PRACTICAL
ELECTRONICS
JANUARY 1973
20p

BIOLOGICAL AMPLIFIER

Solder a friendship! Give Antex this Christmas
Model X25 *
220-240 Volts or 100-120 Volts The leakage current of the NEW X25 is only a few microamps and cannot harm the most delicate equipment even when soldered "live". Tested at 1500v. A.C. This 25 watt iron with its truly remarkable heat-capacity will easily "out-solder" any conventionally-made 40 and 60 watt soldering irons, due to its unique construction advantages. Fitted long-life iron-coated bit 1/8". 2 other bits available 3/32" and 3/16" Totally enclosed element in ceramic and steel shaft Bits do not "freeze" and can easily be removed PRICE: £1.75 (rec. retail) Suitable for production work and as a general purpose iron
Model CCN *
220 volts or 240 volts The 15 watt miniature model CCN also has negligible leakage. Test voltage 4000v. A.C. Totally enclosed element in ceramic shaft. Fitted long-life iron-coated bit 3/32" 4 other bits available, 1/8" 3/16" 1/4" and 1/16" PRICE: £1.80 (rec. retail) OR Fitted with triple-coated, (iron, nickel and Chromium) bit 1/8" £1.95 (rec. retail)
Model CN *
Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 1/16" to 3/16". Voltages 240, 220, 110, 50 or 24 PRICE £1·70 (rec. retail)
Model SK.1 Kit
contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet. PRICE £2·75 (rec. retail)
Model MES Kit
Battery–operated 12v. 25 watt iron fitted with 15' lead and 2 heavy clips for connection to car battery. Packed in strong plastic wallet with booklet "How to Solder". PRICE £1·95 (rec.retail) *
Model SK.2 Kit
contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, and "How to Solder" booklet. PRICE £2·40 (rec.retail)
precision soldering kit
* as selected for the DESIGN CENTRE
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PRACTICAL
ELECTRONICS

VOLUME 9 No. 1 JANUARY 1973

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our February issue will be published on Friday, January 12, 1973

RTVC THE

THE FABULOUSLY SUCCESSFUL VISCOUNT III AUDIO £52 complete

14 + 14 watts r.m.s. 40Hz to 40kHz ± 3dB. Total distortion at 10 watts at 1kHz — 0·1%.

This is real value for money! We have designed 2 systems and the heart of them all is the Viscount III amplifier. A unit of great eye appeal with teak finished cabinet. FET's (Field effect transistors) are incorporated on the input stages, just like top priced units. FET's give you more of the signal you want and almost none of the hiss you don't. Both units have output sockets for headphones and tape recorder. Filters and tone controls give a wide range of bass and treble adjustment.

For both systems we have chosen the famous Garrard SP25 Mk. III deck, with fitted magnetic cartridge, which comes complete with simulated teak plinth and tinted acrylic cover.

The exclusive Duo loudspeaker systems are incomparable for quality within their price range. Large speakers in extremely substantial cabinets. There's a choice of the Duo II's for the smaller room or the big Duo III's for real bass response.

SPEAKERS

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

Duo Type III Size approx. 23½in. × 11½in. × 9½in. Drive unit 13½in. × 8½in. with H.F. speaker. Max power 20 watts 8 ohms. Freq. range 20Hz to 20kHz. Teak veneer cabinet. £32 pair + £3 p & p.

SPECIFICATION R101

14 watts per channel into 3 to 4 ohms (suitable 3-15 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) — P.U.I. and radio −65dB, P.U.2 −58dB. *Cross talk* better than −35dB on all inputs. *Overload characteristics* better than 26dB on all inputs. Size approx. 13¾in. × 9in. × 3¾in.
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PRICES: SYSTEM 1

Viscount III R 101 amplifier	£22·00+90p p&p
2 × Duo Type II speakers	£14·00+£2 p&p
Garrard SP25 Mk. III with MAG. cartridge plinth and cover	£23·00+£1·50 p&p
Total	£59·00

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

PRICES: SYSTEM 2

Viscount R 101 amplifier	£22·00+90p p&p
2 × Duo Type III speakers	£32·00+£3 p&p
Garrard SP25 Mk. III with MAG. cartridge plinth and cover	£23·00+ £1·50 p&p
Total	£77·00

Available complete for £69 + £4 p & p

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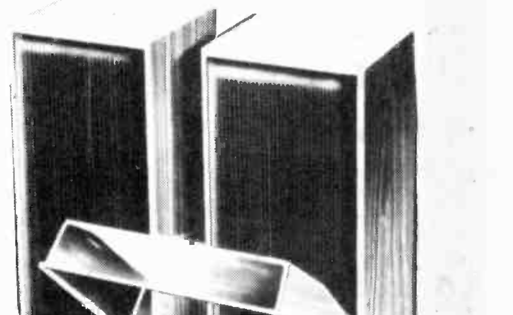

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UNISOUND FOR THE NEW SOUND

AT £25

The whole system is complete *including superb cabinets in simulated teak*—just simply screw together the components and you save pounds!
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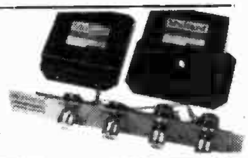
Easy to follow step-by-step instructions guide you quickly and effortlessly to taking the wraps off truly realistic stereo sound.
£25 complete plus £2·80 p. & p. Diamond Stylus £1·25 extra.
Power output: 4 watts per channel into 8 ohms. Inputs: 120 mV (for ceramic cartridges).
Stereo headphones with adaptor £4·00.

UNISOUND MODULES ONLY £6·95
If you prefer, you can buy the three modules—pre-amplifier power supply/dual power amplifier, and control panel—by themselves for only **£6·95.** P. & P. 50p extra.
No soldering, just simply screw together with screwdriver supplied. Their overall specification is the same as shown for the complete Unisound console, using the high efficient I.C. monolithic power chips to ensure very low distortion at all power levels, correct operation in all ambient temperatures, full power over the audio spectrum.



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A 'NATURAL' ONLY FROM RTVC
THE TOURIST PB CAR RADIO KIT

If you can solder on printed circuit board, you can build this push-button car radio kit. It's simple—just follow the step-by-step instructions.

Apart from the output stage, which is an integrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modulised IF stages which are pre-aligned before despatch. As well as electronic components, this kit also contains 2 diamond-spun aluminium knobs, elegant matching front panel, dial, washers, screws and wire.
The Tourist PB is suitable for 12 volt working on both negative and positive earth vehicles. It covers the full medium and long wave bands. Four push-buttons for medium wave, one for long wave. It is permeability tuned and sturdily constructed. Output is a full 2·5 watts into an 8 ohm speaker. But the Tourist PB will operate into any loudspeaker from 8 to 15 ohms. Power consumption is less than 1 amp.
The Tourist PB can be mounted in any standard size dash panel and it has an illuminated tuning scale for easy reading at night. Chassis size is: 7in wide, 2in. high and 4 15/16 in. deep (excluding front panel, etc.).
★ Circuit diagram and comprehensive instructions 50p, free with parts.
★ Fully retractable lockable car aerial £1·25 post paid.
PRICE ONLY £7 + p & p 50p
8 ohm speaker with baffle and fixing strips £1·50 + 25p p & p, post free if brought with the kit.
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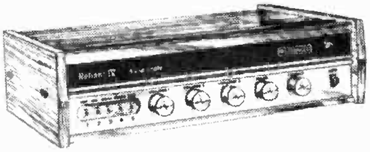

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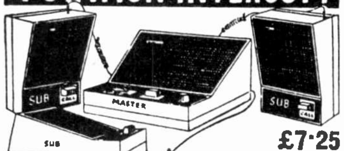

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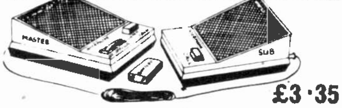

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Same as 4-Station Intercom for two-way instant communication. Ideal as Baby Alarm and Door Phone. Complete with 66ft. connecting wire. Battery 14p. P. & P. 25p.

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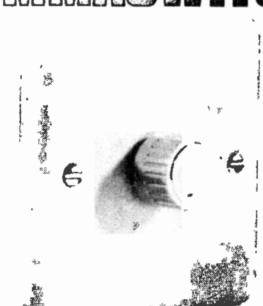

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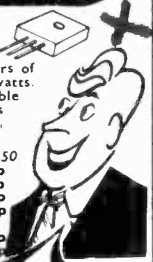

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40W	NPN	20p	18p	16p
40W	PNP	21p	19p	17p
90W	NPN	24p	22p	20p
90W	PNP	25p	23p	21p
PAKS complementary pairs:				
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Full of Short Lead Semiconductors & Electronic Components, approx. 170. We guarantee at least 30 really high quality factory marked Transistors PNP & NPN, and a host of Diodes & Rectifiers mounted on Printed Circuit Panels. Identification Chart supplied to give some information on the Transistors.

Please ask for Pak P.I. Only 50p. 10p P & P on this Pak.

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2/4-input Expander,	BMC933	12p	11p	10p
Hex. Inverter,	BMC934	12p	11p	10p
Hex. Inverter,	BMC935	12p	11p	10p
Hex. Inverter,	BMC936	12p	11p	10p
Hex. Inverter,	BMC937	12p	11p	10p
Decade Counter,	BMC938	25p	23p	21p
Div. by 16 Counter,	BMC939	25p	23p	21p
Hex. Inverter,	BMC940	12p	11p	10p
Hex. Inverter,	BMC941	12p	11p	10p
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Ex. 2/4-input Power,	BMC944	12p	11p	10p
Clocked Flip Flop,	BMC945	20p	18p	16p
4/2 Input Nand Gate	BMC946	11p	10p	9p
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Dual J/K Flip Flop,	BMC953	20p	18p	16p
Dual J/K Flip Flop,	BMC955	20p	18p	16p
Dual J/K Flip Flop,	BMC956	20p	18p	16p
Quad. 2-input Power,	BMC958	12p	11p	10p
2/4-input Gate,	BMC961	12p	11p	10p
3/3-input NAND Gate,	BMC962	11p	10p	9p
3/3-input NAND Gate,	BMC[illegible]	12p	11p	10p
Audio Amp. 3-watts, SL403D		£1·50	£1·40	£1·36
Linear Op. Amp. 709C		25p	20p	15p
Decade Counter, SN7490		65p	60p	55p

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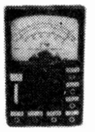
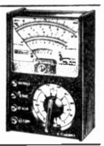


TS60 POCKET MULTIMETER
High-precision at low-cost. Ranges: D.c. 15V, 150V, 1,000V (10,000 O.P.V.). A.c. 15V, 150V, 100V (1,000 O.P.V.).
D.c. Current 150mA. Resistance 100k ohms.
£1·85. Post 15p.

MODEL 1092 Testmeter.



5,000 O.P.V.
0/3/15/150/300/1,200V d.c.
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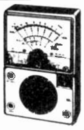
0/300µA/300MA
0/10K/1 meg Ω
Decibels −10 to +16 dB
£2·75 each +15p P. & P.

HIOKI MODEL 720X
20,000 O.P.V.
Overload protection
5/25/100/500/1,000V d.c.
10/50/250/1,000V a.c.
50µA/250mA. 20K/2 meg. ohm. −5 to +62dB.
£4·97. P. & P. 15p.

HIOKI MODEL 730X



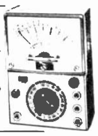
30,000 O.P.V. Overload protection. 6/30/60/300/600/1,200V d.c. 12/60/120/600/1,200V a.c. 60µA/30mA/300 mA. 2K/200K/2 meg-ohm. −10 to +63 dB.
£6·50. P. & P. 15p.

MODEL TE-12
20,000 O.P.V. 0/0·6/6/30/120/600/1,200/3,000/6,000V d.c. 0/6/30/120/600/1,200V a.c. 0/60µA/6/60/600mA. 0/6K/600K/6Meg./60 Meg. Ω 50pF. 0·2mFd. **£5·97.** P. & P. 17p.

MODEL TE-200 20,000 O.P.V. Mirror scale, overload protection. 0/5/25/125/1,000V d.c. 0/10/50/250/1,000V a.c. 0/50µA/250mA. 0/60K/6 meg Ω.,−20 to +62dB. **£3·95.** P. & P. 15p.

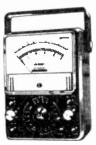
MODEL 500 30,000 O.P.V. with overload protection mirror scale 0/0·5/2·5/10/25/100/250/500/1,000V d.c. 0/2·5/10/25/100/250/500/1,000V a.c. 0/50µA/5/50/500mA. 12 amp. d.c. 0/60/K/6 Meg./60 MegΩ.
£8·87. Post paid.

HIOKI MODEL 750X



50,000 O.P.V.
43 ranges 0·0·3 to 1,200V d.c.
0·3 to 1,200V a.c.
0-30µA/300mA.
0-3K/30 meg ohms. −10 to +17dB.
£8·97. Post 20p.

HT100B4 MULTI-METER



Features a.c. current ranges. 100,000 O.P.V. Mirror Scale. Overload protection.
0/0·5/2·5/ 10 / 50 / 250 / 500 / 1,000V d.c.
0/2·5/10/50/250/500/ 1,000V a.c.
0/10/250µA/2·5/25/250MA/
10 amp. d.c.
10 amp. a.c. 0/20K/200K/2MEG/20 MEG. −20 + 62 dB. **£12·50,** P. & P. 25p.

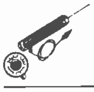
370 WTR MULTIMETER

Features a.c. current ranges. 20,000 O.P.V.
0/0·5/ 2·5 / 10 / 50 / 250/500/ 1,000V d.c.
0/2·5/10/50/250 /500/1,000V a.c.
0/50µA/1/10 / 100mA / 1 / 10 amp. d.c.
0/100mA/1/10 amp. a.c.
0/ 5K / 50K / 500K / 5MEG / 50MEG.
−20 +62dB. **£15,** P. & P. 25p.

RUSSIAN 22 RANGE MULTIMETER

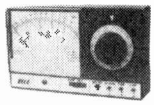
Model U437 10,000 O.P.V.
A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2·5/10/50/250/500/1,000V d.c. 2·5/10/50/250/500/1,000V a.c. D.c. current 100wA/1/10/100mA/1A. Resistance 300 ohms/3/30/300K/3mΩ. Complete with batteries, test leads, instructions and sturdy steel carrying case.
OUR PRICE **£5·97,** P. & P. 25p.

ROUND SCALE TYPE PENCIL TESTER MODEL TS.68



Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V a.c. and d.c. at 2,000 O.P.V. Resistance 0·20K ohms. ONLY **£1·97,** P. & P. 13p.

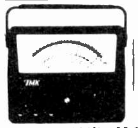
LT 601 MULTI-METER



New style 20,000 O.P.V. pocket multimeter. 5/25/50/250 / 500 / 2,500V d.c. 10/50/100/500/1,000V a.c. 50µA/250A. 6K/6 meg ohms. −20 to +22 dB.
£3·75. Post 20p.

MODEL TH-12
20,000 O.P.V. Overload protection. Slide switch selector. 0/0·25/2·5/10 / 50 / 250 / 1,000V d.c. 0/10/50/250/1,000V a.c. 0/50µA/25/250mA d.c. 0/3K/30K/300K/3 meg. −20 to +50dB.
£4·97. Post 15p.

MODEL TE-300. 30,000 O.P.V. Mirror scale, overload protection 0/0·6/3/15/60/300/1,200V d.c. 0/6/30/120/600/1,200V a.c. 0/30µA/6mA/60mA/300mA/600mA. 0/8K/80K/800K/8 meg. ohm −20 to +63 dB. **£5·97,** P. & P. 15p.



MODEL PL436
20kΩ/V d.c. 8kΩ/V a.c. Mirror scale. 0·6/3/12/30 /120 / 600V d.c. 3/30/120/600V a.c. 50/600µA/60/600mA. 10/100K/1 Meg/10 MegΩ. −20 to +46dB. **£6·97,** P. & P. 12p.

TMK MODEL TW-50K 46 ranges, mirror scale. 50K/V d.c. 5K/V a.c. D.c.: Volts 0·125, 0·25, 1·25, 2·5, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.c. Volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.c. Current: 25, 50µA, 2·5, 5, 25, 50, 250, 500mA, 5, 10 amp. Resistance: 10K, 100K, 1 MEG, 10 MEG Ω. Decibels: −20 to +81·5 dB.
£8·50, P. & P. 17p.

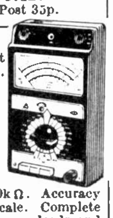
MODEL K228A

Taut band suspension. Overload protection. Polarity reversing switch.
30,000 O.P.V.
0/0·5 / 2·5 / 15 / 50/250/500/1,000/2,500V d.c. 0/15/50/150/500/1,000V a.c. 0/50µA/5/50/150/500mA/5A d.c. 0/3K/300K/3meg. **£8·95.** Post 20p.

HIOKI MODEL 700X
100,000 O.P.V. Overload protection. Mirror scale. 0·3/0·6/1·2/1·5/3/6/12/30/60/120/300/600/1,200V d.c. 1·5/3/6/12/30/60/150/300/600/1,200V a.c. 15/30µA/3/6/30/60/150/300mA 6/12 amp. d.c. 2K/200K/2 Meg/20 Meg ohm −20 to +63 dB. **£13·50.** P. & P. 20p.

MODEL C-7080 EN
Giant 6in mirror scale.
20,000 O.P.V.
0/0·25/1/2·5/10/50/250/1,000/5,000V d.c. 0/2·5/10/50/250/1,000/5,000V a.c. 0/50µA/1/10/100/500mA/10 amp. d.c. 0/2K/200K/20 meg.
−20 to +50dB.
£13·95. Post 35p.

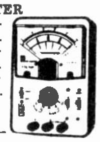
U4312 MULTIMETER



Extremely sturdy instrument for general electrical use. 667 O.P.V.
0/0·3/1·5/7·5/30/60/150/300/600/900V d.c. and 75mV.
0/0·3/1·5/7·5/30/60/150/300/600/900V a.c.
0/300µA/1·5/6/15/60/150
600MA/1·5/6 amp. d.c.
0/1·5/6/15/60/150/600MA/
1·5/6 amp. a.c. 0/200 Ω /3k/30k Ω. Accuracy Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. **£9·50** plus P. & P. 25p.

Selected TEST EQUIPMENT

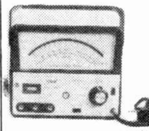
FTC-401 TRANSISTOR TESTER



Full capabilities for measuring A, B and ICO. *npn* or *pnp*. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads.
£7·50. Post 20p.

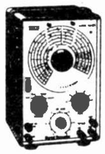
Model S-100TR MULTIMETER/TRANSISTOR TESTER. 100,000 O.P.V. mirror scale/overload protection. 0/0·12/0·6/3/12/30/120/600V d.c. 0/6/30/120/600V a.c. 0 / 12 / 600µA / 12 / 300mA / 12 amp. d.c. 0/10 K/1 MEG/100 MEG. −20 to +50dB. 0·01–2 MFD. Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads.

£13·50. P. & P. 25p.



MODEL 449A IN CIRCUIT TRANSISTOR TESTER
Checks true a.c. beta in/out. Checks Icbo. Checks diodes in/out. Checks SCR, etc.
Beta HI 10—500
LO 2—50
Icbo 0-5000µA.
220/240V a.c. operation. **£17·50.** Post 25p.

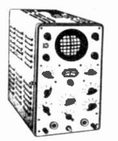
TE-20D RF SIGNAL GENERATOR



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. **£15.** Carr. 37½p. Size 140mm × 215mm × 170mm.

MODEL L-55 FET V.O.M.

Input impedance 10 meg ohms. 0/0·3/1·2/6/30/120/600V d.c. 0/3/12/60/120/600V a.c. 0/120µA/120mA d.c. 0/1K/100K/10 meg/100 meg ohms.
£15·97. Post 25p.



CI-5 PULSE OSCILLOSCOPE
For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth 10MHz. Sensitivity at 100kHz V RMS/mm. 0·1-25; HOR. AMP. Bandwidth 500kHz. Sensitivity at 100kHz, V RMS/mm. 0·3-25; Pre-set triggered sweep 1-3,000µsec.; free running 20-200,000Hz in nine ranges. Calibrator pips. 220mm × 360mm × 430mm. 115-230V a.c. operation.
£39. Carr paid.

TO-3 PORTABLE OSCILLOSCOPE

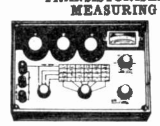
3in tube, Y amp. Sensitivity 0·1V p-p/CM. Bandwidth 1·5cps-1·5MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0·9V. p-p/CM. Bandwidth 1·5cps-800kHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10cps-300kHz. Synchronisation. Internal/external. Illuminated scale 140mm × 215mm × 330mm. Weight 15½lb. 220/240V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

RUSSIAN CI-16 DOUBLE BEAM OSCILLOSCOPE

5MHz Pass Band. Separate Y1 and Y2 amplifiers. Rectangular 5in × 4in C.R.T. Calibrated triggered sweep from 0·2µ/sec to 100 milli-sec per cm. Free running time base 50 Hz-1MHz. Built-in time base calibrator and amplitude calibrator. Supplied complete with all accessories and instruction manual.
£87. Carr. paid.

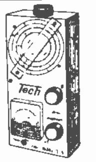
TE-16A Transistorised Signal Generator. 5 ranges 400kHz—30MHz. An inexpensive instrument for the handyman. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. 5½in × 5½in × 3¾in. Complete with instructions and leads. **£7·97.** Post 25p.

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



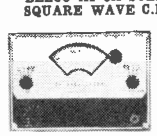
A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω-11·1 megΩ 6 Ranges ±1%. L.1 µH — 111·1 HENRYS 6 Ranges −2%. C. 10pF — 1110 mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000-1:11100. 6 Ranges ±1%. Bridge voltage at 1,000cps. Operated from 9V 100µA. Meter indication. Attractive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

MODEL TE15 GRID DIP METER



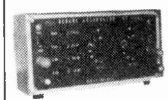
Transistorised. Operates as Grid Dip, Oscillator, Absorption Wave Meter and Oscillating Detector. Frequency range 440kHz-280MHz in 6 coils. 500µA meter. 9V battery operation. Size 180mm × 80mm × 40mm.
£12·50. Post 20p.

BELCO AF-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR



Sine 18-200,000 Hz; Square 18-50,000 Hz. Output max. +10dB (10 K ohms) Operation internal batteries. Attractive 2-tone case 7¾in × 5in × 2in. Price **£17·50.** Carr. 17p.

MODEL MG-100 SINE SQUARE WAVE AUDIO GENERATOR
Range 19-220,000 Hz. Sine Wave 19 — 100,000Hz. Square Wave. Output Sine or Square wave 10V. P. to P. Size 180mm × 90mm × 90mm. Operation 220/240V a.c.
£17·50. Post 37p.



MODEL AT201 DECADE ATTENUATOR
Frequency range 0-200kHz. Attenuator 0-111dB, 0·1dB step. Impedance 600 ohms. Max. input power 30dBm. Size 180mm × 90mm × 55mm.
£12·50. Post 37p.

TE-65 VALVE VOLTMETER

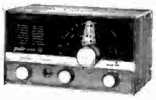
28 ranges. D.c. volts 1·5-1,500V a.c. volts 1·5-1,500V. Resistance up to 1,000 megohms. 200/240V a.c. operation. Complete with probe and instructions. **£17·50.** P. & P. 30p. Additional probes available: R.F. **£2·12;** H.V. **£2·50.**

MODEL U4311 SUB-STANDARD MULTI-RANGE VOLT AMMETER

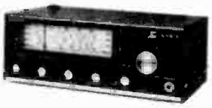
Sensitivity 330 ohms/Volt a.c. and d.c. Accuracy 0·5% d.c. 1% a.c. Scale length 165mm.
0/300/750µA/1·5/3/7·5/15/30/75/150/300/750mA/1·5/3/7·5 amp. d.c. 0/3/7·5/15/30/75/150/300 / 750mA / 1·5 / 3 / 7·5 amp. a.c. 0/75/150/300/750mV/1·5/3/7·5/15/30/75/150/300/750V d.c. 0/750mV/1·5/3/7·5/15/30/75/150/300/750V a.c.
Automatic cut out. Supplied complete with test leads, manual and test certificates. **£49.** Post 50p.

G. W. SMITH & CO. (RADIO) LTD.
Also see opposite page and next two pages

UNR-30 RECEIVER



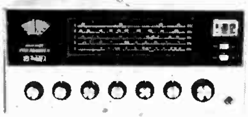
4 Bands covering 550kHz–30MHz. BFO. Built-in Speaker 220/240V a.c. Brand new with instructions. £15·75. Carr. 37p.



UR-1A SOLID STATE COMMUNICATION RECEIVER

4 Bands covering 550kHz–30MHz. FET. S Meter. Variable BFO for SSB, Built-in Speaker, Bandspread, Sensitivity Control. 220/240V a.c. or 12V d.c. 12½in × 4½in × 7in. Brand new with instructions. £25. Carr. 37p.

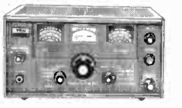
SKYWOOD CX203 COMMUNICATION RECEIVER



Solid state. Coverage on 5 bands 200–420 kHz and 0·65 to 30MHz. Illuminated slide rule dial. Bandspread. Aerial tuning. BFO, AVC, ANL, "S" meter. AM/CW/SSB. Integrated speaker and phone socket. Operation 220/240V a.c. or 12V d.c. Size 325 × 266 × 150 mm. Complete with instructions and circuit. £28·50. Carr. 50p.

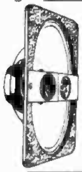
LAFAYETTE HA-600 SOLID STATE RECEIVER

General coverage 150–400kHz, 550 kHz–30MHz. FET front end. 2 mech. filters, product detector, variable BFO, noise limiter. S Meter, Bandspread. RF Gain. 15in × 9½in × 8½in. 18lbs. 220/240V a.c. or 12V d.c. Brand new with instructions. £50. Carr. 50p.



TRIO 9R59DS COMMUNICATION RECEIVER

4 band covering 550kHz–30MHz continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW. ANL. Variable BFO. S meter. Sep. bandspread dial. IF frequency 455kHz. Audio output 1·5W. Variable RF and AF gain controls 115/250V a.c. Size 7in × 13in × 10in with instruction manual. £49·50. Carr. paid.



EMI LOUDSPEAKERS

Model 350. 13in × 8in with single tweeter/crossover, 20–20,000Hz. 15W RMS. Available 8 or 15 ohms. £7·25 each. P. & P. 37p.
Model 450. 13in × 8in with twin tweeter/crossover. 55–13,000Hz. 8W RMS. Available 8 or 15 ohms. £3·62 each. P. & P. 25p.

HONEYWELL DIGITAL VOLTMETER VT.100

Can be panel or bench mounted. Basic meter measures 1V d.c. but can be used to measure a wide range of a.c. and d.c. volt, current and ohms with optional plug in cards. Specification: Accuracy: ±0·2, ±1 digit. Resolution: 1mV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1·999). Input impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100V d.c. Input: Fully floating (3 poles). Input power: 110–230V a.c. 50/60 cycles. Overall size: 5⅜in × 2$\frac{11}{16}$in × 8$\frac{5}{16}$in. AVAILABLE BRAND NEW AND FULLY GUARANTEED. £36·50. Carr. 50p.

SINCLAIR IC-12

List Price £2·98

OUR PRICE **£1·80**
P. & P. 10p.

SINCLAIR EQUIPMENT

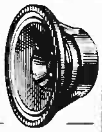
Project 60 Package offers.

2 × Z30 amplifier, stereo 60 pre-amp, PZ5 power supply. £15·95. Carr. 37p. Or with PZ6 power supply. £18·00. Carr. 37p. 2 × Z50 amplifier, stereo 60 pre-amp, PZ8 power supply. £20·25. Carr. 37p.
Transformer for PZ8. £2·97 extra.
Add to any of the above £4·45 for active filter unit and £13·00 for pair of Q16 speakers.
All other Sinclair products in stock.
2000 amp. £21·95. Carr. 37p.; 3000 amp. £28·50. Carr. 37p.; Neoteric Amp. £43·95. Carr. 37p. IC12. £1·80. P. & P. 10p.
NEW PROJECT 605—£20·97. Carr. 37p.

WHARFEDALE MID-RANGE HI-FI UNITS

As used in world famous system. 5in dia. Impedance 4/8 ohms. High flux ceramic magnet. 20W RMS. Brand new £1·50. Carr. 37p.

SPECIAL OFFER! GOODMANS AXIOM 301



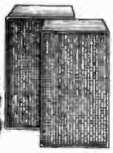
Hi-Fi 12in 20W twin cone full range speaker. 30–16,000Hz. 16,500 gauss. 8 ohm impedance. Brand new and boxed. (List price £21·72). OUR PRICE £12·50 each. Carr. 50p.

EA.41 REVERBERATION AMPLIFIER

Self contained, transistorised, battery operated. Simply plug in microphone, guitar, etc., and output into your amplifier. Volume control, depth of reverberation control. Beautiful walnut cabinet. 7½in × 3in × 4½in. £5·97. P. & P. 15p.

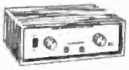
SPECIAL OFFER! ROTEL RH700 STEREO HEADPHONES

20–20,000Hz. 8–16 ohm. (List £9·95). OUR PRICE £6·75. P. & P. 25p.



SPECIAL OFFER! STEREO SPEAKERS

Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 14½in × 9in × 7½in. 8 ohms. 8W RMS. 16W peak. Complete with DIN lead. £12·95. Carr. 50p.

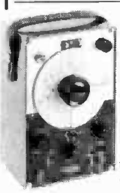


HA-10 STEREO HEADPHONE AMPLIFIER

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 5MU/100MU. Output 50MW. £5·97. P. & P. 15p.

SPECIAL PURCHASE !
NEAT G30J STATIC BALANCE PICK-UP ARMS

Identical specification to NEAT G30 arm but with two-tone chrome and black finish. Complete with head shell, pick-up rest and plug in phono leads. BRAND NEW—FULLY GUARANTEED. ONLY £8·95. P. & P. 25p.



ARF-300 AF/RF SIGNAL GENERATOR

All transistorised, compact, fully portable. AF sine wave 18 Hz to 220 KHz. AF square wave 18 Hz to 100 KHz. Output sine/square 10v. P-P. RF 100 KHz to 200 MHz. Output 1v. maximum. Operation 220/240v. AC. Complete with instructions and leads. £29·95. Post 50p.

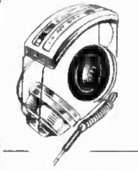
AKAI BARGAINS

SUPER MONEY SAVING OFFERS—BUY NOW WHILE STOCKS LAST! ALL BRAND NEW AND FULLY GUARANTEED

1721 Tape Rec.	£73·95
X5000 Tape Rec.	£99·95
GX365 Tape Rec.	£327·00
4000D Tape Deck	£61·50
4000DS Tape Deck	£73·95
X200D Tape Deck	£99·95
GX220D Tape Deck	£164·95
GX280D Tape Deck	£249·40
X1800SD Tape/8 track Rec.	£101·95
X2000SD Tape/Cas/8 Rec.	£223·30
CR81 8 track Rec.	£80·95
CR81D 8 track Rec.	£65·95
CR81T 8 track/Receiver	£118·90
CR80SS 8 track system	£145·00
CS50 Cassette Rec.	£79·00
CS50D Cassette Deck	£74·95
GXC40 Cassette Rec.	£82·25
GXC40D Cassette Deck	£66·95
GXC40T Cassette/Receiver	£123·95
GXC45D Cassette Deck	£95·95
GXC46D Cassette Deck	£103·50
GXC60D Cassette Deck	£111·25
GXC65D Cassette Deck	£110·25
CS35D Cassette Deck	£59·50
AA6200 Receiver	£74·95
AA6300 Receiver	£82·50
AA6600 Receiver	£109·00
AA8500 Receiver	£175·00
ADM11 Microphones (Pair)	£7·50

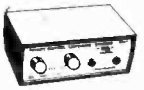
Carriage 50p extra (recorders and decks 75p).

GENUINE BARGAIN!



KOSS SP.3XC STEREO HEADPHONES

Response 10–15,000Hz. Impedance 4–6 ohms. Brand new. Boxed and fully g'teed (List £9·50). OUR PRICE £6·50. P. & P. 25p.



1021 STEREO LISTENING STATION

For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. 2 gain controls, speaker on-off slide switch, stereo headphone sockets. 6in × 4in × 2½in. £2·25. P. & P. 15p.

MP7 MIXER PREAMPLIFIER

5 microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. 9½in × 5in × 3in. Inputs Mics: 3 × 3mV 50K: 2 × 3mV 600 ohm. Phono mag. 4mV 50K. Phono ceramic 100mV 1 meg. Output 250mV 100K. £8·97. P. & P. 20p.

TE-1035 STEREO HEADPHONES

Low cost high performance stereo headphones. Foam rubber ear cups. Adjustable head-band. 8 ohm impedance. 25–18,000Hz. With lead and stereo jack plug. ONLY £1·97. P. & P. 12p.

NEW GARRARD MODULES

Popular range of Garrard decks with Shure cartridge fitted in deluxe plinth with hinged lid.

	Our Price
SP25 III Module/M75-6	£23·50
AP76 Module/M75-6	£33·80
AP96 Module/M75-6	£38·75
Zero 100S Module/M93E	£52·60

Carr. 50p extra any item.

HOSIDEN DH-08S DE-LUXE STEREO HEADPHONES

Features unique mechanical 2 way units and fitted adjustable level, controls. 8 ohm impedance 20–20,000cps Complete with spring lead & stereo jack plug £7·97. P. & P. 12p.

DOLBY SYSTEM NOISE REDUCTION UNIT

Improves the performance of cassette and semi-professional recorders. Reduces tape hiss by 3dB at 600Hz, 6dB at 1200Hz and 10dB for all frequencies above 3000Hz. Controls for input levels and noise reduction on record and replay. 2 meters for Dolby level. Off tape monitoring. Frequency response: 20Hz to 15kHz ± 1dB 19kHz—35dB. Size 15¾in × 9in × 3¼in. A.c. 200/250V.
OUR PRICE **£32·50** Carr. 50p.

HOSIDEN DHO-2S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head-band. 8 ohm impedance. 20–12,000 cps. Complete with lead and plug. ONLY £2·37. P. & P. 12p.

TAPE CASSETTES

Top quality Hi-Fi Low Noise in Library cases.

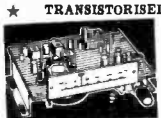
C60	3 for 75p.	10 for £2·35
C90	3 for £1·05	10 for £3·30
C120	3 for £1·35	10 for £4·20

Tape Head Cleaner 30p each. P. & P. 10p extra.

SPECIAL PURCHASE! LEAK MINI-SANDWICH SPEAKERS

Brand new and fully guaranteed. 8W, 8 ohm. Teak finish. (Rec. list £59·50 pr.) **OUR PRICE £39·50 pr.** Carr. £1·00.

★ **TRANSISTORISED FM TUNER** ★

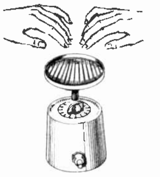


6 TRANSISTOR HIGH QUALITY TUNER, SIZE ONLY 6in × 4in × 2½in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88–108MHz. Ready built ready for use. Fantastic value for money. £6·37. P. & P. 12p. Stereo multiplex adaptors £4·97.

TE 1018 DE-LUXE MONO HIGH IMPEDANCE HEADSET

Sensitive, soft earpads, adjustable headband. Magnetic, impedance 2,600 ohms. £1·97. P. & P. 15p.

G. W. SMITH & CO. (RADIO) LTD.
Also see previous pages and opposite page



AMAZING MAGIC MUSIC BOX

make electronic music waving your hands about

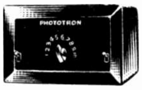
ONLY £2·75

Everyone's heard the weird, wonderful, but beautiful music used in Science Fiction Films. Horror Films, etc. also on Radio & Television. This unearthly, eerie music is almost always produced by a little known electronic device measuring only a few inches . . . called a Theremin. All you have to do is switch on your radio (almost any type will do) and place the Theremin close by. Switch on the Theremin and proceed to wave your hands mysteriously in the air like a magician. The most fantastic musical sounds are then produced, and with a little practice people can learn to play all the well known tunes. Apart from its musical value, its small size allows it to be used to best advantage at parties, gatherings of friends, etc., where it attracts tremendous interest. Provides hours and hours of pleasure to young and old. Uses standard PP3 battery which lasts ages. The 3 Transistor circuit, though fairly advanced is simple to build with our pictorial step-by-step plans. No soldering necessary. Easily built in an hour or so using our special *terminal* board (Pat. applied for). All parts including nuts, bolts, case, etc., **ONLY £2·75** + 25p P. & P. (Parts available separately.)

INGENIOUS ELECTRONIC SINGING & WARBLING CANARY!

