PRACTICAL

ELECTRONICS

JANUARY 1975 25p

FOR SCINTILLATING DECORATION

MAKE THIS

LIGHT PIPE

FOR SCINTILLATING SOUND

build the

PE ORION...

HI-FI STEREO AMPLIFIER

NEW EDU-KIT MAJOR

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

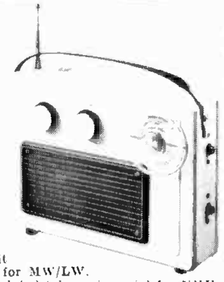
- 4 Transistor Earpiece Radio
- Signal Tracer
- Signal Injector
- Transistor Tester NPN—PNP
- 4 Transistor Push Pull Amplifier
- 5 Transistor Push Pull Amplifier
- 7 Transistor Loudspeaker Radio MW/LW.
- 5 Transistor Short Wave Radio
- Electronic Metronome
- Electronic Noise Generator
- Batteryless Crystal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

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)

TOTAL BUILDING COSTS £7·23 (+8% VAT 57p) P.P. & INS. 44p (Overseas P.P. £1·85p)

NEW ROAMER NINE

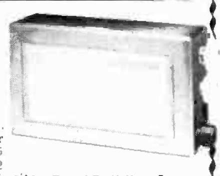


WITH V.H.F. INCLUDING AIRCRAFT

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

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

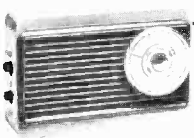
POCKET FIVE



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 × 5½in × 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)

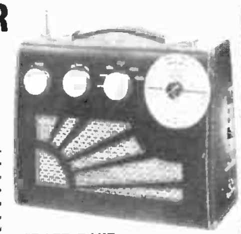
ROAMER EIGHT Mk. I

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

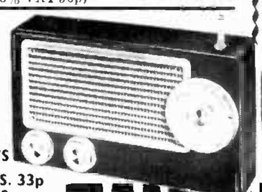
Build Radios Amplifiers, etc., from easy stage, diagrams.

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 ¼in 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 × 2¾in approx. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker Parts price list and plans 25p (FREE with parts).

TOTAL BUILDING COSTS £4·48 (+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 × 2¾in 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)

RADIO EXCHANGE LTD

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

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PE1

PRACTICAL
ELECTRONICS
VOLUME 11 No. 1 JANUARY 1975

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our February issue will be published on Friday, January 10, 1975

DISCOUNTS UP TO 60%

FANTASTIC OFFER
GARRARD SP25 Mk. IV PLINTH AND COVER

Garrard SP25 Mk IV deck Goldring G800 Cartridge Teak finished Plinth Cover (non hinged). All Leads

GLOBAL'S PRICE £19·95

Carr & Ins £1 93

TURNTABLES

Please add £1·05 for P.&P. & Ins.

Garrard SP25 Mk IV Chassis	£12·95
Garrard 86SB P C Cart (Mod)	£47·50
Garrard 86SB Chassis	£22·40
Garrard 401 Chassis	£33·25
Goldring 101 Mk II P C G800	£23·70
Goldring GL75 P C G800	£39·95
Goldring GL78 P C G800	£44·40
Goldring GL85 P C	£66·95
Pioneer PL 12D	P.O.A.
Sansui SR 212	P.O.A.
Thorens TD125 Mk II	£73·75
Thorens TD125AB Mk. II	£111·95
Thorens TD160 ABC	£64·65
Thorens TD165 ABC	£53·95
Transcriptor Saturn with Vestigal Arm	£63·95

AMPLIFIERS

Please add £1·05 for P. & P. & Ins.

Amstrad Integra 4000 Mk II	£25·75
Amstrad IC2000 Mk II	£31·95
Amstrad 8000 Mk III	£18·50
Eagle AA4	£43·10
Eagle AA6	£51·25
Metro-Sound ST20E Mk II	£26·95
Metro-Sound ST40	£34·25
Metro-Sound ST60	£46·75
Sansui AU101	P.O.A.
Sinclair 2000	£29·95
Sinclair 4000	£44·95
Teleton GA202	£30·50
Teleton SAQ206B	£23·95
Teleton SAQ307D	£27·20

COMBINATION UNITS

Please add £1·10 for P.&P. & Ins.

Goodmans Compact 80 (Teak)	£131·15
Goodmans Compact 90	£169·99
Goodmans Compact 1-10 (Teak)	£191·00

TUNERS

Please add £1·05 for P. & P. & Ins.

Amstrad MLX 3000	£28·25
Eagle AA8	£47·50
Eagle TST 152	£32·95
Metro-Sound FMS 20 Mk II	£33·35
Teleton T300	£55·35
Teleton ST202	£38·80
Sinclair 2000	£29·95
Sinclair 4000	£37·45

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Please add £1·21 for P. & P. & Ins.

Amstrad 5000	£56·95
Goodmans Module 90	£92·90
Goodmans 1-10 Module	£110·50
Goodmans 120	£113·95

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Please add 12p for P. & P. & Ins.

Goldring G800H	£3·87
Goldring G800E	£6·20
Goldring G800	£3·40
Shure V15 Type 3	£28·40
Shure M75EJ Type 2	£7·90
Shure M75ED Type 2	£9·10
Shure 91ED	£8·20
Shure M3D	£3·10
Sonotone 9 TACHD	£1·30

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Add £1·62 P. & P. & Ins. per Pair

Amstrad 1500	£25·65
Amstrad 2500	£29·95
Celestion County	£46·25
Celestion Ditton 10 Mk II	£42·95
Celestion Ditton 15	£67·50
Celestion Ditton 25	£132·50
Celestion Ditton 44	£109·95
Celestion Ditton 66	£205·75
Celestion Hadleigh	£39·25
Goodmans Dimension 8	£127·95
Goodmans Havant SL	£44·95
Goodmans Magisters	£107·75
Goodmans Magnum K2 SL	£85·95
Goodmans Minster	£36·00
Goodmans Mezo 3SL	£67·35
Marsden Hall XL10/C N/P	£31·95
Marsden Hall XL15F/C N/P	£36·25
Marsden Hall XL20F/C N/P	£44·95
Marsden Hall XL30F/C N/P	£87·50
Wharfedale Denton 2	£32·25
Wharfedale Dovedale	£85·75
Wharfedale Glendale	£38·75

AMSTRAD IC2000 Mk. II STEREO SYSTEM

Amstrad IC2000 Mk II with increased power 25 + 25W amplifier Complete with a pair of Amstrad Acoustra 2500 speakers. Garrard SP25 Mk IV deck G800 Cart. Plinth Cover (non hinged) All leads.

GLOBAL'S PRICE £80·75

Carr & Ins £3·30

STEREO HEADPHONES

Please add 42p for P. & P. & Ins.

Koss ESP 6	£48·85
Koss ESP 9	£65·75
Koss K7/11 Red Devil	£10·99
Koss 6	£11·70
Koss K6/LC	£13·25
Koss KD 727E	£14·90
Koss 747	£19·75
Koss HV1 1A N/P	£20·85
Koss HV1/LC/A N/P	£24·80
Koss PRO 5/LC	£28·15
Koss K7/11 Black	£9·90
Sennheiser HD414	£10·75
Sennheiser HD424	£15·55

GLOBAL AUDIO

Please Note Every effort is made to ensure prices listed are correct at time of going to press but are subject to alteration without prior notice (E&OE)

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★Portable organ with 4 octave keyboard, £145·29. ★ Console organ with 5 octave keyboard, £269·90. ★Console organ with 2 × 4 octave keyboards and 13 note pedal board, £470·65. ★Console organ with 2 × 5 octave keyboards and 32 note pedal board, £665. ★Console organ with 3 × 5 octave keyboards and 32 note pedal board, £770. ★W/W Sound Synthesiser Kit, £130. ★W/W Touch Sensitive Electronic Piano, £100.

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Full member of AFDEC—the industry's association of franchised electronic component distributors.

Our prices include VAT at the current rate—and carriage on all goods is free.

Send for our catalogue and price list—we'll mail that to you free, too.

THIS MONTH'S BARGAIN OFFER!

Small signal silicon transistor kit—5 each BC108, BC178, BC205, BC208, BFY51, ME1120, ME8003, 2N2924, 2N2926, 2N3394, ACY28.—Catalogue value £7.

Bargain pack PEP2A, £4·90.

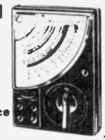
Please send your catalogue—free!

Name ....

Address ....

.... PEP/1A

ASK LASKYS
and make no mistake

MODEL C7202EN

20,000 o.p.v. DC. 10,000 o.p.v. AC Mirror Scale. 5/25/50/250/500/1000/2500 V. DC. 10/50/100/500/1000 V. AC. DC Resistance ×10, ×1000 (30Ω centre scale) DC Current 50uA/2·5mA/250mA. —20 to +68 dB.
OUR PRICE £6.50 P & P 30p

MODEL C7208FM

30,000 opv DC. 15,000 opv AC. ·6/3/15/60/300/600/1200 V. DC. 6/30/120/600/1200 V. AC. DC Resistance ×1, ×10, ×100, ×1000 (50Ω centre scale) DC Current 30uA/3/30/600mA. —20 to +63dB.
OUR PRICE £8.95 P & P 30p

KAMODEN HM720B FET VDM

Input impedance 10 Megohms. Ranges:— 0/.25/1/2.5/10/50/1000V DC. 0/2.5/10 50/250/1000V AC. 0/25uA/2.5/25/250 mA DC. 0/5k/50k/500k/5 M 500 Megohms
OUR PRICE £21.00 P & P 40p

MODEL U4311 Sub-standard Multi-range Volt-Ammeter

Sensitivity 330 Ohms/Volt AC and DC. Accuracy 0.5% DC. 1% AC. Scale length: 165mm. 0/300/750uA/1.5/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A DC. 0/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A AC. 0/75/150/300/750mV/1.5/3/7.5/15/30/75/150/300/750V DC. 0/750mV/1.5/3 /7.5/15/30/75/150/300/750V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificates.
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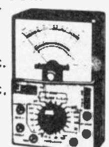
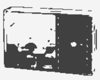
KAMODEN 360 MULTIMETER

High sensitivity. DC 100kohm/V AC 10kohm/V 5" mirror scale, overload protected. Ranges: 0.5/2.5/10/50/250/1000V DC. 5/10/50/250/1000V AC. Current: 0.01mA/0.5/5/50/500mA/10A. Resistance: 0.1/1/10/100 ohms/1/10/100k ohms/10/100M ohms. Decibels —20 to +62dB. Battery operated. Size: 180 x 140 x 80mm. Supplied complete with, test leads etc.
OUR PRICE £17.50 P & P 40p

MODEL AF.105 VOM

50,000 opv. Mirror scale. Meter protection. 0/·3/3/12/60/120/300/600/1200V DC. 0/6/30/120/, 300/600/1200V DC. 0/30μA/6/60/300 mA/12 Amp. 0/10K/1m/10m/100 Meg Ohms. —20 to +17 dB.
OUR PRICE £12.50 P&P 30p.

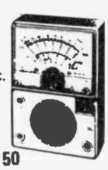
TMK 200 MULTIMETER KIT

Build yourself a quality 20000 opv. multimeter and save money. Complete kit with meter scale, movement and rotary range selector ready mounted in cabinet. All parts, batteries, test prods and instructions. Ranges: 0/0.6/6/30/120/600/1200V D.C. 0/6/30/120 600/1200V A.C. Current: 0/0.6/6/60/600mA. Resistance: 0/10/100K/1/10 Meg ohms. Decibels: —20 to +63db. Size: 90 x 150 x 35mm
OUR PRICE £7.95 P&P 30p.

U4323 MULTIMETER

20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance: x 10, x 100, x 1,000, x 10,000 (50Ω. 500Ω, 5kΩ, 50kΩ centre scale) Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.
OUR PRICE £7.70 P&P 30p

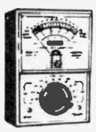
MODEL 500

30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC. 0/50uA/5/50/500mA. 12A DC. 0/60k/6 meg/60 megohms.
OUR PRICE £13.95 Carr. paid
Case for above £1.75

HIOKI 730X

30,000 opv. Overload protection. 6/30/60/300/600/1200V DC. 12/60/120/600/1200V AC. 60/μA/30mA/300mA. 2K/200K/2 Meg Ohm. —10 to +63 dB.
OUR PRICE £7.50
P&P 30p.

HIOKI 750X VOLT-OHM-MILLIAMETER

43 ranges: 0—0.3/0.6/1.5/3/6/12/30/60/150/300/600/1,200V DC. 0—3/6/15/30/60/120/300/600/1,200V AC. Current: 0—30/60uA/1.5/3/15/30/150/300 mA/6/12A. Resistance: 0—3/300k/3/30Mohms. Decibels: —10 to +17dB. Output:— 0—3/6/15/30/60/120/300V. Accuracy ± 3% DC, ± 4% AC. Sensitivity: 50,000 opv DC, 5,000 opv AC. 4 inch meter. Built in protection. Size: 57 x 102 x 153mm.
OUR PRICE £11.95 P&P 40p

AUDIOTRONIC Model ATM1

Top value 1,000 opv pocket multimeter. Ranges:— 0/10/50/250/1,000 volt AC and DC. DC current 0-1mA/100mA. Resistance: 0/150k ohms. Decibels: —10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.
OUR PRICE £3.25 P&P 15p

U4324 MULTIMETER

High sensitivity, overload protected. 20,000opv. Ranges: 0.6/1.2/3/12/30/60/120/600/1200V DC. 3/6/15/60/150/300/600/900V AC. Current: 0.06/0.6/6/60/600mA/3A DC. 0.3/3/30/300mA/3A AC. Resistance: 25/500 ohms/0.5/5/50/500k ohms/5 Mohms. Decibels: —10 to +12dB. Size 167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.
OUR PRICE £9.25 P&P 30p

TMK MODEL TW50K

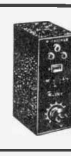
46 ranges, mirror scale. 50k/V DC 50k/V AC. DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistance: 10k/100k/1 Meg/10 Meg ohms. —20 to +81.5dB.
OUR PRICE £12.50 P&P 20p

TMK MODEL 117 FET ELECTRONIC VOLTMETER

Battery operated. 11 Meg input, 26 ranges. Large 4¾" mirror scale. Size: 149x117x60mm. 0.3—12000V DC. 3—300V RMS AC. 8—800V P-P. DC current 0.12—12mA. Resistance up to 2000MOhms. Decibels: —20 to +51dB. Supplied complete with leads and instructions.
OUR PRICE £18.50 P&P 20p

LB3 TRANSISTOR TESTER

Tests ICD and B. PNP/NPN. Operates from 9V battery. Instructions supplied.
OUR PRICE £3.95 P&P 20p

LB4 TRANSISTOR TESTER

Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.
OUR PRICE £4.50 P&P 20p

TMK 100K LAB TESTER

100,000opv. 6½" scale. Buzzer short circuit check. Sensitivity 100,000 opv DC. 5k/V AC DC Volts: 0.5/2.5/10/50/250/1000V AC. 3/10/50/250/500/1000V DC. current 10/100uA/10/100/2.5/10A. Resistance: 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: —10 to +49dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.
OUR PRICE £19.95 P&P 30p

KAMODEN TT35 TRANSISTOR TESTER

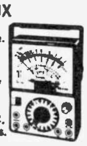
High quality instrument to test reverse leak current and DC current. Amplification factor of NPN, PNP, diodes, transistors, SCR's etc. 4" square clear scale meter. Operates from internal batteries. Complete with instructions, leads carrying handle.
OUR PRICE £17.50 P & P 40p

AUDIOTRONIC Model ATM5

Jewel movement, attractively moulded case with edgwise ohms adjustment. Ranges: 0-3/15/150/300/1200V AC, (2500 opv). 0-6/30/300/600V DC, (5000 opv). 0-300 uA/0-300mA DC. Resistance: x 10 & x 100. —10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 29mm.
OUR PRICE £3.95 P & P 20p

U435 MULTIMETER

20,000opv. Ranges: 75mV/2.5/10/25/100/250/500/1000V DC. 2.5/10/25/100/250/500/1000V AC. Current: 50uA/1/5/25/100mA/0.5/2.5A DC. 5/25/100mA/0.5/2.5A AC. Resistance: 0.3/3/30/300k ohms. Size: 205 x 110 x 84mm. Supplied complete with leads, crocodile clips and steel carrying case.
OUR PRICE £8.75 P&P 30p

HIOKI MODEL 700X

100,000opv. Overload protection. Mirror scale. 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC. 1.5/3/6/12/30/60/150/300/600/1200V AC. 15/30uA/3/6/30/60/150/500mA/6/12A DC. 2k/200k/2M/20MOhms. —20 to +63dB.
OUR PRICE £14.95 P&P 30p

370WTR MULTIMETER

Features AC current ranges. 20,000opv. 0/0.5/2.5/10/50/250/500/1000V DC. 0/2.5/10/50/250/500/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/5 Meg/50 Meg. Decibels: —20 to +62dB.
OUR PRICE £19.95 P&P 30p

U4341 Multimeter & Transistor Tester

27 ranges. 16,700opv. Overload protected. Ranges: 0.3/1.5/6/30/60/150/300/900V DC. 1.5/7.5/30/150/300/750V AC. Current: 0.06/0.6/6/60/600mA DC. 0.3/3/30/300mA AC. Resistance: 0.06/0.6/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.
OUR PRICE £10.50 P&P 30p

MODEL TH12

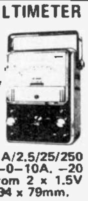
20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/50/150/1000V DC. 0/10/50/250/1000V AC. 0/50uA/25/250mA DC. 0/3k/30k/300k/3 Megohms. —20 to +50dB.
OUR PRICE £5.95 P&P 30p

HIOKI 720X VOM

A versatile, accurate measuring instrument. 20,000 opv. 0/5/25/100/500/1000V DC. 0/10/50/250/1000V AC. 0—50uA/250mA. 0—20k/2 Megohms.
OUR PRICE £5.97
P&P 30p

U4312 MULTIMETER

extremely sturdy instrument for general electrical use. 667opv. 0/0.3/1.5/7.5/30/60/150/300/600/900V DC & 75mV. 0/0.3/1.5/7.5/30/60/150/300/600/900V AC. 0/300uA/1.5/6/15/150/60/600mA/1/1.5/6A DC. 0/1.5/6/15/60/150/600mA/1.5/6A AC. 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.
OUR PRICE £10.25 P&P 50p

Model HT100B4 MULTIMETER

Overload protected, shock proof circuits. 9.5uA Meter with mirror scale. Sensitivity 100kV. Polarity change switch. Ranges: 0.5/2.5/1-/50/250/500/1,000 Volts DC. 2.5/10/50/250/1,000 Volts AC. DC resistance' 0—20/200k/2/20 Meg. ohms. DC current:— 10/250uA/2.5/25/250 mA/10A. AC current:—0—10A. —20 to +62dB. Operates from 2 x 1.5V batteries. Size: 180 x 134 x 79mm.
OUR PRICE £17.50 P&P 40p

KAMODEN 72.200 Multitester

High sensitivity tester. 200,000 opv Overload protected. Mirror scale. Ranges:—0/.06/.3 3/30/120/600/1200V DC. 0/3 12/60/300/11200 V AC. 0/6uA/1.2mA/120mA/600mA/12A DC 0/12A AC. —20 to +63dB. 0/2k/200k/2 Meg/200 Megohms.
OUR PRICE £22.50 P&P 30p

S100TR MULTIMETER TRANSISTOR TESTER

100,000opv. Mirror scale. Overload protection. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600V AC. 0/12/600uA/12/300mA/6/12A DC 0/10k/1 Meg/100 Meg. —20 to +50dB. 0.01—0.2 MFD Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.
OUR PRICE £19.95 P&P 25p

MODEL PL436

20,000 opv DC. 8000 opv AC. Mirror scale ·6/3/12/30/120/600V DC. 3/30/120/600V DC. 50/600μA/60/600mA. 10/100K/1 Meg/10 Meg Ohm. —20 to +46 dB.
OUR PRICE £6.97 P&P 30p.

U91 Clamp VOLT AMMETER

For measuring AC voltage and current without breaking circuit. Ranges: 300/600V AC. Current: 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 36mm. Complete with carrying case, leads and fuses.
OUR PRICE £13.50 P&P 30p

MODEL AS.100D VOM

100,000 opv. Mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600V AC. 0/10μA/6/60/300mA/12 Amp. 0/2K/200K/2M/200 Meg Ohm. —20 to +17dB.
OUR PRICE £17.50 P&P 30p.

U4317 MULTIMETER

High sensitivity instrument for field and laboratory work. Knife edge pointer, 86mm. mirror scale. Overload protection. Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000 V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: —5 to +10dB Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.
OUR PRICE £16.50 P&P 40p

ALL PRICES EXCLUDE VAT

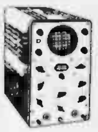
Also see following pages

SWR METER Model SWR3

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

OUR PRICE £4.25 P&P 30p

CI5 PULSE OSCILLOSCOPE



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

OUR PRICE £43.00 Carr. paid

RUSSIAN CI16 Double Beam OSCILLOSCOPE

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

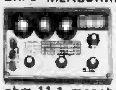
OUR PRICE £87.00 Carr. paid

MODEL TE15 GRID DIP METER

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

OUR PRICE £17.50 P&P 30p

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



A new portable bridge offering excellent range and accuracy at low cost. Resistance: 6 ranges: 0.1 ohm-11.1 megohm ± 1% Inductance: 6 ranges: 1 microhenry-111 henries ± 2% Capacity: 6 ranges: 10pf-1110 mfd ± 2% Turns Ratio: 6 ranges: 1:1/1000-1:11100 ± 1% Bridge Voltage at 1,000cps. Operated from 9-volt battery. 100 microamp meter Indication. Size 7½" x 5" x 2".

OUR PRICE £25.00 P&P 30p

TE-20D RF SIGNAL GENERATOR

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

OUR PRICE £17.50 P&P 50p

TE22 SINE SQUARE WAVE AUDIO GENERATOR

Sine 20cps to 200kHz on 4 bands. Square 20 cps to 30 kHz. Output impedence 5000 Ohms. 200/250V AC operation. Supplied brand new guaranteed, with instruction manual and leads.

OUR PRICE £24.95 P&P 50p

ARF 300 AF/RF SIGNAL GENERATOR

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

OUR PRICE £37.50 P&P 50p

WALKIE TALKIES

SKYFON NV7 Super low cost transmitter/ receivers. 100MW with call buzzer and on/off volume control. 7 transistors. Telescopic rod antenna.

OUR PRICE £28.95 per PAIR P.&P 50p.

NOT LICENSABLE IN THE U.K.

MODEL MG100 SINE SQUARE WAVE AUDIO GENERATOR

Range 19–220,000Hz Sine Wave 19–100,000 Hz Square Wave. Output Sine or Square wave 10v. P. to P. Size 180 x 90 x 90mm Operation 220/240v. A.C.

OUR PRICE £19.95 P&P 50p

POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating.

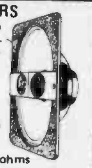
Single hole fixing. ¼" diameter shafts. Bulk quantities available.

25 WATT 10/25/50/100/500/1000/ 2500 ohms. **£1.15** P&P 10p

50 WATT 10/50/100/250/500/ 1500/5000 ohms. **£1.62** P&P 10p

100 WATT 1/5/10/25/50/250/500/ 2500 ohms. **£2.34** P&P 15p

EMI LOUDSPEAKERS



Model 350 13 x 8" with single tweeter/crossover. 20–20,000Hz. 15 watts RMS. Available 8 or 15 ohms.

OUR PRICE £7.50 each P&P 37p

Model 450 13 x 8" with twin tweeter/crossover. 55–13,000Hz. 8 watts RMS. Available 8 or 15 ohms

OUR PRICE £3.62 each P&P 35p

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

8 ohms. 30 watt. Heavy duty, ideal for Hi-Fi P.A. Group.

OUR PRICE £12.50. P&P 50p.

PS200 Regulated POWER SUPPLY UNIT

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

OUR PRICE £19.95 P&P 50p

AUDIOTRONIC LE-102A INTERCOM

Beautifully made and finished in two tone ivory/buff, the LE-102A is useful in the home, office or shop and is suitable for use as baby alarm. Wall or desk mounting 57mm speaker/mic gives clear 2-way communication with on/off and volume control on master unit. Operates on 9V batt. Approx. 60ft lead.

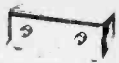
OUR PRICE £3.95 P & P 30p

TRITON 4318 PORTABLE 8 TRACK CARTRIDGE PLAYER WITH MW/LW RADIO

Will play 8 track stereo cartridge monaurally. Channel selector switch. Covers medium and long wave bands. Volume and tone controls. Earphone socket. Battery/Mains operation.

OUR PRICE £11.95 P & P 50p

EA41 REVERBERATION AMPLIFIER



Self contained, transistorised, battery operated. Simply plug in microphone, guitar etc. and output to your amplifier. Volume control and depth of reverberation control. Beau-walnut cabinet. 184 x 77 x 108mm.

OUR PRICE £7.50 P&P 30p

SPECIAL PURCHASES! RECORD DECK PACKAGE by Famous Manufacturer

GARRARD SP25 Mark 111 with G800 cartridge in luxurious plinth with cover.

OUR PRICE £13.95 P & P 75p

GARRARD SP25 Mark 111 Record deck fitted KS 40A cartridge.

OUR PRICE £9.95 P & P 50p

LH02S STEREO HEADPHONES

Light weight head phones with padded ear pieces. 4/16 ohms 20–20,000Hz. Complete with 6' lead and plug.

OUR PRICE £1.97 P&P 30p

DH02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedence 8 ohms. 20–12,000Hz. Complete with lead and plug.

OUR PRICE £2.25 P&P 30p

TE1035 Stereo HEADPHONES

Low cost with excellent response. Foam rubber earcups. Adjustable headband. 8 ohms impedence. Frequency response 25Hz–18kHz. Complete with cable and stereo jack plug.

OUR PRICE £2.60 P&P 30p

SOH8V MONO/STEREO HEADPHONES

Volume control for each channel. 4/16 ohms impedence. Frequency response 20Hz–18kHz. Complete with 10ft. coiled lead and jack plug.

OUR PRICE £4.97 P&P 30p

BH001 HEADSET and Boom Microphone

Moving coil. Ideal for language teaching, communications etc. Headphone impedence 16 ohms. Microphone impedence 200 ohms.

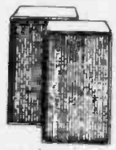
OUR PRICE £5.95 P&P 30p

HANIMEX HRC 3075 CASSETTE RADIO

Covers Medium and FM wave-bands. Slider volume and tone controls. Battery/Mains operation. Will record direct from radio or through built in condenser microphone. Complete with batteries, earphone, and cassette.

OUR PRICE £24·30 P & P 50p

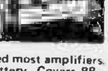
SPECIAL BARGAIN !! STEREOSOUND SPEAKERS



Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 368 x 229 x 190mm. 8 ohms. 8 watts RMS, 16 watts peak. Complete with Din lead.

OUR PRICE £12.95 PAIR P&P 50p

FM TUNER CHASSIS



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

OUR PRICE £8.95 P&P 20p

Stereo Multiplex Adaptor £5.95 extra

SPECIAL OFFER! SAVE OVER 50%

AMSTRAD 8000/2 Stereo amplifier 7 watts per channel rms. Inputs for tuner tape, phono. Headphone socket. List price £29.95.

OUR PRICE £12.95 P & P 60p

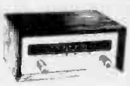
SPECIAL OFFER! CONVERT YOUR STEREO SYSTEM TO 4D SOUND FOR UNDER £16.

Exclusive offer of GOODWIN 4-CHANNEL CONVERTER and a pair of AD15 10 watt 8 ohm bookshelf speakers enables you to add 4D sound to your existing system. Complete with simple connection details. Normal retail value £26.50.

OUR PRICE £15.80 P & P £1.

GOODWIN CONVERTER available separately £3.95 P & P 50p.

Model A1018 FM TUNER



6 transistor high quality unit— 3 IF stages and double tuned discriminator. For use with most amplifiers. Covers 88–108MHz. Powered by 9V battery.

OUR PRICE £13.50 P&P 30p

Stereo multiplex adapter £5.95 extra.

ELECTRONIC CALCULATORS

We carry a tremendous range of both pocket and desk calculators from as little as £8.90 Owing to the demand it is not possible to include them in this advertisement, so send for our latest price list or call into any branch.

MINIATURE ORGAN MUSIC MASTER AM100

Spanning nearly two octaves, including semi-tones. This instrument will give hours of enjoyment to all the family. Beautifully finished. The Keyboard range can be adjusted to be in tune with any instrument. Operates from internal 9V battery. Fitted with on/off switch, vibrato switch, earphone socket and external 9V D.C. socket.

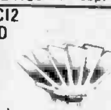
OUR PRICE £7.95 P&P 50p.

BINATONE DIGITAL CLOCK

Attractive Ivory case. Large clear numbers for hours, minutes and seconds. A.C. 240V operation. Size approx. 6¾ x 3 x 3¾ inches.

OUR PRICE £4.50 P&P 50p.

SINCLAIR IC12 INTEGRATED CIRCUIT AMPLIFIER



complete with printed circuit mounting board.

OUR PRICE £1.50 P & P 15p.

SINCLAIR Project 80 Modules

Z40 Power Amp.	£5.95	P & P 15p
Z60 Power Amp.	£7.45	P & P 15p
Stereo 80 Pre-Amp.	£13.95	P & P 15p
Active Filter Unit	£7.45	P & P 15p
FM Tuner	£13.95	P & P 15p
Stereo Decoder	£8.95	P & P 15p
PZ5 Power Supply	£5.95	P & P 30p
PZ6 Power Supply	£8.95	P & P 30p
PZ8 Power Supply	£8.45	P & P 30p
Transformer for PZ8	£4.05	P & P 50p
IC 20 Stereo Amp. kit	£7.95	P & P 15p
PZ20 Power Supply kit	£5.45	P & P 30p

SINCLAIR Project 80 Packages

2xZ40/Stereo 80/PZ5	£28.60	P & P 35p each
2xZ40/Stereo 80/PZ8	£31.30	
2xZ60/Stereo 80/PZ8	£33.55	

TE1021 Stereo Listening Station

For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. Two gain controls, speakers on–off slide switch; stereo headphone socket.

OUR PRICE £2.25 P&P 15p

AUDIOTRONIC LOW NOISE CASSETTES

TYPE	5	10	25
C60	£1.57	£3.00	£7.08
C90	£2.24	£4.25	£10.00
C120	£2.73	£5.17	£12.24

P&P 3p each. 10 and over Post Free

MP7 MIXER-PREAMPLIFIER

5 Microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. Size: 235 x 127 x 76mm. Inputs: Mics. 3 x 3mV 50k; 2 x 3mV 600 ohms. Phono. Mag. 4mV 50k; Phono Ceramic 100mV 1 Meg. Output 250mV 100k.

OUR PRICE £8.97 P&P 20p

AUDIOTRONIC AHA101 Stereo Headphone Amplifier

All silicon, transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. INPUTS: 5mV and 100mV. OUTPUT: 50mV per channel.

OUR PRICE £8.50 P&P 30p

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JOSTY KIT

WE ARE APPOINTED STOCKISTS AT Oxford Street, 42 & 257 Tottenham Court Road, 34 Lisle Street, 152, Fleet Street, 311 Edgware Road, CROYDON BIRMINGHAM KINGSTON LEICESTER NORTHAMPTON SOUTHEND TUNBRIDGE WELLS WOLVERHAMPTON branches, or by Mail Order.

All kits are complete with comprehensive easy to follow Instructions and covered by full guarantee.

Post and Packing 15p per kit.

AF20 Mono amplifier	£5.61
AF25 Mixer	£3.29
AF30 Mono pre-amplifier	£3.20
AF35 Emitter amplifier	£2.42
AF80 0.5W mic. amplifier	£4.86
AF305 Intercom	£7.67
AF310 2 Mono Amplifier	£7.55
M160 Multi-vibrator	£2.18
M1302 Transistor tester	£8.33
M191 VU Meter	£5.37
M192 Stereo balance meter	£5.93
LF380 Quadraphonic device	£8.42
AT5 Automatic light control	£3.75
AT30 Photo cell switch unit	£6.68
AT50 400W triac light dimmer/speed control	£5.18
AT56 2,200W triac light dimmer/speed control	£6.75
AT60 1 channel light control	£10.82
AT65 3 channel light control	£16.52
GU330 Tremolo unit	£8.10
HF61 Diode detector	£3.87
HF65 FM transmitter	£3.21
HF75 FM receiver	£3.66
HF310 FM tuner	£16.32
HF325 Deluxe FM tuner	£26.33
HF330 Decoder (HF310/325)	£10.55
GP310 Stereo pre-amplifier for use with 2 x AF310	£22.98
GP312 Circuit board	£10.02
GP304 Circuit board	£5.33
HF380 lw/vhl aerial amplifier	£6.02
HF395 broadband aerial amp.	£2.10
NT10 Stabilised power supply 100mA, 9V	£6.27
NT300 Stabilised p. supply	£13.16
NT310 Power Supply 240 V AC or 2 x 18 V D C at 2 amps	£5.64
NT305 Voltage converter	£5.64
NT315 Power supply 240 V AC to 4.5/15V DC, 500mA	£12.06

Amateur Electronics by Josty-Kit, the professional book for the amateur - covers the subject from basic principals to advanced electronic techniques. Complete with circuit board for AE1 to AE10 listed below.

OUR PRICE £3.30 (No VAT) P&P 25p plus VAT.

AE1 100mW output stage	£1.55
AE2 Pre-amplifier	£1.32
AE3 Diode receiver	£2.05
AE4 Flasher	£1.26
AE5 Astable multi-vibrator	£1.14
AE6 Monostable multi-vibrator	£1.11
AE7 RC generator	£1.08
AE8 Bass filter	£1.05
AE9 Treble filter	£1.05
AE10 CCIR filter	£1.05

Also see previous page

ALL PRICES EXCLUDE VAT

SEW PANEL METERS

SEW PANEL METERS ARE STOCKED AT OUR 3 LISLE ST., 311 EDGWARE RD., & 152 FLEET ST., BRANCHES or order by post.

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

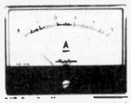
Over 200 ranges in stock—other ranges to order. Quantity discounts available. Send for fully illustrated brochure.

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

CLEAR PLASTIC MODEL SD640
Size: 85 x 64mm

50uA	£3.80	10V DC	£3.65
100uA	£3.75	20V DC	£3.65
200uA	£3.70	50V DC	£3.65
500uA	£3.65	300V DC	£3.65
50-0-50uA	£3.75	15V AC	£3.75
100-0-100uA	£3.70	300V AC	£3.75
1mA	£3.65	VU Meter	£3.90
5mA	£3.65		
10mA	£3.65		
50mA	£3.65		
100mA	£3.65		
500mA	£3.65		
1A DC	£3.65		
5A DC	£3.65		
10A DC	£3.65		
5V DC	£3.65		

CLEAR PLASTIC MODEL SD830
Size: 110 x 83mm

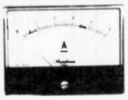


50uA	£4.30	10V DC	£4.10
100uA	£4.25	20V DC	£4.10
200uA	£4.20	50V DC	£4.10
500uA	£4.15	300V DC	£4.10
50-0-50uA	£4.25	15V AC	£4.20
100-0-100uA	£4.20	300V AC	£4.20
1mA	£4.10	VU Meter	£4.40
5mA	£4.10		
10mA	£4.10		
50mA	£4.10		
100mA	£4.10		
500mA	£4.10		
1A DC	£4.10		
5A DC	£4.10		
10A DC	£4.10		
5V DC	£4.10		

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

50uA	£3.95	300V DC	£3.70
100uA	£3.85	15V AC	£3.80
200uA	£3.80	50V AC	£3.80
500uA	£3.75	150V AC	£3.80
50-0-50uA	£3.85	300V AC	£3.90
100-0-100uA	£3.80	500V AC	£3.80
500-0-500uA	£3.70	S Meter 1mA	£4.10
1mA	£3.70	VU Meter	£3.70
1-0-1mA	£3.70	1A AC	* £3.70
5mA	£3.70	5A AC	* £3.70
10mA	£3.70	10A AC	* £3.70
50mA	£3.70	20A AC	* £3.70
100mA	£3.70	30A AC	* £3.70
500mA	£3.70	50mA AC	* £3.70
1A DC	£3.70	100mA AC	* £3.70
5A DC	£3.70	200mA AC	* £3.70
10A DC	£3.70	500mA AC	* £3.70
15A DC	£3.70		
20A DC	£3.80		
30A DC	£3.85		
50A DC	£4.05		
5V DC	£3.70		
10V DC	£3.70		
15V DC	£3.70		
20V DC	£3.70		
50V DC	£3.70		
150V DC	£3.70		

CLEAR PLASTIC MODEL SW100
Size: 100 x 80mm



50uA	£4.60	150V AC	£4.45
100uA	£4.50	300V AC	£4.45
500uA	£4.30	VU Meter	£4.90
50-0-50uA	£4.50		
100-0-100uA	£4.45		
1mA	£4.30		
1A DC	£4.30		
5A DC	£4.30		
20V DC	£4.30		
50V DC	£4.30		
300V DC	£4.30		

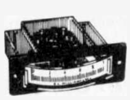
CLEAR PLASTIC MODEL MR 45P
Size: 50 x 50mm

50uA	£3.20	300V AC	£3.05
100uA	£3.15	S Meter 1mA	£2.95
200uA	£3.10	VU Meter	£3.40
500uA	£3.00	1A AC	* £2.95
50-0-50uA	£3.15	5A AC	* £2.95
100-0-100uA	£3.10	10A AC	* £2.95
500-0-500uA	£2.95	20A AC	* £2.95
1mA	£2.95	30A AC	* £2.95
5mA	£2.95		
10mA	£2.95		
50mA	£2.95		
100mA	£2.95		
500mA	£2.95		
1A DC	£2.95		
5A DC	£2.95		
10V DC	£2.95		
20V DC	£2.95		
50V DC	£2.95		
300V DC	£2.95		
15V AC	£3.05		

BAKELITE MODEL S80 Enlarged Window
Size: 80 x 80mm

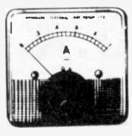
50uA	£4.50
100uA	£4.45
500uA	£4.20
50-0-50uA	£4.45
100-0-100uA	£4.40
1mA	£4.20
1A DC	£4.20
5A DC	£4.20
20V DC	£4.20
50V DC	£4.20
300V DC	£4.20
300V AC	£4.30
VU Meter	£4.70

EDGWISE MODEL PE70
Size: 90 x 34mm



50uA	£4.15
100uA	£4.10
200uA	£4.05
500uA	£3.90
50-0-50uA	£4.10
100-0-100uA	£4.05
1mA	£3.85
300V AC	£3.95
VU Meter	£4.30

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



50uA	£3.10	20V DC	£2.80
100uA	£3.05	50V DC	£2.80
200uA	£3.00	100V DC	£2.80
500uA	£2.85	150V DC	£2.80
50-0-50uA	£3.05	300V DC	£2.85
100-0-100uA	£3.00	500V DC	£2.85
500-0-500uA	£2.80	750V DC	£2.90
1mA	£2.80	15V AC	£2.90
1-0-1mA	£2.80	50V AC	£2.90
2mA	£2.80	150V AC	£2.90
5mA	£2.80	300V AC	£2.90
10mA	£2.80	500V AC	£3.00
20mA	£2.80	S Meter 1mA	£2.80
50mA	£2.80	VU Meter	£3.20
100mA	£2.80		
150mA	£2.80		
200mA	£2.80		
300mA	£2.80		
500mA	£2.80		
750mA	£.280		
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2A DC	£2.80		
5A DC	£2.80		
10A DC	£2.80		
3V DC	£2.80		
10V DC	£2.80		
15V DC	£2.80		

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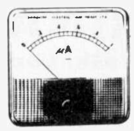
100uA	£7.90	50V DC	£7.60
50-0-50uA	£7.90	300V DC	£7.60
1mA	£7.60	500mA/5A DC	£8.60
1-0-1mA	£7.60	5V/50V DC	£8.60
1A DC	£7.60	5V/15V DC	£8.60
5A DC	£7.60	1/5A DC	£8.60
5V DC	£7.60	1A/15A DC	£8.60
10V DC	£7.60		
15V DC	£7.60		

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



50uA	£3.70	S Meter 1mA	£3.30
100uA	£3.50	VU Meter	£3.80
500uA	£3.35	1A AC	* £3.30
50-0-50uA	£3.50	5A AC	* £3.30
100-0-100uA	£3.45	10A AC	* £3.30
1mA	£3.30	20A AC	* £3.30
5mA	£3.30	30A AC	* £3.30
10mA	£3.30		
50mA	£3.30		
100mA	£3.30		
500mA	£3.30		
1A DC	£3.30		
5A DC	£3.30		
10V DC	£3.30		
20V DC	£3.30		
50V DC	£3.30		
300V DC	£3.30		
15V AC	£3.40		
300V AC	£3.40		

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

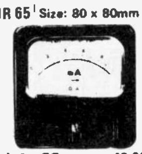
50uA	£5.45	300V DC	£5.20
100uA	£5.40	15V AC	£5.30
200uA	£5.35	300V AC	£5.30
500uA	£5.25	S Meter 1mA	£5.20
50-0-50uA	£5.40	VU Meter	£5.55
100-0-100uA	£5.35	1A AC	* £5.20
500-0-500uA	£5.20	5A AC	* £5.20
1mA	£5.20	10A AC	* £5.20
1-0-1mA	£5.20	20A AC	* £5.20
5mA	£5.20	30A AC	* £5.20
10mA	£5.20		
50mA	£5.20		
100mA	£5.20		
500mA	£5.20		
1A DC	£5.20		
5A DC	£5.20		
15A DC	£5.20		
30A DC	£5.40		
10V DC	£5.20		
20V DC	£5.20		
50V DC	£5.20		
150V DC	£5.20		

CLEAR PLASTIC MODEL SD460
Size: 59 x 46mm

50uA	£3.50	10V DC	£3.30
100uA	£3.45	20V DC	£3.30
200uA	£3.40	50V DC	£3.30
500uA	£3.35	300V DC	£3.30
50-0-50uA	£3.45	15V AC	£3.45
100-0-100uA	£3.40	300V AC	£3.45
1mA	£3.30	VU Meter	£3.85
5mA	£3.30		
10mA	£3.30		
50mA	£3.30		
100mA	£3.30		
500mA	£3.30		
1A DC	£3.30		
5A DC	£3.30		
10A DC	£3.30		
5V DC	£3.30		

POSTAGE & PACKING 15p

BAKELITE MODEL MR 65 Size: 80 x 80mm



25uA	£5.25	300V DC	£3.60
50uA	£4.00	30V AC	* £3.60
100uA	£3.95	50V AC	* £3.60
500uA	£3.65	150V AC	* £3.60
50-0-50uA	£3.95	300V AC	* £3.60
100-0-100uA	£3.90	500V AC	* £3.60
500-0-500uA	£3.60	VU Meter	£4.10
1mA	£3.60	1A AC	* £3.60
1-0-1mA	£3.60	5A AC	* £3.60
5mA	£3.60	10A AC	* £3.60
10mA	£3.60	20A AC	* £3.60
50mA	£3.60	30A AC	* £3.60
100mA	£3.60	50A AC	* £3.60
500mA	£3.60	500mA AC	* £3.60
1A DC	£3.60	50mV DC	£3.75
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5A DC	£3.60		
10A DC	£3.60		
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5V DC	£3.60		
10V DC	£3.60		
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50V DC	£3.60		
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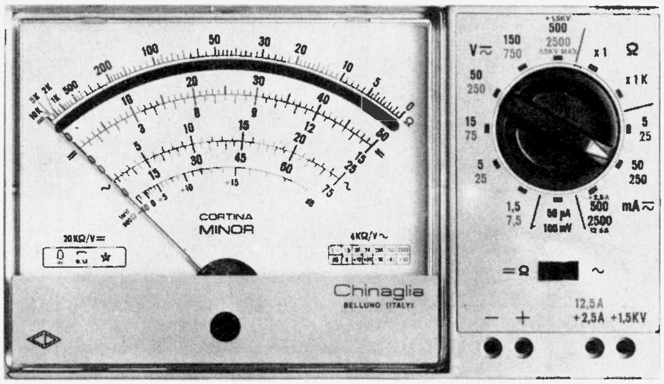

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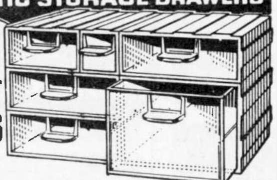

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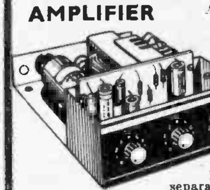
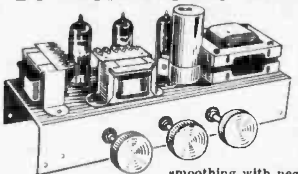
SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 Silicon transistors plus 2 power out-put transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz. 30KHz ±3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high × 6" wide × 7½" deep. AC 200/250V. PRICE £11·80. P. & P. 50p.

