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Philips N2000	£10 50 A
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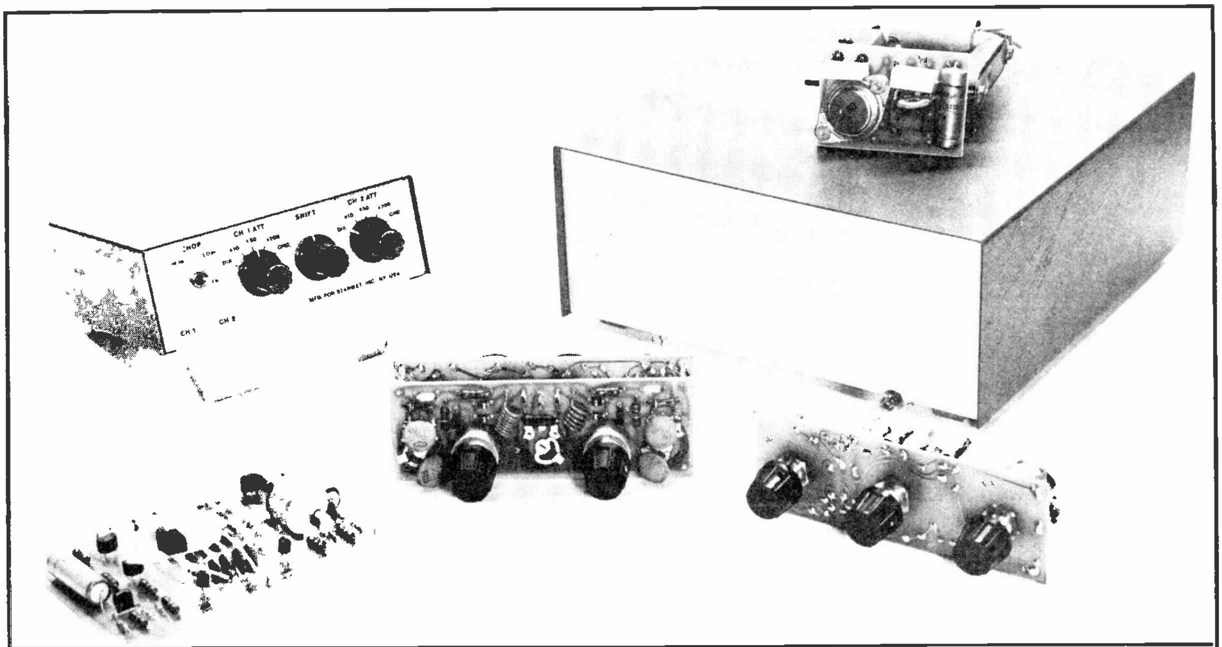

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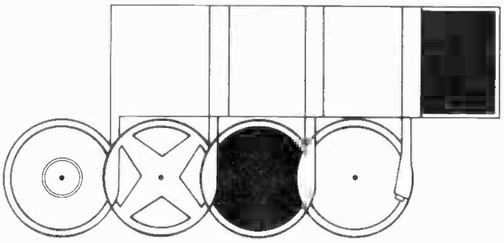

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Fantastic **2-in-1** **PERSONAL PORTABLE and CAR RADIO**

NOW WORLD WIDE RECEPTION

IN YOUR CAR TOO! (RUNS OFF 12v. CAR BATTERY)

Position it for CAR RADIO, results will justify! OR detach & use carry handle for PORTABLE with its own batteries!

4 WAVEBAND VHF AM/FM/ LONG & SHORT WAVEBANDS

FANTASTIC PRICE **£9·95** BOX, POST ETC. 45p.

TRY AND MATCH IT FOR UNDER £35!

FANTASTIC! Brand spanking new from East Europe — we bring you this incredible 2-in-1 Radio! First class makers —because of our crazy price, contract stipulates **we must NOT mention name! Beautifully made.** 9 x 5 x 2¼ inches overall approx. Every up-to-date technological improvement. **15 SEMI-CONDUCTORS**: 9 Transistors. 5 Diodes and Stabiliser! **FOUR WAVE-BANDS! Yes, VHF model with AM/FM Long and Short wavebands!** Will get stations **around the world,** including Standard Long, Medium and Short Wave, also local and new stations not yet operational! Built-in internal ferrite aerial plus 5 section 26in. swivel telescopic aerial. **On/off/volume and tone controls. Clear Station Selector Dial. Waveband selector! Equally wonderful** in CAR or HOME! **TWO Tuning Dials** for flat or upright use as illustrated. **RUNS OFF 12 VOLT BATTERY! (AS A PORTABLE** it runs on standard batteries.) **PLUG IN 12 VOLT ADAPTOR JACK PROVIDED** and **automatically** cut out internal batteries, **using car battery only!** Don't you think it's miraculous? Span the Oceans and pull in hundreds of transmissions **day and night, including short wave—even in car! BUT WAIT**—simply remove Radio from car, "snap on" optional carry handle **AND YOU HAVE A DE-LUXE PORTABLE,** with additional upright tuning dial. **WRITTEN GUARANTEE. Only £9·95 box, post 45p. *Sprung all metal matching detachable carry handle** (as illus.) **+ batteries only 25p ex. if required.** Match with sets costing £35 or more. Test 7 days—refund if not delighted. **Order by post to Uxbridge Road address, or call at either store.**

COMMERCIAL TRAVELLERS NOTE: Merchandising office at Holborn Store.

THIS FANTASTIC OFFER ONLY FROM US!

SAVE £20·25 NOW!

fabulous BRAND NEW **SOLID STATE**

This equipment's got EVERYTHING!

BATTERY/MAINS AC *Combined* **V.H.F AM/FM RADIO and CASSETTE TAPE RECORDER & PLAYER**

"MAGIC EYE"

WITH REMOTE CONTROL MICROPHONE

RECOMMENDED RETAIL PRICE £44

OUR PRICE **£23·75** CARR ETC. 35p

Shopertunities "thunder" ahead with an offer that's FANTASTIC (even by our standards!) We've snapped up 500 magnificent machines. **Latest sensation in the world of sound!** First-class makers! **Fabulous VHF, AM/FM Radio AND Cassette Tape Recorder & Player combined & it also** runs off standard batteries or mains. (Simply plug in the 220/240V. AC line cord.) **Record and play back anything, anywhere! Even tape direct from the Radio as you listen! RECOMMENDED RETAIL PRICE GENUINELY £44! WE OFFER AT ALMOST HALF PRICE!** Wonderful features: **★ Press-button Keyboard Control Panel or latest MASTER SWITCH CONTROL! ★ "MAGIC EYE" Visual Battery check/recording level indicator or built-in automatic Leveller! ★ Separate ON/OFF and HI-LO volume controls! ★ Heavy duty built-in speaker! ★ Earphone** (for personal listening or "monitoring") **and extension speaker sockets! ★ Remote control microphone! ★ Built-in swivel telescopic extension aerial (24in approx.)! Magnificently made case with carry handle. (DESIGNS VARY SLIGHTLY.)** Takes standard 30, 60, 90 or 120-minute Cassette Tapes obtainable everywhere. **AND the amazing built-in full circuit VHF, AM/FM Radio** gives you superb clarity of tone, incredible station selection. Unique rotating Station Selector Dial—get all local city and regional stations in every part of the country plus B.B.C. National, VHF. Picks up dozens of foreign stations. **Fabulous in your car!** You could pay £ £ £'s more for a Car Radio or Car Cassette player ALONE! **£23·75, CARR. ETC. 35p. Complete with simple instructions, remote control microphone with on/off switch and microphone stand. WITH WRITTEN GUARANTEE.** *Send today or call at either store.* Test 7 days, refund if not delighted. **BONUS OFFER; Batteries and Cassette Tape 25p extra if required.**

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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 which comes complete with simulated teak plinth and dust 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. × 8¾in. with H.F. speaker. Max power 20 watts at 3 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.1. 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.
Send S.A.E. for fully illustrated brochure.
12 MONTH'S WRITTEN GUARANTEE.

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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UNISOUND FOR THE NEW SOUND

AT £25

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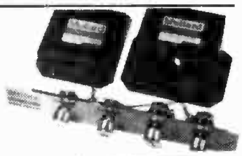
Amplifier is based on the famous Mullard Unilex system. Garrard 2025TC turntable complete with stereo ceramic cartridge, teak simulated plinth and tinted acrylic cover. Plus the big 13in. × 8in. EMI Twin-cone speakers ready for mounting in their elegant cabinets, which simply need screwing and glueing together. All glue and screws supplied.
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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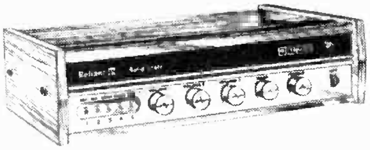
If you can solder on printed circuit board, you can build this push-button car radio kit. It's simple—just follow the step-by- step instructions.

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 loud-speaker 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 11/16 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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CONTROLS:—3 Volume controls. Bass control range: 13dB @ 60Hz. Treble control range: ± 12dB @ 15KHz. Separate ON/OFF Switch. Neon indicator. **POWER OUTPUT:**—12 Watts R.M.S. into 3 to 4 ohms speaker. **SIGNAL NOISE:**—Better than —60dB on inputs 3, 4 and 5 & —50dB on 1 & 2. **SUPPLY:**—220-250 A.C. Mains. **SIZE:**—12½in. × 6in. × 3½in.