ONLY £4·50

Actually whistles and warbles like a real live Canary. Amazing circuitry faithfully reproduces the Canary's magnificent song. Just switch on and leave it—whistling down scale for some seconds, suddenly breaking into a delightful warble, then several seconds later shutting off for a second or two—only to start automatically again in a few seconds. People listen to the delightful song all day and never get bored! Relax, as the sweetest nerve-soothing birdsong takes you to leafy woods and glades. Provides countless hours of joy to young and old alike. Standard self-contained battery lasts ages. Easily built in an hour or so with special pictorial step-by-step plans. No soldering necessary. All parts including terminal board (Pat. applied for), transformers, loudspeaker, transistors, nuts, screws, wire, etc., plus case (which fits under cage—cage and toy bird not supplied). **ONLY £4·50** + 25p P. & P. (Parts available separately.)



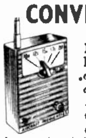
The amazing "Phototron" SOUND OPERATED FLASH

ONLY £4·50

Take flash pictures at the exact instant of the bursting of a balloon. A champagne cork leaving the bottle. The split second a hammer strikes a light bulb. *The mind boggles at the possibilities of the "Phototron" . . . the only limit is your imagination.* Now that inexpensive flash guns are on the market in quantity, it has made possible, with the help of electronics the production of a wide variety of exciting photography effects, once strictly limited to the professionals. The duration of an electronically produced flash is extremely brief and normally measured in Milliseconds. Now, providing the camera shutter is left open in a dark or subdued light, it is the timing of the flash that determines what is imprinted on the film—not necessarily anything done by the camera. As electronic flash guns are fired by making a switched connection then it becomes obvious that one of the latest Silicon Controlled Relay's can be used. If we make this S.C.R. operate by sound (with variable sensitivity control for soft/loud sounds) some real "way out" photography effects can be captured forever on film. Easily built in a couple of hours or so, the "Phototron" is fully solid state, uses self contained PP3 battery. No soldering necessary using our special terminal board (Pat. applied for). All parts including special pictorial step-by-step plans, transistors, microphone, S.C.R., potentiometers, switches, test lamp, case, nuts, screws, etc., etc., **ONLY £4·50** + 25p P. & P. *Made up must be worth at least £10.* (Parts available separately.)

Eavesdrop on the exciting world of Aircraft Communications—

V.H.F. AIRCRAFT BAND CONVERTER ONLY £2·85



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

FIND BURIED TREASURE!

Transistorised Treasure Locator

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

ONLY £2·85

TREASURE LOCATOR MODULE

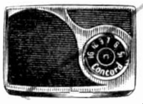
ONLY £4·50

FULLY TRANSISTORISED METAL DETECTOR MODULE. Uses PP3 battery and 'phones. Put it in a case, screw a handle on and YOU HAVE A PORTABLE TREASURE LOCATOR EASILY WORTH ABOUT £20! Extremely sensitive—penetrates through earth, sand, rock, water, etc.—EASILY LOCATES COINS, GOLD, SILVER, JEWELLERY, HISTORICAL RELICS, BURIED PIPES, ETC. So sensitive it will detect certain objects buried SEVERAL FEET BELOW GROUND! GIVES CLEAR SIGNAL ON ONE COIN, **£4·50** + 30p carr. for Kit. (High quality Danish Stethoscope headphones **£2·75** extra if required.)

SHORTWAVE TRANSISTOR RADIO

ONLY £2·75

Anyone from 9 years up can follow the step-by-step, easy as ABC, fully illustrated instructions. No soldering necessary. 76 stations logged on rod aerial in 30 mins—**Russia, Africa, USA, Switzerland,** etc. Experience thrills of world wide news, sport, music, etc. **Eavesdrop on unusual broadcasts.** Uses PP3 battery. Size only 3in × 4¾in × 1¼in. **Only £2·75** + 20p p & p. Kit includes cabinet, screws, instructions, etc. (Parts available separately.)



UNIQUE RADIO FOR BEDROOM OR OFFICE

No batteries, no electricity, never wears out **ONLY £1·70**

Tune in your favourite programmes or the news, or sports in the Office or in your bedroom. Uses sensitive, germanium diode originally evolved from Wartime radar. Never buy a battery. Never use electricity. Never replace. Covers all medium waves. Clear beautiful tone. Size 4¾in × 2¾in × 1¼in in beautiful case. **ONLY SEVEN CONNECTIONS AND IT'S WORKING!** No soldering necessary. **CAN BE BUILT ALMOST BLINDFOLD IN UNDER 15 MINUTES!** Ideal for absolute beginner from 8 years of age upwards. **SPECIAL PRICE TO CLEAR STOCKS OF COMPONENTS, ONLY £1·70** + 20p P. & P. for all parts including beautiful case. Germanium semi-conductor, tuning condensor, personal phone, wire, nuts, screws, **SIMPLE AS ABC INSTRUCTIONS** (Parts available separately).

"READ PEOPLE'S MINDS"—TEST THEIR NERVES—BEAT THEM AT CARDS, ETC. WITH THIS ASTONISHING

ELECTRONIC BRAIN BOX Only £2·87

With this "Brain-box" you will be able to *perform mind-boggling feats.* **THE MIND READING DEVICE** will make people swear you have "telepathic" powers. **THE AMAZING CARD TRICK UNIT** completely mystifies and baffles from one to six people. *You correctly "guess" the two cards each person has selected at random from a pack they themselves shuffled.* **THE ELECTRONICS NERVES TESTER** puts your friends to a very lively test. It gives out fail and finish signals (the winner is the person with lowest number of fail signals). *Can be adjusted from the weakest to strongest person.* **THE ELECTRONIC MAZE** *tests the mental ability of the player* because it uses psychology with an electronic twist to it. You can change the maze pathways in seconds to prevent the maze becoming too stale after lots of use. Completely safe and foolproof. Size 18in × 12in × 6in (max.). You can play all these games and more besides after building the "Brain-box". No soldering, you get pictorial, easy as ABC step-by-step simple instructions. **ONLY £2·87** + 33p P. & P. for all parts including chassis, switches, stylus, signalling lights, wire, nuts, screws, etc. Uses standard battery. Presentation box 33p extra as illus. if reqd. (PARTS AVAILABLE SEPARATELY) **FULL OPERATING DIRECTIONS WITH EACH OF THE PROJECTS.**

NOW YOU CAN CATCH SHOALS OF BIG FISH

with new electronic miracle — special introductory offer **£2·50**

First time marketed in England, this exciting electronic instrument the "Decoytronic" is the one responsible for starting the electronic fish-lure rage in the U.S.A. just recently. Uses ingenious double-action method of attracting all kinds of fish from hundreds and hundreds of feet away . . . saltwater or freshwater. Why this device is so fantastically successful is because it *actually imitates the sound of wet insects milling about the surface.* These sound waves spread out hundreds of feet in all directions. Although this peculiar sonic frequency won't sound like much to you—to all the fish in the area it's their dinner bell! **But that's not all** . . . *electroluminescence neon tubes cunningly flicker intermittently,* penetrating the area for hundreds of feet around, at a frequency fish are unable to resist. The fish mistake this flickering glimmer for the soft phosphorescence glow given off by Plankton . . . a favourite delicacy of most fish! All you do is switch on, lower into the water (it's completely water resistant) allow around 5 minutes—then start reeling 'em in. We'll bet you won't be able to reel 'em in fast enough. Self-contained batteries last ages—cost pence. Kit of all parts including special easy as a.b.c. directions only **£2·50** + 25p P. & P. (Parts available separately.)

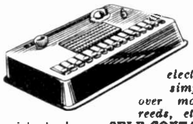
BUILD 5 RADIO AND ELECTRONIC PROJECTS

ONLY £2·45

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

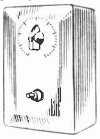
ELECTRONIC ORGAN

ONLY £3·25



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

SOOTHE YOUR NERVES RELAX WITH THIS AMAZING RELAXATRON

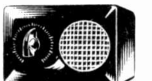


ONLY £2·75

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

INGENIOUS ELECTRONIC SLEEP INDUCER

ONLY £3·25



Can't sleep at nights? Do you wake up in the night and can't get off to sleep again? Would you like to be gently soothed off to satisfying sleep every night? Then build this ingenious electronic sleep inducer. It even stops by itself so you don't have to worry about it being on all night! The loudspeaker produces soothing audio-frequency sounds, continuously repeated—but as time goes on the sound gradually become less and less—until they eventually cease altogether, the effect it has on people is amazingly very similar to hypnosis. A control is provided for adjusting the length of times, etc., all transistor, can be built by anyone over 12 years of age in about two hours. No knowledge of electronics or radio needed. Extremely simple, easy-to-follow, step-by-step, fully illustrated instructions included. No soldering necessary. Works off standard batteries, extremely economical. Size only 3in × 4¾in × 1¼in—take it anywhere. Kit includes case, nuts, wire, screws, etc. SEND **£3·25** + 25p P. & P. (Parts available separately.)

EXAMINE AT HOME FOR 7 DAYS. YOUR MONEY REFUNDED IN FULL IF NOT 100% DELIGHTED.

CONCORD ELECTRONICS LTD. (PEI), 8 Westbourne Grove, London, W.2. (Callers welcome. 9 a.m.-5.30 p.m.)

E.M.I. WOOFER AND TWEETER KIT

£5·75 THE PAIR Post 25p. (Available separately. Woofer £4·25; Tweeter £1·90).

Comprising a fine example of a Woofer 10¾ × 6¼in. with a massive Ceramic Magnet, 44oz, Gauss 13,000 lines. Aluminium Cone centre to improve middle and top response. Also the E.M.I. Tweeter 3¾in. square has a special lightweight paper cone and magnet flux 10,000 lines. Crossover condenser and full instructions supplied.

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

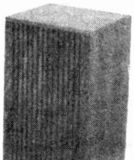
SUITABLE ENCLOSURE 20 x 13 x 9in. MODERN DESIGN. TEAK WOOD FINISH **£9** Post 25p

8in. or 10in. ELAC HI-FI SPEAKER

Dual cone plasticised roll surround. Large ceramic magnet. 50–16,000 cps. Bass resonance 55 cps. 8 ohm impedance. 8in. 10 watts, 10in. 12 watts music power. **£3·75**

TEAK HI-FI SPEAKER CABINETS

Fluted Wood Fronts



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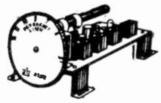

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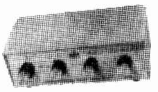

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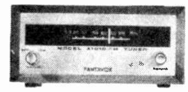

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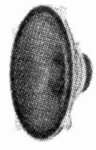

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$\frac{9}{16}$in. Round	83p	1$\frac{3}{16}$in. Round	£1·05	2⅜in. Round	£4.10
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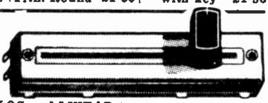

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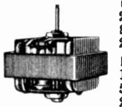

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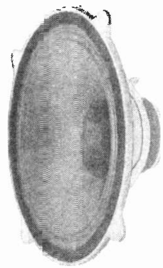

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Flux Density	12,000gauss
Useful response	45-13,000cps

3 or 8 or 15 ohm models

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DE-LUXE Mk I

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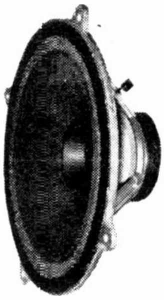

Especially designed to provide full range reproduction at an economical cost. Suitable for use with any high fidelity system. Built-in concentric tweeter cone.

Bass Resonance	30cps
Flux Density	14,000gauss
Useful response	25-16,000cps

8 or 15 ohms models

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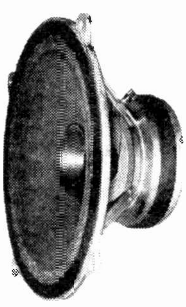
SUPERB

12in. 20 watts



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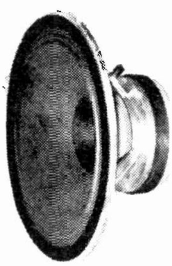

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Bass Resonance	35cps
Flux Density	15,000gauss
Useful response	25-16,000cps

8 or 15 ohms models

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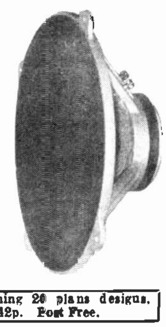
AUDITORIUM

15in. 35 watts



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DOWN TO EARTH

THE obvious sometimes obscures other parts of the picture. The main purpose of a constructional article is to give all information necessary to enable any suitably experienced constructor to produce for himself a correctly functioning replica of a proven prototype equipment.

Obvious and true; but this is far from all. In fulfilling its purpose a constructional article demonstrates in the most effective and objective manner possible how circuits can be applied in practice. Interesting and unusual applications of the technology are frequently first brought to the attention of the reader through a constructional design. The Biological Amplifier described in this month's issue is a good example of this, since it opens a door to an area of activity perhaps totally unfamiliar to many readers.

Purely theoretical articles are essential and they play their important part in explaining new concepts for circuit design and in suggesting lines for experimentation with new circuit devices. But when it comes to the nitty gritty business of determining precise facts, no amount of theorising can be as convincing, nor as reliable, as the detailed technical description of an actual model, with every component value stated and a performance already established, not merely calculated or predicted.

Amongst our readers there will be a sizeable number who confine their interest in electronics mainly to a study of circuitry and its uses in the abstract—and we suspect they include quite a few who have never held a hot soldering iron in their hand. We believe it would be a great error were they to skip the pages devoted to practical designs. The old saw that an ounce of practice is worth a pound of theory is very relevant even when considering general or non-constructing readers, simply because they do rely exclusively upon the printed word and diagram for knowledge.

Constructional articles help to infuse reality into a subject which, because of the impalpable nature of its workings, is all too liable to be elevated into rarefied regions—with the ready connivance of some of the technical intelligentsia, it has to be admitted. No matter whether we build a particular project or not, careful examination of the text and diagrams will usually teach us something; and certainly help us keep the whole of electronics in true perspective and our own feet firmly on the ground.—F.E.B.

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A linear ohmmeter is an essential piece of equipment for carrying out accurate resistance measurements on thermistors, l.d.r.s, resistive transducers, motor field and armature windings, heating elements, etc. Such an instrument is also extremely useful for checking resistors and resistance combinations, or for batch selection from low tolerance components.

The instrument described in this article is ranged 0–5Ω f.s.d. to 0–100kΩ f.s.d. in 10 ranges utilising a divide by two facility. These ranges will cover most applications from measuring low resistance motor armature windings to thermistors and transducer tracks.

The circuit is extremely stable but built-in calibration is provided to compensate for drift as a result of battery deterioration or extreme environmental effects. Battery life is six months or more and the indication can be guaranteed to have an accuracy ±1 per cent of full scale deflection.

PRINCIPLE OF OPERATION

The principle of operation is well established and is based on the simplified circuit diagram shown in Fig. 1.

The resistance to be measured (R_x) is fed by a constant current generator (I_g) to give an input voltage V_i. This is then amplified and the output voltage V_o, proportional to the input resistance value R_x, is measured on a moving coil meter calibrated in ohms. The operational amplifier is connected in its non-inverting mode and has sufficient feedback to ensure good stability of operation, and satisfactory input and output impedance values.

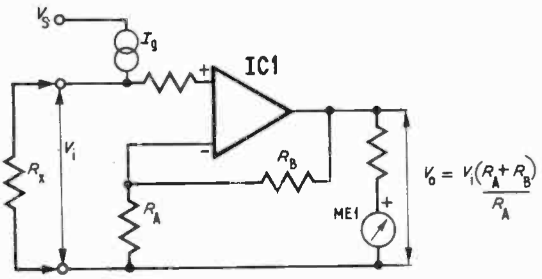


Fig. 1. Simplified circuit diagram of the ohmmeter

THE COMPLETE CIRCUIT

The circuit diagram of the ohmmeter is given in Fig. 2. The constant current generator TR1 is adjusted by VR1, VR2 or VR3 to give the required outputs which may be passed through the test resistance R_x or through the standard range resistors R1 to R5 by selection of switch S1a or S1b. A fine setting is achieved by adjustment of VR4 to give an accurate full scale meter deflection when the standard resistors (calibrated input) are selected. By scale calibration prior to test readings the accuracy of the system is dependent only on the standard range resistors and the meter.

The operational amplifier IC1 is connected to give the required closed loop gain by adjusting the resistor values at the range selection switches S2c and S2d.

I.C. LINEAR OHMMETER

By G. GRIFFITHS B.Sc. (Eng)

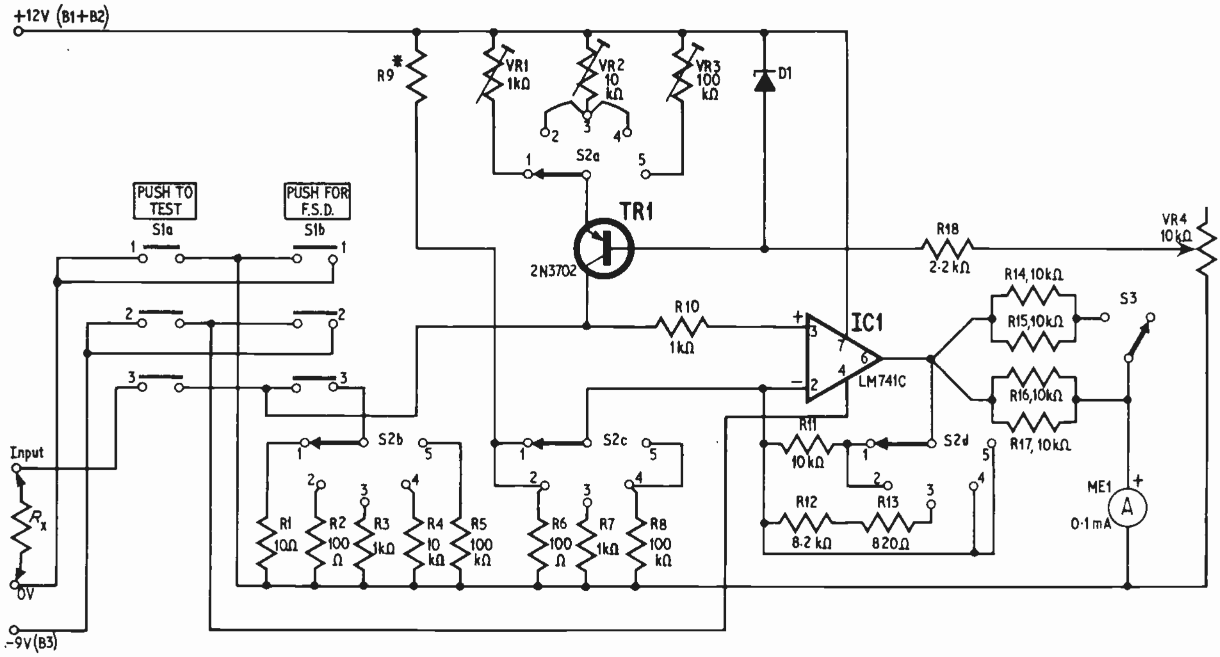


Fig. 2. Circuit diagram of the linear ohmmeter

The amplifier has a minimum input resistance of 25 megohms and 400 megohms in the unity gain condition so that input resistance ranges of up to 10 megohms may be measured without loss of accuracy. The output resistance is never greater than 10 ohms so a 1 milliamp meter movement may be used without loading the amplifier unduly. The use of such an indicator, used with appropriate series resistors, offers better accuracy and shock resistance as well as being cheaper than a more sensitive movement.

The divide by two switch S3 gives a full scale deflection of 2·5V when selected and so expands the range of the instrument. The operating conditions as referred to Fig. 1 are shown in Table 1.

COMPONENTS

Many of the resistors as shown in Fig. 2 are of high tolerance and stability. It is, of course, of paramount importance to have accurate standard range resistors, as the instrument read-out accuracy is dependent on these.

The current generator is constructed from three presets, a Zener diode and a transistor. The presets may be the Cermet type or the skeleton type, but any silicon *pnp* transistor and any 5·1V 400mW Zener will suffice.

The amplifier used in this circuit is preferably the LM741C, but a μA709 may be used with appropriate frequency dependent feedback components. If the latter is used it may be necessary to decouple the supply rails to prevent parasitic oscillation.

The function/on-off switch S1 consists of two, unit assembled three-pole wavechange switches with three functions: f.s.d., test and off.

The range switch S2 is made up of four, single-pole 6-way wafers one way of each not being used. S3 is a single pole on/off slide switch.

Table 1: OPERATING CONDITIONS

Switch Position	Resistance Range	$V_i = [I_g R_x]$	Amplifier Gain = G	R_A	R_B	I_g	V_o
1	10Ω	50mV	100	100Ω	10kΩ	5mA	5V
2	100Ω	50mV	100	100Ω	10kΩ	500μA	5V
3	1kΩ	500mV	10	1kΩ	9kΩ	500μA	5V
4	10kΩ	5V	1	100kΩ	0	500μA	5V
5	100kΩ	5V	1	100kΩ	0	50μA	5V

CABINET DETAILS

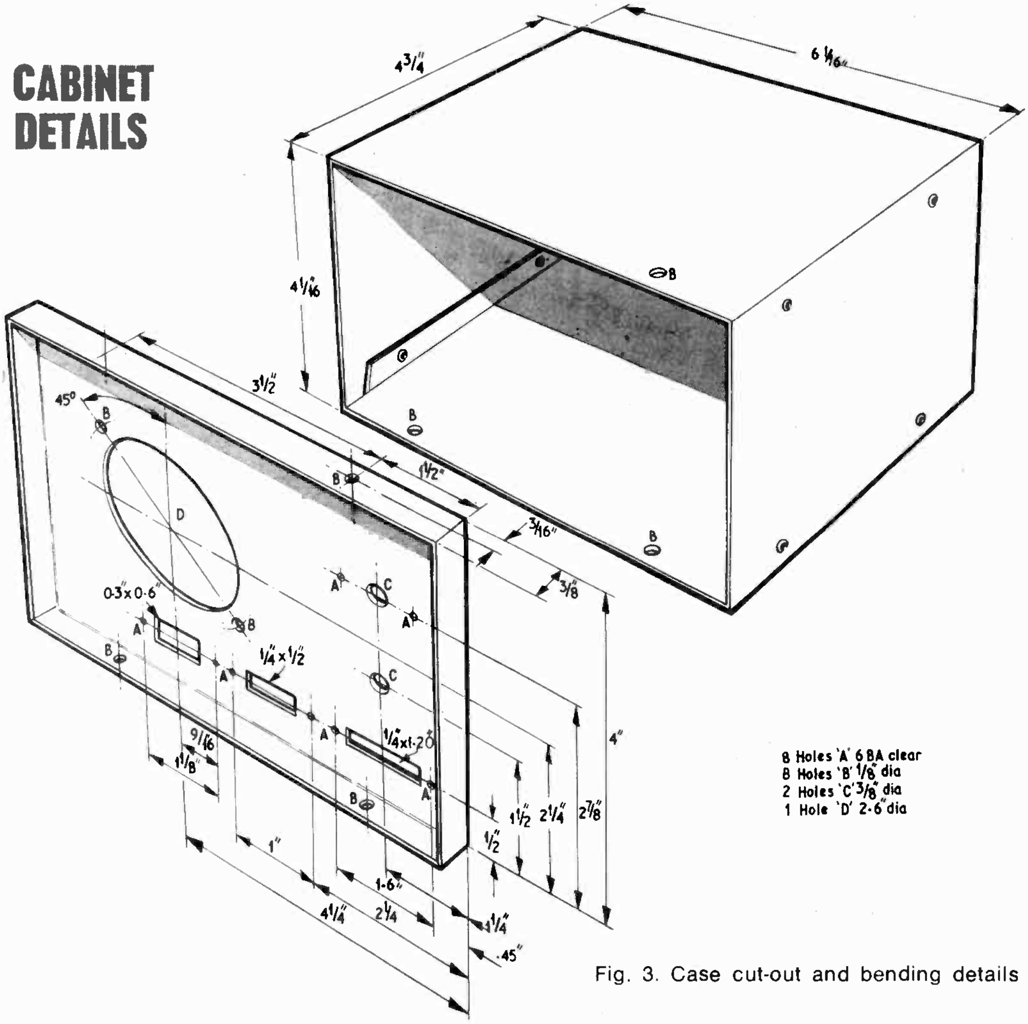


Fig. 3. Case cut-out and bending details

BOARD DETAILS

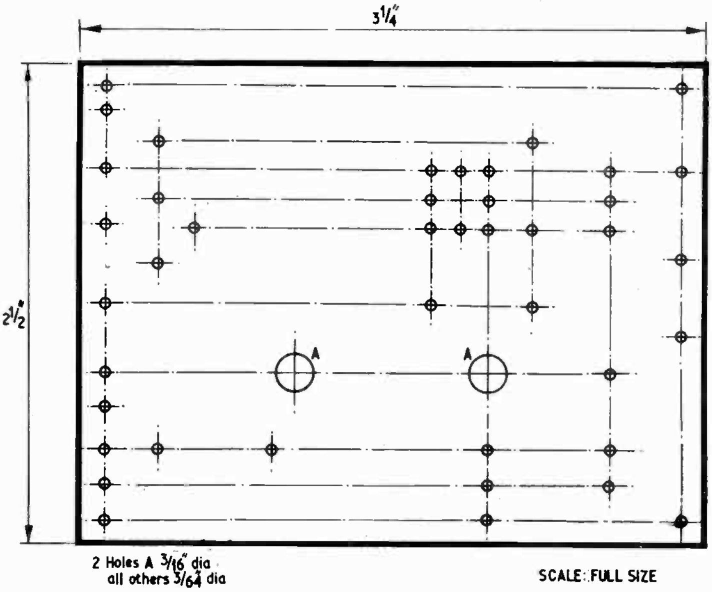


Fig. 4. Drilling details for small component mounting board

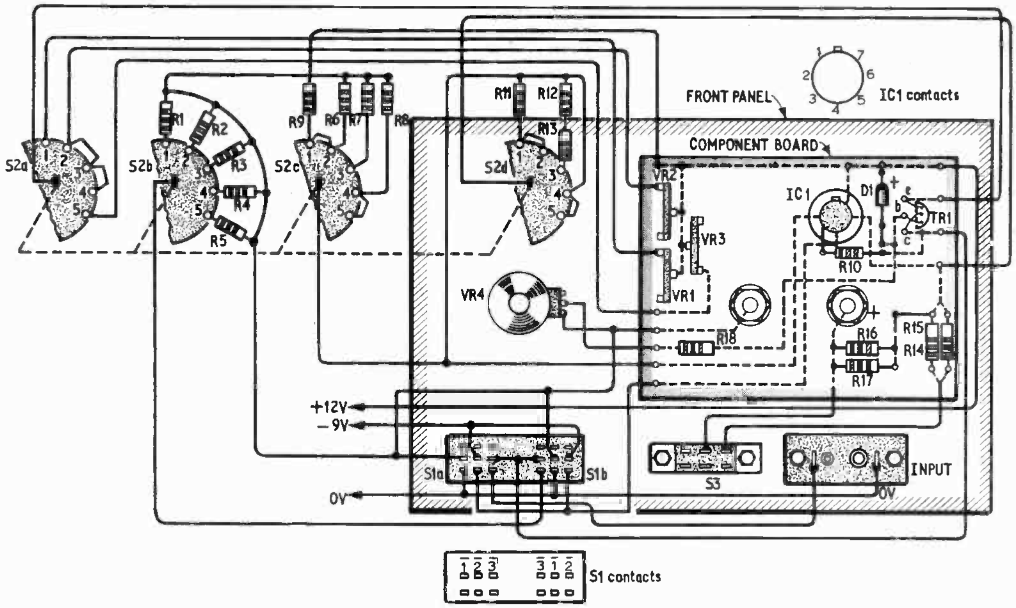


Fig. 5. Component assembly and wiring details. Wafer switch wiring is shown separate for clarity

COMPONENTS . . .

Resistors

R1	10Ω 1%	R10	1kΩ 5%
R2	100Ω 1%	R11	10kΩ 2%
R3	1kΩ 1%	R12	8·2kΩ 2%
R4	10kΩ 1%	R13	820Ω 2%
R5	100kΩ 1%	R14	10kΩ 2%
R6	100Ω 2%	R15	10kΩ 2%
R7	1kΩ 2%	R16	10kΩ 2%
R8	100kΩ 5%	R17	10kΩ 2%
R9*	See text	R18	2·2kΩ 5%

All ¼ watt carbon resistors

Potentiometers
VR1 1kΩ vertical preset
VR2 10kΩ vertical preset
VR3 100kΩ vertical preset
VR4 10kΩ carbon linear

Diode
D1 5·1V 400mW Zener diode

Transistors
TR1 2N3702

Integrated Circuit
IC1 LM741C

Switches
S1 2-bank, 3-pole, 2-way wavechange switch
S2 Switch kit with four 1-pole, 6-way wafers
S3 Single pole on/off slide type

Meter
ME1 1mA moving coil meter 100mm × 80mm (SEW type)

Batteries
B1, B2 6 volt style PP1 (2 off)
B3 9 volt style PP9

Miscellaneous
Aluminium sheet 20 s.w.g. 6in × 4in and 15½in × 13½in

OPERATION

To operate the instrument, S2 is first selected to give the required range (if known). The function switch S1b is then pushed to give full scale deflection on the meter which, if necessary, is adjusted by means of VR4.

The unknown resistance may be connected and the test function switch S1a depressed. Should the ensuing reading be less than half full scale deflection the divide by two facility may be used to give better accuracy of reading.

PRACTICAL CONSIDERATIONS

In the design stage it was envisaged that leakage currents would not give a significant output reading with both inputs grounded, that is, in the zero input resistance condition. However on test it was found that some i.c.s gave up to 40μA leakage under maximum gain conditions.

Under these circumstances it will be necessary to introduce a small offset voltage to the inverting input to give zero output deflection. This may be done by adding resistor R9 as shown in Fig. 2.

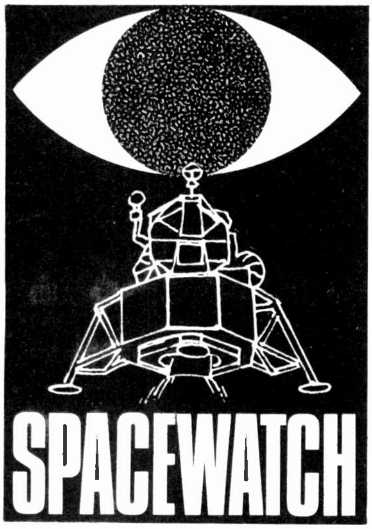
To calculate this resistance use the equation as follows, referring to Table 1 for the appropriate unknown values.

$$R_9 = \frac{12\, R_A\, G}{V_0}$$

where R_A = appropriate value to setting (e.g. $R_A = 100$ when $G = 100$)
G = gain setting
V_0 = indicated leakage output voltage (0–5V f.s.d.)

Finally, for low resistance measurements, it must be remembered to take into account lead resistance. This was 0·18 ohms in the prototype unit.

continued on page 59



BY FRANK W. HYDE

CAMBRIDGE TELESCOPE

Within a few days of operation after the official opening of the Cambridge five kilometres radio telescope at Lords Bridge, new maps were made available.

While the telescope was in construction radio astronomers in America had announced the discovery of radio waves emanating from the bright star Algol. This source has provided the Cambridge workers with the means of calibration much more accurate than hitherto. The radio coordinate system they use is now to be held to a figure better than 0·1 second of arc relative to Algol.

The position of Cygnus X-3 has now been measured to within 0·15 second of arc so that there is now a possibility of identifying the X-ray star with an optical object.

The future prospects for this new telescope are very exciting and with its versatility and resolution potential it will bring a great deal of data for analysis.

The resolving of two of the extra-galactic objects 3C 86A and 3C 295 gives some idea of the telescope potential, for these two objects had not previously been properly resolved. The object 3C 295 is of particular interest because of its large red shift. The new maps show that this is in fact two units spaced some 4·5 seconds of arc apart.

Interest in galactic sources has greatly increased since the molecular lines and infra-red emission from dust clouds have been discovered. One of the new maps using a frequency of 5GHz has shown, in the contours of NGC 7538, an intense source in addition to the extended emission. This source is a galactic hydrogen cloud and the resolving of the main extended source and the intense source, will enable important deductions to be made.

PULSARS

The Jodrell Bank programme for the study of pulsars continues to extend the known catalogue. The total is now in excess of 100 pulsars that can be identified. The programme under the leadership of Prof. J. D. Davies added some 18 more to the list during September and October 1972.

Among the new finds was one pulsar that was within 0·6° of the centre of an extensive nebula known as IC 443. This nebula is a remnant of a supernova which came into being about 65,000 years ago. It is a powerful radio source by reason of the high energy electrons in strong magnetic fields which compose the remnant.

A check on the rotational period of the pulsar showed that it was faster than average yet slowing. The period was 0·334 seconds. Over a period of seven weeks this slowed by 0·33 microseconds. This lengthening of the rotational period is characteristic and is due to the rotational energy of the pulsar being converted into high energy radiation. From the slowing down it is estimated that the pulsar is about 125,000 years old.

The distance from the solar system, based on the dispersion of the radio pulses, would appear to be something of the order of 5,000 light years.

A clue to future methods of search for pulsars is given by the fact that the pulsar is some 50 light years from the point of the original explosion of the supernova. The fact that the pulsars can be thrown out with a large amount of momentum would suggest that search for pulsars should take place outside the supernova remnants as well as within the known area of activity.

OLD GALAXIES AND QUASARS

There has been an attack on the exponents of the theory that quasars and "new" galaxies can be formed from the exploding of "old" galaxies. There would appear to be some doubt as to whether galaxies are in fact interconnected or that quasars are connected to galaxies.

The 46 metre dish at the Algonquin radio observatory operating at wavelengths of 2·2 and 4·2cm was not able to detect any interaction. The fact that the radio spectra were normal and no unusual radio effects appeared suggests that there were no violent reactions to provide the birth of a new galaxy much less a quasar. It is also possible that the "bridges" thought to exist between some galaxies may in fact be optical illusions.

SOVIET PROBE VENUS-8

The results of the findings from the latest Soviet exploration of Venus indicates that there are similarities between the planet and earth.

The Soviet Academician Vinogradov, already familiar with the analysis of moon rocks, said that the material at the Venus landing site seems to be similar to terrestrial granites. The surface soil contained potassium to 4·0 per cent, uranium 0·0002 per cent, and thorium 0·00065 per cent. These measurements were made by the gamma ray techniques.

Although one spot cannot be taken as representing the whole surface it is likely that the surface has been formed from basic igneous rocks that have undergone metamorphosis. The density of the soil at the landing area was about half that of the earth. The figure obtained for Venus was 1·5g per cm^3.

In the planet's atmosphere there were traces of ammonia (about 0·1 per cent) at the level of the cloud cover. The measurements were made at 33 and 44Km altitude. The apparatus used was a silica gel column saturated with a sensitive dye for indication. No details of the composition of the cloud cover is available, but measurements of density shows that there is a detectable difference between night and day and that there is evidence that the light from the sun does reach the surface.

MOON MAGNETISM

Explanations of the residual magnetic field trapped in the rocks brought back from the moon has been examined by various workers. At the moment there are a number of difficulties which prevent a satisfactory explanation to enable a model to be offered for the evolution of the interior of the moon.

To produce the conditions for a magnetic field to have come into being would require that the moon at one time revolved very much faster than earth. This however, would have resulted in its destruction.

There are suggestions regarding the magnetic field which involve certain conditions having been fulfilled during the formation and or the acquisition of the moon. One such theory involves the simultaneous formation of the earth and the moon.

At the present time every hypothesis put forward has faced one or other impossible condition and the field is therefore still wide open. Most of the ideas put forward have involved a liquid core, similar to that of the earth. It could be that this is not a prime requirement and that some other condition existed. The fact that there is no means by which the core of the moon can be examined in detail is the main difficulty.

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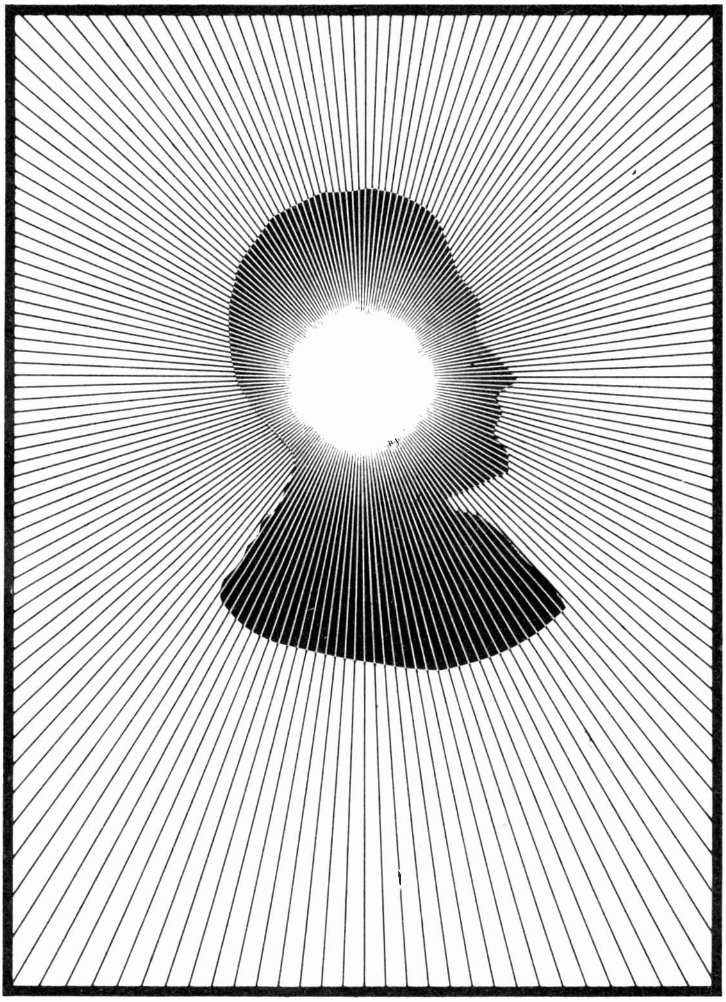


Biological Amplifier

This experimental project can demonstrate how neuro systems and electronics can be made to interact and influence certain muscular functions.

