuit diagram of the Envelope Shaper/Voltage Controlled Amplifier. Note that potentiometer VR4 is fitted only to ES/VCA 1 to provide positive and negative going control envelopes (see block diagram Fig. 1.1)

Essentially the envelope shaper generates a control voltage which, if plotted graphically, will be found to conform with the basic waveform illustrated in Fig. 2.6a. If this waveform is applied to the control input of a VCA the amplitude of the audio signal will vary proportionately, i.e. with the envelope at zero the output of the VCA will be at its minimum volume (in the P.E. Minisonic about 54dB below the peak output signal level).

The first excursion of the envelope shaper output voltage is known as the "attack" and is variable, in the P.E. Minisonic, between about 30 milliseconds and four seconds.

The flat topped portion shown in the illustration is known as the "sustain" and represents the period of time that the VCA output is maintained at maximum volume while, finally, the return to zero volts is known as the "decay" and is variable between about 100 milliseconds and 16 seconds. The period of sustain is determined entirely by the length of time that the envelope shaper trigger signal is present and no separate control is provided. Some idea of the kind of envelope formats possible with this arrangement is given by Fig. 2.6.

CIRCUIT DESCRIPTION

The complete circuit of the ES/VCA is shown in Fig. 2.7. IC1 is a linear integrator whose output voltage is bounded, in a negative direction, by D6 and in a positive direction by D7. Thus the output voltage excursions of the envelope shaper range between −0·5V and +4·5V.

In the quiescent condition R3, R4 and D1 set the bias on TR1 and TR2 such that TR1 is off and TR2 is on. Current reaching the inverting input via TR2/VR1 charges C1/C2 and thus, with the aid of D6, holds the output of IC1 at −0·5V.

When a negative trigger signal is applied TR2 turns off and TR1 turns on. The charge on the integrating capacitors C1/C2 thus leaks away via VR2/TR1 and the integrator output ramps in a positive direction until it reaches the bounded value set by D7.

Triggering signals may be applied in one of three ways:

(i) Through the manual push button S1.
(ii) From an h.f. detector (to be described next month) operated from the stylus or external keyboard.
(ii) From an external source via JK1, thereby overriding the connection to the h.f. detector.

The integrator output is linked through a divider network R6-R7 to the base of TR3 which, with the output of IC1 at −0·5V, is held at the point of conduction by means of a current supplied from the positive rail by means of R8. The table in Fig. 2.7 gives the "on" and "off" d.c. conditions which have proved to be ideal in practice.

COMPONENTS . . .

ENVELOPE SHAPER/V.C.A. (2 required)

Resistors

R1	560Ω
R2	20kΩ
R3	75kΩ
R4	3·9kΩ
R5	1kΩ
R6	10kΩ
R7	620Ω to 750Ω } see text
R8	20kΩ to 36kΩ } see text
R9	560Ω
R10	39kΩ
R11, R12	6·8kΩ (2 off)
R13	3·9kΩ

All ±5% ¼W or ⅛W carbon

Potentiometers

VR1	1MΩ linear carbon
VR2	250kΩ linear carbon
VR3	25kΩ log carbon
VR4	10kΩ log sub. min. carbon (ES/VCA1 only)

Capacitors

C1, C2, C6	10μF 16V tantalum (3 off)
C3	0·1μF 35V tantalum
C4	1·0μF 35V tantalum
C5	680pF

Semiconductors

D1	1N914
D2	BZ88C6V2 6·2V 400mV Zener
D3–D6	IN914 (4 off)
D7	BZY88C5V1 5·1V Zener
TR1	BC213
TR1, TR3	BC184 (2 off)
IC1	Type 741 8-pin d.i.l.
IC2	Motorola MFC6040

Miscellaneous

JK1 3·5mm jack socket   SK1 2mm socket
S1 Miniature pushbutton

SETTING-UP THE ENVELOPE SHAPER

Setting-up is restricted to the establishment of the bias conditions on TR3 as shown in the table of Fig. 2.7. With the output of IC1 at −0·5V, R8 should be adjusted so that a slight positive potential is apparent at the emitter of TR3. This indicates that the transistor is just beginning to conduct.

The actual d.c. level is fairly critical since too much conduction will restrict the gain/attenuation range of the VCA whilst too little will result in a propagation delay between the occurrence of the envelope shaper trigger pulse and the appearance of the audio signal at the output of the VCA.

After setting the bias the envelope shaper should be triggered manually and the button held down in order to check that the bias on the base of TR3 rises from +0·600V to +0·800V with the envelope at maximum level.

It is a good thing, at this time, to run a check on the VCA output with an input signal of 0·4V peak-to-peak. With correct biasing on TR3 the VCA output should be around 1·25V peak-to-peak.

It may be necessary to adjust the value of R7 in order to achieve the VCA output signal specified and, if this is the case, it is well to recheck the biasing with the envelope in the off state and re-adjust R8 as necessary to establish the ideal minimum bias point.

No setting up is required on the VCA as such except as explained above in relating input/output signal levels with the VCA on.

ELECTRONIC ATTENUATOR

The VCA, or to give it the proper title, electronic attenuator, is a purpose designed i.c. by Motorola.

The specification of the device is to provide an attenuation of 77dB and a gain of 13dB, relative to the input signal which should not exceed 500mV r.m.s., when the current sink from the control input (pin 2) is varied from minimum to maximum respectively.

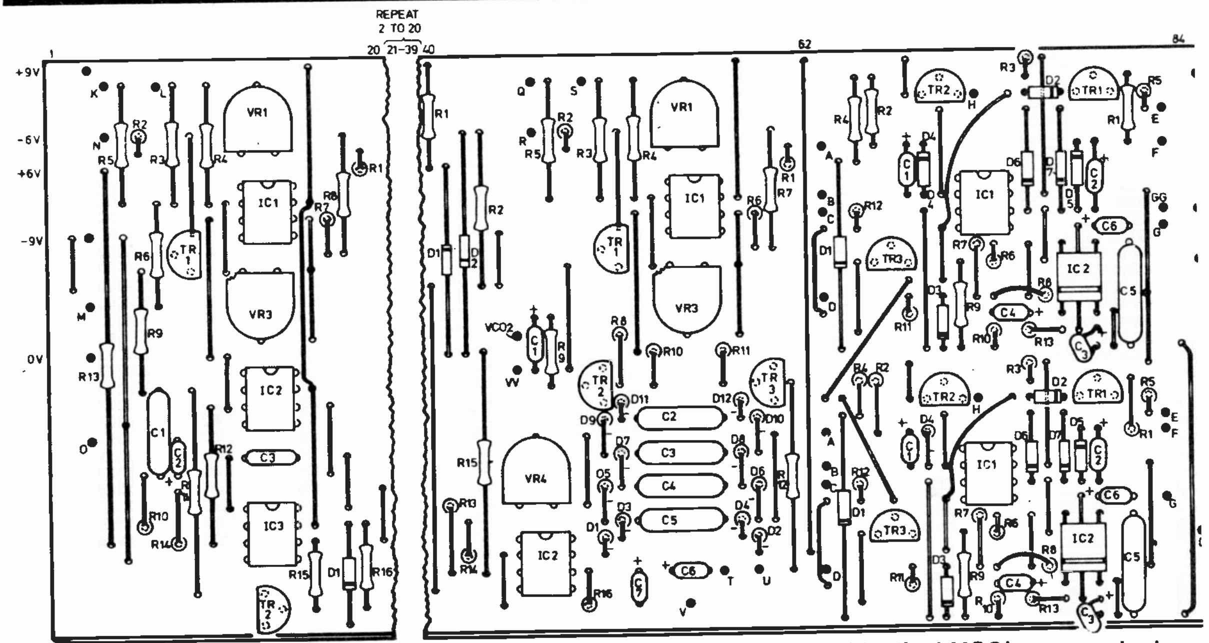
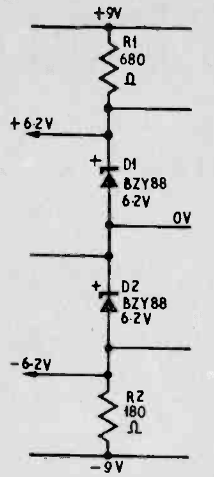


Fig. 2.8. Layout of the components on the Veroboard. Note that two identical VCO's are required side by side on the panel, only one is shown. Both Envelope Shapers are shown in full. Letters next to Veropins are for wiring to the front panel and correspond with those on the circuit diagrams



VOLTAGE REFERENCE

Resistors
R1 680Ω } ±5% ½W carbon
R2 180Ω }

Diodes
D1, D2 BZY88C6V2 6·2V Zener (2 off)

Fig. 2.9. Circuit of the voltage reference section giving ±6V

In the P.E. Minisonic the relatively low operating voltages result in a reduction of the overall attenuation/gain range to about 54dB which is sufficient for most practical purposes.

The current sink from pin 2 of IC2 is, in the off condition, restricted by the series combination of R10 and R13. As TR3 turns on it progressively short circuits R10 with the result that the current sink increases proportionately to a maximum which is limited by R13. It should be mentioned, of course, that the linear envelope of IC1 is converted into a negative exponential characteristic by TR3.

Although this is not ideal for an audio signal envelope, experience has shown that it is extremely difficult to differentiate subjectively between a negative exponential envelope and a positive exponential, or square law, envelope which is considered to give the best effect.

CONSTRUCTION

All the prototype circuits have been built in a number of alternative layouts and there appears to be no particular layout which gives rise to problems. The recommended Veroboard layout is shown in Fig. 2.8.

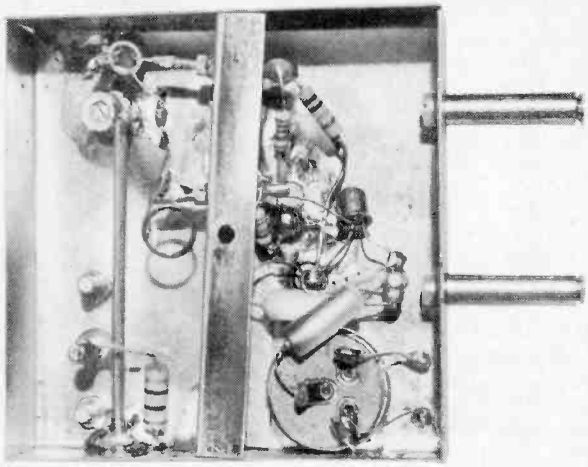
Also mounted on this section of Veroboard is the voltage reference section the circuit of which is shown in Fig. 2.9 (see photograph). This gives the stabilised ±6V rail for use in the VCO's and VCF.

It is recommended that all circuits in the P.E. Minisonic be bench tested and adjusted before any attempt to link the circuit boards with the front panel.

Next month: More of the P.E. Minisonic electronics plus details for wiring and setting-up.

P.E. CCTV CAMERA

continued from page 1059



Interior view of Crofton unit

camera u.h.f. signal might be beating with a normal transmitted signal giving patterning on the screen. Loss of sync is usually due to overloading of the signal and if the tuner has too much gain R10 can be increased until satisfactory results are obtained.

ALTERNATIVE MODULATOR

From what has gone before it can be seen that this form of modulator with a separate tuner might deter some constructors particularly if their involvement has never extended to u.h.f. It is for this reason that a commercial kit, the Crofton modulator, is recommended as an alternative, its obvious attractions being simplicity and small completed size.

The circuit for this is shown in Fig. 4.5 for which we are indebted to Crofton Electronics.

The kit comes complete with detailed building instructions. Numbered packs of piece parts with contents detailed means that instructions can be ticked off in the manual as construction proceeds until the unit is completed.

A step-by-step testing procedure is also included.

SCAN COIL CHANGES

Since the publication of the camera series a run on the specified EMI scan/focus coil assembly and a surprise discontinuation from the contracted manufacturer has meant finding a new coil assembly.

The author has found that the Japanese KV-13 assembly was not only a suitable substitute but provided an improvement in picture quality. Features include an automatic vidicon target connection and vidicon lens focusing by the turn of a small screw.

Both the coils and fitting data can be obtained from EMI, 243 Blythe Road, Hayes, Middlesex. The price is £14 plus VAT.

The only electrical modifications to be made is in the focus coil current supply. For this R50 and C31 in Fig. 2.10 are not required. The supply line input is +15V and should be taken from the Regulator circuit of Fig. 2.8.

Note that in the Components List for Part 1, R39 is 2·7kΩ, R8 —4·7kΩ and R42 —390Ω. These values are correctly shown in the circuits. ★

NEXT MONTH...

Quality need not cost the earth with the PE

ORION

HI-FI STEREO AMPLIFIER

From the same stable as the now-famous P.E. Gemini, comes the P.E. Orion. A medium power stereo amplifier contained in a compact cabinet offering a high performance for a modest outlay. The 20 + 20 watt output will satisfy almost all domestic requirements.

- ★ **Output: 20 + 20W into 8 ohms**
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Flexible decorative effect for the home, discotheque or shop. Can be shaped to almost any desired form.

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Automatic moisture control for greenhouse plants.

Controls a mist watering system so that your plants get just the right amount of water.

PRACTICAL

ELECTRONICS

JANUARY 1975 ISSUE ON SALE DECEMBER 13, 1974

I.C. PULSE GENERATOR

BY M.E.THEAKER

During the course of work with logic circuits it has been found useful to have a source of suitable digital waveforms to hand. However, the popular sine/square-wave generator is not ideal for this task as its signals are not compatible with the two most commonly used logic families, TTL (transistor-transistor logic) and DTL (diode-transistor logic). Whilst complex signal generators, which provide suitable signals, are available at great expense, using one of these for most amateur purposes is rather like using a sledgehammer to crack a nut.

For this reason a simple and compact source of various digital waveforms was developed. It will provide a mechanically switchable output at either of the two logic levels corresponding to 0 and 1, a continuous train of square-wave pulses variable in frequency from 10MHz down to a pulse every few seconds, a monostable multivibrator for providing single pulses of any given duration from seconds to microseconds, a Schmitt trigger circuit and, lastly, a lamp indicator circuit to show whether the logic state of a circuit is high or low (1 or 0).

LOGIC LEVELS

Some basic rules are common not only to 74 series but also to most other TTL and DTL logic families.

First, the signal level should never exceed 5·5V or be less than −0·6V. It should occupy one of two states, "0" which is typically 0·2V (maximum 0·4V), and "1" which is typically 3·0V (minimum 2·4V).

The next important requirement is that the time taken to go from the low state (0) to the high state (1), which is known as the rise time, or the reverse which is known as the fall time, should not exceed one microsecond (1μs).

The reason for this is that both TTL and DTL are saturated logic circuits which operate in one of two stable states corresponding to 1 and 0. As they switch from one state to the other they pass through an unstable linear zone where the circuit can act as an amplifier or an oscillator.

If the signal input to a logic circuit has an unduly long rise or fall time, oscillation of the circuit will occur and is highly undesirable. If the rise and fall times are less than 1μs for gates (150ns for flip-flops), then spurious oscillation will not occur.

THE CIRCUITS

The first requirement for testing logic circuits is to be able to provide a steady output corresponding to logic state 1 or 0 and to be able to switch between these two states at will. It might be thought that a simple switch connected to either 0·2V or 3V as shown in Fig. 1a would suffice, but this circuit would not give a single transition from one state to the other, instead it gives rise to a number of pulses due to contact bounce as at Fig. 1b.

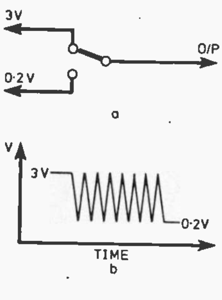


Fig. 1. Illustrating the effect of contact "bounce" when using a normal switch

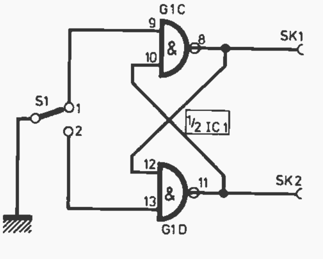


Fig. 2. Eliminating switch bounce using half an SN7400N

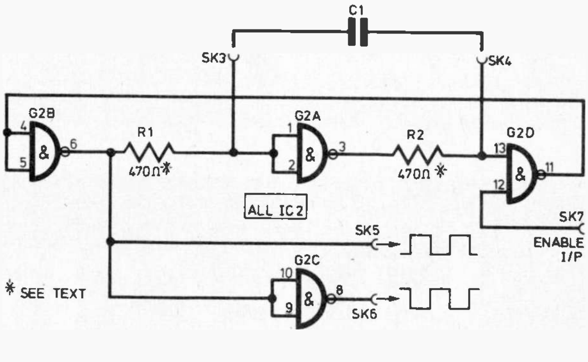


Fig. 3. The frequency of operation of this free-running multivibrator is selected using various values for C1

SWITCHED LOGIC LEVELS

In order to overcome contact bounce problems the switch can be used in conjunction with a flip-flop, which is made up from two 2-input NAND gates as shown in Fig. 2.

With the switch shorting S1.1 to ground one input to gate G1C is low (0 state). As S1.2 is not grounded it is high (1 state). Thus the output at SK2, gate G1D is low. Since both inputs to gate G1C are low its output at SK1 is high.

When the switch is moved to short S1.2 to ground, G1D output goes high. Since S1.1 is no longer connected to ground, it is now high and G1C output goes low. The outputs at SK1 and SK2 are now reversed and the transition is free from contact bounce. Returning the switch to position S1.1 restores the circuit to its original condition once again without contact bounce.

FREE-RUNNING MULTIVIBRATOR

Besides being able to switch at will from one logic level to the other, it is also useful to have a continuous source of pulses variable in speed from very slow to very fast. A suitable circuit is shown in Fig. 3 and consists of four 2-input NAND gates G2A, G2B, G2C and G2D. R1 and R2 affect the symmetry of the waveform and are nominally 470Ω. When they are equal in value the output waveform is nominally square, i.e. the waveform has a 1:1 mark/space ratio. The repetition rate or frequency of the signal is determined by capacitor C1.

The 2-input NAND gates G2A, G2B and G2C, are connected with their two inputs tied together as inverters.

To explain the operation of the circuit, consider the moment when the output of gate G2B goes from 0 to 1. Gate G2A inverts this signal and its output goes from 1 to 0.

The charge on C1 cannot change instantaneously and so the input to gate G2D also goes to 1 and the output goes to 0.

Now capacitor C1 begins to charge through R2 since G2A input is high whilst its output is at 0. As the capacitor charges so the voltage at pin 13 falls until it is sufficiently low to force the output of gate G2D into the high state, which in turn forces the output of gate G2B to go low, thereby commencing the second half of the cycle.

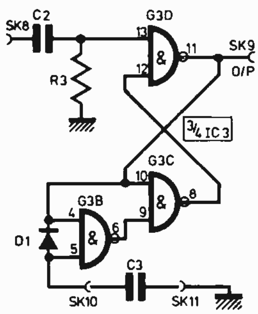


Fig. 4. A three-gate monostable provides a source of single pulses with adjustable duration

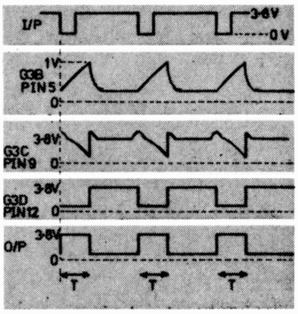


Fig. 5. The waveforms appearing at points in the circuit of Fig. 4

The input to gate G2A now being low forces its output high. Once again the charge on the capacitor cannot change instantaneously and so pin 13 is also low. Capacitor C1 now charges through R2 until the voltage at pin 13 is sufficiently high for gate G2D to change state and its output to go low, causing the output of gate G2B to go high, completing the cycle and starting another.

The process continues indefinitely as long as input to G2D at pin 12 is high. As soon as this input is taken low by an external circuit or is connected to earth, it stops the cycle. So pin 12 can be used to switch the oscillator on and off or, in other words, to "gate" or enable the oscillator. Gate G2C is used merely as an inverter and provides a complementary output from socket SK6.

Values of capacitance C1 for various frequencies are given in Table 1.

MONOSTABLE MULTIVIBRATOR

The third requirement is for a source of single pulses of adjustable duration and such a circuit is shown in Fig. 4. This forms a three-gate one-shot (or monostable) multivibrator circuit.

Varying C3 alters the output pulse duration and approximate values of capacitance for various pulse durations are given in Table 2.

A negative-going edge at the input produces a positive pulse at the output. The various waveforms of the circuit are shown in Fig. 5.