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ALSO AVAILABLE WITH 115/120V SEC. WINDING

Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	P & P £	p
07	20	1	11	7·0 × 6·0 × 6·5	1·61	30
100	60	3	8	8·9 × 8·0 × 7·7	2·39	36
61	100	5	12	10·2 × 8·9 × 8·3	2·62	52
30	200	9	8	12·0 × 10·3 × 10·0	4·39	52
62	250	12	4	9·5 × 12·7 × 11·4	5·80	67
55	350	15	0	14·0 × 10·8 × 12·4	7·77	82
63	500	27	0	17·1 × 11·4 × 15·9	11·20	*
92	1000	40	0	17·8 × 17·1 × 21·6	20·63	*
128	2000	63	0	24·1 × 21·6 × 15·2	34·10	*

AUTO SERIES (NOT ISOLATED)

Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	Auto Taps	P & P £	p
113	20		11	7·3 × 4·3 × 4·4	0-115-210-240	0·85	22
64	75	1	14	7·0 × 6·4 × 6·0	0-115-210-240	1·66	30
4	150	3	0	8·9 × 6·4 × 7·6	0-115-200-220-240	2·00	36
66	300	6	0	10·2 × 10·2 × 9·5	,, ,,	3·89	52
67	500	12	8	14·0 × 10·2 × 11·4	,, ,,	5·78	67
84	1000	16	0	11·4 × 14·0 × 14·0	,, ,,	10·49	82
93	1500	28	9	13·5 × 14·9 × 16·5	,, ,,	15·20	*
95	2000	40	0	17·8 × 16·5 × 21·6	,, ,,	19·84	*
73	3000	45	8	17·4 × 18·1 × 21·3	,, ,,	26·99	*

TOTALLY ENCLOSED 115V AUTO TRANSFORMERS

115V 500 Watt totally enclosed auto transformer, complete with mains lead and two 115V outlet sockets, £7·87, P & P 67p.
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Ref. No.	Amps. 12V	24V	Weight lb	oz	Size cm.	Secondary Windings	P & P £	p
111	0·5	0·25		12	7·6 × 5·7 × 4·4	0-12V at 0·25A × 2	0·85	22
213	1·0	0·5	1	0	8·3 × 5·1 × 5·1	0-12V at 0·5A × 2	1·01	22
71	2	1	1	0	7·0 × 6·4 × 5·7	0-12V at 1A × 2	1·33	22
18	4	2	2	4	8·3 × 7·0 × 7·0	0-12V at 2A × 2	1·86	36
70	6	3	3	12	10·2 × 7·6 × 8·6	0-12V at 3A × 2	2·24	42
108	8	4	5	4	10·0 × 8·3 × 8·2	0-12V at 4A × 2	2·48	52
72	10	5	6	3	7·9 × 10·8 × 10·2	0-12V at 5A × 2	2·94	52
17	16	8	7	8	12·1 × 9·5 × 10·2	0-12V at 8A × 2	4·54	52
115	20	10	11	13	12·1 × 11·4 × 10·2	0-12V at 10A × 2	5·78	67
187	30	15	16	12	13·3 × 12·1 × 12·1	0-12V at 15A × 2	10·67	82
226	60	30	34	0	17·0 × 14·5 × 12·5	0-12V at 30A × 2	19·61	*

30 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
112	0·5	1	4	8·3 × 3·7 × 4·9	0-12-15-20-24-30V	1·01	22
79	1·0	2	0	7·0 × 6·4 × 6·0	,, ,,	1·35	36
3	2·0	3	2	8·9 × 7·0 × 7·6	,, ,,	2·01	36
20	3·0	4	6	10·2 × 8·9 × 8·6	,, ,,	2·48	42
21	4·0	6	0	10·2 × 10·0 × 8·6	,, ,,	2·94	52
51	5·0	6	8	12·1 × 10·0 × 8·6	,, ,,	3·66	52
117	6·0	7	8	12·1 × 10·0 × 10·2	,, ,,	4·36	52
88	8·0	10	0	14·0 × 11·7 × 10·0	,, ,,	5·64	67
89	10·0	12	2	14·0 × 10·2 × 11·4	,, ,,	7·14	67

50 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
102	0·5	1	11	7·0 × 7·0 × 5·7	0-19-25-33-40-50V	1·33	30
103	1·0	2	10	8·3 × 7·3 × 7·0	,, ,,	1·94	36
104	2·0	5	0	10·2 × 8·9 × 8·6	,, ,,	2·69	42
105	3·0	6	0	10·2 × 10·2 × 8·3	,, ,,	3·65	52
106	4·0	9	4	12·1 × 11·4 × 10·2	,, ,,	4·83	52
107	6·0	12	4	12·1 × 11·1 × 13·3	,, ,,	7·14	67
118	8·0	18	9	13·3 × 13·3 × 12·1	,, ,,	9·32	97
119	10·0	19	12	16·5 × 11·4 × 15·9	,, ,,	11·68	97

60 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
124	0·5	2	4	8·3 × 9·5 × 6·7	0-24-30-40-48-60V	1·35	36
126	1·0	3	0	8·9 × 7·6 × 7·6	,, ,,	1·88	36
127	2·0	5	6	10·2 × 8·9 × 8·6	,, ,,	2·94	42
125	3·0	8	8	11·9 × 9·5 × 10·0	,, ,,	4·48	52
123	4·0	10	6	11·4 × 9·5 × 11·4	,, ,,	5·78	67
120	6·0	16	12	13·3 × 12·1 × 12·1	,, ,,	8·37	82
122	10·0	23	2	16·5 × 12·7 × 16·5	,, ,,	13·85	*

LEAD ACID BATTERY CHARGER TYPES

Ref. No.	Amps.	Weight lb	oz	Size cm.		P & P £	p
45	1·5	1	9	7·0 × 6·0 × 6·0	Please note, these units do not include rectifiers	1·34	30
5	4·0	3	11	10·2 × 7·0 × 8·3		2·03	42
86	6·0	5	12	10·2 × 8·9 × 8·3		3·07	52
146	8·0	6	4	8·9 × 10·2 × 10·2		3·49	52
50	12·5	11	14	13·3 × 10·8 × 12·1		5·20	67

All ratings are continuous. Standard construction: open with solder tags and wax impregnation. Enclosed styles to order.

FULL SPEC. TRANSISTORS

BC107/108/109 **9·0p** each	2N 3055 **68p** each + mica and bushes	AD 161/162 **60p** pair + mica and bushes
25+ **7p**	25+ **55p**	25+ **55p**
100+ **6·5p**	100+ **45p**	100+ **50p**
500+ **6p**	500+ **40p**	500+ **45p**
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AC132	12p	BC107	7p	2N2222	13p
AC187	14p	BC108	7p	2N2222A	13p
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709C, **25p** each
723, **51p** each
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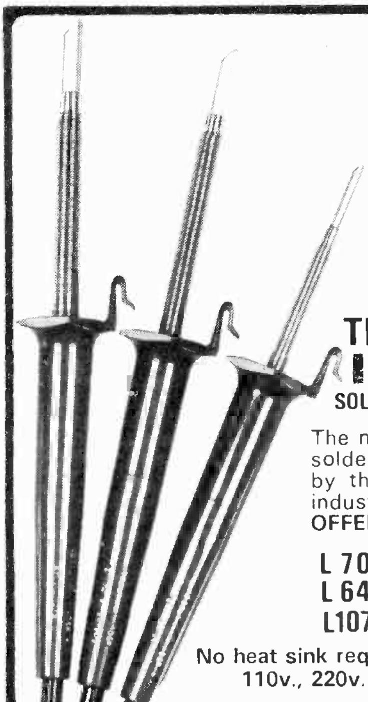

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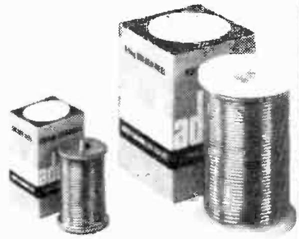

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BF274	0·20	OC25	0·25
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BSY25	0·13	OC28	0·30
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OC41	0·15	2N3055	0·40
OC44	0·13		
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OC71	0·10	AAY42	0·10
OC72	0·10	OA95	0·07
OC81	0·13	OA79	0·07
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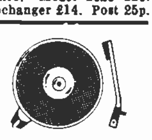

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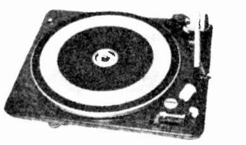

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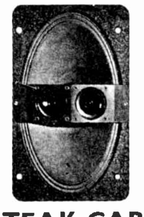

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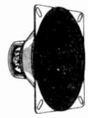

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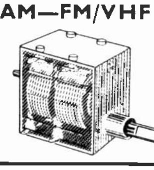

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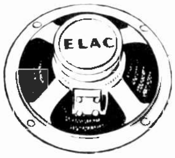
Comprising a fine example of a Woofer 10¾ × 6¼in. with a massive Ceramic Magnet, 44oz. Gauss 13,000 lines. Aluminium Cone centre to improve middle and top response. Also the E.M.I. Tweeter 3½in. square has a special lightweight paper cone and magnet flux 10,000 lines. With Crossover condenser.