DE LUXE STEREO AMPLIFIER



A.C. mains 200-240 v. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line-up:–2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11"w × 4"d. Overall height including valves 5". Ready built and tested to a high standard. £10·22. P. & P. 50p.

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Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case overall size 6" × 3¼" × 2¼". Suitable for Transistor Radios, Tape Recorders, Amplifiers etc. etc. Ready built and tested. **Price £4·90. P. & P. 35p.**

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P. & P. 40p. BARGAIN PRICE **£3·78**

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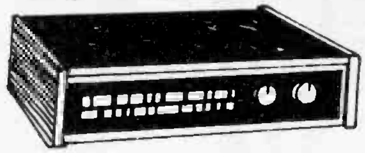

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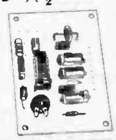
Price £21·60. Post and Packing 50p.

STEREO-DECODER SIZE 2" × 3" × ½"



Ready built. Pre-aligned and tested. Sens. 20-560mV for 9-16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. £5 plus 10p P. & P.
Stereo beacon light if required 40p extra.

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SONOTONE 9TAHC COMPATIBLE STEREO CARTRIDGE T/O stylus Diamond Stereo LP and Sapphire 78.
ONLY £2·27. P. & P. 10p. Also available fited with twin Diamond T/O stylus for Stereo LP. £2·76. P. & P. 15p.
LATEST RONETTE T/O STEREO/COMPATIBLE CARTRIDGE for EP/LP/Stereo 78. £1·60. P. & P. 15p.
LATEST RONETTE T/C MONO COMPATIBLE CARTRIDGE for playing EP/LP/78 mono or stereo records on mono equipment. Only £1·47. P. & P. 15p.

QUALITY RECORD PLAYER AMPLIFIER MK. II
A top quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in wide × 3in deep × 6in high. Ready built and tested. PRICE £4·91. P. & P. 50p.
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Carr. 75p.
OUR PRICE £9·10. Carr. 75p.
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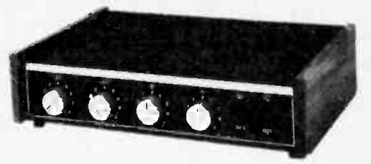
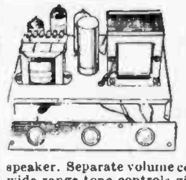
HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT

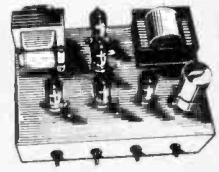


A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal 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. × 2¾"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. × 4¾"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 3–15 Ω 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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Adjustable headband with comfortable flexifoam earmuffs. Wired and fitted with standard stereo ¼in jack plug. Frequency response 30–15,000Hz. Matching impedance 8–16 ohms. Easily converted for Mono. PRICE £3·24. P. & P. 25p.

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Prim. 120/240V. Sec 120/240V Centre Tapped and Screened

ALSO AVAILABLE WITH 115/120V SEC. WINDING

Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	P & P £	p
07	20	1	8	7·0 × 6·0 × 6·0	2·55	38
149	60	3	12	9·9 × 7·7 × 8·6	3·98	45
150	100	5	8	9·9 × 8·9 × 8·6	4·45	45
151	200	8	0	12·1 × 9·3 × 10·2	7·39	53
152	250	13	12	12·1 × 11·8 × 10·2	8·93	73
153	350	15	0	14·0 × 10·8 × 11·8	10·80	73
154	500	19	8	14·0 × 13·4 × 11·8	12·41	91
155	750	29	0	17·2 × 14·0 × 14·0	18·65	*
156	1000	38	0	17·2 × 16·6 × 14·0	26·50	*
157	1500	46	0	21·6 × 13·4 × 18·1	30·23	*
158	2000	60	0	21·6 × 15·3 × 18·1	33·70	*

AUTO TRANSFORMERS

Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	Auto Taps	P & P £	p
113	20	1	0	5·8 × 5·1 × 4·5	0-115-210-240	1·52	30
64	75	2	4	7·0 × 6·7 × 6·1	0-115-210-240	2·64	38
4	150	3	4	8·9 × 7·7 × 7·7	0-115-200-220-240	3·75	45
66	300	6	4	9·9 × 9·6 × 8·6	,, ,,	5·29	53
67	500	12	8	12·1 × 11·2 × 10·2	,, ,,	8·02	67
84	1000	19	8	14·0 × 13·4 × 14·3	,, ,,	12·44	91
93	1500	30	4	14·0 × 15·9 × 14·3	,, ,,	16·65	*
95	2000	32	0	17·2 × 16·6 × 14·0	,, ,,	22·00	*
73	3000	40	0	21·6 × 13·4 × 18·1	,, ,,	31·90	*

CASED AUTO TRANSFORMERS
115V mains lead input and U.S.A. 2-pin outlets, 20VA £2·85, P & P 38p. 500VA £9·50, P & P 80p. 1000VA £15·92, via B.R.S.

LOW VOLTAGE SERIES (ISOLATED)
PRIMARY 200-250 VOLTS 12 AND/OR 24 VOLT RANGE

Ref. No.	Amps. 12V	24V	Weight lb	oz	Size cm.	Secondary Windings	P & P £	p
111	0·5	0·25		8	4·8 × 2·9 × 3·5	0-12V at 0·25A × 2	1·34	23
213	1·0	0·5	1	4	6·1 × 5·8 × 4·8	0-12V at 0·5A × 2	1·58	30
71	2	1	1	12	7·0 × 6·4 × 6·1	0-12V at 1A × 2	2·09	38
18	4	2	2	12	8·3 × 7·7 × 7·0	0-12V at 2A × 2	2·60	38
70	6	3	3	8	8·9 × 8·0 × 7·7	0-12V at 3A × 2	3·75	45
108	8	4	5	8	9·9 × 8·9 × 8·6	0-12V at 4A × 2	4·15	45
72	10	5	6	4	9·9 × 9·6 × 8·6	0-12V at 5A × 2	4·67	53
116	12	6	6	12	9·9 × 10·2 × 8·6	0-12V at 5A × 2	5·02	53
17	16	8	8	12	12·1 × 9·9 × 10·2	0-12V at 8A × 2	6·62	60
115	20	10	11	8	14·0 × 9·6 × 11·8	0-12V at 10A × 2	9·45	73
187	30	15	15	8	14·0 × 12·1 × 11·8	0-12V at 15A × 2	12·29	85
226	60	30	32	0	17·2 × 15·3 × 14·0	0-12V at 30A × 2	15·30	*

30 VOLT RANGE

Ref. No.	Amps	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
112	0·5	1	4	6·1 × 5·8 × 4·8	0-12-15-20-24-30V	1·65	30
79	1·0	2	4	7·0 × 6·7 × 6·1	,, ,,	2·18	38
3	2·0	3	4	8·9 × 7·7 × 7·7	,, ,,	3·18	38
20	3·0	4	8	9·9 × 8·3 × 8·6	,, ,,	4·12	45
21	4·0	6	4	9·9 × 9·6 × 8·6	,, ,,	4·67	53
51	5·0	6	12	12·1 × 8·6 × 10·2	,, ,,	5·83	53
117	6·0	8	0	12·1 × 9·3 × 10·2	,, ,,	6·51	60
88	8·0	12	0	12·1 × 11·8 × 10·2	,, ,,	9·00	67
89	10·0	13	12	14·0 × 10·2 × 11·8	,, ,,	8·97	73

50 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
102	0·5	1	12	7·0 × 6·4 × 6·1	0-19-25-33-40-50V	2·35	30
103	1·0	2	12	8·3 × 7·4 × 7·0	,, ,,	3·08	38
104	2·0	5	8	7·9 × 8·9 × 8·6	,, ,,	4·26	45
105	3·0	6	12	9·9 × 10·2 × 8·6	,, ,,	5·28	53
106	4·0	10	0	12·1 × 10·5 × 10·2	,, ,,	6·91	67
107	6·0	12	0	14·0 × 10·2 × 11·8	,, ,,	11·00	67
118	8·0	18	0	14·0 × 12·7 × 11·8	,, ,,	11·80	85
119	10·0	25	0	17·2 × 12·7 × 14·0	,, ,,	15·45	*

60 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
124	0·5	2	4	7·0 × 6·7 × 6·1	0-24-30-40-48-60V	2·12	38
126	1·0	3	4	8·9 × 7·7 × 7·7	,, ,,	3·10	38
127	2·0	6	4	9·9 × 9·6 × 8·6	,, ,,	4·62	45
125	3·0	8	12	12·1 × 9·9 × 10·2	,, ,,	6·84	60
123	4·0	13	12	12·1 × 11·8 × 10·2	,, ,,	7·96	67
40	5·0	12	00	14·0 × 10·2 × 11·8	,, ,,	8·87	73
120	6·0	15	8	14·0 × 12·1 × 11·8	,, ,,	10·27	85
121	8·0	25	00	14·0 × 14·7 × 11·8	,, ,,	13·64	*
122	10·0	25	0	17·2 × 12·7 × 14·0	,, ,,	15·93	*
189	12·0	29	00	17·2 × 14·0 × 14·0	,, ,,	18·16	*

MINIATURE TRANSFORMERS WITH SCREENS

Ref. No.	mA	Weight lb	oz	Size cm.	Volts	P & P £	p
238	200		2	2·8 × 2·6 × 2·0	3-0-3	1·40	10
212	1A, 1A	1	4	6·1 × 5·8 × 4·8	0-6, 0-6	1·67	30
13	100		4	3·9 × 2·6 × 2·9	9-0-9	1·28	13
235	330, 330		4	4·8 × 2·9 × 3·5	0-9, 0-9	1·42	19
207	500, 500	1	00	6·1 × 5·4 × 4·8	0-8-9, 0-8-9	1·75	30
208	1A, 1A	1	12	7·0 × 6·4 × 6·1	0-8-9, 0-8-9	3·00	38
236	200,200		4	4·8 × 2·9 × 3·5	0-15, 0-15	1·30	19
214	300, 300	1	4	6·1 × 5·8 × 4·8	0-20, 0-20	1·76	30
221	700 (d.c.)	1	8	7·0 × 6·1 × 6·1	20-12-0-12-20	1·98	38
206	1A, 1A	2	12	8·3 × 7·7 × 7·0	0-15-20, 0-15-20	3·15	38
203	500,500	2	4	8·3 × 7·0 × 7·0	0-15-27, 0-15-27	2·73	38
204	1A, 1A	3	4	8·9 × 7·7 × 7·7	0-15-27, 0-15-27	3·50	38

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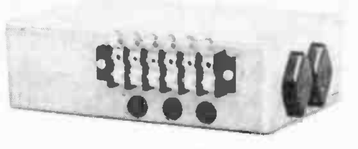

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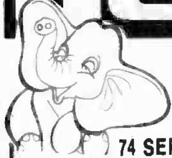

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SN7445N	1·60	SN74160N	1·38	MC1310P	2·91
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SN7447AN	1·60	SN74162N	1·38	MC1710CC	0·80
SN7448N	1·27	SN74163N	1·38	MFC4000P	0·45
SN7450N	0·16	SN74164N	1·76	MFC4010P	0·55
SN7451N	0·16	SN74165N	1·76	MFC6040P	1·00
SN7453N	0·16	SN74166N	1·60	**Others**	
SN7454N	0·16	SN74167N	3·00	TBA800	1·50
SN7460N	0·16	SN74170N	2·52	SN76003N	1·50
SN7470N	0·36	SN74173N	1·66	SN72741P	0·60
SN7472N	0·38	SN74174N	1·57	SN72748P	0·81
SN7473N	0·41	SN74175N	1·10	702C	0·75
SN7474N	0·42	SN74176N	1·26	709C	0·39
SN7475N	0·59	SN74177N	1·26	723C	0·90
SN7476N	0·45	SN74180N	1·26	728C	0·45
SN7480N	0·60	SN74181N	3·95	741C	0·50
SN7481N	1·10	SN74182N	1·26	747C	1·00
SN7482N	0·87	SN74184N	1·80	748C	0·61
SN7483N	1·10	SN74185N	1·80	LM309K	2·00
SN7484N	1·00	SN74190N	2·00	TAA960	1·75

ELECTRONIC COMPONENTS

(Post/Packing 15p per 1–6 items G.B. unless stated)

Ceramic Filters
Miniature 10·7 mHz filters 40p pair.
IC IF Unit
CA3089 10·7 mHz IC £2·94
IC Clock
MM 5314 single chip clock with CCT £9.
Radio IC Chip
ZN414 Radio IC with circuit £1·20.

Ultrasonic transducers
With data/circuits £5·90 pair.
Strobe tubes
ZFT8A (similar to 4A) £4. ZFT12A £5.
7 segment indicators
3015F with data £1·70 each.
Spring delay units
HP42 9in twin spring £3·30 (P. & P.) 20p. HR1 6in twin spring £6·85 (P. & P.) 25p.
Fibre optics
0·01in dia. mono filament £5·50 per 100 metres. 0·13in dia. 64 fibres £1 per metre. 15mm dia. mare's tails £10·50 each.

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MARRIOT XRPS/17 ¼ Track High £2·50; XRPS/18 ½ Track Med. £3·50; XRPS/36 ½ Track Med. £5·00; XRPS/63 ¼ Track High £1·75; Erase Heads for XRPS/17/18/36 (XES11) 75p; 13X12E 343 ¼ Tr. Erase 75p.
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AC187	0·21	BY100	0·27	ZTX108	0·08
ACY17	0·40	BY127	0·12	ZTX300	0·13
ACY39	0·78	BYZ13	0·42	ZTX302	0·18
AD149	0·50	C1060	0·54	ZTX500	0·13
AD161	0·44	GET111	0·72	2N697	0·16
AD162	0·44	GET115	0·90	2N706	0·12
AF117	0·24	GET880	0·60	2N930	0·18
AF118	0·57	LM309K	2·00	2N987	0·42
AF139	0·41	MAT121	0·25	2N1132	0·24
AF186	0·48	MJE340	0·47	2N1304	0·28
AF239	0·44	MJE520	0·63	2N1613	0·21
ASY27	0·33	MJE3055	0·77	2N1671	1·20
BA115	0·10	MJE2955	1·27	2N2147	0·78
BAX13	0·05	MPF105	0·36	2N2160	0·78
BC107	0·14	NKT404	0·66	2N2926	0·12
BC108	0·13	OA5	0·72	2N3053	0·18
BC109	0·14	OA81	0·18	2N3054	0·48
BC109C	0·16	OA200	0·08	2N3055	0·45
BC113	0·15	OA202	0·06	2N3440	0·58
BC147	0·10	OC28	0·66	2N3442	1·39
BC148	0·08	OC35	0·55	2N3525	0·91
BC149	0·10	OC36	0·60	2N3614	0·65
BC169C	0·15	OC44	0·20	2N3702	0·11
BC182	0·12	OC45	0·20	2N3714	1·41
BCY32	0·85	OC71	0·18	2N3771	1·77
BCT39	1·50	OC72	0·28	2N3773	2·40
BCY55	2·64	OC77	0·54	2N3790	2·10
BCY70	0·18	OC81	0·29	2N3819	0·38
BCY71	0·22	OC83	0·27	2N3886	0·72
BCY72	0·12	OC140	1·14	2N3903	0·15
BD124	0·65	OC170	0·30	2N4002	0·14
BD131	0·42	OC200	0·54	2N4126	0·15
BF115	0·20	OC202	0·90	2N4871	0·34
BF180	0·36	OCP71	1·20	2N5457	0·30
BF194	0·10	ORP12	0·60	2S303	0·60
BFX13	0·26	ORP60	0·55	40550	0·54
BFX34	0·70	P346A	0·18	40361	0·45
BFX88	0·24	TIL209	0·20	40362	0·40
BFY50	0·21	TIP29A	0·45	40408	0·50
BFY51	0·20	TIP30A	0·57	40486	0·85
BFY64	0·36	TIP31A	0·61	40636	1·00
BFY90	0·31	TIP41A	0·74	40430	0·85

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CRS1/05AF	0·42
CRS1/10AF	0·48
CRS1/20AF	0·52
CRS/40AF	0·60
CRS1/60AF	0·78
TO48 3 Amp	
CRS3/025AF	0·36
CRS3/10AF	0·48
CRS3/20AF	0·54
CRS3/40AF	0·65
CRS3/60AF	0·80
TO48 7 Amp	
CRS7/400	0·84
CRS7/600	1·14
TO48 16 Amp	
CRS16/100	0·78
CRS16/200	0·85
CRS16/400	0·96

TRIACS

	£ p
3 Amp	
SC35A	0·85
SC35B	0·91
SC35D	0·99
SC35E	1·30
6 Amp	
SC40A	0·88
SC40B	0·97
SC40D	1·20
SC40E	1·50
10 Amp	
SC45A	1·09
SC45B	1·12
SC45D	1·50
SC45E	1·65
15 Amp	
SC50A	1·46
SC50B	1·57
SC50D	1·80
SC50E	2·00
Aleo	
40430	0·85
40669	0·90
40486	0·85

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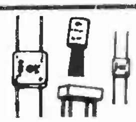


	£ p		£ p		
¼ Amp		B2/20	0·40	**6 Amp**	
B025/025	0·14	B2/40	0·44	B6/05	0·50
B025/05	0·16	B2/60	0·45	B6/10	0·58
1 Amp		B2/100	0·55	B6/20	0·68
B1/05	0·20	**4 Amp**		B6/40	0·75
B1/10	0·21	B4/05	0·45	B6/60	0·87
B1/20	0·24	B4/10	0·48	**1 Amp Tubular**	
B1/60	0·25	B4/20	0·54	W005	0·27
B1/100	0·30	B4/40	0·60	W01	0·29
2 Amp		B4/60	0·70	W02	0·30
B2/05	0·30	B4/80	0·90	W06	0·33
B2/10	0·35				

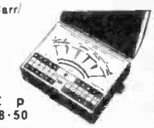
TEST EQUIPMENT

MULTI-METERS

(Carr/packing 35p)	£ p
U4324 20kΩ/V with case	9·25
U435 20kΩ/V with steel case	8·75
U4313 20kΩ/V with steel case	12·50
U4317 20Ω/V with case	18·50
U4341 33kΩ/V plus transistor steel case	10·50
U4323 20kΩ/V plus 1kHz OSC with case	7·70
ITI-2 20kΩ/V slim type	5·95
THL33D (L33DX) 2kΩ/V Robust	7·50
TP5SN 20kΩ/V (Case £2)	8·25
TP10S 2kΩ/V	6·25
TW20S 20kΩ/V	10·00
TW50K 50kΩ/V	11·25
EP10KN 10kΩ/V	9·95
AF105 50kΩ/V Deluxe (case £1·90)	12·50
S100TR 100kΩ/V plus transistor tester	22·50

GENERAL TEST EQUIPMENT

– Carr/packing 50p. *Carr/packing 30p) unless stated



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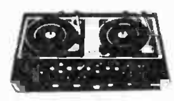
†Tk65 28 Range valve voltmeter	22·50
†Tk20D RF Generator 120kHz–500mHz	18·95
†Tk22D AF Generator 20Hz–200kHz	19·95
*HM350 in circuit transistor tester	19·50
*C3025 Deluxe meter 1–300mHz	6·95
*TT145 Compact transistor tester	14·75

PA-DISCO LIGHTING EQUIPMENT



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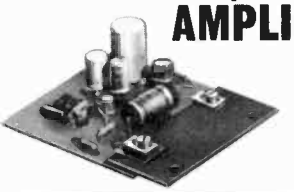
AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



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

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

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

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

AUDIO AMPLIFIER MODULES

AL 10. 3 watts £2·50
AL 20. 5 watts £2·85
AL 30. 10 watts £3·20

POWER SUPPLIES

PS 12. (Use with AL10, AL20, AL30) 95p
SPM 80. (Use with AL60) £3·25
FRONT PANELS FP 12 with Knobs £1·00

PRE-AMPLIFIERS

PA 12. (Use with AL10, AL20 and AL30) £4·35
PA 100. (Use with AL60) £13·15

TRANSFORMERS

T461 (Use with AL10) £1·60 P & P 15p
T538 (Use with AL20, AL30) £2·30 P & P 15p
BMT80 (Use with AL60) £2·75 P & P 25p

PA12 PRE-AMPLIFIER SPECIFICATION

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

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

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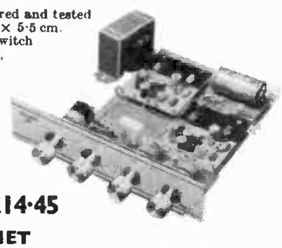
The STEREO 20



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

£14·45

TC20 TEAK VENEERED CABINET

For Stereo 20 (front board undrilled) Size 10¼" × 8¼" × 3", £3·95 plus 30p postage.

SHP80 STEREO HEADPHONES

4-16 ohms impedance. Frequency response 20 to 20,000Hz. Stereo/mono switch and volume controls, £4·95

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

- Max Heat Sink temp 90°C.
- Frequency Response 20Hz to 100KHz
- Distortion better than 0·1% at 1KHz
- Supply voltage 15–50 volts
- Thermal Feedback
- Latest Design Improvements
- Load — 3, 4, 8 or 16 ohms
- Signal to noise ratio 80dB
- Overall size 63mm × 105mm × 13mm

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

STABILISED POWER MODULE SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer BMT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm × 105mm × 30mm.
These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available 10p **PRICE £3·25**

TRANSFORMER BMT80 £2·15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL60 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

SPECIFICATION

Frequency Response	20Hz—20KHz ± 1dB
Harmonic Distortion	better than 0·1%
Inputs: 1. Tape Head	3·25 mV into 50K Ω
2. Radio, Tuner	75 mV into 50K Ω
3. Magnetic P.U.	3 mV into 50K Ω

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

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

ONLY £13·15

MK 60 AUDIO KIT

Comprising: 2 × AL60, 1 × SPM80, 1 × BTM80, 1 × PA 100, 1 front panel, 1 kit of parts to include on-off switch, neon indicator, stereo headphone sockets plus instruction booklets. **Complete Price: £28·75** plus 30p postage.

TEAK 60 AUDIO KIT

Comprising: Teak veneered cabinet size 16¾" × 11½" × 3¾", other parts include aluminium chassis, heatsink and front panel bracket, plus back panel and appropriate sockets, etc. **Kit price: £9·95** plus 30p postage.

Giro No. 388-7006
Please send all orders direct to warehouse and despatch department

BI-PAK

P.O. BOX 6, WARE · HERTS.
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Guaranteed Satisfaction or Money Back

CHROMASONIC electronics

Dept. 2
56, Fortis Green Road, London, N10 3HN.
telephone: 01-883 3705

INDUCTORS

Denco Maxi-Q Coils

Ferrite Rod Aerials

FRA1 Long & Medium Wave band (300pf) 86p
FRA2 Long & Medium " (500pf) 86p

Tuning Coils in two series:

Range			
1	150 khz	to	400 khz
2	515 khz	to	1.545 Mh3
3	1.67 Mhz	to	5.3 Mh3
4	5 Mhz	to	15 Mh3
5	10.5 Mhz	to	31.5 Mhz
6	30 Mhz	to	50 Mhz *
7	45 Mhz	to	78 Mhz *

* 50 pf tuning, all others based on 300 pf.

Series A Transistor – 48p each

Only available in ranges 1 to 5 inc.
4 Coils complete each range:

Blue – Aerial Coil
Yellow – R.F. Interstage
Red – Osc. Coil for 465 khz I.F.
White – Osc. Coil for 1.6 Mhz I.F.

give range number; letter 'T' and colour.

Series B Dual Purpose Coils 48p each

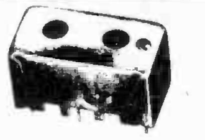
For FET or Valve Circuits
All ranges available
5 Coils complete each range:

Blue – Aerial
Yellow – Interstage R.F.
Green – R.F. plus reaction
Red – Osc. Coil for 465 khg I.F.
White – Osc. Coil for 1.6 Mhz I.F.

(Note use Red instead of White for ranges 6 & 7).

Chokes

We stock from 1 μH to 19 mH
Check levels & prices when ordering



Tuned Block Filter incorporating a Ceramic element. Pre-aligned to 470 Khz. 3db bandwidth 5Khz. Zin 100K. Zout 100K.

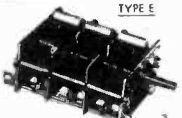
LP1175 £1.46

I.F. Transformers

IFT 13	465 khz 1st & 2nd d/tuned	65p
IFT 14	465 khz final single tuned	65p
IFT 15	10.7 Mhz d/tuned	65p
IFT 16	1.6 Mhz 1st & 2nd d/tuned	65p
IFT 17	1.6 Mhz Final s/tuned	65p
IFT 18	465 khz or 1.6 Mhz d/tuned	75p

TUNING CONDENSERS

TYPE E



3 gang 310pf
£3.99

TYPE OO

208 + 176 pf with screen & trimmers
£1.48

83p
Slow Motion Drive Ratio 6:1 Ref: 4511

TYPE C804

5pf	80p
10pf	80p
15pf	80p
20pf	83p
25pf	80p
50pf	83p
60pf	94p
75pf	94p
100pf	99p

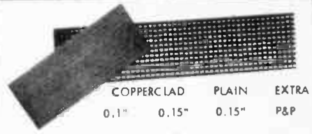
DILECON

100pf	69p
300pf	69p
500pf	69p

TYPE O

365 pf £1.07
365 x 365 pf £1.30

VEROBOARD

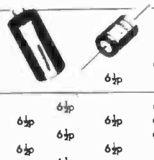


	COPPERCLAD 0.1"	COPPERCLAD 0.15"	PLAIN 0.15"	EXTRA P&P
2½" x 1"	7p	7p	-	-
2½" x 3¾"	26p	21p	12p	-
2½" x 5"	30p	25p	13p	-
3¾" x 3¾"	30p	25p	-	-
3¾" x 5"	34p	34p	25p	-
17" x 2½"	90p	69p	45p	10p
17" x 3¾"	£1.21	75p	57p	10p
17" x 5"	-	-	99p	10p

D.I.P. Breadboard 4.15" x 6.15"	£1.40
VEROSTRIP (State .1" or .15")	30p
Pin Insertion Tool (State .1" or .15")	63p
Spot Face Cutter	51p
Terminal Pins in Pkts. of 50 (State .1" or .15")	22p

Details of I.C.'s; Rectifiers; Diodes; Bridges; Passive Components; LED's; Clocks; Triacs etc. can be seen on other pages and/or issues of Wireless World; Practical Wireless; and Practical Electronics.

Electrolytics



μF	4V	6.3V	10V	16V	25V	40V	63V	100V	160V	450V
1							6½p		8½p	15p
1.5							6½p			
2.2							6½p		8½p	
3.3							6½p			
4.7							6½p		8½p	17p(4uF)
6.8						6½p	6½p	8½p		
8										21p
10					6½p		6½p	8½p		
15				6½p		6½p	6½p			24p(16uF)
22			6½p		6½p		6½p	11p		
33		6½p		6½p		6½p				33p(32uF)
47	6½p		6½p	6½p	6½p	6½p	8p			25p(50uF)
68		6½p		6½p			11p			350V
100	6½p		6½p		6½p	8p	14p	25p		
150		6½p		6½p	8p	11p	14p			
220	6½p		6½p	8p	11p	14p	19p	31p		
330	6½p		8p	11p			25p	44p		
470		8p	11p		14p	20p	26p	47p		
680		10p		14p	20p	25p		59p		
1000	13p		14p	19p	22p	25p	44p	79p		
1500		18p	19p	25p						
2200		18p	24p		39p	44p	79p	149p		
3300		26p								
4700	25p			44p	68p	79p	149p	252p		
6800				75p						

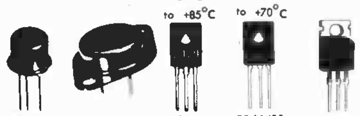
DIODES

AA119	10p	BY103	22p	0A91	8p
AA120	10p	BY105	16½p	0A200	11p
AA129	10p	BY126	16p	0A202	12p
BA100	10p	BY127	16½p	ZS120	8p
BA102	27p	BY133	23p	ZS140	25p
BA110	44½p	BY164	54p	ZS141	42½p
BA115	19p	BY176	£1.62	ZS142	32½p
BA144	20p	BY182	£1.62	ZS170	10p
BA145	22p	BY250	25½p	ZS270	11p
BA148	22p	BZX70	27p	ZS271	16p
BA154	20p	Series		ZS278	36½p
BA155	15½p	BZY88	11p	IN914	8p
BA156	16½p	Series		IN916	10p
BAX16	10p	0A47	11p	IN4009	7p
BB104	45½p	0A79	10p	IN4148	5½p
BB105B	41½p	0A81	8p	IN4448	9p
BY100	16½p	0A85	10p	IZS Series	18p
		0A90	8p		

TRANSISTORS

AC107	16p	BC213L	13p	D13V	52½p	ZTX301	13p	2N3707	12p
AC126	13p	BC214L	13p	D40N3	59p	ZTX302	17p	2N3708	10p
AC127	13p	BC268	15p	MJ480	93½p	ZTX303	14p	2N3709	10p
AC128	13p	BC407	16p	MJ481	£1.18	ZTX304	21p	2N3710	11p
AC176	15p	BCY70	17p	MJ490	£1.01½	ZTX311	10p	2N3711	11p
AC187	22p	BCY71	22p	MJ491	£1.42½	ZTX312	10p	2N3772	£2.00
AC187K	20p	BCY72	17p	MJ900	£1.42½	ZTX341	22p	2N3791	£2.55
AC188	22p	BD115	73p	MJ1000	£1.22	ZTX384	18p	2N3819	27½p
AC188K	25p	BD123	89½p	MJ2955	£1.88½	ZTX500	12p	2N3821	81p
ACY17	39p	BD124	80½p	MJ3055	£1.21	ZTX501	13p	2N3823	99p
ACY17	38½p	BD131	44p	MJ4000	£1.46½	ZTX502	17p	2N3903	15½p
ACY20	22p	BD132	52p	MJ4010	£1.95½	ZTX503	14p	2N3904	19p
AD140	48½p	BD131/2PR	£1.17	MJE340	45p	ZTX504	42½p	2N3905	23p
AD149	48½p	BD135	41½p	MJE350	97½p	ZTX531	22p	2N3906	25p
AD161	37½p	BD136	43½p	MJE2955	£1.20	ZTX550	17p	2N4056	13½p
AD162	38½p	BD201	£1.95½	MJE3055	72p	2N697	16½p	2N4059	19p
AD161/62MP	74p	BD202	£1.46½	MPF102	27p	2N706	13p	2N4062	16p
AF114	17p	BF109	74p	MPF103	40½p	2N708	16½p	2N4289	19p
AF115	17p	BF115	25p	MPF104	44½p	2N914	24½p	2N4441	85½p
AF116	17p	BF160	25½p	MPF105	44½p	2N930	22p	2N4442	£1.04½
AF117	17p	BF167	24p	MPF106	49p	2N1302	20p	2N4443	£1.42½
AF118	54p	BF173	24p	MPF111	22p	2N1303	24p	2N4444	£2.06½
AF124	32½p	BF178	28½p	MPSU06	63p	2N1304	24p	2N4871	59p
AF139	34½p	BF179	32½p	MPSU56	77p	2N1305	24p	2N4901	£1.41½
AF172	25p	BF180	32½p	OC28	49½p	2N1306	24p	2N5067	£1.07½
AF239	40½p	BF181	32½p	OC35	49½p	2N1307	27p	2N5129	16½p
ASY26	32½p	BF184	27½p	OC36	49½p	2N1308	34½p	2N5172	11p
BC107	11p	BF185	27½p	OC44	14p	2N1309	34½p	2N5191	77p
BC108	11p	BF194	15p	OC45	14p	2N1711	26p	2N5194	91p
BC109	12p	BF195	17p	OC71	14p	2N1718	£4.37	2N5295	52½p
BC117	22p	BF196	16p	OC72	14p	2N1893	52p	2N5447	16p
BC147	10p	BF197	16p	OC75	15p	2N2218	22p	2N5449	16p
BC148	10p	BF200	31½p	OC76	27p	2N2219	38½p	2N5457	46½p
BC149	10p	BF244B	27p	OC81	14p	2N2646	54p	2N5458	43½p
BC157	13p	BF262	25p	OC83	25p	2N2894	97½p	2N5459	43½p
BC158	12p	BF263	25p	OC170	27½p	2N2904	32½p	2N5485	52½p
BC159	14p	BF272	£1.19	OC171	32½p	2N2905	30½p	2N5777	48½p
BC167	17p			OCP71	£1.54½	2N2924	16p	2N6068	44½p
BC168B	11p	BFS97	23p	ORP12	65p	2N2925	18p	2N6069	51½p
BC169	12p	BFS98	20p	TIP29	53½p	2N2926G	10p	2N6070	57p
BC171	20p	BFW10	65p	TIP31	67p	2N3053	19p	2N6071	62p
BC172	17½p	BFX29	41½p	TIP31A	67p	2N3054	50½p	2N6073	67p
BC177	22p	BFX88	26p	TIP32A	79½p	2N3055	51½p	2N6075	£1.46½
BC178	22p	BFY50	22p	TIP41A	79½p	2N3375	£3.56½	2N6076	16½p
BC179	24p	BFY51	22p	TIP42A	97½p	2N3442	£1.19	2N6111	54p
BC182L	11p	BFY90	£1.09	TIS43	36p	2N3566	18p	2N6288	60p
BC183L	12p	BR100	42½p	TIS88A	36½p	2N3638	20p	3N140	99½p
BC184L	12p	BRY39	43½p	TIS91	32½p	2N3702	13p	3N141	87½p
BC187	27p	BSX20	18p	ZTX107	10p	2N3703	12p	3N153	87½p
BC204	14p	BSX21	22p	ZTX108	10p	2N3704	13p	40321	54p
BC209	14p	BSY95A	14p	ZTX109	15p	2N3705	12½p	40430	£1.39
BC212L	12½p	BU105/02	£1.95½	ZTX300	12p	2N3706	14p	40673	55p

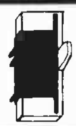
REGULATORS



	100mA (TO-39)	500mA * (TO-3)	500mA * (SOT-32) -20°C to +85°C	500mA * (SOT-32) 0°C to +70°C	1A (TO-220)
5V	TBA625A	L005T1 (MVR5V)	L129	TDA1405	7805UC
	£1.03	£1.45	£1.39	97p	£2.42
12V	TBA625B	L036T1 (MVR12V)	L130	TDA1412	7812UC
	£1.03	£1.45	£1.39	97p	£2.42
15V	TBA625C	L037T1 (MVR15V)	L131	TDA1415	7815UC
	£1.03	£1.45	£1.39	97p	£2.42

*600mA; 500mA and 450mA respectively.

DIGITAL SWITCH

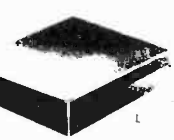


BCD encoded digital switch Reading 0 to 9. Suitable for digital clock alarm setting DVM input scaling etc.

1 to 9. £1.49 each.

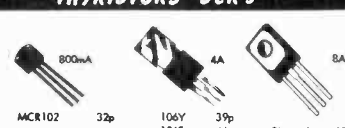
ALUMINIUM BOXES

With Baseplate and screws



REF (No.)	(L)	(W)	(H)	PRICE	P&P
AB7	2¼"	5¼"	1½"	45p	15p
AB8	4"	4"	1½"	45p	15p
AB9	4"	2¾"	1½"	45p	15p
AB10	4"	5¼"	1½"	51p	15p
AB11	4"	2½"	2"	45p	15p
AB12	3"	2"	1"	38p	15p
AB13	6"	4"	2"	61p	17p
AB14	7"	5"	2½"	73p	17p
AB15	8"	6"	3"	92p	17p
AB16	10"	7"	3"	£1.05	20p
AB17	10"	4½"	3"	92p	25p
AB18	12"	5"	3"	£1.04	25p
AB19	12"	8"	3"	£1.38	25p

THYRISTORS SCR's



V	800mA		4A		8A	
30v	MCR102	32p	106Y	39p		
50v			106F	46p	2N4441	87p
60v	MCR103	44p				
100v	MCR104	49p	106A	48p		
200v	MCR120	51p	106B	53p	2N4442	£1.06
400v			106D	67p	2N4443	£1.45
600v			106M	£1.50	2N4444	£2.09

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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. 13¾″ × 9″ × 3¾″.
Garrard SP 25 Mk III deck with magnetic cartridge, de luxe plinth and hinged cover.
Two Duo Type II matched speakers – Enclosure size approx. 17½″ × 10¾″ × 6″ in simulated teak. Drive unit 13″ × 8″ with parasitic tweeter. 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 11½″ 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

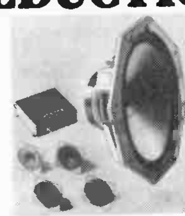
System consists of a 13″ × 8″ (approx) eliptical woofer unit with a 8″ × 5″ (approx.) mid range unit incorporating parasitic tweeter and crossover components.
Technical Specification:
Bass Unit
Flux density–100 K, speech coil–1½
Cone. Triple laminated paper with P.V.C. surround.
Mid Range Unit
Flux density-33K, 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 3¼″ dia. approx., are fed by the crossover which critically adjusts signal for maximum fidelity. Impedance at 1 kHz is 8 ohms. Bass coil 2″, others 0·5″ Recommended list price £44·00.