By D. BOLLEN

ELECTRICAL signals from the human body have been used for many years to diagnose certain illnesses and to monitor the condition of a patient during treatment. However, the possibility of using such signals for non-medical applications is a recent development.

The alphaphone, or electroencephalophone, is currently being used by mystics and others to achieve "instant" relaxation, by feeding back brain signals. A similar instrument can also serve as a lie detector monitoring the level of brain signals during interrogation.

Car drivers, athletes, and other people subject to stress, can learn to control their heart rate consciously with a cardiophone, which establishes an external feedback loop between heart and brain.

The biological pre-amplifier described in this article was designed as a general purpose module for detecting very low frequency signals from electrodes placed on the skin. Also described are a selection of output stages for specific projects, which include the alphaphone, lie detector, and cardiophone.

SKIN SIGNALS

Brain and nerve cells are similar to logic circuits in that they operate by emitting pulses of electrical energy. Under certain conditions, a group of cells will "fire" together in synchronism, to give a combined output either in the form of a large amplitude pulse (heartbeat) or slow sinusoidal waveform (brain rhythm). The nerve cells of a tensed muscle emit a stream of random pulses.

As a rough guide to signal levels from a pair of electrodes damped with salt water and placed on the skin, the chest will yield a heartbeat pulse of, say, 500 microvolts peak, the forehead an eyeblink pulse of 200 microvolts peak, and the crown of the head an alpha rhythm amplitude of around 50 microvolts r.m.s.

Other brain rhythms, with the exception of delta, tend to be of low amplitude, generally not more than 10 microvolts, and there is also a rapid, low voltage asynchronous activity when the subject is concentrating or excited.

The very approximate frequency range and psychological characteristics of some brain rhythms are as follows:

ALPHA Frequency 1-4Hz for infants, 4-7Hz for children and 8-12Hz for adults. This frequency can be modified by intake of certain drugs. Alpha is normally present when subject is relaxed with eyes closed, and signal is reduced or eliminated by seeing, sleep, unfamiliar sounds, anxiety, and mental concentration. A high level of alpha associated with deep meditation and pain immunity.

BETA Frequency 18-25Hz. Amplitude increased by anxiety and reduced during the initiation of movements and by muscular activity.

DELTA Frequency 2-3Hz. Strictly speaking, the name applies only to a type of rhythm associated with brain damage, but signals of similar frequency occur during sleep, accompanied by short bursts or "spindles" at around 14Hz.

THETA Frequency 4-7Hz. Thought to be related to creative thinking and problem solving activities, and with disappointment and frustration in young people.

BIO-FEEDBACK

Experiments currently being conducted in the U.S.A. seem to indicate that bio-feedback techniques can be used to alleviate symptoms arising from stress (of which there are many), to reduce heartrate and blood pressure, as well as provide a short-cut to the benefits arising from meditative practices such as Yoga.

The two most convenient ways of feeding signals back to the brain is via the ears or eyes. Fig. 1a shows the aural feedback alphaphone, which picks up subsonic alpha waves from the brain, uses them to modulate an audio signal, and feeds the resulting output to the ears.

The direct link between ear and brain is the feedback path, and the brain itself appears to be capable of adjusting a signal phase to positive or negative. With the alphaphone, the user quickly learns to reinforce his alpha waves, or reduce them, at will.

In the second example of bio-feedback (Fig. 1b), the heartbeat pulse is made to flash a light and the eye feeds this light pulse back to the brain. In time, the subject finds it possible to reduce or increase his heartrate by several beats per minute.

Visual feedback can also be achieved by watching an oscilloscope display, or meter readout of a biological signal.

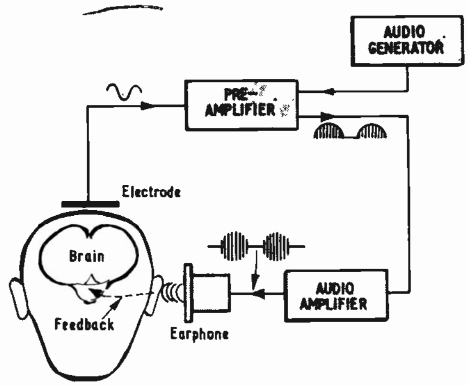


Fig. 1a. Graphical illustration showing the aural feedback path

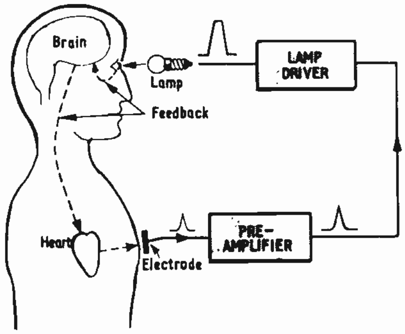


Fig. 1b. Graphical illustration showing the visual feedback path

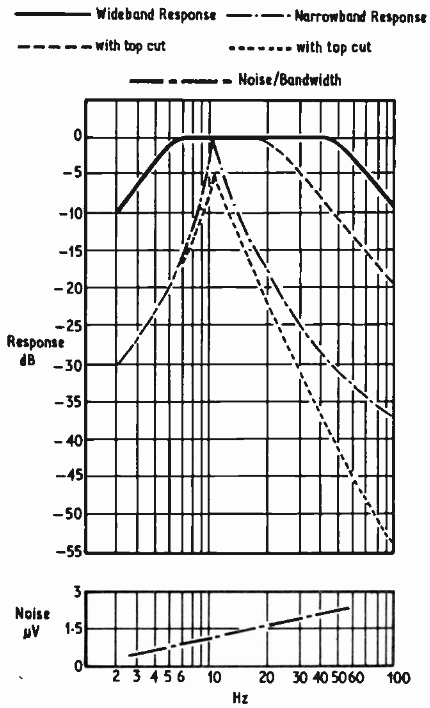


Fig. 2. Graphs of frequency response and noise of the biological pre-amplifier

Table 1. TUNED FILTER

	C5,C6 (µF)	C7 (µF)	Circuit tuned to
Alpha rhythms (muscle pulses)	0·47	1·0	10Hz
Beta rhythms	0·22	0·47	20Hz
Delta rhythms	2·2	4·7	2·5Hz
Theta rhythms	1·0	2·2	5Hz

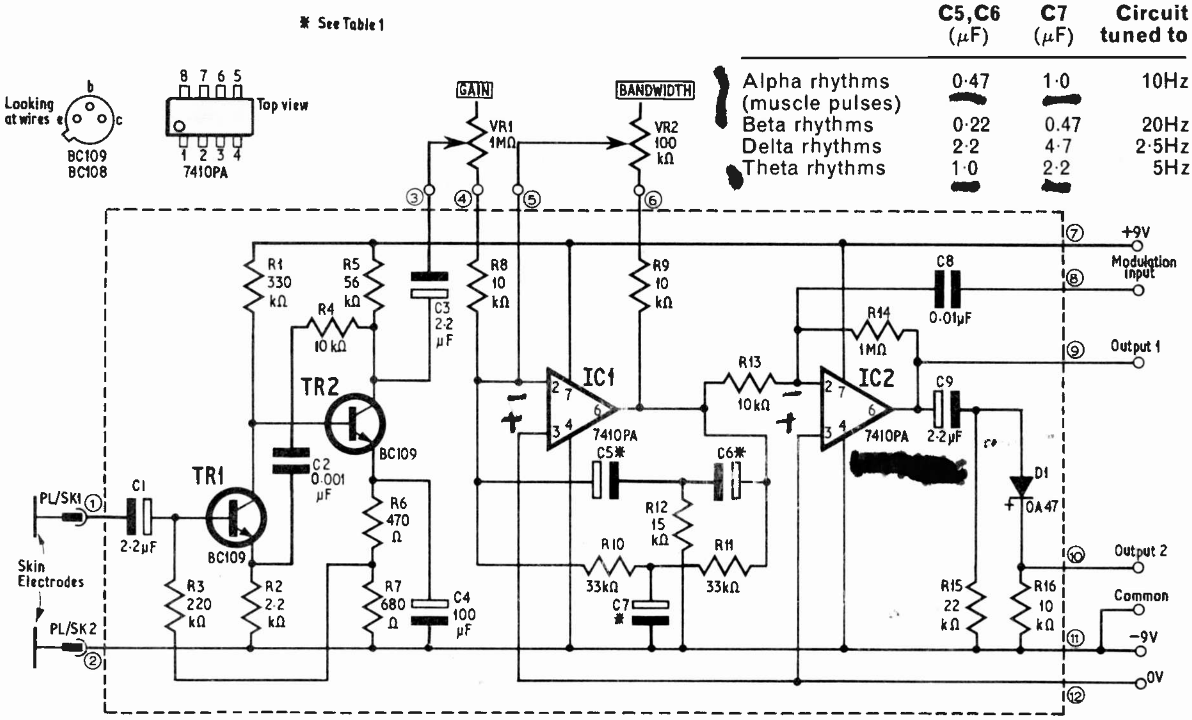


Fig. 3. Circuit of the biological pre-amplifier with component values of C5, C6 and C7 for different rhythms

CIRCUIT CONSIDERATIONS

Professional electroencephalographs (brain rhythm recorders) are carefully screened and operated under controlled conditions to achieve a typical noise-bandwidth performance of 2 microvolts at 0 to 75Hz. There is usually some provision for reducing bandwidth by means of switched filters to improve hum and noise rejection.

A noise performance only slightly inferior to that of a professional electroencephalograph is achieved with the biological pre-amplifier described here by sacrificing d.c. coupling. Flicker noise from transistors rises very steeply at sub-audio frequencies, and a considerable reduction in total noise can be obtained by giving the circuit a response roll-off below about 5Hz.

The pre-amplifier also incorporates a continuously variable bandwidth control which can be set to exclude mains interference in ordinary domestic environments and reduce amplifier noise.

Response and noise curves are shown in Fig. 2. At maximum bandwidth (−3dB at 4 and 60Hz) noise is less than 2·5µV, while at minimum bandwidth this figure is reduced to less than 0·5µV.

In its basic form, the pre-amplifier is tuned to 10Hz to give good resolution of alpha signals, but will also handle large amplitude beta, theta, and muscle pulses when set to wideband. However, the circuit can be modified quite easily for narrowband handling of beta, theta, delta, and low frequency alpha signals by altering the values of three capacitors.

All of the circuits given here are battery powered with outputs of less than 6 volts r.m.s., because it is potentially very dangerous to conduct electrode experiments with mains powered equipment. Even so, a mere 6 volts applied to the scalp is sufficient to cause visual strobing effects, twitching of facial muscles, an unpleasant tingling under the electrodes, and a mild headache if prolonged.

As a general policy, therefore, it is inadvisable to touch any circuit wiring while wearing head electrodes, and the temptation to couple bio-amplifiers to, say, audio amplifiers or flashing light systems, should be strictly avoided.

PRE-AMPLIFIER CIRCUIT

The circuit of the biological pre-amplifier is shown in Fig. 3. Input transistor TR1 has a collector current of 50µA for low noise working with typical skin electrode impedances of around 5 kilohms.

A proportion of TR2 emitter voltage is fed back to TR1 base via R3, to set the d.c. operating points of TR1 and TR2. C2 and R4 reduce the gain of the input stage above 100Hz to combat noise and instability. At 10Hz, the combined voltage gains of TR1 and TR2 is approximately 300.

A resistance placed between the inverting input and output of an operational amplifier will determine its gain. In the circuit in Fig. 3, an operational amplifier (IC1) uses a twin-T filter between input and output (C5-C7, and R10-R12) to offer a near infinite impedance at the frequency to which it is tuned; a low impedance is presented at other frequencies. Hence, the gain of IC1 is very high at the centre frequency and the amplifier behaves like a high-Q tuned circuit.

The bandwidth of IC1 is controlled by a variable resistance VR2 placed in parallel with the twin-T filter. With VR1 at minimum and VR2 at maximum resistance, stage gain is eleven, and can be reduced

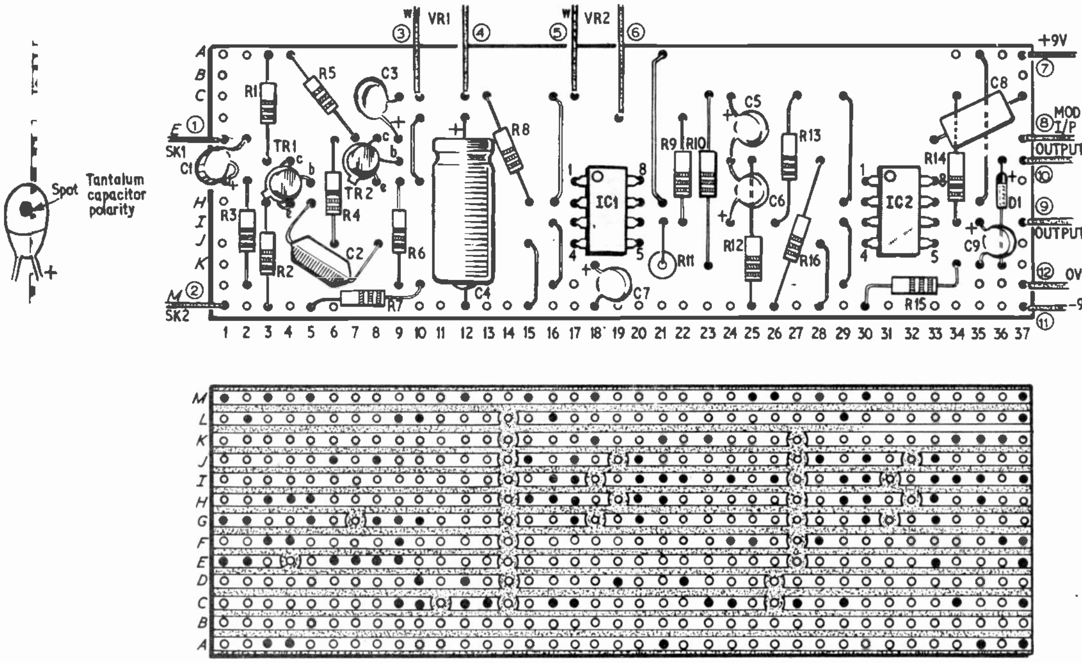


Fig. 4. Layout and wiring of the pre-amplifier board

to less than unity when VR1 is at maximum resistance.

The values listed for C5–C7 in Table 1 with Fig. 3 will give centre frequencies to suit different brain rhythms, but a frequency of 10Hz will serve for general purpose use, including muscle activity.

Output stage IC2 is another operational amplifier set for a voltage gain of 100, making the total gain of the pre-amplifier 330,000. Capacitor C8 has a dual purpose role, firstly as a modulation input whereby the subsonic bio-frequencies can be rendered audible after demodulation by diode D1, and secondly to act as an additional top-cut filter when connected to output 1, depending on the type of output circuit used with the pre-amplifier.

As it is not practicable to use conventional de-coupling techniques with very high gain low frequency circuits, owing to the large values of coupling capacitance required, the pre-amplifier is independently powered by two miniature 9 volt batteries, with output circuits separately powered to avoid interaction.

CONSTRUCTING THE PRE-AMPLIFIER

Pre-amplifier components can be assembled on a 3·7in by 1·3in piece of 0·1in matrix Veroboard, see Fig. 4. Having cut the circuit board to size, cut the copper strips where shown with a spot face cutter or sharp knife, then proceed to mount and solder components in position.

Take care not to let solder bridge the gaps between copper strips (a miniature soldering iron is essential here) and ensure that capacitor and diode polarities are correctly observed. To complete the panel, solder 3in lengths of 20 s.w.g. tinned copper wire as circuit board leads, in positions numbered 1 to 12 in Fig. 4.

For preliminary testing of the pre-amplifier module, join leads 3 and 4, and also leads 5 and 6. Spread out the remaining leads so that they do not touch, and connect leads 7, 12, and 11 to two 9 volt batteries. Polarity is shown in Fig. 3.

COMPONENTS . . .

PRE-AMPLIFIER

Resistors

R1	330kΩ ½ watt metal oxide.	R9	10kΩ
R2	2·2kΩ	R10	33kΩ
R3	220kΩ	R11	33kΩ
R4	10kΩ	R12	15kΩ
R5	5·6kΩ	R13	10kΩ
R6	470Ω	R14	1MΩ
R7	680Ω	R15	22kΩ
R8	10kΩ	R16	10kΩ

All ± 10% ½W carbon except R1

Potentiometers

VR1 1MΩ preset knob trimmer
VR2 100kΩ preset knob trimmer

Transistors

TR1, TR2 BC109 (2 off)

Integrated circuits

IC1, IC2 741OPA or equivalent (2 off)

Diode

D1 OA47 or 1B40

Capacitors

C1	2·2μF tantalum 35V
C2	1,000pF polystyrene
C3	2·2μF tantalum 35V
C4	100μF elect. 6V
C5, C6, C7	35V tantalum (see text and Fig. 3)
C8	0·01μF polyester
C9	2·2μF tantalum 35V

Miscellaneous

Veroboard 0·1in matrix, 3·7in × 1·3in. Two 2mm plugs and sockets.

Now, with a 20 kilohms-per-volt testmeter, measure the voltage relative to lead 11 of the following: TR1 case (1·9V), TR2 case (11V), IC1 pin 6 (9V), IC2 pin 6 (9V). A variation of about ±0·5V can be allowed on the above voltages.

Disconnect the batteries and place the pre-amplifier on one side for use with the projects to be described next.

ALPHAPHONE

The purpose of the alphaphone is to apply bio-feedback to the brain to increase the level of alpha rhythms and thus promote those "good feelings" which, for some people, are associated with alpha.

Commercial versions of the alphaphone retail in the U.S.A. for £100 or more, but the version shown in Fig. 5 can probably be built for under £10 if a pair of headphones are already available.

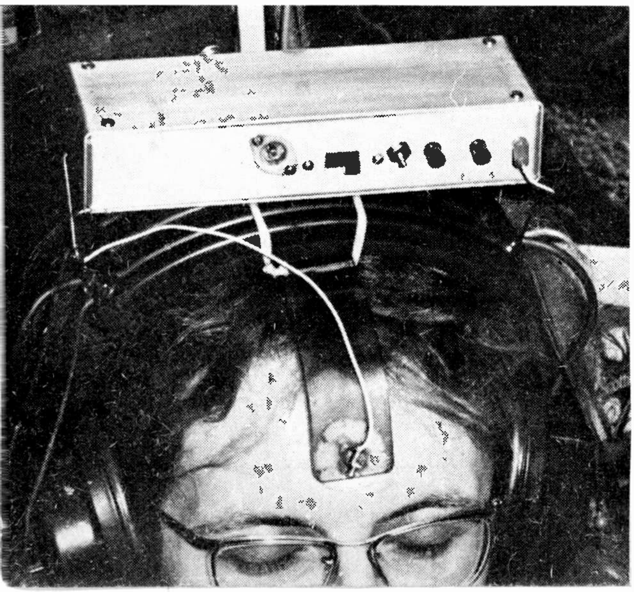
It is important that the sound heard by the alphaphone user should not be harsh, otherwise this will tend to interfere with relaxation. Another important point is that the alpha signal may have to compete with a background of external, domestic sounds which tend to distract the user and "block" his alpha. Ordinary stereophones, with their soft ear cushions, are excellent for attenuating noise, and a pair may be to hand. Alternatively, cheap mono phones with good sound insulation can be purchased for use with the alphaphone.

Referring back to the pre-amplifier circuit (Fig. 3) if white noise or an audio note is fed to the modulation input (lead 8) it will be mixed with the subsonic alpha signal at the input of IC2, and the intensity of this noise or note will vary in sympathy with the alpha signal after being passed through a non-linear diode D1.

In preference to an audio note, which is tedious to listen to for long periods, the alphaphone circuit (Fig. 5) uses a simple white noise generator (D2, R17, R18) to supply a restful "chuff-chuff" sound in the headphones, rather like a distant steam locomotive.

An output taken from the pre-amplifier demodulator diode (lead 10) is taken by way of R19 and C10 to a standard type of pre-built audio amplifier. The low alpha frequency is removed by C10 to leave only the higher frequency white noise, which is then amplified and fed to the phones.

The alphaphone fitted to the headband



LISTENING AMPLIFIER

Almost any small 9V amplifier, of about 50mV sensitivity and ½ watt output into 8 ohms, will serve. The author used a Newmarket module PC7+. The value of R17 (Fig. 5) can be adjusted to raise or lower the sound output in the phones, and it may be necessary to reduce the value of C10 with audio amplifiers of high input impedance, to give the required alpha frequency rejection.

The output socket, SK3 in Fig. 5, is shown wired for mono and stereo phones, to drive mono earpieces in parallel, and stereo earpieces in parallel.

The alphaphone should be well screened to minimise interference and instability. A suggested layout, inside a metal box, is included in Fig. 5, and this will give an instrument small enough to fit in a large pocket, and light enough to be carried by a stereophone headband.

The pre-amplifier module can be supported on its stiff wire leads, with a rectangle of s.r.b.p. under the Veroboard copper strips to prevent contact with the base of the metal box.

The PC7+ amplifier can be held in place with two screws, on stand off spacers. VR1 and VR2 may be glued to the front panel with a semi-flexible adhesive, which is easy to prise apart if one of the sub-miniature potentiometers needs to be replaced.

HEAD ELECTRODES

Electrodes held in place with sticky tape tend to pull at hair and leave adhesive behind on the skin, so the arrangement adopted here was to use spring loaded electrodes mounted on a shaped headband; see Fig. 6.

The electrode configuration shown, with one on the forehead and one on the crown of the head, is suitable for all brain rhythms except beta, and will pick up a good eyeblink pulse. A couple of layers of lint covering the electrode discs will retain the salt water conductive liquid for long periods without attention.

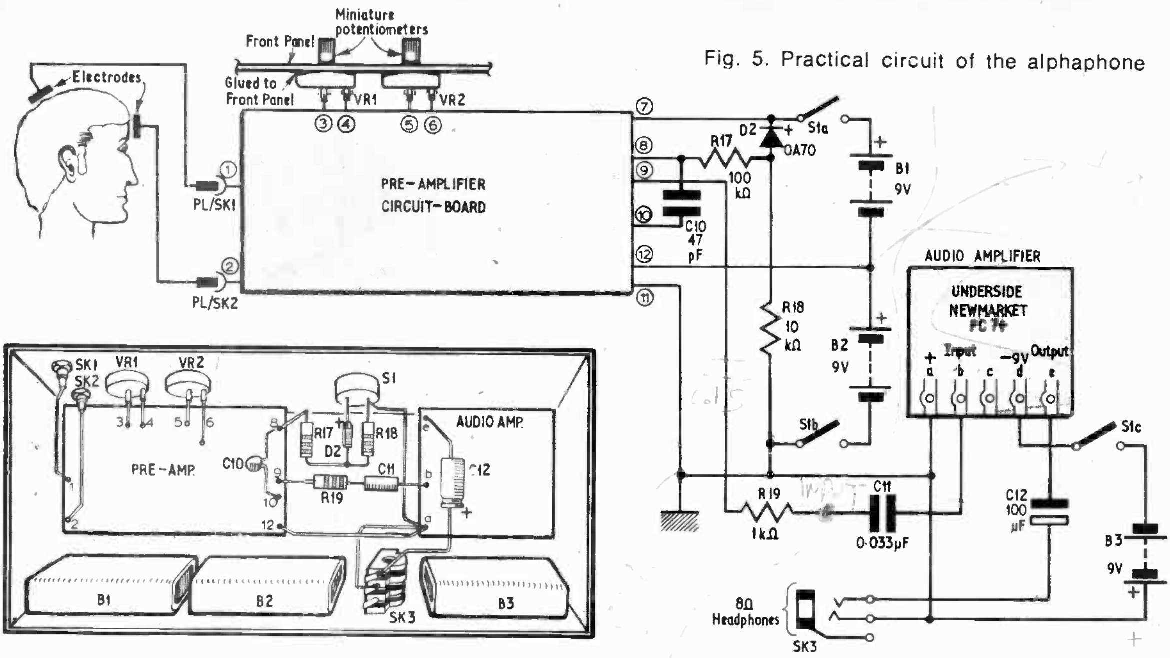
The electrode headband is a strip of $\frac{3}{16}$in sheet Perspex measuring approximately 10in by 1¼in and shaped in a steam jet or boiling water to be a loose fit on the top of the head. Holes are drilled at each end of the strip to take the spring loaded electrodes.

The eyeblink pulse is useful to test that equipment is in working order, but it may interfere with brain rhythm experiments, in which case the forehead electrode can be resited near the top of the head by drilling another hole in the Perspex strip. The complete electrode assembly is held in place on the head either with an elastic strap under the chin, or when mounted on a stereophone headband.

Electrode leads should preferably be of twisted or "side-by-side" insulated wire, as ordinary screened cable generates several microvolts of low frequency noise when bent or pulled. Even so, some amount of electrode lead noise is unavoidable if the alphaphone user moves his head around or touches the leads with his hands.

When using the electrodes, the lint covering is first soaked in salt water, and good contact is made with the crown of the head by soaking the patch of intervening hair with salt water. Natural skin grease acts as an insulator and should be removed with hair shampoo or surgical spirit.

Fig. 5. Practical circuit of the alphaphone



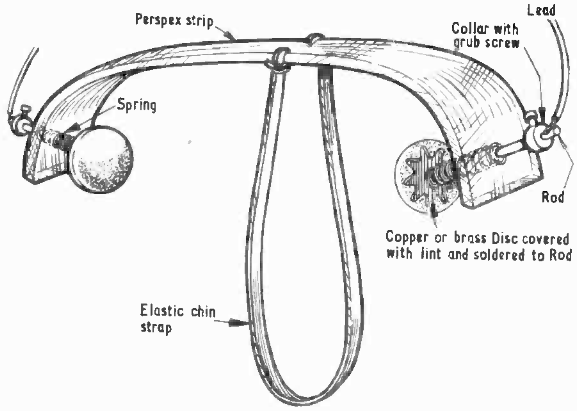


Fig 6. Construction of the head electrode assembly

USING THE ALPHAPHONE

When ready to use the alphaphone, insert the headphone jack in SK3, but leave the head electrodes disconnected from SK1 and SK2. Set VR1 to mid-resistance and VR2 to minimum resistance (wide-band) and switch on. A low, steady hiss should just be audible in the headphones. If there is humming, or buzzing sounds, this will probably be mains interference, so try resiting the alphaphone away from house wiring.

Advance VR1 to the point where low frequency noise from the pre-amplifier is just audible. When a 4·7 kilohm resistor is inserted across SK1 and SK2, pre-amplifier noise should disappear.

Wet the electrodes and place them on the head, and connect to SK1 and SK2. A sharp sound should now be heard every time the eyes are blinked, and a crackling noise from jaw muscles when the teeth are clenched, against a background of random brain noise.

Relax with the eyes closed and listen for the "chuff chuff" alpha signal; initially this will tend to come and go in short bursts, but with practice the alpha can be maintained at a steady, high level.

COMPONENTS . . .

ADDITIONAL COMPONENTS FOR ALPHAPHONE

Resistors
R17 100kΩ
R18 10kΩ
R19 1kΩ
All ±10% ½W carbon

Capacitors
C10 47pF polystyrene
C11 0·033µF polyester
C12 100µF elect. 12V

Diode
D2 OA70

Switch
S1A, B, C 3-pole, 2-way miniature wafer

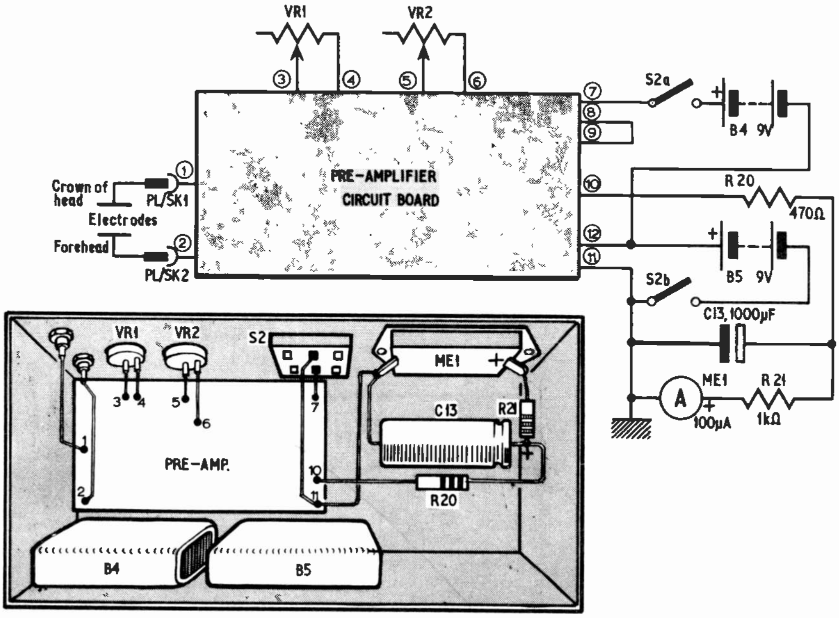
Socket
SK3 3-pole jack

Batteries
B1, B2, B3 9 volt style PP3 (3 off)

Audio amplifier
Newmarket PC7+ or similar (see text)

Miscellaneous
8 ohm mono or stereo headphones
Electrodes (see text)
Battery connectors
Metal box (see text)

Fig. 7. Suggested wiring of the pre-amplifier for an alphameter



COMPONENTS . . .

ADDITIONAL COMPONENTS FOR ALPHAMETER

Resistors
R20 470Ω
R21 1kΩ
Both ±10% ½W carbon

Capacitor
C13 1,000µF elect. 3V

Meter
ME1 100µA edgewise type level indicator

Switch
S2 Double-pole change-over slide

Batteries
B4, B5 9 volt style PP3 (2 off)

Miscellaneous
Battery connectors
Electrodes (see text)
Metal box (see text)

If mains interference is impossible to avoid, decrease gain (VR1) and reduce bandwidth (VR2) until a satisfactory signal is obtained. The tendency of the pre-amplifier to oscillate at 10Hz when VR2 is near minimum bandwidth can be checked by blinking the eyes. If there is appreciable ringing after an eyeblink (several cycles of 10Hz oscillation) increase bandwidth.

ALPHAMETER

The circuit in Fig. 7 can be variously employed as a relaxation meter, lie detector, and sleep threshold monitor, on the principle that alpha rhythm amplitude varies inversely with anxiety, and is reduced to zero by sleep.

Diode D1 in the pre-amplifier module here acts as a meter rectifier, to feed ME1 in Fig. 7 via series resistors R20 and R21, while C13 provides a time constant of 2-3 seconds to smooth out signal fluctuations. C8 in the pre-amplifier module is linked to output 1 (leads 8 and 9) for additional top-cut (see Fig. 2) to reduce interference and unwanted brain noise. Low frequency roll off is also increased by the meter load placed on output capacitor C9 in the pre-amplifier circuit, to remove delta type sleep rhythms.

CONSTRUCTING AND USING THE ALPHAMETER

If ME1 is a miniature edgewise meter, small enough to mount on the front panel, the alphameter can be housed in a metal box of the same dimensions as that used for the alphaphone. A suggested layout is shown in Fig. 7, with ME1 and C13 taking up the space previously occupied by the packaged amplifier.

To use the alphameter as a relaxation meter, set VR1 to maximum gain and VR2 to wideband. Place the electrode assembly on the head, after wetting with salt water, and switch on. When the subject's eyes are open, a reading of about 5% of full scale should be obtained, assuming that there is little or no mains interference.

Now ask the subject to close his eyes and relax, whereupon the meter reading should rise to about half full scale, indicating a state of moderate relaxation. A gentle tap on a door will cause the meter reading to fall back towards zero, by alerting the subject out of his relaxed state, and the same applies if the subject is asked to do mental arithmetic.

It is interesting to note the increase of meter reading when the subject's eyes are open and be becomes excited, caused by a rise in "brain noise" and theta.

LIE DETECTION

A similar technique to the above is employed for lie detection, with the virtue that the instrument cannot be misused against the will of the person being interrogated because nervousness or tension obliterates the alpha signal, and renders the lie detector inoperative.

With the subject relaxed and showing a consistently high meter reading, interrogate with a series of simple, undemanding questions, with a short pause allowed between question and answer. If a significant question is suddenly interposed, which calls for a devious answer, the meter reading will fall dramatically towards zero, despite the apparent outward calm of the subject.

To use the alphameter as a sleep threshold detector, the subject is asked to compose himself for sleep, and when the eyes are closed alpha rhythms will initially be generated, causing the meter to read. Just before sleep, the alphameter reading will start to become erratic, and will fall to near zero at the onset of unconsciousness.

Part 2 will describe a brain rhythm frequency meter and cardiophone.

Gerry Brown . . .

ON THE FRINGE

BAROMETERS 'N' THINGS

My younger daughter came to me some months ago indignant that her sister ought to be able to know (instinctively) that the weather was going to be awful, particularly as Nanny always reckoned she could tell!

My answer was that her sister probably didn't suffer with rheumatics and that I fancied many people might have this ability, certainly it was no stranger to me. But, I wondered, had anyone bothered to see if there was any correlation between aches and pains, and low (whatever that may mean) barometric pressure.

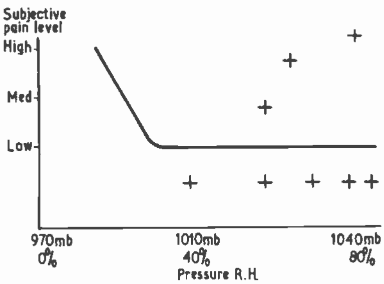


Fig. 1. Curve shows response vs pain level. Crosses indicate RH.

A relatively diligent search reveals that a high proportion of individuals from almost all ages maintain that they are able to indicate with fair accuracy when the weather is going to take a turn for the worse. However, not content with this (and feeling that relative humidity, RH, might play a hand in it too) I determined over the next few months to plot a graph (Fig. 1) of pressure and RH versus the subjective level of "ouch", averaged for several people.

It is a particularly interesting fact that although relative humidity doesn't seem to influence things very much, discomfort is definitely related to low pressure, that is pressures much below 1006 millibars (see Fig. 1). Sure, temperature effects have not been mentioned, but at the time of preparing the graph (during Summer) no great temperature excursions were recorded.

Don't ask me what causes the effect, but there may be some connection with the fact that bone is piezoelectric. This, however, is a subject to which we must return in a later column.

Perhaps in future times, homes will be pressurised so that no one will be able to predict weather conditions, but then they probably won't care either. In the meantime we must either tolerate bouts of "the screws", or go on frequent diving holidays to avoid "weather forecasts"!

POSITION FIX

Some of the most elegant concepts in engineering are delightfully simple in actuality. No exception to this is an (old, British Rail?) idea recently tested as a feasibility exercise by the U.S. Department of Transportation, New Jersey, to reduce the high costs incurred by existing highway aid systems.

Dear old Britain resorts to motorway telephones spread at intervals of about a third of a mile from one another; but let's face it, this just wouldn't do if our country was even half the size of the United States. The way they have beaten the problem, and simultaneously raised the number of call-points per mile too, has been to adopt the scheme shown simply in Fig. 2.

Initial tests were performed along an 8 mile stretch of "freeway", cables being buried either side of the road. Each cable, which carried two wires, was broken by a current-monitoring position at four miles, and these stretches were interrupted at intervals of about 200ft by paralleled push-button switches. At a distance farthest from the monitoring point the cables were terminated in a 100 ohm resistor.

Prior to testing, the line-current (with no buttons pressed) was nulled out. Subsequent operation of any switch thus resulted in a current value corresponding to its position. Hence, a switch near to the monitoring point gave a higher current indication than one operated farther down the cable.

Clearly the whole exercise is based upon a bit of economic thinking, I just hope that when this system is installed on the large scale no more than one button gets pressed at a time!

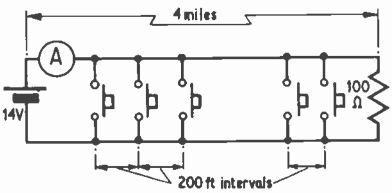
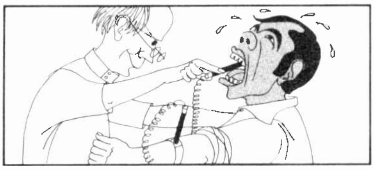


Fig. 2.