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

SUITABLE ENCLOSURE 20 × 13 × 9in. MODERN TEAK DESIGN **£9** Post 25p

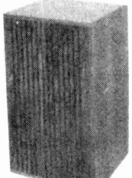


8in. or 10in. ELAC HI-FI SPEAKER

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

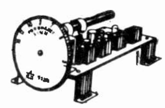


MODEL "A". 20 × 13 × 9in. For 12in. dia. or 10in. speaker. **£9** Post 25p

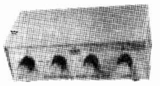
MODEL "B". 16 × 10 × 9in. For 13 × 8in. or 8in. speaker **£5** Post 25p

MODEL "C". 16 × 8 × 6in. For 10 × 6in. or 6in. speaker. **£4** Post 25p

LOUDSPEAKER CABINET WADDING 18in. wide, 15p ft

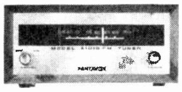


BARGAIN AM TUNER. Medium Wave. Transistor Superhet Ferrite aerial. 9 volt. **£4·50**



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

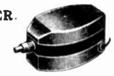
STEREO VERSION OF ABOVE £4·50.



BARGAIN FM TUNER 88-108 Mc/s Six Transistor. 9 volt. Printed circuit. Calibrated slide dial tuning. Walnut Cabinet. Size 7 × 5 × 4in. **£12·50**

BARGAIN FM TUNER as above less cabinet **£8·85**

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



THE "INSTANT" BULK TAPE ERASER & HEAD DEMAGNETISER. Suitable for cassettes, and all sizes of tape reels. A.C. mains 200/250V. Leaflet S.A.E. **£2·35** Post 15p

WAFER THIN HEATING ELEMENTS

OFFERING 1001 USES for every type of heating and drying applications in the home, garage, greenhouse, factory (available in manufacturing quantities). Approx. size 10¾ × 8½ × 1/16in. Operating voltage 200/250V. a.c. 250 watts approx. Printed circuit element enclosed in asbestos fitted with connecting wires. Completely flexible providing safe Black heat. British-made for use in photocopiers and print drying.

Ideal for home handymen and experimenters. Suitable for Heating Pads, Food Warmers, Convector Heaters, etc. Must be clamped between two sheets of metal, etc., to make efficient clothes dryers, towel rails—ideal for airing cupboards. Ideal for anti-frost device for the garage—preventing frozen radiators or acting as oil sump heater. Use in the greenhouse for seedraising and plant protection. Invaluable aid for bird houses, incubators, etc., etc. Can be used in series or parallel.

ONLY **40p** EACH (FOUR FOR £1·50)

ALL POST PAID—Discounts for quantity.

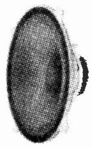
BAKER 12in MAJOR £9

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

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

BAKER "BIG-SOUND" SPEAKERS

Robustly constructed to stand up to long periods of electronic power. As used by leading groups. Useful response 30-13,000 cps. Bass Resonance 55 cps.



GROUP "25" 12in. 25 watt 3, 8 or 15 ohms. **£8** Post Free

GROUP "35" 12in. 35 watt 3, 8 or 15 ohms. **£9** Post Free

GROUP "50" 15in. 50 watt 3, 8 or 15 ohms. **£20** Post Free

BAKER 100 WATT ALL PURPOSE TRANSISTOR AMPLIFIER

4 inputs speech and music. Mixing facilities. Response 10-30,000 cps. Matches all loudspeakers. A.C. 200/250V. Separate Treble and Bass controls. Guaranteed. Details S.A.E. **£49** Post Free

CALLERS ONLY! DE-LUXE 100 WATT AMPLIFIER CHASSIS. 7 Valve version, 4 inputs, 10 wide range controls. Limited number! **£55**

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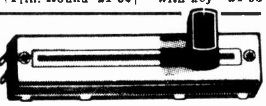
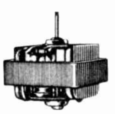
A die, punch and Allen Screw

3/8in. Round	68p	15/16in. Round	98p	Key "B" for above	8p
7/16in. Round	75p	1in. Round	98p	2in. Round	£2·05
Key "T" for above	5p	1 1/16in. Round	98p	2 3/32in. Round	£2·30
1/2in. Round	83p	1 1/8in. Round	98p	Key "C" for above	12p
9/16in. Round	83p	1 3/16in. Round	£1·05	2 1/4in. Round	£4.10
5/8in. Round	83p	1 7/32in. Round	£1·05	2 1/2in. Round	£5·25
11/16in. Round	88p	1 1/4in. Round	£1·05	3in. Round	£8·10
3/4in. Round	88p	1 5/16in. Round	£1·10	Key "E" for above	18p
13/16in. Round	90p	1 3/8in. Round	£1·10	1in. Square with key	£1·93
7/8in. Round	90p	1 1/2in. Round	£1·25		
Key "A" for above	5p	1 5/8in. Round	£1·43		
		1 3/4in. Round	£1·50		

SLIDER VOLUME CONTROLS



Available in both LOG and LINEAR type. Size 3 7/8 × 3/8 × 5/8in. with knobs. 5K, 10K, 25K, 50K, 100K, 250K, 500K, 1 MEG, 2 MEG. **65p** EACH



E.M.I. TAPE MOTORS. 120v. or 240v. AC. 1,200 r.p.m. 4 pole 135mA. Spindle 0·187 × 0·75in. Size 3½ × 2½ × 2¼in. (illustrated). Post 15p. **£1·25**

BALFOUR GRAM. MOTORS. 120v. or 240v. AC. 1,200 r.p.m. 4 pole 50mA. Spindle ⅜ × 3/20. Size 2½ × 2¼ × 1½in. Post 15p **85p**

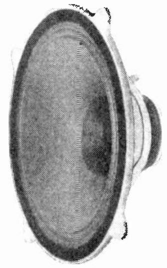
E.M.I. GRAM MOTORS. 120V or 240V a.c. 2,400 rpm. 2-pole 70mA. Spindle ⅜ × 3/16in. Size 2⅞ × 2½ × 2 3/16in. **75p** Post 15p

BAKER HI-FI SPEAKERS

HIGH QUALITY — BRITISH MADE

REGENT

12in. 15 watts



An inexpensive unit for the beginner in high fidelity and for general purposes. May be used to advantage with any Radio, Amplifier or Television receiver.

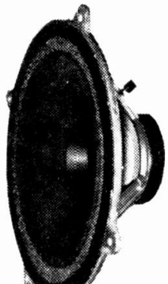
Bass Resonance	45cps
Flux Density	12,000gauss
Useful response	45-13,000cps

3 or 8 or 15 ohm models

£8 Post Free

DE-LUXE Mk II

12in. 15 watts



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

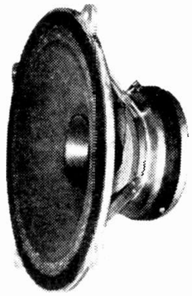
Bass Resonance	30cps
Flux Density	14,000gauss
Useful response	25-16,000cps

8 or 15 ohms models

£10 Post Free

SUPERB

12in. 20 watts



A high quality loudspeaker, its remarkable low cone resonance ensures clear reproduction of the deepest bass. Fitted with a special copper drive and concentric tweeter cone resulting in full range reproduction with remarkable efficiency in the upper register.

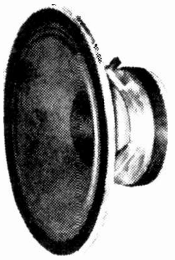
Bass Resonance	25cps
Flux Density	16,500gauss
Useful response	20-17,000cps

8 or 15 ohms models

£15 Post Free

AUDITORIUM

12in. 25 watts



A full range reproducer for high power. Electronic Guitars, public address, multispeaker systems, electronic organs. Ideal for Hi-Fi and Discotheques.

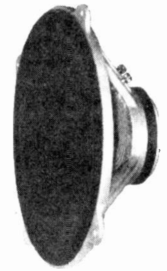
Bass Resonance	35cps
Flux Density	15,000gauss
Useful response	25-16,000cps

8 or 15 ohms models

£14 Post Free

AUDITORIUM

15in. 35 watts



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

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

8 or 15 ohms models

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Hi-Fi Enclosure Manual containing 20 plans, crossover data and cubic tables. 42p. Post Free.

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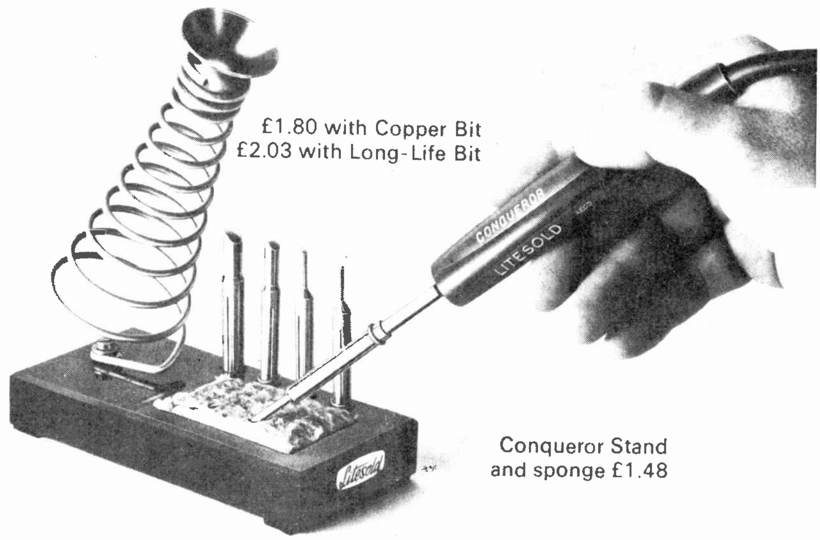

£1.80 with Copper Bit
£2.03 with Long-Life Bit

Conqueror Stand and sponge £1.48

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MULLARD POLYESTER CAPACITORS C296 SERIES
160V: (µF) 0·01, 0·015, 0·022, **2p**; 0·047, 0·068, **3p**; 0·15, 0·22, **4p**; 0·33, **5p**; 0·47, **6p**; 0·68, 1·0, **10p**.
400V: (µF) 0·001, 0·0015, 0·0022, 0·0033, 0·01, **2p**; 0·015, 0·033, **3p**; 0·068, **4p**.