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

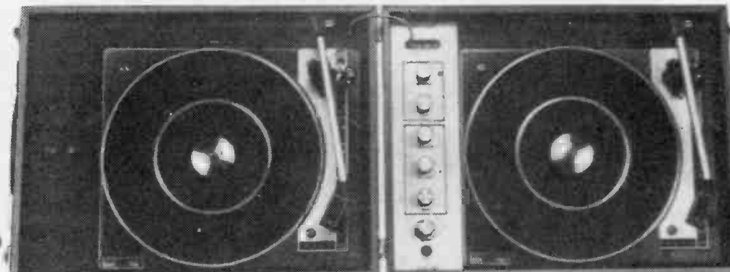
FOR DISCO PAGE AND DETAILS OF HOW TO ORDER – TURN OVER...

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.



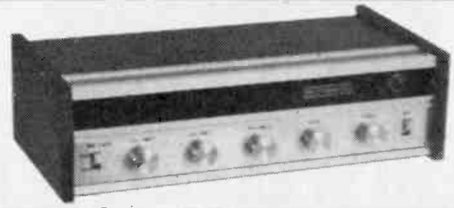
TECHNICAL SPECIFICATION:
Pre-amp – Output – 200mV. Auxiliary inputs – 200mV and 750mV into 1 meg. Mic input – 6mV into 100K. 240 volt operation.
Turntables capacity – 7", 10" or 12" records.
Rumble, wow and flutter – Rumble – Better than –35dB. Wow – Better than 0.2%. Flutter – Better than 0.06% (Gaumont 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"×4⅜" (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 470 K
Size: 19¼"×10½"×8" (approx.) Amplifier **£27.50 + £1.50 p. & p.**



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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.

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Code	*Watts*	*Ohms*	*1 to 9*	*10 to 99* (see note below)	*100 up*
C	1/3	4·7–470K	1·3	1·1	0·9 nett
C	1/2	4·7–10M	1·3	1·1	0·9 nett
C	3/4	4·7–10M	1·5	1·2	0·97 nett
C	1	4·7–10M	3·2	2·5	1·92 nett
MO	1/2	10–1M	4	3·3	2·3 nett
WW	1	0·22–3·9Ω	11	10	8 nett
WW	3	1–10K	9	8	6 nett
WW	7	1–10K	11	10	8 nett

Codes:
C = carbon film, high stability, low noise.
MO = metal oxide. Electrosil TR5 ultra low noise.
WW = wire wound. Plessey.

Values: All E12 except C ⅓W, C ½W and MO ½W.
E12: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

Tolerances:
5% except WW 10% ± 0·05Ω below 10Ω and MO ½W 2%.

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Axial Lead

μF	3V	6·3V	10V	16V	25V	40V	63V	100V
0·47	—	—	—	—	—	—	11p	8p
1·0	—	—	—	—	—	11p	—	8p
2·2	—	—	—	—	11p	—	8p	9p
4·7	—	—	—	11p	—	8p	9p	8p
10	—	—	—	—	8p	9p	8p	8p
22	—	—	8p	—	9p	8p	8p	10p
47	8p	—	9p	8p	8p	8p	10p	13p
100	9p	8p	8p	8p	9p	10p	12p	19p
220	8p	8p	9p	10p	10p	11p	17p	28p
470	9p	10p	10p	11p	13p	17p	24p	45p
1,000	11p	13p	13p	17p	20p	25p	41p	—
2,200	15p	18p	23p	26p	37p	41p	—	—
4,700	26p	30p	39p	44p	58p	—	—	—
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Type B42540 Working Voltage—250V
Values in mF:
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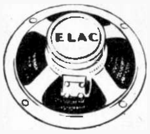

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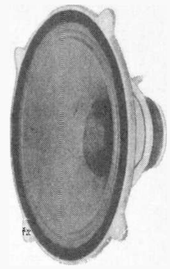

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Flux Density	12,000 gauss
Useful response	45–13,000cps

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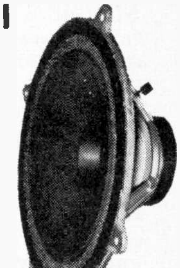

Especially designed to provide full range reproduction at an economical cost. Suitable for use with any high fidelity system. Built-in concentric tweeter cone.

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Flux Density	14,000 gauss
Useful response	25–16,000cps

8 or 15 ohms models.

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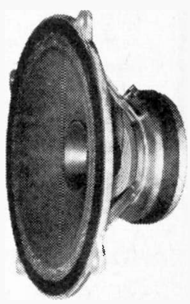
12in. 20 watts



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Useful response	20–17,000cps

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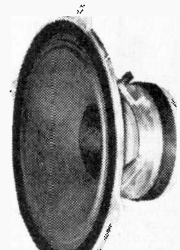

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Useful response	25–16,000cps

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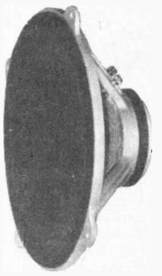

A high wattage loudspeaker of exceptional quality with a level response to above 8,000 cps. Ideal for Public Address, Discotheques, Electronic instruments and the home.

Bass Resonance	35cps
Flux Density	15,000 gauss
Useful response	20–14,000cps

8 or 15 ohms models.

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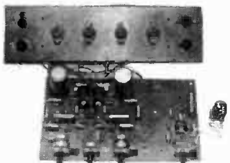

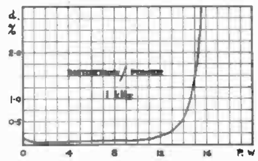

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2N709	0·42
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2N718	0·23
2N718A	0·28
2N720	0·50
2N721	0·55
2N914	0·22
2N916	0·28
2N918	0·32
2N929	0·30
2N1302	0·19
2N1303	0·19
2N1304	0·24
2N1305	0·24
2N1306	0·31
2N1307	0·22
2N1308	0·40
2N1309	0·36
2N1671	1·44
2N1671A	1·54
2N1671B	1·72
2N1671C	4·32
2N1711	0·45
2N1907	5·50
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
2N2222A	0·25
2N2368	0·25
2N2369	0·37
2N2369	0·41
2N2646	0·55
2N2647	1·12
2N2904	0·22
2N2904A	0·24
2N2905	0·24
2N2905A	0·26
2N2906	0·19
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
2N3414	0·20
2N3415	0·21
2N3416	0·34
2N3417	0·24
2N3638	0·15
2N3638A	0·15
2N3639	0·27
2N3641	0·17
2N3702	0·12
2N3703	0·13
2N3704	0·14
2N3705	0·12
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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
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AC127	0·20
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AC151V	0·25
AC152V	0·17
AC153	0·25
AC153K	0·33
AC154	0·20
AC176	0·23
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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	0·30
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	0·25
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
BD116	1·00
BD121	0·75
BD123	0·32
BD124	0·67
BD131	0·40
BD132	0·50

BD135	0·43
BD136	0·49
BD137	0·55
BD138	0·63
BD139	0·71
BD140	0·87
BDY20	1·05
BF115	0·25
BF116	0·23
BF117	0·43
BF119	0·58
BF121	0·25
BF123	0·27
BF125	0·25
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BF153	0·21
BF154	0·20
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BF198	0·18
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BF200	0·40
BF225J	0·19
BF237	0·22
BF238	0·22
BF244	0·21
BF245	0·33
BF246	0·58
BF247	0·49
BF254	6·16
BF255	0·17
BF257	0·46
BF258	0·59
BF259	0·55
BFS21A	2·30
BFS28	0·92
BFS61	0·27
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
BFY52	0·21
BFY53	0·18
BFY90	0·75
BRY39	0·23
BU104	2·00
BU105	2·25
C106A	0·46
C106B	0·55
C106D	0·65
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CA3048	2·11
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CD4000	0·51
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CD4009	1·07
CD4010	1·07
CD4011	0·51
CD4015	2·66
CD4016	1·02
CD4017	2·66
CD4020	2·96
CD4023	0·51
CD4024	1·90
CD4027	1·56
CD4028	2·34
CD4029	3·79
CD4041	2·11
CD4044	2·11
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CD4049	0·90
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LM304A	2·03
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OC28	0·76
OC35	0·60
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OC71	0·20
OC72	0·25
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SN7410	0·16
SN7411	0·25
SN7412	0·28
SN7413	0·50
SN7416	0·45
SN7417	0·30
SN7420	0·16
SN7423	0·37
SN7425	0·37
SN7427	0·45
SN7430	0·18
SN7432	0·45
SN7437	0·35
SN7438	0·35
SN7440	0·18
SN7441	0·85
SN7442	0·85
SN7445	1·59
SN7446	2·00
SN7447	1·30
SN7448	1·50
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	2·18
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	1·66
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
SN74176	1·44
SN64180	1·44
SN74181	5·18
SN74190	1·95
SN74191	1·95
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Containing all the components you need, this Electro Spares PE Scorpio Mk. 2 Kit is simply built, using our easy to follow instructions. Each component is a branded unit by a reputable manufacturer and carries the manufacturer's guarantee. Ready drilled for fast assembly. Quickly fitted to any car.

When your PE Scorpio Mk. 2 is installed, you instantly benefit from all these PE Scorpio Mk. 2 advantages:

★ Easier starting from cold ★ Firing even with wet or oiled-up plugs ★ Smoother running at high speed ★ Fuel saving ★ More power from your engine ★ Longer spark plug life ★ No more contact-breaker burn.

Electro Spares prices:
De luxe Kit only £11.50 inc. VAT and p & p.
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State 6V or 12V system.

Send SAE now for details and free list.

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As featured in the May 1973 issue of 'Practical Electronics'. Superb Hi-Fi tuner Kit now available from Electro Spares. Including cabinet and all components – pre-set Mullard modules for R.F. and I.F. circuits. Motorola I.C. Phase Lock Loop Decoder for perfect stereo reception. No alignment needed. Guaranteed first time results – or send it back, and we'll return it in perfect order (for a nominal handling charge). Electro Spares price **only £28.50 inc. VAT and p & p.**

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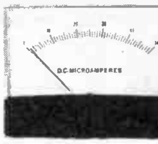

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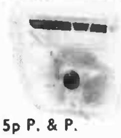

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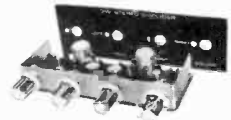

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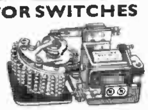

2 Bank, 11 position, 24 volt D.C. operation, full wiper with ancillary contacts. NEW Price **£2·50.** Post 20p. As above but with 5 Bank, 11 position. Price **£3·50.** Post 20p.

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Continuously rated, removable aluminium blades. Price **£1.** Post 20p.

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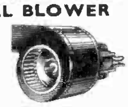

Mfg. Airflow Developments Ltd. Heavy Duty continuously rated, smooth running, 230/240V a.c. motor. Size: 16 × 14cm (case only). OAL 15cm. Aperture 6 × 6cm. **£6·50.** Post 50p.

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Comprising of impeller, continuously rated motor, motor housing and fixings as illustrated. Price **£1·75.** Post 25p. (Total incl. VAT and Post **£2·16**).

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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.

STROBE! STROBE! STROBE!

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

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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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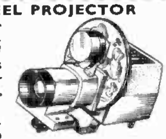

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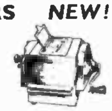

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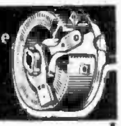

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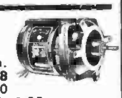
230/240 VOLT A.C. MINIATURE MOTOR. **20 R.P.M.** Price **£1.** Post 10p.

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.**
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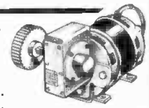

33 r.p.m. 30 lb. ins. Reversible. Fitted with mounting feet. Brand New. **£14.** Post 60p. (Total price incl. VAT **£15·77**).

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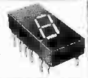

7 series, L/H d.p. one-third high character. 14 pin D.I.L. Available in RED or GREEN. Price **£1·65.** Post 10p. 4 for **£6.** Post paid.

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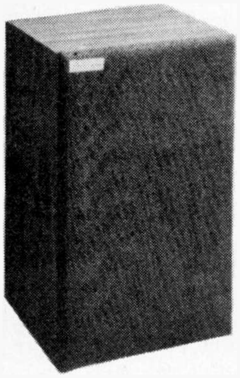
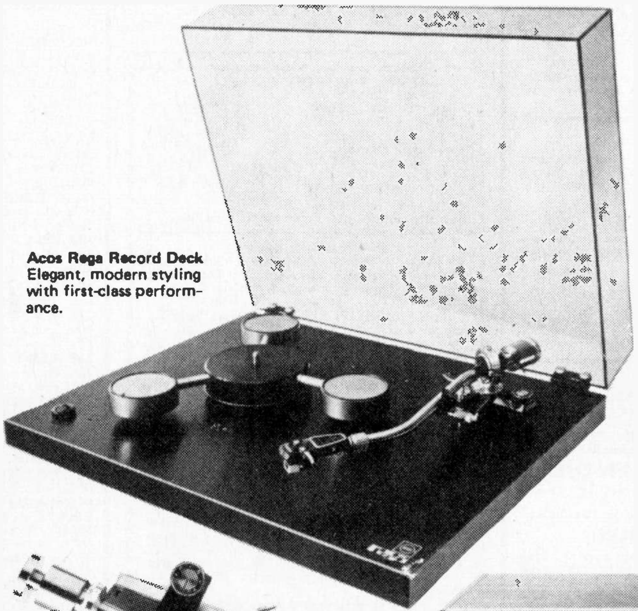
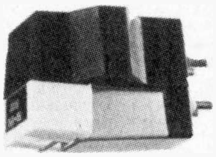
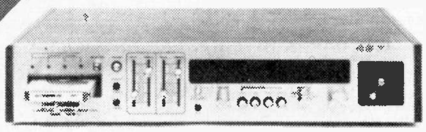


Acos Rega Record Deck
Elegant, modern styling with first-class performance.



The Acos M6 Range of Magnetic Cartridges are acknowledged to give high performance at low cost for two channel and four channel stereo.





Acos Eleanor Range of two channel and four channel stereo tuner amplifiers provide a new concept of sound enjoyment in any home setting.

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THE TRIUMPHS OF RADIO ASTRONOMY

THE charting of unimaginable depths of space has been assiduously carried out by radio astronomers in a number of countries since this science was formally established some 30 years ago. In Britain we can be especially proud of the achievements of our own radio astronomers, in particular those at Mullard Radio Astronomy Observatory, Cambridge, who have reached out to the furthermost parts of the Universe. And now has come international recognition and reward. Two scientists chiefly responsible for the significant discoveries at Cambridge have been awarded the 1974 Nobel Prize for Physics (see page 38).

The triumphs of radio astronomy are scintillating examples of pure science working hand in hand with technology in the quest for knowledge of the very Universe itself. Undoubtedly this young science does deserve more general recognition.

Lacking any dramatic dynamic action and readily assimilatable evidence like, for example, that which accompanies each Space Shot, radio astronomy has remained a distant and little understood or appreciated science so far as the general public is concerned. Radio telescopes in the popular mind are parabolical structures that can be rotated and aimed at any desired part of the sky, as exemplified by the very familiar Jodrell Bank telescope. In reality, radio telescopes can take diverse forms, and as often as not consist of static arrays of aerials bearing no resemblance to the general conception of a "telescope".

The emissions received from the far-off radio sources are recorded and provide data for computers and mathematicians to digest. It is only after the scientists have performed their analysis that the results can be presented in more tangible form that will be meaningful to the non-expert. This is of course in contrast to optical astronomy. Armed with even a modest telescope, anyone can make observations from his back garden. The results obtained will differ, essentially, only in degree of magnitude of resolution and distance covered with those of the professional optical astronomers.

With radio astronomy, as we have indicated, the observer has to be an expert interpreter, while the apparatus employed will comprise complex aerial arrays and highly sensitive receiving equipment—often unique and specially developed by members of a radio astronomy observatory staff for particular kinds of observations. Thus at both levels, science and technology, radio astronomy is almost exclusively the domain of the professionals. And in addition, so far as the larger observatories are concerned, generous financial backing is essential, from government or industrial bodies.

This does not mean that the amateur is precluded from undertaking any investigations in radio emissions from extraterrestrial bodies. But it does mean that from practical considerations he is restricted to observations of the Solar System, our own Galaxy, and the more powerful sources of nearby galaxies. Here he will be following in the footsteps of the professionals, whose early work included extensive examination of these regions and, we should note, they themselves were following the pioneer investigations made by an American amateur named Grote Reber. It is indeed all too easy to assume that no significant discoveries are likely to reward amateur efforts today. But does one *really* know for sure?

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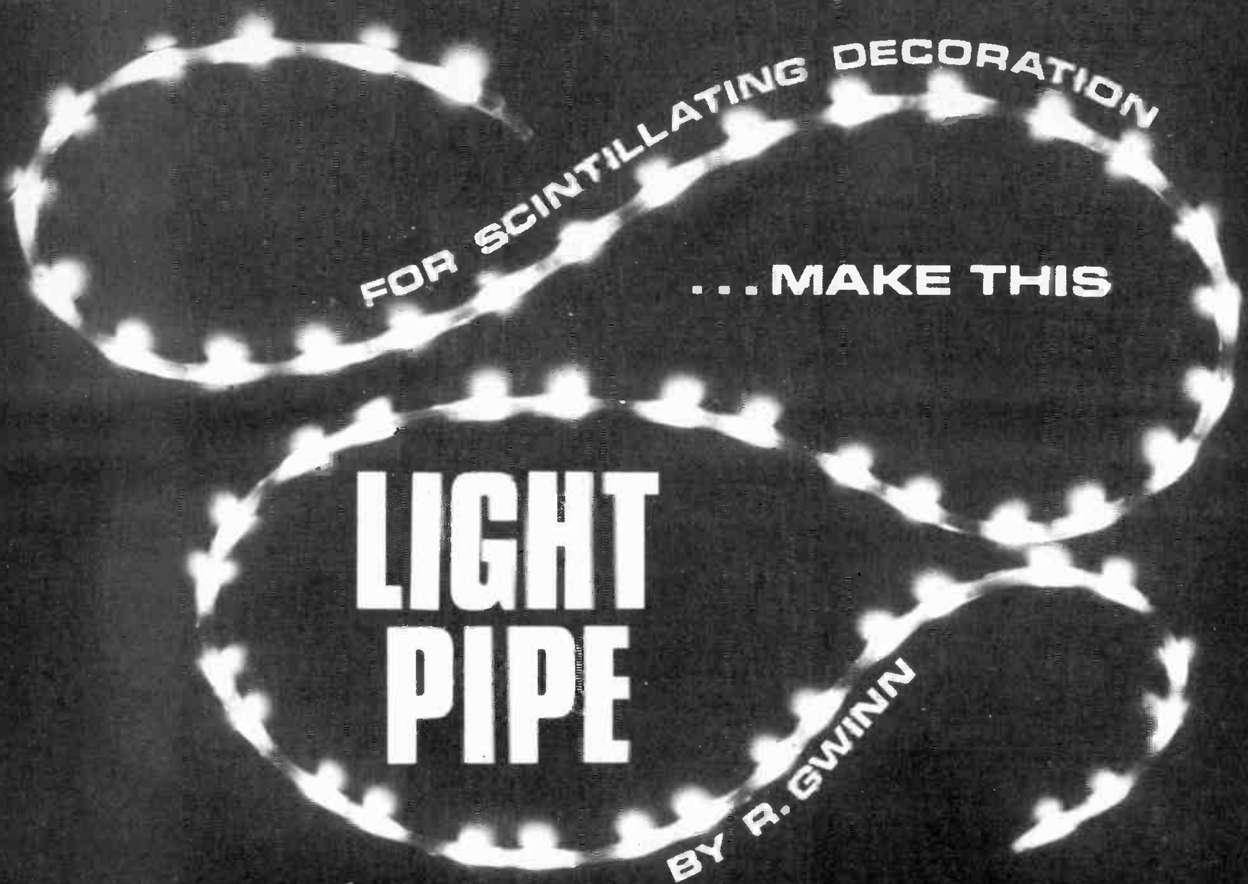


FOR SCINTILLATING DECORATION ... MAKE THIS

LIGHT PIPE

BY R. GWINN

MOBILE light displays are all the rage nowadays with multi-coloured displays driven by amplifiers a common feature of parties and dances. The flexibility of electronics has not yet been exploited fully in this area but this article, describing a plastic pipe down which light can be made to seem to flow, shows the potential available to constructors with imagination.

The light pipe consists of a plastic tube 24ft long, containing 144 miniature light bulbs which are flashed in a sequence which makes bands of light appear to move down the tube.

The bulbs are connected in four series chains of 36 bulbs, and at any time two adjacent bulbs are on and two are off. This pattern is repeated 36 times down the tube and to give the effect of motion, the rear bulb of a pair is turned off and the bulb in front is turned on. This sequence is shown in Fig. 1.

SEQUENCING LOGIC

The generation of the sequence switching is performed by five TTL i.c.s. In fact a variable pulse generator clocks two flip-flops which count up to four, providing the four possible states. The two-bit binary is decoded into one-of-four by four NAND gates in a 7400.

Besides decoding, these gates also invert the outputs. This is convenient because the next operation requires OR gating to turn on control channels for two consecutive states. This can be done with NAND gates, as these effectively become NOR gates in negative logic, which is the result of the one-of-four outputs being inverted.

TIME	PAIR 1 (1st bulb)	PAIR 1 (2nd bulb)	PAIR 2		PAIR 3		PAIR 4		PAIR 5	ETC.
1	1	1	0	0	1	1	0	0	1	1
2	0	1	1	0	0	1	1	0	0	1
3	0	0	1	1	0	0	1	1	0	0
4	1	0	0	1	1	0	0	1	1	0

Fig. 1. The first ten bulbs in the Light Pipe showing the four switching states, 0 being the off condition and 1 the on condition. The diagonal pattern indicates the apparent direction of light motion

THE CIRCUIT

The circuit diagram of Fig. 2 indicates the basic simplicity of the light pipe. Mains power drives the logic via a power supply circuit and a variable pulse generator, whilst the strings of bulbs in the light pipe are switched by thyristors CSR1, 2, 3 and 4 under control of the logic output from IC5.

INTERFERENCE SUPPRESSION

IC4 gates through the information to IC5 only when the supply to the lamps, which it can be seen is pulsating d.c., is low. This is to reduce interference which could be caused if a large current was switched on very quickly by a thyristor.

As the pipe can be draped round loudspeakers and amplifiers, which if badly screened can pick up an objectionable clicking, it is good practice not to generate interference in the first place rather than try to eliminate it later.

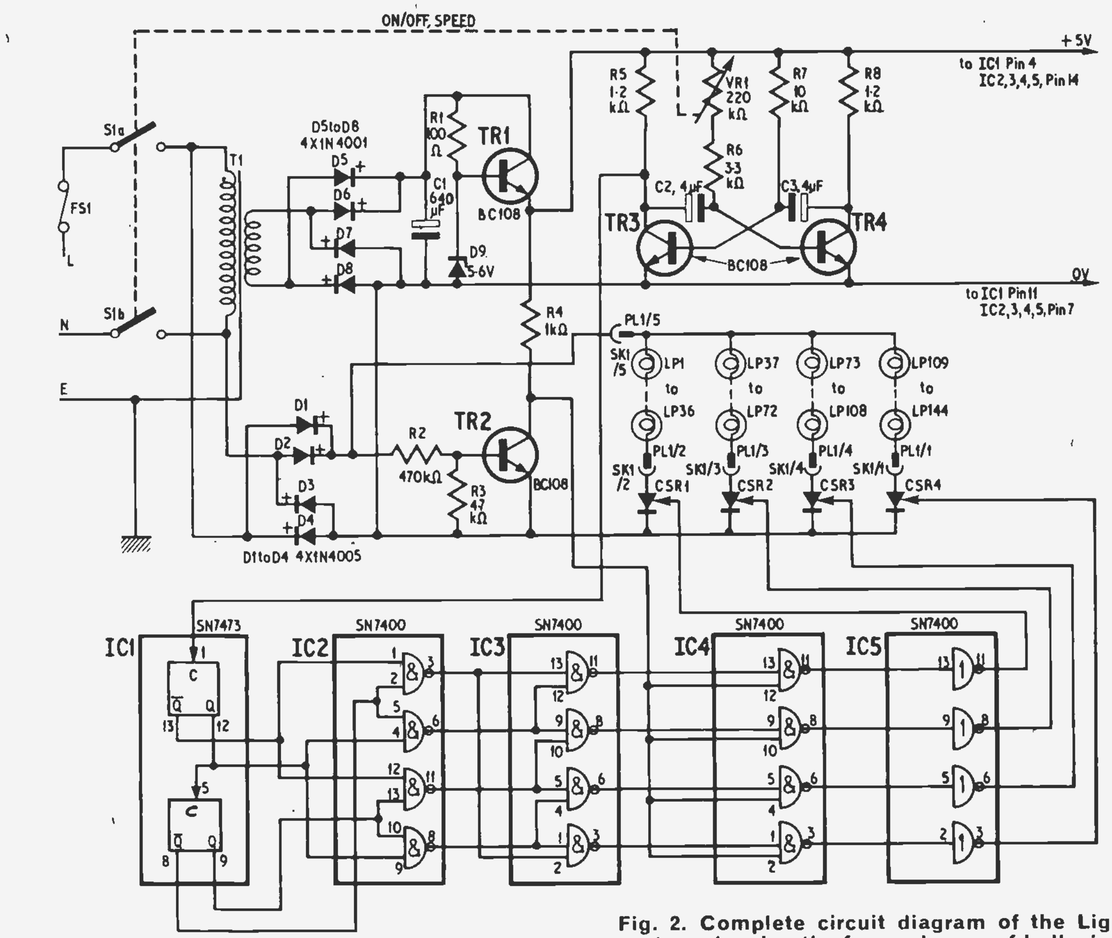


Fig. 2. Complete circuit diagram of the Light Pipe system showing the four columns of bulbs in dashed line. Note that the live side of the mains supply is connected to the logic 0V line through D4 and thus care is required in ensuring insulation of the circuitry from the case and controls

IC5 inverts the signals and directly drives the gates of the thyristors.

The zero-crossing pulses for IC4 are produced by TR2, which is on until the supply to the lamps falls below a given level.

POWER SUPPLIES

The logic 5V is obtained from a 6V transformer, rectified to give 8V d.c. regulated at 5V. The lamps are driven from full-wave rectified mains, so that the thyristors are operational in both positive and negative half cycles of the mains. The thyristor cathodes are connected to logic 0V, which means that this is **not** at the same potential as earth and **no connection should be made between this and the case,** which is earthed for safety.

CONSTRUCTION

As a wrong connection could have dramatic results, it is suggested that construction is done in stages, and each stage checked. The best order is logic power supply, multivibrator, counting and decoding i.c.s, mains rectifier and thyristors, and zero crossing pulse generator.

The Veroboard cuts and component layout are shown in Fig. 3 and the accompanying photographs. Individual constructors will no doubt modify this as they see fit to accommodate components of differing dimensions.

Check the board carefully for shorts between adjacent strips and for strips not cut in the right place. Note that there are not always seven cuts underneath i.c.s as sometimes it is necessary to join the opposite pins.

The thyristors used in the prototype had their anodes connected to their heat sinks. The wires to the output socket were soldered to the heat sinks rather than to the anode wire on the Veroboard, as this was more convenient.

The five-way connector used for the output should be as non-standard as possible for safety. A five-pin DIN would work but is almost bound to be connected to audio equipment at some time.

THE PIPE

The bulbs used in the prototype pipe were 8V, 150mA, 11mm diameter, Vitality type no. G537. A supplier for these is mentioned in the components list. They are a tight squeeze in the pipe, but once installed, the pipe may be bent round fairly sharp corners without danger of them breaking.

If a smaller bore pipe is being used, there is an electrically similar type, the 676W/E, which is wire ended and much smaller. They are, however,

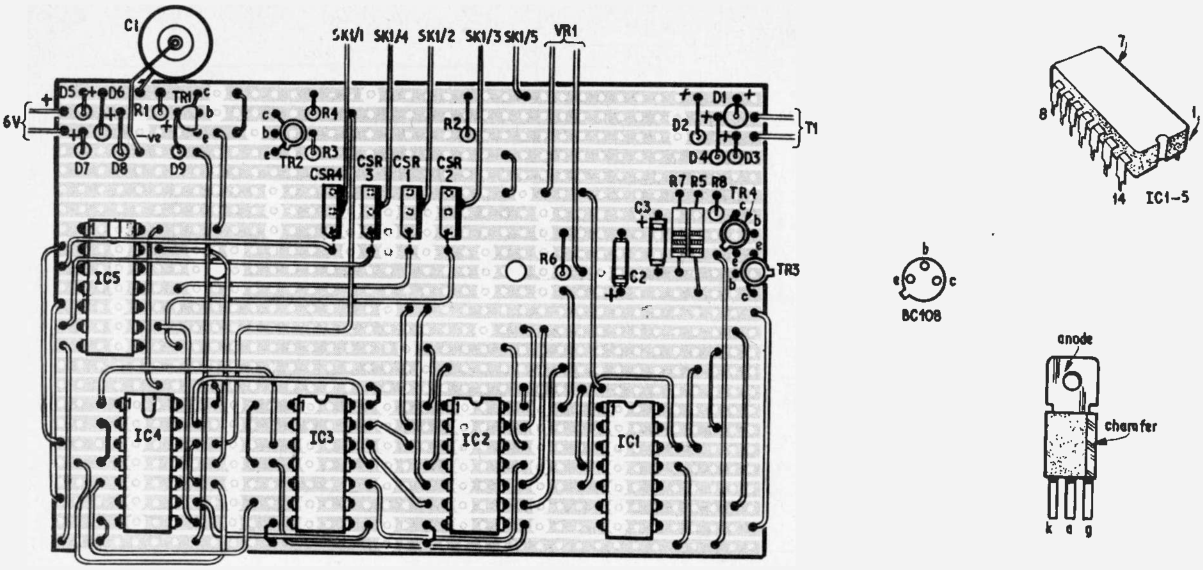


Fig. 3. Component layout and Veroboard cuts and interconnections for the Light Pipe showing connections to unmounted components

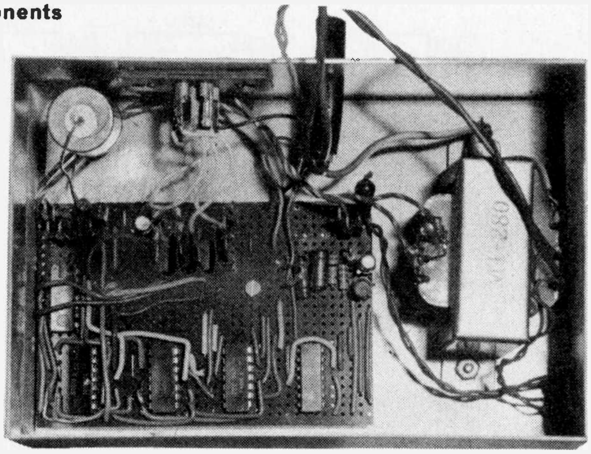
more expensive, and come in packs of 200. These are available from the same supplier.

As the lamps are somewhat inaccessible in the pipe it is important that there are as few failures as possible. The lamps are considerably underrun to increase their life. This also reduces light output and hence temperature. The pipe should be mildly warm after a few minutes running, but there is no danger of the plastic melting.

CONSTRUCTION OF THE PIPE

First, solder the bulbs into four chains of 36 bulbs. There should be 8in between each bulb for an overall length of eight yards. The connecting wire should be as thin as possible and multistranded. Some sort of jig to hold the bulbs while soldering is of great help in speeding up the operation.

The chains should be tested on the mains at this stage to find any blown or broken bulbs, or dry joints.



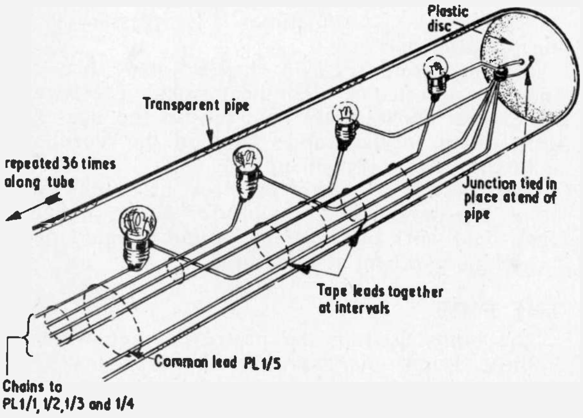


Fig. 4. Sketch showing the method of tying the light bulbs to draw them through the pipe. Note that particularly with the wire-ended bulbs the taping of the various conductors between each bulb is important in protecting the bulbs during installation

The four chains should be laid out so that there is 2in between each bulb, and taped together at intervals with a fifth common wire. The pipe is prepared for insertion by blowing talcum powder down it.

This reduces friction which otherwise might impose too great a strain on the bulbs during insertion.

To thread the lights, a piece of string must first be put through the pipe, using a piece of iron or steel and a magnet to pull it through. The string is used to pull the light chain back through. The bulbs should be pulled through with great care in order to avoid damaging them where the lead-out wires emerge from the envelope if the 676 type is used.

It is easier to fix the string at the far end of the pipe, and pull the pipe over the lamps, with liberal addition of talcum powder if it is difficult to pull.

The common wire should be joined at one end to the four other wires and held at the end by tying a piece of wire round the joint and tying this to a piece of plastic which is glued over the end of the pipe.

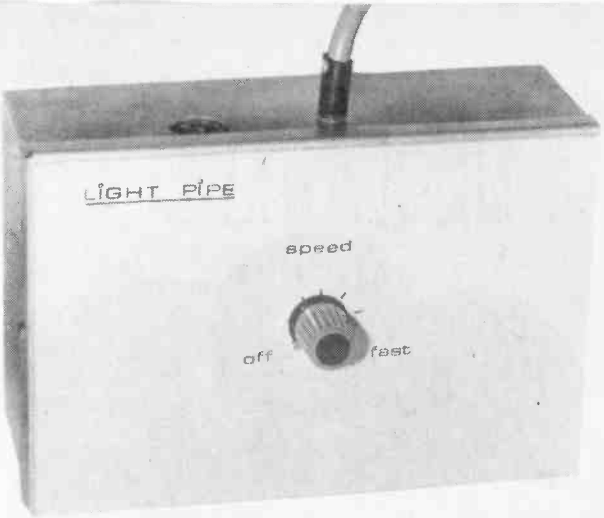
The wire leading to the pipe is two yards of five-core (four-core + screen audio will do), with a suitable plug, of which any metal parts should be well insulated from the pins. The joint between it and the pipe is hidden by wide insulating tape wrapped round the pipe. The far end is similarly covered to improve appearance.

FAULT FINDING

In the event of a lamp failure, it is easier to cut into the tube and replace the lamp in situ rather than pull out all the lamps and deal with it externally.

The bulbs which have gone out should be marked on the outside of the tube with a felt pen. Then by pushing a pin through the tube it is possible to make contact with one side of the bulb and the continuity between it and the common line can be tested. If the first test is done in the centre, further tests can be made to subdivide the faulty section until the blown bulb is found.

Whilst cutting the tube might seem drastic it is certainly simple and providing a sharp knife or scalpel is used to give a clean cut it is not difficult to re-glue the cut faces using one of several fast



setting adhesives now on the market such as Thixofix or Araldite. Also the cut is usefully 'L'-shaped rather than through the whole pipe.

DEVELOPMENTS

The direction of apparent motion may be reversed by reversing the anode wires to CSR1 and CSR3, and if desired a switch may be included for this function.

There is no reason why several pipes may not be run off the same controller as the thyristors are rated at 1A and each chain takes only 150mA. It could be arranged to flash coloured lamps as well as the light pipe, provided the current is kept well within the ratings of the thyristors. 3A types could be substituted with no circuit modifications if a high power output is needed.

Any increase in demand for current will of course affect the choice of diodes D1 to 4 and these will need uprating if demand exceeds 1A. ★

COMPONENTS . . .

Resistors
R1 100Ω
R2 470kΩ
R3 4·7kΩ
R4 1kΩ
R5 1·2kΩ
R6 3·3kΩ
R7 10kΩ
R8 1·2kΩ

Potentiometer
VR1 220kΩ linear with double pole mains switch

Capacitors
C1 640μF 10V electrolytic
C2, C3 4μF 10V electrolytic (2 off)

Transistors
TR1–4 BC108 (4 off)

Diodes
D1–4 1N4005 (4 off)
D5–8 1N4001 (4 off)
D9 5·6V Zener

Integrated Circuits
IC1 SN7473
IC2–5 SN7400 (4 off)

Thyristors
CSR1 to 4 CRS1/40 (1A, 400V)

Miscellaneous
144 type G537 8V 0·15A bulbs (Vitality) (Townsend-Coates Ltd., Coleman Road, Leicester, LE5 4LP. Valiant Electrical Wholesale, 20 Lettuce St., Fulham, London. Farnell Electronic Components)
8 yards green polythene tube (o.d. 2·3cm, i.d. 1·6cm) (Transatlantic Plastics, Surbiton)
Aluminium box type AB13
Veroboard 24 strips × 36 holes
Transformer Eagle MT280 6V, 280mA
Suitable 5-pin socket and plug assembly. 1A fuse and fuseholder

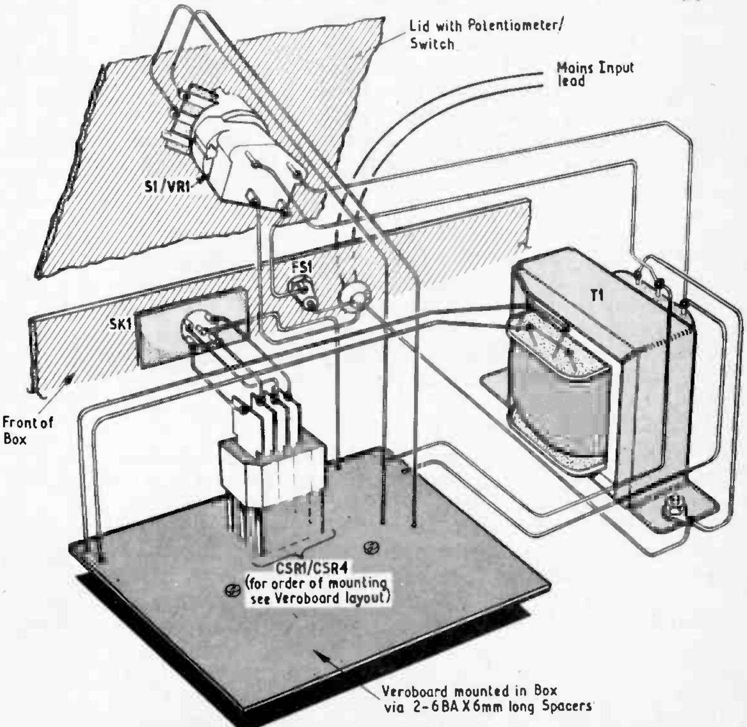


Fig. 5. Interwiring diagram

DIGITAL

LEAF

BY J. S. HAGGIS

ONE requirement for greenhouse owners whether amateur or professional is a system for keeping leaf surfaces moist. This is achieved by spraying the leaves, at intervals, with a fine water mist. The timing of the intervals depends on the rate of evaporation at any one time. This article describes the principle, theory, and construction of a device that will automatically control this process.

The system uses a sensor which consists of two electrodes placed approximately ½in apart and cast in and Araldite block. The surface of this block is machined flat so that when it is sprayed with water the two electrodes eventually become bridged with a blob of water. If no further spray is directed at the surface, evaporation soon starts to reduce the amount of water bridging the electrodes, until finally the bridge is broken. The time taken for this to happen depends on the rate of evaporation. On a hot summer day the time will be short, whereas on a damp cloudy day the time will be longer.

PRACTICAL CIRCUIT

The making and breaking of the sensor circuit can be used to operate the electronic circuit of Fig. 1. At first sight this might seem rather complex for such a simple operation, but as will be seen later the system allows for quite a degree of control, coupled with sound operation and reliability.

The object of the circuit is to actuate a standard mains operated solenoid water valve to feed water to a mist propagator when required, and to do this with no moving parts except the solenoid valve, i.e. relays, thus eliminating any trouble from corroded contacts which can easily happen in the greenhouse environment.