ELECTROPHONIC HEARING

What it's called now, I really couldn't say, but back in 1953 a paper bearing the title "Electrophonic Hearing", and written by Gordon Flottorp of the Psycho-acoustics laboratories at Harvard University, made pretty compelling reading. The effect he discussed, electrophony, was first observed in the early nineteenth century by Volta and others. They found that the sensation of hearing could be evoked by passing low currents through the head. Of course, only d.c. was available at that time, although a.c. effects, more recently investigated, show better promise.

Flottorp reported that in later experiments an "indifferent" electrode was usually connected to the fore-arm while the second electrode could have sites as varied in location as the roof of the mouth or the nape of the neck. Sometimes the tests have been performed using dampened electrodes, while at other times the results have been blessed with greater success when dry ones were employed; actually, under certain conditions, good results were achieved with a moving electrode too.

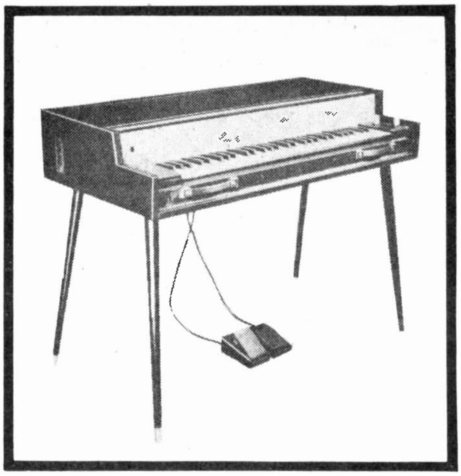


Quite wide frequency ranges have been obtained; e.g., 200Hz to 17kHz, although the intensity does not appear to have been very large. This was typically little more than a whisper at about 30dB above the threshold of hearing, but, significantly, a discernible signal.

Considerable difficulty has been experienced in all attempts to establish an exact mechanism for electrophonics, since, when passing current directly through the head, the number of possible paths must be very high. It is, therefore, likely that both the 8th cortical (auditory) nerve *and* the (sensory) organ of Corti are stimulated simultaneously. Indeed, there is a distinct possibility that the skin itself could take the role of a transducer, the sound it produces being sensed as "direct" hearing!

The voltages employed in these experiments have been kept within the range 1 to 5 volts at currents no greater than 30mA. Although at higher levels of *V* and *I* things are certain to become a little bit excruciating, it does rather look as if the effect ought to be re-examined as a possible aid to the deaf, always assuming that the neural function is intact in the first place.

ELECTRONIC PIANO



Part 5

By A. J. Boothman B.Sc.

THE final part of the series describes the complete mechanical construction of the piano, together with details on tuning and a number of points concerning the use of the instrument.

KEYBOARD

Since the commencement of this series of articles F-F keyboards have become available, but as a number of constructors will have purchased C-C Keyboards we now give modification details as promised in the first part of the series.

MORELLI-A KEYBOARD MODIFICATION

To modify the Morelli-A keyboard to F-F it was necessary to remove the lower C-E section from the main assembly. The wire which acts as a spindle for all the keys was withdrawn from the bottom end by first hammering a nail, whose point was positioned on the end of the spindle, at the top end of the compass. The spindle was then pulled out from the bottom end with a pair of pliers. Prior to this all springs had been released from their bottom clips in order to ease the pressure on the spindle.

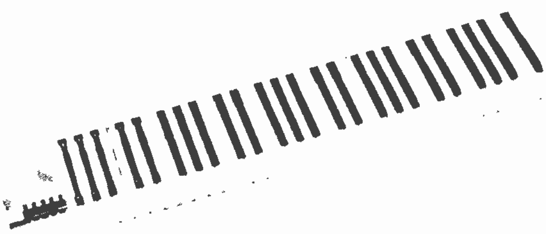


Fig. 5.1. The Swedish keyboard with the section C-E separated

In this state all the keys are loose and should be placed on a clean flat surface in the order in which they are removed from the frame. With all keys removed the frame can be cut at the appropriate point with a hacksaw. On completion the keys are replaced in position with the lower C-E section now positioned at the top end.

The wire spindle is replaced from the bottom end, and the final top key (which was originally a C) is now put back to act as the top F. This key will require to be made captive since it is free to move up the rod, and for the prototype a brass collet was obtained from a model shop, and clamped on to the end of the rod using the grub screws tapped into the collet.

The frame should now be very carefully stored prior to mounting on the subframe, since the only mechanical linkage between the two parts of the keyboard is the spindle which could easily be accidentally bent.

The author has not attempted to modify the Morelli-B keyboard, but it should be possible to follow a similar procedure to that outlined above.

KIMBER-ALLEN SWEDISH KEYBOARD MODIFICATION

The Kimber-Allen keyboard is considerably different in construction to the two previously mentioned models, but as in their cases it is not possible to simply rearrange the keys, since the spacing of the fulcrum slots varies over an octave, and it is therefore necessary to cut the frame in order to remove the bottom C-E section and to fix it to the upper end (see photograph).

The first task is to remove some of the keys from the frame by first removing the springs at the rear of the board, which then frees the metal levers which are slotted into the keys. It is then necessary to remove the actuator pegs from the keys by pulling away from the keys. The actuators are a nylon plastic with push fit pegs into two holes in the key. The keys can then be removed.

In order to reduce the risk of damaging any keys, a fairly large area should be cleared—from C to B-flat at the lower end, and B to F at the top end—having first noted the position of E and F keys at the bottom. It would be wise to pencil the key letters on to the alloy frame opposite the relevant actuator holes.

The cut when made will be immediately to the left (viewing the keyboard from the front) of the hole corresponding to note E. This then leaves about half an inch of frame protruding beyond the bottom F key when the assembly is complete, which makes for easy mounting to the wooden sub-frame. For the same reason the line should be drawn to run close to the edge of the hole to leave the maximum amount possible on the piece being cut off, since this part acts as the mounting for the upper end of the keyboard when complete.

Three cuts are necessary, the first being to remove the unpunched section from the bottom end. A line should be drawn to the left of the first (C) hole and a sawcut made keeping the hacksaw vertical. Care should be taken not to damage the fulcrum slot, and to protect the fulcrum knife edge to the left of the slot. The second cut is made in the position described above—i.e. alongside the bottom E hole. Again the saw should be kept as vertical as possible. The third cut is made at the top end of the keyboard and removes the section containing half an actuator hole.

This is necessary in order to finish with the correct spacing between keys. The cut should be made $\frac{1}{8}$in to the right of the last complete actuator hole, but it is important that the slot in the plastic spacer at the front of the frame is preserved by leaving some plastic protruding beyond the keyboard ($\frac{1}{4}$in). When the new section is fitted its plastic can be cut back slightly in order to accommodate the protruding piece. The slot in the plastic is important in that it acts as the front key locator, preventing lateral movement.

The C-C board has two spare actuator holes at the top end which will now take C and D, having swapped the bottom C key with the previous top C key. The new section will accommodate E flat, E and F (the old top C key), with one surplus actuator hole at the top.

JOINING PLATES

Three steel plates should now be cut and drilled as shown in Fig. 5.2, and mounted as follows:

a. Plate with four holes not countersunk—inside front edge.
b. Plate with four holes countersunk—inside rear edge.
c. Plate with two holes countersunk—outside rear top. This plate should be mounted as far back as possible so as not to interfere with the keyswitch assembly.

Holes should be drilled in the keyboard frame to line up with the metal plates, with the transferred section of frame positioned such that the distance between the two adjacent edges of the actuator holes is $\frac{1}{4}$in.

If all sawcuts have been made in a square manner there should be a gap between the two sections, however it is unlikely that such a degree of squareness can be achieved with a handsaw, and it may be necessary to make slight adjustments with a file.

The four holes on the front edge of the frame should be countersunk and the screws inserted from the front. The rear edge screws should be inserted from underneath the frame, and the top screws from the top, using the countersink in the plates. When all screws have been tightened the D, E-flat, and E keys should be tried on the frame in order to check that they do not catch each other, thus requiring further adjustment of the joint.

All keys can then be replaced and the actuators pressed back into position.

SUB-FRAME FOR MORELLI-A KEYBOARD

The construction of the Morelli-A keyboard sub-frame, which carries the keyboard, key switch contacts, and terminal strips, is shown in Fig. 5.3.

Assembly of the sub-frame is best carried out using the large baseboard on which to screw down the unit thus ensuring a fully square frame during the process. Particular attention should be paid to this point when fixing the end cheeks which should be both glued and screwed. Using parts obtained from the materials list given the following procedure should be followed.

1. Take the large baseplate and mark out the position for front and rear 2in × 1in battens, and the end cheeks as shown in Fig. 5.3.
2. Cut the front and rear battens, the end cheeks, the terminal strip mount and the 1in × $\frac{1}{2}$in hardwood strip as shown in Fig. 5.3.
3. Screw both battens to the baseboard, and glue and screw the end cheeks to the battens.
4. After the glue has been allowed to set remove the frame from the baseboard and fix the 1in × $\frac{1}{2}$in hardwood strip and the terminal strip mount.
5. The front of the keyboard frame is fixed to the 1in × $\frac{1}{2}$in strip with nuts and bolts, whilst woodscrews are used on the rear batten fixing. Holes should be drilled in the metal framework to accommodate the fixings.

Should it later be found that the downward travel of the white keys is restricted by the front 2in × 1in batten, metal washers should be inserted between the keyboard frame and the 1in × $\frac{1}{2}$in hardwood strip in order to raise the front of the keyboard. This results in a very slight keyboard tilt which gives a comfortable playing position. Checks on the freedom of the key travel should only be made when the sub-frame is screwed down to the baseboard as the procedure given automatically results in some movement of the hardwood strip as the outer sub-frame is screwed home.

It is recommended that wherever possible the keyboard and sub-frame assembly should be kept on the baseboard whilst the project continues in order to avoid the possibility of mechanical distortion of the assembly, which still depends largely on the base for its mechanical rigidity.

KIMBER-ALLEN KEYBOARD SUB-FRAME

Fig. 5.4 shows the construction of the sub-frame for the Kimber-Allen keyboard. Again the simplest procedure is to lay out the battens on the main baseboard and glue and screw the four pieces together. The keyboard is fixed to the sub-frame at the ends using long screws passing through $\frac{7}{8}$in × $\frac{3}{8}$in packing pieces. The latter prevent too much stress being applied to the alloy frame when inserting the screws. For additional strength screws can be inserted into the front and rear legs into their respective battens.

Holes of approximately $\frac{3}{16}$in diameter should be drilled at an angle as shown to take the wires from the keyswitch to the terminal strips on the rear of the assembly. The terminal strips are cut into groups of six, one for each main p.c.b., and depending on the thickness used for the interconnecting wire either one or two holes per strip will be necessary.

The 2in × 1in planed front bar and side plates are separate from the sub-frame and form part of the main frame which is described in more detail later. Again, it is recommended that the keyboard sub-frame assembly should be stored on the base-board to avoid mechanical distortion occurring.

THE KEYSWITCH ASSEMBLY

The keyswitch assembly consists of a printed circuit board which anchors gold plated springy wires, and carries the touch sensitivity resistors, and seven rod supports which carry two gold plated rods. Fig. 5.5 shows the arrangement of the various components of the assembly.

Before assembling the parts together, the p.c.b. should be placed on the underside of the keyboard, and used as a template for drilling the $\frac{1}{8}$in holes required to take the self-tapping screws which fix the switch assembly to the frame.

The front edge of the switch assembly should be placed approximately $\frac{1}{4}$in from the keyboard actuators, and should be centralised over its length with respect to the actuators. In the case of the Morelli keyboards the p.c.b. pads will roughly line up with the actuators, whilst in the case of the Kimber-Allen keyboard, which is longer, the overall length of the keyswitch is less than the total span of the actuators.

When the gold plated wires are attached they will be bent to fan out towards the extreme ends of the keyswitch, thus resting on the centre of each actuator.

MATERIAL AND COMPONENTS FOR KEYBOARD SUB-FRAMES AND MAIN CABINET ASSEMBLY

SUB-FRAME

	MORELLI-A	KIMBER ALLEN
Front Batten	$34\frac{3}{4}$in × $1\frac{7}{8}$in × $\frac{7}{8}$in	35in × $\frac{7}{8}$in × $\frac{7}{8}$in
Rear Batten	$34\frac{3}{4}$in × $1\frac{7}{8}$in × $\frac{7}{8}$in	35in × $1\frac{7}{8}$in × $\frac{7}{8}$in
End Cheek (2)	$6\frac{7}{8}$in × $2\frac{3}{4}$in × $\frac{3}{4}$in Block	$3\frac{1}{8}$in × $\frac{7}{8}$in × $\frac{7}{8}$in
Packing Piece (2)	—	$3\frac{1}{2}$in × $\frac{7}{8}$in × $\frac{7}{8}$in
Mounting Strip	$34\frac{3}{4}$in × 1in × $\frac{1}{2}$in	—
Terminal Mount	$31\frac{1}{2}$in × $\frac{7}{8}$in × $\frac{7}{8}$in	—
Terminal Strips—6 contact	12 off	12 off
Terminal Strips—2 contact	2 off	2 off

MAIN CABINET

Baseboard	42in	× $20\frac{1}{2}$in	× $\frac{1}{2}$in	Chipboard
Side Pieces (2)	$20\frac{1}{2}$in	× $6\frac{3}{4}$in	× $\frac{3}{4}$in	Blockboard
Front Bar	$40\frac{1}{2}$in	× $1\frac{7}{8}$in	× $\frac{7}{8}$in	
Rear Panel	42in	× $7\frac{1}{2}$in	× $\frac{3}{8}$in	Plywood
Rear Panel strip	$40\frac{1}{2}$in	× $\frac{1}{2}$in	× $\frac{1}{2}$in	
Top Panel standard version	$40\frac{1}{2}$in	× $13\frac{1}{4}$in	× $\frac{1}{8}$in	Plywood
Top Panel Strip	$40\frac{1}{2}$in	× $\frac{3}{8}$in	× $\frac{3}{8}$in	
Mains Panel (3)	$5\frac{1}{2}$in	× 2in	× $\frac{1}{8}$in	Plywood
Mains Panel Cover	$2\frac{1}{8}$in	× 2in	× $\frac{1}{8}$in	Plywood
Speaker Panel Support (2)	$2\frac{1}{2}$in	× $\frac{7}{8}$in	× $\frac{7}{8}$in	
Switch Panel (2)	X	× Y	× $\frac{1}{8}$in	Plywood
Panel Support (2)	2in	× $\frac{1}{2}$in	× $\frac{1}{2}$in	
Speaker Panel	$40\frac{1}{2}$in	× $3\frac{1}{2}$in	× $\frac{1}{4}$in	Plywood
Panel Stiffners (2)	14in	× $\frac{7}{8}$in	× $\frac{7}{8}$in	
Main Amplifier Support	$2\frac{1}{2}$in	× $\frac{7}{8}$in	× $\frac{7}{8}$in	
Lid Panel	$40\frac{1}{4}$in	× $6\frac{1}{2}$in	× $\frac{1}{4}$in	Plywood
Lid Panel	$40\frac{1}{4}$in	× 8in	× $\frac{1}{8}$in	Plywood
Music Support Panel	$39\frac{1}{2}$in	× 7in	× $\frac{1}{8}$in	Hardboard
Lid End Pieces	$6\frac{1}{4}$in	× $3\frac{1}{2}$in	× $\frac{1}{4}$in	Plywood
36in Piano hinge				
2 Carrying handles				
4 Cupboard catches				
4 24in legs				
Covering Material				

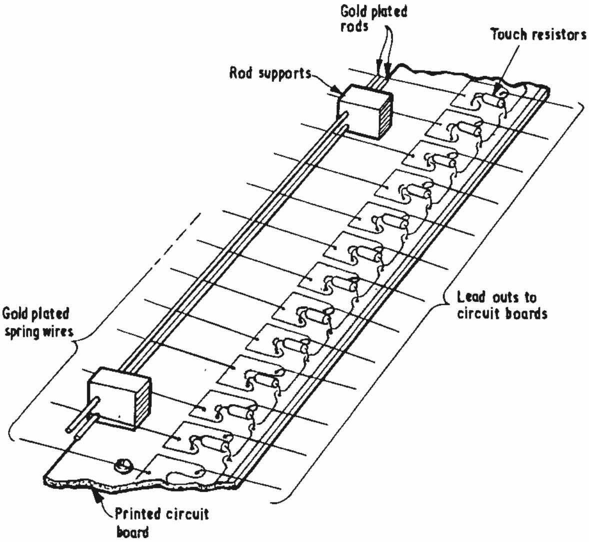
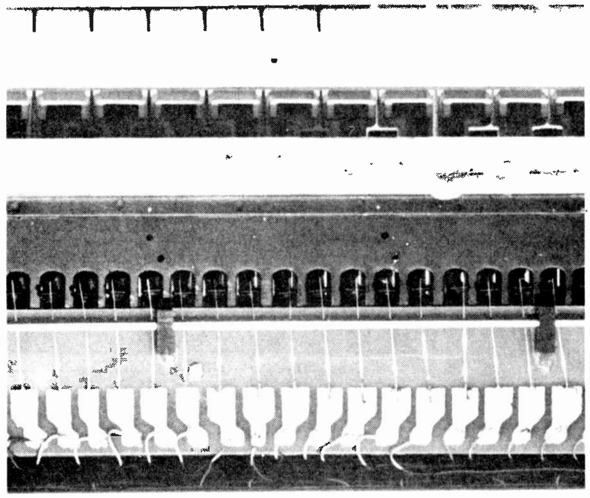


Fig. 5.5. Keyswitch assembly is screwed to the underside of the keyboard so that the actuators press against the spring wires



View of the key contacts at the underside of the keyboard

MAKING IT UP

When the holes have been drilled, and the p.c.b. removed from the frame, the keyswitch is assembled as follows:

1. Slide the seven rod supports on to one rod, using the hole nearest the face marked with a "B".
2. Insert the second rod through the remaining rod holes, and space the supports roughly opposite the holes which have been countersunk from the non-copper side of the p.c.b.
3. Fix the rod supports to the copper side of the p.c.b., using the countersunk screws, nuts and locking washers, with the support face marked "B" closest to the p.c.b.
4. Solder resistors to the pads provided, one on the common positive rail, and the other on the land which also carries the gold plated spring wire. The remaining land is used to anchor the output leads.
5. Solder wire links between the bottom rod and the negative printed track, and the top rod and positive printed track.
6. Cut the gold plated wire into 61 lengths of 1¾in, and tin approximately ¼in of one end of each wire. Some wire will be left over to provide longer lengths where necessary.
7. Pass each wire between the two rods and solder the tinned end to a main pad. About ½in should be left to hang over the front edge of the p.c.b. The wire should be pressed flat to the p.c.b. close to the main pad using a match stick, and the soldering iron applied to the wire and land for as short a time as possible.

MATING WITH THE KEYBOARDS

The assembly can now be fixed to the underside of the keyboard using the self-tapping screws, and a first attempt made to line up each gold wire with the centre of its corresponding actuator.

Some wires will require resoldering to the pads in a different position in order to avoid obstacles such as the rod supports. In certain cases a considerable amount of bending will be required, and it may be necessary to use some of the spare wire to give longer lengths in these instances. The apparently complicated dog leg shapes are perfectly satisfactory in operation.

The final process is to adjust the bend of each wire to ensure that it seats satisfactorily against each rod in turn, whilst gently resting on the actuator in the non-depressed state. As a further precaution to avoid the wires springing off the actuators, small slots can be filed in the centre of each actuator to prevent the wires sliding.

WIRING THE SUB-FRAME

To complete the keyboard sub-frame assembly wires must be taken from each switch pad to the corresponding terminal strip at the back of the assembly. The pads are labelled with the note concerned and as suggested earlier one or two holes have been drilled against each terminal strip which carries all octaves of a particular note.

A single link is also required between the sixth contact on each of the terminal strips, as this acts as the common sustain connection. Wires are also taken from the positive and negative pads on the keyswitch p.c.b. to a two contact terminal strip mounted on the left hand (power supply) end of the keyboard sub-frame.

CABINET ASSEMBLY

The general layout of the cabinet is shown in Figs. 5.2 to 5.9.

The cabinet construction has been kept deliberately simple, whilst achieving some aesthetic quality.

PIANO CAB

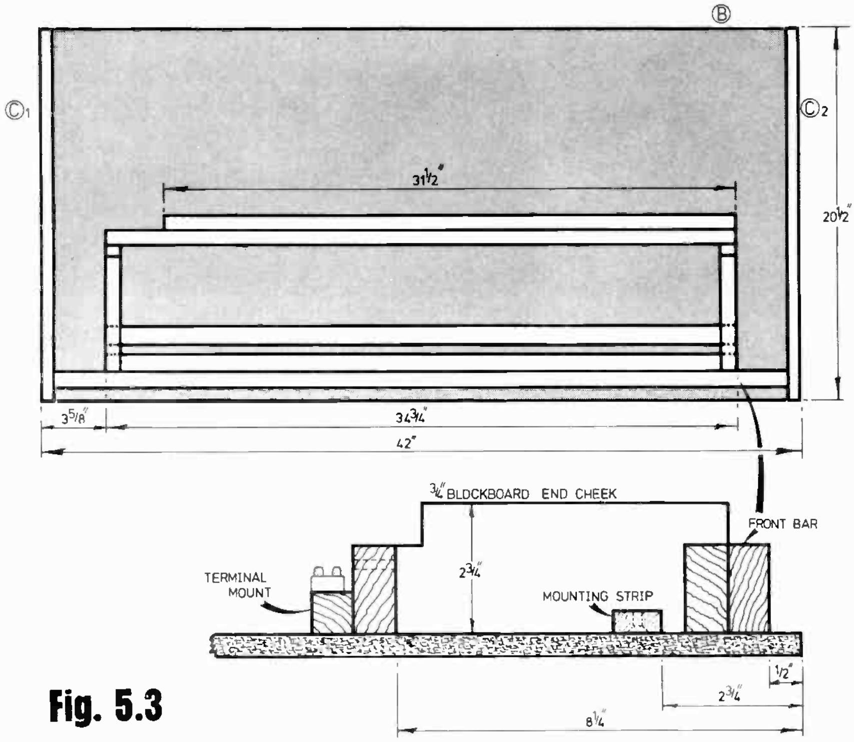


Fig. 5.3

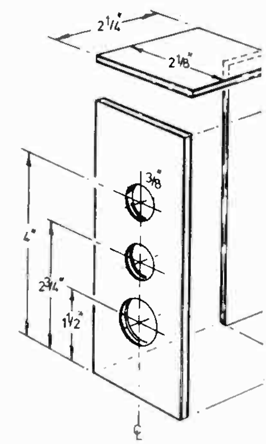
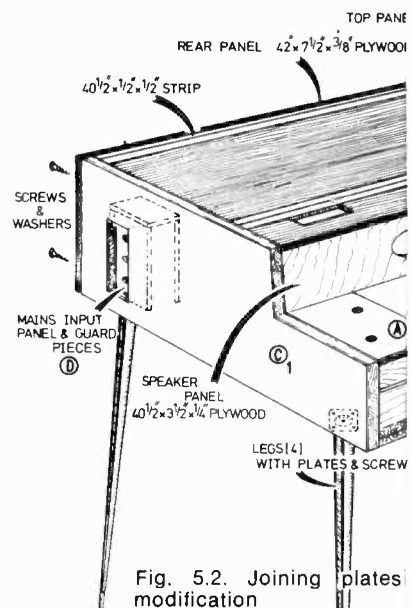


Fig. 5.8



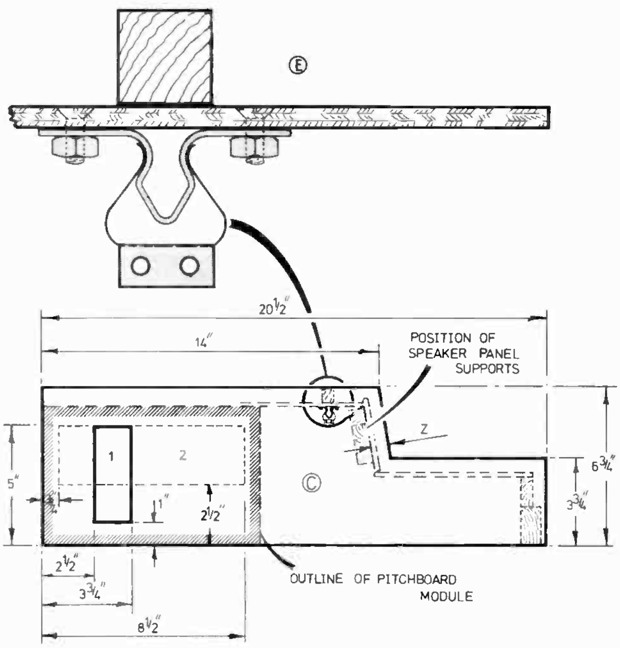


Fig. 5.7

Fig. 5.2. Joining plates modification

Fig. 5.3. Baseboard layout end view of sub-frame ass

Fig. 5.4. Baseboard layout and end view of sub-frame

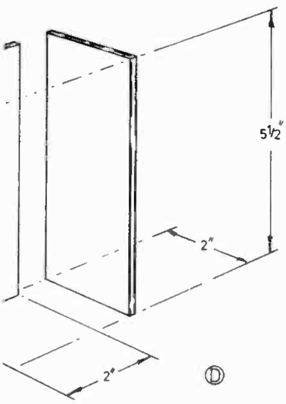
Fig. 5.6. General assembl panel dimension in parent keyboard only

Fig. 5.7. End pieces for the board. Two are required. endpiece (mains input). endpiece

Fig. 5.8. Mains input pane from ⅛in plywood

Fig. 5.9. Keyboard control panel is shown

IET DETAILS



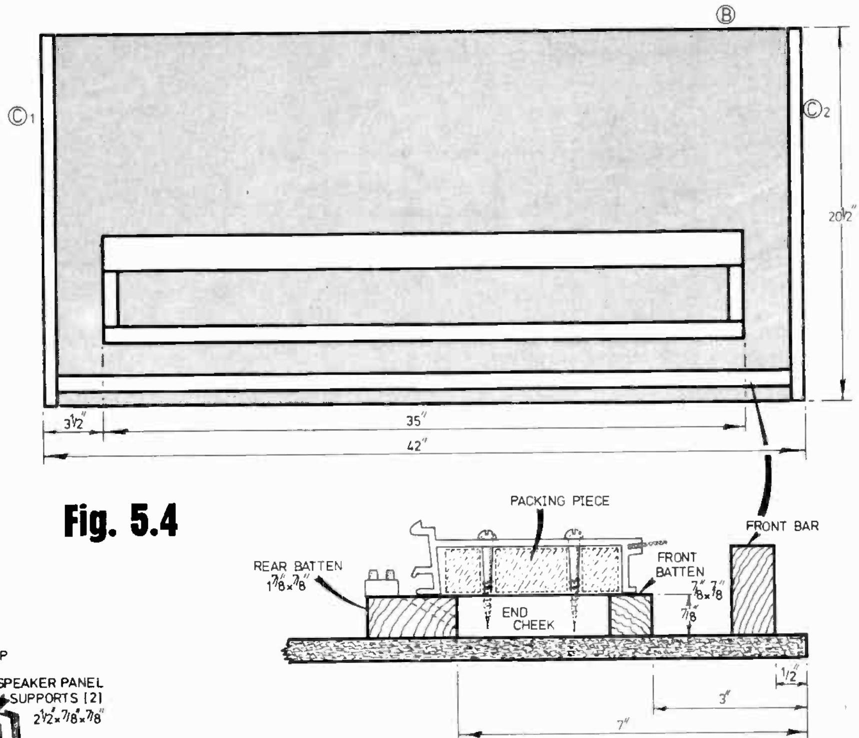


Fig. 5.4

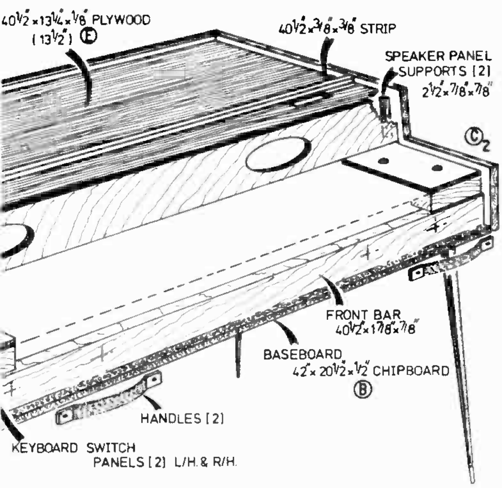


Fig. 5.6

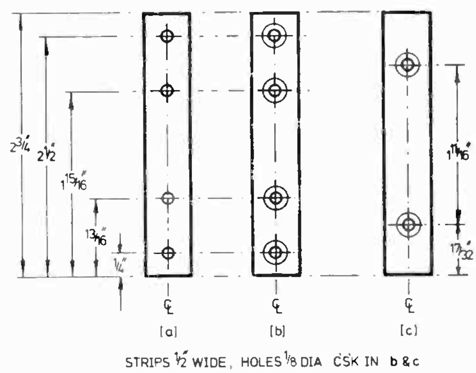
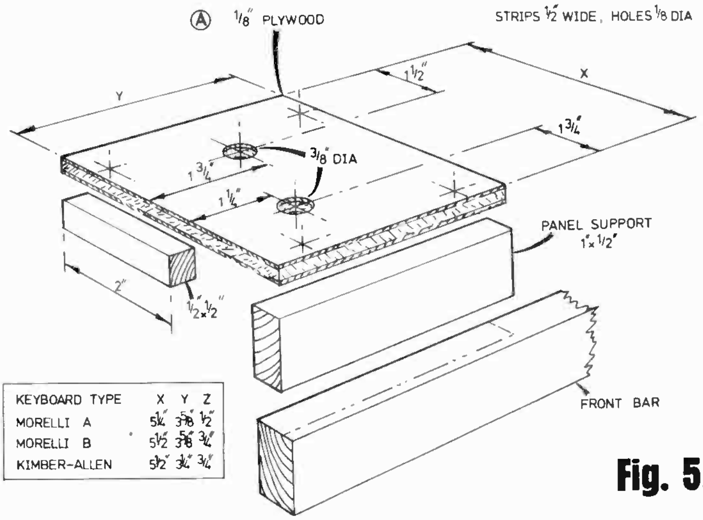


Fig. 5.2



KEYBOARD TYPE	X	Y	Z
MORELLI A	5¼"	3⅝"	½"
MORELLI B	5½"	3⅝"	¾"
KIMBER-ALLEN	5½"	3¼"	3¼"

Fig. 5.9

or Kimber-Allen keyboard

for Morelli-A keyboard and
mbly

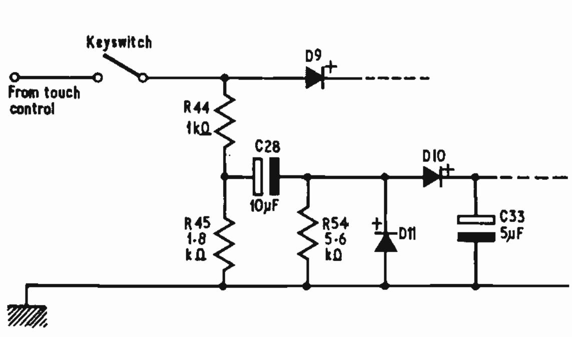
for Kimber-Allen keyboard

of the cabinet. The top
hesis is for the Morelli-A

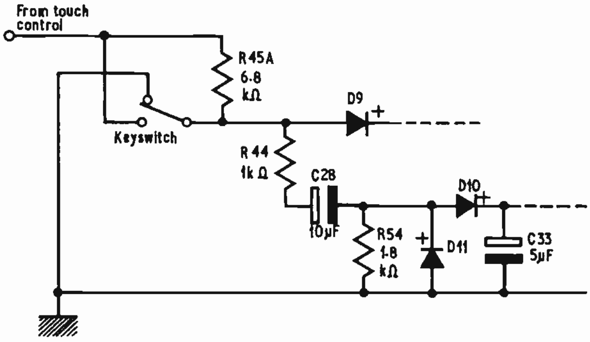
main box using ¾in block-
(1) Cut-out for left-hand
(2) Cut-out for right-hand

l and guard pieces made

panel details. The left-hand



(a) Envelope input circuit as used during the initial setting up procedure on the pitch board



(b) Modified envelope input circuit to give touch sensitivity. R45A is mounted on the keyswitch assembly as shown in Fig. 5.5

Fig. 5.10. Circuit changes to give individual key touch sensitivity

The two end pieces are permanently fixed to the baseboard, joined by the front bar. All other parts are detachable in order to give easy access to the various sub units.

Two end pieces should be cut from ¾in block board, each one requiring a different cut out as shown in Fig. 5.7. The position of the speaker panel supports is also indicated in this diagram. The two pieces should be glued and screwed to the chipboard base, with the front bar positioned ½in from the front edge of the base board.

The mains input panel should be cut and drilled from ⅛in plywood as shown in Fig. 5.8. The other three pieces shown form a box which covers the back of the mains switch, etc. to avoid the danger of electric shock.

The speaker panel was covered earlier, and is a removable unit which seats on the supports shown.

The rear panel has a ½in × ½in strip glued along its top edge which acts as a retainer for the top panel. The rear panel is screwed to the end pieces and is easily removable.

The top panel is retained in position by the strip attached to the rear panel, and by spring clips positioned at the front, with the female part screwed to the end pieces. The clips used were of the common cupboard door type and are shown in Fig. 5.7. The slots cut in the top panel allow heat to be released from the power supply and main amplifier, whilst the ⅜in × ⅜in strip acts as location for the lid when used in the music stand position.

Dimension W is dependant on the keyboard used, and if the constructor uses the Morelli-A keyboard he may like to add a ¼in strip on the sloping edges of the end pieces in order to retain the same styling as achieved when the other keyboards are used.

CONTROL SWITCH PANELS

Fig. 5.9 shows details of the construction of the keyboard level switch panels. Dimensions X and Y depend on which keyboard is used, and dimension Z from Fig. 5.7 is also given in the table. The 2in × ½in × ½in support strips should be glued to the side pieces. Using the dimensions given it should be possible to line up the front edge of the keys, when fitted on the keyboard sub-frame assembly, with the front edge of the keyboard switch panels.

COVERING THE CABINET

The choice of finish to use on the cabinet greatly depends on finances. To give maximum wear and a smart appearance a heavy grade of black p.v.c. sheeting was used on the prototype, with speaker fabric covering the whole of the speaker panel. Other alternatives could be a Contact/Fablon type material, or paint.

TOUCH SENSITIVITY

Individual touch sensitivity is achieved on each key by the use of a keyswitch assembly which is effectively 61 single pole changeover switches. The two contacts are actually busbars, common to all switches, one at ground and the other at the attack potential. See Fig. 5.10.

Referring to Fig. 5.10b the keyswitch is normally in the grounded busbar position. When a key is depressed the switch leaves the grounded busbar, thus allowing C28 to charge via R45A, the bottom end of which had previously been shorted to ground. The attack level passed on to C33 is determined by the attack voltage from the touch control, reduced by the voltage across C28.

The attack voltage is applied when the second busbar is reached, and the voltage across C28 increases as the time taken to traverse between the two busbars increases. The attack level passed on to C33 is therefore reduced as the time to traverse increases, and is therefore proportional to the average speed of key travel after it is depressed.

This is not of course exactly the same mode of touch sensitivity as on a conventional piano, where the final speed of key travel is the important parameter, but this system does give a degree of realism. The range of touch is considerably less than on a string instrument, but both classical and pop pianists have demonstrated a noticeable level of expression in their playing of the second prototype, relying solely on the keyboard touch sensitivity without access to the soft pedal.

In order to bring the touch sensitivity into operation the value of R54 is altered and R45 removed from the pitch board. R45A is mounted on the keyswitch assembly as described earlier.

Some constructors may find it interesting to experiment with the values of R44, R45A and R54 in order to vary the dynamic range of the touch sensitivity.

TREMOLO PRESET DEPTH

With all units interconnected the preset tremolo depth control (VR6 in Fig. 2.5) can be set. With VR2 in the maximum position and the tremolo on, adjustment of VR6 will produce zero tremolo effect at one extreme, and reduce the signal output to zero at the other extreme. A position can be found where maximum tremolo swing is obtained.

TUNING

Tuning can only be carried out by someone with the so called 'musical ear', so if you do not have one you will need to involve a friend or professional tuner.

Commence with A (the first above middle C) using a tuning fork A440. Strike the tuning fork against the cabinet, and use the top panel as a sound board. The pitch board test jig is used to hold the board under alignment, first using the capacitor values suggested in the table, and then small value changes made until A can be achieved with the inductor setting approximately in mid position.

The 'A' board is then put into the pitch module frame and a second board put in the test jig. The author preferred to tune the F board next by comparison with the 'A' and thus listening to a major third interval. Again the values given for 'F' in Table 1 (last month) are tried first with modifications as necessary.

When the 'F' board seems satisfactory it is inserted into the module, and the 'C' board put into the test jig. The major chord F-A-C is easy to recognise and adjustments to both 'C' and 'F' (now in the module) can be made to give a satisfactory sound. 'A' should not be adjusted, but can be checked a number of times against the tuning fork in order to satisfy the constructor that he has tuned it correctly.