TABLE 1

C1	Period	Frequency
None	60 ns	16·7 MHz
47 pF	120 ,,	8·33 ,,
100 ,,	170 ,,	5·88 ,,
220 ,,	280 ,,	3·57 ,,
470 ,,	515 ,,	1·94 ,,
1 nF	1 µs	1·0 ,,
2·2 ,,	2·1 ,,	476 kHz
4·7 ,,	4·3 ,,	233 ,,
10 ,,	8·1 ,,	123 ,,
22 ,,	19 ,,	53 ,,
47 ,,	37 ,,	27 ,,
100 ,,	70 ,,	14 ,,
220 ,,	190 ,,	5·3 ,,
470 ,,	430 ,,	2·3 ,,
1 µF	909 ,,	1·1 ,,
100 ,,	91 ms	11 Hz

TABLE 2

C3	Pulse width
None	180 ns
47 pF	230 ,,
100 ,,	300 ,,
220 ,,	430 ,,
470	900 ,,
1 nF	1·5 µs
2·2 ,,	3·0 ,,
4·7 ,,	5·8 ,,
10 ,,	12 ,,
22 ,,	25 ,,
47 ,,	50 ,,
100 ,,	110 ,,
220 ,,	260 ,,
470 ,,	680 ,,
1 µF	1·3 ms
10 ,,	2·3 ms

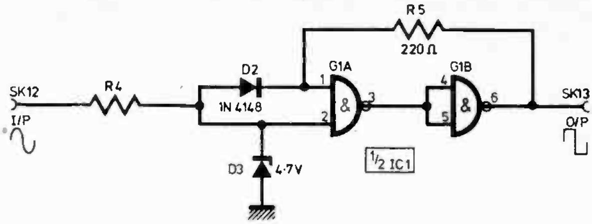


Fig. 6. A simple Schmitt trigger circuit using half of a SN7400N

SCHMITT TRIGGER

As mentioned earlier, TTL circuits require a pulse waveform with a fast rise time. If this requirement is not met, positive feedback between the output and input of the circuits will give rise to high frequency oscillation.

In order to be able to feed signals with slow rise times such as sinusoidal waveforms into TTL circuits a Schmitt trigger is incorporated as shown in Fig. 6. Positive feedback is applied via R5 in order that the output switches swiftly from one state to the other when the threshold is reached. The Zener diode D3 protects the circuit from overvoltage and the resistor R4 protects D3 from exceeding its maximum power dissipation. With R4 equal to 330Ω, inputs of up to 20V r.m.s. can be accommodated and the circuit will trigger on 2·8V r.m.s. With R4 equal to 100Ω, the maximum input is 6V r.m.s. and the minimum input 2V r.m.s.

LAMP INDICATOR

In order to check whether a circuit under test is at high or low level a lamp indicator circuit is included. The circuit is shown in Fig. 7 and consists of a transistor, TR1, a lamp LP1 and a base resistor R6 to limit the input current to the transistor.

COMPONENTS . . .

Resistors
- R1 470Ω
- R2 470Ω
- R3 22kΩ
- R4 330Ω
- R5 220Ω
- R6 470Ω or 1kΩ (see text)
- R7 180Ω
- All ½W, 5%

Capacitors
- C1 68pF Polystyrene (see Table 1)
- C2 150pF ,,
- C3 68pF polystyrene (internal) (internal see Table 2)

Semiconductors
- IC1 SN7400N or equivalent
- IC2 ,, ,,
- IC3 ,, ,,
- D1 1N4148
- D2 1N4148
- D3 4·7V, 400mW Zener
- TR1 BFY51 or similar

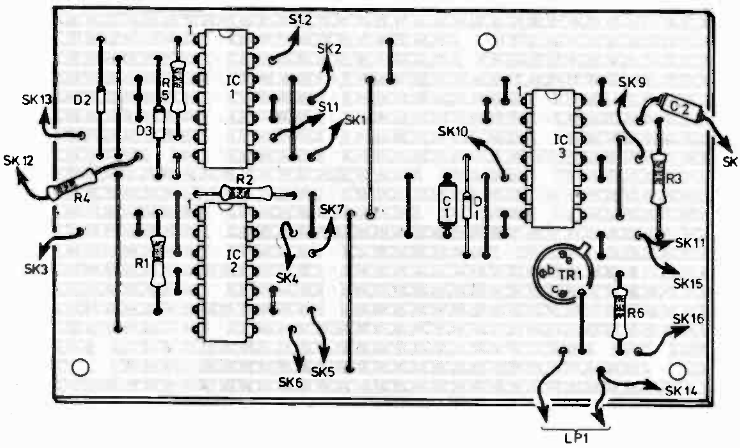


Fig. 9. Veroboard and component layout for the pulse generator

Miscellaneous
- LP1 Miniature 6V, 0·36W Lilliput lamp and holder (Or l.e.d.)
- S1 Miniature toggle switch, SPCO
- SK1 to 16 16 single-pole miniature 1mm sockets, colour to suit

Single-pole miniature 1mm plugs in colour and quantity to suit for leads and supply lines
Veroboard, 0·1in pitch, 3·4in × 2·0in. Veropins.
Case (Prototype used 2 × 2oz tobacco tins), wire, solder etc.

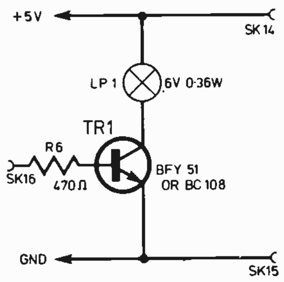
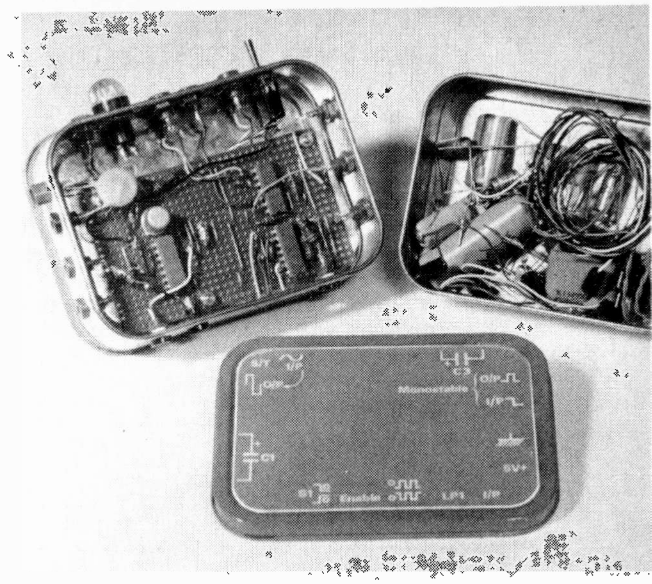


Fig. 7. Lamp indicator using a filament lamp. Note that the power supply is fed to sockets 14 (+5V) and 15 (0V) from an external battery or p.s.u.



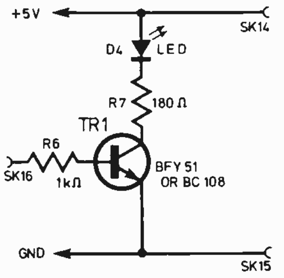


Fig. 8. Indicator using an l.e.d.

When logic 0 is applied at SK16 the transistor is cut off and no current passes through the lamp, but when logic 1 is applied the transistor is switched on and current passes through the lamp which lights.

A further version of the lamp circuit using an l.e.d. is shown in Fig. 8.

CONSTRUCTION

The circuits are all constructed on one piece of 0·1in pitch Veroboard, 3·4in by 2·0in. Whilst the layout is not critical leads should be kept as short as possible and the suggested layout of Fig. 9 works well.

The easiest way of constructing such a board is first to cut it to size, then drill the three 6B.A. clearance holes required for mounting the board in the case. Next the pins should be inserted and then the cuts in the copper strips should be made. Following this, the wire links should be inserted and soldered in place, followed by the discrete components and finally the transistor and three integrated circuits.

CASE

The case for the prototype pulse generator was made from a standard two-ounce tobacco tin. Three 6B.A. screws approximately half an inch long should be screwed through the bottom and Araldited in place to accept the Verobard. The top of a further tin can be rubbed down to remove the paint from the top rim and then Araldited underneath the bottom of the case and allowed 24 hours to set.

Bonding a lid underneath the case prevents the heads of the 6B.A. screws (which are now hidden) from scratching other equipment or furniture and means the generator may be stacked on to a second tin containing the leads and spare timing capacitors.

When the Araldite has set, the case should be painted and the sockets labelled as shown in the photograph. "Letraset" was used for the prototype and then varnished, which provides a very durable finish.

The capacitors used for adjusting the frequency of the astable multivibrator and the pulse width of the monostable multivibrator should have Veroboard (or similar) pins soldered to their leads for connection into the sockets provided on the case. A number of leads should be made up, some with a plug on one end for connection to external circuits, and some with plugs on both ends for interconnecting the sockets of the generator. These leads should preferably not exceed 1ft length for reliable operation.

The 1mm sockets used here are probably the only ones small enough to use in a tobacco tin. However, if a larger unit is used different output arrangements could be adopted. If component switching and other refinements are added care will be required over length of leads and interaction between signals. ★

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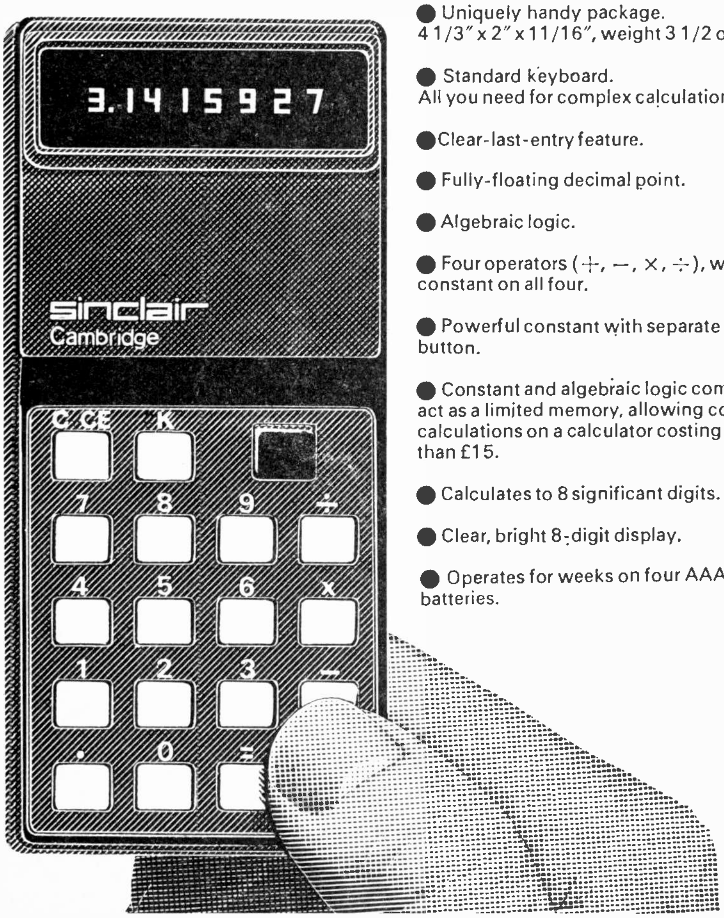

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NEW DEVICES ...APPLICATIONS

PHASE LOCKED LOOP FOR HIGH PERFORMANCE F.M. RECEIVERS

THE SIGNETICS International Corporation have recently introduced a new type of phase locked loop integrated circuit known as the NE563. This device employs new techniques to provide an extremely good performance in high quality f.m. receivers.

PERFORMANCE

The NE563 can provide an audio output signal having a total harmonic distortion of less than 0·5 per cent when fed with a 10·7MHz input signal having a 75kHz deviation at a 1kHz modulation frequency. This distortion level is lower than that of any other f.m. demodulator circuit known to the writer.

However, the NE563 not only excels in its low distortion, the a.m. rejection is 70db, far greater than that of most other circuits which seldom exceed 50db. The signal-to-noise ratio of 70db also illustrates the performance of this new device.

Although it provides such good performance figures, the NE563 is also convenient to use, since it functions as a complete i.f. strip without any coils whatsoever. It also contains a built-in limiter circuit which itself has a gain of up to 60db.

POWER SUPPLY

The NE563 operates from power supply voltages in the range 10V to 15V, this being less than that required by the earlier NE560, 561 and 562 series. The supply current is about 35mA. The NE563 is more sensitive than these earlier devices, having an input sensitivity of typically 5μV (maximum 10μV) for a 30db signal-to-noise ratio.

A further added bonus provided by the 563 is the high audio output level of 500mV r.m.s. (which may be compared with the typical value of 60mV obtainable from the NE560 series of devices). The maximum load which can be applied to the audio output is 2kΩ.

The NE563 also incorporates facilities for inter-station muting and for the operation of a signal strength meter.

The 563 device is encapsulated in a 16 pin dual-in-line case with the connections shown in Fig. 1.

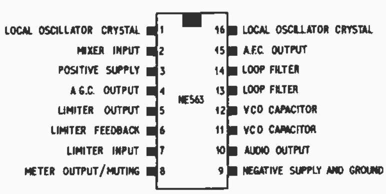


Fig. 1. The connections of the NE563 device

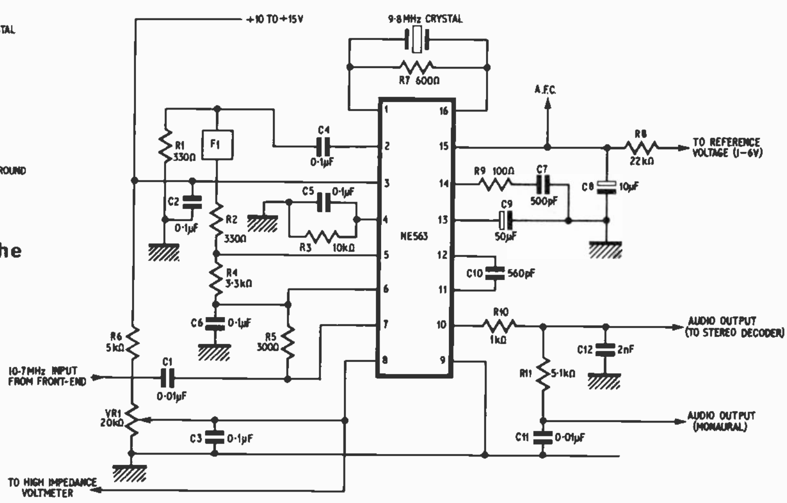


Fig. 2. Recommended circuit for the NE563. (R11 has been reduced from the value of 7·5kΩ suitable for the 75μs pre-emphasis used in the U.S.A.)

CIRCUIT OPERATION

The basic circuit recommended by the manufacturers of the 563 is shown in Fig. 2. The excellent performance is, of course, related to the techniques employed in this circuit.

A 10·7MHz signal from the front-end unit is capacitively coupled into the limiter input at pin 7 of the device. The limited output signal from pin 5 is passed through the 10·7MHz miniature ceramic filter marked F1 into the mixer input at pin 2.

The two resistors R1 and R2 on each side of the filter F1 are required for matching the filter impedance to that of the circuit. If they are omitted, the band-pass characteristics of the filter will be impaired.

The 10·7MHz signal entering the device at pin 2 is mixed with a 9·8MHz local oscillator signal generated by the crystal controlled oscillator connected in the circuit of pins 1 and 16. A difference frequency of 0·9MHz is thereby generated.

Table 1: Showing the typical readings of a high resistance voltmeter connected to pin 8 at various input signal levels

Input	Meter Reading (V)
1μV	0·3
10μV	0·35
50μV	0·6
100μV	0·85
500μV	1·4
1mV	1·6
5mV	2·3
10mV	2·75
50mV	3·6
100mV	4·0

The centre frequency of the voltage controlled oscillator of the phase locked loop is determined by the value of the capacitor C10 connected between pins 11 and 12 of the device; this capacitor is selected to provide a free-running or centre frequency of about 0·9MHz. The loop therefore becomes locked to the frequency of the difference signal.

The error signal voltage which keeps the loop in lock is the required audio output. The audio signal is filtered by R10 and C12 (time constant 2μs) to reduce the amplitude of any radio frequencies present, whilst leaving the high frequency components of the stereo signal virtually unaffected.

The audio signal is also filtered by R11 and C11 which provide the required de-emphasis of 50μs for monaural signals.

The 563 provides an automatic frequency control output signal from pin 15 which may be fed to the front end unit. A voltage is provided by pin 8 which can be fed to a high resistance voltmeter to provide an indication of the signal level at pin 7. Typical values of the meter reading for various input voltages are shown in the table.

CONCLUSION

The use of this new device should lead to both an improvement in the performance of high quality f.m. receivers and also a simplification in their circuitry. Although a 9·8MHz crystal is required for use with the NE563, the circuit is extremely simple and requires no coils or alignment. It seems to be equally suitable for use by the manufacturer of high quality commercial receivers and by the amateur constructor.

NEWS BRIEFS

Approval of Ceefax and Oracle experiments

The Home Secretary has approved the introduction for a two-year experimental period, of the broadcasting of live information on television by means of the techniques known as CEEFAX (BBC) and ORACLE (IBA).

The purpose of the experiment, whereby those in possession of the necessary receivers will be able to receive printed information over a wide range of topics on their television screen, is to enable an assessment to be made of the demand for the service, to determine what form it should take and to estimate the scope for the manufacture of the equipment. It is assumed that the Annan Committee on the Future of Broadcasting will consider the techniques involved against its review of broadcasting policy as a whole.

Oracle demonstration

Just prior to the Home Secretary's approval a "live" demonstration of the "Oracle" system was staged at Crawley Court near Winchester, headquarters of IBA's engineering division. There direct feeds from ITN, the Meteorological Office and the A.A. provided information which could be immediately up-dated. The display material was coloured with upper and lower case letters, included graphics and whole words could be flashed to rivet the attention of the viewer to an important item.

"Oracle," an acronym for Optional Reception of Announcements by Coded Line Electronics, can provide such presented information at the touch of a button.

This "broadcasting of the written word" is obtained by inserting a digital signal during part of the field blanking interval of a 625 line waveform. Since the details of the signal coding differed for the experimental BBC and IBA systems it has been necessary to draw up a common data broadcast standard which has now been ratified.

Up to 100 different pages of data, each page comprising up to 150 words or diagram could be transmitted continuously. Viewers having the necessary decoder (which will be integral to future generation receivers) will have immediate access to any of the pages being transmitted on the channel tuned. This can be displayed on a neutral background or superimposed on the television picture.

Whilst a regular transmission of live broadcasts by the BBC was started on September 23rd, the IBA experimental service is not expected to commence till next year.

−68°C to +175°C THERMOMETER / CONTROLLER

By J. N. JONES

THE relationship between the forward voltage drop of a diode and the temperature of the surroundings often causes problems in electronic circuitry. The present project makes use of this drawback to measure temperature.

The circuits described are simple, easily constructed and linear. The diode used is the very common 1N914 (equiv: 1S914) which can be obtained for as little as 3p and, since it is physically small, can be used to sense the temperature of small as well as large objects. Also, the size leads to a fast response rate.

Silicon diodes have one limitation, the range extends only from −65°C up to +175°C but this is wide enough for most applications and the instrument can be calibrated anywhere in this range.

APPLICATIONS

The article describes four basic circuits, a simple indicator in detail and an indicator/controller with set-point display, a blind (non-indicating) controller and a switched range version of the first indicator. The first mentioned is taken to the prototype stage in detail whilst the others are described in basis only.

Obviously there are many applications including normal workshop testing as when a transistor is running hot. The indicator can show if it is too hot or still within its range. The blind controller can be used to maintain an item of equipment at a given pre-set temperature using a heating element.

CIRCUIT

A basic indicator circuit is shown in Fig. 1. Here a stable reference voltage for the diode probe and operational amplifier inputs is provided by an integrated circuit IC1 which is in fact a 723 device which also carries an amplifier used elsewhere in the circuit (IC3).

The diode probe is connected in the feedback loop of IC2, connected to the inverting input. By careful adjustment of the potentiometer VR1, the bias provided to the non-inverting input of IC2 is held to about 600mV below the V_{ref} (Pin 6) provided by IC1. (Actually the diode D1 forward voltage drop at 0°C or whatever temperature zero meter current represents.)