Electrode making and breaking is sensed by TR1 and here one of the prime requirements is to keep the current that flows through the sensor, when covered with water, as low as possible to reduce the effect of electrolysis which would soon fur-up the two electrodes.

With no water bridging the electrodes TR1 base is open-circuit therefore the collector is almost at supply potential. As soon as the electrodes are bridged the base goes high turning TR1 on, the collector then going to 0 volts.

At this stage it could be argued that no further circuitry is required other than a relay or thyristor to switch the mains. This would be fine if water behaved to our liking, but in fact this is not so. Once the sensor has been exposed to the atmosphere for some time the surface becomes slightly greasy. This causes the water droplets to have greater surface tension which means in practice that the sensor must be fully covered with water before the spray is stopped or intermittent operation of the circuit will take place, settling down once the surface has accumulated enough water.

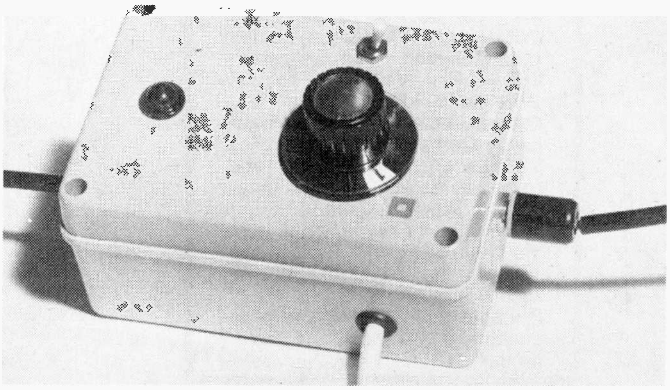
TIMER

However, to overcome this problem and to give more choice of control a timer has been added. This takes the form of the now well-known 555 i.c. (IC2) discussed in depth in June 1973 PRACTICAL ELECTRONICS.

The 555 is used in the monostable mode and thus the trigger pulse must be shorter than the timing period. Differentiation of the input signal is achieved by R4 and C3. In order to provide a sharp pulse edge a Schmitt trigger is required and this also provides jitter-free operation.

The Schmitt used is a monolithic integrated, 14 pin package, type SN 7413 (IC1). The package contains two identical triggers. Each circuit functions as a four input NAND gate. All four inputs are held high by internal resistors and in this condition the output is held at logic 0. Any one input going to logic 0 sends the output to logic 1 level, i.e. 5V.

If any constructor wishes to omit the timer circuit and chance any intermittent switch-off, he can do so by leaving out the timer package and associated components.



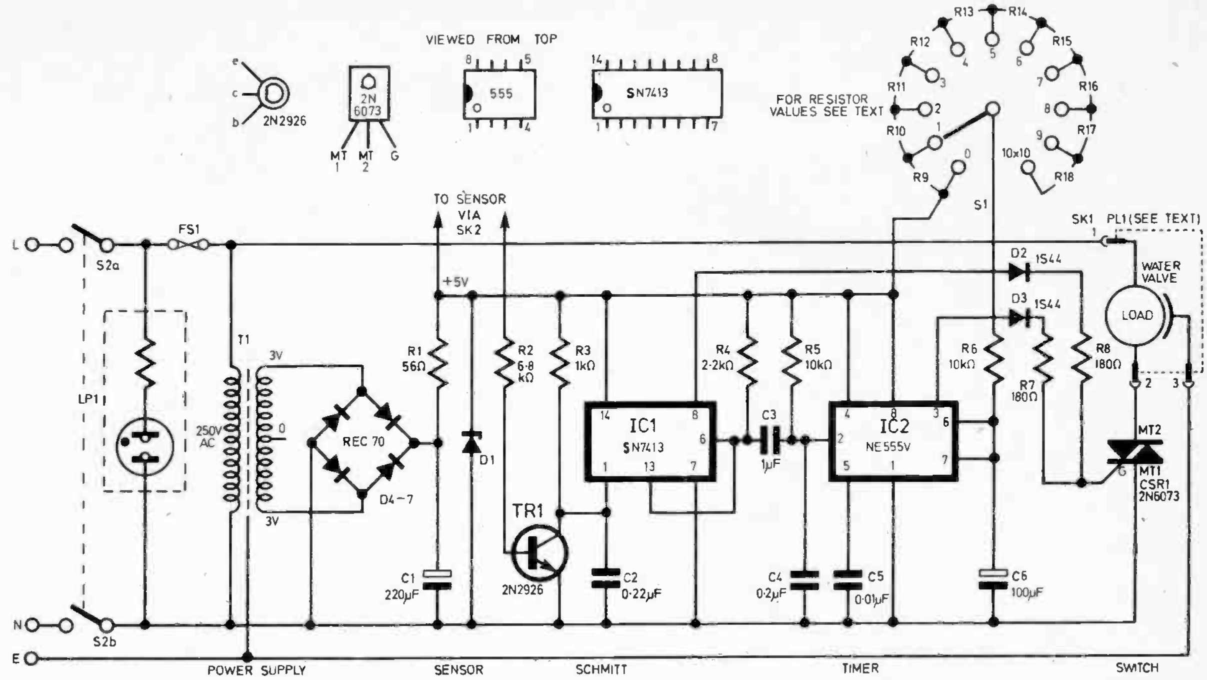


Fig. 1. Circuit diagram of the complete plant moisture control system. Note that the earth line is connected to the case of the control valve if possible and to any metal case parts if these are used

CIRCUIT DESCRIPTION

As can be seen, the power supply is not special. The 5 volt rail is Zener stabilised whilst the mains transformer T1 is an R.S. Components Ltd., sub. min. 3-0-3V device rated at 200mA. The total circuit consumption is 45mA. Even so the transformer gets quite warm but long tests have been given to the prototype with no ill effect.

As stated earlier, when the sensor X1 is bridged with a blob of water the collector of TR1 is at 0V. This state is fed to that trigger input whose output under these conditions is high. The requirement is to have a high output on C3, because the timer is started by a falling voltage.

When the blob of water has evaporated sufficiently to break the contact between the electrodes of the sensor, the base of TR1 becomes open circuit and the collector goes high. Thus the output of the Schmitt goes low and starts the timer, the output of which goes high, to approximately 5V. This is applied through a resistor to the gate of CSR1 thus turning it on.

The time the output of the timer remains in this state is determined by the setting of S1 which selects the series resistors R9 to R18.

The electrodes can be bridged again with the spraying water with no further effect on the timer. Once the time sequence is ended the circuit is set for the next sequence when evaporation dictates.

A brief look at the circuit diagram will reveal a direct connection through diode D2 and resistor R8 from the output of the second Schmitt to the gate of CSR1.

This has two functions, the first being if the operator wishes the sensor to control the "off" time as well as the "on", and accept the possibility of an unstable switch-off, he can do so by turning the time

COMPONENTS . . .

Resistors

R1	56 Ω	R6	10k Ω
R2	6·8k Ω	R7	180 Ω See text
R3	1k Ω	R8	180 Ω See text
R4	2·2k Ω	R9 to R18	See text
R5	10k Ω		

All ½ watt carbon

Capacitors

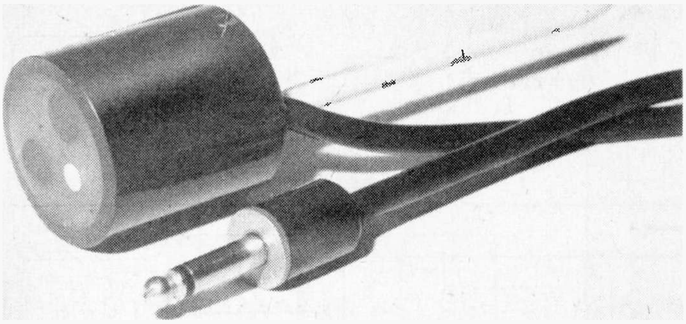
C1 220μF elect. 40V printed circuit type
C2 0·22μF disc
C3 1μF non-elect 63V Wima
C4 0·2μF disc
C5 0·01μF disc
C6 100μF electrolytic 63V Wima

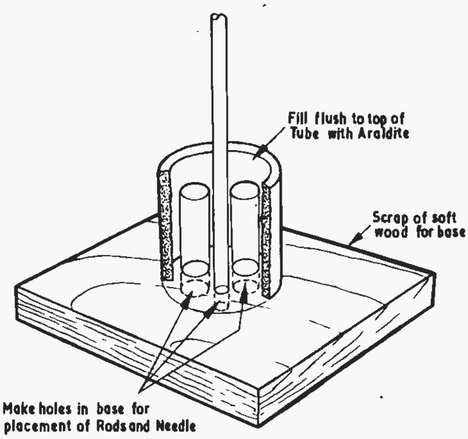
Semiconductors

TR1	2N 2926
CSR1	2N 6073
IC1	SN 7413
IC2	NE 555V
D1	4·7V, 1·3W Zener BZX61 series or IS2000A, IS7000A series (Doram)
D2 and D3	1S44 (2 off)
D4 to D7	Rec 70 (800mA 400V) Doram (4 off)

Miscellaneous

T1 3V type 200mA. Doram
SK2/PL2 Jack and socket min.
Case Sarel Ref. No. 308 from Hawnt and Co. Ltd., Pritchett Street, Birmingham B6 4EN.
Mains cable 3 core P.V.C. Circuit board. Rubber flex connector (Woolworths). Neon indicator 250V miniature. Knob and dial skirt 'C' ¾in. Doram. Midget rotary switch 1 pole 12 way. Miniature toggle ON/OFF switch. Mains fuse and socket. Materials for sensor. Solenoid valve—see text.





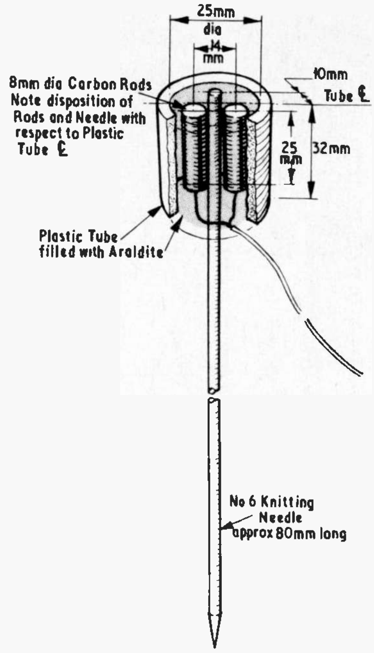


Fig. 2. A completed sensor (above) showing the dimensions in mm and simplicity of construction

Fig. 3. Manufacture of the sensor is also simple using this jig made up from a bit of scrap wood (left)

control to its minimum. Thus when the water breaks the contact the collector, as before, goes high, and starts a timing cycle which with the control turned to minimum, is only in the order of 1s and therefore of no consequence.

But the second Schmitt output volts are applied direct to CSR1 gate and this turns on CSR1 for as long as the electrodes remain open. Each Schmitt within the package inverts therefore the output from the first Schmitt must be fed into the input of the second which is in turn used for direct control of CSR1.

Without the D2, R8 connection and the timer interval inadvertently set too short to allow full coverage of the sensor with water, the timer would be triggered as before thereby turning on the spray. But if the spray were to cease before the sensor was properly bridged, no further action could be taken by the circuit. In fact if man did not intervene the circuit would remain stuck in this state for good. But with the direct connection from the Schmitt this cannot happen. The two diodes are to prevent any possible interaction.

SENSOR

The sensor X1 consists of two $\frac{5}{16}$in carbon rods cast in Araldite at $\frac{9}{16}$in centres (see Fig. 2).

The design of the sensor is quite critical. The relationship between the total diameter of the sensor, the diameter of the carbon rods, and their separation distance is important. Because of surface tension the blob of water that forms on the top of the sensor can roll about the surface and avoid the carbons and even roll off the surface if the design is not correct.

SENSOR CONSTRUCTION

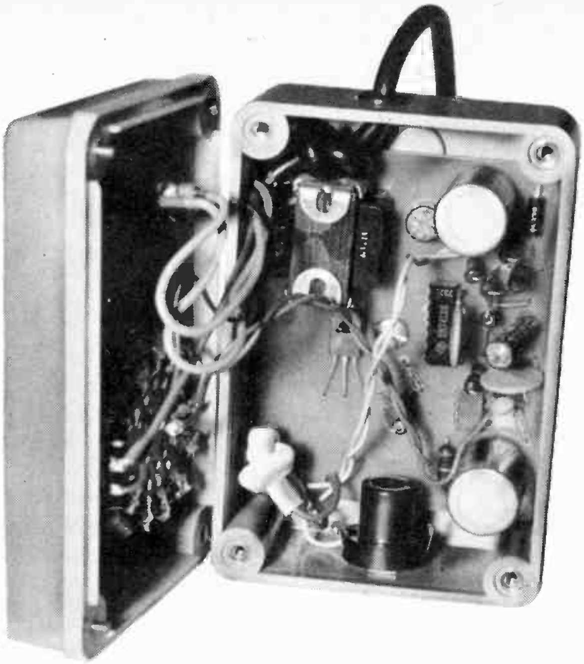
The sensor is best cast in a piece of plastic pipe with a 1in inside diameter. This has two advantages, the first being ease of casting and the second and more important being that the plastic edge surrounding the sensor surface tends to prevent the blob of water from rolling off.

The two carbon rods can be obtained from any used-up U2 type battery, the metal cap ends being used to solder the wire connections.

Cut the two carbon rods at 1¼in long from the metal cap end. Drill two holes $\frac{5}{16}$in dia. at $\frac{3}{8}$in centres, ¼in into a piece of scrap softwood. Drill a third hole to one side, as indicated in Fig. 3 to accommodate a No. 6 plastic knitting needle.

Push the two carbon rods into the holes as far as possible. Acquire a 4¾in length of No. 6 knitting needle (sharp end if possible) and insert the blunt end into the third hole as far as it will go. Next place a 1¼in length of 1in inside dia. plastic tube over the carbon rods and needle. All is now ready to attach the wires. Any twin cable with a plastic outer sheath is suitable. Solder one wire each onto the metal caps of the carbon rods. Ensure that the cable sheath is below the edge of the tube so that it will be well covered with Araldite.

When all is ready mix the Araldite resin as directed and heat until it runs quite freely, then pour it into the plastic tube ensuring that air bubbles are not trapped. Rotate the tube a little and position correctly round the carbons. Leave to set over night. One packet of Araldite is sufficient.



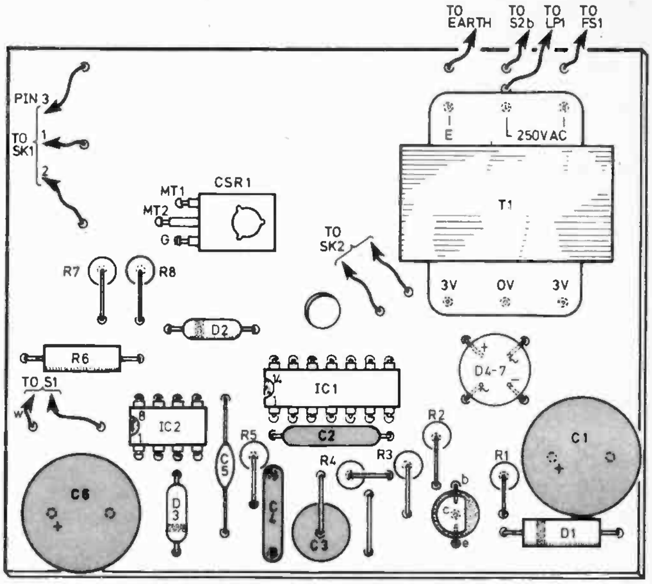


Fig. 4. Component layout on the prototype printed circuit board

Once the Araldite has hardened the timber can be split from around the ends of the carbon rods. Saw the carbons and needle flush across the surface of the sensor and then sandpaper the surface flat, finally finishing with a very fine sandpaper. Wipe the surface with methylated spirits. The sensor is now ready for use.

CIRCUIT CONSTRUCTION

In the prototype all components were mounted on one printed circuit board, including the mains transformer as shown in Fig. 4 and using the circuit layout of Fig. 5. If any constructor wishes to alter this arrangement there is no problem, the layout is not critical other than the necessity to adequately separate adjacent conductors carrying 230V a.c.

It might be noted here that the whole circuit is connected to the mains neutral line and care should be taken when handling the circuit board when switched on as full mains potential is on the board. Preferably the board should not be handled at all when power is connected.

The board is housed in a Sarel box measuring $4\frac{1}{4} \times 2\frac{3}{4} \times 2$in. The Sarel boxes are made from a tough plastic and are waterproof which makes them safe when containing mains in possibly damp conditions.

The three core mains lead enters the box through a tight fitting grommet and may either be wired direct into a fused distribution box or connected to the mains via a fused standard square pin 13A plug. It is suggested that this cable be black.

The cable to the load, in this case a water valve, again leaves the box through a tight fitting grommet and is terminated with a three pin rubber flex connection to which the water valve may be connected. It is suggested that this cable be white to eliminate any possible confusion.

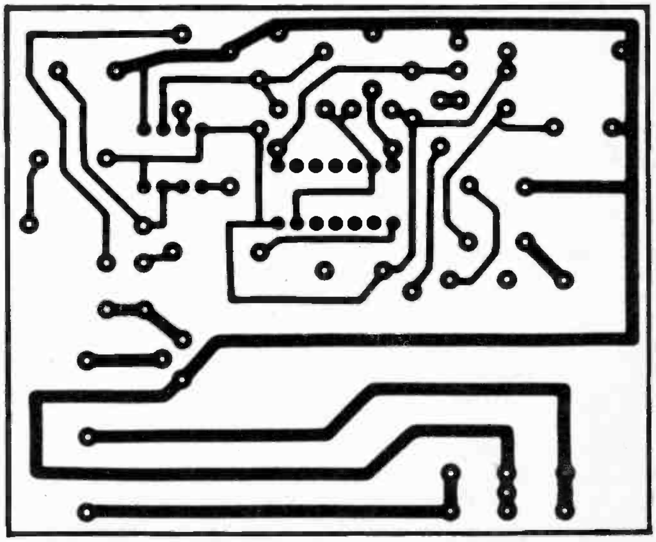
The sensor X1 is plugged into the box using a normal jack plug PL1 and socket SK1. To enable the circuit to be tested or as a convenient way of operating the water valve manually, the jack socket is wired such that when the jack is withdrawn the base of TR1 is left open circuit, thereby turning on CSR1 for as long as the jack remains out of the socket.

C2 should be mounted as closely as possible to the Schmitt input. This is best achieved by soldering it directly onto the package pins.

SETTING UP

First ensure that the circuit has the correct d.c. voltage, 5V, and if not change the value of R1 accordingly. For most practical purposes a maximum time value of 100 seconds in 10 second steps

Fig. 5. Printed circuit master as used in the prototype Leaf



is quite adequate. But if longer or shorter time intervals are required it is only necessary to change the value of C6, and/or the values of R9 to R18 on the rotary switch S1.

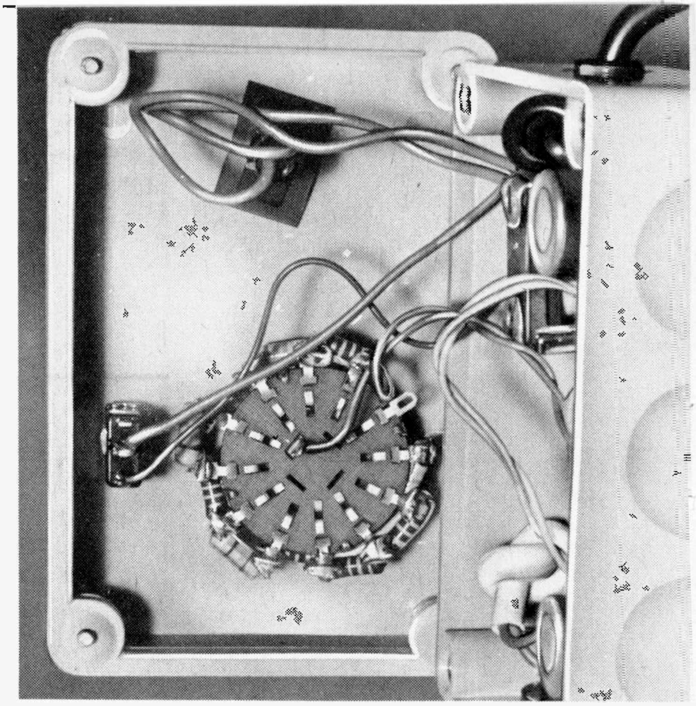
S1 is a midget rotary 12 way switch set to give 11 positions and assembled with knob and dial skirt "C" in order to give indications from 0 to 10.

With C6 at 100μF and a maximum time of 100 seconds required, the total value of R9 to R18 is approximately 500kΩ. This will vary according to tolerance spread of different condensers.

In order to test and set-up the circuit, connect a 60W mains bulb in the load position SK1, pins 1 and 2. This gives clear indication of the operation of the circuit. Then stand the sensor up and cover the sensing surface with a small piece of very wet blotting paper. Turn the rotary switch to the 0 position, plug in the sensor, apply the mains and switch on.

If all is working correctly the bulb should light up as soon as the wet blotting paper is removed and remain lit as long as the paper is off the sensor. Replace the blotting paper and the light should extinguish about 1 second later.

If when the bulb is lit, it appears to flicker and not to be at full brilliance it is because CSR1 is not switched fully on. This could happen because of variations in sensitivity of individual devices and can be rectified by reducing the value of R7 and R8.



TIMING RESISTORS

If all is well up to this stage it now only remains to fit the individual timing resistors around S1. Solder into the first position a 47kΩ resistor and select 1 on the dial (remember all these numbers on the dial are ×10). Then with a suitable time piece handy, remove and replace the blotting paper and note the length of time the bulb stays illuminated. With preferred resistor values it may be difficult to time precisely, but times within 10 per cent can be achieved. If for instance, the 47kΩ gives 11 seconds instead of the required 10 seconds, then in the next position solder a 33kΩ; this should then bring the 20 second timing to about 18 or 19 seconds. It is possible by carrying on in this manner to stay quite close to the required timing. More accuracy can be gained, if required, by making use of resistor tolerance spread.

The repeatable timings of the circuit are very good and this is what matters most. It does not matter much that a time of 62 seconds is given when 60 is wanted as long as it repeats.

INSTALLATION

Securely mount the control box and connect the circuit to the mains through a fuse box or a 13A square pin fused plug fitted with a 3A (or thereabouts) fuse. Connect up a suitable mains operated water valve for the spray system.

CSR1 is rated at 4A and this load should not be exceeded or damage will occur. There is little advantage in fitting a fuse because in general CSR1 will blow before a fuse. If it is required to switch greater loads it will be necessary to select a different CSR1.

Stick the sensor spike into the soil at a convenient spot amongst the plants to be sprayed, but not covered by them. Wipe the top of the sensor with some methylated spirits to remove any grease. Select position 0 and switch on noting the length of time required for the sensor surface to become covered and the system to switch off.

It is unlikely that subsequent operations will take as long as the first because the subsequent operations will not be starting from a dry surface, but an idea of the time required can be gained. The unit can now either be left on "0" and control its own switch off time as stated earlier, or set to a time interval as suggested by the initial timing. Experience will soon enable a useful setting to be found.

MAINTENANCE

The only maintenance required is an occasional wipe of the sensor with meths.

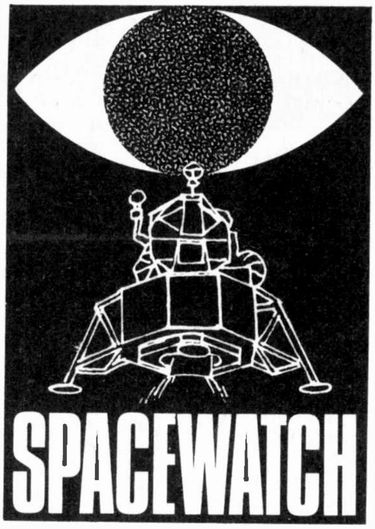
If at any time it is required to test the unit it is only necessary to remove the sensor jack and replace it again and the system will operate for as long as the selected time interval set.

SOLENOID VALVE

The choice of valve used depends on the water pipe system in use, water pressure and availability. The author used one from C. W. Wheelhouse & Sons, 9-13 Bell Road, Hounslow, Middx. which had ½in B.S.P. fittings.

The EVJD10 and the EVD15 are ½in B.S.P. male and female fitting valves from Danfoss (London) Ltd., 6 Wadsworth Road, Perivale, Greenford, Middx. Both cover most water pressures which will be met and are available from stockists at around £12.

A d.c. operated valve could be accommodated by using a transformer to supply the correct voltage and a suitable rectifier. ★



BY FRANK W. HYDE

MERCURY AGAIN

The second visit to Mercury by *Mariner 10* confirmed the previous assessment generally. The second fly-by was 50,000km. More than 500 high resolution pictures have been received, all of excellent quality. This pass was entirely on the sunlit side of the planet and covered some areas that had been checked on the first pass in March last year. There were no startling new discoveries.

The hemisphere observed showed that the planet has only one large impact basin. This area known as the Colaris Basin was on the terminator at the first pass. The floor of the crater would seem to be about the size of the Mare Imbrium of the Moon.

Many craters seem to have a central peak which suggests that the terrain was extremely soft at the time of impacts. There are also many craters within craters. A number of rayed craters exist and there is one large area near the south pole with the rays extending out through other craters. The south pole is inside a large crater.

There seem to be two distinct types of configuration of craters, those which are concentric and those which are in long chains. The concentric craters seem to be of the order of 200km in diameter.

Another feature is the large number of random scarps hundreds of kilometres long and of heights of the order of one to three kilometres. The stresses shown are compressional and the result of the compression produces these scarps. They appear to be random in direction and do not follow any particular pattern. The scarps appear to be antipodal to the Colaris Basin and a similar situation is indicated on the Moon in relation to Mare Imbrium.

It would appear that the condition in which Mercury is now found fits in very well with the current theories of early development of the Solar system. This means that there was a huge infall of large bodies on the emerging planets followed by a period of high internal heating with volcanic activity. This takes care of the changing surface features leaving the primordal conditions hardly discernible.

OPTICAL NAVIGATION IN SPACE

Another important experiment carried out by *Mariner 10* was to test the optical techniques for navigation. These techniques are vital to the missions to outer planets. The need to be able to dodge the satellites of Jupiter, Saturn and Uranus is imperative because of the sparse data as to the exact ephemerides of these bodies.

Previous navigation of deep space missions have relied on Earth-based radio measurements. *Mariner 10* carried out a real-time experiment as it approached Mercury. Over a hundred pictures were taken to show the angular between Mercury and the nearby (optically) stars. The experiment was successful and this means that spacecraft on long distant missions will be able to continuously monitor the space ahead and therefore automatically adjust course.

Provided *Mariner 10* can limit its fuel for modifying its course and not suffer another distraction because fast particles interfere with the sensor which is locked on Canopus, it should be possible for the spacecraft to make another pass of Mercury in 1975.

MORE FROM SKYLAB

Adding to the preliminary reports that have appeared about the effect of weightlessness and the general ability of the astronauts to be in a condition to carry out their tasks, some particular findings are now available. These were released at a symposium arranged by the American Astronautical Society.

Altogether there were 171 days of free orbital flight during the *Skylab* mission and not only has it been demonstrated that man can adapt indefinitely to the weightless environment, it has also shown that provided there has been adequate exercising during the mission the return to normal gravity presents no problem. The state of the individual readily adapts to the return to Earth with no resultant effects. This settles the problems that were thought to exist for long missions into space.

Many ways of overcoming the weightless condition have been investigated and these are no longer required. All that is needed for an astronaut is a programme of physical exercises for 90 minutes each day during the flight.

ASTRONAUT PERFORMANCE

In each of the *Skylab* missions there was a progressive improvement in astronaut performance. This was due mainly to the increased exercise taken. The first crew were so occupied with the various technical problems that arose; little time was available for an intense study of the exercise aspect. Even when the extra vehicular activities continued to six hours at a stretch there were no "clinical" events to record.

No signs of heart deterioration appeared but there was the usual loss of red cell mass, this reduced as the exercising was extended and the flights were longer. Thus the first mission crew lost 14 per cent, the second crew 12·3 per cent but the third crew loss was down to 6·8 per cent. As on the *Apollo* missions there was a wide variation between individuals.

Post recovery was better in the case of the last mission of 84 days. The astronauts on the last mission lost least weight. Most of them gained in height, this averaged about an inch. There was a shifting of the body fluids. Some of the crew experienced slight malaise for the first two or three days. However, all got their "space legs" in a day or so and thereafter were immune.

The calorific requirements proved to be the same or thereabouts as their normal routine on Earth.

Testing the ability of these men as observers of the Earth from space, an analysis made of the observations and the ability to carry out the tasks allotted showed that in 850 observations and some 2,000 hand held camera shots, during the 84 days' mission covering 83 widely varied categories, led to these conclusions. The ability to recognise objects and patterns, to integrate these observations from a wide range of aspects and lighting angles, to reason, to make selected observations and describe them brings a new dimension into play. This ability transcended anything that could be programmed or made automatic.

NOBEL PRIZE
FOR CAMBRIDGE RADIO ASTRONOMERS
By Frank Hyde

THE announcement that the Nobel Prize for Physics had been awarded to Professor Sir Martin Ryle FRS, now the Astronomer Royal, and Professor Anthony Hewish FRS, is a fitting reward for the work of these two quiet and unassuming men from the Mullard Radio Astronomy Observatory. It is a far cry from the angle iron and wire structures, which began a series of programmes more than two decades ago, to the 5km radio telescope now in operation at Lord's Bridge near Cambridge.

The official citation for the award ends with these words "for their pioneering research in radioastrophysics: Ryle for his observations and inventions, in particular the aperture-synthesis technique and Hewish for his decisive role in the discovery of pulsars".

Ryle, together with Hewish and Graham-Smith, were the original team. Hewish has stayed on but Graham-Smith moved to a Professorial Chair at Manchester and on the 1st January 1975 takes up the position of Director of the Royal Greenwich Observatory.

INTERFEROMETRY

The techniques of interferometry formed the basis of the work at Cambridge. The first telescopes were simple interferometers but very soon the phase switched interferometer came into being; the details of this were published about 1950 by Ryle and Vonberg.

From the early beginning the resolution obtained by these methods was better than the single aerial systems. The interferometer developed into a number of variations and gave rise to the more advanced technique of aperture synthesis for which Cambridge is famous. Digitation of observations led to a number of advances.

The first aperture synthesis aerials consisted of one long corner reflector and one movable one about forty feet long. In those days it was quite a sight to see the small reflector being carried to its new position by the observers and technician. This was followed by a more sophisticated cylindrical parabola driven in attitude by synchronous motors and the smaller complementary aerial fitted to a bogey on a railway system. Here the long aerial was set up east and west and the smaller one could travel on the rails north and south.

APERTURE SYNTHESIS

The technique of aperture synthesis can be described simply as two apertures moving relative to each other in such a way that they sweep out a narrow ring of large diameter. The apertures are the aerials and the rotation of the earth varies their orientation such that seen from the sky, one aerial appears to trace out an ellipse relative to the other. The interference patterns which are made by superimposing the signals of the two aerials are then synthesised. From this a chart of the structure of a source can be deduced.

The next major step was the One Mile Telescope which came into operation at the end of 1964. This was the first complete aperture synthesis purpose-built telescope. The sensitivity was extremely high. It was able to detect faint objects near the edge of the observable universe.

At that time the cosmological debate was in full flow. The first results from the new telescope showed quite clearly that the count of the sources at great distances (and therefore very old) was less than the number required by the "steady state" theory, but consistently supported the "big bang" theory. For most of the theorists this fact, together with discovery of the microwave background, which appeared universal, marked the end of support for the "steady state" protagonists.

MAPPING RADIO GALAXIES AND QUASARS

Leading on from the far-distant-source discoveries, the next successful objective was the mapping of the radio galaxies and quasars. The properties of the galaxies were of particular interest because they are enormous wasters of energy and among the largest objects known.

The detailed mapping of the galaxies and quasars enabled some conclusions to be drawn as to their birth, evolution and final demise. In this area Ryle not only made the initial discoveries but also showed that the exploding galaxies threw out on each side large clouds. These clouds appear to interact with the inter-galactic medium. These great radio clouds seem to continue to receive energy from the optically observable nucleus of the original galaxy or quasar for millions of years.

In 1964 at the International Astronomical Union meeting in Hamburg, Anthony Hewish released the details of his method of finding quasars by their scintillation. A quasar is to the radio telescope a small object of high intensity. The interplanetary medium gives changes of density with the same effects as the atmosphere on light coming toward the Earth. The small apparent diameter of a quasar is comparable with the variations. In consequence a quasar is revealed by the amount of scintillation that takes place.

The preliminary work on this problem was undertaken with three stations, Cambridge, Thetford, and Clacton, roughly in an equilateral triangle. The particular quasar studied was 3C 48. This showed nearly 50 per cent scintillation. The pilot experiment was successful and the triangle was extended between Cambridge, Jodrell Bank, and Malvern.

DISCOVERY OF PULSARS

It was during the testing of the 18,000 square metre aerial at Cambridge that Jocelyn Bell first noticed the regular pulses. Later observations showed that the regularity and accuracy of the pulses was more reliable than any clock available. The team went to great lengths to establish what these pulses really were and what mechanism was involved. It became clear that what had been discovered were the playthings of the theoretical astronomers, the neutron stars. This discovery was extremely exciting, opening up as it did new possibilities in gravitational physics, the behaviour of very dense matter, and the effect on radiation physics.

SUPER-SYNTHESIS

The reward for enterprise had already been given by the Science Research Council in approving the setting up of the 5km aerial with its eight parabolas on the site of the old railway axed by Beeching. This system of aerials went one step further than aperture synthesis. It reached the stage of super-synthesis.

The principal task was to be the examination at the new high level of resolution, of quasars and radio galaxies. This was an opportunity to resolve some of the problems. In some of the observations there were more than two radio clouds associated with the explosions that took place. There were also bridge-like links between the areas of activity. The radio emission may come from the highly charged particles moving at speeds near that of light and trapped in a tangled magnetic field. They may well be accelerated by the gravitational collapse of groups of stars near the centres of visible galaxies.

All these problems and many others should respond to the high resolution of the 5km telescope. Since 1972 the telescope has already shown that its inception was more than justified.

THE MAKING OF HISTORY

The history of radio astronomy as made at the Mullard Radio Astronomy Observatory at Cambridge includes many activities which need a whole volume for description, but the story will go down in history of the time when two men, mainly responsible for that history, were honoured while still making it. ★

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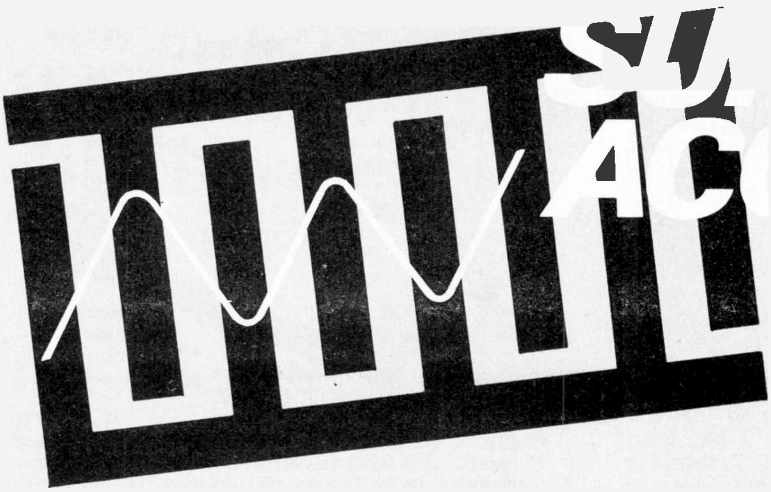


So you've never heard of surface acoustic waves. Well you soon will. Progress has been astonishing in the last five years. Devices have moved from starry eyed physicists' dreams to commercial evaluation in electronic systems—a real case of fantasy to fact.

Imagine you are standing on your favourite holiday beach looking out to sea; a yacht rocks peacefully at the end of the breakwater whilst the waves are gently lapping the sand at your feet. You are witnessing the analogy of surface acoustic waves (S.A.W.).

Transfer the sea waves to the surface of a piece of flat polished crystal and you have S.A.W. Thin metal films deposited on the crystal surface enable the transfer between electrical and S.A.W. energy to be effected. By manipulating these waves on the crystal surface, oscillators, amplifiers, signal processors and delay lines have been constructed.

HISTORICAL VIEWPOINT

Lord Rayleigh is accredited with the identification of the surface acoustic wave. In 1885 he described waves travelling along the earth's surface after an earthquake, and subsequently a great deal of information has been gathered by seismologists.

It was not until the early sixties that the propagation of high frequency sound waves through a solid crystal was demonstrated. The development of a means of conversion between electrical energy and S.A.W. energy, the Interdigital Transducer (I.D.T.) in the mid and late sixties, meant that the breakthrough had come. S.A.W. exploitation was here.

THE NATURE OF S.A.W.

Surface Acoustic Waves are only one in a family of wave motions identified in crystalline materials. The property of all these waves is that of transferring acoustic energy from one part of the crystal structure to another.

In crystalline materials the particles are arranged in an orderly lattice type of structure, each particle being held in place by an elastic force generated between itself and its neighbours (imagine a lattice of billiard balls coupled by pieces of rubber band).

The longitudinal wave travels through an elastic material by alternately expanding and compressing the crystal lattice. This is definitely a bulk wave not found on the surface of the crystal.

The second type, the shear wave, vibrates the lattice at right angles to the direction in which the wave is travelling. The layers of the lattice slide up and down past each other. Again a bulk wave not found on the crystal surface.

The third type is the S.A.W. (Fig. 1a). It is a combination of the longitudinal and shear waves and is only associated with the surface of a crystal. To tie up the analogy with the waves on the surface of the sea, mentioned earlier, it is interesting to note that the motion of a particle travelling in a S.A.W. is also retrograde elliptical (Fig. 1b).

To digress for a moment; bulk waves occur in the familiar, so called, crystal oscillators which are widely used for highly stable frequency sources in, amongst other things, communications equipment.

It is easy to appreciate early fears that the frictional forces generated by this mechanical vibration of the crystal lattice would absorb the acoustic wave energy excessively when the frequency of oscillation got too high. Fortunately crystals of quartz and lithium niobate have been found to transmit frequencies from 30MHz to 10GHz acceptably.

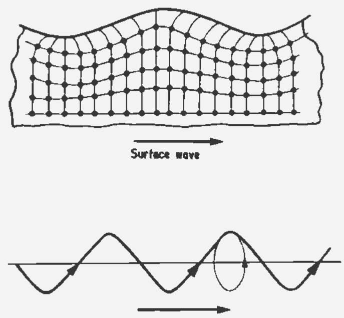


Fig. 1(a). Surface Acoustic Waves distort the crystal lattice as the wave moves along. A particle near the surface exhibits retrograde elliptical motion (b) directly analagous to waves in water

THE SPEED OF S.A.W.

We now come to one of the outstanding properties of S.A.W.—the velocity with which the waves travel along the crystal is around 10^5 times *slower* than the velocity of electromagnetic waves, i.e. the velocity of light. In other words an electronic signal that would occupy a cable one mile long could be contained on the surface of a piece of crystal only half an inch long. This means that the time taken for the signal to travel one mile in the cable would be the same as the time taken for it to travel just half an inch on the crystal.

It is now possible to glimpse how a delay line of incredible compactness might be constructed. But first a means of transferring the electrical signal to the surface of the crystal (into a S.A.W.) is needed. Ideally the process should be reversible so that the electrical signal can be recovered after it has been delayed. A transducer is required. Fig. 2 shows a delay line with input and output transducers.

THE TRANSDUCER

The transducing action for converting electrical energy to S.A.W. energy occurs in two parts. The first stage is a conversion of the incoming electrical signal to an electrical field which varies in strength and polarity as the incoming signal.

The second stage takes advantage of the property of piezo-electric materials to mechanically vibrate in sympathy with an applied electric field.

As mentioned above, suitable crystals for the transmission of S.A.W. are quartz and lithium niobate, both of which are also piezo-electric. Thus, all that is necessary to excite a S.A.W. is to apply a suitable temporally varying electric field to the piezo-electric crystal substrate which will also transmit the S.A.W. This is done using an Interdigital Transducer (I.D.T.).

THE INTERDIGITAL TRANSDUCER

Imagine the fingers of your left hand interleaved with your right and you have the form of an I.D.T. This shape is laid down on the crystal substrate as a thin aluminium film.

The incoming electrical signal is applied with each hand (in analogy only of course!) acting as the terminals. The electric field will be generated between the finger of each hand since there will be a time dependent potential between them due to the electric signal (Fig. 3).

The spacing between each of the fingers is equal to half the wavelength of the S.A.W. and the width of the fingers is typically a quarter wavelength. The wavelength is determined from a precise knowledge of the velocity of the S.A.W. on that particular crystal substrate and the frequency of the incoming electrical signal.