Using 'C' as the base, 'E' can now be tuned (major third) followed by 'G' in the major chord C-E-G.

Using 'G' as the base, 'B' can be tuned (major third) followed by 'D' in the major chord G-B-D, thus completing the white notes.

Two approaches are now possible to tune Eflat. Some would find evaluation of the F7 chord F-A-C-Eflat to be relatively easy, whilst others may prefer to use the major third B to Dsharp (Eflat)—that is using B as the root.

Bflat can be tuned from the major chord Eflat-G-Bflat.

A choice exists again to tune Aflat, either using the Bflat seventh chord Bflat-D-F-Aflat or the major third E-Gsharp (Aflat). The full major chord E-Gsharp-B can be used to make judgement easier.

Fsharp can be tuned using the major third interval D-Fsharp, with A completing the major chord.

Csharp can be tuned using the A major chord A-Csharp-E.

The cycle may need repeating a number of times, and other chords will probably produce some out of tune effects which small adjustments in tuning will bring into line. Tuning the piano should not be any more difficult than tuning a guitar, but it will take longer, and requires patience.

FINAL ASSESSMENT

The piano can now be played, and an evaluation made by the constructor of the properties of his instrument. Probably the most important observation will be an assessment of the relative outputs from each note on the keyboard using a constant playing action. If the constructor is dissatisfied he can adjust individual notes or complete pitch boards for increased or reduced output by variation of the resistors quoted in an earlier part of the series.

USING THE PIANO

Whilst the accent in the early part of the series was on constructing an instrument to use in the home, the electronic piano has very great potential for use in modern groups or bands, particularly since the pitch of pianos normally present in private rooms in hotels is often very flat, which can cause very great difficulties for wind instrumentalists in the same band.

The piano can be connected directly to a public address or guitar amplifier thus offering the pianist power capabilities much higher than he has known before. In this connection it is important that very heavy duty speakers are always used when high amplification is involved.

The author uses an amplifier rated at 25 watts r.m.s. driving a speaker with a nominal rating of 50 watts (Fane POP-50). This has withstood a considerable amount of hard work with the piano and three microphones on the same system.

Rating of loudspeakers in this application can be very misleading, since music power is the important factor, and a 25 watt r.m.s. amplifier is capable of driving 50 watts of music power thus requiring a suitably rated loudspeaker.

PLAYING THE PIANO

To close some comments are now made on the technique of playing the piano.

The normal switch setting when using the touch sensitive system is maximum attack. The other attack positions can be used to give a less percussive characteristic for variety.

It is vitally important that the use of the keyboard level control is fully understood. Five positions are offered, but position one must only be used for single note solos, since the power output in this position is the same as a five note chord in position two.

Considerable distortion will occur if this is ignored.

With position two selected, the volume control should be set to give the maximum required listening level. Selection of level for any particular passage is then controlled by the keyboard switch and the foot pedal. The volume control is not varied during a performance.

The natural tendency when trying to achieve greater attack on a piano is to hit the keys harder, up to a stage where great physical effort is involved. This tendency should be resisted on the electronic piano where as mentioned earlier the attack function is different.

It will be found after practice that the touch can be very light, leading in some cases to an easier playing technique, whilst retaining a range of expression. ★

Note: There are a number of resistor value corrections in Fig. 3.1. These are: R84 should be 100 kΩ, R85-R88, 56 kΩ (4 off) and R110, 270Ω. Also, in Fig. 3.4, TR16 collector, base and emitter are labelled in reverse.

CEEFAX

A PROPOSED NEW BROADCASTING SERVICE

IMAGINE sitting down in front of your television set, and at the touch of a switch seeing the latest news, up to the minute stockmarket prices or a list of the day's television programmes with a summary of each. Just a pipedream? Not any more, for the BBC has developed a system which can allow you to do just that, and demonstrations should be underway as early as the middle of 1973.

THE CEEFAX SYSTEM

The system is known as Ceefax and the form that it will take is shown in the photograph. Fig. 1 shows how the Ceefax system fits into the existing television transmission network. At the transmitting end it will mean incorporating a terminal into the broadcasting system so that the pages to be sent out are mixed with the normal picture signals. This will probably mean using the frame synchronisation pulses on which are superimposed the digital signals.

At the receiving end the user will have to purchase a storage and display unit which will probably have a storage capacity of up to 30 pages. The general block diagram of the terminal is shown in Fig. 2. The user will type out whichever of the 30 pages he requires and it will immediately appear on the screen, in a teleprinter type format, either on a blank background or superimposed on the normal television picture.

COST TO THE CONSUMER

The cost of the additional electronics to the domestic user will undoubtedly decrease as technology develops but it is estimated that in quantity production the cost will be approximately the same as a monochrome set or a tape recorder.

Any of the pages stored in the receiving unit can be updated in a matter of seconds, and some pages could be updated every few seconds to present information in book form or perhaps to provide subtitles for television programmes in foreign languages when we enter the Common Market.

INFORMATION AVAILABLE

Examples of the information which can be transmitted using the Ceefax system are limitless but some of the more obvious are: specialised weather

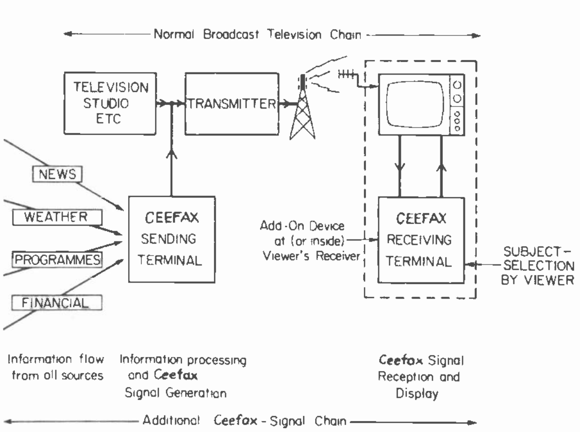


Fig. 1. The Ceefax programme material is injected into the normal television transmission in digital form

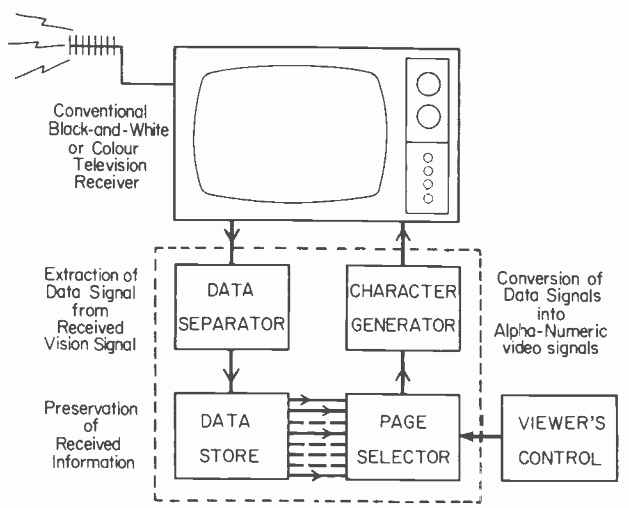


Fig. 2. The domestic receiver uses an add-on decoder and store ready for selected display on the screen

forecasts; a list of the day's television programmes with summaries; specialised programme news for the coming week; facts and figures relevant to current affairs programmes; public notices; up to the minute news (with the option of a flash service whereby important events are flashed onto the screen over the normal programmes), commercial news such as stockmarket prices; sports information; and entertainment in the form of recipes or crossword puzzles.

In the future it is hoped to co-ordinate Ceefax with the Post Office so that pages of information can be received over the normal telephone lines. This will bring the television set into the realms of the computer terminal and no doubt eventually personal facts stored in a computer, such as bank statements, will be at the fingertips of the user through the Ceefax system.

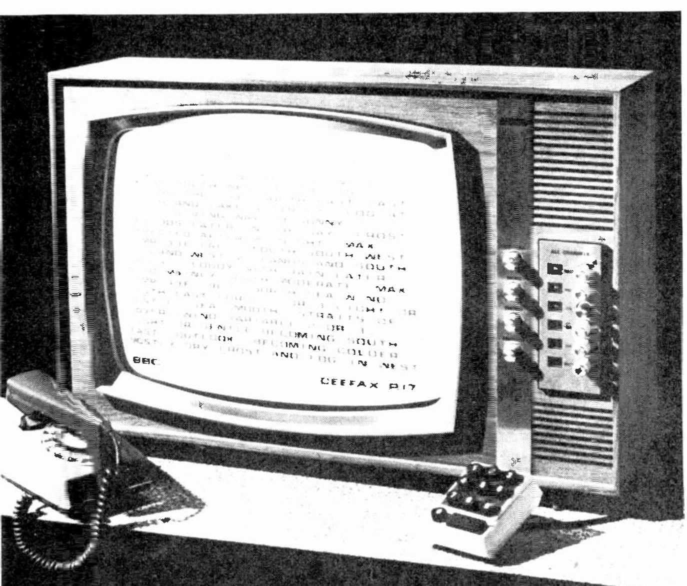
OTHER POSSIBILITIES

There is also no reason why educational institutions should not use one of the available channels for passing information on to the students, in reply to queries made over the phone. The telephone system could also be useful for receiving telegrams and telex messages, there being no need for the recipient to be present when the message is sent.

Although the Ceefax system seems at first like a simple development it is one of those advances, like the introduction of the telephone system, which could have a profound effect upon all our lives as it brings centres of information within easy reach of everyone. It could easily mean the end of newspapers as we know them today for they would be unable to provide such an immediate source of news and would probably only serve to give deeper insight into the news.

The first trials will probably use equipment manufactured by the BBC, but industry will have the opportunity of producing Ceefax units for a public service operation.

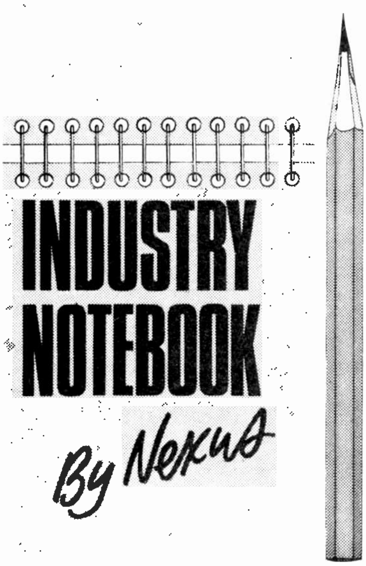
★



NEW BOSS AT MULLARD

Look out for the name Akerman. You'll hear a lot about him and a lot from him starting on January 1, 1973. For that's the date that Jack Akerman takes up his new role as managing director of Mullard Ltd. in succession to Dr. F. E. Jones who leaves to join the Board of Philips Industries Ltd.

Akerman is no newcomer to Mullard—he joined the company in 1936—but it is only in recent years that he has become prominent. Five years ago he moved into the higher echelons through his appointment to the Board of Associated Semiconductor Manufacturers Ltd., an associated company of Mullard. In 1969 he became head of Mullard's consumer electronics division and a year later, in 1970, he became commercial director and a member of the Mullard Board.



Dr. F. E. Jones came to wide public notice through the celebrated "Brain Drain" report which came out during the Wilson administration. But he was well known in the electronics industry long before that both as a brilliant engineer and businessman—a rare combination. He joined Mullard from the Royal Aircraft Establishment, Farnborough, where he was deputy director. After six years as technical director he became MD in 1962 so he has had a full ten years of the top job during which major expansion has been almost a routine.

Jack Akerman comes to the top job at an interesting time. Business is on the upturn and it is not only the consumer component side of Mullard business that is now doing well after the recession. Professional components are also booming and delivery times are lengthening.

LED PRICE BATTLE

Last month I mentioned the bright outlook for optoelectronic devices. Since then I have met Mike Meltzer, in London for a few days representing Monsanto interests in light-emitting diodes and associated devices.

Monsanto announced price cuts of typically 30 per cent but in a few cases up to more than 40 per cent on standard product lines. Not to be outdone, Sperry announced in the U.S.A. cuts of up to 40 per cent on some of their devices and Litronix, another US company, has also joined in the price battle.

How far prices will tumble is anybody's guess but most companies in the LED business now believe that the time is ripe to go for a huge volume market. Monsanto's Meltzer told me that if pocket calculators fall again in price next year, as they are likely to do, then that one single market could generate a demand for 100 million digits a year.

A real enthusiast on his subject, Meltzer spoke of the untold millions of digits which will be needed for as yet untapped markets like cars and the telephone industry. One of Meltzer's forecasts is that by 1980 the LED industry will be as large as the whole semiconductor industry today. Nice work for the survivors after the price war has taken its toll.

NEW FIELDS

Ever anxious to tap new markets, the industry is queuing up to get orders from oil companies. These new rigs scattered round the North Sea are becoming big business. Not so much a drilling platform, more a small town by the sound of things, and there are now over 40 of them all needing not only high grade communications systems but also beacons and other devices for bringing in helicopters as well as surface vessels.

One company, Marconi Marine is doing well supplying complete packaged radio stations including radio officers. Other companies tend to supply individual pieces of equipment.

THE VALVE IS NOT DEAD

Biggest ouptut in the U.K. of any single component group is still in the field of domestic receiving valves and tubes which are running at a rate of £60 million per year. Industrial valves and tubes are worth another £25 million per year. Despite the advent of solid state, valve and tube manufacturers are still doing excellent business.

If you think there is nothing new in the pipeline I suggest you remember the initials *CFA* and *FWI* of which you may hear more in the next few years. CFA stand for Crossed Field Amplifier and FWI stands for Fast-Wave Interaction. CFA and FWI valves are reported under development at English Electric Valve Company.

The CFA combines the advantages of the magnetron and the travelling wave tube and could open up a new range of advanced radar systems. The FWI could open the way to much higher microwave power.

PRODUCTION SHOW BREAKS RECORDS

The fifth Internepcon Show at Brighton again broke all records. It concentrates almost entirely on packaging and production techniques for the electronics industry and is supported by a full-scale conference. This year it attracted over 14,500 visitors including a large number from overseas, some 1,000 of these having registered on the first day.

The Nepcon shows are popular world wide and are money spinners for the organiser as well as the exhibitors who seem so well pleased with results that they come back every year for more despite rising costs.

January sees the second Internepcon held in Tokyo. Ten British companies will be exhibiting. Then next June, the organisers will be launching the first European edition in Brussels which will be called Internepcon Europe 73. Sixty British companies are expected to be there as one of the national groups. This will be followed in October by the usual show in Brighton for which many of this year's exhibitors have already booked space.

EXPANSION TARGET

Semicomps Ltd., the component distributors recently acquired by Simms Motor Division of Joseph Lucas, is embarking on a five-year plan to expand its business to £8 million a year turnover. Managing director Bill Richardson, founder of Semicomps, is confident that the new financial backing he now enjoys will ensure he attains his objective.

The big turnover will be achieved by setting up extra companies to give complete U.K. coverage. The parent company, based in the South East, already has a subsidiary in the North and another in Ireland. More will be set up and each will be expected to contribute £750,000 to £1 million turnover to the group total. First two areas to see new Semicomps companies will be the Midlands and Central Southern England.

JUST PUBLISHED '73
AUDIO-TRONICS

The great new 1973 edition of Lasky's famous Audio-Tronics catalogue is now available—FREE on request. The 48 newspaper size pages—many in full colour—are packed with 1,000's of items from the largest stocks in Great Britain of everything for the Radio and Hi-Fi enthusiast, Electronics hobbyist, Serviceman and Communication's Ham. Over half the pages are devoted exclusively to every aspect of Hi-Fi (including Lasky's budget Stereo Systems and Package Deals). Tape recording and Audio Accessories, see the great new Lasky's Credit Plan Scheme—enabling you to buy your ideal choice of equipment on easy terms. Send your name and address and 15p for post and inclusion on our regular mailing list.

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Teak or Walnut case for Stereofetic tuner only.
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Double case to hold Stereo 30 or Stereo 70 and Stereofetic tuner in Teak or Walnut.
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LEAK TRUSPEED

2-speed 45 and 33⅓ rpm belt drive turntable complete with plinth, cover and Shure cartridge.
LIST PRICE £69·50
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SINCLAIR PHASE LOCK LOOP STEREO FM TUNER

Incorporates varicap diodes, printed circuit, coils, squelch circuit I.C. Decoder, etc., supplied completely built and tested and ready to be mounted into any cabinet you choose. It may be used with any High Fidelity Amplifier. Power requirements 25/30V DC.
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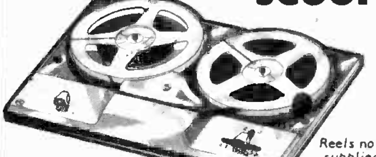
BSR TAPE DECK SCOOP

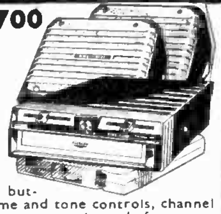


Reels not supplied

BSR TD2

FANTASTIC VALUE, ONLY Lasky's can offer you a tape deck at such an amazing price. The BSR TD2 tape deck operates by a simple reliable mechanism using the minimum of controls.
With ¼ track mono heads. Incorporates fast wind and fast rewind, records at 3¾ ips. giving up to 3 hrs playing time, takes up to 5¾in. spools. Size 13in. 8¾in. front to rear, 2$\frac{11}{16}$in. below plate, 1$\frac{11}{16}$in. above plate.
ALSO SUITABLE FOR USE AS A TAPE TRANSPORTER
LASKY'S PRICE **£8·95** C & P 35p

BELTEK C5700 8 TRACK



Stereo car Player
Accepts all standard pre-recorded 8 track stereo cartridges. Features include automatic head cleaner, channel select and channel repeat push buttons, slider type volume and tone controls, channel balance. Output 5 watts per channel, frequency response 50Hz-10kHz. Output imp. 4 ohms, size 4¾(W) × 1$\frac{13}{16}$(H) × 6¼(D) in. Operates on 12V DC negative earth. Beautifully styled with black ivory and chrome trim.
BELTEK C5700 complete with mounting brackets and 8 track pre-recorded demonstration cartridge.
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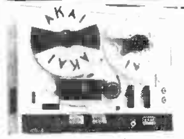
Add £3·75 to any BELTEK car player for pair of FANTAVOX KS701 car speakers.

AKAI TAPE RECORDER SCOOP !



(C & P 75p on all Tape Decks.)

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2 CSS-8 Speakers
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2 ADM 11/8 mics. Suitable for use on all Akai tape recorders. List Price £11·90.
Lasky's Price (pair) **£7·50.** C & P 15p.

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LASKY'S PRICE **£17·95** C & P 35p

Powered by a 25,000 rpm, 115V, 75A Universal motor. This small versatile, easy to handle, power tool is ideal for handymen, hobbyists and professionals. The wide selection of bits helps you grind, sharpen, drill, rout, cut, etc. Perfect for delicate work and hard to reach places. The complete MINI-WORKSHOP is housed in a strong plastic carrying case. For 240V a.c. mains operation.
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LEAK SPEAKERS

150 Speakers (pair)	£39·90	C & P
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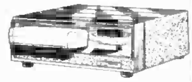
EXCLUSIVELY FROM LASKY'S
The clock measures 5¾" (W) x 2¾" (H) x 3" (D) (overall from front of drum to back of switch). SPEC.: 210/240V a.c. 50Hz operation; switch rating 250V, 3A. Complete with instructions. **NOW WITH ILLUMINATED DIAL COMPLETE WITH KNOBS FEATURES: ● MAINS OPERATION ● 12-HOUR ALARM ● AUTO "SLEEP" SWITCH ● HOURS, MINUTES AND SECONDS READ-OFF ● FORWARD AND BACKWARD TIME ADJUSTMENT ● SILENT OPERATION ● SHOCK AND VIBRATION PROOF ● BUILT IN ALARM BUZZER**
SPECIAL QUOTES FOR QUANTITIES LASKY'S PRICE **£6·50** C & P 25p

BSR TD8S



8 TRACK STEREO CARTRIDGE PLAYER
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These new "Module" systems from Garrard and Lasky's enable you to buy your record player complete with attractive wood plinth, tinted acrylic dust cover and high quality compatible stereo magnetic cartridge —together offering optimum performance and appearance.

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Designing with Integrated circuits

BY A.FOORD

Schmitt Trigger

In many applications it is necessary to drive TTL circuits from a non-TTL input. How this may be achieved will depend on the input signal, but one possible arrangement is shown in Fig. 4.1. This is suitable for many input waveforms and there is no danger of the logic level for the integrated circuit being exceeded.

When the transistor is turned on its collector is pulled down to the logical 0 level for the gate, producing a 1 at the output. This circuit can be used where the rise and fall times of the input are faster than 1μs. Unfortunately when high speed gates are driven directly by input signals which have a slow rise or fall time it is possible for oscillations to occur while the input signal passes through the linear region of the input/output characteristic. The gate acts as a linear amplifier with a high gain, and various feed back paths exist which contribute to instability and consequent false outputs.

One solution for slow rise time inputs is to use a Schmitt trigger. The basic Schmitt trigger has a positive feedback arrangement which introduces hysteresis to the input/output characteristic, and its snap action prevents oscillation.

SCHMITT TRIGGER USING GATES

A Schmitt trigger can be constructed by using gates as in Fig. 4.2, but this circuit is not temperature stable, needs to be driven from a low impedance source, and requires discrete components.

THE SN7413

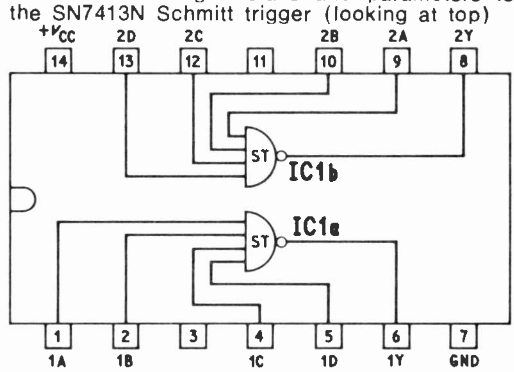
The SN7413 consists of two identical Schmitt trigger circuits, similar to the usual transistor arrangement. Each functions as a four input NAND gate with different input threshold levels for positive and negative going signals. This hysteresis is typically 800mV. The SN7413 is fully compatible with the other TTL circuits in the range.

Propagation delay from input to output is typically 16ns. The package details and parameters are shown in Table 4.1. It has built-in temperature compensation to maintain high stability of the threshold levels

HYSTERISIS Having a different switching threshold for increasing and decreasing signals.

INTERFACE A circuit or "black box" which joins dissimilar systems.

Table 4.1. Package details and parameters for the SN7413N Schmitt trigger (looking at top)



Supply voltage (nominal)	5V
Fan-out from each output	10
Positive going threshold	1·7V
Negative going threshold	0·9V
Hysteresis	0·8V
Logical 1 output	3·3V
Logical 0 output (max)	0·4V

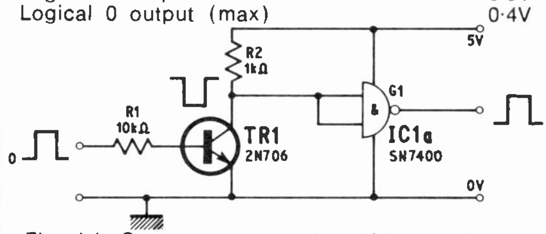


Fig. 4.1. One arrangement for driving logic from a non-TTL source

and can be triggered from the slowest of input waveforms and still give a jitter-free output.

PULSE SHAPER

The SN7413 can be used as a pulse shaper interface between slow waveforms and fast TTL circuits as shown in Fig. 4.3a and b.

SINE TO SQUARE WAVE CONVERSION

This is perhaps one of the simplest applications of the Schmitt trigger, and is shown in Fig. 4.4. The input of the circuit is biased midway between the upper and lower threshold points by R1 and R2 which gives a 50 per cent output duty cycle for sinusoidal inputs. The circuit can also be operated in a self biased mode, Fig. 4.5. These circuits can be used up to 5MHz or more.

Although the input impedance is not high these circuits can usually be driven directly from an oscillator; care should be taken that the input logic levels are not exceeded.

R-C MULTIVIBRATOR

The circuit of Fig. 4.6 can be used over a wide frequency range for experimental work with TTL circuits, and makes a reliable oscillator from 1Hz to 1MHz by selection of the capacitor value. Suppose that initially the capacitor is discharged and the output is at logical 1. The capacitor then charges towards V_{cc} through resistor R1 until the upper threshold voltage is reached. The output then changes to a logical 0 and the capacitor discharges through R1 to the lower threshold voltage, and the cycle repeats.

The duty cycle is 2 : 1 rather than 1 : 1 because the internal 4 kilohms resistor on the base of the input multi-emitter transistor acts as a current source. The capacitor required for a given frequency is best found empirically, typical values are shown in Fig. 4.7. This circuit only has a fan-out of two and should be buffered by the other Schmitt trigger in the package or by a SN7400 if a larger fan-out is required.

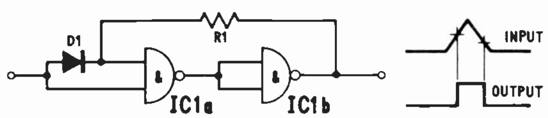


Fig. 4.2. A Schmitt trigger using gates and discrete components

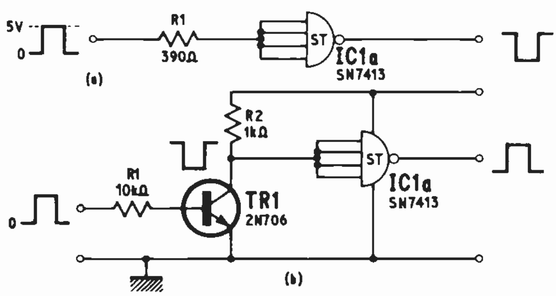


Fig. 4.3. Arrangements using the SN7413 for driving logic from a non-TTL source

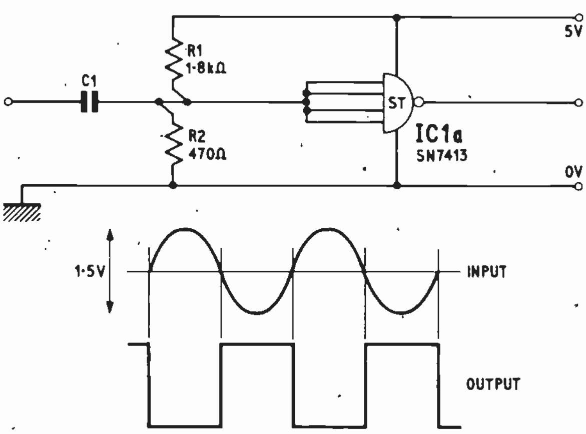


Fig. 4.4. Sine to square wave conversion using the SN7413

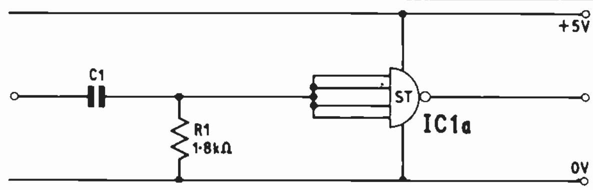


Fig. 4.5. Sine to square wave conversion using the SN7413 in a self biased mode

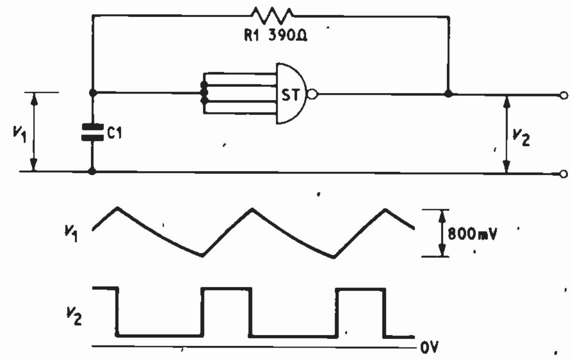


Fig. 4.6. The SN7413 as a multivibrator

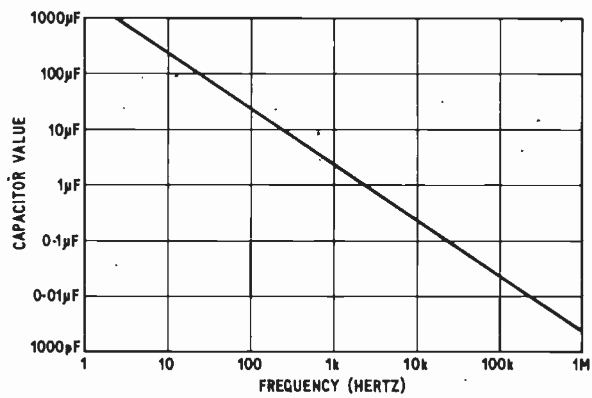


Fig. 4.7. The capacitor values required for various frequencies of oscillation in Fig. 4.6

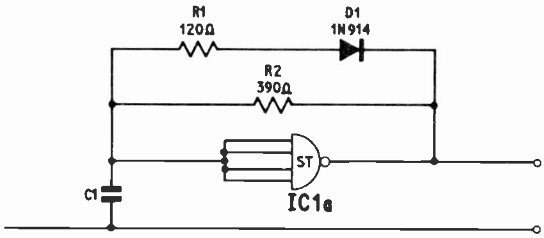


Fig. 4.8. The circuit in Fig. 4.6 modified for an approximately 1 : 1 mark to space ratio

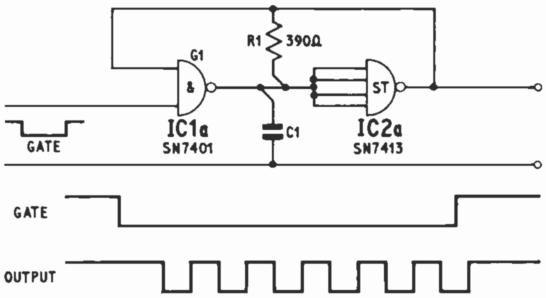


Fig. 4.9. The SN7413 used as a gated multivibrator

The circuit can be modified for an approximate 1 : 1 mark to space ratio as in Fig. 4.8, but the best way to obtain an exact 1 : 1 mark to space ratio is to generate twice the required frequency and divide by two.

GATED OSCILLATOR

The basic multivibrator can be gated by adding an SN7401 open collector NAND gate, Fig. 4.9. The feedback path from the output of the SN7413 to the input of the SN7401 prevents the gate signal from acting until the output of SN7413 is at a logical 1, so that the oscillator will always produce a complete number of cycles.

When the oscillator is released the capacitor has to charge up from ground to the upper threshold level of the Schmitt trigger, so that there is a delay between the negative going edge of the start pulse and the beginning of the output pulse train. This delay is very approximately 0·7 of the total period of oscillation.

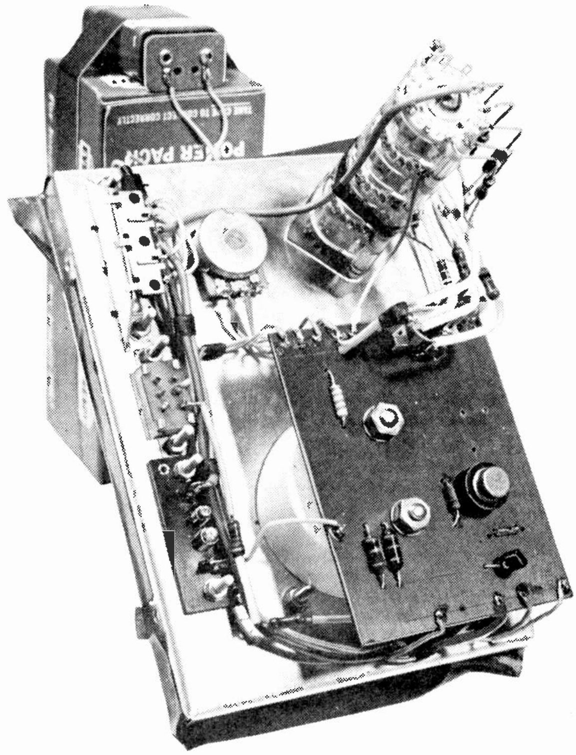
CONCLUSION

This article has shown several applications of the SN7413 Schmitt trigger, but it is especially useful as a straightforward wide range oscillator for future experiments.

Next month: Operational amplifiers with power stages

I.C. LINEAR OHMMETER

continued from page 29



Underside of ohmmeter control panel. Note the strapped battery pack assembly

CONSTRUCTION

The case is made from 22 s.w.g. aluminium and cut out as shown in Fig. 3. The front panel is cut out and drilled from 20 s.w.g. aluminium sheet.

A piece of paxolin, $2\frac{1}{2}$in by $3\frac{1}{2}$in is drilled according to Fig. 4. Wiring pins should be added to the board's extremities as seen in Fig. 5 and components assembled and inter-wired according to the dotted lines.

All control panel components should now be mounted, which includes the wafer switch assembly S2.

The component board is bolted onto the meter terminals and connections from these to the appropriate board pins made. Final wiring should be carried out according to Fig. 5.

To make up the power supplies a battery pack consisting of one 9V and two 6V batteries are strapped together (see photograph) and housed in the case.

SETTING UP

The resistance settings of VR1, VR2 and VR3 to give the required current generator outputs are approximately 900Ω, 9kΩ and 90kΩ respectively. These may be roughly set before switching on. Fine adjustment may then be carried out with the instrument on, to give full scale deflection.

The output should, of course, be perfectly linear but this may be checked by testing with some high accuracy resistors. ★

PATENTS REVIEW...

LIFE TESTING

The not particularly cheerful but daily more pressing question of a definite test for life applicable to medical transplant techniques is raised by E. Roy John of New York in BP 1 257 114. Obviously the need for a definitive "absence of life" test is crucial in transplant surgery. If removal of the transplant organ is delayed unnecessarily, the organ will be useless. If the organ is removed too early, the doctor will be acting immorally and illegally.

The original test for life was the existence of breath and heartbeat, but this is clearly outdated. Attempts are being made to use electroencephalograph and electrocardiograph readouts for sensing brain and heart activity respectively. But amplifier noise can be mistaken for brain activity—or more important, it may be mistakenly assumed that what is in fact brain activity, is simply amplifier noise.

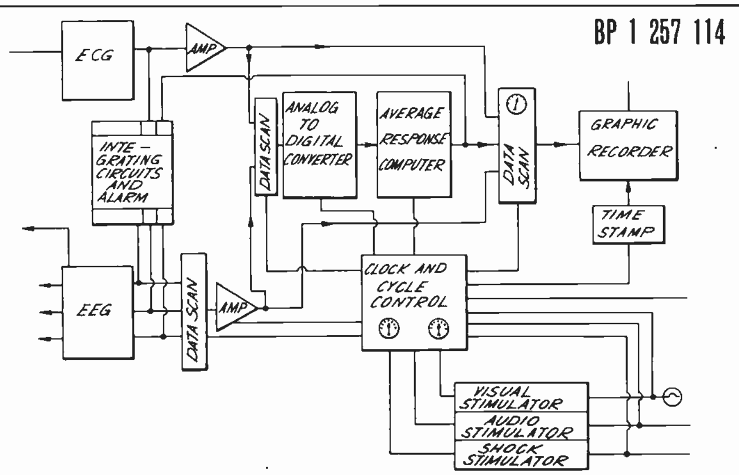
The most recent technique is to stimulate the brain and detect response; but to avoid false results, due to areas of the brain being damaged, three of the major sensory systems have to be tested. All this can become very time consuming and time is of the essence in transplant surgery.

The patent suggests using digital and analogue systems for evaluating the *EEG* and *ECG* readouts after visual, auditory and somatic stimuli. To this end a graphic recorder is used which has at least three recording channels. An *EEG* has its input electrode connected to the patient and its output connected to the first of these channels. An *ECG* has its input electrode connected to the patient and its output connected to the second of the channels.

Finally, a data averaging device has its input connected to the outputs of both the *EEG* and *ECG* and its output connected to the third channel of the graphic recorder.

By using data averaging techniques a response signal can be separated from noise even though visual inspection of the "raw" readouts from the *EEG* and *ECG* will show no signs of response to stimulus. Brain response to a flashing light may, for instance, be indistinguishable when viewed on an oscilloscope but will be revealed by an average response computer. So by applying this average response data to the graphic recorder in addition to the "raw" readouts from the *EEG* and *ECG*, the doctor will be in a far better position to make a positive decision without delay.

BP 1 257 114



SOUND RESPONSIVE CIRCUIT

ARRANGING for electric lights to be illuminated in response to the presence of sound above a selected threshold level can be useful in many areas. The sounding of telephone or doorbells can be detected (e.g., when the user is deaf or has hi-fi headphones on); and burglar alarm systems can be devised which rely on noise detection.

In BP 1 279 335 Novar Electronics Corporation of Ohio, USA, also suggest that audio actuated light can help the deaf learn to speak.