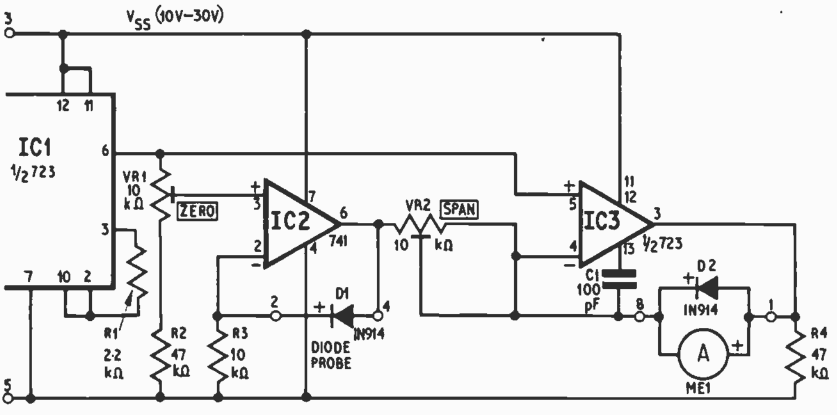


Fig. 1. Circuit diagram of the heart of the indicating diode thermometer showing the use of integrated circuits to provide sophisticated circuit functions in a very simple manner

IC2 works in the inverting mode feeding current through D1 to R3 so that the inverting input is held at the same potential as the non-inverting. The output is thus one diode drop greater than the bias voltage provided by VR1.

The sensitivity of a silicon diode is about -2mV/degree C, thus the p.d. is in fact about 600mV at 0°C and 400mV at 100°C. IC2 output thus changes from V_{ref} at 0°C (or zero meter current temperature) to approximately $V_{ref} - 200$mV at 100°C.

Amplifier IC3 also operates in the inverting mode, passing current through the indicator ME1 to maintain the two input pins at the same potential. As the input impedance of IC3 is high all the meter current passes through VR2. Thus one end of VR2 is held at V_{ref} by IC3 whilst the other varies from V_{ref} to $V_{ref} - 200$mV (at 100°C).

Thus VR2 value determines the current per unit temperature flowing in ME1. A 100μA indicator, to correspond to 0°C to 100°C requires VR2 of about 2kΩ and thus a 10kΩ potentiometer is suitable.

VOLTAGE REGULATOR

A circuit of this type, to retain accuracy, needs to be supplied with reasonably constant voltage at the probe and other operational amplifier inputs. Hence the use of the 723 regulator chip. These can be obtained for about 57p and contain the required 7V reference source and an amplifier which is useful.

In the circuit, R1 provides short circuit protection for the amplifier section and C1 is necessary for frequency compensation.

The 741 amplifier chip was selected for IC2 and either the 8 or 14-pin d.i.l. packages may be used in the Veroboard layout of Fig. 2. This device has its own internal frequency compensation.

R4 is required if negative (below 0°C) temperatures are to be investigated and for setting to zero since IC3 can only drive the meter in one direction.

METER PROTECTION

Since removal of the diode probe with the instrument switched on will cause heavy meter current, apart from any other reasons, meter protection is a good idea. Hence diode D2 which protects the meter against large overloads but does not affect normal readings.

In addition, the 723 amplifier, IC3, has programmable short circuit protection which can be selected to lie close to the sum of meter f.s.d. current and R4 current. Programming is by selection of R1 from the following equation:

$$I \simeq \frac{0{\cdot}65\text{V}}{\text{R1}}$$

As R4 is selected to sink enough current to give reverse f.s.d. on the meter then I must equal (current through R4 plus the current through the meter) × 1·5. The factor 1·5 is to ensure that normal IC3 currents do not enter the range where

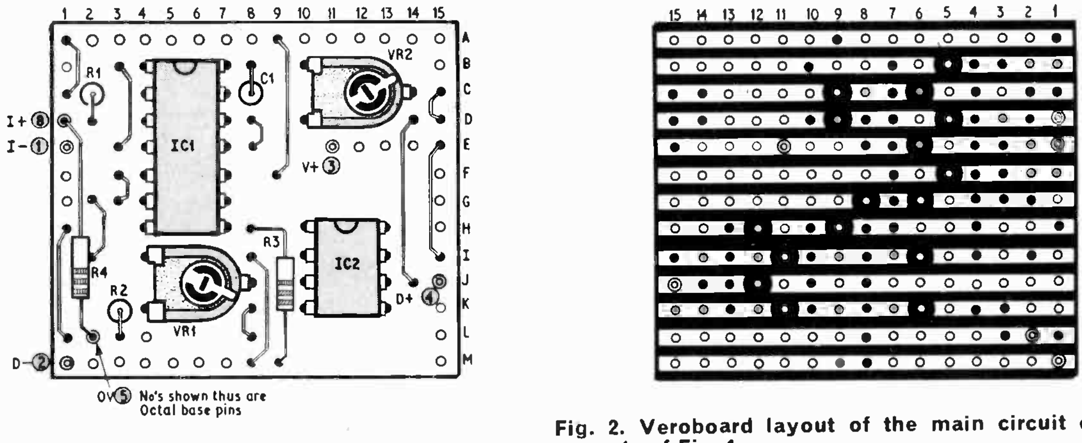


Fig. 2. Veroboard layout of the main circuit components of Fig. 1

COMPONENTS . . .

Resistors

R1	2·2k Ω	R7	1k Ω
R2	47k Ω	R8	3·9k Ω
R3	10k Ω	R9	68k Ω
R4	47k Ω	R10 to R18	100 Ω
R5	180k Ω	R19	18k Ω
R6	47k Ω		

All 2% except R10 to R18 which are 1%.

Potentiometers

VR1 10k Ω VR3 5k Ω VR5 50k Ω
VR2 10k Ω VR4 5k Ω
For best results use Cermets or miniature multi-turn pots

Capacitors

C1 100pF

Integrated Circuits

IC1 & 3 One 723 Regulator i.c.
IC2 741 Operational Amplifier
IC4 741 Operational Amplifier

Diodes

D1 1N914 D2 1N914

Transistors

TR1 BFY51

Switches

S1 3-pole, 4-way slide or rotary
S2 2-pole changeover
S3 1-pole, 10-way

Miscellaneous

ME1 100μA meter or to suit.
Veroboard; Octal relay plug and socket if required; case, batteries, wire, etc.

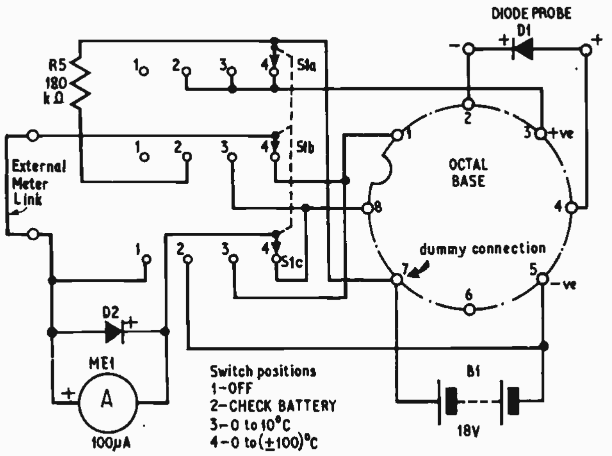


Fig. 3. The assembled circuit of the indicating instrument developed from the basis of Fig. 1

short circuit protection begins as scale non-linearity could result.

PROTOTYPE CONSTRUCTION

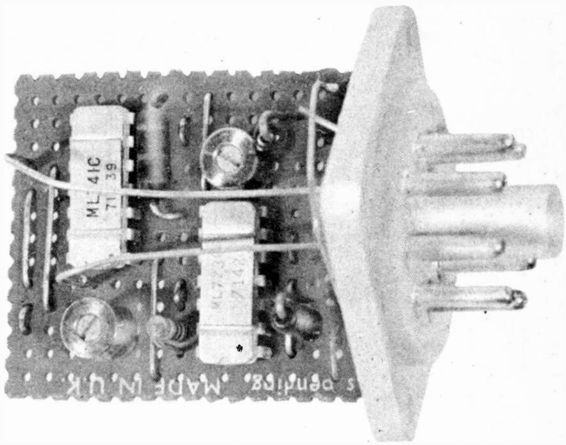
For convenience and neatness the original was made up in an octal-based relay case and the pin numbers used are shown in both Fig. 1 and Fig. 3. These are not firm and can be modified. Pin 7 for example was used to retain the battery lead for convenience but is not connected to the Veroboard.

SWITCHING

The 3-pole, 4-way switch S1 of Fig. 3 provides on/off, battery check, 0 to ±100°C (in fact only to −60°C). In the off position the meter is shorted out for added protection.

In the battery check position the 180kΩ resistor R5 converts ME1 to an approximately 18V voltmeter. This is effected with the load connected so a proper test is indeed performed.

In fact the instrument can function with battery voltage as low as 10V with very little loss in accuracy.



An assembled circuit board mounted on its octal plug carrier and with the cover removed

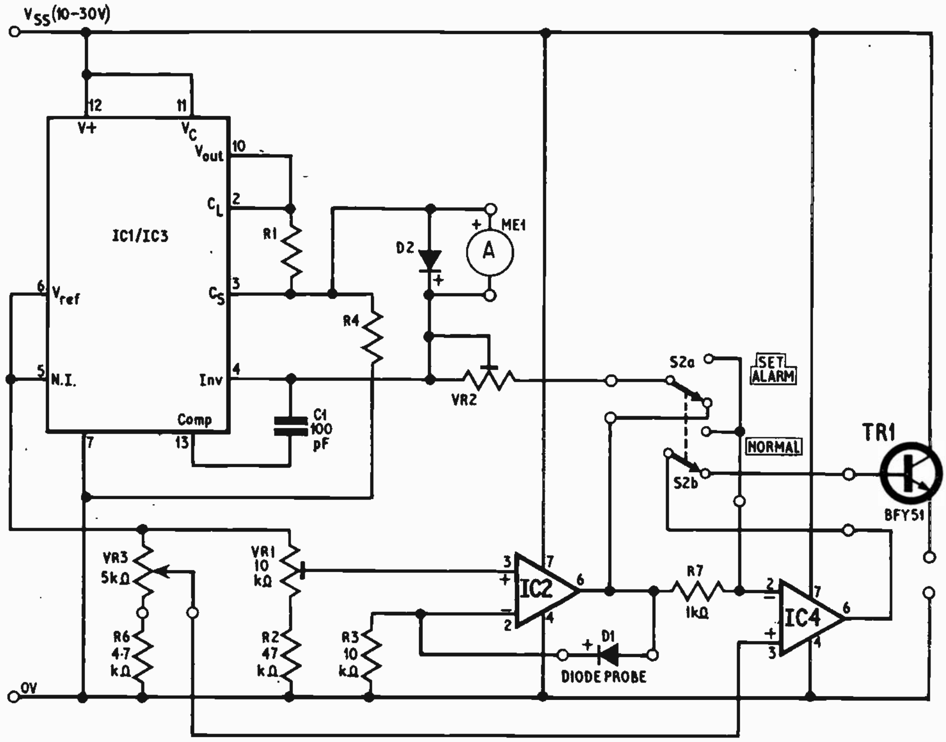


Fig. 4. A variation of the diode thermometer designed to give both control and indication functions

METER

Provision is made for an external meter if this is required. It should of course match the existing meter (100μA). Normally the link is left in place.

If it is required to substitute a 1mA movement for the 100μA suggested in Fig. 1 then R1 becomes 220Ω, VR2 becomes 1kΩ, and R4 becomes 4·7Ω. Other meter values between these two limits can be accommodated if desired by interpolation.

CALIBRATION

Instrument calibration is in fact fairly simple. After assembly and circuit checking the instrument is now ready. Due to characteristic variations from diode to diode, calibration is needed each time a diode is changed.

In addition, the diodes themselves need some form of protection. Thus it is best to coat them with material such as cellulose varnish, synthetic resin, silicone rubber or the like to both prevent ingress of damaging fluids and, of course, to avoid faulty readings due to conductive fluids altering the diode characteristics.

Of course the coating will to some extent reduce the speed of reaction of a diode but this can be accepted happily in many applications.

The easiest way to calibrate is to use boiling water for the 100°C standard and melting ice for the other 0°C level. Thus a simmering pan of water and a thermos flask containing a water/ice mix are convenient.

With the instrument switched on, place the probe first in the ice/water mix and adjust VR1 to set the meter zero value. Now place the probe in the simmering water and adjust VR2 to set the end-of-scale 100°C correctly to the f.s.d. mark on the meter if it is a 0 to 100 scale.

An interesting point is that whilst Fahrenheit is now out of fashion it is just as easy to calibrate a scale to Fahrenheit if one wants.

It will probably be necessary to repeat the procedure to check calibration. Of course, the scale can be compressed or expanded as required.

INDICATOR/CONTROLLER

By using an extra amplifier IC4 as in Fig. 4, in the comparator mode, the signal at IC2 output can be compared to any preset value and a resulting switching action used to provide control or alarm functions. With the switch S2 in the "Normal" position the circuit of Fig. 4 provides both visual indication of temperature and a switching output function. IC4 comparator controls TR1 which in turn controls the required external circuits.

With S2 in the "Set Alarm" position IC4 is connected as a voltage follower, buffering the set-point potential of VR3 and presenting it to IC3 and the meter. Thus the meter indicates the setpoint value.

BLIND CONTROLLER

The circuit of Fig. 5 can be used to drive lamp or relay circuits in order to effect a blind (non-indicating) control function.

SWITCHED RANGE INSTRUMENT

The circuit of Fig. 1 can be modified as in Fig. 6 to provide a scale expansion function in which the indicator gives a 0 to 10 degree indication and the switch S3 selects the lower point of the indicated scale. Thus as shown the 10°C scale can start at 0°C, 10°C, 20°C and so on up to 90°C as selected by the switch.

This gives a scale expansion of one order of magnitude which can be useful in many applications.

When calibrating this version of the instrument VR1 is adjusted as before with S3 in the 0°C position, VR2 is adjusted to give a 10°C range indication, and then VR5 is adjusted with S3 at 90°C position and the probe in boiling water to give f.s.d. The VR2 adjustment will probably require the use of a normal thermometer. ★

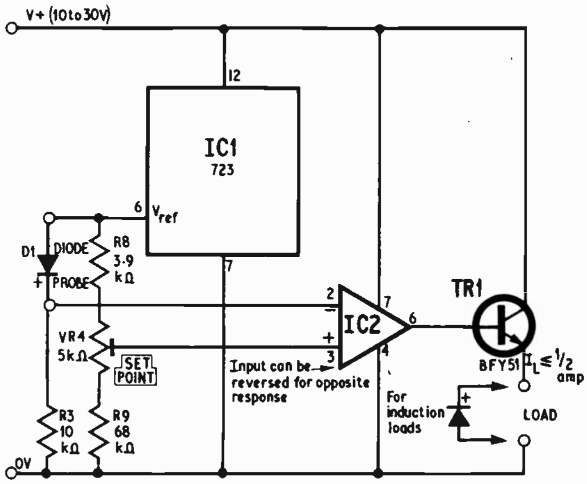


Fig. 5. A "blind" controller based on the diode thermometer. The output is "on" when the sensed temperature is below the set point

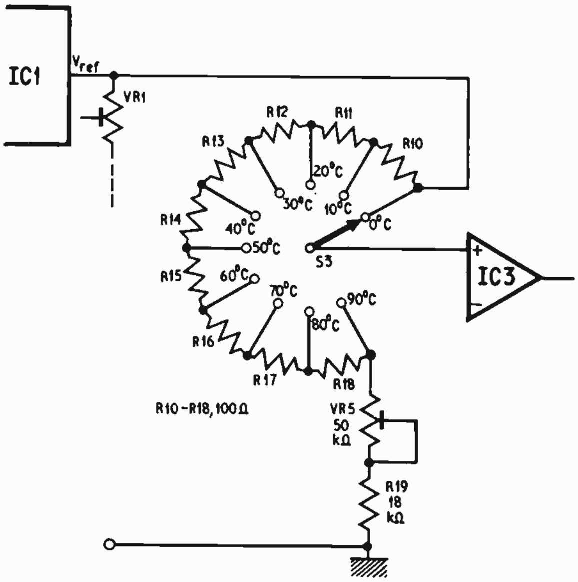


Fig. 6. A modification of Fig. 1 which gives an expanded scale covering 10°C but switchable to start at any of a number of selected temperatures

BOOK REVIEWS

PIEZOELECTRIC CERAMICS

By J. van Randeraat and R. E. Setterington
Published by Mullard Ltd.
211 pages. Price £4 clothbound

THIS latest addition to the Mullard technical library offers, in one volume, a comprehensive textbook on the subject of piezoelectric ceramics from basic theory through mechanics and associated mathematics to the practical application of a wide range of devices manufactured by the publishers.

This volume is up to the usual high Mullard standards with plenty of back-up information provided in the form of recognised symbols used in the art, tables of information on the various shapes and forms of device available and details of behaviour under temperature variation.

Apart from the in-depth technical information, space is given to discussion of the main application areas for this recently developed material, such as in gas ignition, in flexture elements (those which move on application of electric current) and in resonant devices as in filters and ultrasound equipment.

A variety of circuits are worked through, even as far as production of p.c.b., and suggestions are put forward for such items as a depth sounder, control transmitter/receiver installations and intruder alarms.

Following the usual Mullard tradition this book will be of use anywhere this type of device is considered from the educational establishment to the industrial workshop and is undoubted value in current terms.

Available from technical bookshops or directly from the distributor, Technical Press Ltd., Freeland, Oxford, OX7 2AP.

R.D.R.

SL600 SERIES APPLICATIONS MANUAL

By James M. Bryant
92 pages, 6in × 8¼in

THIS is the second edition of collected applications information specific to the Plessey Semiconductors SL600 series i.c.s.

Completely updated, the contents break down to three sections with appendices. Section 1 covers circuit data; section 2—system design and section 3 on relevant technical data.

In section 1 chip circuitry is explained and the area of applications detailed. The remainder of the manual looks at complete communications systems including the devices with an end section on product characteristics with operating notes.

Copies of the manual are available from Plessey Components Ltd., Plessey Semiconductors, Cheney Manor, Swindon, Wiltshire SN2 2QW. Price 50p.

G.G.

RADIOISOTOPE EXPERIMENTS IN PHYSICS, CHEMISTRY AND BIOLOGY

By J. B. Dance
Published by Hutchinson Educational
246 pages, 8½in × 5½in (softback). Price £1·75

THE study of nuclear radiation is receiving increasing attention in schools and colleges. It offers opportunities to demonstrate the fundamental nature of matter with quite simple equipment, such as the well-known Geiger counter.

This book describes in full detail more than 70 experiments that can be performed using either naturally occurring radioisotopes or artificially produced isotopes. The topics covered include those of interest to students of physics, chemistry, statistics, and biology, up to G.C.E. Advanced Level.

The collection of experiments (well catalogued for immediated reference in the Contents) makes up rather more than half of this book. It is preceded by five sections dealing with theoretical and practical matters, which collectively form an excellent introduction to the subject.

Appendices give valuable information and data; in particular, the regulations and codes of practice governing the use of radioisotopes in educational establishments and addresses of suppliers of equipment and radioactive sources.

This book is an expanded and updated version of the author's *Radioisotope Experiments for Schools and Colleges* which was first published by Pergamon Press in 1967.

F.E.B.

RECEIVING PAL COLOUR TELEVISION

By A. C. Priestley
Published by Argus Books Ltd.
261 pages. Price £5

TO readers of our companion magazine Television, the author's name is no doubt familiar. With a background of many years in TV design and the creator of correspondence courses in colour TV one would assume these were the ingredients for producing a successful book on the subject.

With a publishing date that coincides nicely with the start of a new term of evening and day classes it will obviously attract engineers, technicians and students who already have a working knowledge of the principles of monochrome television and wish to extend their knowledge to embrace PAL colour systems.

Since the mathematical explanations are marginal, the enthusiastic amateur might get better results from his set with judicious reading.

Chapter one deals with the origins of the PAL system, basic light theory and a short review of monochrome fundamentals.

Subsequent chapters include analyses of the transmitted colour signal, display tubes, decoding, colour display adjustment and servicing which includes test gear requirements, interpretation of results along with rudimentary troubleshooting procedures.

The reading is made so much easier by the abundance of sideheads which break up each chapter. They also prove a useful reference, being included in the contents page.

There are many line drawings and a number of colour plates. Final appendices cover vectors, phasors and colour bar signal waveforms.

G.G.

INDUSTRY NOTEBOOK

By Nexus

CALCULATOR NEWS

Sinclair Radionics, Britain's largest calculator manufacturer with an output of 50,000 units per month, of which 70 per cent are exported, is on the brink of its biggest deal ever. This is a completely new calculator which will be marketed by the Gillette Company of Boston, U.S.A. First reports suggest that the calculator is unlike any of the five Sinclair models currently available and is being designed to an original Gillette specification. Details are hush-hush at the time of writing, but I understand a test marketing by Gillette in the United States is imminent. If the market responds satisfactorily, big production contracts will follow. And it is hinted that "big" is measured in millions of units.