The aperture of the transducer (see Fig. 3) determines the impedance seen by the incoming electrical signal and where possible is made to match the line impedance, e.g. 50 ohms. This typically means an aperture of 20 to 100 wavelengths.

The transducer described generates a bi-directional S.A.W. The bandwidth of this I.D.T. is inversely proportional to the number of finger pairs in the transducer (see Fig. 3). The inverse of this same process of S.A.W. generation is used to detect S.A.W., i.e. to generate an electrical signal from an incoming S.A.W.

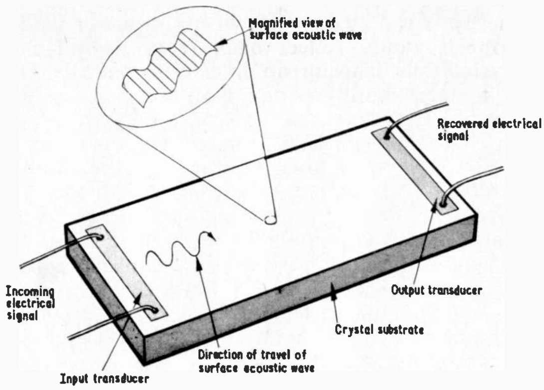


Fig. 2. A delay line consists of a crystal substrate with transducers separated by a distance depending on the delay required

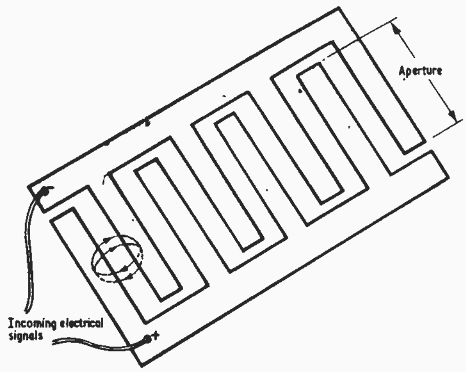


Fig. 3. An interdigital transducer is used to induce the S.A.W. into the crystal. At the instance depicted the polarity of the signal and the lines of force between two points of a finger pair are as shown. An alternating electric signal produces an alternating field.

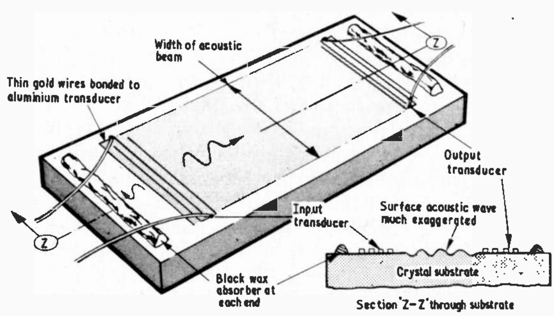


Fig. 4(a). Detailed structure of a delay line showing I.D.T.s and wax which absorbs waves so preventing unwanted reflections from the ends of the crystal. (b) shows the delay line in cross section.

DELAY LINES

Delay lines are perhaps the most fundamental S.A.W. devices. Their function is simply to provide a delay between the receipt of a signal and its onward transmission, leaving its form unchanged.

They comprise of an I.D.T. at either end of a crystal substrate. The length of the crystal determines the delay (see Fig. 4).

Since the I.D.T. is bi-directional, half the S.A.W. energy is radiated in the wrong direction and if not stopped would reflect back from the edge of the crystal thus causing an interfering signal. Thinking of the sea shore analogy, mentioned above, imagine the waves hitting the wall of a cliff or promenade and being reflected back out to sea.

Black wax is used to absorb these unwanted S.A.W. It is painted on the crystal surface and the effect can be likened to the sand of the sea shore which tends to dissipate the waves' energy.

Omni-directional transducers can be constructed but these have only two thirds the bandwidth of the bi-directional transducer. The delay possible with lithium niobate, for instance, is 2·88 microseconds per centimetre.

FABRICATION

The method of construction is common to most forms of S.A.W. device. Having selected the crystal required, cut and polished it, the I.D.T. thin metal films are deposited using conventional integrated circuit techniques.

Electrical connection to the I.D.T. is made via extremely fine gold wires bonded to the metal film. These wires are typically one to two thousandths of an inch in diameter.

The formation of the I.D.T. requires only one vacuum deposition stage and, once the master mask defining the areas to be covered with metal is made, mass production of devices is possible.

Obviously the cost of such a procedure is minimal and complete standardisation is assured. This compatibility with micro-electronic techniques and promise of inherently economic production are major reasons for the present flurry of keen commercial interest.

VARIABLE DELAYS

A variable delay line is clearly now possible using a multiplicity of output I.D.T.'s to give varying delays; electronic switching being used to select the delay required.

It can easily be appreciated that just as a wave on the sea is damped a little by a ship riding on top of it, so an I.D.T. riding on a S.A.W. will reflect some of the incident acoustic energy, i.e. attenuate the ongoing wave. This can give rise to unwanted signals as they bounce between adjacent I.D.T's. Special techniques have been developed to overcome these problems.

The variable delay line mentioned will give only discrete delays and for a linearly variable delay two crystal substrates are used. From Fig. 5 it will be seen that if the lower substrate is held stationary while the upper one is moved mechanically, a continuously variable delay is possible.

An alternative to using longer and longer crystal substrates to obtain larger delays, and incidentally the larger the crystal the more difficult it is to obtain, is to use the helical delay line (Fig. 6).

This is so called because the delay path is a helix, the signal travelling round and round a specially prepared crystal many times. As can be seen from the diagram, transducers are placed along the S.A.W. path giving many temporally spaced outputs. These outputs can be up to several milliseconds after the original input pulse.

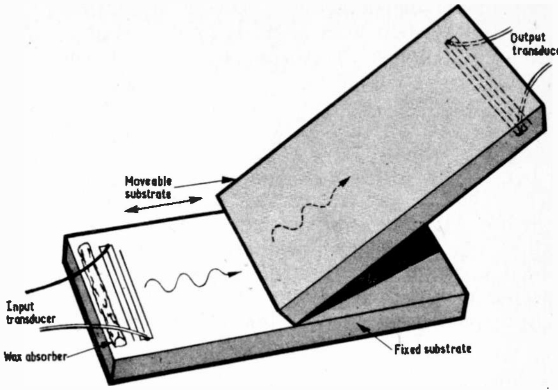


Fig. 5. A linearly variable delay line can be created by having a moveable substrate in contact with a fixed substrate

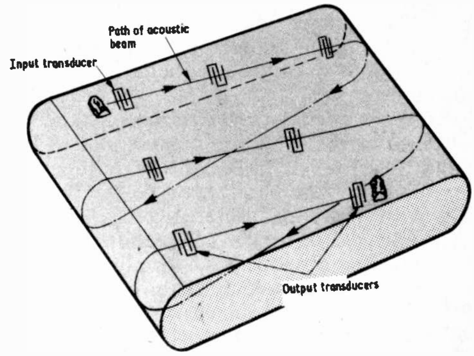


Fig. 6. For very long delays a specially prepared crystal substrate can be used to give a helical multiple-tap delay line

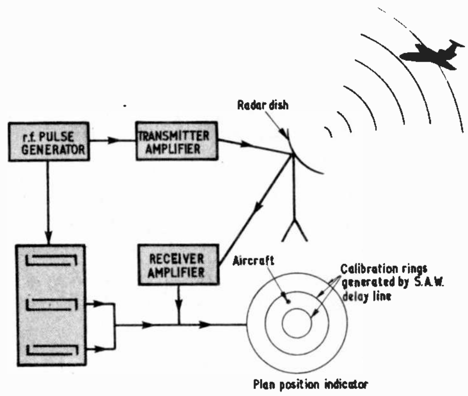


Fig. 7. A tapped delay line can be used in a radar system to give marker pips on a display screen

RADAR SYSTEMS

Applications for these types of delay lines include radar systems. Here the devices would provide range calibration and in featureless terrains simulate a background, i.e. clutter generation. Fig. 7 shows the simplified block diagram of such a radar range calibration system.

A pulse generated by the r.f. pulse generator is transmitted via the radar dish to the atmosphere. If an object such as a plane is encountered a reflection of that pulse is returned to the dish some time later.

The sensitive receiver amplifier then generates a pulse on the plan position indicator (p.p.i.) the distance of which, from the centre of the screen, indicates the distance of the plane from the radar dish. The r.f. generator also passes a pulse simultaneous with the transmitted pulse, to the S.A.W. delay line. The delay line then gives delayed outputs which correspond, when displayed on the p.p.i., to specific distances from the radar dish. Thus range calibration of the radar system is achieved.

FILTERS

The bandwidth of the I.D.T. can be closely controlled as mentioned earlier by varying the number of fingers.

Since the bandwidth is inversely proportional to the number of finger pairs, a filter, which allows only a limited range of frequencies through either side of its designed centre frequency, can be easily constructed.

The centre frequency is determined by the spacing between each finger, which is made equal to half the wavelength of the desired centre frequency. The resulting filter is of the bandpass type.

Filters with these characteristics are essential in every TV and radio, in the i.f. section for instance. The markets are obviously just right for a simple mass-produced device which requires no tuning up after fabrication. Enormous efforts have been turned in this direction and the complex requirements for a TV receiver are close to being obtained.

SIGNAL RECOGNITION

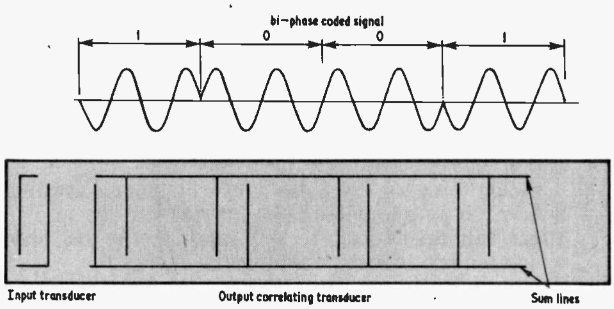
Suppose that we require a system whereby a plane flying around an airport control tower is able to tell the controller automatically that it wants to land. Let the plane have a transmitter which gives out a signal on a particular frequency.

The signal could be coded so that it is unique to that aircraft. A digital code would be suitable, i.e. a series of 1's and 0's, let these be modulated on the carrier as a bi-phase coding. This means that the carrier unchanged represents a 1 and a phase change of 180° of the carrier is a 0. If the code were four bits long, e.g. 1001 and two cycles of carrier are allotted to each bit, then the coded signal would be as shown in Fig. 8.

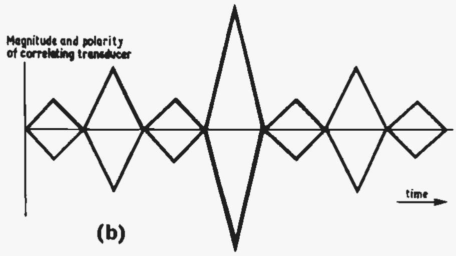
How can this signal of known form be recognised immediately it occurs notwithstanding the presence of much interference? Naturally S.A.W. come to our aid in the form of a tapped delay line or correlator.

The signal is first converted into a S.A.W. by the input I.D.T. As the signal feeds in it is compressed in length until it all lies along the substrate.

For simplicity the output I.D.T.s are made up of single finger pairs called taps. These taps will give a maximum output when a 1 or 0 bit of the S.A.W. appears beneath them, depending to which sum line the fingers are connected (Fig. 8). Thus if the taps are arranged 1001, as in the diagram, a S.A.W. of exactly that form at the correct frequency will cause them all to give a maximum output, simultaneously, when it appears beneath them.

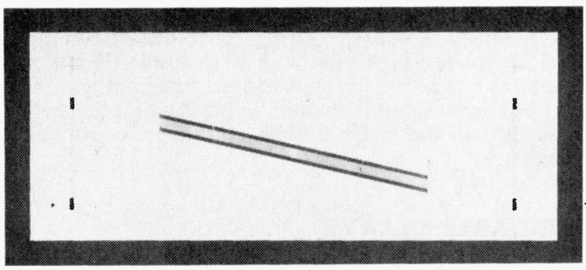


(a)

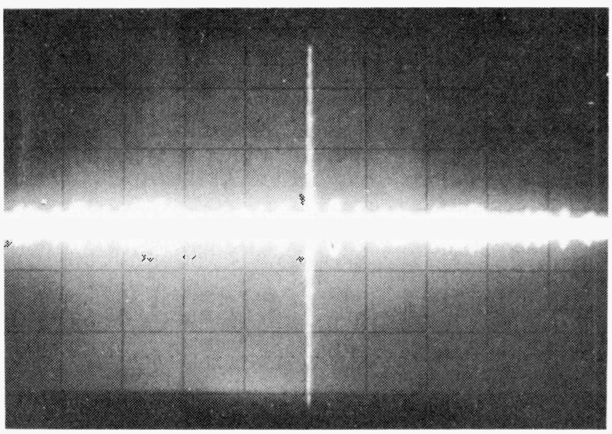


(b)

Fig. 8(a). A S.A.W. correlator may be used for detecting a particular sequence by arranging the taps to coincide with the desired signal. A typical output is shown in (b)



(a)



(b) *(G.E.C. Hirst Research Centre)*

Fig. 9(a). Photograph of an actual S.A.W. correlator which is capable of recognising a particular 127 bit sequence. The output transducer is inclined to minimise distortion due to its length. Photograph (b) shows the large peak produced when the sequence is recognised

The sum lines add these tap outputs to give a large pulse which indicates the signal has been recognised. Since the S.A.W. signal travels along the substrate under the taps it will cause small spurious signals before and after it is in the correct position to cause a large pulse; these are shown in Fig. 8b.

The photographs show a more ambitious example of a tapped delay line (Fig. 9a). It has 127 taps each of six finger pairs. Fig. 9b shows the output obtained from the large centre transducer, when the coded sequence is fed into the device. The detection pulse is easily recognised.

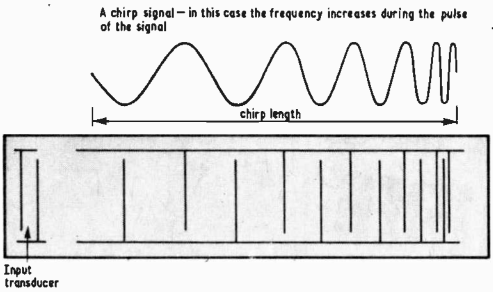


Fig. 10. By varying the spacing between taps as shown a "chirp" signal can be recognised

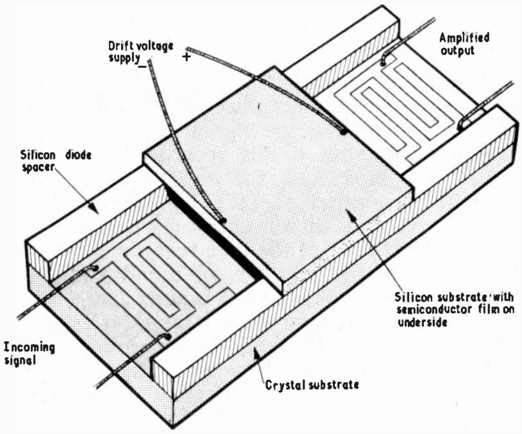


Fig. 11. The structure of an amplifier using S.A.W. principles

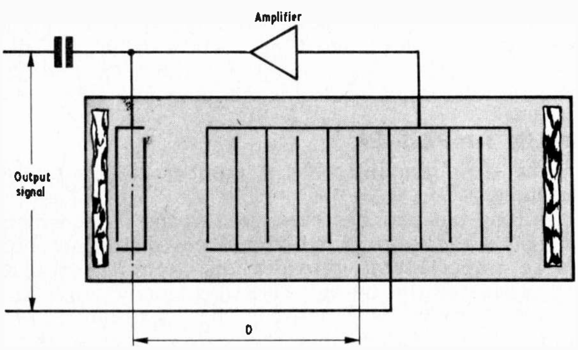


Fig. 12. A S.A.W. oscillator is produced by combining a bandpass filter with an external amplifier, the frequency of oscillation being determined by the spacing between taps on the S.A.W. crystal

CHIRP DETECTION

If instead of bi-phase modulation a pulse of signal is used which is rising in frequency with duration, see Fig. 10. This could be detected by appropriately spacing the taps on a transducer as shown. The chirp system is common in radar systems.

AMPLIFIERS

The need for S.A.W. amplifiers is apparent in, say, a long delay line where attenuation of the wave by the crystal becomes the limiting factor in the achievable delay time.

The amplifier to be described makes use of the electric field generated by the S.A.W., travelling along a piezo-electric material, by causing it to interact with electrons travelling through this electric field.

Since the electric field is localised to the surface of the crystal, a conducting medium for the electrons has to be placed very near the surface, yet not touching, since this would distort the waves. Fig. 11 shows such an amplifier arrangement; a semiconductor film is used to conduct the electrons.

If the electrons are moving faster than the S.A.W. energy passes to the wave. Gains of up to 10^7 times are being achieved at present. These require voltages of several kilovolts across the semi-conductor film.

It is interesting to note that if the electrons in the semi-conductor film are travelling slower than the S.A.W., energy is removed from the S.A.W. and the electrons benefit. This property is useful in absorbing unwanted signals.

OSCILLATORS

The oscillator structure (Fig. 12) combines the filter layout mentioned earlier with an external amplifier. This amplifier returns the signal taken from the filter output I.D.T. to the input I.D.T. with an excess of gain. The frequency of oscillation is determined by the output I.D.T. and the spacing of the two transducers (D).

The number of finger pairs in the output I.D.T. determines the bandwidth whilst the spacing of the fingers sets the centre frequency. This bandpass filter then selects one of the many possible frequencies of oscillation, which are determined by the distance between the input and output I.D.T.s.

The range of frequencies presently possible is 20MHz to 1GHz. Oscillators above 300MHz will be small enough to fit inside transistor type TO-8 cans complete with their i.c. amplifiers.

Applications for these small, cheaply produced oscillators include TV tuners, low noise microwave sources and strain gauges.

SUMMING UP

It is seldom that one technique can achieve so much in such a short time. It is easy to see that this could be an area scheduled for intense activity and immense growth.

The combination of minimal power requirements (or none at all), microminiature construction, cheap mass production combined with a powerful signal processing capability must ensure the future of this branch of technology. ★

FOR SCINTILLATING SOUND

PART 1

PE ORION...

HI-FI STEREO AMPLIFIER

By D.S. GIBBS & I.M. SHAW C.Eng., M.I.E.E.*

THIS amplifier has been designed on a value for money basis to give the highest standard of performance compatible with a small case and a components budget of about £30. The result is a circuit with an output of over 20 + 20 watts into 8 ohm loads at less than 0·12 per cent distortion, in a case measuring only 14in × 6in × 2in.

This has been made possible by the use of a toroidal mains transformer, by the small size of the latest electrolytic capacitors and by the use of the case of the amplifier as a heatsink.

PRE-AMPLIFIER

The circuit of the pre-amplifier is shown in Fig. 1.1. Here TR1 and TR2 form a complementary feedback pair. This arrangement has excellent bias stability due to the d.c. feedback through R12. Both transistors are low noise types and TR1 is run at a bias current of only 150μA to minimise noise.

The equalisation components are connected in the feedback loop. R14, R15, C9 and C10 provide equalisation for magnetic pickups to within ± 1dB of the R.I.A.A. curve, between 20Hz and 20kHz, whilst R13 and C8 give a flat frequency response for the tuner and auxiliary inputs. No special equalisation has been provided for ceramic pickups as these seem to be falling out of favour nowadays, but ceramic pickups can be used with the magnetic equalisation by connecting passive matching networks of the type shown in Fig. 1.3 inside the record player plinth.

The frequency response of the disc, tuner, and auxiliary inputs is shown graphically in Fig. 1.2.

Emitter follower TR3 provides a high input impedance for the tape input and also enables a tape A/B facility to be provided. This is of particular value with tape recorders having separate recording and playback circuits as it enables one to make a direct comparison between the signal source and the recording. For example, if one wishes to make a recording of a radio programme the input selector is set to "Tuner" and the signal passes through the input stages and out to the recorder. The signal is recorded on tape and the tape playback signal appears at the emitter of TR3. By operating S2 one can then make a direct comparison between the input and the output of the tape recorder.

The tone control circuit is of the Baxendall type and uses an integrated circuit operational amplifier. The very high gain and large output voltage swing of this i.c. are advantageous in obtaining very low distortion and a good dynamic range, whilst the signal level in this stage is sufficiently high to make the noise negligible.

The characteristics of the bass and treble controls are shown in Fig. 1.4. With the tone controls flat the circuit has an overall gain of 2 and gives an output of 200mV.

The scratch filter is a second order type and gives an initial slope of 12dB per octave from its 3dB point at 5kHz. The response of the filter and its effect on the treble control is shown in Fig. 1.5.

MAIN AMPLIFIER

The main amplifier has a number of interesting features.

A long tail pair has been used at the input which increases the loop gain and reduces distortion, but more important it provides an accurate ground reference for the output. The d.c. potential on the output terminal will normally be less than 50mV and this will ensure that any d.c. current through the loudspeaker is of negligible proportions. However, if an output transformer, or a loudspeaker containing a matching transformer (such as the Quad electrostatic) is used the d.c. resistance is then very

*Ferranti Ltd.

SPECIFICATION . . .

Continuous Output Power

Load	Both channels driven	One channel driven
4 ohms	31+31 watts r.m.s.	44 watts r.m.s.
8 ohms	23+23 watts r.m.s.	30 watts r.m.s.
15 ohms	17+17 watts r.m.s.	19 watts r.m.s.

Measured at 1kHz

Toneburst Output Power

Load	Both channels driven	One channel driven
4 ohms	52+52 watts r.m.s.	57 watts r.m.s.
8 ohms	36+36 watts r.m.s.	42 watts r.m.s.
15 ohms	21+21 watts r.m.s.	22 watts r.m.s.

Measured with a 1kHz tone burst of 8 cycles on and 512 cycles off.

Distortion

15 ohm load—Less than 0·1 per cent at any power level up to 15 watts between 100Hz and 10kHz. Less than 0·02 per cent below 1 watt output.

8 ohm load—Less than 0·12 per cent at any power level up to 20 watts between 100Hz and 10kHz. Less than 0·02 per cent below 1 watt output.

4 ohm load—Less than 0·5 per cent at any power level up to 30 watts between 100Hz and 10kHz. Less than 0·05 per cent below 1 watt output.

Frequency Response

Tuner and Aux. inputs { −1dB at 28Hz and 15kHz; −3dB at 17Hz and 30kHz

Tape input { −1dB at 25Hz and 30kHz; −3dB at 14Hz and 60kHz

Disc input—Within 1dB of the RIAA curve between 20Hz and 20kHz

Tone Control

Bass ±12dB at 100Hz, ±18dB at 30Hz
Treble ±12dB at 10kHz, ±16dB at 20kHz

Scratch Filter

−3dB at 5kHz. Slope 12dB per octave

Inputs

Disc —3·5mV at 47k Ω RIAA equalised
Tuner—100mV at 100k Ω Flat response
Aux. —100mV at 100k Ω Flat response
Tape —100mV at 100k Ω Flat response

Tape Output

100mV at 4·7k Ω Tape A/B facility

Signal to Noise Ratios

Unweighted figures measured with a bandwidth of 20kHz.
Weighted figures follow CCIR C curve. Volume control at max.

Tuner, Aux. Unweighted −68dB, Weighted −72dB
Disc. Unweighted −62dB, Weighted −76dB
Tape Unweighted −76dB, Weighted −82dB

(Figures are relative to an output of 20 watts into 8 ohms)

MAIN AMPLIFIER ONLY (volume control at min.) { Unweighted −96dB; Weighted −100dB

Balance Control

Full rotation cuts off either channel

Dynamic Range

Disc input at 1kHz = 32dB (i.e. input of 150mV)

Interchannel Crosstalk

−50dB

Stability

Unconditionally stable. Will drive electrostatic loudspeakers

Output Impedance

Less than 0·1 ohms

Dimensions

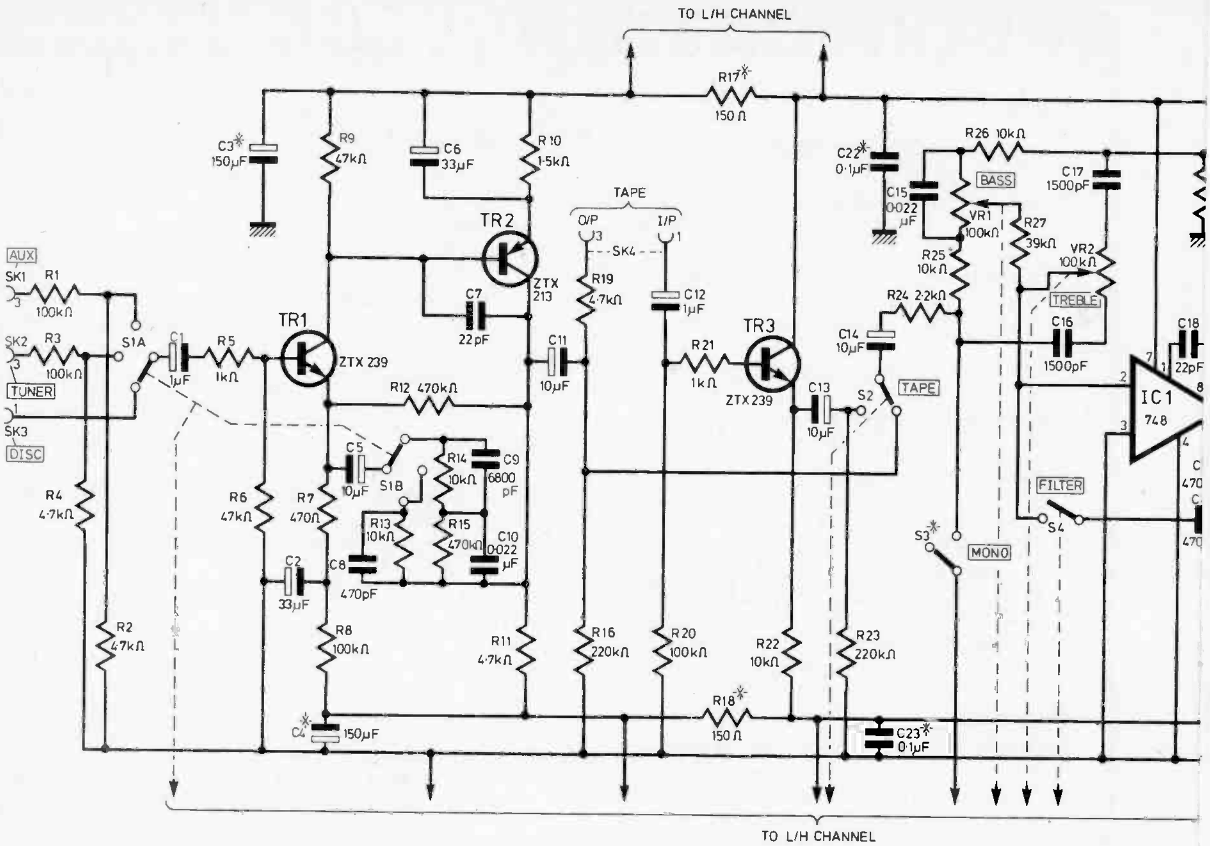
14 × 6 × 2 in.

much lower than the speaker impedance and it is advisable to connect a resistor of about 0·5 ohms in series with the output of the amplifier.

This will reduce the output power by a few per cent but will minimise the d.c. current. In practice the resistance of the speaker leads will often be sufficient to provide the 0·5 ohm required.

The d.c. coupled output ensures that the speaker damping is maintained right down to d.c. giving a clean solid bass response. Normally, when a speaker coupling capacitor is used, the reactance of this capacitor starts to become appreciable at low frequencies just when the most damping is required. The d.c. coupled output is made possible by the use of balanced positive and negative supply rails, and these also assist in obtainin clean symmetrical limiting under all load conditions.

The constant current source TR8 helps in obtaining low crossover distortion by providing a rapid transition of drive current between the two output



COMPONENTS . . .

Resistors

R1, R101	100kΩ	R25, R125	10kΩ
R2, R102	4·7kΩ	R26, R126	10kΩ
R3, R103	100kΩ	R27, R127	39kΩ
R4, R104	4·7kΩ	R28, R128	4·7kΩ
R5, R105	1kΩ	R29, R129	4·7kΩ
R6, R106	47kΩ	R30, R130	22kΩ
R7, R107	470Ω	R31, R131	1kΩ
R8, R108	100kΩ	R32, R132	2·2kΩ
R9, R109	47kΩ	R33*	470Ω 1W
R10, R110	1·5kΩ	R34*	470Ω 1W
R11, R111	4·7kΩ	R35, R135	100kΩ
R12, R112	470kΩ	R36, R136	1kΩ
R13, R113	10kΩ	R37, R137	22kΩ
R14, R114	10kΩ	R38, R138	4·7kΩ
R15, R115	470kΩ	R39, R139	3·3kΩ
R16, R116	220kΩ	R40, R140	1·2kΩ
R17*	150Ω	R41, R141	100kΩ
R18*	150Ω	R42, R142	4·7kΩ
R19, R119	4·7kΩ	R43, R143	100Ω
R20, R120	100kΩ	R44, R144	1·5kΩ
R21, R121	1kΩ	R45, R145	1kΩ
R22, R122	10kΩ	R46, R146	0·33Ω 2·5W
R23, R123	220kΩ	R47, R147	0·33Ω 2·5W
R24, R124	2·2kΩ	R48, R148	10Ω 1W

All ½W 5% carbon film unless otherwise rated

Note: R17*, R18*, R33* and R34* are common to both channels; similarly for all other components asterisked

Potentiometers

VR1, VR101	100kΩ twin gang linear law (RS)
VR2, VR102	100kΩ twin gang linear law (RS)
VR3, VR103	10kΩ twin gang log law (RS)
VR4*	25kΩ single gang linear law (RS)
VR5, VR105	1kΩ skeleton preset (RS)

Capacitors

C1, C101	1µF 35V tantalum
C2, C102	33µF 16V elect.
C3*	150µF 16V elect.
C4*	150µF 16V elect.
C5, C105	10µF 25V tantalum
C6, C106	33µF 16V elect.
C7, C107	22pF 160V polystyrene
C8, C108	470pF 160V polystyrene
C9, C109	6,800pF 400V polyester
C10, C110	·022µF 160V polyester
C11, C111	10µF 25V tantalum
C12, C112	1µF 35V tantalum
C13, C113	10µF 25V tantalum
C14, C114	10µF 25V tantalum
C15, C115	·022µF 160V polyester
C16, C116	1,500pF 160V polystyrene
C17, C117	1,500pF 160V polystyrene
C18, C118	22pF 160V polystyrene
C19, C119	4,700pF 400V polyester
C20, C120	4,700pF 400V polyester
C21, C121	10µF 25V tantalum
C22*	0·1µF 30V disc
C23*	0·1µF 30V disc
C24*	470µF 25V elect.
C25*	470µF 25V elect.
C26, C126	1µF 35V tantalum
C27, C127	10µF 25V elect.
C28, C128	22pF 160V polystyrene
C29, C129	33pF 160V polystyrene
C30, C130	·1µF 250V polyester
C31, C131	22µF 63V elect.
C32, C132	22µF 63V elect.
C33, C133	·1µF 250V polyester
C34*	3,400+3,400µF 40V elect.
C35*	3,400+3,400µF 40V elect.
C36*	·01µF 750V disc

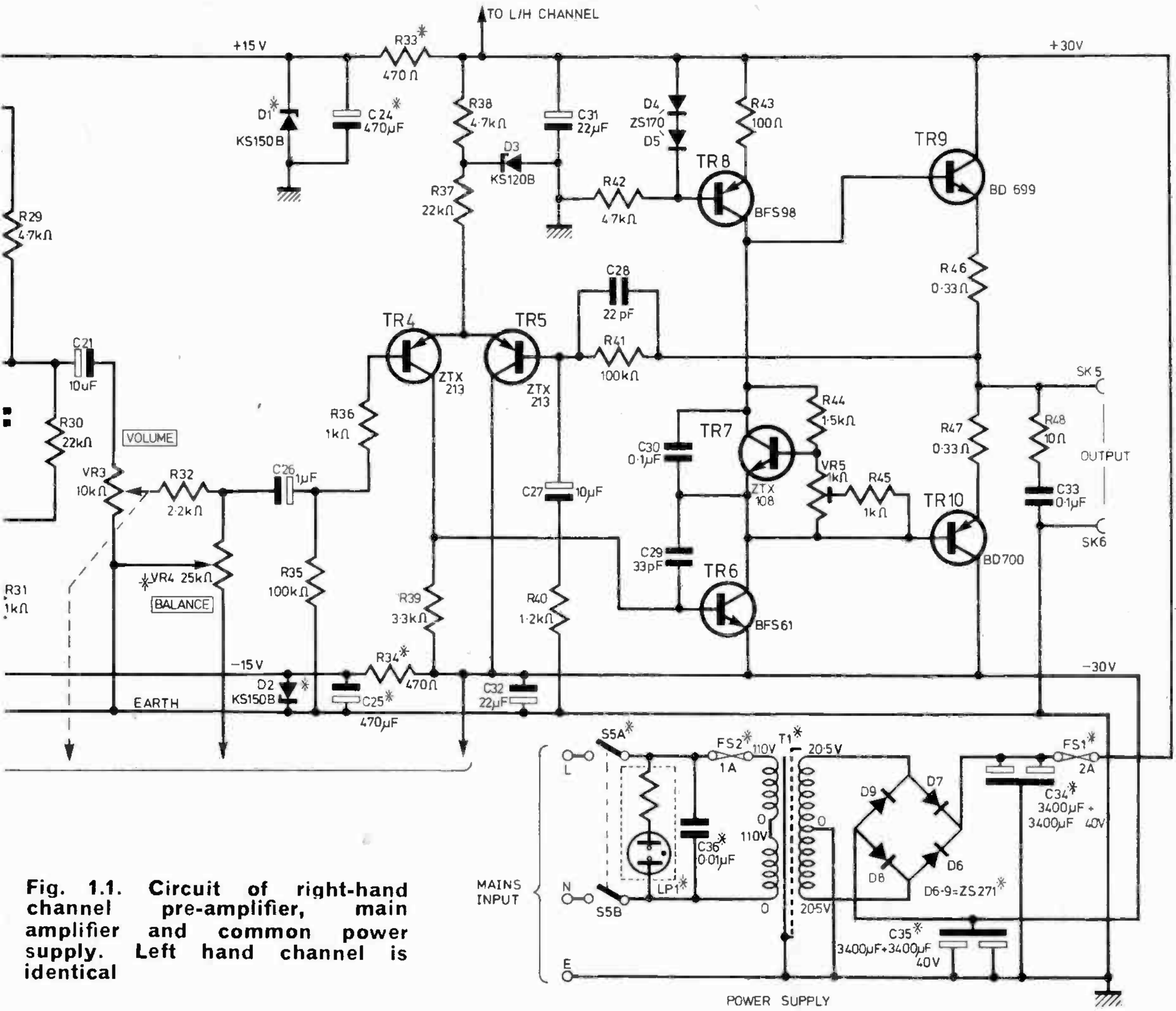


Fig. 1.1. Circuit of right-hand channel pre-amplifier, main amplifier and common power supply. Left hand channel is identical

Semiconductors

	Recommended type	*Alternatives*
TR1, TR101	ZTX239 Ferranti	ZTX384, ZTX109C
TR2, TR102	ZTX213 Ferranti	ZTX214, ZTX530, ZTX502
TR3, TR103	ZTX239 Ferranti	ZTX384, ZTX109C
TR4, TR104	ZTX213 Ferranti	ZTX214, ZTX502, ZTX531
TR5, TR105	ZTX213 Ferranti	ZTX214, ZTX502, ZTX531
TR6, TR106	BFS61 Ferranti	ZTX451
TR7, TR107	ZTX108 Ferranti	ZTX238, ZTX239, ZTX109
TR8, TR108	BFS98 Ferranti	ZTX551
TR9, TR109	BD699 Motorola	BD699A
TR110, TR110	BD700 Motorola	BD700A
D1*, D2*	KS150B Ferranti	KS150A
D3, D103	KS120B Ferranti	KS120A
D4, D104	ZS170 Ferranti	Any ZS170/270 series diode
D5, D105	ZS170 Ferranti	Any ZS170/270 series diode
D6*, D7*, D8*, D9*	ZS271 Ferranti	ZS272, ZS274, ZS276 or ZS278
IC1, IC101	UA748CV Signetics	Texas SN72748P

Switches

S1A, S1B, S101A, S101B 4-pole 3-way rotary (Lorlin)
S2, S102 2-pole changeover pushbutton (RS)
S3* 2-pole changeover pushbutton (RS)
S4, S104 2-pole changeover pushbutton (RS)
S5 D.p.s.t. rotary mains switch (RS)

Miscellaneous

T1 Gardners mains transformer type SL8, 20·5–0–20·5 volts
LP1 Neon panel lamp with internal resistor
Case—H.M. Electronics type GB3
Stereo jack socket, 4-DIN 5 way sockets, four 4mm sockets, five control knobs, three push-button switch buttons (RS), two Eagle 20mm fuseholders, 1A fuse, 2A fuse, four Lektrokit spring clips type LK2791 (1·5in), five way tag-strip. screws, spacers, grommets, aluminium angle, connecting wire.
A glass fibre printed circuit board printed with component locations, and a kit of semiconductor devices for this project are available from Davian Electronics, PO Box 38, Oldham, Lancs.

transistors. Bias transistor TR7 operates in the "amplified diode" mode and is thermally coupled to the output transistors by being clamped to the heat-sink. This gives a great improvement in bias stability as any increase in heatsink temperature is compensated for by a reduction in bias.

OUTPUT TRANSISTORS

The output transistors TR9, TR10 on the circuit diagram are shown as single transistors for simplicity, but they are in fact monolithic Darlington pairs with a minimum current gain of 750 at 3 amps. These transistors have proven themselves to be electrically very robust and we have found that a 2 amp fuse in the positive rail is adequate to protect them against short circuits on the output.

Note that the fuse should be connected in the positive rail and not the negative rail. When the positive supply is removed the whole main amplifier is turned off because the bias is removed from the constant current source TR8, and also from the input stage TR4 and TR5. This in turn turns off TR6.

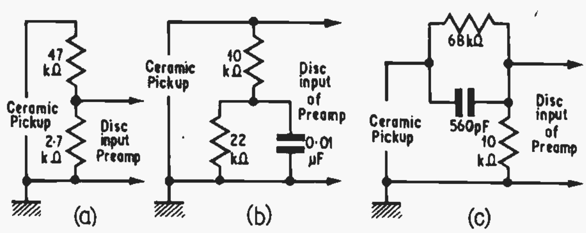


Fig. 1.3 (a). Circuit giving approximate matching for most types of ceramic pick-up; (b) circuit for matching the Decca Deram ceramic pick-up; (c) circuit for matching the Sonotone 9TAHC ceramic pick-up

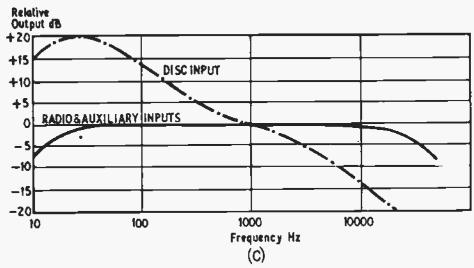


Fig. 1.2. Frequency response of disc, tuner and aux inputs

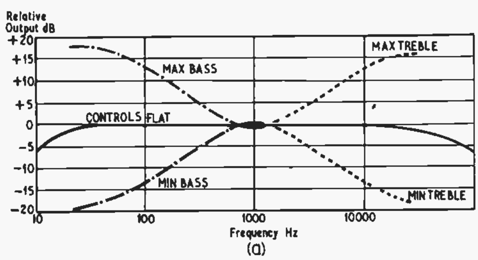


Fig. 1.4. Frequency response of the tone controls

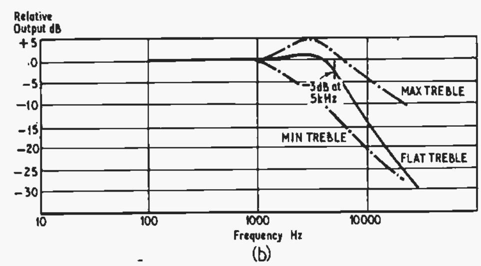


Fig. 1.5. Frequency response of the scratch filter

POWER SUPPLIES

When one is designing a small, low cost amplifier the first refinement that one has to do without is the use of a stabilised power supply. This introduces a number of problems; but there are compensating advantages.

The problems arise because of the lack of stabilisation. To get 20 watts output into an 8 ohm speaker we need a power supply which will deliver 45 volts on load. But when the amplifier is not giving any output and there is only a light load on the power supply, its voltage can easily rise to 60V. If we allow for mains voltage variations, then under the worst conditions the supply voltage could reach nearly 70V. With a stabilised power supply output transistors rated at 50V would have been satisfactory, but with our unregulated supply we need output transistors which will stand at least 70V. Not only this but all the electrolytic capacitors need to be conservatively rated as well.