BP 1 279 335

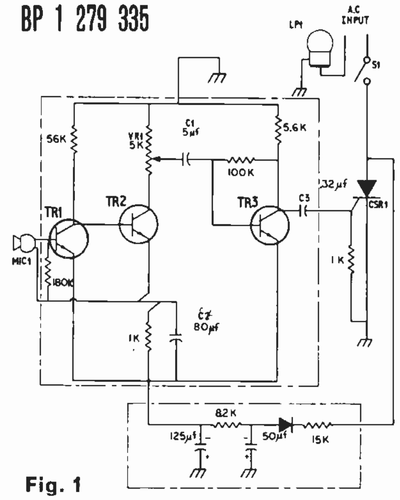


Fig. 1

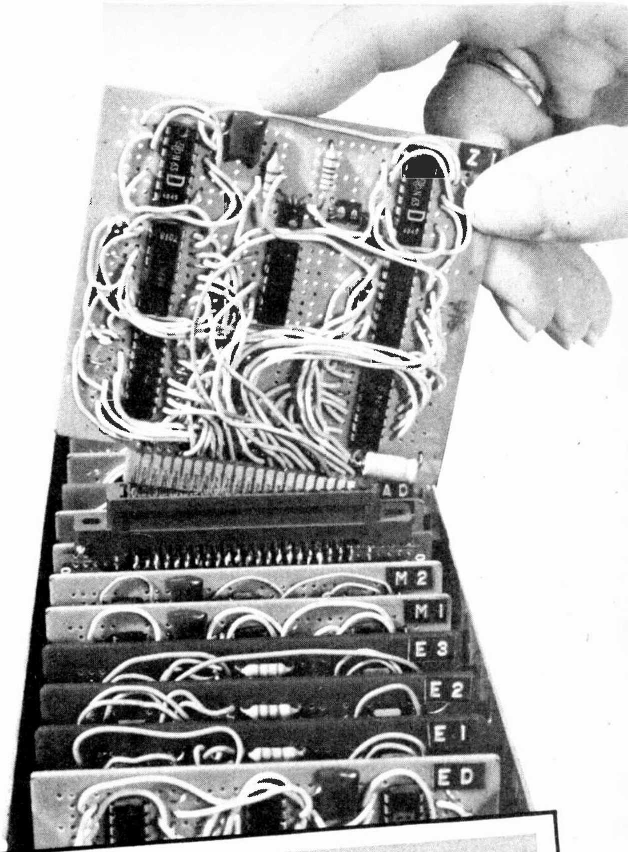
Their proposed basic circuitry is fairly simple and is shown in Fig. 1 above. An a.c. source is connected to the input terminals. The anode and cathode terminals of CSR1, being in series with the lamp and the power supply thus operate as a switch to block or pass current to the lamp.

The microphone picks up sounds, converts them into an audio output which is amplified and impressed on the gate electrode of CSR1.

In one possible circuit the first stage amplifier transistor TR1 is coupled to TR2 with its load resistor being the track of the 5K control VR1. The wiper of VR1 is coupled via a 5µF capacitor C1 to a third amplifier transistor TR3, the latter being coupled to the thyristor gate via the 32µF capacitor.

In the absence of sound at the microphone no trigger signal is present at CSR1 gate and the lamp LP1 stays off. But any signal from the microphone is amplified and if the peaks at gate are greater than the gate firing voltage, the lamp will be illuminated during that part of each half cycle of the a.c. source in which the anode and cathode terminals of the CSR are forward biassed.

The potentiometer VR1 of course, controls sensitivity, and thus can effectively decide between either continual illumination or flickering during speech as well as basic sensitivity to telephone bells.



PE Digi-Cal

By R.W.COLES

PART 7

CLOCK GENERATOR BOARD

The subject of this month's article is the clock generator board which has the function of generating a range of timing pulses for use throughout the arithmetic operations. A single capacitor is used to control the speed at which the whole system operates and this fact means that by running the system at slow speed, faults become relatively easy to trace.

CLOCK BOARD

The circuit and logic of the clock pulse generating board is more interesting than, say, the shift register boards because of the diversity of the logic operations performed. The tasks which this circuit is called upon to carry out are listed below:

(a) Generate batches of ten clock pulses for the A, Z, and AD boards when instructed to do so by the programme. During addition or subtraction a single batch is required whereas during multiplication or division batches are produced continuously until detection logic decides that the arithmetic operation has been completed.

(b) Generate a single batch of n (or 10-n) clock pulses when instructed to do so at the beginning of the MULTIPLICATION programme and the end of the DIVISION programme respectively to clock the A, Z, and AD boards. These clock pulses are used for decimal point positioning purposes, where n is less than ten and is determined by the setting of the decimal point thumbwheel.

(c) Provide an ungated clock pulse output to operate the programme counter and the ENTRY register normalisation system.

(d) Generate a single output pulse for every batch of ten clock pulses produced so that the number of batches can be counted during the MULTIPLICATION and DIVISION programmes. This pulse to be generated *during* the batch generation time, to offset propagation delay problems.

(e) Generate a single output pulse at the *end* of each batch of clock pulses for use with the OVERFLOW detection logic.

(f) Generate an output to restart the programme sequence at the end of the series of additions or subtractions carried out during multiplication and division.

(g) Provide an isolated buffering circuit for the large load represented by the A board PRESET input. (This buffer is not connected with any of the other clock circuits.)

BASIC CIRCUIT

The heart of the CLOCK board is the circuit which produces a batch of ten pulses on demand, all other requirements being met by modification of this basic logic arrangement, which is shown in Fig. 7.1.

The "clock" shown in Fig. 7.1 is simply a square wave oscillator, and this is used to trigger a four-stage, decade counter via a single gate.

The counter will register each of the clock pulses until the tenth one sets the decade counter back to the 0000 state.

This event is detected by the output of the D counter stage falling, and is used to clock a D type flip-flop which has its data input (D) connected to a level "1" gate output (STOP CLOCK signal). When the counter clocks the flip-flop in this way the STOP CLOCK input causes the flip-flop Q output to go to a "1" level and its $\overline{Q}$ output to go to a "0" level.

The "0" level output from the $\overline{Q}$ side of the flip-flop is connected back to the gate in series with the clock input to the counter, and has the effect of preventing any further pulses from getting through to the trigger input.

If at some future time another batch of ten pulses is required, the flip-flop can be reset via its CLEAR input, whereupon the sequence is repeated.

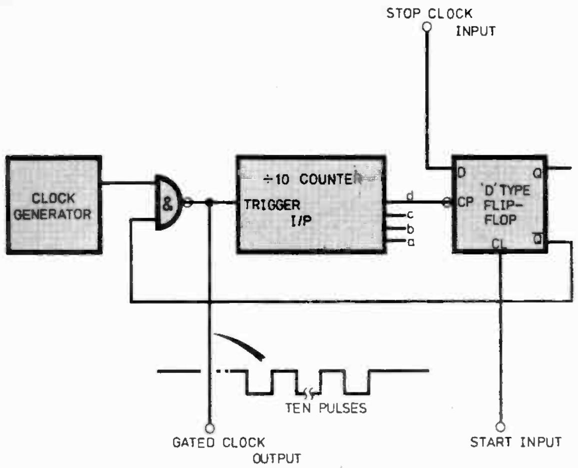


Fig. 7.1. This diagram shows the heart of the clock generator board

If more than one batch of ten pulses is required the STOP CLOCK input can be left in the "0" state so that when the flip-flop is clocked at the end of ten pulses, its $\bar{Q}$ output remains in the "1" state.

When sufficient batches have been produced the STOP CLOCK input can be taken to the "1" condition so that at the end of the next batch the clock is shut off.

Note that with this system no matter how long the clock is allowed to run before being stopped the total number of clock pulses produced will always be divisible by ten, and this is obviously essential for the correct operation of Digi-Cal.

If a smaller number of clock pulses were produced during any batch, the answer produced would be in error by one or more powers of ten.

FULL CIRCUIT

The full clock circuit is shown in Fig. 7.2 and as can be seen a considerable amount of extra gating has been added to modify the basic circuit to enable it to perform all the tasks listed earlier. To make

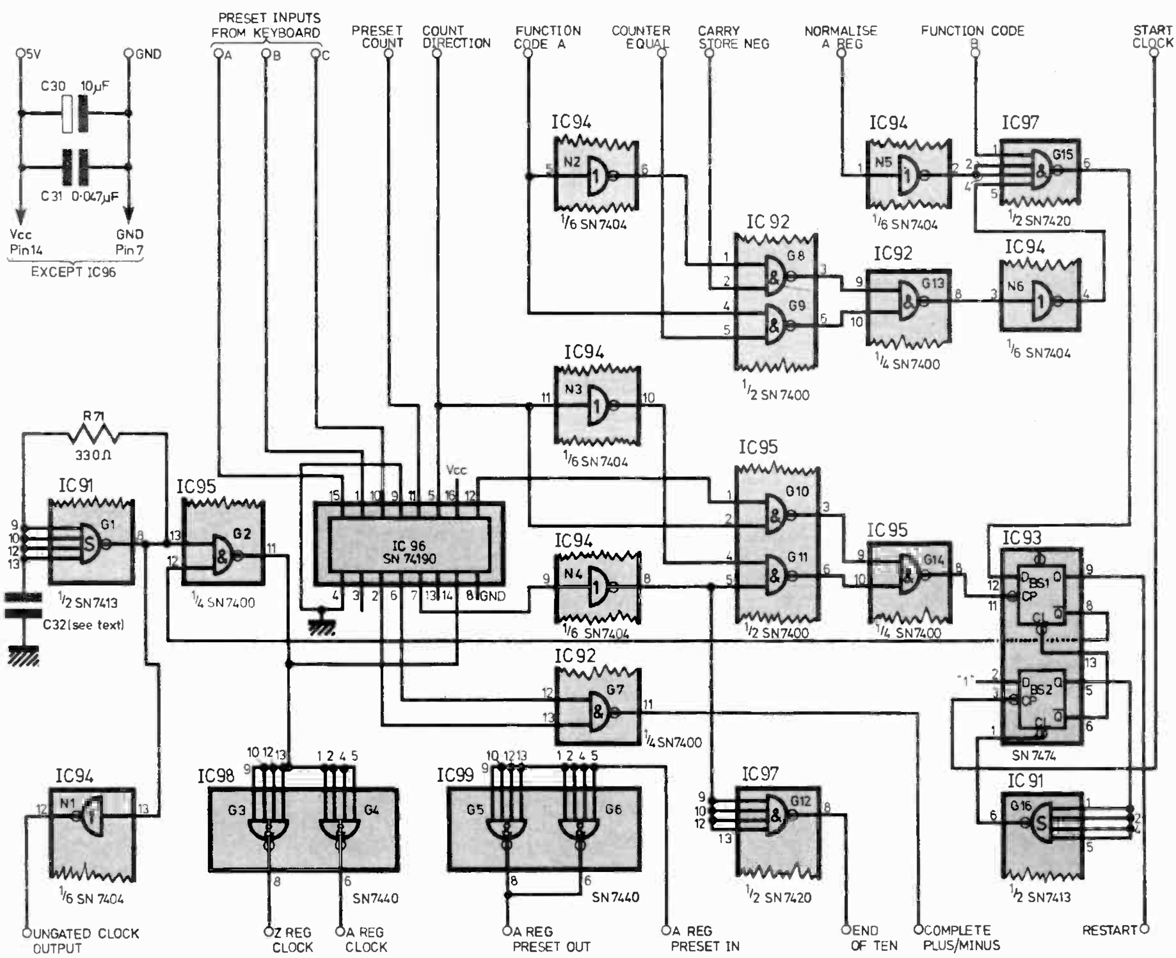


Fig. 7.2. The full circuit diagram of the clock generator board

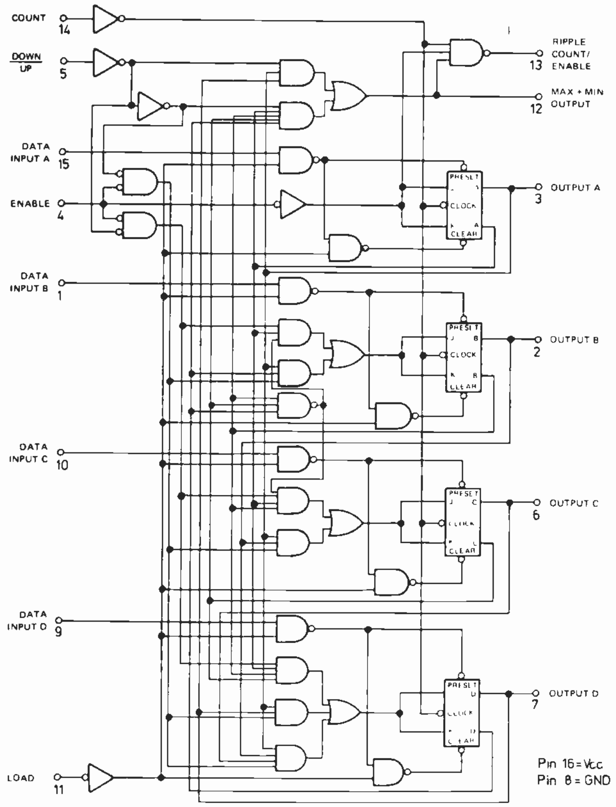


Fig. 7.3. The internal logic of the SN74190 reversible counter with pin numbers of the D.I.L. package

the circuit easier to follow, the gates have not been rigidly constrained within a square box as they have been in previous circuits. That kind of approach can make the whole thing look more complicated than it really is where a lot of gating logic is employed.

UP/DOWN COUNTER

The decade counter used on this board is not the ubiquitous SN7490 as may be expected, because although this type of counter would perform satisfactorily in the basic circuit already discussed, it could not be modified to allow it to carry out task (b).

The counter chosen is in fact the SN74190 which incorporates several extra facilities including the ability to count down as well as up, and the provision of parallel data inputs which allow the starting count to be preset to any b.c.d. number from zero to nine.

The logic diagram of this counter is shown in Fig. 7.3 and a glance at this will serve to confirm that being able to buy one of these in a 16 pin package saves a lot of time and money over having to construct such a circuit from separate gates and flip-flops!

Note that apart from the usual clock input and data outputs, there are parallel data inputs and a wide variety of control inputs and outputs whose functions are listed as follows.

DOWN/UP	Decides count direction (i.e. 0 to 0 or 9 to 0)
ENABLE	Allows counting to take place (not required in Digi-Cal)
LOAD	Presets the counter to the condition on the DATA INPUTS
MAX/MIN	Goes to a logic "1" if the counter contains 9 and is counting UP, or 0 and is counting DOWN
RIPPLE COUNT ENABLE	Output used for cascading SN74190 (not required in Digi-Cal)

CLOCK OSCILLATOR

The clock oscillator is very simple and takes advantage of the useful properties of the SN7413 dual, four input, Schmitt trigger gate. The gates in this package have regenerative feedback applied so that they can be operated from slowly changing d.c. inputs without any spurious oscillations being produced as can sometimes occur with the standard TTL gate circuit.

The hysteresis embodied in the input characteristic of the SN7413 makes it ideal for use as a free-running multivibrator for use between 1Hz and 30MHz.

The only components required to form such a multivibrator, in addition to one of the gates in an SN7413 package, are a 330 ohm resistor and a capacitor of suitable value to set the frequency to the required range.

When Digi-Cal is completed the clock frequency will be left set to one value, but during the testing phase it is handy to be able to alter the frequency to a much lower value so that things happen more slowly.

To assist constructors in the choice of capacitor for low frequency operation, Fig. 7.4 shows a graph for reading frequency against capacitor value.

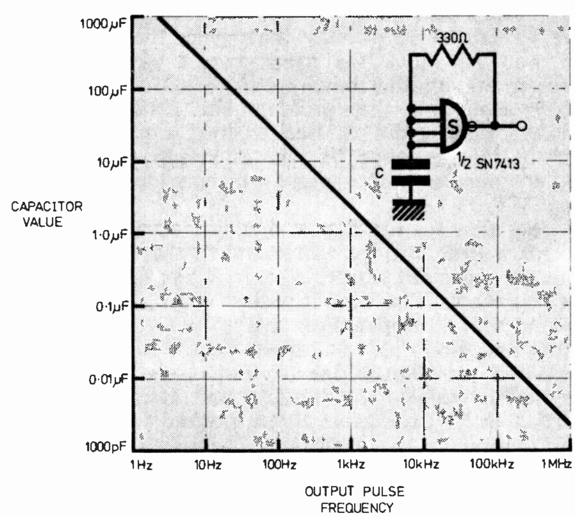


Fig. 7.4. This graph shows the relationship between the clock frequency and the value of the timing capacitor

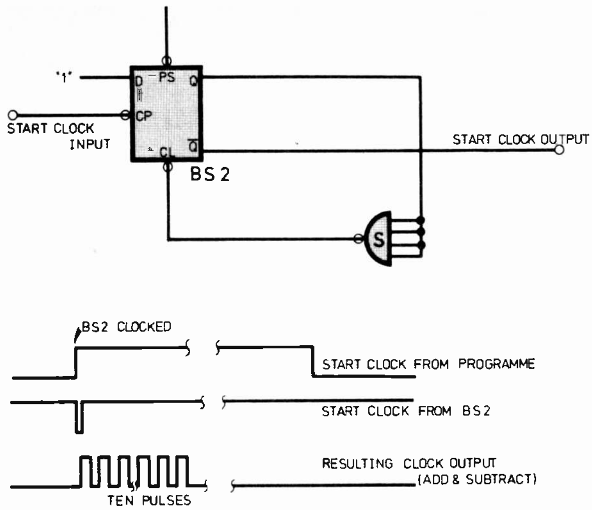


Fig. 7.5. Detail of Fig. 7.2 showing the flip-flop and Schmitt gate used to generate a narrow pulse

COUNTER OPERATION

Using the output of the counter to clock the D-type latch flip-flop is complicated in the full circuit by the need to use different clock stimuli depending on the count direction. This is taken care of by gates G10, G11, G14 and inverters N3, N4 which, depending on the state of the UP/DOWN control line select either the D output or the MAX/MIN output of the counter to feed the SN7474 clock input.

The operation of the counter when generating batches of ten clock pulses is the same as that of the basic circuit, but some extra logic is necessary to start the sequence.

The START CLOCK command arrives as a long pulse from the programme circuits, and because of its length it cannot be used directly to clear BS1. If it was used for this purpose it would start the clock generation satisfactorily, but the ten clock pulses are generated so quickly that when the time came to stop the clock the START CLOCK would still be present and another batch would begin.

To overcome this problem the necessarily long START CLOCK pulse is used to trigger a monostable circuit in the shape of BS2 and G16, which gives a very narrow output pulse which is ideal for clearing BS1.

The use of a flip-flop and a gate as a monostable seems a little strange and to make the operation of this arrangement a little clearer it has been redrawn as Fig. 7.5. The circuit relies upon the normally troublesome "propagation delays" associated with all gates and flip-flops, to allow its operation.

When the rising edge of the START CLOCK pulse arrives it triggers the flip-flop and causes the open circuit or "1" condition to be clocked through from the D input to the Q output. The rising Q output is then used to operate the flip-flop CLEAR input via the SN7413 gate which acts as an inverter *and* a delay element.

When the flip-flop is cleared the circuit returns to its starting condition, ready to be retriggered in the future. The output pulse width (which could be taken from either the Q or the $\overline{Q}$ output) is dependent on the delay in the gate and the delay between a CLEAR input and a corresponding output (this varies from device to device), but gives a pulse of about 30 to 40 ns in practice.

STOP CLOCK INPUTS

The logic decision whether or not to allow the STOP CLOCK input to BS1 to go to a "1" level is a function of five board inputs, and depends on the arithmetic operation in progress.

The logic producing the STOP CLOCK signal comprises gates G8, G9, G13, G15, and inverters N2, N5, N6. The FUNCTION CODE B input (which is a "0" level during ADDITION and SUBTRACTION) and the NORMALISE A REGISTER input (which is a "0" level during the MULTIPLICATION and DIVISION decimal point positioning period) have a direct effect and stop the clock at the end of one batch of pulses.

The COUNTER EQUAL input (which is the basic STOP signal during MULTIPLICATION) and the CARRY STORE NEGATIVE input (which is the basic STOP signal during DIVISION) are allowed to stop the clock when sufficient batches of ten pulses have been produced, and are selected according to the programme used, by the FUNCTION CODE A input. This input is a '0' level for MULTIPLY and a "1" level for DIVIDE.

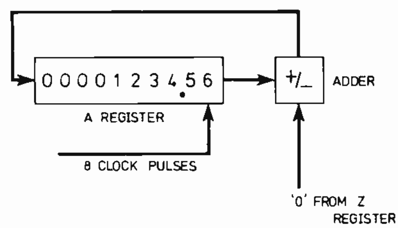


Fig. 7.6. This diagram shows the basic A register and adder sections to illustrate how virtual left shifts are managed

NORMALISATION

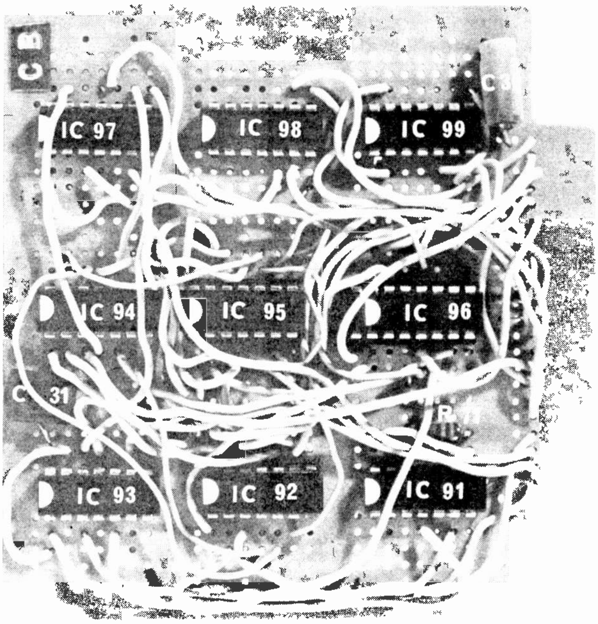
The arithmetic section of Digi-Cal does not take account of decimal fractions directly, and treats all numbers as integers. Thus, 2·5 times 2·0 is treated as 25 times 20, giving an answer of 500 which, when displayed, appears as 50·0, instead of 5·0 as required.

The answer reached in this way obviously needs correction, and this is achieved by shifting it to the right by the number of decimal places selected on the thumbwheel. This part of the programme sequence is called NORMALISATION, and is achieved in a different way during DIVISION.

Division of 2·5 by 0·5 leads to an initial answer of 0·5, which suggests a left shift of one place is required, but in practice it is necessary to left shift not the ANSWER, but the DIVIDEND, before the arithmetic process starts. In this way, 2·5 divided by 0·5 becomes 25·0 divided by 0·5, which gives the correct answer of 5·0 without correction.

Left and right shifts such as those described above obviously require a batch of less than ten clock pulses, and this is where the PRESET inputs of the SN74190 are used to advantage. Before looking at

CLOCK GENERATOR BOARD



Z CLOCK	23
SWITCH CODE C	24
SWITCH CODE B	25
SWITCH CODE A	26
PRESET CNT	27
CNT DIR'N	28
FUNCTION A	29
CARRY STORE NEG	30
CNT EQUAL	31
FUNCTION B	32
GND	33
+5V	34
END OF TEN	35
spare	36
NORM A REG	37
A REG PRESET (OUT)	38
A REG PRESET (IN)	39
A REG CLOCK	40
ADD/SUB COMPLETE	41
RESTART	42
UNGATED CLOCK	43
START CLOCK	44

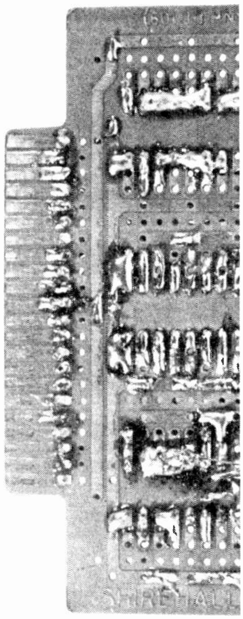


Fig. 7.7. Layout of the components on the clock generator board and function of the edge contacts. Also shown is the wiring details of the edge connector (below left)

1	23	Z1/21, Z2/21
2	24	C SW. CODE (fr kbd)
3	25	B SW. CODE (fr kbd)
4	26	A SW. CODE (fr kbd)
5	27	P'SET CNT (fr prog)
6	28	CNT DIR'N (fr prog)
7	29	FUNC CODE A (fr kbd)
8	30	AD/36
9	31	M1/17
10	32	FUNC CODE B (fr kbd)
11	33	GND
12	34	+5V
13	35	TO O'FLOW LOGIC
14	36	not used
15	37	NORM A REG (fr prog)
16	38	A1/43, A2/43
17	39	P'SET A REG (fr prog)
18	40	A1/40, A2/40
19	41	M1/22
20	42	RESTART (to kbd)
21	43	UNGATED CLK (to prog)
22	44	START CLK (fr prog)

CB

COMPONENTS . . .

CLOCK GENERATOR BOARD

Resistors

R71 330Ω ¼W ±10% carbon

Capacitors

C30 10μF 15V elect.
C31 0·047μF
C32 see text

Integrated Circuits

IC91	SN7413
IC92	SN7400
IC93	SN7474
IC94	SN7404
IC95	SN7400
IC96	SN74190
IC97	SN7420
IC98, IC99	SN7440 (2 off)

Printed Circuit Board

Type DL109/22 (Shirehall)

the generation of these shortened batches, it is necessary to look at just how the normally right-shifting A register is made to shift left.

VIRTUAL LEFT SHIFTS

The way in which left shifts are achieved is best studied with the aid of Fig. 7.6 which shows the basic Digi-Cal A REGISTER and ADDER.

The requirement is to shift the number 1234·56 two places to the left, because DIVISION is in progress and the thumbwheel is set to two.

To turn the A REGISTER into a bi-directional type at the hardware level would require considerable numbers of extra gates, not to mention the preclusion of the use of SN7496 devices, and for this reason any such move is undesirable.

Fortunately, by employing what amounts to a programming "dodge" it is possible to turn a hardware right shift into a virtual left shift, and this is achieved by clocking the register with 10 minus *n* pulses.

By applying only eight pulses to the register in Fig. 7.6, and by leaving the output of the ADDER unmodified by the Z REGISTER input, the A data recirculates until it ends up as 123456·00.

This system relies on the fact that there are at least *n* zeros to the left of the number to be shifted, and provides one reason why the A and Z registers are ten digits long.

GENERATING LESS THAN TEN CLOCK PULSES

To generate the *n* pulses needed during the MULTIPLICATION NORMALISATION the counter PRESET COUNT input is taken to a "0" level which loads the true thumbwheel code into the SN74190, e.g. DCBA equals 0011 for a setting of three.

Next, the COUNT DIRECTION input is taken to a "1" level to set the count direction to DOWN, and the START CLOCK input initiates the sequence.

The counter will then count 2, 1, 0, whereupon the MAX/MIN output of the SN74190 will go to "1" clocking BS1 and stopping the clock via G2, only three pulses having been produced in all.

To generate the 10 minus *n* pulses required during DIVISION NORMALISATION the counter is loaded with the same code as before but in this case the count direction is set to UP, and the sequence for the example of three is, 4, 5, 6, 7, 8, 9, 0, producing a total of seven pulses. The D output of the counter is used to trigger BS1 in this case, not the MAX/MIN output.

BOARD OUTPUTS

There are several outputs from the CLOCK board, some of which (such as the A and Z register buffered clock lines), are self-explanatory. Gate G7 is used to detect counts six and seven to give a negative-going edge after clock seven to trigger the counter boards used during MULTIPLICATION and DIVISION. A trigger for this purpose is produced early in the sequence to allow the COUNTER boards and COMPARATOR to register an equality during MULTIPLICATION and still have time to stop the clock at the end of its run.

This output is called PLUS/MINUS COMPLETE. Gate G12 is used to buffer the pulse produced after each batch of ten clock pulses to give the END OF TEN output required by the error detection, or OVERFLOW logic.

The RESTART output is taken from the Q output of BS1 and is used to restart the programme during MULTIPLICATION or DIVISION when the series of additions or subtractions have been completed.

The A register PRESET buffer gates are included on this board for convenience, and have no logic connection with it. They are parallel connected to provide the high drive capability required by the PRESET function of the SN7496.

CONSTRUCTION

This circuit is built on a DL109/22 card, which has a 22-way edge contact on the printed side of the board. The component layout and edge contact wiring is shown in Fig. 7.7.

Wiring-up follows the same pattern as was outlined for previous boards.

The value of the capacitor used to set the clock frequency is about 3,000pF for the completed Digi-Cal (three 0·01µF capacitors in series were used in the prototype) but during testing procedure it is often convenient to use a very slow clock to enable the exact operation of the programme for instance to be traced using only the display and perhaps a voltmeter as indication.

The prototype has been tested with values as high as 1,000µF and still operated correctly, if rather slowly! For this reason it is better not to wire in a capacitor permanently at this stage since a suitable component can be connected when required.

Next month: The Adder Board

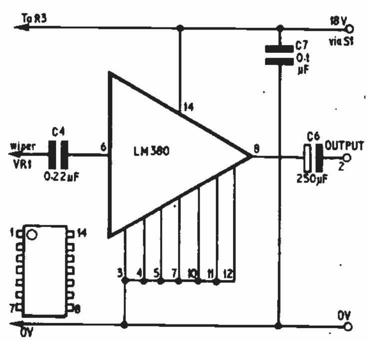
POINTS ARISING

I.C. INTERCOM *(October 1972)*

It has been brought to our notice that the PA234 i.c. is no longer available. A suitable alternative (not substitute) is the LM380, a 2W amplifier with its gain preset at 50. It requires fewer external components than the PA234 (R4, R5, R6, and C5 are not necessary) as shown below.

Minor alterations to the Veroboard layout are required. Pins 3, 4, 5, 10, 11 and 12 must be connected to a heatsink for 2W. It is recommended that a piece of copper be soldered to these pins under the panel if the i.c. is to be used at high power for any length of time. (This i.c. will drive an 8 ohm speaker.)

The LM380 is available (£1·45) from D.T.V. Group Ltd., 126 Hamilton Road, London, S.E.27.



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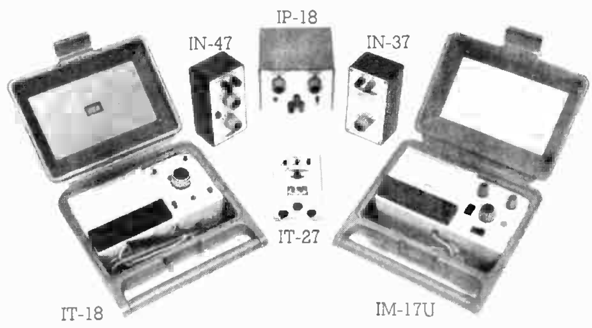

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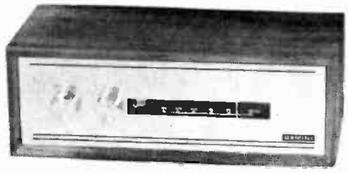

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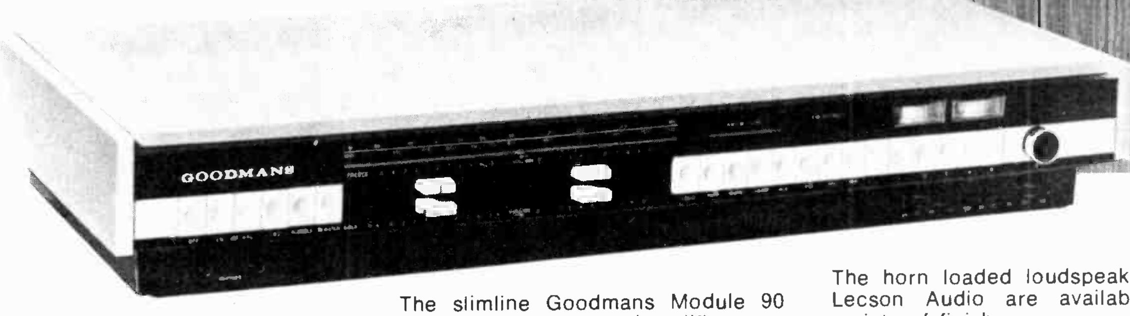
AUDIO FESTIVAL AND FAIR

A look at some of the hi fi developments seen and heard at Olympia
By M. A. COLWELL



The slimline Goodmans Module 90 a.m./f.m. stereo tuner/amplifier

The horn loaded loudspeakers from Lecson Audio are available in a variety of finishes

ARE WE so immersed in the technicalities of hi fi equipment that we are sometimes guilty of spurning the real purpose of that equipment?

This poignant remark heard at this year's Audio Fair at Olympia is perhaps more significant in its implications than in the statement itself. It was a further cause for ponderance on tasting some of the lectures held simultaneously with the exhibition. These were enthusiastically attended and the presentation by the speakers was generally of a high standard. But one must hold some sympathies with the lay public who in some cases found the technical content some justification for not staying to the end.

On further analysis one can conclude that those keenly interested in hi fi equipment are extremely knowledgeable on the technical aspects. So much so that this is largely responsible for the cool reactions so far to quadraphonic reproduction in this country.

There has so far been a continuous air of "wait and see how it goes," while the Japanese persistently try to convince the British public that their systems are "proof of the pudding." If one was to assess quadraphonic sound on what one hears at Olympia then there can be little surprise at disillusionment, with comments like . . . "But who wants to sit in the middle of the orchestra."

SIMULATED AMBIENCE

To sell quadraphonic sound, not only does the cost have to be fully justified, but also the ultimate accommodation in the home has to be compatible with normal domestic requirements. With necessary furnishings to blend with, both acoustically and visually, successful four-channel ambience is largely dependent on room dimensions and acoustic properties. A pseudo mock-up in a crowded stereotype cubicle does not give a fair indication to the listener of what quadraphonic ambience should be like in a domestic setting and all too often these demonstrations were valueless. As one exhibitor put it: The speaker system is only as good as the room that loads it. The addition of ten or twenty listeners in the room adds further influence.

Only a trickling of British companies are offering four-channel facilities, usually in the form of a matrix decoder fed from two-channel equipment. The merits of this method lie only in the convenience of adaptability from existing equipment to suit "quadraphonic" recordings. The major drawback is some loss of channel separation. True quadraphonic ambience is only really authentic when derived from *totally* independent channels. The CD-4 discrete recorded four-channel system is the recommended version that uses this method.

Those offering quadraphonic equipment at the Audio Fair include the following (the code letters indicate equipment origin): J—Japan, WG—West Germany, UK—United Kingdom, USA—United States of America, DM—Denmark.

BRITISH FOUR-CHANNEL EQUIPMENT

Goodmans Module 90 tuner amplifier (UK)—an impressive piece of equipment with excellent styling. This unit receives m.w. and f.m. bands by preset or variable tuning and contains a 45+45 watt r.m.s. amplifier with less than 0·1 per cent total harmonic distortion.

The model shown in our photograph is the white finish version and has elegant push-button arrays, twin level meters and slider controls. The "4D ambiophonic capability" will require two additional speaker units, while the main circuitry incorporates many of the features of the slightly more expensive Models One-Ten and Module 80 (f.m.). Four f.m. band presetting controls are provided at the bottom right-hand end which are selected by four push-buttons above them. Two power output meters are also fitted.

Compared with some units this represents good value at £121 (white finish).

FOREIGN QUAD

Grundig (WG) have an integrated tuner/amplifier complete for four-channel sound and including all the necessary decoder and amplifier circuitry ready for connection to four speakers. This is called the "Studio 2000b," has all the features expected of its kind, but is priced at £238·60, which includes a Dual 1216 transcription auto-changer fitted with a Shure M75 MBD magnetic cartridge.

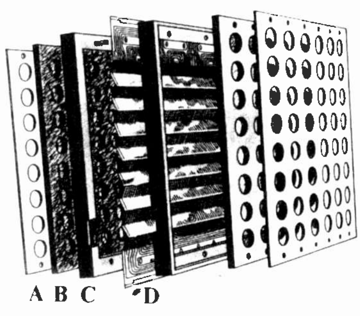
The tuner has seven v.h.f. pre-selectors, each with its own tuning scale and short, medium and long wave reception. This might be classed as budget equipment of superior quality although the distortion figures ought to be better.

An alternative version without the transcription unit and of lower output (12·5W r.m.s.) is the Grundig RTV 800, and the RTV 900 at 25W r.m.s. per channel is similar in appearance. Similar push buttons are used as in the Goodmans unit and slider controls are also preferred. The photograph shows the RTV 800 with the individual tuning scales to the left of the main scale.

All three of these models are large, at least 22in long, the Model 2000b being larger. The RTV 800 is priced at £135·80 and the RTV 900 at £177·25.

Other ranges of quadraphonic equipment shown were from National Panasonic (J), JVC Nivico (J), Pioneer (J), Sansui (J), Sanyo (J), Siemens (WG), Sony (J), most of whom have demonstrated this technique before in some form. Golding Skandia (J) also had cartridge players quoted as "simulated quadphonic" at various prices.

Marantz Model 19 stereo receiver



The layers of the isodynamic headphone structure by Rank Wharfedale. Note the printed circuit style diaphragm at D

ISODYNAMIC HYBRID

In taking an overall view of the equipment on show it is evident that manufacturers are coming close to the ultimate performance versus cost factor and innovations such as have been regular occurrences in the past are now very thin on the ground.