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SPECIAL RESISTOR KITS (¼W 5% CARBON FILM)
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3¾ × 5in	29p	30p
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Insertion tool	54p	54p
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2 pin DIN Plug, **12p**; Socket, **10p**.
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Transistor Equivalents Book, **40p**

1N4001	6p	2N706	10p	AC127	15p
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1N4003	8p	2N1303	17p	BC108	11p
1N4004	9p	2N3055	60p	BFY51	20p
1N914	6p	2N3866	80p	OC71	12p
7400N	15p	7440N	25p	OC75	15p
7401N	15p	7470N	30p	OC83	18p
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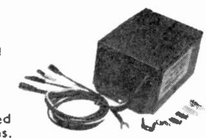

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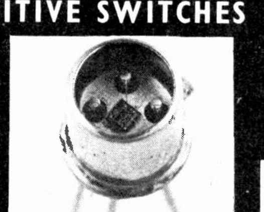

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10 TRANSISTORS. 9 TUNABLE WAVEBANDS. MW1. MW2. LW. SW1. SW2. SW3. TRAWLER BAND. VHF AND LOCAL STATIONS ALSO AIRCRAFT BAND.

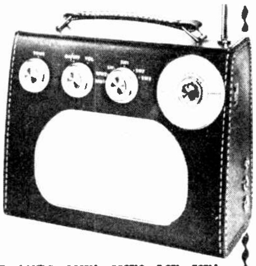
Built-in ferrite rod aerial for MW/LW. Retractable, chrome plated telescopic aerial, for peak short wave and VHF listening. Push-pull output using 600mW transistors. Car Aerial and tape record sockets. 10 transistors plus 3 diodes. Fine tone moving coil speaker. Air spaced ganged tuning condenser with VHF section. Separate coil for Aircraft Band. Volume/on/off, wave change and tone controls. Attractive case in black with silver blocking. Size 9in × 7in × 4in.

Easy to follow instructions and diagrams. Parts price list and easy build plans 30p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

TOTAL BUILDING COSTS **£8·50**

P.P. & INS. 50p (OVERSEAS P. & P. £1)

ROAMER EIGHT Mk. I

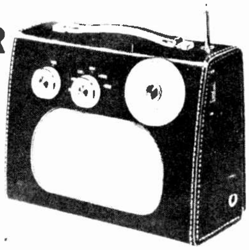


NOW WITH VARIABLE TONE CONTROL

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

TOTAL BUILDING COSTS **£6·98** P. P. & INS. 45p (OVERSEAS P. & P. £1)

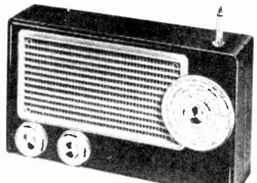
ROAMER SEVEN Mk. IV



7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND. Extra medium waveband provides easier tuning of Radio Luxembourg, etc. Built-in ferrite rod aerial for MW and LW. Retractable 4 section 24in chrome plated telescopic aerial for SW. Socket for car aerial. Powerful push-pull output. 7 transistors and 2 diodes, including micro-alloy R.F. transistors. Fine tone moving coil speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning and wave change controls. Attractive case with carrying handle. Size 9in × 7in × 4in approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 15p (FREE with parts).

TOTAL BUILDING COSTS **£5·98** P. P. & INS. 45p (OVERSEAS P. & P. £1)

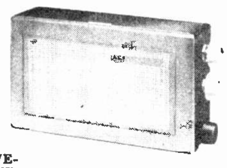
ROAMER SIX



6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, TRAWLER BAND PLUS AN EXTRA MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. Sensitive ferrite rod aerial and telescopic aerial for short waves. 3in speaker. 8 stages 6 transistors and 2 diodes including micro-alloy R.F. transistors, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9in × 5½in × 2¾in approx. Easy build plans and parts price list 15p (FREE with parts).

TOTAL BUILDING COSTS **£3·98** P. P. & INS. 30p (OVERSEAS P. & P. £1)

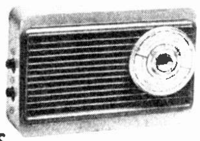
POCKET FIVE



3 TUNABLE WAVEBANDS: MW, LW, TRAWLER BAND WITH EXTENDED MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 5½in × 1¼in × 3½in. Easy build plans and parts price list 10p (FREE with parts).

TOTAL BUILDING COSTS **£2·29** P. P. & INS. 21p (OVERSEAS P. & P. 63p)

TRANSONA FIVE

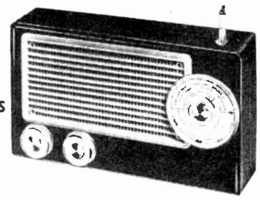


5 TRANSISTORS AND 2 DIODES

3 TUNABLE WAVE BANDS: MW, LW AND TRAWLER BAND. 7 stage 5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker. Attractive case with red speaker grille. Size 6½in × 4½in × 1½in. Easy build plans and parts price list 10p (FREE with parts).

TOTAL BUILDING COSTS **£2·50** P. P. & INS. 24p (OVERSEAS P. & P. 63p)

TRANS EIGHT



8 TRANSISTORS AND 3 DIODES

6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, SW3 AND TRAWLER BAND. Sensitive ferrite rod aerial for MW and LW. Telescopic aerial for short waves. 3in speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9in × 5½in × 2½in approx. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and easy build plans 25p (FREE with parts).

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AAZ13	10p	BC143	23p	BF185	20p	OA202	10p
AC107	34p	BC147	12p	BF194	15p	OAZ223	45p
AC126	25p	BC148	10p	BF195	15p	OAZ230	45p
AC127	25p	BC149	12p	BF196	15p	OC28	65p
AC128	25p	BC152	20p	BF197	15p	OC35	50p
AC141K	25p	BC153	20p	BF200	35p	OC36	65p
AC142K	18p	BC157	15p	BF222	30p	OC44	15p
AC153	25p	BC158	12p	BF224J	15p	OC45	15p
AC153K	22p	BC159	15p	BF256L	30p	OC70	15p
AC175K	36p	BC170	15p	BF256LC	34p	OC71	11p
AC176	25p	BC171	15p	BFS36A	37p	OC74	25p
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AF178	55p	BC250B	14p	BRC4443	90p	TIC46	40p
AF170	60p	BC261	16p	BRY39	30p	TIP29A	50p
AF239	40p	BC268	11p	E1222	40p	TIS60M/61M	37p
ASZ17	50p	BC308A	17p	E5024	40p	TIS61	20p
BA102	30p	BC317	20p	GET102	39p	TIS91	17p
BA145	15p	BCY21	96p	GET103	25p	2N404	15p
BA148	15p	BCY31	40p	IS921	8p	2N697	12p
BA154	9p	BCY42	30p	IS923	12p	2N706	9p
BA155	10p	BCY70	15p	ME0404	11p	2N708	12p
BA163	90p	BCY71	20p	ME0412	15p	2N753	10p
BAX12	12p	BCY72	15p	ME0413	12p	2N919	45p
BAW63	36p	BCY89	97p	ME0462	19p	2N920	42p
BAW65	36p	BD115	75p	ME2002	8p	2N1302	17p
BAW67	35p	BD124	80p	ME4003	12p	2N1304	21p
BB105	37p	BD131	75p	ME4102	10p	2N1306	24p
BBY20	37p	BD132	80p	ME4104	8p	2N1307	24p
BC107	10p	BD135	75p	ME6002	12p	2N1308	24p
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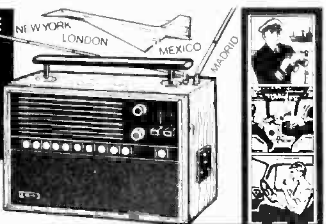

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AC113	0·20	AD161 &		BC149	0·12	BD138	0·50	BF194	0·12	OC20	0·63	2G371B	0·12	2N2220	0·22	2N3055	0·50	2N4060	0·12
AC115	0·23	AD162 (MP)		BC150	0·18	BD139	0·55	BF195	0·12	OC22	0·38	2G373	0·17	2N2221	0·20	2N3391	0·14	2N4061	0·12
AC117K	0·20		0·55	BC151	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	0·35	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	0·16	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	0·16	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	TIS43	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						

DIODES AND RECTIFIERS

AA119	0·08	BY133	0·21	OA10	0·35
AA120	0·08	BY164	0·50	OA47	0·07
AA129	0·08	BYX38/30		OA70	0·07
AAY30	0·09		0·42	OA79	0·07
AAZ13	0·10	BYZ10	0·35	OA81	0·07
BA100	0·10	BYZ11	0·30	OA85	0·09
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	IN34A	0·07
BY114	0·12	CG651		IN914	0·06
BY126	0·14	(Eq) OA70·		IN916	0·06
BY127	0·15	OA79	0·06	IN414B	0·06
BY128	0·15	OA5	0·35	IS021	0·10
BY130	0·16	OA58L	0·21	IS951	0·06