Advance Electronics is offering a version of the Model 162P fully programmable calculator in kit form at £99 plus VAT. The assembled 162P is listed at almost £200 which suggests that assembly and testing is a tedious and time-consuming affair. But Advance say that the kit can be assembled "in a matter of minutes without requiring any special tools". This is another example, it seems to me, of the erratic pricing structure in the calculator business. Even in these days of wage inflation, £70 or so for "a matter of minutes" in assembly seems somewhat excessive.

Mullard's new MOS i.c.s for calculators enable any would-be calculator manufacturer to get into business. Announcing the new range, Mullard say all you need is a keyboard, a display and a few interface components. There are four i.c. kits for desk models of all complexities, including memory circuits and print-out drives, and a couple of single-chip i.c.s for the simpler pocket calculators. But before leaving the car in the drive and setting up an assembly plant in the garage, remember that it's easier to make things than market them. I have been told that in the early days it cost one manufacturer £15 in press advertising for each calculator he sold.

BARGAINS

With share prices at an all-time low it's a wonder more companies haven't been snapped up by bargain hunters than have been. Who would have imagined a few years ago that one of the real high flyers, Advance Electronics, would change hands for a mere £4·25 million? But so it was after weeks of rumour. Advance, who was once well fancied as a possible buyer of Marconi Instruments, now finds itself a wholly-owned subsidiary of Gould Inc., of Chicago.

As long ago as November 1971 Gould was known to be shopping for European companies with over £25 million to invest and is now operating in nine European countries. It's hard to believe that this go-ahead concern runs its European operations not from some lush office suite in one of the great financial centres but from the Epping home of Gould Europe's director Richard A. Holmes.

Advance Electronics is a good buy. Chairman Sir Edward Howard reported record pre-tax profits of £709,793 for 1973 and full order books for 1974. And the Advance product range in no way conflicts with Gould's own range.

Whether George Kent will be a bargain for GEC remains to be seen. Kent was about to conclude a deal with the Swiss company Brown Boveri in which the latter would have acquired a majority shareholding. With remarkable suddenness, and apparently with Government support, GEC put in a counter-bid which would give GEC 50 per cent ownership, the other shares being owned 41 per cent by the Government and nine per cent by Rank. The new alignment was not firm at the time of writing but few observers doubted that the deal would go through. The odd thing about the offer, apart from its speed and timing, was that it is entirely contrary to GEC's normal policy of total control. But these are strange times.

SEMICONDUCTOR PRICE WAR

Following dire warnings from Fairchild, reported in last month's *Industry Notebook*, there is evidence that a new round of price-cutting has started. The European SGS-ATES concern has reacted to reports of U.S. underpricing by slashing their own prices by up to 50 per cent on some consumer i.c.s and by up to 40 per cent on some professional devices.

We all know that demand for consumer i.c.s has slackened but I feel it is perhaps going too far to talk of a "semiconductor mountain". But it is true that stocks have been building up and first reports suggest that the SGS-ATES price cuts apply only to the U.K. market—at least for the time being. Whatever the decline in the demand, a spiral down in prices on a world scale can hardly do anyone any good. As it is, today's prices for i.c.s average out at less than 50 per cent of what they were four years ago in spite of inflation.

AEROSPACE FLIES HIGH

Britain's aerospace industry stood up well in comparison with foreign exhibits at last September's Farnborough Air Show. In round figures the output of the industry is £800 million including £500 million of exports with a labour force of under 200,000 people. And the electronics sector looked really good with plenty of advanced technology products ranging in size from Plessey's new 3-D radar down to a tiny hand-held laser rangefinder shown by Barr & Stroud which, in size and appearance, is like a pair of binoculars and yet has a range of three miles with L.E.D. digital read-out, and all operating from internal batteries.

Industry leaders were clearly pleased with the performance of their companies but with the threat of nationalisation over their heads I can only sum up the general atmosphere as one of nervous optimism.

The most honoured guests were those from the oil-rich nations whose multi-million pound orders were gratefully received. It's a straight swap of technology against the purchase price of oil.

BRIGHT BOYS

Keep an eye on Membrain, already big in automatic test equipment and growing at a phenomenal pace. It's manned by a youthful team of enthusiasts headed by C. A. (Tony) Davies, now aged 30, who started the company in July 1970. Average age of Membrain staff is 33 years and 42 per cent of the 140 staff are under 30.

Starting from zero they have built a business which is now turning over £1·5 million a year. It is still on the cards that Membrain will acquire the ATE interests of Honeywell, though both sides are currently dismissing the rumour. Not bad going for a bunch of youngsters who, apart from building a fine business, won the Queen's Award for Technological Innovation earlier this year.

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. Any idea published will be awarded payment according to its merits. Why not submit YOUR IDEA?

NEON OSCILLATOR

THIS circuit is simple for the beginner to both build and understand and, using readily available components it can be assembled very cheaply. The frequency range is quite wide, from one pulse per second or less up to the higher audio frequencies.

In the circuit of Fig. 1 the capacitor C1 charges via R1 and R2 and the primary of T1, an old valve output transformer of 20 or 30 to 1 turns ratio. When the voltage across C1 reaches the striking voltage of the neon, the latter discharges, producing a flash at the neon and an output pulse from the secondary of T1.

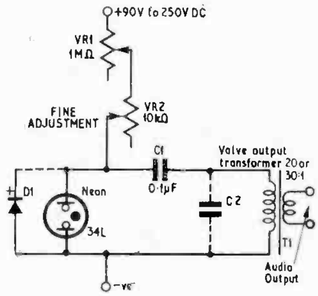


Fig. 1

After the circuit is constructed R1 should be adjusted from its highest value until oscillation starts and then R2 is adjusted to set the rate of charge of C1 and thus the frequency of oscillation. In this way one can use R1 as a coarse adjustment and R2 as a fine adjustment increasing the resistance to reduce the frequency.

With C1 at 0·1µF oscillations vary from a slow flash to about 50Hz. Smaller values of C1 produce higher frequencies. Capacitor C2 is really optional and is used to alter the tone of the audio output. The output can be fed to a small loudspeaker or an amplifier as desired.

Applications are numerous. The circuit can form a useful voltage indicator or can perhaps be the basis of a synthesiser. Powering is either from the mains using a suitable rectifier and smoothing or using a battery of the valve receiver type (90V). With the former it is possible to obtain a descending audio note on switching off and a continued illumination of the neon for some time after that because of smoothing capacitor charge holding. This could perhaps have timing applications.

The diode D1 can be used to replace the neon if only an audio output is required. This should be a low reverse breakdown device so that C1 discharges through it when the breakdown voltage is reached.

M. J. Maynard
Wednesbury.

ZENER DIODE CHARACTERISTICS

AN OSCILLOSCOPE is a fairly usual adjunct to the workshop these days and most oscilloscopes are fitted with a sawtooth output from the ramp generator. This can be used to great advantage to measure the characteristics of Zener diodes.

All that is required in addition to the oscilloscope is a potential divider network which is connected up as shown in Fig. 1. The sawtooth potential is divided down so that it can be applied to the device under test, the same points being connected to the Y-amplifier input.

With no device connected, or one which is open circuit, the oscilloscope will display the plain ramp waveform, an evenly increasing voltage. With a short-circuit device connected the display will be a simple horizontal line as there will be no input to the Y amplifier.

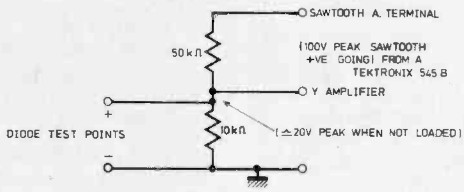


Fig. 1

A good device will cause the display to assume the normal ramp shape until the voltage across the diode reaches the Zener voltage value when the trace will become horizontal. Thus the Zener voltage can be read from the scope graticule and Y amplifier setting.

A device with an intermittent fault will show a display which oscillates between the two possible other displays, depending on the fault failing to short or open circuit.

The characteristics of any diode can be investigated using this method and for other voltages the potential divider is suitably modified using Ohms Law to give a voltage level which exceeds the Zener voltage of the device under test. Of course, the sawtooth output must not be overloaded or the diode parameters exceeded.

R. Beck
Romney Marsh.

INTEGRATED TRIFFID

READERS may be interested in this integrated version of the Triffid receiver published in Practical Electronics. As shown in Fig. 1 the circuit works only on medium waves but if long wave coverage is required the modifications can be found in Practical Electronics, February 1973.

The present circuit was built on a small printed circuit board and mounted in a case measuring 2 × 3 × ⅞in using a 250pF trimmer fitted with a long spindle for tuning.

For size reduction reasons it is probably best to use a combined potentiometer and switch for the 10kΩ potentiometer.

C. M. Rose
Alsager, Stoke-on-Trent

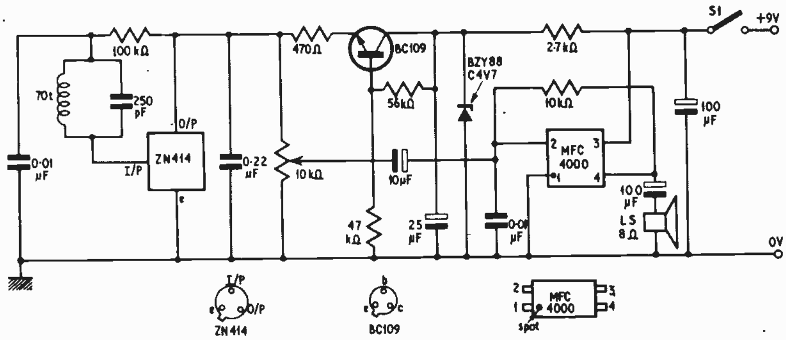


Fig. 1.

OPTICAL COMMUNICATION

THIS system was originally developed for transmitting digital information on a light beam in a security system. In view of the nature of the information a fairly flat response was required and as may be well known, incandescent lamps have a very unlinear response because of their thermal inertia.

Thus one way of overcoming the trouble is to amplify the lamp signal using an amplifier with considerable treble boost. Hopefully in such a case the amplifier characteristics would be a reverse of the lamp characteristics to obtain fairly level response, but this is difficult to obtain in practice.

One way round the problem is proposed here in which an amplifier is still used to feed the lamp but at the same time the output from the lamp is observed by a photocell which is positioned in the feedback circuit of the amplifier. In this way light output is directly linked to amplification with a corresponding smoothing of the response curve.

In the circuit of Fig. 1 an operational amplifier is used to provide the lamp drive via transistor TR1. Output from the lamp is sensed by the ORP70 light dependent resistor which in practice is mounted next to the light bulb. This signal is applied to the amplifier as negative feedback via R4.

In the present instance the amplifier gain is set at 100 by R4 and R5 as higher gain makes the loop unstable but probably it is best to use the highest gain commensurate with the lamp in use.

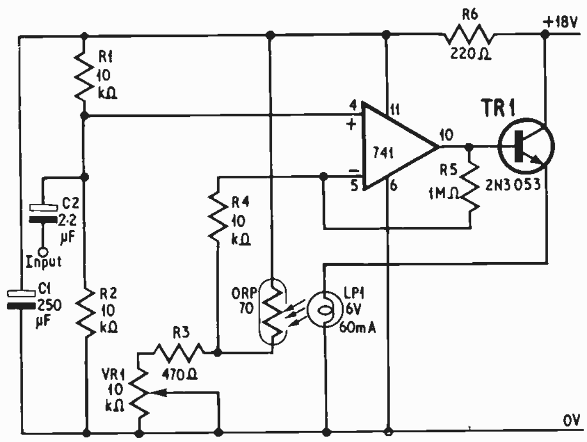


Fig. 1

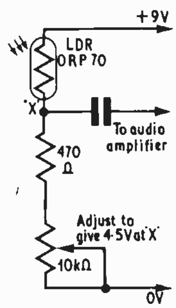


Fig. 2

VR1 sets the quiescent current/brightness of the bulb and is adjusted to give 7V across the bulb in the no-signal condition. Remember to set VR1 to maximum value before switching on the circuit.

The prototype was used over a distance of 10ft but no doubt greater distances could be accommodated with some care as to use of reflectors at transmitter and receiver. In the model these were simple bicycle lamp reflectors and no real care was taken over alignment.

Both speech and music were transmitted over the model circuit with good results but better treble boost above 1kHz would improve matters in noisy environments.

Input to the system was about 100mV to give a reasonable signal and a simple receiver is shown in Fig. 2.

R. Warren-Smith
Redhill.

555 RAMP GENERATOR

Engineers are often on the look-out for a better linear voltage sweep generator for their deflection, ramp, and function generator circuit designs. The recently introduced MC1555 timer can be used to make a simple linear voltage sweep circuit.

In the usual MC1555 timing circuit, it senses the exponentially rising voltage across the capacitor in an RC network. Essentially, from a discharged state, the capacitor begins receiving charge until the voltage across it rises to $2/3V_{CC}$, at which time it is discharged in preparation for the next charging (trigger) pulse.

By replacing the resistor in the RC network with a constant current source, the voltage across the timing capacitor is caused to increase linearly.

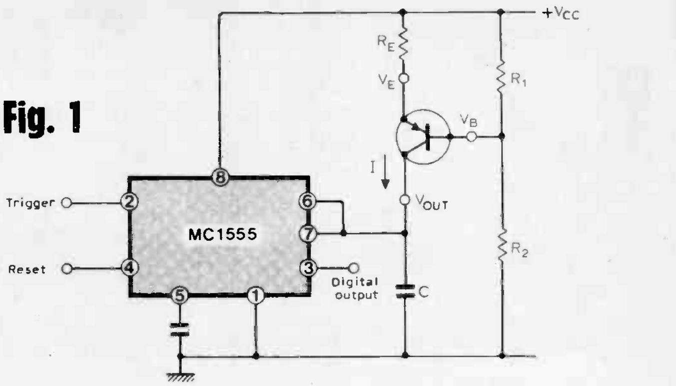
The charging time can be determined as follows:—

$$t = \frac{2/3\ V_{CC}\ .\ C}{I}$$

$$\text{where}: I = \frac{V_{CC} - V_E}{R_E} = \frac{V_{CC} - V_B - V_{BE}}{R_E}$$

(t in seconds, V in volts and C in farads)

Fig. 1



By setting $V_{CC} - V_B$ so that V_{BE} is negligible:

$$I = \frac{V_{CC} - V_B}{R_E}$$

Since V_B is directly proportional to V_{CC}

$$I = \frac{V_{CC} - K\ .\ V_{CC}}{R_E} = \frac{V_{CC} - V_B}{R_E}$$

$$\text{where}: K = \frac{V_B}{V_{CC}}$$

$$\text{or}: t = \frac{2/3\ V_{CC}\ .\ C}{\dfrac{V_{CC}(1-K)}{R_E}} = \frac{2/3\ C\ .\ R_E}{1-K}$$

From this equation, it can be seen that the time period is essentially independent of the supply voltage if the voltage across the emitter resistor of the current source is much larger than the V_{BE} of the transistor.

Since the capacitor voltage must reach at least $2/3V_{CC}$, the current source may be operated on a higher voltage supply than the timer although this is not necessary if the supply voltage is well regulated. The constant current source should be kept larger than $1\mu A$ so that it is always large compared to the current needed for the comparators.

Motorola Semiconductors Ltd.
Geneva

BOOK REVIEWS

NEW DIRECTIONS IN PARAPSYCHOLOGY

Edited by J. Beloff, B.A., Ph.D.
Published by Elek Science
174 pages, 8¾in × 5½in. Price £3·00

Psychical research with its considerable involvement in spiritualism was treated with scepticism by the scientific world following its inception towards the end of the 19th century despite the fact that two of its most important and earliest supporters were those eminent men of science, Sir Oliver Lodge and Sir William Crookes. In later times investigations into the supernatural or paranormal have taken on a more respectable guise and the field of investigation has been extended to cover all phenomena that cannot be explained by the accepted laws of physics.

The number of workers in parapsychology—which is the present day term that has more or less replaced psychical research—is large and includes distinguished academics working in universities and other learned establishments in various countries. It may be "a struggling science" as the Editor of this book describes it, but there can be no doubt of the sincerity and devotion of its apostles.

In *New Directions In Parapsychology* seven specialists who are all actively engaged in research in one or another aspect of ESP or PK have contributed accounts of their experiments and results obtained. Only one of these contributions has direct relevance to electronics, but since most paranormal experiments are based upon statistical data, electronic equipment plays a major role. In the chapter Instrumentation In The Parapsychology Laboratory, Helmut Schmidt describes the use of automated equipment, data recording equipment, random number generators, PK test machines, and provides circuit and technical details of a remote number generator designed by the author for ESP and PK experiments. This chapter makes clear the heavy dependence of parapsychology upon modern electronic techniques.

Through this association many people involved in electronics will already have become aware of parapsychology and some begun to apply their circuit expertise to the devising of circuits for ESP and PK investigations, if not actually undertaking an active part themselves in such investigations. Such individuals and others wishing to learn more about this unusual science will find this book a useful acquisition. The Glossary of Technical Terms and Abbreviations is in itself a good guide for the uninitiated around this strange science.

The Editor John Beloff, who is Senior Lecturer in Psychology at the University of Edinburgh, contributes a reasoned introduction to Parapsychology, arguing that sufficient evidence exists now for a general acceptance of this new "borderland" science, whilst at the same time also acknowledging some embarrassment from the activities of earlier "spiritist" workers and from the current wave of bandwagon jumpers (many associated with fanciful and unscientific occult and religious bodies) who offer a threat to the credibility of Parapsychology as a reputable science.

Arthur Koestler contributes a postscript and appears to support a "chance" basis for paranormal phenomena; this is in contradiction to the "orthodox" philosophy which considers that the prime aim of all PSI experiments is to achieve repeatability and thus establish a clearly defined *cause* as the basis for all extra-sensory experiences. A most fascinating and pregnant argument to round off this instructive and authoritative book.

F.F.B.

PATENTS REVIEW...

AUDIBLY DETECTING SPEED CHANGES

BP 1 352 030

In BP 1 352 030 Customflex Inc. of Ohio, USA, describes a simple gadget for use with a transistor radio to provide an audible indication of speed change, for instance of a boat through water.

As the inventors point out, the ear has difficulty in detecting the difference between 500 clicks per second and 505 clicks per second, but has no trouble in detecting the same difference between 10 clicks and 15 clicks.

With this premise in mind, the inventors suggest an arrangement consisting of a small brass rod, pivoted at one end. A water resistant thread passes from the end of the rod through a coiled compression spring to a ferrite core. All these elements are contained in a hollow, plastic cylinder, which is wrapped with an insulated reaction coil.

This arrangement is mounted on the underside of a boat. As the boat moves through the water, the rod is repeatedly moved in an arc to pull the thread and with it the ferrite core, down against the spring. This movement of the ferrite core changes the induction of the reaction coil.

The coil is connected to an ordinary portable transistor radio by two leads and a miniature jack plug which is inserted in the jack socket provided on most radios for ear-plug use.

According to the inventors this produces a change in the oscillator and thus the sound produced by the radio which is indicative of the rate of the boat movement.

Also described is a circuit for a transistor converter which combines the functions of oscillator and mixer. A capacitor and a variable induction coil is incorporated in a series tuned circuit which imposes an electrical load on the converter to produce controlled "motor boating" clicks. Varying the radio set tuning capacitor by turning the tuning dial will adjust the basic rate of digital clicks heard on the radio.

Few further details of the transistor converter are given because the inventors regard the circuit as sufficiently well known already.

KEYBOARD INSTRUMENT

BP 1 354 407

Electronic musical instruments having 12 keys to the octave are well known. These instruments can produce only semitones and in BP 1 354 407, a Japanese inventor suggests that under certain circumstances it may be desirable for exotic musical effects to produce quarter tones as well.

The circuit achieves this in a very simple manner. A keyboard of the conventional semitone type operates twelve switches of an array, and a d.c. power source circuit which produces d.c. voltages to control a v.c.o.

In conventional manner, individual operation of the keys of the chromatic octave produces individual semitones from the loudspeaker. But, when adjacent keys are simultaneously depressed, the v.c.o. is supplied with a voltage which is substantially one half of the sum of the voltages representative of the keys pressed. The frequency produced is substantially a quarter tone between the two keys simultaneously pressed.

ELECTRONIC AID TO CURE STAMMERING

In BP 1 352 682, George Donovan and Charles Hansel of Swansea claim electronic circuitry for use in speech therapy with particular relevance to the suppression, treatment and study of stammering. The object is to produce speech-masking signals in the lower part of the audio frequency band of various duration and type. For instance, it has been found that a continuous masking sound is effective in most cases to suppress a stammer but, for therapy, bursts of masking sound are required.