Probably one of the most significant commercial developments though shown this year is the Isodynamic Stereo Headphone made by Rank Wharfedale. High quality stereo headphones have so far been somewhat heavy for long term listening, but this one weighs only 13 ounces (375 grammes). It is a semi-hybrid whereby the whole diaphragm is driven evenly and freely as in the electrostatic principle, but is influenced by an anisotropic ceramic/synthetic rubberised sheet magnetised perpendicular to the diaphragm.

The diaphragm is a polymide film with flexible printed circuit style metallic grid. The electromagnetic influences caused by the sound signal passing through this grid, in conjunction with the magnetised rubber, make the diaphragm move.

Subjective measurements on these phones show no violent variation in spectral response and the frequency response using a standard "artificial ear" shows −3dB points at 40Hz and 15kHz. The price is competitive at £19·95.

RAPID DEVELOPMENT

With the expansion of stereo broadcasting to Radio 2 (from early November) and the likelihood of commercial sound broadcasting to come, one would have expected to see a strong emphasis on advanced tuner developments using integrated circuits. There were surprisingly few; the general trend seems to be to integrate the complete tuner with the amplifier in one case. Very few separate tuners were evident.

However, Lecson Audio (a promising newcomer) have in less than 12 months produced some superb high quality equipment in revolutionary new styling. The tuner TF1 is a self-powered unit with preset v.h.f. tuning and variable tuning controls for stereo or mono broadcasts.

The controls take the form of sliding bars matching the case styling. The performance is specified as 1·5μV sensitivity for 30dB quieting; a.m. rejection 42dB; signal-to-noise ratio better than 60dB; audio frequency response ± 1dB 20Hz to 14·5kHz.

LOW DISTORTION

The matching control unit pre-amplifier, also self-powered with slide controls and electronic switching, is a two-channel stereo unit with two four-channel configurations for a supplementary matrix decoding surround-sound unit, to be made available. The performance is claimed to be so impressive that the sceptics will probably need convincing.

There are the usual input facilities to be expected with signal-to-noise ratios of 70dB (magnetic pick-ups) and 80dB for others. Outputs supply 500mV into 1kΩ loads for pick-up and radio; 100mV for tape; 2W into 8 ohms for headphone use. Distortion is quoted as typically less than 0·02 per cent; frequency response ± 0·5dB 10Hz to 25kHz.

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GB10*	5¼in	4in	1½in	44p	18p
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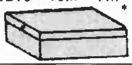
GB12	3in	2in	1in	33p	13p
GB13	6in	4in	2in	52p	18p
GB14	7in	5in	2½in	63p	19p
GB15	8in	6in	3in	81p	26p
GB16	10in	7in	3in	92p	26p



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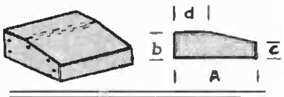
GB22	12	9	3½	2	3	£1·72	30p



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4μF	350V	14p	2,000μF	25V	39p
8μF	450V	17p	2,000μF	50V	53p
16μF	450V	18p	2,500μF	25V	45p
25μF	25V	7p	2,500μF	50V	60p
25μF	50V	10p	3,000μF	25V	48p
32μF	450V	27p	5,000μF	25V	60p
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100μF	25V	10p	8–8μF	450V	18p
100μF	50V	11p	8–16μF	450V	20p
250μF	25V	14p	16–16μF	450V	27p
250μF	50V	17p	16–32μF	450V	63p
500μF	25V	18p	32–32μF	450V	49p
500μF	50V	25p	50–50μF	350V	38p

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1μF	63V	6p	47μF	16V	7p
2·2μF	63V	6p	47μF	25V	6p
3·3μF	63V	6p	68μF	16V	6p
4·7μF	63V	6p	100μF	10V	6p
8μF	40V	7p	220μF	16V	7p
10μF	25V	6p	330μF	16V	11p
10μF	64V	7p	470μF	10V	11p
16μF	40V	7p	1,000μF	16V	19p
33μF	16V	6p	1,500μF	16V	23p

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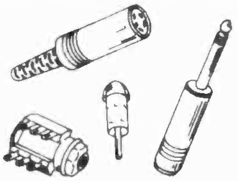
D.I.N. 5 pin, 180°	13p
D.I.N. 5 pin, 240°	15p
D.I.N. 6 pin	15p
Jack, 2½mm unscreened	9p
Jack, 2½mm screened	10p
Jack, 3½mm unscreened	8p
Jack, 3½mm screened	12p
Jack, ¼in unscreened	12p
Jack, ¼in screened	20p
Jack, stereo, unscreened	20p
Jack, stereo, screened	35p
Phono, plastic top	5p
Phono, plated metal	12p
Wander, red or black	3p
Banana 4mm, red or black	6p



LINE SOCKETS

Car aerial	14p
Co-axial	17p
D.I.N. 2 pin (speaker)	15p
D.I.N. 3 pin	16p
D.I.N. 5 pin, 180°	16p
D.I.N. 5 pin, 240°	16p
Jack, 3½mm	15p
Jack, ¼in screened	49p
Jack, stereo, screened	34p
Phono, plated metal	14p

SOCKETS

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

CAPACITORS

2·2pF	500V	S/M	7½p
3·3pF	500V	S/M	7½p
5pF	500V	S/M	7½p
10pF	125V	P.S.	5p
10pF	500V	S/M	7½p
15pF	125V	P.S.	5p
15pF	500V	Cer.	4p
18pF	500V	S/M	7½p
22pF	125V	P.S.	5p
22pF	500V	S/M	7½p
25pF	500V	S/M	7½p
27pF	500V	Cer.	4p
33pF	125V	P.S.	5p
33pF	500V	S/M	7½p
39pF	500V	S/M	7½p
47pF	125V	P.S.	5p
47pF	500V	Cer.	4p
50pF	500V	S/M	7½p
56pF	500V	S/M	7½p
68pF	125V	P.S.	5p
68pF	500V	S/M	7½p
75pF	500V	S/M	7½p
82pF	500V	S/M	7½p
100pF	125V	P.S.	5p
100pF	500V	S/M	7½p
100pF	500V	Cer.	5p
120pF	500V	S/M	7½p
150pF	125V	P.S.	5p
150pF	500V	S/M	7½p
150pF	500V	Cer.	5p
180pF	500V	S/M	7½p
200pF	500V	S/M	7½p
220pF	125V	P.S.	5p
220pF	500V	Cer.	5p
250pF	500V	S/M	8p
270pF	500V	Cer.	5p
300pF	500V	S/M	8p
330pF	125V	P.S.	5p
330pF	500V	S/M	8p
390pF	500V	S/M	8p
470pF	125V	P.S.	5p
470pF	750V	Disc	5p
500pF	500V	S/M	8p
560pF	500V	S/M	8p
680pF	125V	P.S.	6p
680pF	500V	S/M	8p
820pF	500V	S/M	8p
0·001μF	100V	Mylar	3p
0·001μF	125V	P.S.	6p
0·001μF	400V	Poly.	3p
0·001μF	500V	S/M	10p
0·001μF	500V	Cer.	5p
0·001μF	1,000V	MDC	6p
0·0015μF	400V	Poly.	3p
0·0015μF	500V	S/M	10p
0·0015μF	500V	Cer.	5p
0·0018μF	500V	S/M	10p
0·002μF	100V	Mylar	3p
0·002μF	500V	Cer.	5p
0·0022μF	125V	P.S.	6p
0·0022μF	500V	S/M	10p
0·0022μF	1,000V	MDC	6p
0·0027μF	500V	S/M	15p
0·003μF	500V	Cer.	5p
0·0033μF	125V	P.S.	6p
0·0033μF	500V	Poly.	6p
0·0033μF	1,000V	MDC	6p
0·0036μF	500V	S/M	15p
0·0047μF	125V	P.S.	9p
0·0047μF	500V	Poly.	6p
0·0047μF	500V	S/M	20p
0·0047μF	1,000V	MDC	6p
0·005μF	100V	Mylar	3p
0·005μF	500V	Cer.	5p
0·0068μF	125V	P.S.	10½p
0·0068μF	500V	S/M	30p
0·0068μF	500V	Poly.	6p
0·0082μF	125V	P.S.	10½p
0·0082μF	500V	S/M	30p
0·01μF	18V	Disc	4p
0·01μF	125V	P.S.	10½p
0·01μF	160V	Poly.	4p
0·01μF	250V	M.F.	3p
0·01μF	400V	Poly.	3p
0·01μF	500V	Cer.	5p
0·01μF	500V	S/M	30p
0·01μF	600V	MDC	7p
0·01μF	1,000V	MDC	9p
0·015μF	160V	Poly.	3p
0·015μF	400V	Poly.	3p
0·02μF	100V	Mylar	3p
0·022μF	18V	Disc	5p
0·022μF	250V	M.F.	3p
0·022μF	400V	Poly.	3p
0·022μF	600V	MDC	7½p
0·022μF	1,000V	MDC	10p
0·033μF	250V	M.F.	4p
0·033μF	400V	Poly.	4p
0·047μF	12V	Disc	6p
0·047μF	160V	Poly.	3p
0·047μF	250V	M.F.	3p
0·047μF	400V	Poly.	4p
0·047μF	600V	MDC	8p
0·047μF	1,000V	MDC	10p
0·1μF	30V	Disc	6p
0·1μF	250V	M.F.	4p
0·1μF	400V	Poly.	5p
0·1μF	600V	MDC	10p
0·1μF	1,000V	MDC	14p
0·15μF	250V	M.F.	5p
0·22μF	160V	Poly.	6p
0·22μF	250V	M.F.	5p
0·22μF	400V	Foil	10p
0·22μF	1,000V	MDC	15p
0·33μF	250V	M.F.	8p
0·47μF	250V	M.F.	8p
0·47μF	400V	Foil	15p
0·47μF	1,000V	MDC	25p
1·0μF	250V	M.F.	15p

Note:

S/M = silver mica 1% tol.

P.S. = polystyrene 2½% tol.

MDC—a.c. rating = 300V.

M.F. = Mullard min. foil.

Cer. = ceramic.

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

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ERSIN Multicore 5 CORE SOLDER

for fast, easy reliable soldering

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EASY-TO-USE DISPENSERS

Size 5 (Savbit) 18swg, 18p (illustrated)

Size 19A (60/40 alloy) 18swg. 18p

Size 15 (60/40 alloy) 22swg. 22p

BIB WIRE STRIPPER AND CUTTER

NEW!

Model 3A. Strips insulation from cable or flex without nicking wire. 4 different settings, 4&6 BA spanner ends, ground cutting edges Price 32p. Also available, de luxe Model 8. Price 58p.

From Electrical and Hardware Shops. If unobtainable, write to: Multicore Solders Ltd., Hemel Hempstead, Herts.

at all other frequencies and power levels. Transient distortion effects are claimed to be non-existent, while noise is quoted at less than 90dB below 35W.

The two models AP1 (50W per channel) and AP2 (minimum 70W per channel) are housed in decorative cylindrical cases. Prices match performance: The tuner is £70, AC1 control unit £95, AP1 £75, AP2 £90, and the excellent horn loudspeaker introduced earlier this year £89. Distribution is through appointed dealer only network.

The new AR1214 a.m./f.m. stereo receiver from Heath (Gloucester) Ltd. has an integral 15W + 15W r.m.s. power amplifier and, as in the case of the P.E. Gemini Tuner, uses two integrated circuits, two ceramic filters, a phase locked multiplex demodulator, and a pre-assembled ready aligned f.m. tuning head to provide 2μV sensitivity. The kit price is £69·80.

PRICED PERFORMANCE

Prices of equipment generally at the Fair were high when compared with the forerunners; some may be justified, others perhaps taking advantage of a booming market. It is a strange fact that the high quality goods attract some *very* high prices.

It is now not unusual to find a single unit costing more than £100 and some tuner/amplifiers combined at more than £200. One even goes as high as £775 and, when £125 is donated to Government funds in the form of purchase tax, the buyer will be asked to find £880—almost the price of a reasonably comfortable family car.

This particular model is the Marantz Model 19 f.m. stereo receiver. The Marantz demonstrator went to great pains to illustrate that all their amplifiers gave an identical sound (and so it seemed to be at Olympia); the reason for the variation in prices was said to be in the facilities offered.

Comparing this Model 19 with their a.m./f.m. stereo receiver Model 2215 at £186, an immediate difference is apparent: the 2215 has an f.m. sensitivity of 4·5mV against 1·8mV, stereo separation at 30dB against 45dB, t.h.d. and intermodulation distortion at 0·5% against 0·15%.

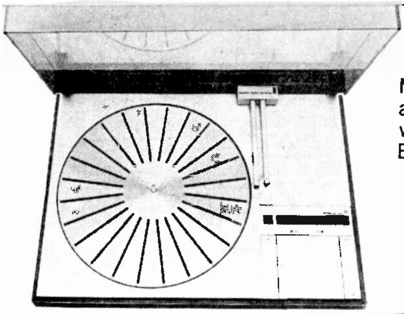
There are others, but do they really add up to nearly £600 worth of extra materials or technical expertise? They also seem to believe that users will frequently need to check amplifier performances on the built-in oscilloscope in the Model 19. Surely this should not be necessary at this price. This American company builds its equipment in Belgium and distributes in the UK through Pyser-Britex (Swift) Ltd., of Edenbridge, Kent.

By comparison with some British units the cost/performance factor of these units and the new Model 1030 and 1060 amplifiers is generally on the high side.

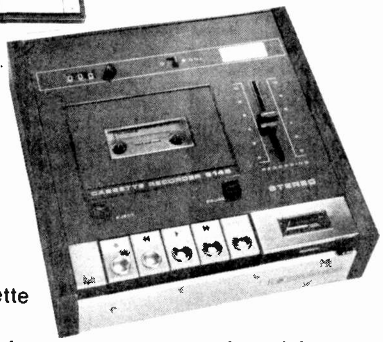
SERVO TRANSCRIPTION

One would not have thought that there was much more room for development on the transcription unit, but B & O attracted considerable attention with their Model 4000, mainly due to the electronically controlled tangential arm.

Disc cutting heads traverse the disc in a straight line along the radius by using the "lathe screw" principle of motion. The 4000 pick-up does likewise, but instead of having only one arm, it has two, one carrying a photocell which senses the presence, size, and specified playing speed of the disc.



Model 4000 tangential arm transcription unit with servo control by Bang & Olufsen



Pye 9145 stereo cassette recorder with DNL

In conjunction with a servo motor the pick-up lathe screw is driven in synchronism with the rotation of the disc, so avoiding drag friction and skating problems. Preset controls on a panel are set to feed basic data to enable correct operation to be carried out. Any error in setting up will inhibit operation.

Provided specially for this pick-up arm, the new SP15 cartridge has a sealed-in stylus which is factory fitted and tested as being the perfect match for the arm supplied. The price for the complete transcription unit is £179·50 (teak), £180·50 (rosewood), and replacement cartridges SP15 are £36·08.

IN BRIEF

Following the success of the DM1 Monitor loudspeaker system by B & W Electronics at £37·39, they have now introduced the DM4 which has greater power handling capacity and extended bass response down to 30Hz. This model sells at £49·66.

BSR have produced an eight-track stereo tape cartridge player, the TD8-3V at £27·99.

New plinth systems have been designed and produced by SME, the Model 2000, which is available in component form to suit various Thorens transcription units and SME pick-ups. Prices vary, but for a complete plinth with Perspex cover you can expect to pay in the region of £50.

Garrard (part of the Plessey organisation) have also produced plinths with Perspex lids. These "modules" are supplied complete with the transcription units for which they are made, prices ranging from £23·49 for the SP25 Mk 3 (less cartridge) to £59·07 for the Z100S (less cartridge), including purchase tax.

Philips introduced their N2510 high quality stereo cassette deck recorder for chromium dioxide tape. It has twin meters, and sleek slider and push button controls.

The well-known Philips dynamic noise limiter circuit is included in the Philips N2506 and the equivalent Pye model 9145 stereo cassette recorders costing £65.

Other less expensive items of equipment were on show, but it seems that, like most things, new products are an accepted method of attracting higher prices, but that is another subject—not for this page. ★

BOOK REVIEWS

TRANSISTOR AUDIO AND RADIO CIRCUITS

Published by Mullard
283 pages, 8½in × 5¾in. Price £1·80

THE GREAT popularity of the first edition of this excellent book published in 1969 has led Mullard to update and augment the information, and present it in a second edition. The appeal of the first edition must be attributed to the wealth of useful and really practical circuits presented. All the circuits are of proven design and the performance figures quoted are taken from the prototypes rather than merely theoretical calculations.

In addition to the established designs for 10W and 25W amplifiers there are three new circuits for 15W, 35W, and 50W amplifiers together with a preamplifier for these circuits.

Other additions to the first edition are a radio receiver, and amplifiers using integrated circuits. There is also a new chapter on loudspeakers, which discusses choosing a suitable speaker and design features of enclosures for high quality systems.

Other sections describe tape recorders with a design for a 4W machine, a circuit for a high quality f.m. tuner, and a chapter on a.f. amplifiers for car radios. Full details of all components are given as well as suppliers for the more difficult to obtain devices. No constructional details are given although where special care needs to be taken, as in the case of stereo amplifiers, this is more than adequately discussed.

Though not designed for the beginner this is a book from which everyone can learn, and a price that anyone can afford makes this an excellent, practical, reference work.

S.R.L.

HI FI YEAR BOOK—1973

Edited by C. Sproxton
Published by IPC Electrical-Electronic Year Book Ltd.
464 pages, 8¾in × 6in. Price £1·50

A FURTHER 88 pages on top of last year's volume, packed with many more items of equipment and accessories for the audiophile. For those new to this regular work, the Hi Fi Year Book catalogues technical specifications and photographs of a wide range of domestic and studio hi fi equipment, following four introductory articles on the state of the art. The articles this year include an insight into specifications jargon, a selection of pre-recorded cassette tapes, an up to date look into quadraphony—its techniques and purpose, and a survey of loudspeaker development.

Included in the classified directory are added quadraphonic equipment, tape transport machines, decks, and players, tables on tape playing times and v.h.f. transmitters. The standard of production is well maintained, although equipment news released after September 1972 may not be included (for some of these refer to our Audio Fair report in this issue).

BEGINNERS GUIDE TO TELEVISION

By Gordon J. King
Published by Newnes-Butterworths
211 pages, 5in × 7⅝in. Price £1·60.

DOMESTIC television receivers have for long had a special kind of fascinating appeal to electronics followers, probably due to the various "tricks" in achieving a satisfactory performance with some pruned down economic circuitry. Since transistors have to a substantial extent replaced valve circuits, I was surprised to find little more than a page devoted to this aspect, but then the majority of this book is concerned with general principles rather than detailed circuit theory. In the examples of valve circuits described, only the basic timebase and pulse circuits are explained, the remainder of the excellent diagrams are mainly illustrative of methods of system operation. The photographs are also of excellent quality, although one or two would probably rate as superfluous.

It is an interesting fact that the 32-page chapter on colour television forms a useful introduction to the colour techniques used, but in the U.K. and Europe the N.T.S.C. system is really only of academic interest. If this system is worth inclusion then, for comparative discussion, so too is SECAM. PAL is the main domestic system, and is briefly described, including delay line techniques; greater detail would have enhanced the value of this book to the service engineer.

Whilst being somewhat critical of contents selection, one must compensate by complimenting the down to earth writing style and presentation of this popular author. This book is still to be recommended on this account if it suits your requirements, but beginners beware—you do need some prior knowledge of general radio and electronics theory for some parts.

M.A.C.

READER'S DIGEST REPAIR MANUAL

Published by The Reader's Digest Association
704 pages, 7¾in × 10½in. Price £6·30

THOUGH the price of this book may be somewhat discouraging, the amount of information contained within its pages is really enormous, covering everything from jewellery to caravans. All practical details are explained with the aid of a multitude of clear, "comic-strip" type drawings and the section on renovating and restoring contains some excellent colour photographs.

To elucidate further on the contents, the main areas covered are: house repairs and decoration; renovating and restoring; repairs around the home and in the garden; electrical equipment; in the garage: and a reference section giving miscellaneous information and advice.

The section on electrical repairs assumes no technical knowledge and thus only deals with "mechanical" work. The chapter on cars contains some useful information on fitting suppressors to improve radio reception.

This book is not only for the do-it-yourself man but also includes lots of information that women would find very useful, not to mention the children.

S.R.L.

THIS IS THE FIRST PAGE OF THE GREAT BI-PAK SECTION

Cut these 3 pages out and keep for reference

BRAND NEW FULLY GUARANTEED DEVICES

AC107	0·20	AD162	0·38	BC148	0·10	BD137	0·45	BF188	0·40	OC19	0·35	2G371	0·16	2N2219	0·20	2N3054	0·46	2N4059	0·10
AC113	0·20	AD161 &		BC149	0·12	BD138	0·50	BF194	0·12	OC20	0·63	2G371B	0·12	2N2220	0·22	2N3055	0·50	2N4060	0·12
AC115	0·28	AD162 (MP)		BC150	0·18	BD139	0·55	BF195	0·12	OC22	0·38	2G373	0·17	2N2221	0·20	2N3391	0·14	2N4061	0·12
AC117K	0·20		0·55	BC151	0·20	BD140	0·60	BF196	0·14	OC23	0·42	2G374	0·17	2N2222	0·20	2N3391A	0·16	2N4062	0·12
AC122	0·12	ADT140	0·50	BC152	0·17	BD155	0·80	BF197	0·14	OC24	0·56	2G377	0·30	2N2368	0·17	2N3392	0·14	2N4284	0·17
AC125	0·17	AF114	0·24	BC153	0·28	BD175	0·60	BF200	0·45	OC25	0·38	2G378	0·16	2N2369	0·14	2N3393	0·14	2N4285	0·17
AC126	0·17	AF115	0·24	BC154	0·30	BD176	0·60	BF222	0·95	OC26	0·25	2G381	0·16	2N2369A	0·14	2N3394	0·14	2N4286	0·17
AC127	0·17	AF116	0·24	BC157	0·18	BD177	0·65	BF257	0·45	OC28	0·50	2G382	0·16	2N2411	0·24	2N3395	0·17	2N4287	0·17
AC128	0·17	AF117	0·24	BC158	0·12	BD178	0·65	BF258	0·60	OC29	0·50	2G401	0·30	2N2412	0·24	2N3402	0·21	2N4288	0·17
AC132	0·14	AF118	0·35	BC159	0·12	BD179	0·70	BF259	0·85	OC35	0·42	2G414	0·30	2N2646	0·47	2N3403	0·21	2N4289	0·17
AC134	0·14	AF124	0·30	BC160	0·45	BD180	0·70	BF262	0·55	OC36	0·50	2G417	0·25	2N2711	0·21	2N3404	0·28	2N4290	0·17
AC137	0·14	AF125	0·25	BC161	0·50	BD185	0·65	BF263	0·55	OC41	0·20	2N388	0·35	2N2712	0·21	2N3405	0·42	2N4291	0·17
AC141	0·14	AF126	0·28	BC167	0·12	BD186	0·65	BF270	0·85	OC42	0·24	2N388A	0·55	2N2714	0·21	2N3414	0·15	2N4292	0·17
AC141K	0·17	AF127	0·28	BC168	0·12	BD187	0·70	BF271	0·30	OC44	0·15	2N404	0·20	2N2904	0·17	2N3415	0·15	2N4293	0·17
AC142	0·14	AF139	0·30	BC169	0·12	BD188	0·70	BF272	0·80	OC45	0·12	2N404A	0·28	2N2904A	0·21	2N3416	0·28	2N5172	0·12
AC142K	0·17	AF178	0·50	BC170	0·12	BD189	0·75	BF273	0·35	OC70	0·10	2N524	0·42	2N2905	0·21	2N3417	0·28	2N5457	0·32
AC151	0·15	AF179	0·50	BC171	0·14	BD190	0·75	BF274	0·35	OC71	0·10	2N527	0·49	2N2905A	0·21	2N3525	0·75	2N5458	0·32
AC154	0·20	AF180	0·50	BC172	0·14	BD195	0·85	BFW10	0·60	OC72	0·14	2N598	0·42	2N2906	0·15	2N3646	0·09	2N5459	0·40
AC155	0·20	AF181	0·45	BC173	0·14	BD196	0·85	BFX29	0·27	OC74	0·14	2N599	0·45	2N2906A	0·18	2N3702	0·10	2S301	0·50
AC156	0·20	AF186	0·45	BC174	0·14	BD197	0·90	BFX84	0·22	OC75	0·15	2N696	0·12	2N2907	0·20	2N3703	0·10	2S302A	0·42
AC157	0·24	AF239	0·37	BC175	0·22	BD198	0·90	BFX85	0·30	OC76	0·15	2N697	0·13	2N2907A	0·22	2N3704	0·11	2S302	0·42
AC165	0·20	AL102	0·65	BC177	0·19	BD199	0·95	BFX86	0·22	OC77	0·25	2N698	0·24	2N2923	0·14	2N3705	0·10	2S303	0·55
AC166	0·20	AL103	0·65	BC178	0·19	BD200	0·95	BFX87	0·24	OC81	0·15	2N699	0·35	2N2924	0·14	2N3706	0·09	2S304	0·70
AC167	0·20	ASY26	0·25	BC179	0·19	BD205	0·80	BFX88	0·22	OC81D	0·15	2N706	0·08	2N2925	0·14	2N3707	0·11	2S305	0·84
AC168	0·24	ASY27	0·30	BC180	0·24	BD206	0·80	BFY50	0·20	OC82	0·15	2N706A	0·09	2N2926 (G)		2N3708	0·07	2S306	0·84
AC169	0·14	ASY28	0·25	BC181	0·24	BD207	0·95	BFY51	0·20	OC82D	0·15	2N708	0·12		0·12	2N3709	0·09	2S307	0·84
AC176	0·20	ASY29	0·25	BC182	0·10	BD208	0·95	BFY52	0·20	OC83	0·20	2N711	0·30	2N2926 (Y)		2N3710	0·09	2S321	0·56
AC177	0·24	ASY50	0·25	BC182L	0·10	BDY20	1·00	BFY53	0·17	OC84	0·20	2N717	0·35		0·11	2N3711	0·09	2S322	0·42
AC178	0·28	ASY51	0·25	BC183	0·10	BF115	0·24	BPX25	0·85	OC139	0·20	2N718	0·24	2N2926 (O)		2N3819	0·28	2S322A	0·42
AC179	0·28	ASY52	0·25	BC183L	0·10	BF117	0·45	BSX19	0·15	OC140	0·20	2N718A	0·50		0·10	2N3820	0·50	2S323	0·56
AC180	0·17	ASY54	0·25	BC184	0·12	BF118	0·70	BSX20	0·15	OC169	0·25	2N726	0·28	2N2926 (R)		2N3821	0·35	2S324	0·70
AC180K	0·20	ASY55	0·25	BC184L	0 12	BF119	0·70	BSY25	0·15	OC170	0·25	2N727	0·28		0·10	2N3823	0·28	2S325	0·70
AC181	0·17	ASY56	0·25	BC186	0·28	BF121	0·45	BSY26	0·15	OC171	0·25	2N743	0·20	2N2926 (B)		2N3903	0·28	2S326	0·70
AC181K	0·20	ASY57	0·25	BC187	0·28	BF123	0·50	BSY27	0·15	OC200	0·25	2N744	0·20		0·10	2N3904	0·30	2S327	0·70
AC187	0·22	ASY58	0·25	BC207	0·11	BF125	0·45	BSY28	0·15	OC201	0·28	2N914	0·14	2N3010	0·70	2N3905	0·28	2S701	0·42
AC187K	0·20	ASZ21	0·40	BC208	0·11	BF127	0·50	BSY29	0·15	OC202	0·28	2N918	0·30	2N3011	0·14	2N3906	0·27	40361	0·40
AC188	0·22	BC107	0·09	BC209	0·12	BF152	0·55	BSY38	0·18	OC203	0·25	2N929	0·21	2N3053	0·17	2N4058	0·12	40362	0·45
AC188K	0·20	BC108	0·09	BC212L	0·11	BF153	0·45	BSY39	0·18	OC204	0·25	2N930	0·21						
ACY17	0·25	BC109	0·10	BC213L	0·11	BF154	0·45	BSY40	0·28	OC205	0·35	2N1131	0·20						
ACY18	0·20	BC113	0·10	BC214L	0·14	BF155	0·70	BSY41	0·28	OC309	0·40	2N1132	0·22						
ACY19	0·20	BC114	0·15	BC225	0·25	BF156	0·48	BSY95	0·12	P346A	0·20	2N1302	0·14						
ACY20	0·20	BC115	0·15	BC226	0·35	BF157	0·55	BSY95A	0·12	P397	0·42	2N1303	0·14						
ACY21	0·20	BC116	0·15	BCY30	0·24	BF158	0·55	Bu105	2·00	OCP71	0·43	2N1304	0·17						
ACY22	0·16	BC117	0·15	BCY31	0·26	BF159	0·60	C111E	0·50	ORP12	0·43	2N1305	0·17						
ACY27	0·18	BC118	0·10	BCY32	0·30	BF160	0·40	C400	0·30	ORP60	0·40	2N1306	0·21						
ACY28	0·19	BC119	0·30	BCY33	0·22	BF162	0·40	C407	0·25	ORP61	0·40	2N1307	0·21						
ACY29	0·35	BC120	0·80	BCY34	0·25	BF163	0·40	C424	0·20	ST140	0·12	2N1308	0·23						
ACY30	0·28	BC125	0·12	BCY70	0·14	BF164	0·40	C425	0·50	ST141	0·17	2N1309	0·23						
ACY31	0·28	BC126	0·18	BCY71	0·18	BF165	0·40	C426	0·35	TI843	0·30	2N1613	0·20						
ACY34	0·21	BC132	0·12	BCY72	0·14	BF167	0·22	C428	0·20	UT46	0·27	2N1711	0·20						
ACY35	0·21	BC134	0·18	BCZ10	0·20	BF173	0·22	C441	0·30	2G301	0·09	2N1889	0·32						
ACY36	0·28	BC135	0·12	BCZ11	0·25	BF176	0·35	C442	0·30	2G302	0·19	2N1890	0·45						
ACY40	0·17	BC136	0·15	BCZ12	0·25	BF177	0·35	C444	0·35	2G303	0·19	2N1893	0·37						
ACY41	0·18	BC137	0·15	BD121	0·60	BF178	0·30	C450	0·22	2G304	0·24	2N2147	0·72						
ACY44	0·35	BC139	0·40	BD123	0·65	BF179	0·30	MAT100	0·19	2G306	0·40	2N2148	0·57						
AD130	0·38	BC140	0·30	BD124	0·60	BF180	0·30	MAT101	0·20	2G308	0·35	2N2160	0·60						
AD140	0·48	BC141	0·30	BD131	0·50	BF181	0·30	MAT120	0·19	2G309	0·35	2N2192	0·35						
AD142	0·48	BC142	0·30	BD132	0·60	BF182	0·40	MAT121	0·20	2G339	0·20	2N2193	0·35						
AD143	0·38	BC143	0·30	BD133	0·65	BF183	0·40	MPF102	0·42	2G339A	0·16	2N2194	0·35						
AD149	0·50	BC145	0·45	BD135	0·40	BF184	0·25	MPF104	0·37	2G344	0·18	2N2217	0·22						
AD161	0·33	BC147	0·10	BD136	0·40	BF185	0·30	MPF105	0·37	2G345	0·16	2N2218	0·20						

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BA116	0·21	BYZ12	0·30	OA90	0·06
BA126	0·22	BYZ13	0·25	OA91	0·06
BA148	0·14	BYZ16	0·40	OA95	0·07
BA154	0·12	BYZ17	0·35	OA200	0·06
BA155	0·14	BYZ18	0·35	OA202	0·07
BA156	0·13	BYZ19	0·28	SD10	0·05
BY100	0·15	CG62		SD19	0·05
BY101	0·12	(Eg) OA91		IN34	0·07
BY105	0·17		0·05	1N34A	0·07
BY114	0·12	CG651		1N914	0·06
BY126	0·14	(Eq) OA70·		1N916	0·06
BY127	0·15	OA79	0·06	IN414B	0·06
BY128	0·15	OA5	0·35	IS021	0·10
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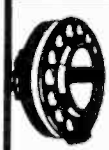

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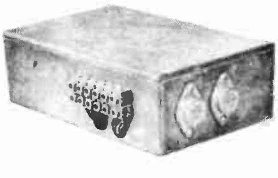

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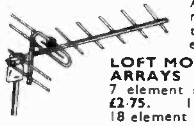

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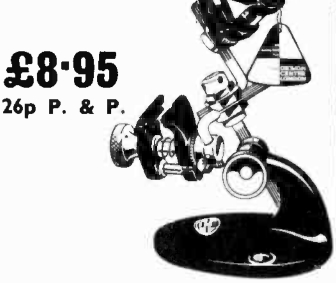

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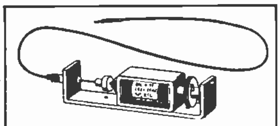

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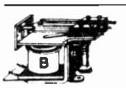

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We can now offer a vast range of Motorola IC's at industrial distributor prices.