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C 3	50	Precision Resistors ·1%, ·01% mixed values	0·50
C 4	75	⅛th W Resistors mixed preferred values	0·50
C 5	5	Pieces assorted Ferrite Rods	0·50
C 6	2	Tuning Gangs, MW/LW VHF	0·50
C 7	1	Pack Wire 50 metres assorted colours	0·50
C 8	10	Reed Switches	0·50
C 9	3	Micro Switches	0·50
C10	15	Assorted Pots & Pre-Sets	0·50
C11	5	Jack Sockets 3 × 3·5m 2 × Standard Switch Types ..	0·50
C12	40	Paper Condensers preferred types mixed values ..	0·50
C13	20	Electrolytics Trans. types	0·50
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets etc. ..	0·50
C15	4	Mains Toggle Switches, 2 Amp D/P	0·50
C16	20	Assorted Tag Strips & Panels	0·50
C17	10	Assorted Control Knobs	0·50
C18	4	Rotary Wave Change Switches	0·50
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C20	4	Sheets Copper Laminate approx. 10" × 7"	0·50

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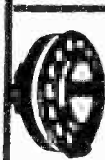

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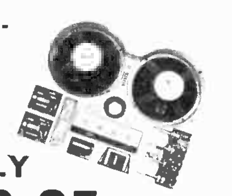

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100	0·25	0·33	0·47	0·47	0·50	0·58	0·63	1·40
200	0·35	0·37	0·49	0·49	0·57	0·61	0·75	1·60
400	0·43	0·47	0·56	0·56	0·67	0·75	0·93	1·75
600	0·53	0·57	0·68	0·68	0·77	0·97	1·25	—
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100	0·04	0·06	0·05	0·13	0·16	0·23	0·75
200	0·05	0·09	0·06	0·14	0·20	0·24	1·00
400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
600	0·07	0·16	0·10	0·25	0·34	0·45	1·86
800	0·10	0·17	0·11	0·25	0·37	0·55	2·00
1000	0·11	0·25	0·14	0·30	0·46	0·63	2·50
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T5	8 2G382T	OC82
T6	8 2G344B	OC44
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U 4	40	Germanium Transistors like OC81, AC128	0·50
U 5	60	200mA Sub-Min. Silicon Diodes	0·50
U 6	30	Sil. Planar Trans. NPN like BSY95A. 2N706	0·50
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U 8	50	Sil. Planar Diodes DO-7 Glass 250mA like OA200/202	0·50
U 9	20	Mixed Voltages, 1 Watt Zener Diodes	0·50
U10	20	BAY50 charge storage Diodes DO-7 Glass	0·50
U11	25	PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904	0·50
U12	12	Silicon Rectifiers Epoxy 500mA up to 800 PIV	0·50
U13	30	PNP-NPN Sil. Transistors OC200 & 2S 104	0·50
U14	150	Mixed Silicon and Germanium Diodes	0·50
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U18	8	6 Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	0·50
U19	25	Silicon NPN Transistors like BC108	0·50
U20	12	1·5 Amp Silicon Rectifiers Top Hat up to 1000 PIV	0·50
U21	30	AF. Germanium Alloy Transistors 2G300 Series & OC71	0·50
U23	30	MADT's like MHz Series PNP Transistors	0·50
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Code No's. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

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Q6	5	OC 72 transistors	0·50
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Q8	4	AC 126 transistors PNP	0·50
Q9	7	OC 81 type transistors	0·50
Q10	7	OC 71 type transistors	0·50
Q11	2	AC 127/128 Complementary pairs PNP/NPN	0·50
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Q13	3	AF 117 type transistors	0·50
Q14	3	OC 171 H.F. type transistors	0·50
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Q19	3	MADT'S 2 × MAT 101 & 1 × MAT 121	0·50
Q20	4	OC 44 Germanium transistors A.F.	0·50
Q21	4	AC 127 NPN Germanium transistors	0·50
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Q31	6	Silicon switch transistors 2N708 NPN	0·50
Q32	3	PNP Silicon transistors 2 × 2N1131, 1 × 2N1132	0·50
Q33	3	Silicon NPN transistors 2N1711	0·50
Q34	7	Silicon NPN transistors 2N2369, 500MHz (code P397)	0·50
Q35	3	Silicon PNP TO-5. 2 × 2N2904 & 1 × 2N2905	0·50
Q36	7	2N3646 TO-18 plastic 300 MHz NPN	0·50
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UIC02 = 12 × 7402	0·50	UIC48 = 5 × 7448	0·50	UIC91 = 5 × 7491	0·50
UIC03 = 12 × 7403	0·50	UIC50 = 12 × 7450	0·50	UIC92 = 5 × 7492	0·50
UIC04 = 12 × 7404	0·50	UIC51 = 12 × 7451	0·50	UIC93 = 5 × 7493	0·50
UIC05 = 12 × 7405	0·50	UIC53 = 12 × 7453	0·50	UIC94 = 5 × 7494	0·50
UIC06 = 8 × 7406	0·50	UIC54 = 12 × 7454	0·50	UIC95 = 5 × 7495	0·50
UIC07 = 8 × 7407	0·50	UIC60 = 12 × 7460	0·50	UIC96 = 5 × 7496	0·50
UIC10 = 12 × 7410	0·50	UIC70 = 8 × 7470	0·50	UIC100 = 5 × 74100	0·50
UIC13 = 8 × 7413	0·50	UIC72 = 8 × 7472	0·50	UIC121 = 5 × 74121	0·50
UIC20 = 12 × 7420	0·50	UIC73 = 8 × 7473	0·50	UIC141 = 5 × 74141	0·50
UIC30 = 12 × 7430	0·50	UIC74 = 8 × 7474	0·50	UIC151 = 5 × 74151	0·50
UIC40 = 12 × 7440	0·50	UIC75 = 8 × 7475	0·50	UIC154 = 5 × 74154	0·50
UIC41 = 5 × 7441	0·50	UIC76 = 8 × 7476	0·50	UIC193 = 5 × 74193	0·50
UIC42 = 5 × 7442	0·50	UIC80 = 5 × 7480	0·50	UIC199 = 5 × 74199	0·50
UIC43 = 5 × 7443	0·50	UIC81 = 5 × 7481	0·50		
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SN7409	0·18	0·17	0·16
SN7410	0·15	0·14	0·12
SN7411	0·25	0·24	0·23
SN7412	0·35	0·31	0·28
SN7413	0·29	0·26	0·24
SN7416	0·43	0·40	0·38
SN7417	0·43	0·40	0·38
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SN7425	0·50	0·48	0·45
SN7427	0·45	0·42	0·40
SN7428	0·70	0·65	0·60
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SN7442	0·67	0·64	0·58
SN7443	£1·30	£1·25	£1·20
SN7444	£1·30	£1·25	£1·20
SN7445	£1·80	£1·77	£1·75
SN7446	0·97	0·94	0·88
SN7447	£1·00	0·97	0·95
SN7448	£1·00	0·97	0·95
SN7450	0·15	0·14	0·12
SN7451	0·15	0·14	0·12
SN7453	0·15	0·14	0·12
SN7454	0·15	0·14	0·12
SN7460	0·15	0·14	0·12
SN7470	0·29	0·26	0·24

	1	25	100+
SN7472	0·29	0·26	0·24
SN7473	0·37	0·35	0·32
SN7474	0·37	0·35	0·32
SN7475	0·45	0·43	0·42
SN7476	0·40	0·39	0·38
SN7480	0·67	0·64	0·58
SN7481	£1·20	£1·15	£1·10
SN7482	0·87	0·86	0·85
SN7483	£1·10	£1·05	0·95
SN7484	£1·00	0·95	0·90
SN7485	£3·60	£3·50	£3·40
SN7486	0·32	0·31	0·30
SN7489	£5·50	£5·25	£5·00
SN7490	0·67	0·64	0·58
SN7491	£1·00	0·95	0·90
SN7492	0·67	0·64	0·58
SN7493	0·67	0·64	0·58
SN7494	0·77	0·74	0·68
SN7495	0·77	0·74	0·68
SN7496	0·87	0·84	0·78
SN74100	£1·65	£1·60	£1·55
SN74104	0·97	0·94	0·38
SN74105	0·97	0·94	0·88
SN74107	0·40	0·38	0·36
SN74110	0·55	0·53	0·50
SN74111	£1·25	£1·15	£1·10
SN74118	£1·00	0·95	0·90
SN74119	£1·35	£1·25	£1·10
SN74121	0·40	0·37	0·34
SN74122	£1·40	£1·30	£1·10
SN74123	£2·80	£2·70	£2·60
SN74141	0·67	0·64	0·58
SN74145	£1·50	£1·40	£1·30
SN74150	£3·00	£2·70	£2·50
SN74151	£1·00	0·95	0·90
SN74153	£1·20	£1·10	0·95
SN74154	£1·80	£1·70	£1·60
SN74155	£1·40	£1·30	£1·20
SN74156	£1·40	£1·30	£1·20
SN74157	£1·90	£1·80	£1·70

LINEAR I.C's—FULL SPEC.