As shown in Fig. 1, a Schmitt trigger Q1 is connected as a free running multivibrator with fixed and adjustable resistors R1, VR1 and a 10μF capacitor C1 to generate a masking signal of which the frequency, 180Hz, is controlled by adjustment of VR1. The output of trigger Q1 is coupled to the first input of NAND gate G1, of which the output is coupled to an earphone.

A second Schmitt trigger Q2 is connected with 2 000μF capacitor C2 as a free running multivibrator and generates a lower frequency, for example 60 or 90Hz, adjustable by R3, VR2. The output of Q2 is coupled to trigger a monostable multivibrator, with parallel capacitances C3, C4, selectively switchable by switch S1. The switch S1 also controls connection of the output of the monostable to the second input of the gate G1.

When the supply switch S2 is closed and with switch S1 in position A, the masking input of the gate G1 is not inhibited and a substantially continuous masking noise is delivered through gate G1 to the earphone. Switching S1 to positions B and C will cause the continuous output of trigger Q1 to be inhibited and an accurately shaped output of adjustable width delivered by the monostable to gate G1. Adjustment of VR3 controls the pulse width, for instance, to give a short burst of speech masking sound producing a metronomic beat in the earphone or a pulse with a mark-to-space ratio of 1 or more, equivalent to long bursts of speech-masking sound. The socket SK1 is provided for coupling auxiliary apparatus to the output of G1.

BP 1 352 682

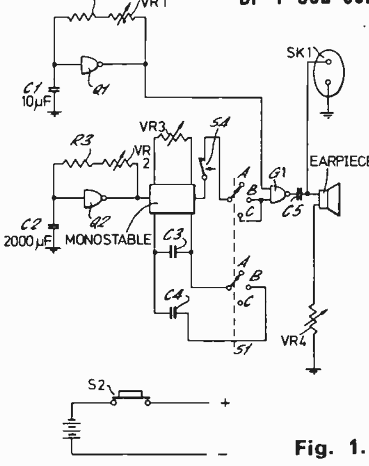


Fig. 1.

Readout—
A SELECTION FROM OUR POSTBAG

Readers requiring a reply to any letter must include a stamped addressed envelope. We regret that we cannot answer any technical queries on the telephone.

Visual monitor

Sir,—A musician myself, I frequently end up advising other musicians on p.a. equipment, not infrequently building units to their requirements. Although most users seem rather unconcerned with it, a point that always worries me is that of the keen performer who turns his volume controls full on automatically (yes! they are still around—you don't have to look for them, just listen!) Distortion and ruined speakers may be prestige symbols to some, but work out expensive.

Whilst it is possible to straddle Vu meters on pre-amplifier outputs it is usually fairly messy to do, and is still only a rough guide (honest) to how rough you are being.

Recently, however, after building a power amplifier that delivered about 100W with an input of 1V, I thought of a very simple way of having a visual indication of overload on the input. I simply put an l.e.d. across it; I used a TIL 209 straight across the input. This device needs just over 1V across it before it will light up and goes on up to about 3V quite happily. Its current consumption is exceedingly low and at worst it puts about 20kΩ across the input. The effect on the input is acoustically unnoticeable.

I've given it a good try out and it does its job very well. Those unavoidable peaks give a pleasing little red flash and on real overload (don't watch the speaker) it works like a traffic light.

It doesn't matter which way round it is connected, of course, since the signal will be a.c. and scanning the market should provide a device of suitable voltage to suit most high power amplifiers.

I know the idea sounds too simple but who cares? It works!

Peter Quinn,
Portsmouth

Russian roulette

Sir,—In his novel "The Gambler", the Russian author Fyodor Dostoyevsky writes the following:

"However, I deduced from the scene one conclusion which seemed to me reliable—namely, that in the flow of fortuitous chances there is, if not a system, at all events a sort of order. This is, of course, a very strange thing. For instance, after a dozen middle figures there would always occur a dozen or so outer ones. Suppose the ball stopped twice at a dozen outer figures; it would then pass to a dozen of the first ones, and then, again, to a dozen of the middle ciphers, and fall upon them three or four times, and then revert to a dozen outers; whence, after another couple of rounds, the ball would again pass to the first figures, strike upon them once, and then return thrice to the middle series—continuing thus for an hour and a half, or two hours. One, three, two; one, three, two. It was all very curious. Again, for the whole of a day or a morning the red would alternate with the black, but almost without any order, and from moment to moment, so that scarcely two consecutive rounds would end upon either the one or the other. Yet, next day, or, perhaps, the next evening, the red alone would turn up, and attain a run of over two score, and continue so for quite a length of time—say, for a whole day".

Alexei Ivanovitch's observations concerning the phenomena of roulette seem to tally very well with Mr. Baily's experiences with the "Random Timer". Perhaps the tense atmosphere which must be in evidence in places where roulette is played is a factor which should be taken into account.

A. J. Fisher,
Hereford

Discord

Sir—I would like to take to task your correspondent Mr Malcolm Pointon regarding his article "Electromuse" in the September issue of P.E. He is altogether making too big a deal about synthesisers and electronic music generally.

What is this new phase we are entering in 1974? Evidently Mr Pointon overlooks the fantastic new phase of electronic music (in its own right) in the early 50's when no-one knew where it was leading—except Stockhausen; or the pioneers of voltage control whose work was consolidated by R. A. Moog in the mid-sixties. No, Mr Pointon, the only new phase entered into in 1974 was my acquisition of a synthesiser and an incredible education in electronics thanks to Messrs. G. D. Shaw and P.E. Music, I'm afraid, is always wallowing in primeval mud waiting for the particles to settle (at least it has been ever since someone discovered the great polyphonic era was not the musical ultimate).

What seven modes were used in early music? As far as I know only six were used. The seventh (Locrian) has never been used except as a joke—no doubt because of its peculiar interval relationships, there being no perfect fifth from the "keynote".

Regarding the emancipated second half of the twentieth century, I cannot see how this suddenly makes the aural universe boundless and open to anyone. It always has been for someone having the will to pursue it. Wagner, Stravinsky *et al.* chose dynamics from the inaudible to the painful; Aloir Haba played "between the cracks"; Liszt and Paganini are known for playing music unperformable by a human being . . . In any event, how much of our human-being music can be played by machine? I'd be delighted to hear from anyone who has patched Stravinsky's "Rite of Spring" or Ravel's "Daphnis and Chloe" on a synthesiser.

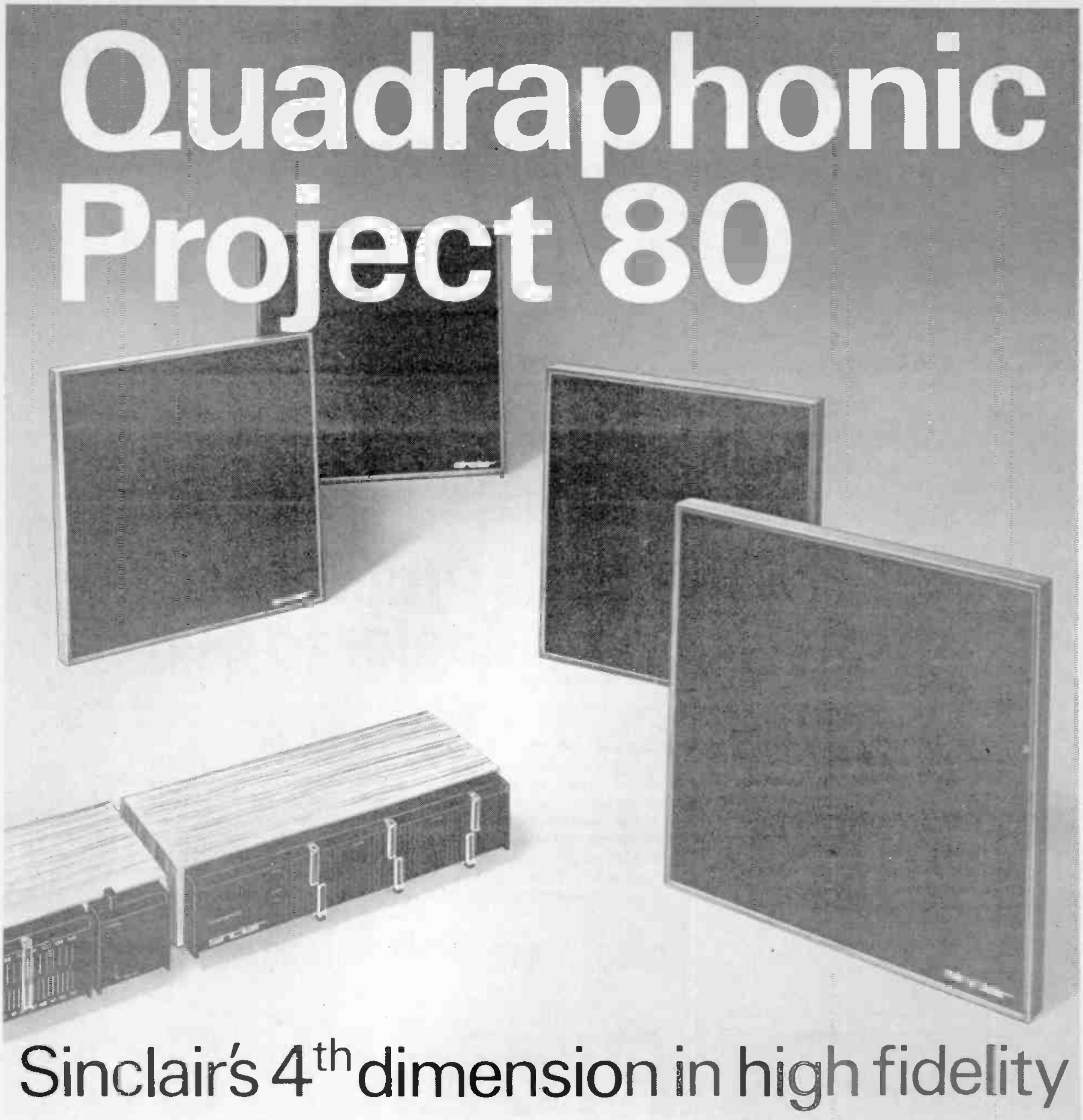
Lastly, how are we "widening our horizons beyond the natural?" With electronics? If Mr Pointon is suggesting that acoustic instruments are natural, a quote from "Studio Sound", May 1972, page 33, would be in place:

"The synthesiser is no more artificial than a saxophone. The one produces sound from vibrating electronics, the other from a vibrating reed, the harpsichord from vibrating strings . . . etc."

Coming to terms, the synthesiser is nothing more than a labour-saving device. Most of the gadgets contained therein have been around for a long time in one form or another. Dr Moog spotted the commercial value of putting them all in the same box, and Mr G. D. Shaw repackaged this to the less wealthy, like myself, who could not afford Dr Moog's prices.

Tragically, many synthesisers will fall to a fate best summarised by a further quote from the above journal: "But, for the love of music, avoid the trap which faces composers of electronic pop: using a £7,500 synthesiser to imitate unconsciously but all too successfully a cheap divider organ. It has been done and it degrades the most promising invention since the development of the chromatic keyboard."

Ivor Stuart-Colwill,
London, S.W.16.



Project 80
The slim modules for building stereo hi-fi with FM.

Project 805
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Project 805SQ
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Q16 Loudspeakers
The square speakers for 4 channel listening

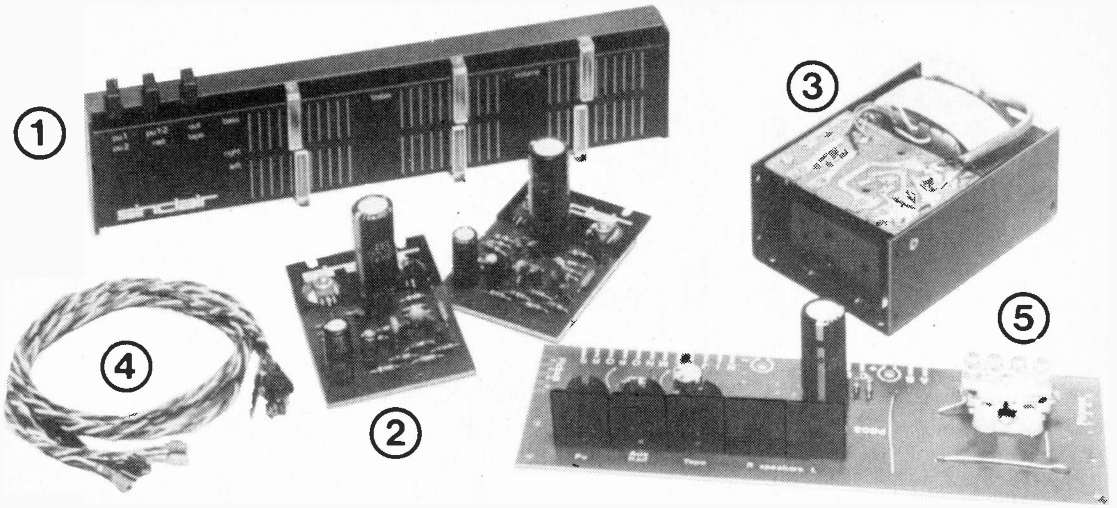
Four channel listening has arrived!

Thanks to Project 80 versatility and marvellous compactness, adding two more channels is easy, efficient and economical – you simply add on Project 805SQ or select the necessary modules from the Project 80 range detailed on the fourth page of this advertisement. Another way is to start with the new Project 805 (which is Project 80 complete in one pack) and add 805SQ to it. Our technicians have adopted the CBS SQ matrix principle to carry the rear left and right channels since it is already clearly the most widely used method in quadraphonic recordings. The decoder, however, can be modified to discrete systems without difficulty. Sinclair suitability for quadraphonics by no means stops with Project 805SQ. The Q.16, always a superb loudspeaker in its own right becomes one of the best ways of creating effective ambience without taking up too much space or money. Project 80 quadraphonic modules are ready now for you to enjoy both stereo and true quadraphonics right away with better reproduction from mono records as well.

Stereo 80 pre-amp/control unit | Project 80 F.M. tuner | Project 80 stereo decoder | Project 80 active filter unit | Project 80SQ quadrophonic decoder

sinclair

Forward with Project 80 into



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1 Stereo 80 Control Unit
For mag. and ceramic cartridges, radio and tape.

2 Project 80 power amplifiers
Two Z.40s to give 8/8 watts R.M.S. output per channel.

3 Power supply unit
One PZ.5.

4 Connecting wires
All wires plus nuts, bolts, screws etc.

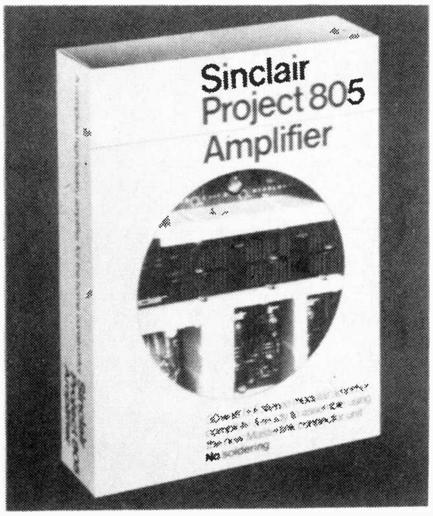
5 Project 805 Masterlink
For input and output connections.

6 Mains switch block and instructions manual (not illustrated).

This is Project 80 made even easier to build

You have seen how the marvellously compact Project 80 modules (only 2″ high × $\frac{3}{4}$″ deep) are so adaptable and easy to install. Now, with Project 805, this wonderful system is made easier still to put together. In this, you have not only all the Project 80 modules in one pack for building an 8/8 watt R.M.S. hi-fi amplifier – there is also a loom of colour coded wires cut to length and tagged for clipping on so that you don't even have to solder! Input and output connections go via the 805 Masterlink panel. With the explicit stage-by-stage large 32 page instructions manual included, it becomes easy for anyone, no matter how inexperienced to install an ultra-modern assembly so advanced in appearance and design that it sets brand new concepts in domestic hi-fi – and of course, you can convert to quadraphony just whenever you wish by adding 805SQ. Only Sinclair know-how and manufacturing facilities could hope to bring you such quality and versatility.

TAGGED WIRES CUT TO LENGTH·NO SOLDERING



Project 805

the complete ready-to-build hi-fi STEREO AMPLIFIER

Project 805 comprises a Stereo 80 Pre-amp/Control Unit with input for both magnetic and ceramic cartridges, radio, tape; separate bass and treble cut/lift, and volume controls 2 × Z.40 power amplifiers, PZ.5 power unit, 805 Masterlink, wire loom, instructions manual, etc. down to nuts, bolts and washers. For technical specifications, see fourth page of this advertisement.

£39.95
+£3.20 VAT (R.R.P.)

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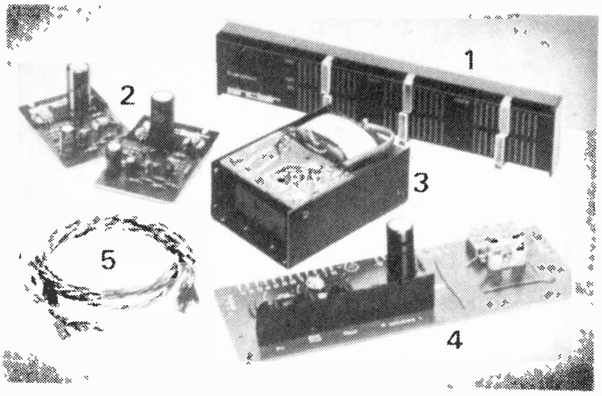
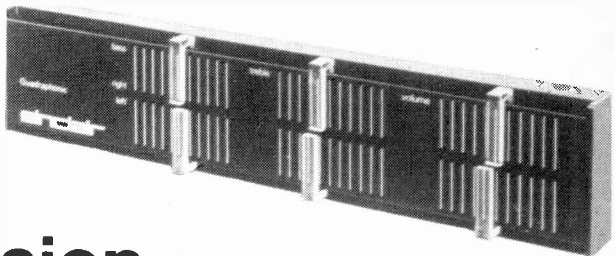
true quadraphonics... NOW!



The most effective and economical way to enjoy this spectacular break-through in hi-fi listening

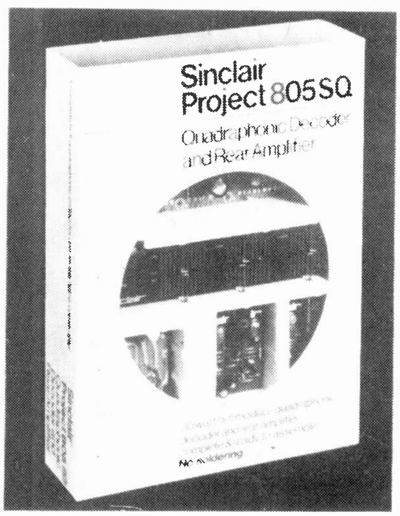


1. Project 80SQ decoder with controls.
2. Two Z.40 power amplifiers.
3. PZ.5 power pack
4. Project 80Q Masterlink unit.
5. Wire loom, with clip-on tags – NO SOLDERING!
6. (Not illustrated) Instructions manual, nuts bolts, washers, etc.

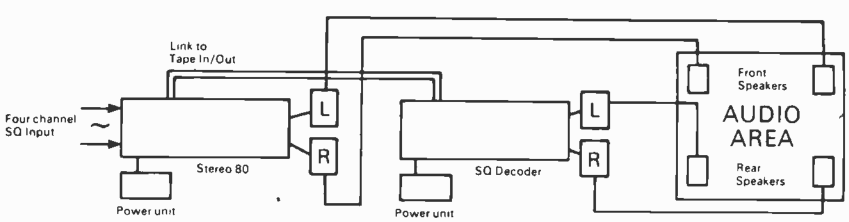
Add a fourth dimension to your stereo sound

It's so simple to convert to quadraphonics when you already have Project 80, or are about to start with Project 805. Project 805SQ is a complete add-on system at the heart of which is the Project 80SQ decoder. It uses the CBS.SQ matrix principle, by now the widest used method of containing four sound channels within the groove of the record. Project 805SQ includes two power amplifiers, power supply unit, connecting wire loom, 805Q Master-link, switch block and instructions manual. The 80SQ decoder (also obtainable separately) has independent tone and volume slider controls on the two rear channels for matching true four channel sound to domestic environment. Project 805SQ is money saving too since you do not have to scrap existing Project 80 equipment to enjoy the newest and most exciting form of home listening in the entire history of sound, and your Project 80 quad-raphonic assembly is compatible with stereo and mono records.