The unregulated power supply does however have one very great advantage. A musical signal has a low average power level with occasional peaks of high power. For a short period (until the power supply voltage drops) an amplifier with an unregulated supply can deliver a power output very much greater than its continuous rating. This amplifier will deliver 23 watts per channel continuously into 8 ohms, but on a musical signal it is almost as good as a 35 watt amplifier.

Lastly it might be as well to clear up exactly what we mean by continuous power. With 15 ohm loads the power dissipation is sufficiently low for the amplifier to be run at full sinewave power continuously. With 8 ohm loads it will also safely run continuously provided that it is placed in a well ventilated position where air can circulate freely around it, but the back of the amplifier tends to become rather hot after about 30 minutes of full sinewave power. With 4 ohm loads the amplifier should not be run at full sinewave power for more than about 10 minutes at a time, or the temperature of the output transistors may become excessive.

One does not normally listen to sinewaves of course and with a normal music or speech input the amplifier can be run continuously at full volume without any reservations.

DISTORTION

At full output the distortion introduced by the other components in the hi-fi system will be much greater than that of any reasonable amplifier. Moving coil loudspeakers can generate up to 10 per cent distortion and even electrostatic types can give 0·5 per cent. A good modern f.m. tuner can generate 0·5 per cent., a tape recorder about 2 per cent, and a gramophone pickup can reach as much as 20 per cent on the inner grooves. Compared to these figures the performance of all but the most mediocre amplifiers is adequate at full output.

There lies the snag. All the signal sources may have considerable distortion at full output, but the distortion falls rapidly at lower levels. This is not necessarily the case with an amplifier. If crossover distortion is present the distortion may be only 0·1 per cent at full output but may easily rise to 1 per cent or more at low levels. Crossover distortion is particularly unpleasant because it generates high order harmonics, which are discordant and easily perceived.

For crossover distortion to be negligible it should be less than 0·1 per cent at all power levels. Low order harmonic distortion is less objectionable and up to 0·5 per cent can be tolerated. So we can say that our amplifier should have a distortion specification of no worse than 0·5 per cent at full output, and below 0·1 per cent at all power levels below 1 watt.

The use of a constant current source in this amplifier has helped us to achieve a very low level of crossover distortion—typically about 0·01 per cent at 1 watt—and with 8 or 15 ohm loads the harmonic distortion is below about 0·1 per cent at all power levels up to full output. With 4 ohm loads the performance does not reach quite the same standard, but it is still below 0·1 per cent at 1 watt and 0·5 per cent at full output.

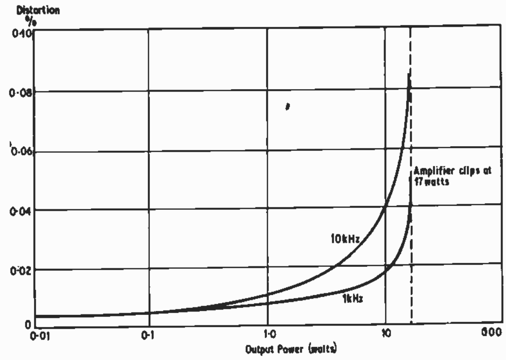


Fig. 1.6. Distortion against output power for 15 ohms measured at 1 and 10kHz

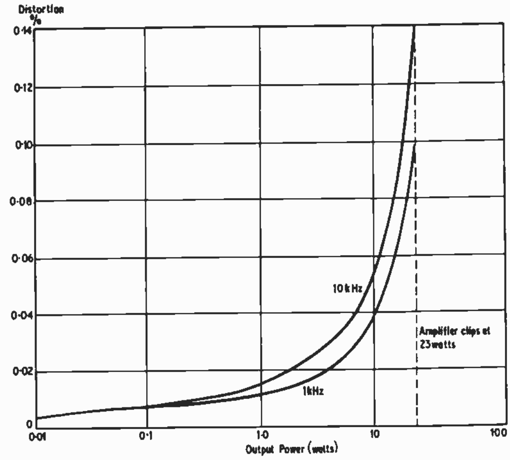


Fig. 1.7. Distortion against output power for 8 ohms measured at 1 and 10kHz

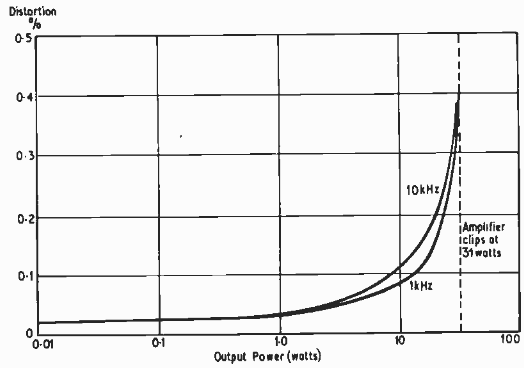


Fig. 1.8. Distortion against output power for 4 ohms measured at 1 and 10kHz

FREQUENCY RESPONSE

Many constructors are firmly convinced that a very extended frequency response is a good thing. This is a complete fallacy because—

1. Human hearing extends from about 20Hz to 20kHz at the best. There is some evidence that transients containing harmonic components above 20kHz can be distinguished but there is certainly nothing to be gained by extending the response past 40–50kHz.

2. There are very few loudspeakers with any useful response below 30Hz or above 20kHz.

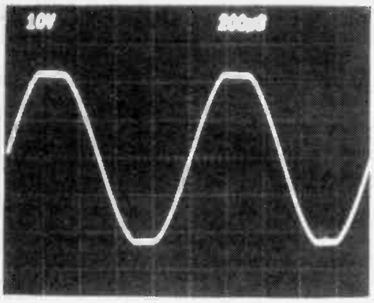
3. There are no radio signals with any audio above 15kHz.

4. There are no records or cassettes with any audio above 20kHz.

In fact the only audio signal available which might have anything above 20kHz would be a very high quality tape recording of a live performance.

A very extended frequency response can be a very bad thing. If the low frequency response is very extended then low frequency noise from turntable rumble, warped or off centre records, or tape recordings can get through the system and cause the speaker cone to flutter violently. If the h.f. response is very extended then h.f. noise and multiplex sideband components can intermodulate with each other and with h.f. audio signals to produce audible distortion and noise. So what is the ideal response? Probably something like 20Hz to 50kHz ± 3dB.

This amplifier has been designed so that the frequency response falls rapidly below 10Hz, and so



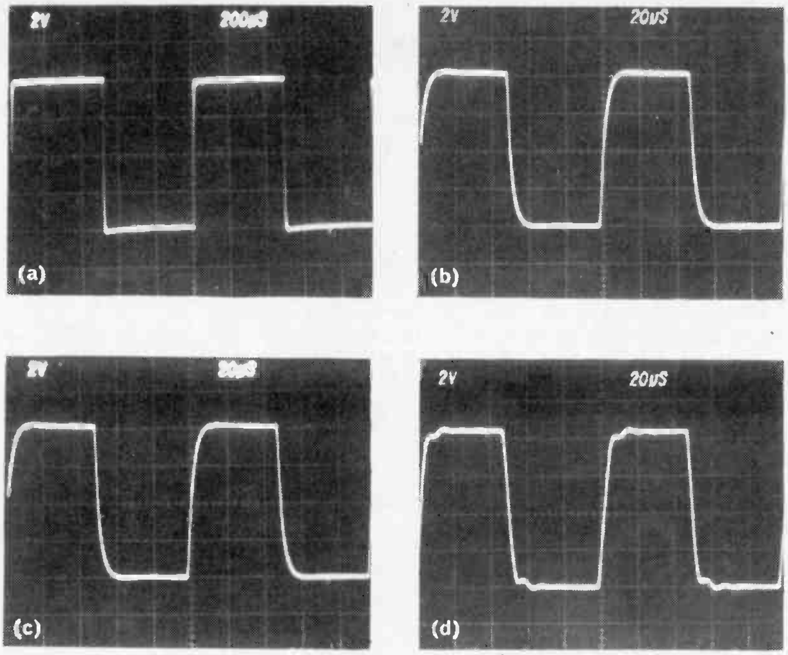


Fig. 1.9. Output waveform of the amplifier when slightly overdriven with a 1kHz sinewave showing the clean symmetrical limiting with freedom from latch-up

Fig. 1.10 (a). 1kHz square wave response with 8Ω resistive load; (b) 10kHz square wave response with 8Ω resistive load; (c) 10kHz square wave response with load of 8Ω and 0·1μF; (d) 10kHz square wave response with a load of 8Ω and 2μF

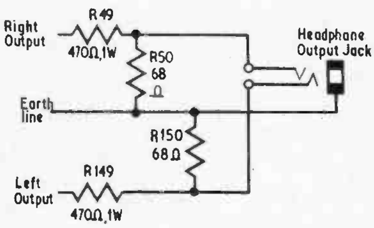


Fig. 1.11. Headphone attenuator circuit if required. Note that resistors have been omitted from Components List

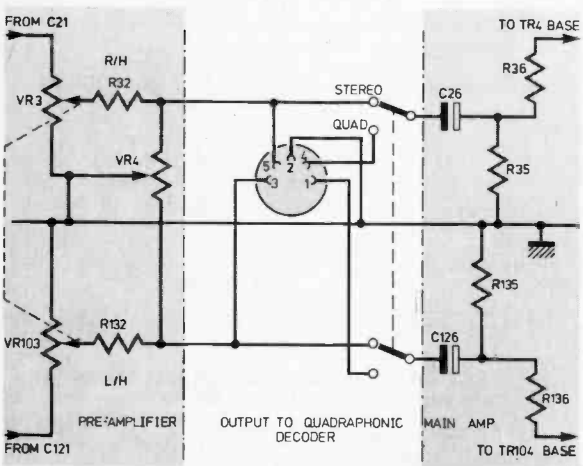


Fig. 1.12. Connections for quadraphonic decoder. DIN socket connections are as follows:—
1. **Left channel front input from decoder**
2. **Earth**
3. **Left channel output to decoder**
4. **Right channel front input from decoder**
5. **Right channel output to decoder**

a separate rumble filter is not necessary. The h.f. response of the tape input extends to 50kHz but the radio input has been restricted to 30kHz to attenuate multiplex and carrier components. With the scratch filter switched in all the inputs are 3dB down at 5kHz.

TRANSIENT RESPONSE

For good reproduction it is essential that the amplifier should have a good transient response with as little ringing as possible, even when fed into a highly reactive load such as an electrostatic loudspeaker.

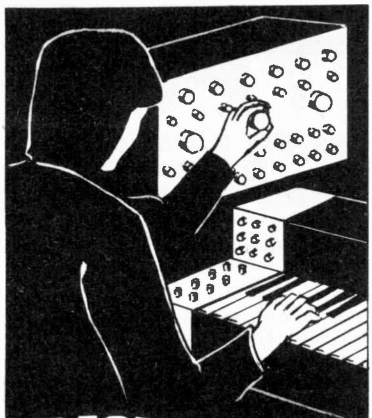
In this amplifier a particular effort has been made to achieve a good transient response and Fig. 1.10 shows the performance of the amplifier under various load conditions. Note that with a 2μF capacitive load the ringing is of very low amplitude and soon dies away. If a 0·5 ohm resistor is connected in series with a 2μF load (as we recommended for the Quad speaker), then even this small amount of ringing is completely eradicated.

QUADRAPHONICS

No special provision has been made for quadraphonics in the prototype, mainly because of lack of space, but it is a simple matter for the enthusiast to adapt the circuit for use with a quadraphonic decoder.

All that is necessary is to break the connection between the preamplifier and the main amplifier and replace it with a switch and a DIN input socket, as shown in Fig. 1.12. The two front channels can then be fed back into the Orion main amplifiers whilst the back channels are fed to another amplifier. An additional pair of Orion main amplifiers would be ideal for this purpose.

Next month: Constructional details and setting up.



ELECTROMUSE

By Malcolm Pointon

RE-READING one of the earliest publications on electronic music recently I came across the following statement made by Herbert Eimert, founder of the Cologne Radio Electronic Music Studio:

> "That—electronic music cannot be performed on Instruments is due to the fact that the number of individual sound elements is so great that any attempt to find means of instrumental realisation is doomed to failure."

One's immediate reaction is to wonder whether he would have ventured to say this now, in the age of the synthesiser, when many pop groups have some kind of synthesiser.

Perhaps even twenty-odd years ago, when Eimert's article was written, there was little excuse for such a statement; the electronic and electrophonic instrumental field was by then quite sophisticated. A little relatively recent history may be pulled in here to support, or maybe excuse, his apparently negative remark.

The Years Between

In the years between the two world wars Arnold Schoenberg, Austrian composer, systematised the 12 notes of the traditional chromatic scale to produce music which did not rely on key (i.e. the predominance of one note over any other) but used all the available pitches equally. Amongst his pupils was Anton Webern who went a stage further than his master; rather than treating the 12 notes in a fairly conventional linear manner he perfected a style of writing which laid weight on each individual note as and when it occurred in the musical flow.

The dynamic levels, pitch and timbre were carefully controlled in his sparsely written aphoristic instrumental and vocal compositions.

Lionised Webern

After the war a group of young German musicians picked up the almost submerged threads of these revolutionary concepts and made Webern their idol. Reinforced by similar pre-organised, or serial, ideas put forward in works by the French composer Olivier Messiaen, these young intellectuals went on to produce a new music in which all the parameters available to music were fully exploited, almost mathematically. The musical results were often impossible to perform by human beings, yet the European scene rapidly became thick with "avant-garde" concerts, many of dubious integrity.

That any worthwhile music has survived this period is a minor miracle, given the arrogance of the exponents and the loud raspberries of the musical press.

It was during this babel of activity that the tape recorder came into general use, and with it the very latest in sensational sound, electronic music. Anything essentially of an acoustic nature was taboo. Needless to say electronic compositions were meticulously edited and fixed for all time on magnetic tape.

Colouristic Effect

Meanwhile in France there was another little sonic revolution taking place. Whilst those who whored after strange gods studied the latest serial techniques in Germany, others stayed behind to practice the art of colouristic effect for which the French have always been renowned.

Pierre Schaeffer founded a studio in Paris dedicated to the study of the physics and psycho-physics of acoustic phenomena and to the production, on discs initially, of musical compositions which took raw, natural sounds as their starting point. Plain aural effect was the ambition; Schaeffer and his colleague Pierre Henry had little time for the intricate number games which the Germans were playing. The search for *"musique concrete"* [natural or non-abstract music] ended with the arrival of the tape recorder and the simplicity of editing magnetic tape.

Partisan Factions

So electronic music began life in two partisan factions: the German-influenced found the French *"musique concrete"* positively naive and artless, whilst the French considered the Germans inhumanly mathematical and equally artless. Both came together, however, in considering their respective tape compositions to be one-off, once-and-for-all performances.

Live electronics

So Eimert was right. Given the complexity of a totally serial composition with its rapidly changing rhythmic, pitch, spatial, dynamic and timbre elements, only a taped sequence could do justice to a particular concept. No amount of juggling around with electronic organs and peripheral sound effect units would reproduce on the concert platform what could be realised on tape.

The same applies to Schaeffer's collages, where natural sounds, recorded wherever they existed, were processed electronically, the result defying any musical instruments—save perhaps the Melotron, which is nothing more than a filing cabinet of tape recordings with a piano keyboard attached. Eimert lacks credence in his underlying assumption that Electronic Music is a *style* rather than a medium of expression.

Today's Electronic Music

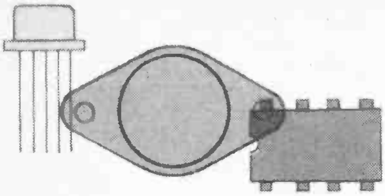
In today's Electronic Music the factions have largely disappeared; Stockhausen has cast off the strait-jacket of total serialisation and in his taped works uses the human voice, gramophone records, short-wave radios and acoustic instruments. Schaeffer and his colleagues rely quite heavily on purely electronic sound producers.

Along with this fusion of two differing approaches to taped material came the feeling that performers ought to take some share in the interpretation of this kind of music; hence "Live electronics".

Pop Sounds

By far the largest purveyors of live electronics are the pop groups. (Only a pedant would argue that their music is not strictly electronic.) Electronic instruments work admirably here since most of the music performed is geared to the traditional pattern of twelve notes to the octave and is old fashioned enough to use fairly common juxtapositions of these notes. Above all, pop-music is primarily melodic music and this means that a given instrumental line is unlikely to require rapid changes of timbre.

To some extent "serious" live electronic groups have taken a lead from the pop world; the music they perform is no more complex to realise than an equivalent piece of acoustic instrumental music. Should they require complex arrangements of sound these still have to be pre-recorded on tape.



THE NEXT DECADE?

Final selection of readers' predictions

ARMCHAIR VIEWING

I BELIEVE that in the next decade we could well see many changes in our everyday life due to electronics. Instead of travelling to conferences, businessmen might stay at home and "attend" the conference via video and audio links to a central conference control, through which they would be able to see and hear their colleagues. They would also be able to "look up" relevant information through the conference control and have it displayed on their screens for as long as they wish.

We could watch any television (if it could rightly be called this) programme whenever we pleased.

The printing world can throw away its presses, for we will be able to dial for, say, the front page of today's newspaper and have it displayed on our "newscreens." Yes! even our beloved *Practical Electronics* will come to us like this. (Don't worry Ed., you will still be needed.)

No-one will have to think as much, for we will all have our own computer calculators, and musical instruments will be replaced by synthesisers, so that the Pablo Casals' of tomorrow will play upon streamlined keyboards instead of peculiarly shaped pieces of wood.

All this sounds rather unlikely? Well, you wait and see.

S. J. Baxendale.

COMMON PLACE

IN the next ten years no progression is forseeable in the direction of component miniaturisation, owing to the impossibility of decreasing pin and encapsulation size. It is likely that more will be fitted into a single module—Mr. Shaw's synthesiser on a chip, for example.

Specialisation of these circuits is almost inevitable, specifications going further and further towards the extreme, with fantastic power handling and even more fantastic frequency ranges, now only the dream of hi-fi enthusiasts. Technology cannot be underrated in sorting out the problems which may make these two characteristics (now) incompatible.

For the home constructor, today's high-powered technology may be tomorrow's workbench experiment. A home made integrated circuit kit for example; which is not such a far fetched idea if one looks at the basic simplicity of overlaying the semiconducting layers, assuming there will be enough semiconducting material left by tomorrow!

Soon one may be able to leaf through a catalogue of "surplus" equipment, which at present is described as a technological breakthrough. Basic techniques could soon be outmoded, soldering and the printed circuit board might soon be replaced by the plug-in module.

In conclusion, it could be said that in the next decade, though there may not be the advances of the like of the integrated circuit in the last ten years, technology will push its usage to the limits. Also, present technology will be commonplace to the constructor in not so many years.

N. J. Eastaugh

MAN AND HIS ELECTRONICS

THE philosophy of electronics in the next decade is summed up by "digital is best, and smaller is better".

Compromised by cost, and using the results of researches into the nature of human perception, manufacturers will set lower standards of sound and image reproduction.

Enthusiasts will reconstruct the electronic achievements of the 1920's with antique components or replicas made by new cottage industries.

A wide range of games-machines designs will be published for the constructor. At best, they will be war games, or a form of Monopoly in which the players are relieved of the arithmetic of accounting and cannot break the rules.

The power of present-day minicomputers will be available in a single i.c. costing £20, or less.

The military applications of microelectronics will shock and horrify us, but the constructor will find light relief from the problems of the day by assembling the parts of a micro-computerised mouse for his cat to play with.

There will be great interest in the generation of special effects. Today's Wind and Rain generator will be supplemented by tomorrow's Thunder and Lightning, the degree of authenticity rising according to ingenuity and the size of purse.

Electronic musical instruments will have substantial computer power, and the constructor will spend more time in programming than constructing his creations, having purchased programmes from the lists in the advertisement pages of his favourite journal, P.E.

Seated at the console of his electronic organ, engaged in extempore musical invention, such will be the interaction between man and his electronics that the player may well exclaim from the profundity of philosophical doubt, "Just who is playing this machine?" The folly of the decade will be an attachment for colour TV receivers to permit the display of electronically simulated goldfish.

D. Letts

HIGHER QUALITY

THE next decade will not unveil any major electronic breakthroughs but instead, in a time of financial instability, manufacturers will concentrate on improving the quality of goods already available, the risks being too great for a large scale venture into something radically new. Maximum profit being essential, the fear of failure in a component would be too daunting.

Transistors and integrated circuits will continue to be the main "workbench" of electronics, both on an amateur and professional scale. The valve will still command itself a place but will always run a poor second to the modern semiconductor, as I feel it does now.

With everybody striving to attract the prospective customer to their particular line of components there will inevitably be many new i.c.s on the market, having better power handling capacities and such-like in an effort to better their predecessors, but none of them will be fundamentally different.

A shortage of raw materials, evident at the present time, will mean price rises and delivery delays (nothing new!) This could also result in the amalgamation of many small component retailers who would otherwise be forced into liquidation by the bigger concerns cornering all the custom.

The overall trend will be to encapsulate the components in plastic containers which constantly seem to diminish in size.

Finally, the high degree of competitiveness between manufacturers will result in a higher quality of components—which can only be to the good of the constructor in the end.

M. S. Johnson

ELECTRONIC LABEL

THE present trend of improvement in electronic technology is likely to provide some new and perhaps exciting uses of the circuits as we know them. It may be taken for granted that they will reduce in size, become more reliable and presentable, and who can say how long they would last.

The reading of domestic meters by remote computer, preparation of account, and even automatic payment of the bill by pre-arrangement, is but one aspect.

It is likely that television receivers will be used in the dual role of entertainment or access to information, such as availability of goods or prices. The telephone line perhaps, would be switchable to a number of facilities, with a "back up" visual display.

One possible change is in the use of pocket, or desk calculators. It is quite feasible to envisage these being used as mini computers without major circuit change. For instance, with a microfilm attachment, and "access code" operation using the same styled keypad, the film could be rotated by the command word, and illuminated on a slightly enlarged screen.

Finally, how about the "Electronic Label", a microcircuit, so small that it could be incorporated into almost any article at the manufacturing stage, and with its own identity calling signal, quiet, unless called by a master beacon. Nasty though, if you want to go into a pub for a quick one and the wife is looking for you!

A. J. Williams

DIGITAL TRACKS

THE next decade will be dominated by political change, which will include higher taxation for the individual, and wage rates so high that the cost of maintenance and repair will often exceed the value of the article to be repaired.

The first item will make it unlikely that the colour television boom will be repeated with video cassette recording or the Ceefax/Oracle system. However, this may well give rise to a new system of video recording towards the end of the period using digital methods with about 150 narrow tracks instead of the helical scan system with its mechanical complexity.

Such a change would be less likely if a large number of helical scan recorders were already in use.

The lack of money in the hands of individuals will be compensated by more in the hands of government, who will spend more on electronics.

One possibility taken at random could be a distress calling system for old and disabled people. The caller presses a button that activates a device to send a high frequency signal into the local mains electricity network. This signal is modulated by a series of pulses representing a number allocated to the caller. A warden who has a receiver on the same local mains ring is alerted that the caller is in trouble.

A second is the introduction of automated speed traps, made necessary by increasingly restrictive speed limits due to overcrowding and fuel shortages. These would photograph offenders' cars showing the speed on a print-out. An official would collect the photographs every so often. To avoid the possibility of malfunction causing injustices, offenders would be prosecuted if caught more than once in a set period of time.

The second item, wages, will lead to novel methods of improving reliability of electronic goods. Touch-operated integrated circuit sub-systems will replace potentiometers and switches, and possibly i.c. optical modulators and demodulators coupled with optical fibres will replace plugs and sockets for connecting audio discrete units.

J. de. Rivaz

INTEGRATED I.C.'s

TEN YEARS is not a long time, but I believe that man will advance more in the next ten years than in the last ten. After long consideration I came to the conclusion man's advancement was of a logarithmic nature and not a linear one. Our greatest advancement will be in the field of i.c.s and their interconnection.

Soon we will see the inductor being incorporated in i.c.s and midway through the decade we will see the key to a new kind of electronics. No more will i.c.s be coupled by wires, coupling will be similar to the lecher lines used in u.h.f. tuners. Simply placing the i.c.s one on top of another, rather like the child's building bricks only in a miniature form. From this giant leap electronics will virtually know no bounds. The solid state power pack recharging itself from air, light, heat, or vibration, for example.

Air and light may be used, as in plants, to create chemical changes. These we can change into electrical energy. Heat given off due to power loss will be channelled back to the power pack to help recharge power cells. Vibration as used in self winding watches, used to generate power.

These advancements will lead to vast developments, such as the pocket computer, rather similar to the pocket calculator we have today, only thousands of times better and incorporating an audio output.

Programme cartridges will also be solid state, as in microfilm one small block containing many hundreds of hours of information.

Such an instrument would place the home constructor almost on a par with the professional.

Roll on 1984.

A. Tannock.

DIODES AND ALL

EXPERIENCE shows that the development of technology follows something akin to a log. law curve. In semiconductor technology there has been a veritable explosion of new ideas and techniques. If interpolation of this curve is attempted then the results can be somewhat surprising.

Today's computers using holographic or ferrite memory stores are far too cumbersome, slow and expensive. Development of heavy metal organo compounds already well under way should bring about the production of high temperature (in excess of 100°K) superconducting memory stores:—possibly a very primitive forbear of Asimov's positronic brain!

For constructors, l.s.i. circuits are already available, the question remains how large (or small) can they get and for what purpose. Pocket calculators already have chips containing thousands of active elements, and I rather think that today's constructor in ten years will be in much the same boat as those are now who lament the passing of the valve, we shall be lamenting the passing of the discrete transistor.

Looking back, most developments seem to stem from the humble diode, the latest being the ubiquitous l.e.d. so the logical development of this would be the "light emitting transistor"—alter the base bias and "hey presto"; modulated light output.

E. J. Marchant.

SIMPLIFICATION

THE following decade, for myself and fellow constructors, should bring simplification in the form of reduced wiring and soldering for more complicated circuits with increasing use of i.c.s.

With spiralling cost of most products, the hope of continued amateur construction may lie in continued progress in i.c. technology to reduce manufacturing costs.

For the home constructor whose use of i.c.s was exclusively bipolar (TTL), he may find himself making adjustments in the not too distant future towards a different form (CMOS). In this increasing energy-conscious world, the life of the bipolar form of logic could be drawing to an end, with less power consuming logic forms such as CMOS becoming more and more popular.

Amateurs and professionals over the coming years will be made more power conscious and a tendency towards battery supplies in contrast to more expensive a.c./d.c. Transformation will be encouraged as a practical step for the home constructor.

Manufacturers will be responsible for this trend, as they become more aware of producing the form of logic which will be more financially secure for the future.

S. Naismith

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Britain's most original calculator now in kit form
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It offers logs, trig, and true scientific notation over a 200-decade range – features normally found only on calculators costing around £100 or more.

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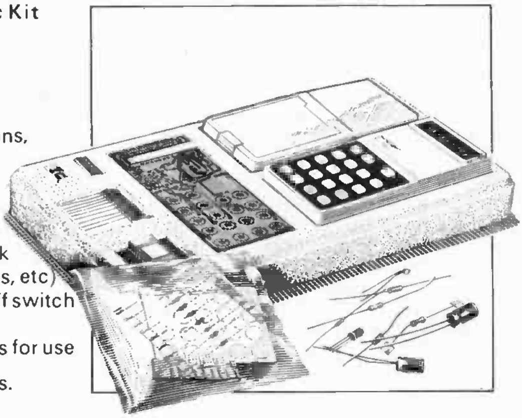
Components for Scientific Kit (illustrated)

1. Coil
2. LSI chip
3. Interface chips
4. Case mouldings, with buttons, windows and light-up display in position
5. Printed circuit board
6. Keyboard panel
7. Electronic components pack (diodes, resistors, capacitors, etc)
8. Battery assembly and on/off switch
9. Soft carrying wallet
10. Comprehensive instructions for use

Assembly time is about 3 hours.



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10^{-99} to 10^{+99}.

● **Reverse Polish logic** Post-fixed operators allow chain calculations of unlimited length – eliminate need for an = button.

● **25-hour battery life**
4 AAA manganese alkaline batteries (e.g. MN2400) give 25 hours continuous use. Complete independence from external power.

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4 1/3" x 2" x 11/16". Weight 4 oz. Attractively styled in grey, blue and white.

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3. Interface chip
4. Thick film resistor pack
5. Case mouldings, with buttons, window and light-up display in position
6. Printed circuit board
7. Keyboard panel
8. Electronic components pack (diodes, resistors, capacitors, transistor)
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10. Soft wallet

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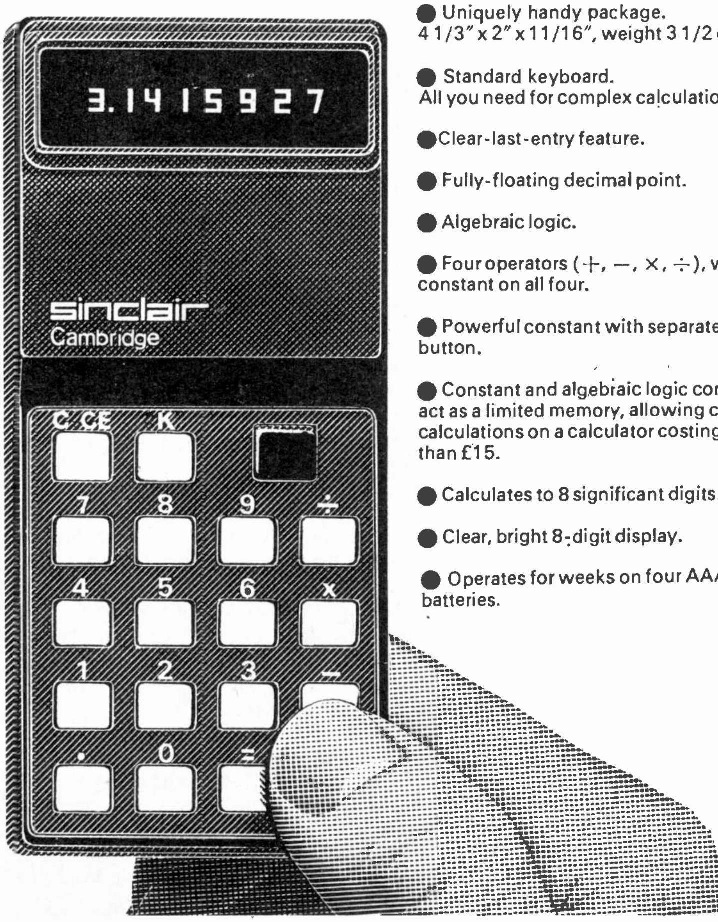
Features of the Sinclair Cambridge



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- Standard keyboard. All you need for complex calculations.
- Clear-last-entry feature.
- Fully-floating decimal point.
- Algebraic logic.
- Four operators (+, −, ×, ÷), with constant on all four.
- Powerful constant with separate 'K' button.
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PE MINISONIC

By D. SHAW

PART THREE

- Keyboard Controller
- Noise Generator
- Ring Modulator
- Power Amplifiers

THIS month the remainder of the electronic circuitry in the synthesiser is described which includes KEYBOARD CONTROLLER, RING MODULATOR, NOISE GENERATOR and POWER AMPLIFIERS.

THE KEYBOARD CONTROLLER

The KEYBOARD CONTROLLER as illustrated in Fig. 3.1 is a relatively simple means of providing a range of voltages which, when applied to the input of a VCO, cause it to oscillate over a range of pitches normally associated with a chromatic scale or, alternatively, over a range of pitches quite outside what might be termed normal musical acceptance.

IC1 and IC2 are inverting operational amplifiers whose outputs are linked by a chain of resistors the junctions between which are connected to the keyboard contacts. R5 and VR1 form a divider between the positive rail and ground such that the swing of the potentiometer covers a range of about 4·7 volts.

The wiper of VR1 is linked to both i.c.'s so that the output of these devices will track, in unison, the setting of VR1. R1 and VR2 form a second divider between the negative rail and ground with the wiper linked to IC1 only. Thus VR2 is able to provide an offset to IC1 which is variable over 4·5 volts.

The purpose of the voltage difference between the swings of the two potentiometers, is so that, under normal conditions, the key contact voltages can never go positive and thus drive the VCO's into saturation.

SPAN AND TUNE CONTROLS

The KEYBOARD CONTROLLER can be matched to a wide range of keyboard sizes and VCO control voltages.

If, for example, a two octave keyboard is to be used and the required control voltage for the VCO's is 600mV per octave, then VR2 (the "Span" control) will require to be offset by 1·2V with respect to the inverted value of VR1's setting. Once this has been used and the required control voltage for the VCO's are able to reproduce a chromatic octave by making a series of consecutive key contacts, then VR1 may be adjusted over a wide range without affecting the "tune" of the VCO's.

In simple terms the "position" of the two-octave keyboard may be varied over the audio frequency range and the "white" notes may be made to play in any required key signature. This latter feature will commend itself to those "play-it-by-ear" musicians who may sometimes find difficulty in translating a well known melody in the key of C into its correct signature.

For more serious applications, however, the ability to swing the keyboard "position" enables the Minisonic to play in tune with a number of conventional acoustic instruments which may, themselves, not be precisely "spot-on" as far as tuning is concerned.

KEYBOARD RESISTOR CHAIN

No setting-up is required for the KEYBOARD CONTROLLER other than to check that the outputs of both IC1 and IC2 respond correctly to the settings of VR1 and VR2. Fig. 3.1 gives a table of resistor values which may be used for the divider system on keyboards of various sizes.

It will be noted that the overall value of resistance in each case is approximately the same in order that the loading on the i.c.'s will vary by a minimum amount regardless of the size of keyboard employed.

THE "HOLD" OR ANALOGUE MEMORY

Although covered by the general heading of KEYBOARD CONTROLLER the HOLD circuit is a quite separate entity which fulfils an important function in the scheme of the synthesiser.

Last month it was indicated that the ENVELOPE SHAPER could give a decay characteristic lasting up to 16 seconds. In other words, from the instant the key contact is broken, the audio signal will continue —at a diminishing level—for the prescribed period. It is obvious therefore that, for the best effect to be achieved, the VCO frequency must remain constant for the period over which the decay is taking place.

With the key contact broken so too is the VCO programming voltage disconnected unless there is some means by which the VCO can continue to be programmed regardless of key contact condition. The HOLD circuit provides the means whereby the VCO can continue to oscillate at the frequency prescribed by the last programmed voltage either until the ENVELOPE SHAPER completes its cycle or until another voltage is programmed in.

HOLD CIRCUIT

The circuit of the HOLD facility is shown in Fig. 3.2a. IC3 is an operational amplifier in which the output signal is divided by means of VR4, R8 and R9 to provide balanced levels of positive and negative feedback.

When the balancing is carefully done the circuit is theoretically capable of presenting an infinite impedance to incoming signals. In practice, however, it is more usual to calculate the input impedance on the basis of the parallel value of the feedback resistors times the open loop gain of the amplifier. Thus the input impedance is of the order of 2,500 megohms.

The hold capacitor (C2) is, ideally, a low leakage type. A charge applied to C2 is reflected at the output of IC3 with any drift at the output due to a combination of capacitor leakage and minor thermal effects within the i.c.

COMPONENTS . . .

KEYBOARD CONTROLLER AND HOLD

Resistors
R1 10kΩ
R2–R4 47kΩ (3 off)
R5 9·1kΩ
R6, R7 47kΩ (2 off)
R8, R9 20kΩ (2 off)
R10 47kΩ
R11 et seq See text

Potentiometers
VR1, VR2 10kΩ linear carbon (2 off)
VR3 10kΩ sub-miniature horizontal skeleton preset
VR4 10kΩ 15-turn preset

Capacitors
C1 1,000pF
C2 1µF 63V polycarbonate

Integrated Circuits
IC1–IC3 Type 741 8-pin d.i.l. (3 off)

Miscellaneous
SK1 2mm socket

KEYBOARD CONTROLLER

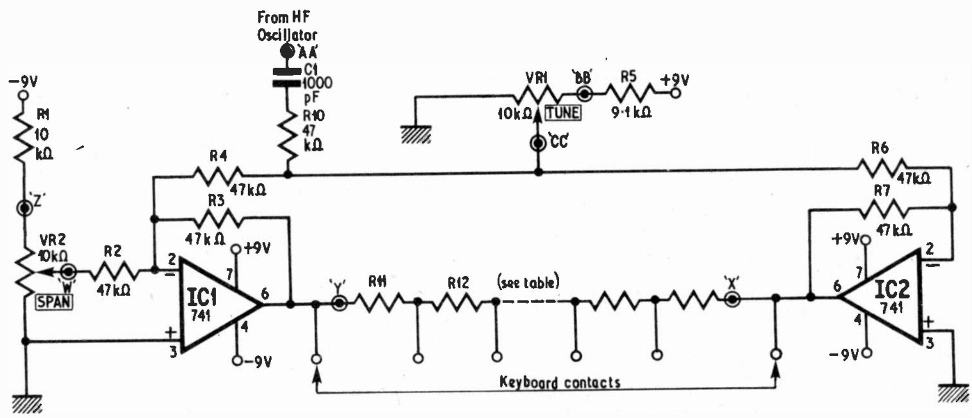


Fig. 3.1. Circuit of the KEYBOARD CONTROLLER (excluding the HOLD circuit). The table (below) shows values of resistors (R11 et seq) and numbers required for various length keyboards. This applies to both printed circuit and conventional keyboards

KBD DIVIDER RESISTORS

Size	Resistor	Number off
1 octave	150Ω	13
2 octave	82Ω	25
3 octave	51 or 56Ω	37
4 octave	39 or 43Ω	49
5 octave	33 or 36Ω	61

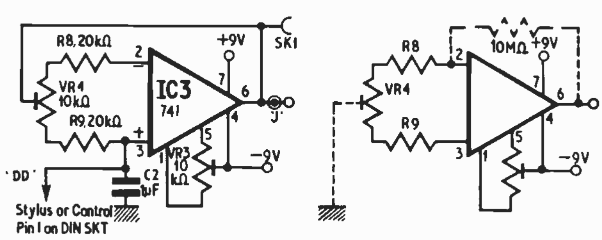


Fig. 3.2(a). The circuit of the HOLD section of the KEYBOARD CONTROLLER. (b) It is important that this circuit should be adopted when nulling the HOLD offset. Temporary links are shown dashed. The feedback resistor should be 10MΩ or more

It is possible to balance the circuit such that the output drift is better than 1mV/sec but to do so requires considerable patience and care, particularly when nulling the offset. The circuit for this latter procedure is shown in Fig. 3.2b. The component assembly should be as shown on the circuit board layout but the wiper of VR4, instead of being linked direct to the output of IC3, is temporarily connected to the 0V rail.

A second temporary feature is the inclusion of a high value feedback resistor (ideally 10MΩ or more) as shown hatched in Fig. 3.2b.

Adjust VR4 so that its wiper is close to the centre of travel and, with power on, adjust VR3 until the output of IC3 is *precisely* zero volts. The temporary links and feedback resistor may now be removed and the circuit completed as shown in Fig. 3.2a.

Minimising the drift in the HOLD circuit is best done by ear, i.e. using the Minisonic vco's rather than an oscilloscope as part of the test equipment. Details of this procedure will be included as part of the final setting up.

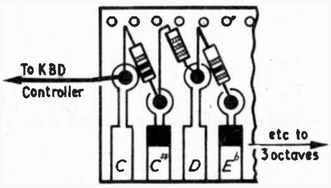


Fig. 3.3(a). Wiring of the edge connector strip as used on the prototype. Resistors are wired in from the conductor side of the board. Excess wire on the other side of the p.c.b. should be trimmed off and filed flush so that the board may be glued to the front panel

THE KEYBOARD

The Minisonic offers the possibility of being operated with a number of keyboard options, the cheapest being the edge-connector type. Other options will be discussed next month.

A printed circuit keyboard was adopted in order that the instrument could be both compact and fully self-contained. In the prototype a three-octave keyboard was made up using a standard edge-connector strip as shown in Fig. 3.3a but satisfactory operation could only be achieved after much practice due to the narrow conductors involved. Mounting of the divider resistors should be generally as shown in the diagram.

COMPONENTS . . .

HARDWARE

Control Knobs, 14mm—19 with skirt, 1 without skirt (ReAn Products—see *Market Place*)
On/off d.p.d.t. toggle
Battery connectors, PP9 2-off positive and negative
0·1in matrix Veroboard 45 × 34 holes
Keyboard 37-way edge connector strip (or see text)
Materials for stylus (see text)
5-pin 180° DIN socket

STYLUS

In the first prototype the stylus employed two contacts and was illustrated on the front cover of the November issue. The double contact, however, greatly added to the difficulties of playing the instrument and thus modifications were carried out so that a single contact stylus could be employed.