Type No.	Price 1–24	25–99	100 up
BP 201C—SL201C	63p	58p	45p
BP701C—SL701C	63p	50p	45p
BP 702C—SL702C	63p	50p	45p
BP 702—72702	53p	45p	40p
BP709—72709	36p	34p	30p
BP 709P—µA709C	36p	34p	30p
BP 710—72710	44p	42p	40p
BP 711—µA711	45p	43p	40p
BP 741—72741	75p	60p	50p
µA703C—µA703C	28p	26p	24p
TAA 263—	70p	60p	55p
TAA 293—	90p	75p	70p
TAA 350	170p	158p	150p

S.G.S. EA1000 2·63

ROCK BOTTOM PRICES
LOGIC DTL 930 Series I.C's

Type No.	Price 1–24	25–99	100 up
BP930	12p	11p	10p
BP932	13p	12p	11p
BP933	13p	12p	11p
BP935	13p	12p	11p
BP936	13p	12p	11p
BP944	13p	12p	11p
BP945	25p	24p	22p
BP946	12p	11p	10p
BP948	25p	24p	22p
BP951	65p	60p	55p
BP962	12p	11p	10p
BP9093	40p	38p	35p
BP9094	40p	38p	35p
BP9097	40p	38p	35p
BP9099	40p	38p	35p

Devices may be mixed to qualify for quantity price. Larger quantity prices on application. (DTL 930 Series only).

NUMERICAL INDICATOR TUBES

MODEL	CD66	GR116	3015F Minitron
Anode voltage (Vdc)	170min	175min	5
Cathode Current (mA)	2·3	14	8
Numerical Height (mm)	16	13	9
Tube Height (mm)	47	32	22
Tube Diameter (mm)	19	13	12 wide
I.C. Driver Rec.	BP41 or 141	BP41 or 141	BP47
PRICE EACH	£1·70	£1·55	£1·90

All indicators 0·9 + Decimal point. All side viewing. Full data for all types available on request.

RTL MICROLOGIC CIRCUITS

Epoxy TO-5 case	Price each 1–24	25–99	100 up
uL900 Buffer	35p	33p	27p
uL914 Dual 2i/p gate	35p	33p	27p
uL923 J-K flip-flop	50p	47p	45p

Date and Circuits Booklet for IC's Price 7p.

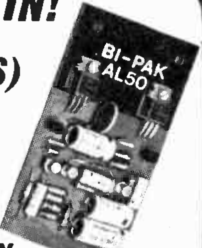
DUAL IN LINE SOCKETS.
14 & 16 Lead Sockets for use with

DUAL-IN-LINE I.C's. TWO Ranges PROFESSIONAL & NEW LOW COST.

PROF. TYPE No.	1–24	25–99	100up.
TSO 14 pin type	30p	27p	25p
TSO 16 ,, ,,	35p	32p	30p
LOW COST No.			
BPS 14	15p	13p	11p
BPS 16	16p	14p	12p

BI-PAK DO IT AGAIN!

50W pk 25w (RMS)



0·1% DISTORTION!
HI-FI AUDIO AMPLIFIER

THE AL50

★ Frequency Response 15Hz to 100,000—1dB.

★ Load—3, 4, 8 or 16 ohms.

★ Distortion—better than ·1% at 1KHz.

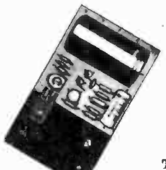
★ Signal to noise ratio 80dB.

ONLY £3.25p each

★ Supply voltage 10–35 Volts.

★ Overall size 63mm × 105mm × 13mm.

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and ALSO was conceived to fill the need for all your A.F. amplification needs.
FULLY BUILT — TESTED — GUARANTEED.



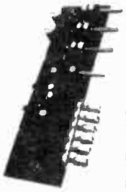
STABILISED POWER MODULE SPM80

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm × 105mm × 30mm.
These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available, 10p **PRICE £2·95**

TRANSFORMER BMT80 £1·95 p. & p. 25p.

STEREO PRE-AMPLIFIER TYPE PA100

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



SPECIFICATION

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

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

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

ONLY £11·95

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £23·00 FREE p. & p.

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BI-PAK

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Postage and packing add 7p. Overseas add extra for airmail.
Minimum order 50p. Cash with order please.

Guaranteed Satisfaction or Money Back

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.

LEAK TEAK CASES

Teak or Walnut case for Stereofetic tuner only.

LIST PRICE £7·37 LASKY'S PRICE **£2·50** C & P 25p

Double case to hold Stereo 30 or Stereo 70 and Stereofetic tuner in Teak or Walnut.

LIST PRICE £10·37 LASKY'S PRICE **£4·95** C & P 35p

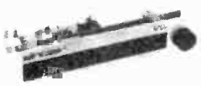
LEAK TRUSPEED

2-speed 45 and $33\frac{1}{3}$ rpm belt drive turntable complete with plinth, cover and Shure cartridge.

LIST PRICE £69·50

LASKY'S PRICE **£47·50** C & P £1·50

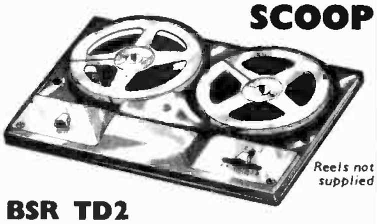
SINCLAIR PHASE LOCK LOOP STEREO FM TUNER



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.

LIST PRICE £25·00 LASKY'S PRICE **£15·75** C & P 25p

BSR TAPE DECK SCOOP



Reels not supplied

BSR TD2

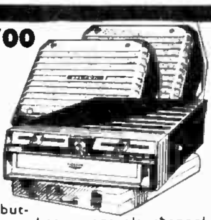
FANTASTIC VALUE, ONLY Lasky's can offer you a tape deck at such an amazing price. The BSR TD2 tape deck operates by a simple reliable mechanism using the minimum of controls.

With $\frac{1}{4}$ track mono heads. Incorporates fast wind and fast rewind, records at $3\frac{3}{4}$ ips. giving up to 3 hrs playing time, takes up to $5\frac{3}{4}$in. spools. Size 13in. $8\frac{3}{4}$in. front to rear, $2\frac{13}{16}$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 $4\frac{3}{4}$(W) × $1\frac{13}{16}$(H) × $6\frac{1}{4}$(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.

£19·75 C & P 30p

BELTEK R5310 FM TUNING ADAPTOR

Matches the C5700, the ideal car stereo system.

LASKY'S PRICE **£18·95** C & P 25p

Add £3·75 to any BELTEK car player for pair of FANTAVOX KS701 car soeakers.

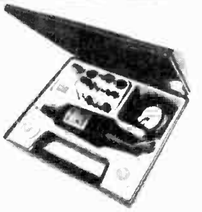
AKAI TAPE RECORDER SCOOP!

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

AKAI 4000D illustrated List Price £93·65	Lasky's Price £61·50
AKAI 1720L List Price £87·36	Lasky's Price £58·95
AKAI X1800SD List Price £162·79	Lasky's Price £111·50
AKAI X200D List Price £157·93	Lasky's Price £106·50
2 CSS-8 Speakers List Price £25·00 (pair)	Lasky's Price £15·95 C & P 50p

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.



NEW WELLER MINI WORKSHOP KIT MODEL 600K

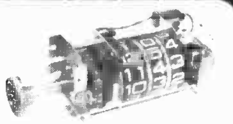
Powered by a 25,000 rpm, 115V, 75A Universal motor. This small versatile, easy to handle, power tool is ideal for handymen, hobbyists and professionals. The wide selection of bits helps you grind, sharpen, drill, rout, cut, etc. Perfect for delicate work and hard to reach places. The complete MINI-WORKSHOP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

MODEL 600K place Kit contains: ● Model 600 Power Unit ● Accessory Caddy ● 8 Grinding/Sharpening Bits ● 3 polishing Wheels ● 4 Cleaning Bits ● 8 Abrasive Discs ● 3 Abrasive Bands ● Expanding Drum ● Drill Bit ● Mandrell ● Chuck Wrench ● Dressing Stone ● Plastic polish ● Jewellers Rouge ● Complete with owners' manual ● Size of power unit only $7\frac{1}{2}$in.

LEAK SPEAKERS

150 Speakers (pair)	£38·95	C & P
250 ,, ,,	£48·95	£2·50
600 ,, ,,	£68·75	

DIGITAL CLOCK



EXCLUSIVELY FROM LASKY'S

The clock measures $5\frac{1}{4}$" (W) x $2\frac{3}{4}$" (H) x 3" (D) (over-all 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 **£6·75** C & P 25p

BSR TD8S

8 TRACK STEREO CARTRIDGE PLAYER

The TD8S is suitable for use with most modern stereo amplifiers and delivers a pre-amp output of 125mW. Power requirements: 210/250V AC, 50Hz. Frequency response: 50Hz-10KHz. 4 pole dynamically balanced synchronous motor. Black and woodgrain plastic cabinet. Size: $8\frac{1}{2}$(W) $3\frac{1}{4}$(H) $10\frac{1}{4}$ (D) in.

C & P 35p

List Price £24·20 LASKY'S PRICE **£17·95**

Garrard Record Players

SP25 Mk. III Deck Only

SP25 Mk III	£10·85
AP76	£18·75
SL95B	£32·50
SL95B on base with 9TA cart.	£44·00
SL72B	£23·95
401	£28·95
40B	£9·50
2025TC with stereo 9TA cart.	£7·95
Zero 100	£39·95
Zero 100S	£37·50

NEW RECORD PLAYER MODULES

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.