Examples	£p	Data Sheets
MC724P	0·67	
MC790P	1·24	£0·12½
MC1303L	2·70	extra

FAIRCHILD (RTL)

	1-5	6-11	12+
L900	40p	37p	35p
L923	40p	37p	35p

Data sheet 12½p

LINEAR

Op. Amps.		1-11 £p	12-24 £p	25-99 £p
L702A	TO5	2·80	2·70	2·60
L702C	TO5	0·75	0·70	0·67
L703C	TO5	0·62	0·57	0·52
L709C	TO5	0·38	0·36	0·31
L709C	DIL	0·33	0·31	0·27
L710C	TO5	0·47	0·42	0·37
L710C	DIL	0·45	0·40	0·35
L711C	TO5	0·49	0·44	0·39
L711C	DIL	0·45	0·40	0·35
L716	TO5	1·87	1·75	1·70
L723C	TO5	0·90	0·85	0·80
L739		1·95	—	—
L741C	TO5	0·40	0·38	0·34
L741C	DIL	0·38	0·36	0·32
LM741CN	DIL	0·70	0·65	0·60
SN72700P	DIL	0·45	0·40	0·35

GENERAL ELECTRIC

	£p
PA239	2·21
PA246	1·54
PA264	1·76
PA265	1·98

TOSHIBA

20 WATT POWER PACK
TH9013P £3·50
PRE-AMP
TH9014P £1·25
Limited number only

SIEMENS

	£p
TAA151	0·88
TAA435	0·73

MULLARD LINEAR

	£p
TAA241	1·30
242	4·00
263	0·70
293	0·80
300	2·00
310	1·30
320	0·65
350	2·10
435	0·73
521	0·57
522	1·50
530	4·95
570	2·60
700	3·50
811	4·45
TAB101	0·97½
TAD100	1·97½
TAD110	1·97½

PLESSEY

	£p
SL403D	1·50
SL611C	1·70
SL621C	2·60
SL701C	1·30
SL702C	1·30

DATA SHEETS 17½p

SGS

TAA661B £1·32   TAA700 £3·50
TAA621 £2·03   TBA651 £1·69

All TTL IC's may be mixed to qualify for quantity discounts.
8 Pin TO-5 I.C. Holders, £0·25
10 Pin TO-5 I.C. Holders, £0·35
12 Pin TO-5 I.C. Holders, £0·57
8 Pin Dual-in-Line I.C. Holders, £0·20
14 Pin Dual-in-Line I.C. Holders, £0·17
16 Pin Dual-in-Line I.C. Holders, £0·20

TTL LOGICS

	1-24 £p	25-99 £p		1-24 £p	25-99 £p
SN7400	0·20	0·18	SN7422	0·48	0·42
SN7401	0·20	0·18	SN7423	0·52	0·45
SN7402	0·20	0·18	SN7425	0·48	0·42
SN7403	0·20	0·18	SN7426	0·32	0·28
SN7404	0·22	0·18	SN7427	0·48	0·42
SN7405	0·22	0·18	SN7428	0·50	0·41
SN7406	0·56	0·24	SN7430	0·20	0·18
SN7407	0·56	0·48	SN7432	0·48	0·42
SN7408	0·20	0·18	SN7433	0·71	0·62
SN7409	0·20	0·18	SN7437	0·52	0·45
SN7410	0·20	0·18	SN7438	0·52	0·45
SN7411	0·22	0·20	SN7439	0·52	0·45
SN7412	0·42	0·36	SN7440	0·20	0·18
SN7413	0·30	0·27	SN7441AN	0·75	0·72
SN7416	0·45	0·40			
SN7417	0·45	0·40	SN7442	0·79	0·63
SN7420	0·20	0·18	SN7443	1·04	0·88
SN7421	0·22	0·20	SN7444	1·04	0·88

	1-24 £p	25-99 £p		1-25 £p	25-99 £p
SN7445	1·85	1·70	SN74120	1·06	0·93
SN7446	2·00	1·60	SN74121	0·43	0·38
SN7447	1·30	1·20	SN74122	0·52	0·47
SN7448	1·04	0·92	SN74123	0·90	0·80
SN7449	Price to be announced		SN74128	0·80	0·70
			SN74141	0·90	0·80
SN7450	0·20	0·18	SN74145	0·90	0·80
SN7451	0·20	0·18	SN74150	1·19	1·05
SN7452	0·20	0·18	SN74151	1·10	0·92
SN7453	0·20	0·18	SN74153	1·18	1·00
SN7454	0·20	0·18	SN74154	1·89	1·75
SN7460	0·20	0·18	SN74155	1·55	1·35
SN7470	0·30	0·26	SN74156	1·30	1·15
SN7472	0·36	0·25	SN74157	1·30	1·15
SN7473	0·40	0·34	SN74158	1·30	1·15
SN7474	0·40	0·34	SN74160	1·80	1·70
SN7475	0·45	0·35	SN74161	2·60	2·50
SN7476	0·44	0·39	SN74162	2·60	2·50
SN7480	0·75	0·70	SN74163	3·52	3·08
SN7481	1·25	1·07	SN74164	2·26	1·64
SN7482	0·87	0·61	SN74165	4·00	3·85
SN7483	1·00	0·82	SN74166	4·25	3·72
SN7484	0·95	0·85	SN74167	6·25	6·00
SN7485	2·50	2·30	SN74170	4·18	3·90
SN7486	0·45	0·40	SN74174	2·00	1·74
SN7488	12·40	11·80	SN74175	1·35	1·17
SN7489	4·97	4·40	SN74176	1·50	1·30
SN7490	0·80	0·75	SN74177	1·30	1·10
SN7491	1·20	1·00	SN74178	1·80	1·55
SN7492	0·75	0·70	SN74179	1·80	1·55
SN7493	0·75	0·70	SN74180	1·45	1·20
SN7494	0·85	0·80	SN74181	6·50	6·15
SN7495	0·80	0·75	SN74192	1·48	1·34
SN7496	1·00	0·90	SN74190	1·95	1·75
SN7497	6·25	5·25	SN74191	1·95	1·75
SN74100	2·20	2·05	SN74192	1·90	1·80
SN74104	1·52	1·33	SN74193	1·90	1·80
SN74105	1·52	1·33	SN74194	2·00	1·80
SN74107	0·43	0·38	SN74195	2·00	1·80
SN74109	1·06	0·93	SN74196	1·60	1·38
SN74110	0·80	0·70	SN74197	1·60	1·38
SN74111	1·57	1·38	SN74198	4·00	3·75
SN74118	1·00	0·72	SN74199	4·00	3·75
SN74119	1·92	1·68			

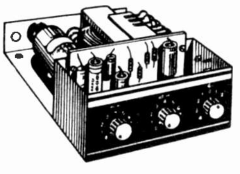
	£p		£p
SN74800N	1·10	SN74810N	1·10
SN74804N	1·32	SN74520N	1·10
SN74864N	1·10	SN74865N	1·10
SN74840N	1·28	SN748140N	1·70
SN748112N	2·86	SN748114N	2·86
SN74L00N	0·54	SN74L02N	0·60
SN74L04N	0·60	SN74L47N	2·15
SN74L85N	4·03	SN74L74N	1·02
SN74053N	1·10	SN74L93N	3·06

RCA

Type	1-24 £p	25-99 £p	Type	1-24 £p	25-99 £p
CA3000	2·28	1·88	CA3044V1	1·42	1·17
CA3001	3·38	2·79	CA3045	1·50	1·08
CA3002	2·26	1·86	CA3046	0·86	0·71
CA3004	2·26	1·86	CA3047	1·59	1·31
CA3005	1·50	1·24	CA3047A	2·92	2·41
CA3006	3·47	2·86	CA3048	2·34	1·93
CA3007	3·28	3·00	CA3049	1·96	1·62
CA3008	1·98	1·64	CA3050	2·28	1·88
CA3008A	3·24	2·67	CA4051	1·73	1·43
CA3010	0·56	0·47	CA4052	1·80	1·48
CA3010A	0·69	0·57	CA3053	0·52	0·43
CA3011	0·92	0·76	CA3054	1·19	0·98
CA3012	1·11	1·00	CA3058	3·32	2·74
CA3013	1·30	1·07	CA3059	1·84	1·52
CA3014	1·52	1·26	CA3060AD		
CA3015	1·40	1·15		3·47	2·86
CA3015A	1·82	1·50	CA3060BD		
CA3016	2·61	2·15		5·93	4·89
CA3016A	3·90	3·22	CA3060D	4·70	3·88
CA3018	0·88	0·72	CA3060E	2·74	2·26
CA3018A	1·19	0·98	CA3062	2·97	2·45
CA3019	0·94	0·78	CA3064	1·42	1·17
CA3020	1·55	1·28	CA3065	1·42	1·17
CA3020A	2·01	1·65	CA3066	2·61	2·15
CA3021	1·90	1·57	CA3067	2·72	2·24
CA3022	1·61	1·33	CA3068	3·01	2·48
CA3023	1·55	1·28	CA3070	2·15	1·78
CA3026	1·25	1·03	CA3071	2·01	1·65
CA3028A	0·88	0·72	CA3072	2·07	1·71
CA3028B	1·17	0·97	CA3075	1·46	1·21
CA3029	0·52	0·43	CA3076	1·67	1·38
CA3029A	0·63	0·52	CA3078AT	4·68	3·86
CA3030	1·08	0·89	CA3078T	2·80	2·31
CA3030A	1·64	1·35	CA3079	0·94	0·78
CA3033	2·92	2·41	CA3080	0·58	0·48
CA3033A	4·93	4·07	CA3080A	1·90	1·57
CA3035	1·52	1·09	CA3081	1·80	1·48
CA3035V1	1·52	1·26	CA3082	1·80	1·48
CA3036	0·90	0·64	CA3083	1·36	1·12
CA3037	1·68	1·39	CA3084	1·71	1·41
CA3037A	2·60	2·14	CA3085	0·94	0·78
CA3038	2·60	2·14	CA3085A	1·44	1·19
CA3038A	3·40	2·80	CA3085B	3·78	3·12
CA3039	1·00	0·91	CA3086	0·46	0·38
CA3040	2·95	2·43	CA3088E	1·38	1·51
CA3041	1·30	1·07	CA3089E	2·18	1·80
CA3042	1·30	1·07	CA3090Q	4·70	3·88
CA3043	1·73	1·43	CA3091D	6·52	5·38
CA3044	1·42	1·17	CA3093E	1·36	1·12

YES

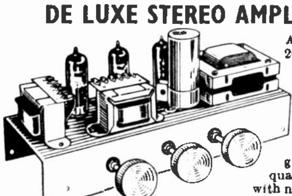
SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13W r.m.s. into 8 ohm. 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 3in high × 6in wide × 7½in deep. A.C. 200/250V.

PRICE £10·50 P. & P. 25p.

DE LUXE STEREO AMPLIFIER



A.c. mains 200–240 volts. 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 11in. w × 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. **Price £8·92.** P. & P. 45p.

NEW! POWER SUPPLY UNIT

200/240V A.C. input. Four switched fully smoothed D.C. outputs giving 6V and 7½V and 9V and 12V at 1 amp continuous (1½ amp intermittent).
Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case, overall size 6" × 3½" × 2½". Suitable for Transistor Radios, Tape Recorders, Amplifiers, etc., etc. Ready built and tested.

PRICE £4·50 P. & P. 35p.

BLACK ANODISED 16g. ALUMINIUM HEAT SINKS. For TO3, complete with mica's and bushes. Size 2½in × 3in approx. **25p** pair. P. & P. 5p.

LIMITED NUMBER! COILED SPRING BACK TELEPHONE CABLE. Closed approx. 10", extends to 36". 4 core or 6 core. **25p** each. P. & P. 5p. 5 or more post free.

SPECIAL OFFER! MAINS TRANSFORMER. 200/240V A.C. input. 35V at 1½ amp A.C. output. Overall size 2½" × 2½" × 3" approx. Suitable for drop through or vertical mounting. **90p.** P. & P. 30p.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-0-10, 20-0-20, 30-0-30V, at 2 amps full wave. Size 3inL × 3½inW × 3inD. Price **£1·85.** P. & P. 30p.

MAINS TRANSFORMER. For transistor power supplies.
Pri. 200/240V. Sec. 9–0–9 at 500mA. **85p.** P. & P. 13p.
Pri. 200/240V. Sec. 12–0–12 at 1 amp. **95p.** P. & P. 13p.
Pri. 200/240V. Sec. 10–0–10 at 2 amp. **£1·45.** P. & P. 30p.

GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER. For P.U. Tape, Mike, Guitar, etc., and suitable for use with valve or transistor equipment. 9–18V. Battery or from H.T. line 200/300V. Frequency response 15Hz–25KHz. Gain 26dB. Solid encapsulation size 1½ × 1½ × ½in. Brand new — complete with instructions. Price **88p.** P. & P. 13p.

HANDBOOK OF TRANSISTOR EQUIVALENTS and SUBSTITUTES

A must for servicemen and home constructors. Including many 1000's of British, U.S.A., European and Japanese transistors. ONLY **40p.** Post 5p.

4-SPEED RECORD PLAYER BARGAINS

Mains models. All brand new in maker's packing.
LATEST B.S.R. C109/C129 4-SPEED AUTOCHANGER. With latest mono compatible cartridge **£6·97.** Carr. 50p. With stereo cartridge **£7·97,** Carr. 50p.

SPECIAL BARGAIN OFFER!
PRECISION ENGINEERED PLINTHS

Beautifully constructed in heavy gauge "Colorcoat" plastic coated steel. Resonance free. Designed to take Garrard 1025, 2000, 2025TC, 2500, 3000, 3500, 5100, SP25 II and III, SL65B, AT60, etc., or B.S.R. C109, C129, A21, etc. Black leatherette finish. Size 12½in × 14½in × 3½in high (approx. 7½in high, including rigid smoked acrylic cover). P. & P. 35p. **NOW ONLY £4·50**

LATEST ACOS GP91/1SC Mono Compatible Cartridge with t/o stylus for LP/EP/78. Universal mounting bracket. **£1·50.** P. & P. 8p.

SONOTONE 9TAHC COMPATIBLE STEREO CARTRIDGE T/O stylus. Diamond Stereo LP and Sapphire 78. ONLY **£2·50.** P. & P. 10p. Also available fitted with twin Diamond T/O stylus for Stereo LP. **£3.** P. & P. 10p.

LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. **£1·63.** P. & P. 10p.

LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono or stereo records on mono equipment. **£1·50.** P. & P. 10p.

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. w. × 3 d. × 6 h. Ready built and tested. PRICE **£3·95.** P. & P. 40p. ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit cabinet below. PRICE **£5·25.** P. & P. 50p.

DE LUXE QUALITY PORTABLE R/P CABINET MK II
Uncut motor board size 14½ × 12in., clearance 2in. below, 5½in. above. Will take above amplifier and any B.S.R. or GARRARD changer or Single Player (except AT60 and SP25). Size 18 × 15 × 8in. PRICE **£4·75.** P. & P. 50p.

SPECIAL OFFER!!
HI-FI LOUDSPEAKER SYSTEM

Beautifully made teak finish enclosure with most attractive Tygan-Vynair front. Size 16½in high × 10½in wide × 5½" deep. Fitted with E.M.I. Ceramic Magnet 13in × 8in bass unit, two H.F. tweeter units and crossover. Power handling 10W. Available 3, 8 or 15 ohm impedance.

Our Price £8·40 Carr. 65p.

CABINET AVAILABLE SEPARATELY **£4·50.** Carr. 60p.
Also available in 8 ohm with EMI 13in × 8in. bass speaker with parasitic tweeter. **£6·50.** Carr. 65p.

LOUDSPEAKER BARGAINS
5in 3 ohm **£1·05,** P. & P. 15p. 7 × 4in 3 ohm **£1·15,** P. & P. 20p. 10 × 6in 3 or 15 ohm **£1·90,** P. & P. 30p. E.M.I. 8 × 5in 3 ohm with high flux magnet **£1·62,** P. & P. 20p. E.M.I. 13½ × 8in with high flux ceramic magnet 3, 8, or 15 ohm **£3·20.** P. & P. 30p. E.M.I. 13 × 8in, 3 or 8 or 15 ohm with two inbuilt tweeters and crossover network **£4·20.** P. & P. 30p. E.M.I. 13" × 8" twin cone (parastatic tweeter) 8 ohm **£2·25.** P. & P. 30p.

BRAND NEW. 12in 15w H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly **£6·75.** Guitar models: 25w **£6·75.** 35w **£8·50.** P. & P. 38p each.

SPECIAL OFFER!

LIMITED NUMBER OF BRAND NEW ELAC 10" TWIN CONE LOUDSPEAKERS. With large ceramic magnet and plasticised cone surround. 8 ohm impedance.

£3·75. P. & P. 25p.

12in "RA" TWIN CONE LOUDSPEAKER
10 watts peak handling. 3, 8 or 15 ohm, **£2·20.** P. & P. 30p.
35 ohm SPEAKERS 3". ONLY **63p.** P. & P. 13p.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER
Size 11½in × 14½in × 1⅛in deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz–20kHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details. Only **£5·95** each. P. & P. 25p.

VYNAIR & REXINE SPEAKERS & CABINET FABRICS app. 54 in. wide. Usually £1·75 yd., our price **75p** yd. length. P. & P. 15p per yd. (min. 1 yd.). S.A.E. for samples.

HI-FI STEREO HEADPHONES

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 **£2·95.** P. & P. 15p.

HIGH IMPEDANCE CRYSTAL STICK MIKES. OUR PRICE **£1·05.** P. & P. 8p.

CENTRE ZERO MINIATURE MOVING COIL METER. $100\mu A$ for balance or tuning. Approx. size 1in × 1in × ⅞in. Limited number **75p.** P. & P 10p.

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT

NEW FURTHER IMPROVED MODEL WITH HIGHER OUTPUT AND INCORPORATING HIGH QUALITY READY DRILLED FIBRE GLASS PRINTED CIRCUIT BOARD WITH COMPONENT IDENTIFICATION CLEARLY MARKED FOR EVEN EASIER CONSTRUCTION

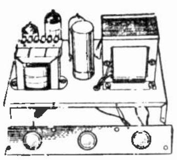
A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. (Very simple to modify to suit magnetic cartridge—instructions included). Output stage for any speakers from 5 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled fibre glass printed circuit board, 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 specification: Power output 14W r.m.s. per channel into 5 ohms. Frequency response ± 3dB 12–30,000Hz. Sensitivity better than 80mV into 1MΩ. Full power bandwidth ± 3dB 12–15,000Hz. 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" wide × 8" deep × 2½" high.
Fully detailed 7-page construction manual and parts list free with kit or send 18p plus large S.A.E.

PRICES AMPLIFIER KIT, **£10·50** P. & P. 15p.
(Magnetic input components 30p extra)
POWER PACK KIT, **£3** P. & P. 30p.
CABINET, **£3** P. & P 30p.

(Post Free if all units purchased at same time). Full after sales service. Also available ready built and tested, **£20·50.** 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 7½in w. × 4in. d. × 4½in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4·95.** P. & P. 35p.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **£4·10.** P. & P. 40p.

HARVERSON'S SUPER MONO AMPLIFIER

A super quality gram amplifier using a double wound fully isolated mains transformer, rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3·5 watts. Volume and tone controls. Chassis size only 7in. wide × 3in. deep × 6in. high overall. AC mains 200/240V. Supplied absolutely Brand New, completely wired and tested with good quality output transformer.

OUR ROCK BOTTOM BARGAIN PRICE £2·75 P. & P. 35p

10/14 WATT HI-FI AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3–15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 13p (Free with parts). **All parts sold separately.** ONLY **£7·97.** P. & P. 55p.

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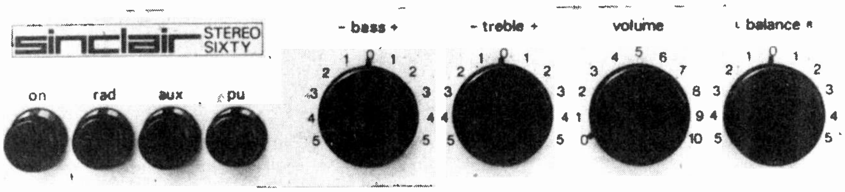
Sinclair Project 60

Stereo 60



Built and tested post free
£9.98

pre-amplifier/control unit

The versatility of Project 60 high-fidelity modules is well demonstrated in this excellent unit. It provides the facilities essential to good stereo and will enhance the quality of any system it is used with, whether Project 60 or any any other top line power amplifiers. Compact, yet robustly constructed, the unit is easily panel mounted and will operate satisfactorily from 18 to 35 volts supply. Silicon epitaxial transistors are used throughout to achieve a very high signal to noise ratio with excellent separation between channels. Distortion at maximum output is barely 0·02% with magnetic p.u. input. Accurate equalisation is provided for all inputs, which are selected by push buttons. For maximum effectiveness, the Sinclair A.F.U. is recommended for use with the Stereo 60 pre-amp/control unit. A comprehensive manual supplied with Project 60 modules makes installing and connecting easy and ensures best possible results from your system.

SPECIFICATIONS

Input sensitivities: Radio – up to 3mV. Mag. p.u. 3mV correct to R.I.A.A. curve ±1dB, 20 to 25,000 Hz. Ceramic p.u. – up to 3mV; Aux – up to 3mV. **Output:** 250mV

Signal to noise ratio: better than 70dB.

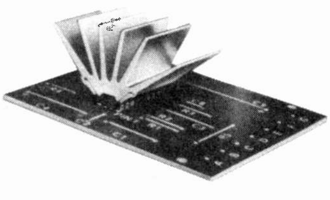
Channel matching: within 1dB.

Tone controls: TREBLE ±12 to —12dB at 10KHz; BASS +12 to —12dB at 100Hz.

Front panel: brushed aluminium with black knobs and controls.

Size: 66 × 40 × 207mm.

Super IC.12 Integrated circuit high fidelity amplifier



Having introduced Integrated Circuits to hi-fi constructors with the IC.10, the first time an IC had ever been made available for such purposes, we have followed it with an even more efficient version, the Super IC.12, a most exciting advance over our original unit. This needs very few external resistors and capacitors to make an astonishingly good high fidelity amplifier for use with pick-up, F.M. radio or small P.A. set up, etc. The free 40 page manual supplied, details many other applications which this remarkable IC. make possible. It is the equivalent of a 22 transistor circuit contained within a 16 lead DIL package, and the finned heat sink is sufficient for all requirements. The Super IC.12 is compatible with Project 60 modules which would be used with the Z.50 and Z.30 amplifiers. Complete with free manual and printed circuit board.

SPECIFICATIONS

Output power: 6 watts RMS continuous (12 watts peak). 6–8Ω. **Frequency Response:** 5Hz to 100KHz±1dB. **Total Harmonic Distortion:** Less than 1%. (Typical 0·1%) at all output powers and frequencies in the audio band (28V). **Load Impedance:** 3 to 15 ohms. **Input Impedance:** 250 Kohms nominal. **Power Gain:** 90dB (1,000,000,000 times) after feedback. **Supply Voltage:** 6 to 28V. **Quiescent current:** 8mA at 28V. **Size:** 22 × 45 × 28mm including pins and heat sink..

Manual available separately 15p post free.

With FREE printed circuit board and 40 page manual.
£2.98 Post free

Project 605

The easy way to buy and build Project 60

Project 605 is one pack containing: one PZ5, two Z30's, one Stereo 60 and one Masterlink. This new module contains all the input sockets and output components needed together with all necessary leads cut to length and fitted with neat little clips to plug straight on to the modules. Thus all soldering and hunting for the odd part is eliminated. You will be able to add further Project 60 modules as they become available adapted to the Project 605 method of connecting.

Complete Project 605 pack with comprehensive manual, post free £29.95

Everything you need to assemble a superb 30 watt high fidelity stereo amplifier without having to solder.

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RESISTORS
½W Iskra high stability carbon film—very low noise—capless construction.
⅓W Mullard CR25 carbon film—very small body size 7·5 x 2·5mm.
¼W 2% ELECTROSIL TR5

Power watts	Tolerance	Range	Values available	Price 1–99	Price 100+
½	5%	4·7Ω–2·2MΩ	E24	1p	0·8p
½	10%	3·3MΩ–10MΩ	E12	1p	0·8p
¼	2%	10Ω–1MΩ	E24	3·5p	3p
½	10%	1Ω– 3·9Ω	E12	1p	0·8p
1	5%	4·7Ω–1MΩ	E12	1p	0·8p
4	10%	1Ω–10Ω	E12	6p	5·5p

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

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

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

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

TRANSISTORS

AC107	15p	AF125	20p	BD132	75p	OC28	50p	2N3702	13p
AC126	12p	AF126	20p	BD133	75p	OC35	50p	2N3703	12p
AC127	12p	AF127	20p	BF115	25p	OC42	12p	2N3704	13p
AC128	12p	AF139	32p	BF173	20p	OC44	12p	2N3705	12p
AC131	12p	AF178	32p	BF177	28p	OC45	12p	2N3706	11p
AC132	12p	AF180	40p	BF178	32p	OC70	12p	2N3707	12p
AC176	12p	AF181	40p	BF179	32p	OC71	12p	2N3708	10p
AC187	22p	BC107	9p	BF180	32p	OC72	12p	2N3709	11p
AC188	22p	BC108	9p	BF181	32p	OC81	12p	2N3710	11p
AD140	50p	BC109	9p	BF194	15p	OC82D	12p	2N3711	11p
AD149	15p	BC147	13p	BF195	15p	2N2904	20p	2N4062	12p
AD161	33p	BC148	13p	BF197	15p	2N2926R	9p	40360	35p
AD162	36p	BC149	13p	BF200	32p	2N2926O	9p	40361	35p
AF114	20p	BC157	14p	BFY50	20p	2N2926Y	9p	40362	40p
AF115	20p	BC158	14p	BFY51	20p	2N2926G	10p	40408	40p
AF116	20p	BC159	14p	BFY52	20p			ZTX302	15p
AF117	20p	BC187	22p	BU105	225p	2N3054	58p	ZTX500	15p
AF117	38p	BD131	75p	OC26	45p	2N3055	60p	ZTX502	20p
AF124	22p								

ZENER DIODES
400mW 5% 3·3V to 30V, 15p.

LINEAR I.C.'s (D.I.L.)
709 40p 741, 45p
710 45p 748, 45p

DIL Socket 14 and 16 pin. 16p

DIODES
RECTIFIER

BY127	1250V	1A	12p
BZV10	800V	6A	25p
BZY13	200V	6A	20p
IN4001	50V	1A	7p
IN4004	400V	1A	8p
IN4007	1000V	1A	12p

SIGNAL

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

BRUSHED ALUMINIUM PANELS
12in × 6in = 25p; 12in × 2½in = 10p; 9in × 2in = 7p

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

THERMISTORS

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

COMPACT CASSETTES—IN PLASTIC LIBRARY BOX

C90	65p
C120	85p

MULLARD POLYESTER CAPACITORS C296 SERIES
400V: 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, 2½p. 0·0068μF, 0·01μF, 0·015μF, 0·022μF, 0·033μF, 3p. 0·047μF, 0·068μF, 0·1μF, 4p. 0·15μF, 6p. 0·22μF, 7½p. 0·33μF, 11p. 0·47μF, 13p.
160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, 3p. 0·1μF 3½p. 0·15μF 4½p. 0·22μF, 5p. 0·33μF, 6p. 0·47μF, 7½p. 0·68μF, 11p. 1·0μF, 13p.

MULLARD POLYESTER CAPACITORS C280 SERIES
250V P.C. mounting: 0·01μF, 0·015μF, 0·022μF, 3p. 0·033μF, 0·047μF, 0·068μF, 3½p. 0·1μF, 4p. 0·15μF, 0·22μF, 5p. 0·33μF, 6½p. 0·47μF, 8½p. 0·68μF, 11p. 1·0μF, 13p. 1·5μF, 20p. 2·2μF, 24p.

MYLAR FILM CAPACITORS 100V
0·001μF, 0·002μF, 0·005μF, 0·01μF, 0·02μF, 2½p. 0·04μF, 0·05μF, 0·068μF, 0·1μF, 3½p.

CERAMIC DISC CAPACITORS
100pF to 10,000pF, 2p each.

ELECTROLYTIC CAPACITORS—MULLARD O15/6/7 RANGE REPLACES C426, C457 RANGES.
(μF/v) 1·0/63, 1·5/63, 2·2/63, 3·3/63, 4·7/63, 6·8/40, 10/25, 10/63, 15/16, 15/40, 15/63, 22/10, 22/25, 22/63, 33/6·3, 33/40, 47/4, 47/10, 47/25, 47/40, 47/63, 68/6·3, 68/16, 100/4, 100/10, 100/25, 100/40, 150/6·3, 150/16, 150/25, 220/4, 220/10, 220/16, 330/4, 330/10, 470/6·3, 5p each. 68/63, 150/40, 220/25, 330/16, 470/10, 680/6·3, 1,000/4, 9p. 100/63, 150/63, 220/40, 470/25, 680/16, 1,000/10, 1,500/6·3, 12p. 220/63, 470/40, 680/25, 1,000/16, 1,500/10, 2,200/6·3, 15p. 330/63, 680/40, 1,000/25, 1,500/16, 2,200/10, 3,300/6·3, 4,700/4, 18p.

SOLID TANTALUM BEAD CAPACITORS — 12p

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

ELECTROLYTIC CAPACITORS Miniature P.C. mounting — 5p each.
(μF/V): 10/12, 50/12, 100/12, 200/12, 5/25, 10/25, 25/25, 100/25.

VEROBOARD

	0·1	0·15
2½ × 3¾	22p	16p
2½ × 5	24p	24p
3¾ × 3¾	24p	24p
3¾ × 5	27p	27p
17 × 2½	75p	57½p
17 × 3¾	100p	78p
17 × 5 (plain)	—	82p
17 × 3¾ (plain)	—	60p
17 × 2½ (plain)	—	42p
2½ × 5 (plain)	—	12p
2½ × 3¾ (plain)	—	11p
Pin insertion tool	52p	52p
Spot face cutter	42p	42p
Pkt. 50 pins	20p	20p

JACK PLUGS AND SOCKETS

Standard screened	18p	2·5mm insulated	8p
Standard insulated	12p	3·5mm insulated	8p
Stereo screened	35p	3·5mm screened	13p
Standard socket	15p	2·5mm socket	8p
Stereo socket	18p	3·5mm socket	8p

D.I.N. PLUGS AND SOCKETS
2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin
Plug 12p. Socket 8p.
4 way screened cable, 15p/metre.
6 way screened cable 22p/metre.

BATTERY ELIMINATOR — £1·50
9V mains power supply. Same size as PP9 battery.

LARGE (CAN) ELECTROLYTICS

1600μF	64V	74p	2600μF	64V	80p	4500μF	16V	50p
2500μF	40V	74p	2800μF	100V	£3·00	4500μF	25V	£1·68
2500μF	50V	58p	3200μF	16V	50p	5000μF	50V	£1·10

HIGH VOLTAGE TUBULAR CAPACITORS—1,000 VOLT

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

POLYSTYRENE CAPACITORS 160V 2½%
10pF to 1,000pF E12 Series Values 4p each.

SMOKE AND COMBUSTIBLE GAS DETECTOR—GD1 — £2
The GD1 is the worlds first semiconductor that can convert a concentration of gas or smoke into an electrical signal. The sensor decreases its electrical resistance when it absorbs deoxidizing or combustible gases such as hydrogen, carbon monoxide, methane, propane, alcohol, North Sea gas, as well as carbon-dust containing air or smoke. This decrease is usually large enough to be utilized without amplification. Full details and circuits are supplied with each detector.

PRINTED BOARD MARKER — 97p
Draw the planned circuit onto a copper laminate board with the P.C. Pen, allow to dry, and immerse the board in the etchant. On removal the circuit remains in high relief.

OIL WHEEL PROJECTOR

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Suitable for mounting on virtually all slide projectors. Kit contains: ★ 6" dia. multi-coloured oil wheel. ★ 1 rpm miniature geared mains motor (available separately 80p). ★ Full instructions.

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Circuit incorporates mixer, oscillator, i.f. amplifier, a.g.c. and audio pre-amp stage.

PLUS

Suitable 470 kHz ceramic resonator. Complete with circuit for L.W./M.W. Receiver.

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19" Tube £125 — 25" Tube £160

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Carr. + ins. £2·50. Famous make D/S chassis—Thoroughly overhauled—Fitted with "Square Screen" tube—Transistorised "Push Button" tuner—Fitted in an attractive cabinet, refinished in a choice of teak, walnut, or mahogany veneers (state 1st and 2nd choice)

12 month written guarantee with every set—Leaflet and copy guarantee sent on receipt of your stamped, self addressed envelope.

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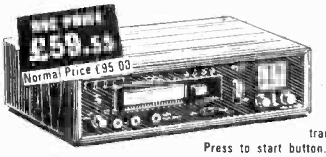
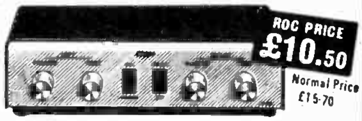


8-TRACK STEREO CARTRIDGE TAPE DECK MODEL RP-1000ST
The popular Lear-Jet type recording unit is the heart of the fantastic RP-1000ST, which has full record and playback facilities. Automatic track change with manual over-ride. Press to start button. Stereo headphone and Left and Right Mic sockets on front panel. Dual recording level meter, and Left and Right volume controls. Built-in pre-amp. Tape speed 3¾ ips (9·5 cms). Frequency response: playback 30-10,000 Hz; recording/playback 30-8,000 Hz. Line output: fully variable 0-500mV. The RP-1000ST incorporates all the features you'd expect on a top quality Cartridge Tape Deck. Size 16" wide, 4" high, 9" deep. Cabinet in walnut. Including connecting leads.

A-3000 36-WATT SOLID STATE STEREO AMPLIFIER
The A-3000 looks as good as it sounds! Giving you a big performance this superb audio amplifier has a full range of facilities on the front and rear panels. On the front – all the controls you're ever likely to need plus a headphone socket. On the rear – signal inputs, speaker outputs and a line fuse for circuit protection.
Specifications: 18 watts rms per channel into 8 ohms. Frequency response 20-35,000 Hz (± 2db) Inputs Magnetic, Ceramic, Tuner, Tape, Aux, Tape Play. Size: 345mm × 300mm × 130mm.



OLSON AM400 4-WATT STEREO AMPLIFIER
Here's marvellous value for someone just starting to set themselves up in audio! At only £10·50, you get a fine amplifier in a scratch resistant metal cabinet, with a smart brushed aluminium front panel. It incorporates separate tone and volume controls for each channel. Inputs are provided for turntable (ceramic cartridge), tuner and tape deck or recorder. Frequency response: 70-20,000 Hz ± 3dB. Output: 2 watts r.m.s. per channel into 8 ohms. Inputs: phono 80mV; tuner/aux 80mV. Size 8" wide, 2½" high, 4½" wide.

25-WATT 3-WAY CRYSLER 'LIVING AUDIO' SPEAKER CE-5b
This high quality speaker has its own built-in 3-way sound response switch, giving you the ideal frequency response for hi-fi, natural or mood music listening. Its beautiful, heavy, oiled walnut cabinet incorporates two separate speaker units an 8" woofer, and a 5" mid-range with 2" concentric tweeter. Power handling capacity: 25 watts r.m.s. into 8 ohms. Overall frequency response: 35-20,000 Hz. Cabinet size: 10½" × 7½" × 8¾". Exactly right for matching the most modern decor.

REALISTIC 30 WATT STEREO AMPLIFIER MODEL SA-500
A superb hi-fi amplifier with all the features you've ever wanted – for under £46·00. Saving over £10·00 on the normal retail value. Up-to-the-minute slider controls for bass and treble. Separate volume and balance controls. Headphone socket on front panel. Push-button input controls – magnetic phono (high/low) tuner, aux, mono, monitor. Loudness push-button control for perfect sound at low output levels. Left and right push-button on/off switches for speakers. Noise filtering and tape monitoring facilities. Two auxiliary AC outlets. Frequency response 20-20,000 Hz ± 1 db at full power. 15 watts rms per channel. Walnut cabinet with satin aluminium trims. Inputs: phono 2·5mV and 5mV RIAA; tuner/aux 250mV. Hum and noise: phono – 50db; tuner/aux – 65db. How's that for a specification! Size 14¾" wide, 3½" high, 10½" deep.

OLSON RA-310 AM/FM/MPX STEREO TUNER
This ROC Tuner is especially designed to match the Olson AM-395 Stereo Amplifier. In price and value, as well as it's good looking design! But of course it's also ideal for use with any other amplifier. The RA-310 costs £10·00 less than the normal retail value, and yet it is a highly sophisticated unit, incorporating the latest solid state techniques. Operation is drift free for supreme station-holding capability. You can connect this Tuner to a stereo amplifier, to a tape deck or a tape recorder. And of course it covers all the stations in the AM and FM bands. FM: 87-108 MHz; AM: 525-1605 kHz. FM Sensitivities: FM, 3μV; AM, 250μV. Stereo separation 30dB at 1kHz, image rejection 60dB. Size: 11$\frac{1}{16}$" wide, 4" high, 7½" deep.

REALISTIC SA-100B 6-WATT STEREO AMPLIFIER
Here's fabulous, exciting value in miniature! This high quality stereo amplifier measures only 9" wide × 3" high × 5¾" deep. And yet it has separate ganged volume, balance and tone controls. Plus speaker in/out, mono/stereo, phono/tuner and power on/off slide switches. The ends are oiled walnut, with matching enamelled metal top. The front panel is satin aluminium and walnut-brown enamel. Frequency response is 50 to 10,000 Hz ± 3dB. Output 3 watts r.m.s. per channel into 8 ohms. Inputs are 100mV for both phono and tuner.

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Complete with solar cell
£2·50

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Build a radio, morse key, etc.
£3·50

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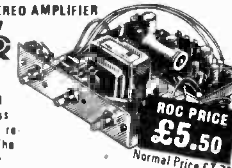
20 ways of harnessing the sun's energy
£4·50

TWO OCTAVE ELECTRONIC ORGAN KIT
Make your own music. Complete with speaker
£4·50

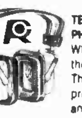
LIMITED STOCKS BUY NOW FOR XMAS!

PALACE AM/FM/MPX STEREO TUNER AMPLIFIER SSA-18
This is one of the lowest priced stero tuner amplifiers on the market. It covers the full range of both AM and FM broadcast frequencies. And when you're switched to FM, an indicator lights up when a stereo signal is received – that's the time to switch to 'Stereo'! The SSA-18 has all the facilities you'd expect to find on tuners costing twice as much – separate volume, bass, treble, balance and tuning controls. Selector switch for tape, phono, AM, FM, stereo. Jack socket on front panel for stereo headphones. Frequency range: FM 88-108 MHz. AM 535-1605 kHz. Frequency response: 50-10,000 Hz ± 3dB. Power output: 4 watts total music power into two 8 ohm speakers. Size: 16" wide, 4½" high, 8" deep.

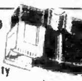
ROC 7-WATT STEREO AMPLIFIER CHASSIS SK-317
This exclusive R O C Stereo Chassis is completely self-contained, and it costs £2·25 less than the normal retail value! The SK-317 is a really compact unit measuring only 5½" wide, 1¾" high and 6¾" deep. It contains its own mains power supply, and has a ganged volume control and separate treble controls for each channel. Specification: frequency response 40-17,000 Hz ± 3dB; output 3·5 watts music power per channel into 8 ohms; input, phono, 600mV; signal-to-noise ratio better than 45dB.



SPECIAL OFFER!



TEC HR-007 HEADPHONE RADIO
When you want to listen to the radio all by yourself! Then this will solve the problem. Separate volume and tuning controls with easy-to-use knobs. Frequency range is 535 to 1605 kHz medium wave band. Maximum output is 300 mW.
Normal Price £7.65 **ROC PRICE £5.00**



EAGLE LC.07 STEREO MOVING-MAGNET CARTRIDGE
Here's your opportunity to own a transcription cartridge for the price of a ceramic! It's specially designed to match top quality tone arms, and to get the very best from your hi-fi amplifier. 0·7 mil diamond stylus. Output: 7mV per channel. Frequency range: 20-21,000 Hz. Channel balance: ± 1dB. Channel separation: 28dB. Compliance: 12 × 10-6 cm/dyne
ROC PRICE £6.37

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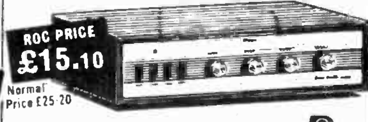

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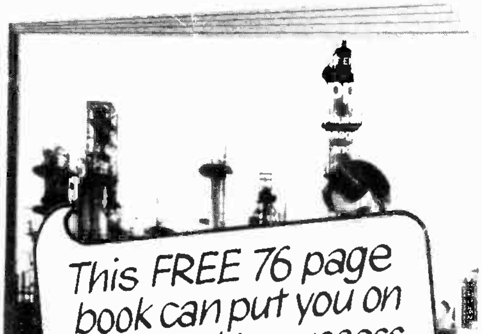

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