Perhaps the simplest stylus involves the adaptation of a ball-point pen (see Fig. 3.3b). If this method is chosen it is important that all traces of ink are removed from the ball end using an organic solvent before any attempt is made to solder in the wire lead.

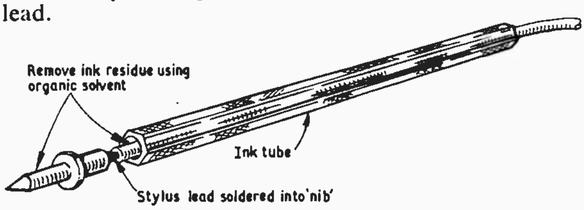


Fig. 3.3(b). A suggested construction method for the stylus using an old ball-point pen

Note that organic solvents should be treated with caution since most of them give off a vapour which can be harmful if inhaled continuously. The assembly when completed should be potted within the lower half of the pen by means of Araldite or Silicon Rubber Compound.

Those constructors having access to a lathe could make up a stylus from a piece of ¼in brass rod. If this method is used it is important that the extreme tip of the stylus should be rounded off and well polished to ensure a good contact.

ULTRASONIC TRIGGER SYSTEM

(The circuitry in this section is the subject of a Patent Application)

The changeover from a double-contact to a single-contact stylus presented a difficult problem simply because the signals required to set the HOLD circuit and to trigger the ENVELOPE SHAPERS are essentially incompatible. Direct coupling between the inputs of these two circuits was therefore not possible since, once the HOLD capacitor was charged, the d.c. level would remain on the stylus lead and the ENVELOPE SHAPER in the "on" condition, until the charge on the HOLD capacitor had leaked away.

This would occur quite rapidly in the circumstances thereby giving rise to an undesired portamento effect. Similarly it was not possible to decouple the ENVELOPE SHAPER from the stylus lead since so doing would restrict the "attack" phase to one rate only—and that very fast. The solution proved to be the application of a principle which is believed to be unique in electronic musical instruments.

HF OSCILLATOR

A HIGH FREQUENCY OSCILLATOR is coupled directly into the KBD CONTROLLER in such a way as to distribute the signal evenly across the divider. The stylus lead which now goes direct to the HOLD capacitor is also connected through a decoupling capacitor to an a.c. detector circuit which, through an integral switch, is used to trigger the ENVELOPE SHAPER.

Four components only go to make up the HF OSCILLATOR which is shown in Fig. 3.4.

VR1 controls the frequency of operation by prescribing the proportion of positive feedback and thereby varying the peak to peak value of the output signal. With the component values given the frequency range is from 2kHz at 18V peak-to-peak, to 250kHz at 80mV peak-to-peak. Output waveforms are also shown in Fig. 3.4.

OSCILLATOR FREQUENCY

The optimum setting of the HF OSCILLATOR is 40kHz at 6V p-p as measured at point "AA." The attenuating effect of C1, R10 and VR1 in the KBD CONTROLLER will combine to reduce the signal to 500mV p-p measured on the keyboard contacts.

It should be noted however that the setting of VR1 in the controller will affect the level of the h.f. signal—the lower the setting of VR1 the lower will be the level of the signal on the contacts. This is not really a problem since the detector sensitivity is around 50mV and also, for most applications, it will be found that VR1 will require to be at a relatively high setting.

HF DETECTOR

The circuit of the DETECTOR is shown in Fig. 3.5. IC2 is a high gain follower decoupled from the stylus lead by means of C2. C1 provides additional decoupling for the stylus lead thereby ensuring that hum signals which may be included in the lead do not cause triggering of the envelope shapers. C4 and C5 provide frequency compensation for IC2 which is a 709 operational amplifier to give the advantage of the higher gain bandwidth offered by this device.

The output of IC2 provides drive to TR1 the collector of which is coupled through R6 to the bases of TR1 and TR2 on both ENVELOPE SHAPERS. (Note that this latter coupling is via the DIN socket and JK1 on both ENVELOPE SHAPERS.) C6 blocks any d.c. appearing at the output of IC2 while R5 sets a current limit.

Under quiescent conditions the output of IC2 is nominally zero volts and TR1 is off. An a.c. signal of sufficient level on the stylus lead will cause IC2 to follow and each positive excursion of IC2 output will switch TR1 on causing the collector to go to about −8·5 volts. The ENVELOPE SHAPERS thus start to attack and C7 receives a negative charge.

H.F. OSCILLATOR AND DETECTOR

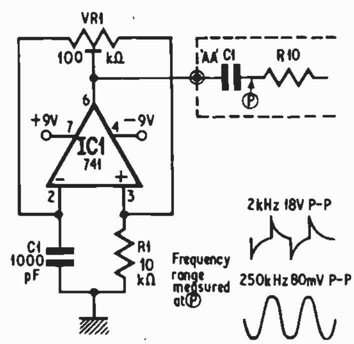


Fig. 3.4. Circuit of the HF OSCILLATOR. Components in the dotted box are on KBD CONTROLLER circuit and are mounted on main board. Typical waveforms at different settings of the VR1 are also shown

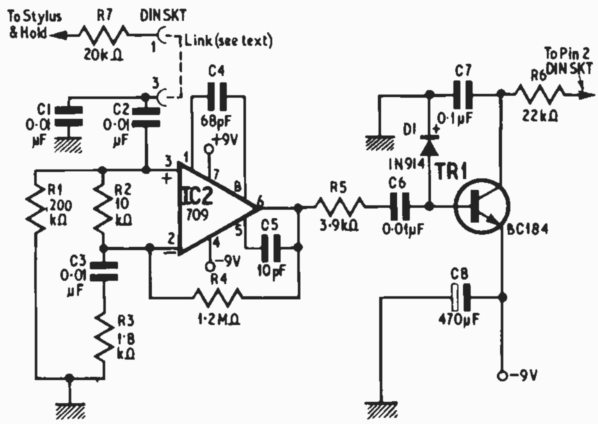


Fig. 3.5. Circuit of the HF DETECTOR. Resistor R7 is for isolation and was 20kΩ in the prototype. The DIN socket is for external keyboard attachment and wiring options will be described next month. C1 is mounted on the DIN socket

COMPONENTS . . .

HF OSCILLATOR

Resistors
R1 10kΩ
VR1 100kΩ subminiature horizontal skeleton preset

Capacitor
C1 1000pF

Integrated Circuit
IC1 Type 741 8-pin d.i.l.

HF DETECTOR

Resistors

R1	200kΩ	R5	3·9kΩ
R2	10kΩ	R6	22kΩ
R3	1·8kΩ	R7	20kΩ (see text)
R4	1·2MΩ		

Capacitors

C1–C3	0·01µF (3 off)	C6	0·01µF
C4	68pF	C7	0·1µF
C5	10pF	C8	470µF 16V elect.

Semiconductors
D1 1N914
IC2 Type 709 8-pin d.i.l.

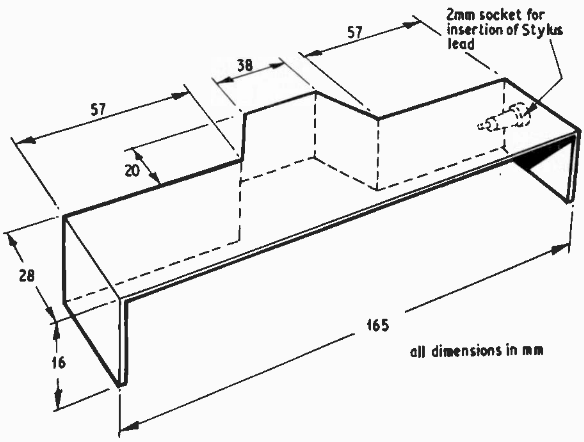


Fig. 3.6. Dimensions of the keyboard cover which was made from 3mm card

The time constant of C7 is such that it will lose only a small proportion of its charge during the negative half cycle of the h.f. signal. The result is that an effectively constant negative signal is presented to the ENVELOPE SHAPERS during the period that the stylus and/or key contacts are made.

ISOLATION RESISTOR

In addition to the components making up the DETECTOR Fig. 3.5 also shows a resistor, R7, in series with the stylus lead and HOLD circuit. The purpose of this resistor is to provide a degree of isolation for C2 in the HOLD circuit so that its relatively large capacity will not over-attenuate the signal on the stylus.

R7 (20kΩ in the prototype) also provides a delay in the d.c. charging rate of C2 with the result that there is a 20ms portamento effect. This effect is not really too noticeable unless consecutive KBD voltages are programmed from opposite ends of the KBD but it could perhaps be a source of irritation for the constructor wishing to use the Minisonic for serious musical purposes.

In these circumstances R7 could be replaced by an inductance which would provide the degree of a.c. isolation required whilst presenting only a nominal resistance to d.c. A suitable choke could be made up from a small ferrite ring toroidally wound with about 20 to 30 turns of 34 s.w.g. enamelled copper wire.

Some experimenting will possibly be required to get just the right value and it would be best to start with the greater number of turns and reduce these as necessary to get the best balance between a.c. isolation and d.c. resistance.

PORTAMENTO

As a modification to the prototype circuits some constructors may wish to incorporate a variable portamento control. In view of the lack of space on the front panel the best way to do this is to mount a miniature edgewise volume control—such as is used on some transistor radios—inside the upper edge of the printed circuit keyboard cover.

The cover is shown in Fig. 3.6. The wire from the stylus socket on the side of the KBD cover would then be routed to one end of the potentiometer while the slider would go via R7, or inductor as mentioned above, to pin 1 on the DIN socket.

RING MODULATOR

The Minisonic RING MODULATOR is an improved version of the circuit which originally appeared in the *P.E. Sound Synthesiser* (August 1973). The essential features of the circuit have been retained however and the circuit is shown in Fig. 3.7.

The RING MODULATOR produces a unique output waveform which comprises, at the same instant, the sum and difference between any two applied input frequencies. This function is carried out in a purpose-built integrated circuit, the SG3402N. With one of the input frequencies fixed, variation in the other will ring the changes in the output frequencies as shown in Table 3.1.

Referring to Fig. 3.7, R1 and R2 form an input attenuator on the so-called carrier input (pin 7) such that, when driven from a VCO, the input signal level at C1 will be about 40mV.

Similarly R3 and R4 attenuate the modulator or control input so that, when driven by a VCO, the input at C2 is about 200mV. This procedure results in an output signal of about 1·5 volts at pin 4 and the same signal in antiphase at pin 11. The antiphase signals are amplified differentially by IC2 to give a peak output signal of three volts which is then attenuated by R9 and R10 to a level compatible with the remainder of the Minisonic circuits.

SETTING UP THE RING MODULATOR

Setting up the RING MODULATOR is very simple. With the circuit completed link the modulator input to the 0V rail and connect the output to a suitable power amplifier. Apply a signal of about 1kHz to the carrier input (normally connected direct to VCO1) and adjust VR1 until the output signal reduces to the lowest possible level. This should, with a correctly wired circuit, be 50dB or more below the peak signal level. At this point the RING MODULATOR is correctly balanced with minimum carrier breakthrough.

NOISE GENERATOR

The NOISE GENERATOR is built round the highly successful Z1J noise diode manufactured by Semitron Ltd., and is shown in Fig. 3.8. Output from the Z1J

Table 3.1: OUTPUTS FROM THE RING MODULATOR

	Frequency						
Carrier	700	600	500	400	300	200	100
Modulator	400	400	400	400	400	400	400
Sum	1100	1000	900	800	700	600	500
Difference	300	200	100	0	100	200	300

RING MODULATOR

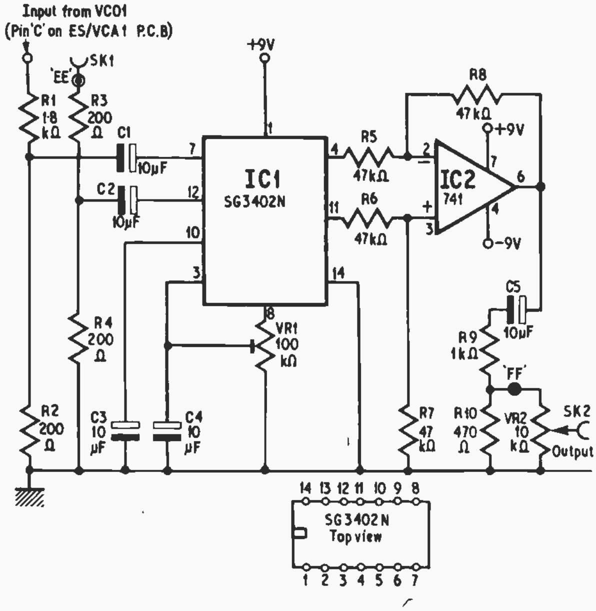


Fig. 3.7. Complete circuit of the RING MODULATOR

COMPONENTS . . .

RING MODULATOR

Resistors
- R1 1·8kΩ
- R2–R4 200Ω (3 off)
- R5–R8 47kΩ (4 off)
- R9 1kΩ
- R10 470Ω

Potentiometers
- VR1 100kΩ subminiature horizontal skeleton preset
- VR2 10kΩ log carbon

Capacitors
- C1–C4 10µF 6·3V tantalum (4 off)
- C5 10µF 16V tantalum

Integrated Circuits
- IC1 SG3402N
- IC2 Type 741 8-pin d.i.l.

Miscellaneous
- SK1, SK2 2mm sockets (2 off)

is amplified by the high gain follower IC1 and led, through decoupling capacitor C5, to the volume control VR1.

The NOISE GENERATOR is the only circuit in the Minisonic which does not operate completely successfully down to a battery voltage of ± 7·5 volts.

In the prototype the noise generator ceased to work when the battery voltage had reduced to ± 7·8V. This situation may be corrected to a certain extent by shorting out R2 and R3 and/or by reducing the value of R1 to, say, 82kΩ. No setting up is required for this circuit.

NOISE GENERATOR

COMPONENTS . . .

NOISE GENERATOR

Resistors

R1	91kΩ	R5	200kΩ
R2, R3	22Ω (2 off)	R6	56kΩ
R4	470kΩ	R7	1·2kΩ

Potentiometer
- VR1 10kΩ linear carbon

Capacitors
- C1 0·01µF
- C2 100µF 25V elect.
- C3 0·01µF
- C4 100µF 25V elect.
- C5 0·01µF

Integrated Circuit and Diode
- IC1 Type 741 8-pin d.i.l.
- D1 Z1J noise diode (Semitron)

Miscellaneous
- SK1 2mm Socket

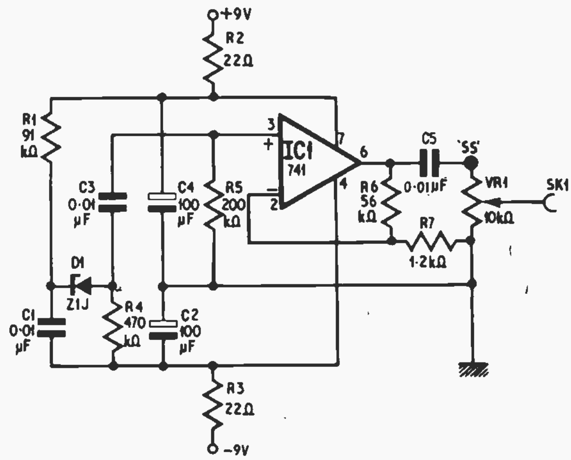


Fig. 3.8. Circuit of the NOISE GENERATOR

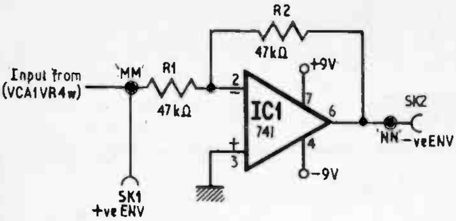


Fig. 3.9. Circuit of the **CONTROL ENVELOPE INVERTER**. This is fed with the output of **ES/VCA1** via **VR4** (see last month)

COMPONENTS . . .

R1, R2	47kΩ (2 off)
IC1	Type 741 8-pin d.i.l.
SK1, SK2	2mm sockets (2 off)

POWER AMPLIFIER

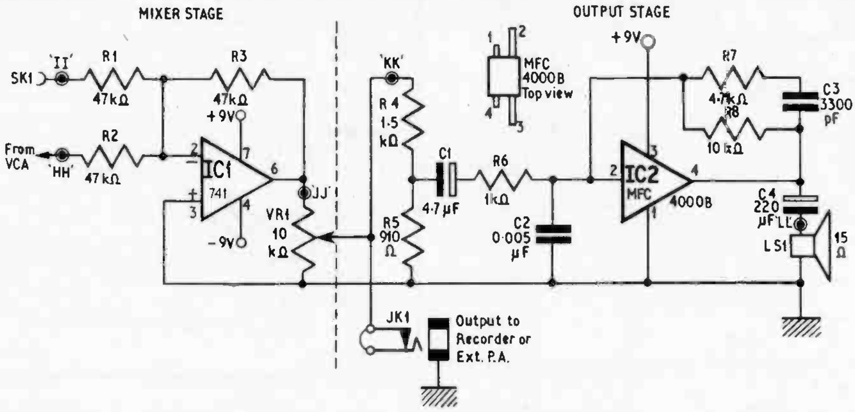


Fig. 3.10. Complete circuit diagram of one of the POWER AMPLIFIERS with integral two-input mixers. Note that the mixer stages are mounted on the main circuit board

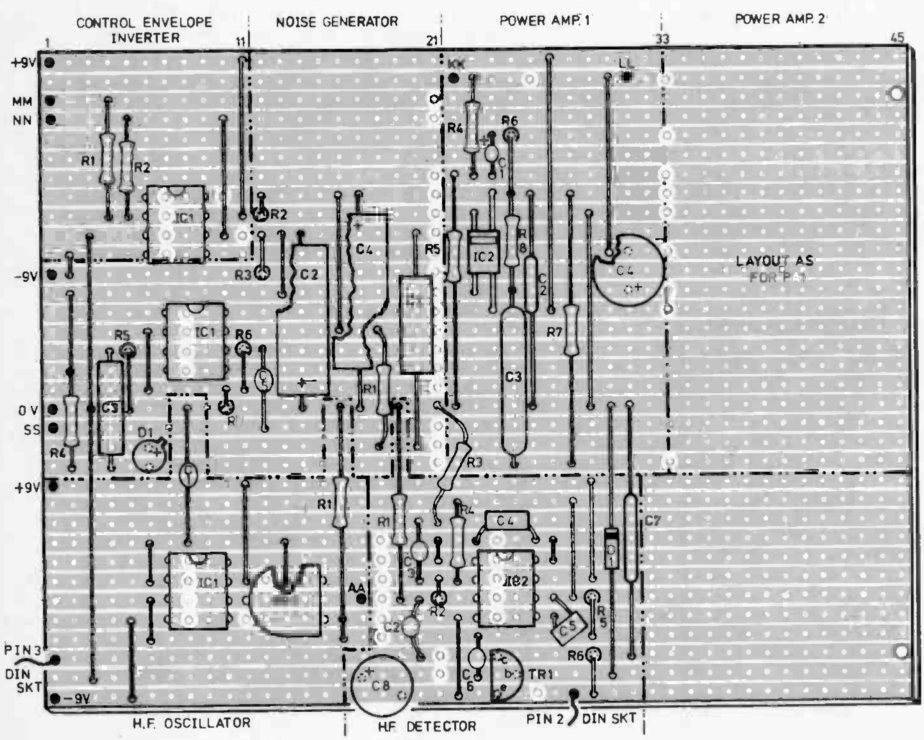


Fig. 3.11. The Veroboard panel which carries the NOISE GENERATOR, HF OSCILLATOR AND DETECTOR, CONTROL ENVELOPE INVERTER, AND POWER AMPLIFIERS

COMPONENTS . . .

POWER AMPLIFIERS AND MIXERS (2 off)

Resistors

R1–R3	47kΩ (3 off)
R4	1·5kΩ
R5	910Ω
R6	1kΩ
R7	4·7kΩ
R8	10kΩ

Potentiometer

VR1 10kΩ log carbon

Capacitors

C1	4·7μF 35V tantalum
C2	0·005μF ceramic
C3	3300pF
C4	220μF 40V elect. (or 470μF 16V)

Integrated Circuits

IC1	Type 741 8-pin d.i.l.
IC2	MFC4000B

Miscellaneous

LS1	3in 15 speaker
SK1	2mm socket
JK1	3·5mm jack socket

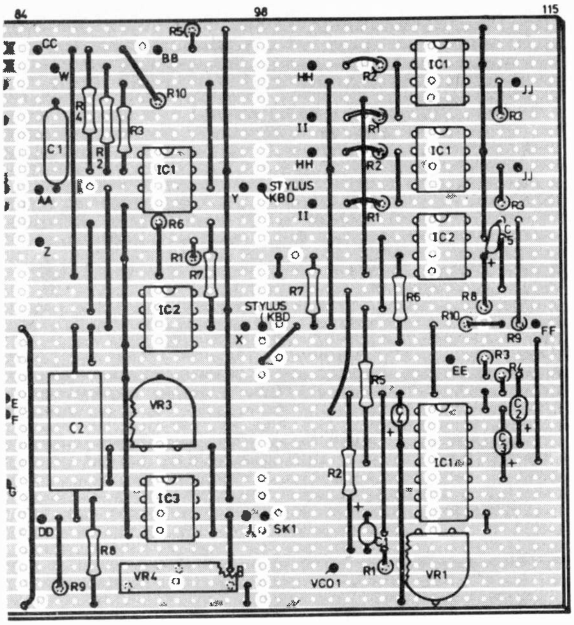


Fig. 3.12. The layout on the main Veroboard panel, the majority of which was shown last month

CONTROL ENVELOPE INVERTER

Shown in Fig. 3.9, the CONTROL ENVELOPE INVERTER represents a modification to the prototype instrument and has been included, principally, so that the VCF may be programmed automatically from ENVELOPE SHAPER 1. The inverter itself is a simple unity-gain inverting amplifier which requires no setting up procedure.

POWER AMPLIFIERS

The complete circuit of the power amplifiers, which includes a two-input inverting mixer, is shown in Fig. 3.10. As with all the virtual earth circuits in the Minisonic the mixer has the minimum number of inputs and almost any number of additional inputs may be applied by following the basic details given in Part 1 of the series.

The slider of the volume control (VR1) at the mixer output is wired directly to a jack socket from which may be taken a signal suitable for driving an external power amplifier, tape recorder, external mixer, etc.

CIRCUIT BOARD LAYOUT

The CONTROL ENVELOPE INVERTER, HF OSCILLATOR and DETECTOR, NOISE GENERATOR, and POWER AMPLIFIER stages are carried on a separate circuit board which is illustrated in Fig. 3.11.

The KEYBOARD CONTROLLER, RING MODULATOR and POWER AMPLIFIER/MIXER stages are all included on the main circuit board part of which was illustrated last month. The remainder of the board is shown in Fig. 3.12.

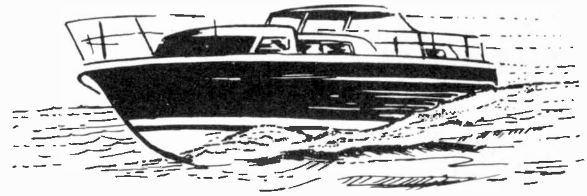
Next month: Final wiring-up and adjustments. Keyboard options, as well as circuit additions for more ambitious constructors will be discussed.

Stop Press: The author has developed a printed circuit board to carry all the Minisonic electronics. More details next month.

NEXT MONTH...

MARINE SPEEDOMETER

Solid-state electronics provide an easy-to-make solution to the measurement of boat speed—suited to both motor and sail environments and giving reasonable accuracy at sensible cost.



AC/DC MILLIVOLTMETER

A fully protected voltmeter which will read a.c. voltages down to 5mV r.m.s. but will withstand overloads of up to 250V. Operates at all audio frequencies.

PROBABILITY ANOMALY DETECTOR

Investigate your powers of extra-sensory perception with this specially designed unit. A meter registers your influence on the random noise in a Zener diode—the greater your power the higher the reading.

PRACTICAL
ELECTRONICS
FEBRUARY ISSUE ON SALE JANUARY 10, 1975

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?

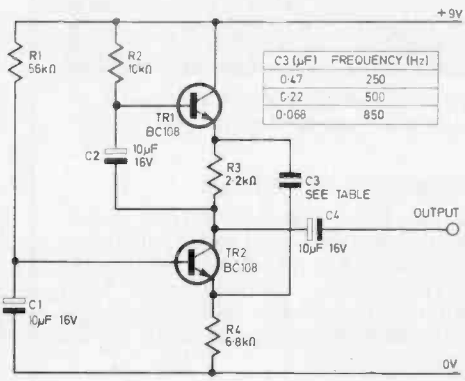
A SERIAL CONNECTION MULTIVIBRATOR

A SIMPLE square wave generator with equally fast rise and fall times is always useful. The conventional astable multivibrator has the disadvantage that although one edge of the output waveform is fast, the other edge is comparatively slow. This is due to the fact that the collector of the off transistor has to recover to the potential of the supply in a time determined by the capacitor associated with the collector and the value of the collector load. Improving the output waveform by the use of extra diodes or perhaps an extra transistor are solutions but a novel approach is a serial connection.

Consider the circuit shown and let TR1 be fully conducting and TR2 cut off with C3 fully discharged. It will be evident that C3 has a charging path via R4 and so this capacitor charges exponentially allowing the emitter of TR2 to approach ground.

When the charging current has decreased sufficiently so that the base potential of TR2 is again more positive than its emitter, then this transistor promptly conducts. This negative going transition at the collector of TR2 is communicated via the bootstrap connection of C2 to the base of TR1. This results in TR1 being cut off and C3 now acts as an effective collector potential for TR2. Therefore C3 discharges through R3 until the emitter potential of TR1 is again negative with respect to the base. Thus TR1 conducts and thereby completes the cycle and the whole sequence will start again.

If the time constants R1–C1 and R2–C2 are sufficiently large, the frequency of oscillation is predominantly determined by C3/R3 and C3/R4. Current consumption from a 9V battery is only 0·7mA since the circuit only consumes current during one half period of the cycle.



C3 (μF)	FREQUENCY (Hz)
0·47	250
0·22	500
0·068	850

Fig. 1

Unlike its more conventional counterpart the serial connection is always self starting. The output amplitude with the circuit shown is 5·5V peak-to-peak.

M. Harding,
Cheadle, Cheshire.

SOUND/LIGHT MODULATOR

A VERY simple sound/light modulator is shown in Fig. 1 which may be of use to experimenters. Input signals can be taken from the output (loudspeaker) of an audio amplifier since in most pop or disco environments the small amount of distortion introduced using this method will hardly be noticed.

Sensitivity is controlled by VR1 whilst the transformer provides isolation and the drive for triac MAC 11-6. This is possible as the triac drive pulses need not be shaped.

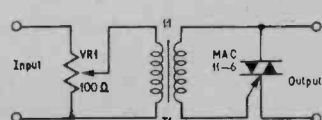
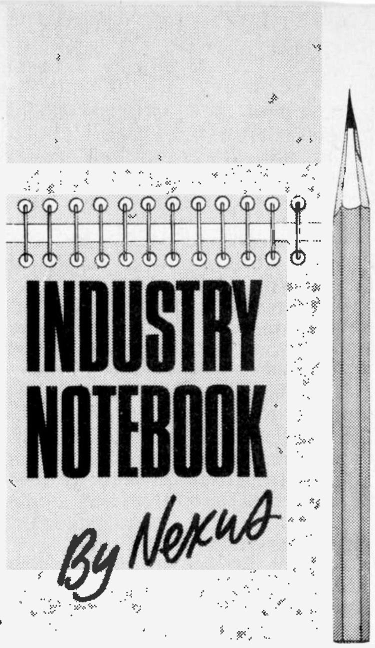


Fig. 1

To provide frequency sensitivity and/or other channels, capacity can be inserted in the triac gate circuit. Using 100V 1μF capacitors, bass response can be selected by inserting the capacitor in parallel with the secondary of the transformer. For the treble the capacitor is in series with the gate and for the mid ranges two capacitors are used, one in each of the foregoing positions.

In this way three circuits can be built up to control three separate lamps if desired.

P. Vleck
Cheltenham.



EASIER SERVICING

Colour television is easily the most complicated box of tricks in the home. Healthy competition has kept prices low, despite inflation. And that same competition, in effect the struggle for market share, is still spurring manufacturers to give the buying public more and more value for money.

It follows that the more complex a machine is the more it costs to service. And TV sets, by their very nature, have a fine in-built monitor, the screen itself, which instantly shows up defects or deterioration in performance. The broadcast authorities are even kind enough to transmit test patterns designed to highlight imperfections.

Every manufacturer has nightmares over servicing. Apart from losing goodwill, every time a set goes wrong during guarantee another chunk of profit goes down the drain. So in their own interests, manufacturers do genuinely try to make sets that are reliable and there has been a strong move over the past few years to build sets in modules to allow servicing by module replacement.

Now Grundig in Germany has gone one step further by building in a rapid diagnosis system in every set. Grundig had switched to a nearly fully modular system some three years ago in which 75 per cent of the circuitry is split among a dozen plug-in modules, each with a defined function. If any one module failed it was fairly obvious to the service engineer and he just plugged in a replacement. Now the diagnostic adaptor enables an instant check of the non-modular circuits.

Key check-points of the circuits are all brought to a single 13-way socket into which the service engineer plugs his monitor. The monitor has 13 led's and if any one of these fails to light up there is an indication of a specific fault. It costs very little extra on each set to provide the facility and the saving in engineer's time can be enormous. And, of course, with soaring labour costs, time saved is very important, not to mention customer satisfaction. The plug-in diagnostic aid costs the dealer under £10. Quite a bargain. And the customer benefits, too. Other set makers are expected to follow the trend.

EXPORTS

If you've ever thought that export promotion is not given enough priority in Britain, reflect for a moment on the current trading quarter which ends on December 31, 1974. The British Overseas Trade Board is giving support to 1,360 British companies at 76 overseas trade fairs in 27 countries. In addition there are 54 outward trade missions representing 730 companies and involving 45 countries. These group activities are in addition to hundreds of "private" promotions by individual companies.

One of next year's big trade drives is to be centred on Western Canada and seminars are already being held in Britain which will brief exporters on trade opportunities in advance of parties of exporters visiting the two big growth areas of Alberta and British Columbia. In the direct field of electronics, one of our biggest 1974 efforts was at Munich's Electronica Exhibition at which 57 British companies took part in a joint venture.

PACEMAKER BOOM

It was only a few years ago that we were all marvelling at the way microelectronics had made possible the heart pacemaker which has done so much to extend human life. With improved techniques in implant surgery and technical advances in pacemakers this single branch of medical electronics has now blossomed into an industry in its own right with world sales this year expected to top £25 million and reach over £200 million by 1980.

The technical problem which has been engaging pacemaker researchers is how long they can be kept working without recourse to further surgery to replace the battery. One approach was to use nuclear power to give infinite life. Another was a rechargeable unit that could be recharged by induction through an external unit. But both these solutions are losing favour, mainly expense in the nuclear field and susceptibility to outside interference with rechargeable units, apart from the occasional inconvenience to the user.

It seems now that long-life batteries will do the job quite well. Reasons are that in the early days pacemakers were more powerful than they needed to be, the new active devices using technologies such as CMOS take far less current, and battery technology itself has improved.

With current drain reduced to less than 20 micro-amps a three-year life can be obtained from mercury-oxide-zinc units and possible developments in sodium-bromine and lithium cells could give a battery life of seven years or more. This figure ties in well with the life-expectancy of pacemaker users who statistically have an average age at implant of 67 years and can expect another 5–7 years of life.

HUMBLE HARDWARE

Racks, panels, instrument cases hardly ever hit the headlines. Yet they are still big business in electronics clocking-up European sales of over £30 million a year and double that if you add in PCB edge connectors and other interconnection devices. So don't despise the metalwork in electronics. It might not make so much profit as glamour products but the commercial risk is much lower. Provided, of course, that you can get your materials. One prominent manufacturer, lamenting recently on production hold-ups, commented that "screws have seemingly ceased to exist, and costs have gone up alarmingly". And steel, plastics and paint have also been hard to get.

TAKE OFF

Great sighs of relief that the European Multi Role Combat Aircraft has received the go-ahead for its final development phase. This is the project that is exercising the best brains in electronics. It's costing the earth, of course, but how else do you keep ahead in technology?

At a more mundane level it's good to see Plessey has started delivering ILS systems for Chinese airfields in a contract worth £850,000. And British aerospace companies as a whole are doing well with exports worth more than £2 million every working day with our best customer still being the United States followed by France and Germany.

MARKET PLACE

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

MOUNTING PILLARS

A useful new product for the constructor has just been released by **West Hyde Developments Ltd.** Called Ilex pillars, they are designed to insulate circuit boards from cases or chassis and at the same time support them either vertically or horizontally one on top of another.

Made from moulded nylon, they have a rigid girder-shaped supporting section with a spring loop fastener at the top and tension feet together with a push-in clip at the base.

Suitable holes are drilled in the chassis and boards and the pillars are simply pressed into place and any subsequent boards mounted on the top of the pillars, see photograph. The sizes of the pillars vary from ¼in to 1¼in and cost approximately 3p each for a minimum order of 10 (for ¼in size).

Full particulars and sizes together with price list can be obtained from West Hyde Developments Ltd., Ryefield Crescent, Northwood Hills, Middlesex, HA6 1NN.

ON TAPE

Two new cassette tapes have been announced recently by **EMI Ltd** and **3M United Kingdom Ltd.**

The new X1000 ferric oxide cassette from EMI is claimed to give as good reproduction as chrome dioxide cassettes. A C60 cassette is expected to retail at 99p (excluding VAT).

The main technical improvements claimed for the X1000 are: an increase of 3–4dB in the 8–15kHz frequency range, compared to low noise tapes. A wider dynamic range due to the tape's increased magnetic remanence, resulting in less tape hiss. Improved high frequency response ensures a low level of intermodulation distortion.

When used with good quality audio equipment the tape is claimed to give excellent performance down to 25Hz and up to 15kHz.

Undoubtedly the new Scotch Classic tapes from 3M's, with a C90 cassette at £2·16, is aimed at the "serious" end of the market.

This new double coated or dual layer tape indicates the trend towards the use of a product compatible with existing tape and equipment rather than the current trend of using metallic dioxide tape. It is claimed that the new tape combines the high frequency abilities of chromium dioxide with the bias characteristics and low frequency response of the low-noise ferric oxide tape.

Both the above tapes are available from all good audio shops and large stores.

LITERATURE

A comprehensive 724-page data book covering Motorola's range of linear i.c.s is available from **Semicomps Ltd.** The book contains not only full data but, in many cases, valuable application information on over 300 devices.

The range includes op. amps, drivers and line receivers, d/a and a/d converters, comparators, voltage regulators, timing and power control units, consumer TV, audio and radio circuits, r.f. amplifiers and automotive circuits.

For easy reference the data sheets are arranged in alpha numeric sequence without regard to product category.

The book costs £1·26 and is obtainable from Semicomps Ltd., Northfield Industrial Estate, Beresford Avenue, Wembley, Middlesex, HA0 1SD.

NEWS BRIEFS

Readers who are building the "P.E. CCTV Camera" may be interested to know that **Crofton Electronics** are now able to offer a complete kit of parts for this project. They can also supply lenses, coils, tubes and printed circuit boards separately.

For full details readers should write to Crofton Electronics at 124 Colne Road, Twickenham, TW2 6QS.

We understand that **Re An Products Ltd** are able to supply all the control knobs (19 with skirts and one without) for the P.E. Minisonic synthesiser. These knobs have a translucent numbered skirt and are available with coloured caps.

It has been suggested that by using a colour code system for the knobs the front panel layout of the Minisonic can be identified in colour groups (i.e. envelope shapers, voltage controlled oscillators and amplifiers, etc.), which can make the instrument easier to use.

A price list for the knobs, type R62, is obtainable from Re An Products Ltd, Burnham Road, Dartford, Kent, DA1 5BN.

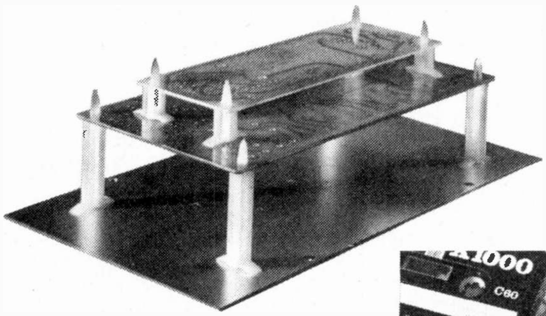
What is believed to be a unique service for the private constructor, has been announced by **SCS Components.**

Now, branded guaranteed components are being offered at very competitive "one-off" prices, in fact the same as applying to industrial users. Included in this offer is a very large range of integrated circuits and transistors.

A complete price list (free) is obtainable from SCS Components, Northfield Industrial Estate, Beresford Avenue, Wembley, Middlesex.

To help beat rising costs **Amtron U.K. Ltd.** are now able to supply direct to the customer many of their more expensive electronic kits.

A full list of the construction kits available is obtainable from Amtron U.K. Ltd., 4 Castle Street, Hastings, Sussex TN34 3DY.



New p.c.b. mounting pillars from West Hyde Developments

3M's Classic cassette tape

The X1000 cassette tape from EMI

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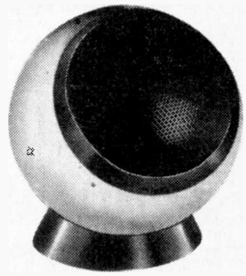

NEW PROJECTS

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BOOK REVIEWS

ROBOTICS

By John F. Young
Published by Butterworths
300 pages, 8½in × 5¼in. Price £6·00

THERE is nothing mythical about this book. It is concerned with hard facts of engineering. Robots have a very real existence, and in various forms perform many useful tasks in industry and elsewhere. Tasks which range from the mundane and repetitive to those of a highly specialised and skilled nature.

All this is clearly brought out in *Robotics*. The author, who has had a long experience in this field, describes notable developments in robot design which have been or are currently being undertaken in various advanced countries. Some of the devices mentioned will be familiar, like the Lunakhod, the Robotug, and the mobile robot used by the army to explode bombs left in cars. But there are many other significant developments in robotics which this book now brings to the attention of a wider audience.

Underlying all this activity are unmistakable signs of the eventual appearance of the General Purpose Robot for domestic use. The idea of an automated housewife is not just wishful thinking; it is the target of many designers in a number of countries. Indeed, according to the author, the Japanese are already well advanced with plans for a G/P Robot suitable for mass production with the inevitable economic advantages this will bring.

This book does not cover the "brain" of the robot, but concentrates upon the engineering of the "body". Hydraulic, pneumatic, and electrical techniques for actuation of the "limbs" are discussed. Electronics comes into its own with the imitation of the human senses, and all the commonplace sensoring devices are considered. Character and voice recognition pose greater problems; some indication of recent work by the author and his associates at Aston University in devising circuitry to solve some of the difficult problems in this frontier area of electronics is given.

Extensive lists of references accompany each chapter. Valuable as sources for the specialist researcher, these items provide additional evidence of the determined efforts that have already been made in this field of Robotics, and indicate how the robot has already become usefully employed in so many and varied everyday activities.

F.E.B.

ELECTRONICS — AN ELEMENTARY INTRODUCTION FOR BEGINNERS (SI UNITS)

By L. W. Owers
Published by Publication Mailing Services
120 pages. Price £1·45

IN LINE with the current tendency, this book is perfect bound between linen covers to keep costs to a reasonable level. It is nonetheless a valuable introduction to electronics for any beginner, particularly those meeting this type of subject for the first time.

Diagrams are used extensively with the addition of formulae where necessary and these latter are spelt out in SI units to conform to international practice.

The reader is led by the hand through complexities of fundamental particles, atoms, energy in its various forms, static and current electricity and the basic raw materials of electronics from theory to simple example.

Finally, the theory is exemplified by discussions of the valve and semiconductor and their use in radio and television and other areas.

R.D.R.

NEWS BRIEFS

G. D. SHAW LECTURES AT AUDIO FAIR

THE tremendous interest in synthesisers was reflected by the massive attendance at the two lectures at this year's Audio Fair by G. D. Shaw, the author of P.E. Minisonic articles currently appearing in *Practical Electronics*.

Entitled "Sound Synthesis for the Amateur", the lectures described synthesisers ranging from the simplest, in the form of the Minisonic, to the synthesiser of the future in the form of a digitally organised instrument having full polyphony (the ability to play more than one note simultaneously), and a memory facility.

The part of the lecture dealing with the Minisonic was illustrated with some impressive tape recordings made, using the Minisonic, by Malcolm Pointon. Most people were amazed at the range of effects that could be produced by such a simple instrument.

In the realm of digital synthesisers, Mr Shaw hopes to be the first to produce a design suitable for the amateur, a formidable task when one appreciates the complexity of such a system. The instrument is to be designed in such a way as to allow expansion from a basic unit simply by plugging in printed circuit boards as and when they are needed (or can be afforded).