- Frequency response ±3db 15 Hz-25kHz
- Rated output 100mV
- S/N ratio 58dB
- Distortion 0·1%
- Power requirements 22-35 volts
- Phase shift network 90° ±10° 100 Hz-10kHz
- Adaptable to discrete (CD4) use



Project 805SQ



The output from any good stereo cartridge feeds into Stereo 80 and passes via the tape outlet to the 80SQ decoder. Here the signal is separated into its constituent 4 channels, those for the front being accepted by the Stereo 80, those for the rear going from the decoder to the two additional power amplifiers and speakers.

£44.95

+£3.60 VAT (R.R.P.)

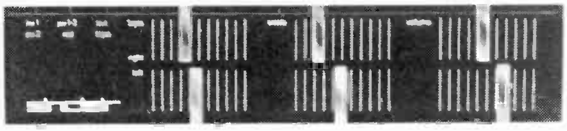
Guarantee If, within 3 months of purchasing any product direct from us, you are dissatisfied with it, your money will be refunded on production of receipt of payment. Many Sinclair Appointed Stockists also offer this guarantee Should any defect arise in normal use within 2 years, we will service it without charge. For damage arising from mis-use a nominal charge will be made.

Project 80 quadraphonic modules may be purchased separately if required. The Project 80SQ decoder may be used with any other amplifier having tape and monitoring facilities. Z40 or Z60 power amps can be used as required.

The Project 80 programme to date

KEEP THIS PAGE FOR HANDY REFERENCE ***USE THE PRIORITY ORDER FORM IN CASES OF DIFFICULTY***

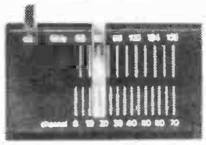
Stereo 80 pre-amp/control unit



260 x 50 x 20mm ($10\frac{1}{4}$ x 2 x $\frac{3}{4}$ ins.) separate slider controls on each channel for treble, bass and volume. INPUTS – Mag. P.U 3mV (RIAA corrected) ceramic – 300mV, Radio 100mV, Tape 30mV S/N ratio 60dB. Frequency range – 20Hz to 15KHz ± 1dB. OUTPUTS – 2·5V rms max (30V supply) and tape plus AB monitoring. PRESS BUTTONS for P.U., Radio and Tape. Operating power – 20 to 35V. Black case with white indications

£13.95 + £1.12 VAT (R.R.P.)

Project 80 F.M. tuner



Size 85 x 50 x 20mm ($3\frac{1}{2}$ x 2 x $\frac{3}{4}$ ins.). Tunes 87·5 to 108MHz. DETECTOR – I.C balanced coincidence (I.C equivalent to 26 transistors) Distortion – 0·2% at 1KHz for 30% modulation. SENSITIVITY – 5 microvolts for 30dB quieting. Output – 300mV for 30% modulation. Aerial imp. – 75 Ω or 240-300 Ω. Dual Varicap tuning. 4 pole ceramic filter. Switchable A.F.C. Operating power 23-30 volts.

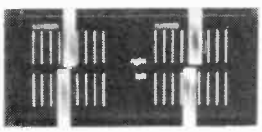
£13.95 + £1.12 VAT (R.R.P.)

Project 80 stereo decoder

Size 47 x 50 x 20mm. For adding to Project 80 FM tuner. With one I.C equal to 19 transistors, and LED indicator which glows on tuning in stereo signal.

£8.95 + 72p VAT (R.R.P.)

Project 80 active filter unit (A.F.U.)



Size 108 x 50 x 20mm. Useful where there is need to eliminate unwanted high frequencies (scratch, whistle, etc) or low (rumble). Voltage gain – minus 0·2dB. Frequency response (filter at zero) 36Hz to 22KHz. H.F cut (scratch) variable from 22KHz to 5·5KHz 12dB/octave slope. L.F cut (rumble) – 28dB at 28Hz, slope 9dB/octave.

£7.45 + 60p VAT (R.R.P.)

Project 80 power amplifiers

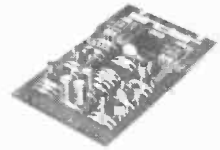
Intended for use in Project 80 installations, these modules readily adapt to an even wider range of applications. Both incorporate built-in protection against short circuiting and risk of damage from mis-use is greatly reduced

Z.40

Size – 55 x 80 x 20mm
9 transistors
Input sensitivity – 100mV
Output – 12 watts RMS continuous into 8 Ω (35v)
Frequency response – 10Hz – 100KHz ± 1dB
S/N ratio – 64dB
Distortion – 0·1% at 10 watts into 8 Ω at 1KHz
Power requirements – 12 to 35 volts

£5.95 + 48p VAT (R.R.P.)

Z.60



Size – 55 x 98 x 20mm
12 transistors
Input sensitivity – 100-250mV
Output – 25 watts RMS continuous into 8 Ω (50V).
Distortion – 0.02% at 10W/8 Ω/1KHz
Frequency response – 10Hz to more than 200KHz ± 3dB
S/N ratio – better than 70dB
Built-in protection against transient overload and short circuiting
Load impedance – 4 Ω min; max. safe on open circuit

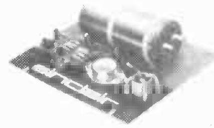
£7.45 + 60p VAT (R.R.P.)

Power-supply units

PZ.5 Unstabilized. 30 volts. Suitable for Z.40 assemblies, etc. **£5.95** + 48p VAT (R.R.P.)

PZ.6 Stabilized. Output voltage adjustable between 20 and 50 volts approx. Protecting fuse. **£8.95** + 72p VAT (R.R.P.)

PZ.8 Stabilized. Output adjustable from 20 to 60V. approx. Re-entrant current limiting makes damage from overload or even shorting, impossible. Without mains transformer.

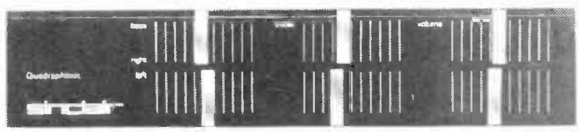


£8.45 + 68p VAT (R.R.P.)

Project 805 (previous pages) **£39.95** + £3.20 VAT (R.R.P.)

Project 805SQ quadraphonic add-on kit **£44.95** + £3.60 VAT (R.R.P.)

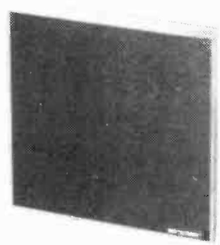
Project 80SQ quadraphonic decoder



Size 260 x 50 x 20mm, matching Stereo 80 in style. Connects with tape socket on stereo 80 or similar facility on any stereo amplifier. Frequency response 15Hz to 25KHz ± 3dB. Distortion 0·1%. S/N ratio 58dB. Rated Output – 100mV. Separate bass and treble slider controls on each channel, also volume. Phase shift network 90° ± 10° 100Hz to 10KHz. Operating power – 22-35V.

£18.95 + £1.52 VAT (R.R.P.)

Sinclair Q.16 loudspeaker



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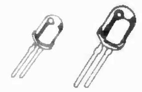

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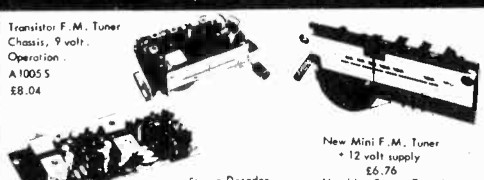
F.M. STEREO TUNERS



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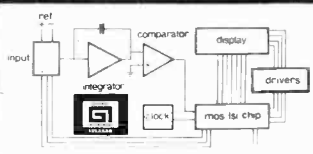

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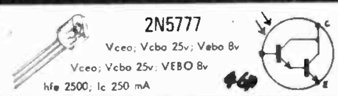

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Vceo; Vcbo 25v; Vebo 8v
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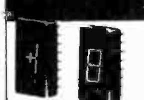

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2N916	0·28
2N918	0·32
2N929	0·30
2N1302	0·19
2N1303	0·19
2N1304	0·24
2N1305	0·24
2N1306	0·31
2N1307	0·22
2N1308	0·40
2N1309	0·36
2N1671	1·44
2N1671A	1·54
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2N1711	0·45
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2N2102	0·50
2N2147	0·78
2N2148	0·94
2N2160	0·90
2N2192	0·40
2N2192A	0·40
2N2193	0·58
2N2193A	0·61
2N2194	0·73
2N2194A	0·30
2N2218A	0·22
2N2219	0·24
2N2219A	0·26
2N2220	0·25
2N2221	0·18
2N2221A	0·21
2N2222	0·20
2N222A	0·25
2N2368	0·25
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2N2647	1·12
2N2904	0·22
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2N2905	0·24
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2N2906A	0·21

2N2907	0·22
2N2907A	0·24
2N2924	0·14
2N2925	0·17
2N2926	
Green	0·12
Yellow	0·11
Orange	0·11
2N3053	0·25
2N3054	0·60
2N3055	0·75
2N3390	0·26
2N3391	0·23
2N3391A	0·29
2N3392	0·13
2N3393	0·13
2N3394	0·13
2N3402	0·18
2N3403	0·19
2N3440	0·59
2N3441	0·97
2N3442	1·25
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2N3415	0·21
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2N3639	0·27
2N3641	0·17
2N3702	0·12
2N3703	0·13
2N3704	0·14
2N3705	0·12
2N3706	0·09
2N3707	0·13
2N3708	0·10
2N3709	0·11
2N3710	0·12
2N3711	0·11
2N3712	0·96
2N3713	1·20
2N3714	1·33
2N3715	1·50
2N3716	1·80
2N3771	2·20
2N3772	1·80
2N3773	2·65
2N3789	2·06
2N3790	2·40
2N3791	2·35
2N3792	2·69
2N3794	0·24
2N3819	0·37
2N3820	0·64
2N3823	0·78
2N3900	0·28
2N3901	0·32
2N3903	0·24
2N3904	0·27
2N3905	0·24
2N3906	0·27
2N4036	0·63
2N4037	0·42
2N4058	0·16
2N4059	0·09
2N4060	0·11

2N4061	0·11
2N4062	0·11
2N4126	0·20
2N4289	0·34
2N4919	0·84
2N4920	0·99
2N4921	0·73
2N4922	0·84
2N4923	0·83
2N5172	0·12
2N5174	0·22
2N5175	0·26
2N5176	0·32
2N5190	0·92
2N5191	0·95
2N5192	1·24
2N5195	1·46
2N5245	0·43
2N5457	0·49
2N5458	0·45
2N5459	0·49
40361	0·48
40362	0·50
40363	0·88
40389	0·46
40394	0·56
40395	0·65
40406	0·44
40407	0·33
40498	0·50
40409	0·52
40410	0·52
40411	2·00
40414	3·55
40430	0·85
40583	0·23
40601	0·67
40602	0·46
40603	0·53
40604	0·56
40636	1·10
40669	1·00
40673	0·70
AC107	0·51
AC113	0·16
AC117	0·20
AC126	0·20
AC127	0·20
AC128	0·20
AC151V	0·25
AC152V	0·17
AC153	0·25
AC153K	0·33
AC154	0·20
AC176	0·23
AC176K	0·33
AC187K	0·23
AC188K	0·34
ACY18	0·24
ACY19	0·27
ACY20	0·22
ACY21	0·26
ACY28	0·20
ACY30	0·58
AD142	0·59
AD143	0·60
AD149V	0·58

AD150	0·63
AD161	0·45
AD162	0·45
AD161 } AD162 }	PR 1·05
AF109R	0·40
AF115	0·24
AF116	0·25
AF117	0·20
AF118	0·55
AF124	0·30
AF125	0·30
AF126	0·28
AF127	0·28
AF139	0·39
AF170	0·25
AF172	0·25
AF178	0·55
AF179	0·65
AF180	0·58
AF186	0·46
AF200	0·35
AF239	0·51
AF240	0·72
AF279	0·54
AF280	0·54
AL102	0·75
AL103	0·70
BC107	0·16
BC108	0·15
BC109	0·19
BC113	0·15
BC115	0·17
BC116	0·17
BC116A	0·18
BC117	0·21
BC118	0·11
BC119	0·29
BC121	0·23
BC125	0·16
BC126	0·23
BC132	0·13
BC134	0·13
BC135	0·13
BC136	0·17
BC137	0·17
BC138	0·24
BC140	0·34
BC141	0·29
BC142	0·23
BC143	0·23
BC145	0·21
BC147	0·12
BC148	0·13
BC149	0·12
BC153	0·18
BC154	0·18
BC157	0·14
BC158	0·13
BC159	0·14
BC160	0·37
BC167B	0·13
BC168B	0·13
BC168C	0·11
BC169B	0·13
BC169C	0·13
BC170A	0·11

BC171	0·13
BC172	0·11
BC182	0·12
BY182L	0·12
BC183	0·09
BC183L	0·09
BC184	0·11
BC184L	0·11
BC186	0·25
BC187	0·27
BC207	0·12
BC208	0·11
BC212K	0·10
BC212L	0·16
BC214L	0·16
BC237	0·09
BC238	0·09
BC239	0·09
BC251	0·20
BC252	0·18
BC253	0·23
BC257	0·09
BC258	0·09
BC259	0·13
BC261	0·20
BC262	0·18
BC263	0·23
BC300	0·36
BC301	0·34
BC302	0·29
BC303	0·54
BC307	0·11
BC307A	0·10
BC308	0·12
BC308A	0·12
BC308B	0·09
BC309	0·10
BC309A	0·10
BC309B	0·10
BC237	0·21
BC238	0·19
BC337	0·19
BC338	0·19
BCY30	0·64
BCY31	0·64
BCY32	1·15
BCY33	0·45
BCY34	0·49
BCY38	0·55
BCY39	1·50
BCY40	0·87
BCY42	0·28
BCY58	0·21
BCY59	0·22
BCY70	0·17
BCY71	0·22
BCY72	0·13
BCY87	3·54
BCY88	2·42
BCY89	0·97
BD115	0·75
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BD124	0·67
BD131	0·40
BD132	0·50

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BD136	0·49
BD137	0·55
BD138	0·63
BD139	0·71
BD140	0·87
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BF116	0·23
BF117	0·43
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BF121	0·25
BF123	0·27
BF125	0·25
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BF153	0·21
BF154	0·20
BF158	0·23
BF159	0·27
BF160	0·23
BF161	0·42
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BF197	0·15
BF198	0·18
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BF258	0·59
BF259	0·55
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BFS98	0·25
BFX29	0·30
BFX30	0·27
BFX44	0·33
BFX63	2·48
BFX68	0·30
BFX84	0·24
BFX85	0·30
BFX87	0·28
BFX88	0·25
BFX89	0·45
BFY18	0·52

BFY19	0·62
BFY20	0·50
BFY29	0·40
BFY50	0·23
BFY51	0·23
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SN7417	0·30
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SN7423	0·37
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SN7450	0·16
SN7451	0·16
SN7453	0·16
SN7454	0·16
SN7460	0·16
SN7470	0·30
SN7472	0·38
SN7473	0·44
SN7474	0·48
SN7475	0·59
SN7476	0·45
SN7480	0·75
SN7481	1·25
SN7482	0·87
SN7483	1·20
SN7484	0·95
SN7485	1·58
SN7486	0·45
SN7490	0·65
SN7491	1·10
SN7492	0·75
SN7493	0 65
SN7494	0·85
SN7495	0·80
SN7496	1·00
SN74100	2.16
SN74107	0·43
SN74118	1·00
SN74119	1·92
SN74121	0·57
SN74122	0·80
SN74123	0·72
SN74141	1·00
SN74145	1·44
SN74150	1·44
SN74151	1·10
SN74153	1·09
SN74154	1·68
SN74155	1·55
SN74157	1·09
SN74160	1·58
SN74161	1·58
SN74162	1·58
SN74164	2·01
SN74165	2·01
SN74167	4·10
SN74174	1·80
SN74175	1·29
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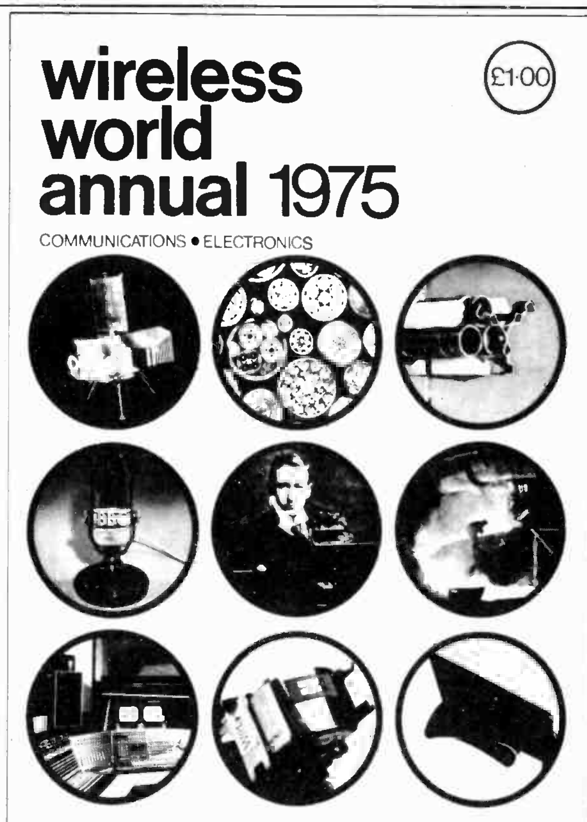

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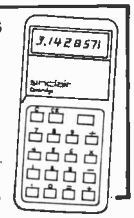

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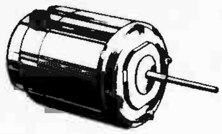

Type SS15. These fine motors are easily reversed, starting and stopping in less than 5° without electrical or mechanical braking. Simple relay circuit can be applied to give DC. to winding for a maximum holding torque of 300oz/in with 35v at 0·35 amps through winding. For AC. (synchronous) operation at 120r., 50Hz. Speed 60 rpm at 60Hz., 72 rpm. STEPPING. Holding torque at 50 steps per second—100 oz/in. Can be wired to give 100 or 200 steps per revolution with accuracy of 0·1° per step non-cumulative. Torque characteristics can be modified by simple R.C. circuits. Dimensions: dia. 4", body length 4½", spindle length 2½" × $\frac{1}{4}$" dia. Weight 6½ lbs. BRAND NEW in maker's packing. Offered at less than ½ maker's price.

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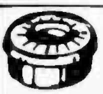

Reliable 15 minute times, spring wound (concurrent with time setting) 15 × 1min divisions, approximately ¼" between divisions. Panel mounting with chrome bezel 3½" dia. £1·40. 15p P. & P.

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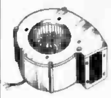
Impedance approx. 200Ω, output 60 or 80 DB at 1 Kc. As used in deaf aids, bugging device, etc. Size (60 DB) $\frac{1}{32}$" × $\frac{1}{32}$" × ¼". (80 DB) ½" $\frac{1}{32}$" ½". Ex-equipment, all tested £1·20 each. P. & P. FREE.

Ultra PRECISION CENTRIFUGAL BLOWER by Air Control Ltd.



30 segments individually balanced in heavy cast alloy case. 2,300 r.p.m. 240 V a.c. Very powerful and silent running. 5½" dia. 3" inlet dia. Outlet flange 3" × 2½".

Limited number only £8·95. P. & P. 40p.

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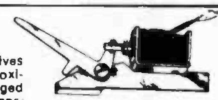
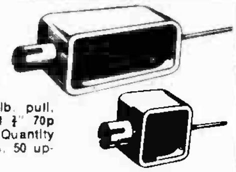


This little unit gives vertical lift of approximately 1" through hinged "elbow". Bracket incorporates 2 fixing screws. Length of arm, 2½". 240V AC. Pull at coil is approximately 1lb. £1. FREE P. & P. Special quotes for quantities.

SOLENOIDS by WESTOOL



240AC type MM6. 3lb. pull, 2½" × 1" × 1¼". Travel 1". 90p. each. P. & P. 10p.

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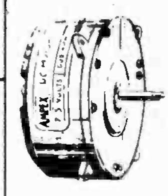

An ultra precision tape motor designed for use in the AG20 portable recorder. Torque 450GM/CM. Stall load at 500ma. Draws 60ma on run. 600rpm ± speed adjustment. Internal AF/RF suppression. ½" dia. × 1" spindle, motor 3" dia. × 1½". Original cost £16·50. OUR PRICE £3·30. P. & P. 25p. Quantities available. Mu-metal enclosure available 75p each. FREE P. & P.