GARRARD MODULES

Garrard SP25 Mk. III turntable with Shure M75/6 cartridge	£23·95
Gerrard AP76 turntable with Shure M75/6 cartridge	£33·95
Garrard AP96 turntable (single play version of SL95B)	£38·75
Garrard Zero 100S turntable with Shure M93/E cartridge	£52·75

C. & P. 75p.

LASKY MODULES

Lasky's (Garrard) SP25 Mk. III turntable with Goldring G800 cartridge	£20·50
Lasky's (Garrard) AP76 turntable with Goldring G800 cartridge	£30·50
Lasky's (Goldring) GL75 turntable with Goldring G800 cartridge	£45·00
Lasky's (Goldring) GL75 turntable with Goldring G800/e cartridge	£49·50

C. & P. 75p.

Laskys

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NEW "SEW" DESIGNS!

CLEAR PLASTIC METERS

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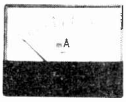
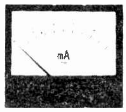
100 x 80 mm



50μA	£3·80	500μA	£3·50
50-0-50μA	£3·80	1mA	£3·40
100μA	£3·80	20V d.c.	£3·40
100-0-100μA	£3·80	50V d.c.	£3·40
		300V d.c.	£3·40
		1A d.c.	£3·40
		5A d.c.	£3·40
		300V a.c.	£3·40
		VU Meter	£4·15

BAKELITE PANEL METERS

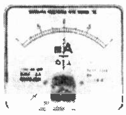
TYPE S-80
80 mm square fronts



50μA	£3·50	1A d.c.	£2·85
50-0-50μA	£3·40	5A d.c.	£2·85
100μA	£3·40	300V a.c.	£2·85
100-0-100μA	£3·30	VU Meter	£3·70
500μA	£3·05		
1mA	£2·85		
20V d.c.	£2·85		
50V d.c.	£2·85		
300V d.c.	£2·85		

"SEW" CLEAR PLASTIC METERS

Type MR.85P. 4½in · 4¾in fronts.



50μA	£3·95	50mA	£3·10
50-0-50μA	£3·40	100mA	£3·10
100μA	£3·40	500mA	£3·10
100-0-100μA	£3·30	1A	£3·10
200μA	£3·30	5A	£3·10
500μA	£3·20	15A	£3·10
500-0-500μA	£3·10	30A	£3·20
1mA	£3·10	20V d.c.	£3·10
1-0-1mA	£3·10	50V d.c.	£3·10
5mA	£3·10	150V d.c.	£3·10
10mA	£3·10	300V d.c.	£3·10
		15V a.c.	£3·10
		300V a.c.	£3·10
		S Meter 1mA	£3·15
		VU Meter	£3·95
		1A a.c.*	£3·10
		5A a.c.*	£3·10
		10A a.c.*	£3·10
		20A a.c.*	£3·10
		30A a.c.*	£3·10

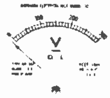
Type MR.52P. 2⅜in square fronts.

50μA	£3·40	20V d.c.	£2·20
50-0-50μA	£2·85	50V d.c.	£2·20
100μA	£2·85	300V d.c.	£2·20
100-0-100μA	£2·75	15V a.c.	£2·30
500μA	£2·55	300V a.c.	£2·30
1mA	£2·20	S Meter 1mA	£2·30
5mA	£2·20	VU Meter	£3·50
10mA	£2·20	1A a.c.*	£2·20
50mA	£2·20	5A a.c.*	£2·20
100mA	£2·20	10A a.c.*	£2·20
500mA	£2·20	20A a.c.*	£2·20
1A	£2·20	30A a.c.*	£2·20
5A	£2·20		
10V d.c.	£2·20		

Type MR.65P. 3½in · 3¼in fronts.

50μA	£3·70	20V d.c.	£2·40
50-0-50μA	£3·00	50V d.c.	£2·40
100μA	£3·00	150V d.c.	£2·40
100-0-100μA	£2.90	300V d.c.	£2·40
200μA	£2·90	15V a.c.	£2·55
500μA	£2·65	50V a.c.	£2·55
500-0-500μA	£2·40	150V a.c.	£2·55
1mA	£2·40	300V a.c.	£2·55
5mA	£2·40	500V a.c.	£2·55
10mA	£2·40	S Meter 1mA	£2·60
50mA	£2·40	VU meter	£3·70
100mA	£2·40	50mA a.c.*	£2·40
500mA	£2·40	100mA a.c.*	£2·40
1A	£2·40	200mA a.c.*	£2·40
5A	£2·40	500mA a.c.*	£2·40
10A	£2·40	1A a.c.*	£2·40
15A	£2·40	5A a.c.*	£2·40
20A	£2·40	10A a.c.*	£2·40
30A	£2·55	20A a.c.*	£2·40
50A	£2·75	30A a.c.*	£2·40
5V d.c.	£2·40		
10V d.c.	£2·40		

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



50μA	£2·30	200mA	£1·75
50-0-50μA	£2·10	300mA	£1·75
100μA	£2·10	500mA	£1·75
100-0-100μA	£1·95	750mA	£1·75
200μA	£1·95	1A	£1·75
500μA	£1·80	2A	£1·75
500-0-500μA	£1·75	5A	£1·75
1mA	£1·75	10A	£1·75
1-0-1mA	£1·75	3V d.c.	£1·75
2mA	£1·75	10V d.c.	£1·75
5mA	£1·75	15V d.c.	£1·75
10mA	£1·75	20V d.c.	£1·75
20mA	£1·75	50V d.c.	£1·75
50mA	£1·75	100V d.c.	£1·75
100mA	£1·75	150V d.c.	£1·75
150mA	£1·75	300V d.c.	£1·75
		500V d.c.	£1·75
		750V d.c.	£1·75
		15V a.c.	£1·85
		50V a.c.	£1·85
		150V a.c.	£1·85
		300V a.c.	£1·85
		500V a.c.	£1·85
		S Meter 1mA	£1·85
		VU meter	£2·30

Type MR.45P. 2in square fronts.

50μA	£2·50	10V d.c.	£1·85
50-0-50μA	£2·30	20V d.c.	£1·85
100μA	£2·30	50V d.c.	£1·85
100-0-100μA	£2·05	300V d.c.	£1·85
200μA	£2·05	15V a.c.	£2·00
500μA	£1·85	300V a.c.	£2·00
500-0-500μA	£1·85	S Meter 1mA	£2·05
1mA	£1·85	VU Meter	£2·50
5mA	£1·85	1A a.c.*	£1·85
10mA	£1·85	5A a.c.*	£1·85
50mA	£1·85	10A a.c.*	£1·85
100mA	£1·85	20A a.c.*	£1·85
500mA	£1·85	30A a.c.*	£1·85
1A	£1·85		
5A	£1·85		

"SEW" BAKELITE PANEL METERS

Type MR.65 3½in square fronts.

25μA	£3·85	1A	£2·15
50μA	£3·00	5A	£2·15
50-0-50μA	£2·60	15A	£2·15
100μA	£2·60	30A	£2·15
100-0-100μA	£2·50	50A	£2·15
500μA	£2·45	5V d.c.	£2·15
500-0-500μA	£2·15	10V d.c.	£2·15
1mA	£2·15	20V d.c.	£2·15
1-0-1mA	£2·15	50V d.c.	£2·15
5mA	£2·15	150V d.c.	£2·15
10mA	£2·15	300V d.c.	£2·15
50mA	£2·15	50mV d.c	£2·40
100mA	£2·15	100mV d.c	£2·40
500mA	£2·15	30V a.c.*	£2·20
		50V a.c.*	£2·20
		150V a.c.*	£2·20
		300V a.c.*	£2·20
		500mA a.c.*	£2·15
		1A a.c.*	£2·15
		5A a.c.*	£2·15
		10A a.c.*	£2·15
		20A a.c.*	£2·15
		30A a.c.*	£2·15
		50A a.c.*	£2·15
		VU meter	£3·40

* MOVING IRON — ALL OTHERS MOVING COIL

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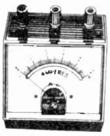
"SEW" EDUCATIONAL METERS



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

50μA	£5·50	20V d.c.	£4·85
100μA	£5·10	50V d.c.	£4·85
1mA	£4·85	300V d.c.	£4·85
50-0-50μA	£5·10	Dual range	
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10V d.c.	£4·85		

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PE.70 3 17/32in 1 15/32in 2½in deep.

50μA	£3·40	500μA	£3·05
50-0-50μA	£3·30	1mA	£2·70
100μA	£3·30	300V a.c.	£2·70
100-0-100μA	£3·20	VU meter	£3·75
200μA	£3·20		

MULTIMETERS for EVERY purpose!

MODEL LT.101 1000 O.P.V. 0/10/50/250/1000 V. D.C. 0/10/50/250/1000 V. A.C. 0/1/100 M.A. 0/150 K ohms. **£1·97.** P. & P. 15p.