This was not the only area where P.E. scored a "sound" success. On our stand the "P.E. Joanna" piano, exhibited for the first time, created enormous interest amongst the public. This unique instrument, ideal for the modern home, features piano, harpsichord and honky-tonk facilities with true touch sensitive operation.

The P.E. Joanna is a future project and full details will be published in the next few months.

LINK(S) UP

AN almost unbelievable 5 watts of transmitted power was used, in conjunction with a satellite, to beam a transmission over a distance of more than 50,000 miles recently in America.

In an experiment involving a simple antenna made from a golfer's umbrella, an engineer from the General Electric Company of USA used a low power "walkie-talkie" radio to prove that even with such rudimentary equipment the only important requirement for long-range communication is the presence of a satellite overhead.

To be fair, the antenna was specially made up from the golfer's umbrella but nonetheless a morse message was beamed from the NASA headquarters to a geo-stationary satellite *ATS-3* and then to *GE (USA)'s* Radio-Optical Observatory near Schenectady, New York.

The demonstration shows all too clearly just how easy it would be for almost world-wide coverage to be provided for some form of search-and-rescue system based on a simple man-carried emergency transmitter. It is also envisaged that the system could carry phone signals, not just morse.

PRICE CUT

IN this period of constantly rising prices it is heartening to know that at least some items are becoming cheaper. Motorola have recently announced their second price reduction in the CMOS device area.

This second reduction, worth an average of 25 per cent, applies to standard MC14000 and the in-house MC14500 devices. When applied to MSI the new pricing will give an individual gate function cost at around just a few pence and when this is coupled to the saving in power supply requirements and package count the total effect is a distinct improvement when using CMOS.

Readout—
A SELECTION FROM OUR POSTBAG

Gas Detectors

Sir—As the comment appearing on page 794, September 1974 issue, may raise doubts as to the life of the TGS sensors, we trust the following brief outline of the operating principles of the sensor will indicate why we claim that their life is comparable to that of other semiconductor devices, rather than the catalytic type of gas detector.

Molecules of flammable or deoxidizing gases are absorbed on the surface of the Taguchi sensors, resulting in electron transfer between absorbate and the solid sensor surface. In the case of hydrocarbon gases the reaction is related to the ionization potential of the gas absorbed on the surface of the pellet. The lower the ionization potential, the more readily is the gas detected. Hence isobutane (ionization potential 10.79eV) is detected more easily than methane (ionization potential 13.04eV).

The change in conductivity of the sensor is not caused by heat resulting from the combustion of a gas at its surface. The lack of combustion and relatively low operating temperature, 250°C, eliminates deterioration of the inert 82 per cent Palladium + 18 per cent Iridium filaments encapsulated in the bead.

The Taguchi gas detectors have been in continuous use in Japan for six years, and the only noticeable change in performance has been an increase in sensitivity with time, up to a maximum of 30 per cent when a levelling-off occurs.

Damage can occur to the sensor if it is exposed for long periods to high concentrations of gases containing sulphur or lead, and such gases will in any case inhibit the performance of most gas detectors.

There are of course, many applications where the catalytic type sensor is superior to the Taguchi especially in the areas of selectivity and long term repeatability, but where a pre-set low level long-life sensor is required, the Taguchi have found good acceptance. More than two million have been put in service to date.

From the design point of view, it is essential that a current limiting resistor be included in series with the sensor, or else the sensor may be destroyed by excessive current at switch-on. For example, if a low voltage 6V to 24V circuit is used then the minimum value of load resistor is 2 kΩ. A variable resistor alone should not be used in this position as it is possible for the unit to be switched on with the variable resistor set to the low end of its range.

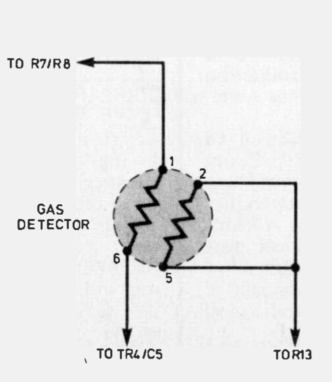
D. Lahiff,
Manager, Figaro Engineering,
Shannon, Ireland.

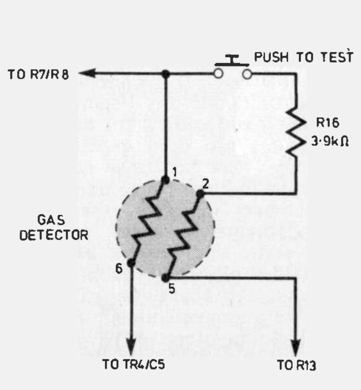
Gas Sense (or)

Sir—In the circuit of the "Boat/Caravan Gas Detector" (October 1974) the fact that the l.e.d. is alight proves that the heater side of the gas detector is connected and conducting. A dangerous situation could arise if the alarm circuitry, or more likely the wire connecting it to the detector, were to become open-circuited. This problem could arise from corrosion of the B7G socket or the gas detector pins (and boat bilges are known to be very damp places).

The simple modification shown in the enclosed diagrams will enable the detector to be fully tested each time it is turned on. The resistor R16 corresponds to a concentration of approximately 0·2 per cent of Butane or Propane in air, well below the inflammability range of 1·8 to 9 per cent.

R. A. Wood,
Wolverhampton.





Growing Upwards!

Sir—With reference to Mr. Crilly's letter (*Readout*, September), I feel that I in turn must draw attention to two points.

Firstly, the magnetic properties of a material are determined by the spin configurations of the constituent atoms or ions. The vast majority of elements and compounds are said to be paramagnetic—this means that unbalanced spins among the electrons leave a nett magnetic moment on the atom. In the presence of a magnetic field, at low temperatures so that thermal vibrations do not upset things, a degree of alignment can occur.

In the case of iron and certain other materials, ferromagnetism is observed. This means that over small regions of the crystal the magnetic moments (which are due to the same mechanism as above) are aligned by an internal crystal field. These regions are called "domains", and may themselves be aligned by an external field. Thus, ferromagnetism is a bulk property of iron, and it is inaccurate to speak of iron-containing molecules as being more "magnetic" than magnesium containing ones without considering the nett spins for the molecules concerned.

Secondly, Mr. Crilly states that strong magnetic forces radiate from the centre of the earth. This is not strictly true; the earth's field is not a monopole but approximates to a dipole. As a result of this there are regions of the earth's surface at the geomagnetic equator, where the field is parallel to the surface—in fact it is vertical only at the geomagnetic poles.

The suggested mechanism of tropisms would, therefore, not work in general, producing horizontal roots at the geomagnetic equator, and roots inclined to the vertical in most regions. I should also point out that plants transplanted from the Northern hemisphere to the Southern would develop into roots growing upwards at an angle to maintain their accustomed orientation with respect to the field.

C. R. Francis,
Sheffield.

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B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	50p
B86	100	Sil. Diodes sub. min. IN914 and IN916 types	50p
H20	20	BY126/7 Type Silicon Rectifiers 1 amp. plastic. Mixed volts	50p
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H67	10	3819N Channel FET's plastic case type.	50p

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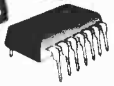

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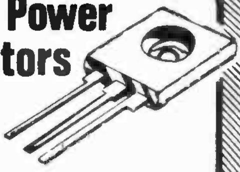

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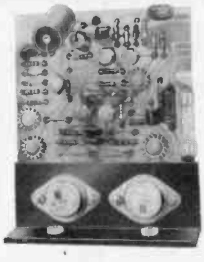
7 transistors, 7 diodes

SA50 £6.90 Carriage free
50W RMS 25–65V
7 transistors, 7 diodes

SA100 £12·50 Carriage free
100W RMS 45–70V
10 transistors, 7 diodes

- ★ 25Hz–25kHz
- ★ 0·2% distortion
- ★ Noise—80dB
- ★ 500mV into 20K
- ★ 4–16 ohms
- ★ Simple wiring
- ★ Short and open circuit proof
- ★ Continuously rated
- ★ Top-grade components

120 watt module complete with built-in supply—extra heavy duty £22·50 Carr. 60p



THE SA100 MODULE

POWER SUPPLIES

UNSTABILISED—READY WIRED

PU45	Suits 2 SA35 or 1 SA50 (4 ohm)	£5·45	Carriage 30p
PU70	Suits 2 SA50 or 2 SA100 (8 ohm)	£8·45	Carriage 40p

STABILISED

PS45	Suits 2 SA35 or 2 SA50 (4 ohm)	£4·45	Carriage free
MT45	Transformer for above	£3·50	Carriage 30p
PS70	Suits 2 SA100	£5·45	Carriage free
MT70	Transformer for above	£4·90	Carriage 40p

N.B. PS70 is not suitable for the SA50

Mk II STEREO DISCO MIXER £22·50
Carr. 30p

This well tried unit mixes two decks, handles any ceramic cartridge, and features mic over-ride plus separate full range bass and treble controls on both mic and deck inputs. Ample headphone power is available for P.F.L. May be used for mono and is mains operated. Fitted with sturdy screening case. Controls: Mic vol, bass, treble. Left/Right fade, deck volume, bass, treble, h/phone select, vol, Mains. Size 17½in × 3in × 4in deep.

DISCO MODULE £9·50 Carr. 20p

Thousands sold of this extremely popular mono version. A mic input may be fitted using the VA30 (see below). Low consumption from a 9V battery. Features the same high standards of reproduction as the Stereo version. Controls: H/phone select, vol, Left deck vol, Right deck vol, bass, treble, master vol. Size 12½in × 3in × 2in deep.

3-CHANNEL SOUND-LITE £22·50 Carr. 30p

Only SAXON can supply such incredible value for money. This unit features 3kW power handling, full-wave control, bass, middle, treble AND master controls. Twin loudspeaker jacks for "through" connections. It may be used free standing or will panel mount next to either of the above. Also features unique CUT-BACK circuitry for extra wide range response. Size 12in × 3in × 2½in deep. Professional standards at a price you can afford!

SINGLE CHANNEL VERSION £7·50 Carr. free
Recently reduced in price due to increasing sales, handles 1kW. Full wave operation

Add 8% VAT to all orders

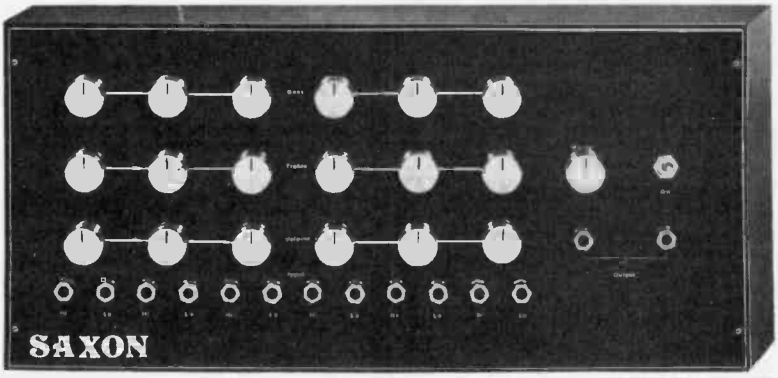
MULTI-PURPOSE MIXERS

M4HL £19·50 Carr. 50p
M6HL £29·50 Carr. 50p

Featuring multiples of our VA30 module, the M4HL and M6HL fulfil the requirements of all clubs, groups, etc. where a high quality mixer is required. Each channel has one high and one low impedance input, plus volume, treble and bass controls. Input impedances may, if required, be easily changed. The M4HL has four channels, and one output, and the M6HL six channels (12 inputs) and a master control and two outputs. Either unit may be used free-standing or panel mounted. These mixers will feed all types of amplifier. Recommended for their versatility and high performance, and excellent value for money.

VA30 CHANNEL MODULE £3·50 Carr. free

This is the basic channel module in the above mixers and may also be used for extra inputs on either the mono or stereo mixers. Fitted with volume, bass and treble controls, requires just a jack and supply (9–100V)



SAXON CSE 100 COMPLETE AMPLIFIER

100W of speech and music—Two separately controlled inputs. Wide range bass and treble controls. Sturdy and attractive vynide case. Twin outputs. Ideal for groups, discos, etc. Fully tested and guaranteed. 50W version identical in appearance.

£34·90 Carr. free

CSE 50 £29·50 Carr. free

Four individually controlled FET input stages plus wide range bass and treble controls. 120W of speech and music output from twin loudspeaker sockets. Sturdy case, and an attractive facia make this excellent value for money. Hundreds in use by groups, discos, clubs, etc.
50W version identical in appearance.

SAXON 100 COMPLETE AMPLIFIER £53·00 Carr. free

SAXON 50 £37·50 Carr. free

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VAT at 8% must be added to all orders including carriage charges.

Parapsychic phenomena

Sir—Sometimes I read your articles about "ESP" in PRACTICAL ELECTRONICS with great interest. I'm working in parapsychic phenomena as a "hobby" and I have some results, which may interest you and your readers.

During the spring and summer I discovered that a magnetic field stimulates germination and even growth of seeds and plants. I made experiments with lobelia, bindweed, pea, lentil and various other plants. In all cases germination increases about 20-30 per cent, germination time was shortened by approximately 30 per cent and plants were 50 per cent higher than in control tests. In addition, it is interesting that the same effect was caused by hand movement, so called "magnetisation", known 200 years ago and used by Mesmer for healing with "animal magnetism".

It is my opinion that these effects are caused by water polarisation in *both cases*. The same effect is obtainable by using "magnetised" water, activated by passing through a strong magnetic field.

These two phenomena will be discussed and published in two parapsychological magazines.

V. Patrovsky,
Czechoslovakia.

A Boolean Breakfast

Sir—I was recently having breakfast in an hotel and reading a book on Boolean Algebra. I had reached a point where the author stated that $A + (A \cdot B) = A$, when I realised that the waitress was looking over my shoulder. She asked whether I would like egg, or egg and bacon. My natural gluttony lead me to order egg and bacon. I continued reading and learnt that the expression above was read as "A or A and B equals A", and that if either A or B is present it is given a value of 1 and if absent its value, reasonably enough, is 0. The author proved the statement by a truth table.

At this moment the waitress placed in front of me a plate on which there was an egg but no bacon. Of course, I pointed out with maximum natural charm that I had ordered egg and bacon. I was surprised, even dismayed, when she said that what she had served was the same as egg and bacon, the book had just proved it by a truth table—egg, or egg and bacon equals egg.

Later, when the management presented me with the bill for bed and breakfast, I pointed out that the bill for bed, or bed and breakfast, should be the same. In the tariff, breakfast was a separate item, and although I had just eaten it, like the bacon I could prove by Boolean Algebra that it did not exist. One could not be charged, even in these times of rampant inflation, for something that did not exist whether one ate it or not. The cost of breakfast should therefore be deleted.

The Manager appeared to have an entirely mistaken grasp of Boolean Algebra, and the adviser he called in had not even heard of it. Possibly Boolean Algebra does not form part of a constable's training.

Perhaps some of your more erudite readers can point out where the fallacy lies.

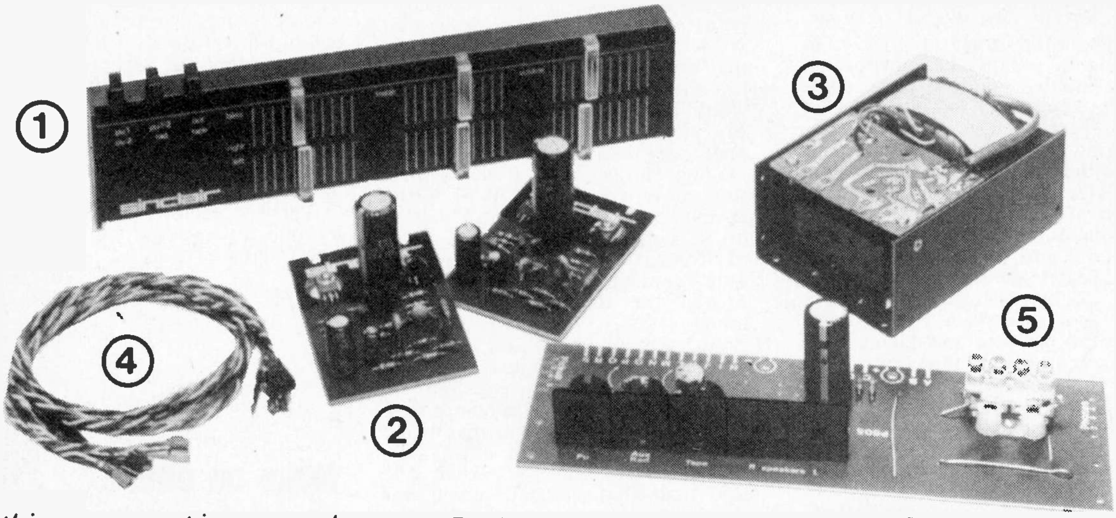
R. Parfitt,
Croydon.

Make an offer

Sir—Before my husband's death in May 1974 he had started to buy various parts for the "Electronic Piano", described in your Magazine some time ago. He already bought two manual contact assemblies, two C-C keyboards, digital master oscillator and other parts. Is it possible for you to help me to dispose of these items?

Mrs. E. Szwimer.

Forward with Project 80 into



Everything you want in one pack to build the world's most advanced modular hi-fi WITHOUT SOLDERING

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 × ¾" 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 third page of this advertisement.

£39.95
+£3.20 VAT (R.R.P.)

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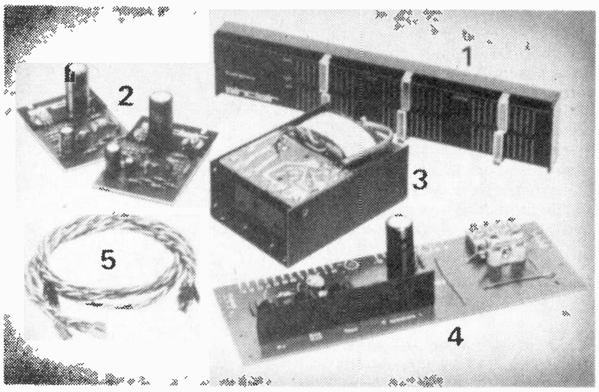
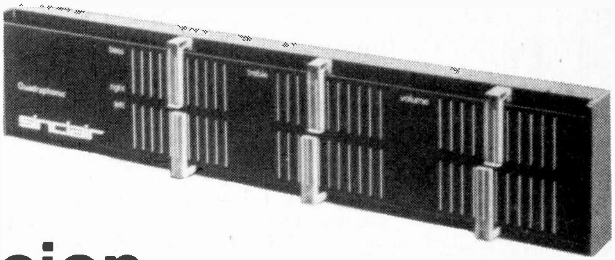
Telephone St. Ives (0480) 64646

true quadraphonics... NOW!



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

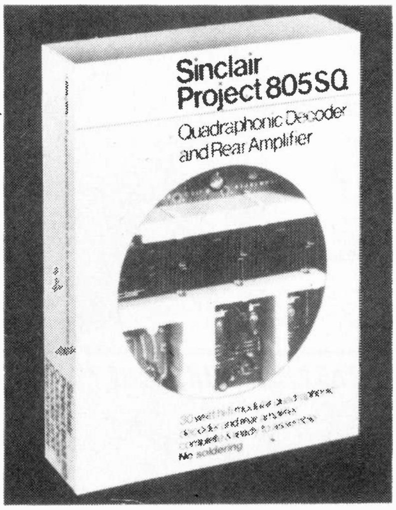


1. Project 80SQ decoder with controls.
2. Two Z.40 power amplifiers.
3. PZ.5 power pack.
4. Project 80Q Masterlink unit.
5 Wire loom, with clip-on tags – NO SOLDERING!
6. (Not illustrated) Instructions manual, nuts bolts, washers, etc.

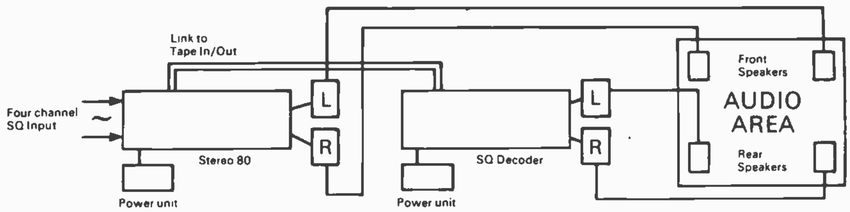
Add a fourth dimension to your stereo sound

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 Masterlink, 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 quadraphonic 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.)

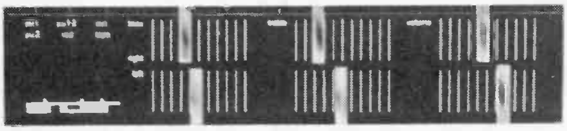
Guarantee If, within 3 months of purchasing any product direct from us, you are dissatisfied with it, your money will be refunded on production of receipt of payment. Many Sinclair Appointed Stockists also offer this guarantee. Should any defect arise in normal use within 2 years, we will service it 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***

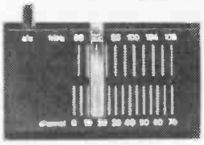
Stereo 80 pre-amp/control unit



260 x 50 x 20mm ($10\frac{1}{4} \times 2 \times \frac{3}{4}$ 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.)

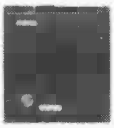
Project 80 F.M. tuner



Size 85 x 50 x 20mm ($3\frac{1}{2} \times 2 \times \frac{3}{4}$ 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.)

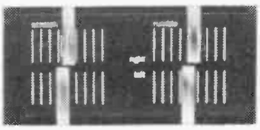
Project 80 stereo decoder



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.)

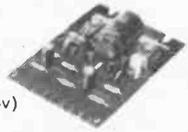


Size 108 x 50 x 20mm. Useful where there is need to eliminate unwanted high frequencies (scratch, whistle, etc) or low (rumble). Voltage gain – minus 0·2dB. Frequency response (filter at zero) 36Hz to 22KHz. H.F cut (scratch) variable from 22KHz to 5·5KHz 12dB/octave slope. L.F cut (rumble) – 28dB at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

£7.45 +60p VAT (R.R.P.)

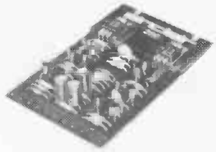
Project 80 power amplifiers

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

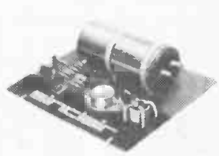
£7.45 +60p VAT (R.R.P.)

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.

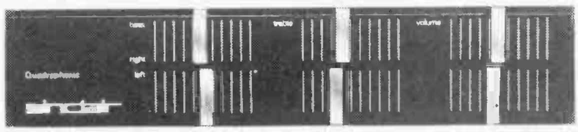


£8.45 +68p VAT (R.R.P.)

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.)

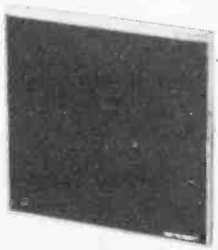
Project 80SQ quadraphonic decoder



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



An original and uniquely designed speaker of outstanding efficiency. Balanced sealed sound chamber and special driver assembly. Loads up to 14 W./R.M.S. 8 ohms imp. Size 248mm square x 120mm deep. Pedestal base. All-over black front, teak surround.

£8.95 +72p VAT (R.R.P.)

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SUPPLIERS OF QUALITY PRINTED CIRCUIT BOARDS, KITS AND COMPONENTS TO A WORLD-WIDE MARKET

SOUND-TO-LIGHT
The ever-popular AURORA—4 or 8 channels each responding to a different sound frequency and controlling its own light. Can be used with most audio systems and lamp intensities. A *must* for any Disco, and a fascinating visual display for the home.

4 channel component set (excl. thyristors)	£11·49
8 channel component set (excl. thyristors)	£20·32
Power supply component set	£4·78
PCB for 4 frequency channels	£2·50
PCB for power supply and 8 lamp drivers	£1·25

P.E. CCTV CAMERA
Details in List

VOICE OPERATED FADER
For automatically reducing music volume during "talk-over"—particularly useful for Disco work, or for home-movie shows.

Component set, incl. PCB £2·95

P.E. GEMINI 30W STEREO AMPLIFIER
An exceptionally high quality Stereo Amplifier system, specifications for which are shown in detail in our list, together with semiconductor requirements.

Main Amplifier:	
Set of resistors, capacitors and presets	£5·96
Stereo printed circuit board	£1·28
Pre-Amplifier:	
Sets of resistors, capacitors, potentiometers and switches—	
Standard Tolerance Set	£10·57
Superior Tolerance Set	£16·04
Stereo PCB (as Published)	£2·20
Regulated Power Supply:	
Set of resistors, capacitors and preset	£4·58
Printed circuit board	72p

HI-FI TAPE LINK
Designed for use with reasonable quality tape decks, this high performance pre-amp includes record, playback and metering circuits.

Stereo component set (excl. panel meter)	£22·05
Mono component set (excl. panel meter)	£13·31
Power supply component set	£3·72
Stereo main PCB	£2·50
Stereo sub-assembly PCB	86p

TAPE-NOISE LIMITER
Very effective circuit for reducing the hiss found in most tape recordings.

Component set (incl. PCB)	£2·30
Regulated power supply (including printed circuit board)	£3·71

PROJECT Q4
Multi-system Quadraphonic Decoder.

Decoder component set	£13·74
Power supply components	£3·22
Set of PCBs	£2·60

SEMICONDUCTOR TESTER
Essential test equipment for the enterprising home constructor.

Set of resistors, capacitors, semiconductors, potentiometers, makaswitches and sub-assembly PCB (fuller details in list) £6·06

PHASING UNIT
A simple but effective manually controlled unit for introducing the "phasing" sound into live or recorded music.

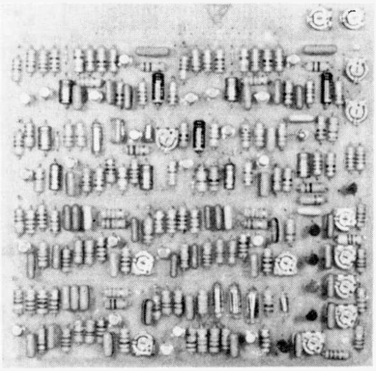
Component set (incl. PCB) £2·20

P.E. SOUND SYNTHESISER
The well-acclaimed and highly versatile Synthesiser published in P.E. Feb. 1973 to Feb. 1974.

Component sets and printed circuit boards: Full details in list.

RHYTHM GENERATOR
Programmable for 64,000 rhythm patterns from 8 effects circuits (high and low bongos, bass and snare drums, long and short brushes, blocks and cymbal), and with variable time signatures.

Tempo, Timing and Logic Circuit	
Component set (excl. switches)	£17·25
Double-sided PCB for above	£2·30
Mixer, Pre-amp and Effects Circuits	
Component set	£12·70
PCB (illustrated)	£2·67
Monitor Amplifier	
Component set and PCB	£3·10
Power Supply	
Component set and PCB	£5·65



AUDIO MILLIVOLTMETER
Wide-ranges and good accuracy. Component set (excl. meter) while stocks last £5·23

ULTRASONIC TRANSMITTER-RECEIVER
A highly sensitive and long range "invisible beam" detection circuit with numerous applications.

Component set with PCBs, but excluding transducers £4·40

P.E. RONDO
PCB details in List.

POWER SLAVES
PCB details in List.

P.E. ELECTRONIC PIANO
Details in List.

HOME INTERCOM
Details in List.

SOUND BENDER
A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice operated fader, automatic fader and frequency doubler.

Component set	£5·83
Printed circuit board	£1·44

REVERBERATION UNIT
A high-quality unit having microphone and line input pre-amps, and providing full control over reverberation level.

Component set (excl. spring unit)	£6·44
Printed circuit board	£1·40

P.E. MINISONIC
Details in List

8W AMPLIFIER
A moderately powered amplifier of more than average performance.

Main Amplifier	
Mono component set	£4·18
Stereo component set	£8·36
Mono printed circuit board	72p
Pre-Amplifier	
Mono component set	£2·50
Stereo component set	£6·46
Stereo PCB	£1·66
Power Supply	
Component set	£3·90

BIOLOGICAL AMPLIFIER
Multi-function circuits that, with the use of other external equipment, can serve as lie detector, alphaphone, cardiophone, etc.

Pre-Amplifier Module	
Component set and PCB	£3·48
Basic Output Circuits	
Combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feed-back lamp driver circuits	£4·96
Audio Amplifier Module	
Type PC7	£5·20

PHOTOPRINT PROCESS CONTROL
For colour and B & W, an indespensible dark-room unit for finding exposure, controlling enlarger timing, and stabilising mains voltage.

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Send S.A.E. for free list giving fuller details of kits, PCBs, and other components.

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P. & P. will be charged at cost. VAT does not currently apply. List gives fuller details including kit weights. Charge for list: Europe 10p, other countries 20p.

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AC176	20p	NKT0033	112p	2N4870	36p
BC107	13p	OC28	65p	2N4871	36p
BC108	13p	OC71	14p	2N5777	45p
BC109	13p	OC84	25p		
BC147	12p	ORP12	55p	**Diodes**	
BC148	12p	ZTX107	12p	1N914	4p
BC149	12p	ZTX503	15p	1N4001	6p
BC157	13p	ZTX531	23p	1N4002	7p
BC158	13p	2N706	13p	1N4004	8p
BC159	13p	2N914	22p	1N4005	8p
BC182L	12p	2N1304	22p	1OD6	8p
BC204	14p	2N2219	27p	BA145	23p
BC209c	14p	2N2905	27p	OA91	7p
BC212L	15p	2N2907	22p	OA200	8p
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BCY71	22p	2N3055	50p	1SJ50	11p
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BFY52	23p	2N3703	12p		
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7420	20p
7447	175p
7473	44p
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µA7815 TO220	250p
CA3046	69p
MFC6040	95p
PA263	169p
SG3402N	169p
Minitron 3015F	225p

Zeners

3·3V 400mW	12p
4·7V 1W	25p
5·6V 1·3W	20p
6·2V 400mW	15p
9·1V 400mW	15p
11V 1W	20p
12V 400mW	15p
12V 1·3W	20p
18V 400mW	15p
18V 1W	20p
20V 400mW	15p
20V 1·3W	23p
27V 400mW	15p

Thyristors

1A 400V	75p

Electrolytic Capacitors (µF/V)

0·47/63V	6p	47/63	7p	470/40	20p
1 0/63V	6p	50/6·4	6p	500/64	46p
1·5/63V	6p	100/10	6p	680/6·3	10p
2·2/63V	6p	100/25	6p	680/25	20p
4 7/63	6p	100/40	7p	680/40	25p
6·8/40	6p	100/63	12p	1000/10	14p
10/25	6p	150/16	6p	1000/16	25p
10/63	6p	150/63	12p	1000/25	25p
15/40	6p	220/10	6p	1000/40	40p
22/10	6p	220/16	6p	2200/25	45p
22/25	6p	220/25	10p	2200/40	50p
33/6·3	6p	220/40	14p	2800/100	350p
33/16	6p	220/63	21p	3300/63	133p
33/40	6p	330/10	6p	3300/100	350p
33/50	6p	470/6·3	6p	4700/16	60p
47/25	6p	470/10	10p	4700/25	75p
47/40	6p	470/25	14p	4700/40	93p

Polyester (µF)

0·01	3p
0·015	3p
0·022	3p
0·033	3½p
0·047	3½p
0·068	3½p
0·1	4p
0·15	5p
0·22	5p
0·33	7p
0·47	8p
0·68	11p
1·0	14p
2·2	24p

Tantalum (µF/V)

0·1/35	12p
0·22/35	12p
0·47/35	12p
1·0/35	12p
1 5/35	16p
2·2/35	12p
4·7/35	12p
10/16	12p
10/25	16p
15/6·3	16p
22/16	16p
47/6·3	16p
47/16V	25p
100/3	16p

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250V P.C. Mounting: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, **3½p.** 0·068μF, 0·1μF, **4½p.** 0·15μF, **4½p.** 0·22μF, **5½p.** 0·33μF, **8p.** 0·47μF, **9p.** 0·68μF, **12p.** 1μF, **15p.** 1·5μF, **23p.** 2·2μF, **26p.**

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

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50V: (pF) 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820, 1K, 1K5, 2K2, 3K3, 4K7, 6K8, (μF) 0·01, 0·015, 0·02, 0·033, 0·047, **2½p** each. 0·1, 30V, **4½p.**

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⅓	CF	22-1M	1	0·75	0·60	0·55	5·5 × 16
¼	MF	10-2M7	2	1·54	1·32	1·1	3 × 7
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2·2μF	63V	6½p	100μF	10V	6½p
3·3μF	63V	6½p	100μF	25V	6½p
4·0μF	40V	6½p	100μF	63V	14p
4·7μF	63V	6½p	150μF	16V	6½p
6·8μF	63V	6½p	150μF	63V	15p
8·0μF	40V	6½p	220μF	6·4V	6½p
10μF	25V	6½p	220μF	10V	6½p
10μF	63V	6½p	220μF	16V	8p
15μF	16V	6½p	220μF	63V	21p
15μF	63V	6½p	330μF	16V	12p
16μF	40V	6½p	330μF	63V	25p
22μF	25V	6½p	470μF	6·4V	9p
22μF	63V	6½p	470μF	40V	20p
32μF	10V	6½p	680μF	16V	15p
33μF	16V	6½p	680μF	40V	25p
33μF	40V	6½p	1000μF	16V	20p
32μF	63V	6½p	1000μF	25V	25p
47μF	10V	6½p	1500μF	6·4	15p
47μF	25V	6½p	1500μF	16V	25p
47μF	63V	6½p	2200μF	10V	25p
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3¾ × 3¾"	36p	36p
2½ × 1"	9p	9p
2½ × 5" (Plain)	—	19p
2½ × 3¾" (Plain)	—	16p
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Insertion tool	73p	73p
Track Cutter	56p	56p
Pins, Pkt. 50	22p	22p

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BC108	12p	OC44	18p
BC109	13p	OC71	13p
BC148	12p	OC81	16p
BC149	12p	OC170	23p
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BC183L	12p	2N2926	11p
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IN4004	9½p
IN4005	12p
IN4006	14p
IN914	7p
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BA100	10p
OA5	42p
OA47	9p
OA81	11p
OA200	8p

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DIN 2 Pin	12p
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5 Pin 180°	16p
Std. Jack	20p
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500V: 0·025, 0·05, **6p.** 0·1, **6p.** 0·25, **7½p.** 0·5, **9p.**
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μA709C	50p
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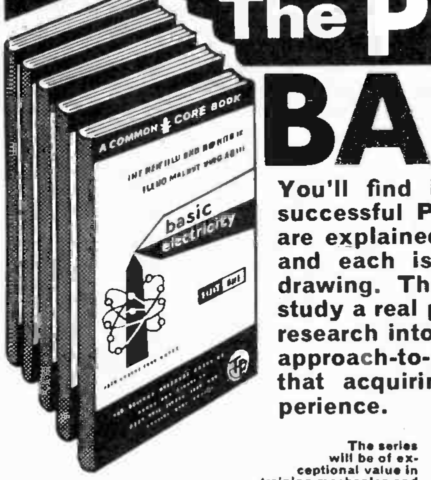

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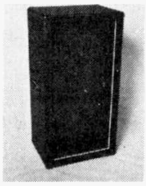
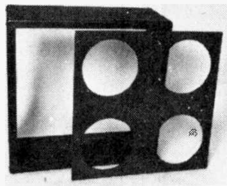

2′ x 12″ Cabinet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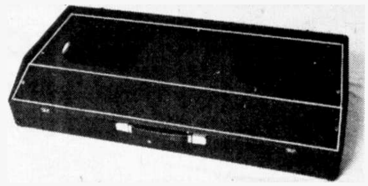
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4 x 12″ P.A. Column	48″ x 27″ x 13″ x ¾	£33·00	£23·65
1 x 18″	31″ x 31″ x 13″ x ¾	£26·95	£19·25
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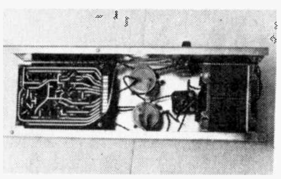
Please ask for quotation on any other type or size of cabinet you may require.



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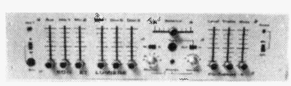

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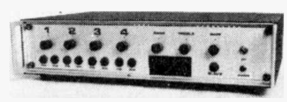

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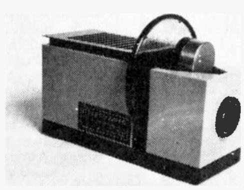

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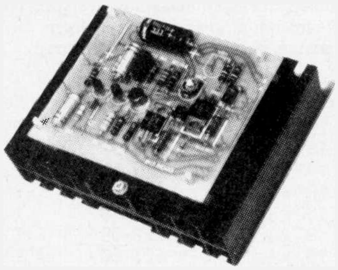

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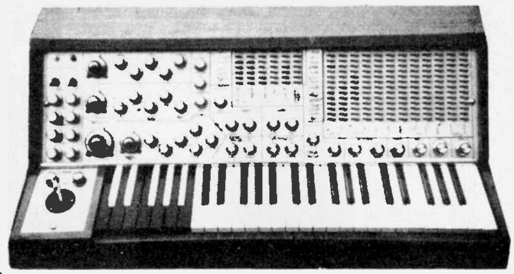
Modules by *Dewtron*®



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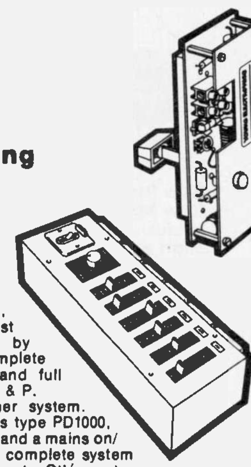

Illustrated is the popular PMSD1000 module. A 1000W professional quality dimmer, linear operation, interference suppressed, 60mm slider range, size 12 × 5 × 4cm. Ideal for low cost stage and disco lighting. Used by schools, theatres, studio, etc. Complete with scale plate, fixing screws and full instructions. £7·25 inc. VAT and P. & P.

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The Dimmit range includes standard wall mounting models for home and office, etc. Professional modules for industrial heating applications, etc. Rotary and slider control versions. Ratings: 1000W; 2000W; 3000W; 110V and 240V.

Model SL800 sound to light converter. Modulates the light in time with sound. Built in microphone. Just place unit near any sound source—radio, hi-fi, TV, human voice, etc. No connections to speaker required, simple wiring—similar to dimmer. Rating 800W. Complete with full instructions.

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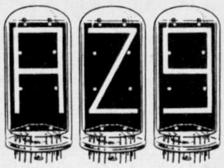

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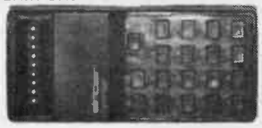

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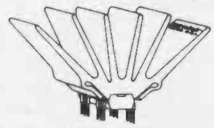

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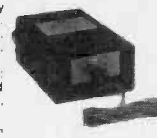

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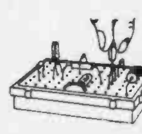

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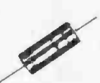
Axial lead electrolytic



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4·7	63	6p	100	10	6p	470	6·3	6p
6·8	40	6p	100	25	6p	470	10	14p
6·8	63	6p	100	40	6p	470	25	16p
10	25	6p	100	63	16p	470	40	25p
10	63	6p	150	6	6p	680	6·3	14p
15	16	6p	150	16	6p	680	16	16p
15	40	6p	150	25	6p	680	25	25p
15	63	6p	150	40	14p	680	40	28p
22	10	6p	150	63	16p	1000	4	14p
22	25	6p	220	4	6p	1000	10	16p
22	63	6p	220	10	6p	1000	16	25p
33	6·3	6p	220	16	6p	1000	25	28p
33	16	6p	220	25	14p	1500	6·3	16p
33	40	6p	220	40	16p	1500	10	25p
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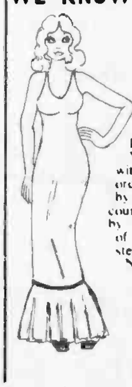

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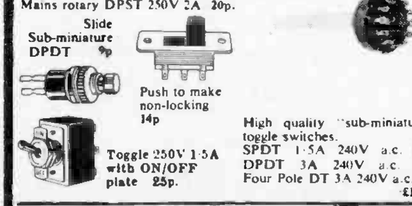

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Dual gang (Stereo) without switch Log or Lin 5k to 2M as above 49p.

Single gang with DP switch 250V 2A Log or Lin 5k to 2M as above 33p.

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Sub-miniature 0·1W
Vert or Horiz
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Carbon Film ¼W 5%	1Ω to 10Ω; 10% 1·2M to 10M	E12	1p
Carbon Film ½W 5%	11Ω to 910k	E12 & E24	1p
Carbon Film 1W 5%	10Ω to 10M	E12	3½p
Metal Oxide ½W 2%	10Ω to 1M	E12 & E24	4p
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