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7410	0·20	7442	0·86	7485	1·65	72723	0·80	IN4006	0·09
7412	0·26	7445	1·60	7486	0·46	72741	0·36	IN4007	0·12
7413	0·38	7447	1·30	7489	4·95	72747	1·00	IN4148	0·05
7416	0·44	7450	0·20	7490	0·66	72748	0·36	OA47	0·07
7417	0·30	7451	0·20	7491	1·10	ZN414	1·25	OA90	0·06
7420	0·20	7453	0·20	7492	0·70	TAA350	2·10	OA91	0·06
7422	0·28	7454	0·20	7493	0·66	LM301B	0·75	OA200	0·06
7425	0·36	7460	0·20	7494	0·90	CA3046	0·70	OA202	0·09
7427	0·45	7470	0·34	7495	0·82	CA3036	1·00	IN916	0·06
7428	0·45	7472	0·34	7496	0·99	CA3028	1·20	BB105	0·45
7430	0·20	7473	0·45	74100	2·20	CA3090Q	4·50	IS44	0·05
7432	0·45	7474	0·42	74141	0·99	NE555	0·85	TIL209	0·27
7433	0·45	7475	0·60	74192	2·12	TAA661B	1·40	OA81	0·07
BC107	0·10	BCY70	0·13	OC23	0·48	2N930	0·20	2N3702	0·10
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BC109	0·10	BCY72	0·12	OC28	0·70	2N1132	0·28	2N3705	0·10
BC177	0·22	BD121	0·78	OC35	0·60	2N1711	0·18	2N3706	0·10
BC178	0·22	BFY50	0·25	OC170	0·25	2N1893	0·52	2N3707	0·10
BC179	0·24	BFY51	0·21	OC171	0·25	2N2219	0·40	2N3819	0·20
BC182	0·10	BFY52	0·22	TIP30A	0·62	2N2904	0·40	2N3820	0·45
BC183	0·10	BSX20	0·18	TIP29A	0·52	2N2905	0·23	2N3823	0·21
BC184	0·10	OC44	0·20	TIP41A	0·85	2N3053	0·16	2N3442	1·45
BC212	0·12	OC45	0·20	TIP42A	0·90	2N3054	0·48	3N140	0·98
BC213	0·12	OC71	0·13	ZTX304	0·26	2N3055	0·48	3N141	0·88
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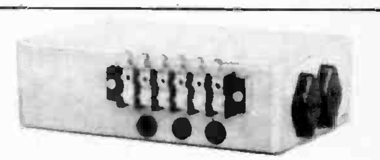

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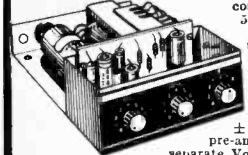

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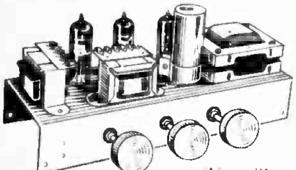

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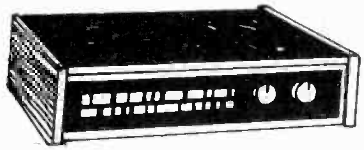

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5in. 3 ohm £1·25, P. & P. 15p. 7 × 4in. 3 ohm £1·40, P. & P. 20p. 10 × 6in. 3 or 15 ohm £2·10, P. & P. 30p. E.M.I. 8 × 5in. 3 ohm with high flux magnet £1·70, P. & P. 20p. E.M.I. 13½ × 8in. with high flux ceramic magnet with parasitic tweeter 3, 8 or 15 ohm £3·50, P. & P. 30p. E.M.I. 13 × 8in 3, 8 or 15 ohm with two inbuilt tweeters and crossover network £4·65, P. & P. 30p. E.M.I. tweeter. Approx. 3½". Available 3 or 8 or 15 ohms, £1·25 + 20p. P. & P.

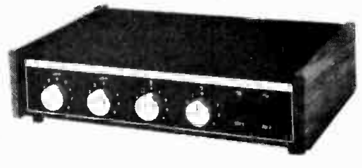
BRAND NEW. Bakers Loudspeakers at substantial discounts. 12in. 15w. H/D Speakers, 3, 8 or 15 ohms. State which. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly £7·50. Guitar models: 25w. £7·50. 35w. £8·50. P. & P. 45p.

12in. "RA" TWIN CONE LOUDSPEAKER. 10 watts peak handling. 3 or 8 or 15 ohm (state which) £2·70. P. & P. 36p.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER Size 11¾" × 14⅝" × 1¼" 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 £6·43 each. P. & P. 34p.

SPECIAL BARGAIN OFFER! Limited number of BSR C123 Auto Changer De Luxe with lightweight tubular arm and stereo cartridge. Brand new. ONLY £7·86 + p. & p. 60p.

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board with component identification clearly marked, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specifications: Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ±3dB 12–30,000 Hz Sensitivity: better than 80mV into 1MΩ. Full power bandwidth: ±3dB 12–15,000 Hz. Bass, boost approx. to ±12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 35v. at 1·0 amp. Overall Size 12"w. × 8"d. × 2½"h.

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

AMPLIFIER KIT	£11·34	P. & P. 30p
(Magnetic input components 33p extra)		
POWER PACK KIT	£3·46	P. & P. 40p
CABINET	£3·46	P. & P. 40p

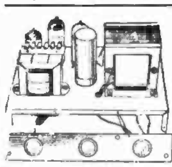
(Post Free if all units purchased at same time)

Full after sales service

Also available ready built and tested **£24·60.** 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.

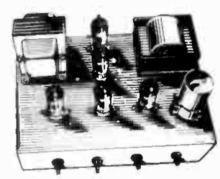
3-VALVE AUDIO AMPLIFIER HA34 MK II.



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½"w. × 4"d. × 4½"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 £5·90. 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. £4·92. 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 base and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 15p × SAE (Free with parts). All parts sold separately. ONLY £9·60. P. & P. 60p. Also available ready built and tested £12·75. P. & P. 70p.

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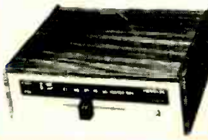
TEXAN 20 + 20 WATT IC STEREO AMPLIFIERS

Features glass fibre PC board. Gardners low field transformer. 6 ICs. 10 transistors plus diodes. etc. Designed by Texas Instruments engineers for Henry's (and P.W. 1972). Supplied with full chassis work, detailed construction handbook and all necessary parts. Full input and control facilities. Stabilised supply. Overall size 15½in × 2½in × 6½in. Mains operated. Free teak sleeve with every kit. **£28·50 (G.B. post paid). BUILT AND TESTED £35·00.**



STEREO FM TUNER

Features capacity diode tuning, led and tuning meter indicators, stabilised power supply—mains operated. High performance and sensitivity with unique station indication IC stereo decoder. Overall size in teak sleeve 8in × 2½in × 6½in.
Complete kit with teak sleeve. **£21·00 (G.B. post paid). BUILT AND TESTED £24·95.**

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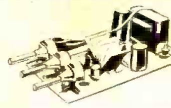
TRANSISTORISED MODULES



Tuners-Power Suppliers-Amplifiers

Amplifiers (All single channel unless stated)

			£ p
4–300	9V	300mW O/P 3–8 ohm. 1–10mV I/P	1·75
2004	9V	250mW O/P 3–8 ohm. 10–100mV I/P	2·70
104	9V	1W O/P 8–16 ohm. 10mV I/P	3·10
304	9V	3W O/P 4–8 ohm. 10mV I/P	3·95
555	12V	3W O/P 8–16 ohm. 150mV I/P	4·10
555ST	12V	1½in + 1½in O/P 8 ohm. 150mV I/P	5·95
E1208	12V	5W O/P 4–16 ohm. 25–60mV I/P	5·10
608	24V	10W O/P 4–8 ohm. 30–50mV I/P	4·95
410	28V	10W O/P 8 ohm. 160mV I/P	4·95
620	45V	30W O/P 4–8 ohm. 150mV I/P	9·95
Z40	30/35V	15W O/P 4–8 ohm. 100mV I/P	5·45
Z60	45/50V	25W O/P 4–8 ohm. 100–250mV I/P	6·95
SA6817	24V	6 + 6 O/P 8 ohm. 100mV I/P	10·20

Amplifiers with controls

E1210	12V	2½ + 2½W	8 ohms	8·25
R500	Mains	5W	4–16 ohms	6·30
SAC14		7 + 7W	8 ohms	11·75
SAC30		15 + 15W	8 ohms	14·95
CA038	9V	1½ + 1½W	8 ohms	6·95
CA068	12V	3 + 3W	8 ohms	10·50

FM Modules

Mullard LP1186 FM tuner (front end) with data 10·7 MHz O/P	4·85
Mullard LP1185 10·7 MHz IF unit with data	4·50
Gorler Permeability FM tuner (front end) 10·7 MHz O/P	4·20

FM and AM tuners and decoders

FM5231 (Tu 2) 6V FM tuner	7·95
TU3 12V version (FM use with decoder)	7·95
SD4912. Decoder for Tu3 12V	7·95
Stereo	14·95
SP62H 6V stereo FM tuner	4·80
A1007 9V MW–AM tuner	11·95
Sinclair 12/45V FM tuner stereo recorder for above	7·45
A1018 9V FM tuner in cabinet	13·95
A1005M (S) 9–12V stereo decoder FM for above	7·50
1062 12V stereo decoder, general purpose	6·50

Preamplifiers

Sinclair	Stereo 60 Preamplifier		6·75
E1300	Cart./Tape/Mic inputs	9V	2·85
E1310	Stereo 3–30mV mal cart	9V	4·75
FF3	Stereo 3mV tape head	9V	4·95
3042	Stereo 5–20mV Mag. cart. mains		5·95
EQ25	Mono 3–250mV Tape/Cart./Play	9V	1·95

Power Supplies—Mains input (* chassis-rest cased)

470C	6 7½ 9V 300mA with adaptors	2·25	P12	4½–12V 0·4–1A	7·15
P500	9V 500mA	3·20	SE10 A	3.6.9 12V 1A stabilised	12·75
HC244R	3.6.7½ 9V 400mA stabilised	5·50	P1076	3 4½ 6.7½ 9 12V ½A	4·20
*P11	24V ½A £3·30 *P15 28V ½A	3·30	SE800A	1–15V 0–½A stabilised	17·50

EXCLUSIVE DECCA KELLY SPEAKERS

12W speaker Tweeter systems. 8in bass mid-range. Melinex domed HF radiator plus crossover. Built into veneered cabinets size 18in × 12in × 6½in. Price **£19·50** pair (carr., etc. £1).

EMI SPEAKERS SPECIAL PURCHASE

13in × 8in chassis speakers (carr./packing 30p each or 50p pair).
* 150 TC 10W 8 ohm twin cone **£2·20.** * 450 TC 10W 4, 8, 15 ohm with twin tweeters and crossover £3·85 each.

EW 15W 8 ohm with tweeter		£5·25
350 20W 8, 15 ohm with tweeter	each	£7·80
* Polished wood cabinet		£4·80

(carr., etc. 35p each or 50p pair).

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EXCLUSIVE PURCHASE

Brand new Philips 12V operated 8W fluorescent tube units for standby lighting. Complete with tube and instructions. Price £3·50 (P. & P. 25p).

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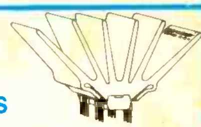

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(Post etc. 15p each)

	£ p
AF20 Mono transistor amp.	5·61
AF25 Mixer	3·30
AF30 Mono transistor pre-amp.	3·20
AF35 Emitter amplifier	2·43
AF80 Small 0·5W amp. for mic.	4·86
AF305 Intercom	7·68
AF310/2 Mono amp. (for stereo use two)	7·56
M160 Multivibrator	2·19
M1302 Transistor tester	8·34
M191 Vu-Meter	5·37
M192 Stereo balance meter	5·94
LF380 Quadrophonic device	8·43
AT60 Psychedelic light control, single channel	10·82
AT65 Psychedelic light control, 3 channel	16·53
AT25 Window wiper robot	5·82
AT30 Photo cell switching unit	6·69
AT50 400W triac light dimmer speed control	5·19
AT56 2·200W triac light dimmer speed control	8·75
AT5 Automatic light control	3·75
GU330 Tremelo unit for guitars, etc.	8·10
HF61 Diode detector	3·87
HF65 Frequency modulated FM transmitter	3·21
HF75 FM transistor receiver	3·66
HF310 FM tuner unit	16·31
HF325 De-luxe FM tuner unit	26·34
HF330 Stereo decoder for use with HF310/325	10·56
GP310 Stereo pre-amp (for use with 2 AF310)	22·96
GP312 Basis circuit board	10·02
GP304 Basis circuit board	5·33
HF380 Aerial amp. for LW to VHF	6·03
HF395 Broadband aerial amp.	2·10
NT10 Power supply 100mA 9V stab and 12V unstable	6·27
NT300 Prof. stab. power supply	13·17
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NT330 Power pack AF310/GP304	8·27
NT315 P/S 240V a.c. to 4·5–15V d.c. 500mA	12·06
AE1 Output stage 100mW	1·56
AE2 Pre-amplifier	1·32
AE3 Diode-receiver	2·05
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AE5 Astable multivibrator	1·14
AE6 Monostable multivibrator	1·11
AE7 RC generator	1·08
AE8 Bassfilter	1·06
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SINCLAIR MODULES AND KITS

SINCLAIR PROJECT 80	£
ST80 Stereo pre-amp.	11·95
Audio Filter unit	6·95
Z40 15W amp.	5·45
Z60 25W Amp.	6·95
PZ5 Power supplies for 1 or 2 Z40	4·98
PZ6 Power supplies (S Tab) for 1 or 2 Z40	7·96
PZ8 Power supplies (S Tab) for 1 or 2 Z60	7·98
TRANSFORMER FOR PZ8	3·95
FM TUNER	11·95
STEREO DECODER	7·95
All above post paid (G.B. only)	
IC20 power amp kit	7·95
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2 × Z60, ST80, PZ6	27·75
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Cambridge calculator kit £13·84 (post 15p)

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*Project 605 Kit £19·95 (post 25p)
K12 6W Amp £2·20 (post 15p)

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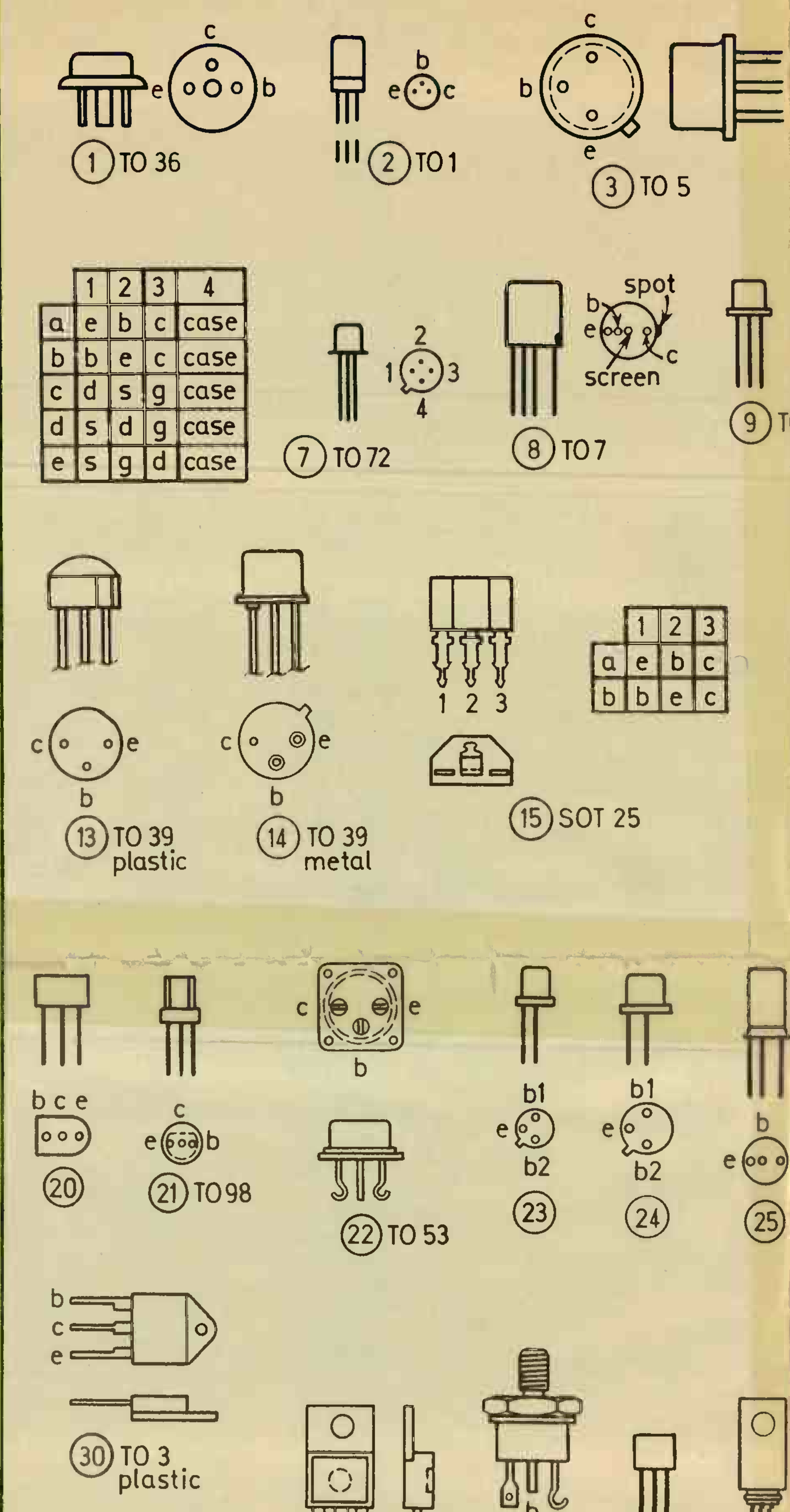
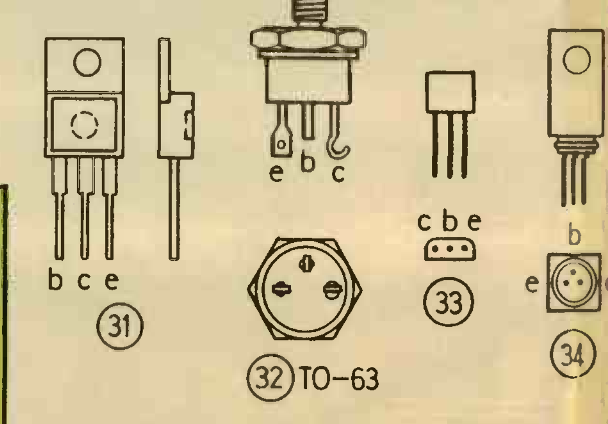
TYPE	DIAG.	MAKE
AC107	26	Mul
AC121	2	Sle
AC126	2	Mul
AC127	2	Mul
AC128	2	NKT
AC151	2	Sle
AC152	2	Sle
AC153	2	Sle
AC153K	34	Sle
AC176	2	NKT
AC176K	34	Sle
AC187	2	Mul
AC187K	34	Sle
AC188	2	Mul
AC188K	34	Sle
ACY17	3	Mul
ACY18	3	Mul
ACY19	3	Mul
ACY20	3	Mul
ACY21	3	Mul
ACY22	3	Mul
ACY28	2	NKT
ACY29	2	NKT
ACY30	2	NKT
ACY39	3	NKT
ACY40	3	NKT
ACY41	3	NKT
ACY44	3	NKT
AD133	35	Sle
AD136	4	Sle
AD140	5	NKT
AD142	5	NKT
AD143	5	NKT
AD149	5	NKT
AD150	5	Sle
AD161	6	Sle
AD162	6	Sle
AD163	5	Sle
ADZ11	1	Mul
AF109R	7a	Sle
AF114	8	Mul
AF115	8	Mul
AF116	8	Mul
AF117	8	Mul
AF118	8	Mul
AF124	7a	NKT
AF125	7a	NKT
AF126	7a	NKT
AF127	7a	NKT
AF139	7a	SGS
AF178	9	Mul
AF179	9	Mul
AF180	9	Mul
AF200U	7b	Sle
AF201U	7b	Sle
AF239	7a	Sle
AF239S	7a	Sle
AF240	7a	Sle
AF279	10	Sle
AF280	10	Sle
AF306	16c	Sle
AFY42	7a	Sle
AL102	5	SGS
AL103	5	SGS
ASY26	3	Sle
ASY27	3	Sle
ASY28	3	NKT
ASY29	3	NKT
ASY48	2	Sle
ASY70	2	Sle
AUY21	35	Sle
AUY22	35	Sle
BC107	11	SGS
BC108	11	SGS
BC109	11	SGS
BC113	12	SGS
BC114	12	SGS
BC115	13	SGS
BC116	13	SGS
BC116A	13	SGS
BC117	13	SGS
BC119	14	SGS
BC121	28	Sle
BC122	28	Sle
BC125	13	SGS
BC126	13	SGS
BC140	14	SGS
BC141	14	SGS
BC142	14	TI
BC143	14	TI
BC148	15a	Sle
BC149	15a	Sle
BC153	12	SGS
BC154	12	SGS
BC157	15a	Sle
BC158	15a	Sle
BC159	15a	Sle
BC160	14	SGS
BC161	14	SGS
BC168	16a	Sle
BC169	16a	Sle
BC172	16b	ITT

TYPE	DIAG.	MAKE
BC177	11	SGS
BC178	11	SGS
BC179	11	NAS
BC182	11	TI
BC182L	11	TI
BC183	11	TI
BC184L	16a	TI
BC186	16a	TI
BC202	28	Sle
BC207	12	SGS
BC208	12	SGS
BC209	12	SGS
BC212L	16a	TI
BC214L	16a	TI
BC237	16c	AEG
BC238	16c	AEG
BC239	16c	AEG
BC257	16a	Sle
BC258	16a	Sle
BC259	16a	Sle
BC261A	11	ITT
BC261B	11	ITT
BC262A	11	ITT
BC262B	11	ITT
BC263A	11	ITT
BC263B	11	ITT
BC264L	16e	TI
BC288	14	SGS
BC297	11	SGS
BC300	14	SGS
BC301	14	SGS
BC302	14	SGS
BC303	14	SGS
BC307	16c	Sle
BC308	16c	Sle
BC309	16c	Sle
BC327	16c	Sle
BC328	16c	Sle
BC337	16c	Sle
BC338	16c	Sle
BCX70	18	Sle
BCY30	3	Mul
BCY31	3	Mul
BCY32	3	Mul
BCY33	3	Mul
BCY34	3	Mul
BCY38	3	Mul
BCY39	3	Mul
BCY40	3	Mul
BCY42	11	Fer
BCY43	11	Fer
BCY54	5	Mul
BCY58	11	AEG
BCY58A	11	TI
BCY59	11	AEG
BCY66	11	Sle
BCY70	11	Mul
BCY71	11	Mul
BCY72	11	Mul
BCY78	11	AEG
BCY79	11	AEG
BCZ11	1	Mul
BD127	19	AEG
BD128	19	AEG
BD129	19	AEG
BD130	5	Sle
BD131	19	Mul
BD132	19	Mul
BD135	19	Sle
BD136	19	Sle
BD137	19	Sle
BD138	19	Sle
BD139	19	Sle
BD140	19	Sle
BD234	19	Sle
BD236	19	Sle
BD238	19	Sle
BD433 to BD438	19	Sle
BD439 to BD442	19	Sle
BD533 to BD538	31	Sle
BDY10	5	Mul
BDY11	5	Mul
BDY20	5	Mul
BDY38	5	Mul
BDY60	5	Mul
BDY61	5	Mul
BDY62	5	Mul
BF115	7b	Mul
BF152	12	SGS
BF154	12	SGS
BF158 to BF160	12	SGS
BF161	7a	SGS
BF163	12	SGS
BF166	7a	SGS
BF167	7b	SGS
BF173	7b	SGS
BF179	3	Mul
BF180	7a	Mul
BF181	7a	Mul
BF184	7b	AEG
BF185	7b	AEG
BF194	15b	Mul

TYPE	DIAG.	MAKE
BF195	15b	Mul
BF196	15b	Mul
BF197	15b	Mul
BF198	16d	AEG
BF199	16d	AEG
BF200	7a	Mul
BF222	7a	SGS
BF237	36a	TI
BF238	36a	TI
BF240	16d	AEG
BF243	36a	TI
BF244	16e	TI
BF246	16e	TI
BF246A	16e	TI
BF254	16d	AEG
BF255	16d	AEG
BF257	14	SGS
BF258	14	SGS
BF259	14	SGS
BF310	16c	AEG
BF311	16d	AEG
BF362	10	Sle
BF379	16c	AEG
BF411	16c	AEG
BF412	16c	AEG
BF440	16d	AEG
BFS92	14	NAS
BFS93	14	NAS
BFX29	3	NKT
BFX30	3	NKT
BFX84	3	NKT
BFX85	3	NKT
BFX86	3	NKT
BFX87	3	NKT
BFX88	3	NKT
BFX89	7a	Ph
BFX93A	11	TI
BFX98	14	SGS
BFY10	3	Ph
BFY11	3	Ph
BFY18	11	SGS
BFY19	11	SGS
BFY51	3	NKT
BFY52	3	NKT
BFY53	3	NKT
BFY56	3	SGS
BFY56A	3	SGS
BFY57	14	SGS
BFY63	14	SGS
BFY74	11	SGS
BFY75	11	SGS
BFY76	11	SGS
BFY79	11	SGS
BFY80	11	AEG
BFY85	3	AEG
BFY86	3	AEG
BFY90	7a	AEG
BLY47	5	TI
BLY48	5	TI
BLY49	5	TI
BLY50	5	TI
BLY50A	6	TI
BLY61	14	TI
BSV15	14	AEG
BSV16	14	AEG
BSV46	11	ITT
BSV49A	11	ITT
BSV57	16g	AEG
BSV60	14	AEG
BSV69	14	AEG
BSX19	11	NKT
BSX20	11	NKT
BSX27	11	NKT
BSX28	11	SGS
BSX29	11	SGS
BSX30	14	SGS
BSX32	14	SGS
BSX33	11	SGS
BSX36	11	SGS
BSX39	11	SGS
BSX60	3	NKT
BSX61	3	NKT
BSX77	11	Mul
BSX78	11	Mul
BSX87	11	SGS
BSX88	11	SGS
BSX93	11	SGS
BSY17	11	Sle
BSY18	11	Sle
BSY34	14	Sle
BSY38	11	Mul
BSY39	11	Mul
BSY40	11	Mul
BSY41	11	Mul
BSY58	14	Sle
BSY62	11	Sle
BSY63	11	Sle
BSY95A	11	NKT
BU204	5	AEG
BU205	5	AEG
BU208	5	AEG
BU209	5	AEG





TYPE	DIAG.	MAKE
BU310	5	Sle
BU311	5	Sle
BU312	5	Sle
BUY21	5	TI
BUY48	14	SGS
BUY68	14	SGS
C451	3	SGS
C452	3	SGS
GET895	3	Mul
GET896	3	Mul
GET897	3	Mul
GET898	3	Mul
GET914	11	GE
GET929	11	GE
GET930	11	GE
MAT100	2	Sln
MAT101	2	Sln
MAT120	2	Sln
MAT121	2	Sln
MJ480	5	Mo
MJ481	5	Mo
MJ490	5	Mo
MJ491	5	Mo
MJE2955	37a	Mo
MJE2955K	37b	Mo
MJE3055	37a	Mo

KEY TO LEADS

b base c collector e emitter

KEY TO MANU

AEG	*AEG-Telefunken*
Fer	*Ferranti*
GE	*General Electric*
ITT	*ITT*
Mo	*Motorola*
Mul	*Mullard*
NAS	*North American Semiconduct*

(Some devices shown have m

NOTE: The publishers of this chart cannot accept

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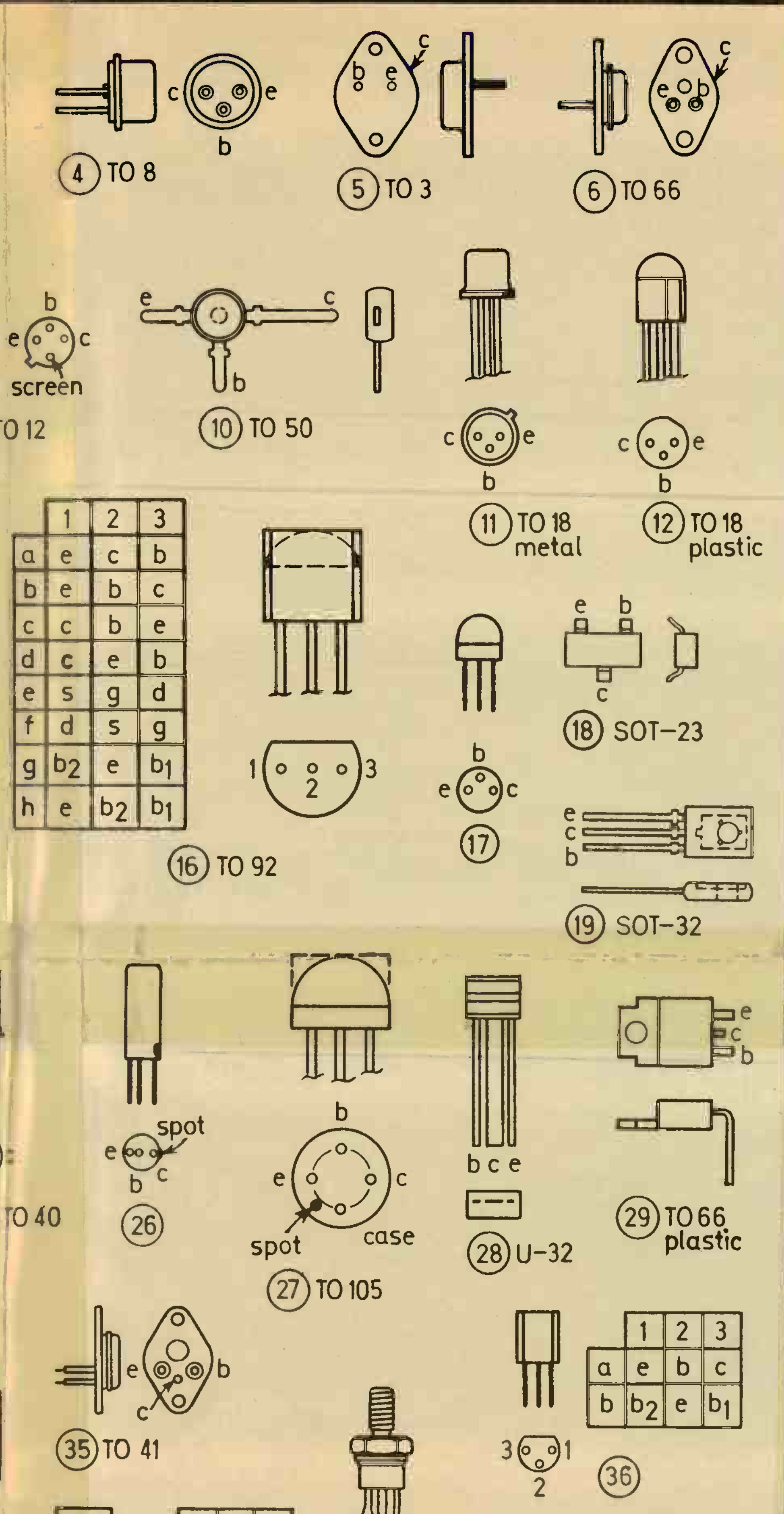

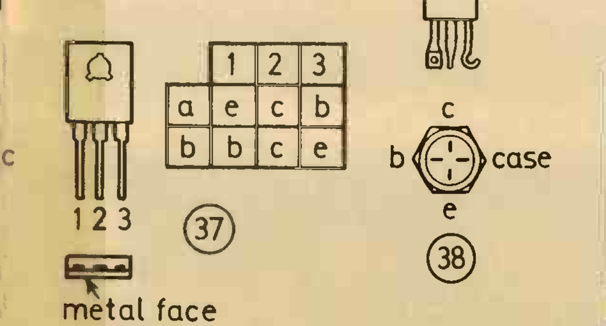

TYPE	DIAG.	MAKE
MJE3055K	37b	Mo
MPF102	16f	Mo
MPF103	16f	Mo
MPF104	16f	Mo
MPF105	16f	Mo
MPF106	16f	Mo
NKT0033	6	NKT
NKT0128	3	NKT
NKT211	2	NKT
NKT212	2	NKT
NKT213	2	NKT
NKT216	2	NKT
NKT217	2	NKT
NKT218	2	NKT
NKT223	3	NKT
NKT271	2	NKT
NKT275	2	NKT
NKT281	2	NKT
NKT351	4	NKT
NKT401	5	NKT
NKT402	5	NKT
NKT403	5	NKT
NKT404	5	NKT
NKT405	5	NKT
NKT406	5	NKT
NKT451	5	NKT
NKT452	5	NKT
NKT453	5	NKT
NKT713	2	NKT
NKT4054	6	NKT
NKT4055	5	NKT
NKT13329	11	NKT
NKT13429	11	NKT
OC19 to OC36	5	Mul
OC41	26	Mul
OC42	26	Mul
OC43	26	Mul
OC44	26	Mul
OC45	26	Mul
OC46	26	Ph
OC47	26	Ph
OC57	27	Mul
OC58	27	Mul
OC59	27	Mul
OC60	27	Mul
OC65N	2	NKT
OC66N	2	NKT
OC70	26	Mul
OC71	26	Mul
OC72	26	Mul
OC73	26	Mul
OC74	26	Mul
OC75	26	Mul
OC76	26	Mul
OC77	26	Mul
OC78	26	Mul
OC79	26	Mul
OC80	26	Mul
OC81	26	Mul
OC81D	26	Mul
OC82	26	Mul
OC83	2	Mul
OC84	2	Mul
OC122	8	Mul
OC123	8	Mul
OC139	26	Mul
OC140	26	Mul
OC170	8	Mul
OC171	8	Mul
OC200	26	Mul
OC201	26	Mul
OC202	6	Mul
OC203	26	Mul
OC204	26	Mul
OC205	26	Mul
OC206	26	Mul
OC207	26	Mul
OCP71	26	Mul
TIP29	29	TI
TIP29A	29	TI
TIP30	29	TI
TIP31	29	TI
TIP32	29	TI
TIP32A	29	TI
TIP33	30	TI
TIP33A	30	TI
TIP34	30	TI
TIP34A	30	TI
TIP34B	30	TI
TIP35	30	TI
TIP36	30	TI
TIP36A	30	TI
TIP41	29	TI
TIP41A	29	TI
TIP41B	29	TI
TIP42	29	TI
TIP42A	29	TI
TIP42B	29	TI
TIP2955	30	TI
TIP3054	29	TI
TIP3055	30	TI
TIS43	16h	TI
TIS56	7a	TI
TIS57	7a	TI
TIS58	16e	TI
TIS59	16e	TI
ZTX107	33	Fer
ZTX108	33	Fer
ZTX109	33	Fer
ZTX300	33	Fer
ZTX302	33	Fer
ZTX303	33	Fer
ZTX304	33	Fer
ZTX314	33	Fer
ZTX320	33	Fer
ZTX330	33	Fer
ZTX500	33	Fer
ZTX501	33	Fer
ZTX502	33	Fer
ZTX503	33	Fer
ZTX504	33	Fer
ZTX530	33	Fer
ZTX531	33	Fer
40250	6	RCA
40251	5	RCA
40347	3	RCA
40348	3	RCA
40349	3	RCA
40361	3	RCA
40362	3	RCA
40363	5	RCA
40389	3	RCA
40394	3	RCA
40395	2	RCA
40406	3	RCA
40407	3	RCA
40408	3	RCA
40409	3	RCA
40410	3	RCA
40411	5	RCA
40414	7a	RCA
40439	5	RCA
2N404	3	RCA
2N404A	3	RCA
2N489	24	GE
2N490	24	GE
2N491	24	GE
2N492	24	GE
2N493	24	GE
2N696	14	SGS
2N697	14	SGS
2N698	14	SGS
2N699	14	SGS
2N706	11	RCA
2N706A	11	RCA
2N708	11	NAS
2N709	11	RCA
2N711	11	RCA
2N718	11	TI
2N718A	11	RCA
2N726	11	TI
2N834	11	RCA
2N914	11	RCA
2N916	11	SGS
2N918	7a	RCA
2N929	11	SGS
2N930	11	SGS
2N956	11	SGS
2N1090	3	RCA
2N1091	3	RCA
2N1131	3	TI
2N1132	14	SGS
2N1302	3	RCA
2N1303	3	RCA
2N1304	3	RCA
2N1305	3	RCA
2N1306	3	NKT
2N1307	3	NKT
2N1308	3	NKT
2N1309	3	NKT
2N1483	4	RCA
2N1507	3	TI
2N1613	3	RCA
2N1631	25	RCA
2N1632	2	RCA
2N1637	2	GE
2N1638	2	GE
2N1639	2	RCA
2N1701	4	GE
2N1711	3	GE
2N1890	14	TI
2N1893	3	GE
2N1936	32	TI
2N1937	32	TI
2N2017	3	NAS
2N2147	5	RCA
2N2148	5	GE
2N2151	38	TI
2N2160	24	TI
2N2192	3	GE
2N2192A	3	GE
2N2193	3	GE
2N2194	3	TI
2N2195	3	GE
2N2218	3	NKT
2N2218A	3	NKT
2N2219	3	NKT
2N2219A	3	NKT
2N2220	11	TI
2N2221	11	Fer
2N2221A	11	Fer
2N2222	11	TI
2N2222A	11	TI
2N2368	11	TI
2N2369	11	TI
2N2369A	11	TI
2N2646	23	Mo
2N2647	23	Mo
2N2711	21	GE
2N2712	21	GE
2N2713	21	GE
2N2714	21	GE
2N2904	3	TI
2N2904A	3	TI
2N2905	3	TI
2N2905A	3	TI
2N2906	11	TI
2N2906A	11	TI
2N2907	11	Fer
2N2907A	11	Fer
2N2923	21	GE
2N2924	21	GE
2N2925	21	GE
2N2926	21	GE
2N3012	11	NAS
2N3053	3	TI
2N3054	22	RCA
2N3055	5	TI
2N3134	3	NAS
2N3390	21	GE
2N3391	21	GE
2N3392	21	GE
2N3393	21	GE
2N3394	21	GE
2N3402	21	GE
2N3403	21	GE
2N3405	21	GE
2N3414	21	GE
2N3416	21	GE
2N3417	21	GE
2N3439	3	RCA
2N3440	3	RCA
2N3441	6	RCA
2N3442	5	RCA
2N3564	17	SGS
2N3638	17	NAS
2N3638A	17	NAS
2N3639	17	NAS
2N3641 to 2N3645	17	SGS
2N3702	16a	TI
2N3703	16a	TI
2N3704	16a	TI
2N3705	16a	TI
2N3706	16a	TI
2N3707	16a	TI
2N3708	16a	TI
2N3709	16a	TI
2N3710	16a	TI
2N3711	16a	TI
2N3713	5	TI
2N3714	5	TI
2N3715	5	TI
2N3716	5	TI
2N3725	3	NAS
2N3771	5	RCA
2N3772	5	RCA
2N3773	5	RCA
2N3791	5	Mo
2N3792	5	TI
2N3798	11	Mo
2N3819	16e	TI
2N3820	16e	TI
2N3823	7d	TI
2N3854	21	GE
2N3855	21	GE
2N3856	21	GE
2N3858	21	GE
2N3859	21	GE
2N3860	21	GE
2N3877	21	GE
2N3900	21	GE
2N3901	21	GE
2N3903	16b	Mo
2N3904	16b	Mo
2N3905	16b	Mo
2N3906	16b	Mo
2N3980	23	TI
2N4036	3	RCA
2N4037	3	RCA
2N4058	16a	TI
2N4059	16a	TI
2N4060	16a	TI
2N4061	16a	TI
2N4062	16a	TI
2N4286 to 2N4294	20	NS
2N4401	16b	NAS
2N4891	36b	TI
2N4892	36b	TI
2N4893	36b	TI
2N5142	27	NAS
2N5172	21	GE
2N5174	21	GE
2N5175	21	GE
2N5176	21	GE
2N5267	7e	Mo
2N5457	16f	Mo
2N5458	16f	Mo
2N5459	16f	Mo
2S024	22	TI
2S034	5	TI
2S035	5	TI
2S036	5	TI
2S303	3	TI
2S304	3	TI
2S305	3	TI
2S306	3	TI
2S307	3	TI
3N108	7a	TI
3N109	7a	TI
3N110	7a	TI
3N111	7a	TI

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FACTURERS

NKT Newmarket
NS National Semiconductor
Ph Philips
Sie Siemens
Sin Sinclair Radionics
SGS SGS-ATES
r TI Texas Instruments
ore than one manufacturer)

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