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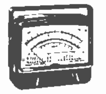
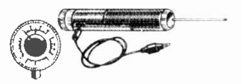


TMK LAB TESTER. 100,000 O.P.V. 6½in scale buzzer short circuit check. Sensitivity: 100,000 OPV d.c. 5/Volt a.c. D.c. volts: 0·5, 2·5, 10, 50, 250, 1,000V. A.c. volts: 3, 10, 50, 250, 500, 1,000V. D.c. current: 10, 100μA, 10, 100, 500mA, 2·5, 10A. Resistance: 1K, 10K, 100K, 10 meg, 100 meg. Decibels: −10 to +49dB. Plastic case with carrying handle. size 7½in × 6⅜in × 3⅛in. **£18·90.** 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 0–20kΩ. ONLY **£1·97.** P. & P. 13p.

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Battery operated, 11 meg input. 26 ranges. Large 4½in mirror scale. Size 5⅞in × 4⅛in × 2⅛in. D.c. volts 0·3–1,200V. A.c. volts 3–300V R.M.S. 8·0–800V P-P. D.c. current 0 12–12MA. Resistance up to 2,000M ohm. Decibels −20 to +51dB. Complete with leads/instructions. **£17·50.** P. & P. 20p.

Model S-100TR MULTIMETER TRANSISTOR TESTER
100,000 o.p.v. MIRROR SCALE OVERLOAD PROTECTION

0/·12/·6/3/12/30/120/600 VDC. 0/6/30/120/600 VAC. 0/12/600uA/12/300MA/12 AMP DC. 0/10K/1 MEG/100 MEG. −20 to +50 db. 0·01 – ·2 MFD. Transistor tester measures Alpha, Beta and Ico. Complete with batteries, instructions and leads. **£13·50.** P. & P. 25p.

TE22 SINE SQUARE WAVE AUDIO GENERATORS

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

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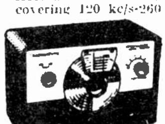
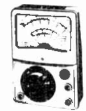
Accurate wide range signal generator covering 120 kc/s–260 Mc/s on 6 bands. Directly calibrated variable R.F. attenuator. Operation 200/240V a.c. Brand new with instructions. **£15.** P. & P. 37½p. S.A.E. for details.





HIOKI MODEL 720X 20,000 O.P.V. Overhead protection. 5/25/100/500/1000V D.C. 10/50/250/1000V A.C. 50μA/250mA. 20K/2 meg ohm. −5 to +62db. **£4·97.** P. & P. 15p.

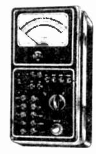
MODEL PL436. 20kΩ/Volt d.c. 8kΩ/Volt a.c. Mirror scale. 0·6/3/12/30/120/600V d.c. 3/30/120/600V a.c. 50/600μA/60/600mA. 10/100K/1 Meg/10 meg Ω. −20 to +46dB. £6·97½. P. & P. 12½p.

MODEL 5025. 57 ranges, giant 5¼in meter, polarity reverse switch. Sensitivity: 50K/Volt d.c. 5K/Volt a.c. D.c. Volts: 0·125, 0·25, 1·25, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.c. Volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.c. current: 25, 50μA, 2·5, 5, 25, 50, 250, 500mA, 5, 10A. Resistance: 2K, 10K, 100K, 1 meg, 10 meg. Decibels: −20 to +85dB. **£12·50.** P. & P. 17½p.

HIOKI MODEL 700X 100,000 O.P.V. Overload protection. Mirror scale.
·3/·6/1·2/1·5/3/6/12/30/60/120/300/600/1200VDC
1·5/3/6/12/30/60/150/300/600 1200 VAC
15/30μA/3 6/30 60/150 300 mA
6/12 AMP DC
2K/200K/2 Meg/20 meg ohm
−20 to +63 db

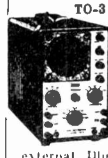
£13·50 P. & P. 20p.

RUSSIAN 22 RANGE MULTIMETER



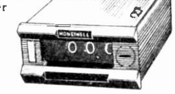
Model U437 10,000 o.p.v. A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2·5/10/50/250/500/1000V d.c. 2·5/10/50/250/500/1000V a.c. D.c. current 100 mA/1/10/100mA/1A. Resistance 300 ohms/3/30/300kΩ/3MΩ. Complete with batteries, test leads, instructions and sturdy steel carrying case. **OUR PRICE £5·97.** P. & P. 25p.

TO-3 PORTABLE OSCILLOSCOPE



3in tube. Y amp. Sensitivity 0·1V p-p/CM. Bandwidth 1·5 cps-1·5MHz. Input imp. 2megΩ 25pF X amp. sensitivity 0·9V -800KHz. Input imp. 2 megΩ 20pF. Time base, 5 ranges 10cps-300KHz. Synchronisation. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15¾lb 220/240V a.c. Supplied brand new with handbook. **£40.** Carr. 50p.

HONEYWELL DIGITAL VOLTMETER VT.100



Can be panel or bench mounted. Basic meter measures 1 volt d.c. but can be used to measure a wide range of a.c. and d.c. volt, current and ohms with optional plug-in cards.
Specification. Accuracy. 0·2, · 1 digit. Resolution: 1mV. No. 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: 5⅝in. × 2 13/16in. × 8 3/16in AVAILABLE BRAND NEW AND FULLY GUARANTEED.
£35.50 Carr. 50p

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2N706A	12p
2N708	15p
2N709	62p
2N718	25p
2N718A	30p
2N726	30p
2N727	30p
2N914	17p
2N916	17p
2N918	30p
2N929	22p
2N930	20p
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2N5367	57p
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3N141	72p
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3N143	67p
3N152	87p
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40467A	57p
40468A	35p
40528	72p
40600	57p
40603	50p
AC107	30p
AC126	20p
AC127	24p
AC128	20p
AC151	18p
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AC154	22p
AC176	20p
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ACY39	47p
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AD149	47p
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AD162	35p
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AF115	25p
AF116	25p
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ASY50	25p
ASY51	32p
ASY54	25p
ASY67	45p
ASY86	32p
ASZ21	51p
AUY10	150p
BC107	10p
BC108	10p
BC109	10p
BC113	10p

Type	Price
BC114	15p
BC115	15p
BC116	15p
BC118	15p
BC119	30p
BC121	20p
BC122	20p
BC125	15p
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BC184	11p
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BC187	27p
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BCY43	15p
BCY54	32p
BCY58	22p
BCY59	22p
BCY60	97p
BCY70	15p
BCY71	20p
BCY72	15p
BCY78	30p
BCY79	30p
BCZ10	27p
BCZ11	40p
BD112	50p
BD116	112p
BD121	65p
BD123	80p
BD124	60p
BD131	75p
BD132	80p
BDY10	125p
BDY20	105p
BDY61	125p
BDY62	100p
BF115	25p
BF117	47p
BF152	22p
BF154	30p
BF158	22p
BF159	25p
BF163	25p
BF167	18p
BF170	22p
BF173	25p
BF177	30p
BF178	35p
BF179	30p
BF180	30p
BF181	30p
BF182	30p
BF184	30p
BF185	20p
BF194	15p
BF195	15p
BF196	15p
BF197	15p
BF198	25p
BF200	25p
BF224	14p
BF225	19p
BF237	22p
BF238	22p
BF244	22p
BFW61	47p
BFW87	25p
BFW88	25p
BFW89	20p

Type	Price
BFW90	22p
BFW91	20p
BFX12	22p
BFX13	22p
BFX29	25p
BFX30	25p
BFX37	30p
BFX44	37p
BFX68	67p
BFX84	25p
BFX85	30p
BFX86	25p
BFX87	25p
BFX88	20p
BFX89	62p
BFX93A	70p
BFY11	42p
BFY18	25p
BFY19	25p
BFY21	42p
BFY24	45p
BFY29	40p
BFY30	40p
BFY41	42p
BFY43	62p
BFY50	20p
BFY51	20p
BFY52	20p
BFY53	15p
BFY56A	57p
BFY76	42p
BFY77	57p
BFY90	65p
BSX19	17p
BSX20	15p
BSX21	20p
BSX26	45p
BSX27	45p
BSX28	33p
BSX60	82p
BSX61	62p
BSX76	15p
BSX77	20p
BSX78	20p
BSY24	15p
BSY25	15p
BSY26	17p
BSY27	15p
BSY28	17p
BSY29	17p
BSY32	25p
BSY36	25p
BSY37	25p
BSY38	20p
BSY39	20p
BSY43	50p
BSY51	32p
BSY52	32p
BSY53	37p
BSY54	40p
BSY56	90p
BSY79	45p
BSY90	57p
BSY95A	20p
C424	15p
C450	15p
GET102	30p
GET113	20p
GET114	20p
GET118	20p
GET120	25p
GET873	12p
GET880	30p
GET887	20p
GET889	22p
GET890	22p
GET896	22p
GET897	22p
GET898	22p
MAT100	25p
MAT101	25p
MAT120	25p
MAT121	25p
MJ400	107p
MJ420	80p
MJ421	80p
MJ430	102p
MJ440	95p
MJ480	97p
MJ481	125p
MJ490	100p
MJ491	137p
MJE340	50p
MJE370	80p
MJE371	85p
MJE520	60p
MJE521	70p
MPF102	45p
MPF103	35p
MPF104	37p
MPF105	37p
MPS3638	32p
NKT124	42p
NKT125	27p
NKT126	27p
NKT128	27p
NKT135	27p
NKT137	27p
NKT210	30p
NKT211	25p
NKT212	25p
NKT213	25p
NKT214	20p
NKT215	25p
NKT216	35p
NKT217	40p

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NKT223	27p
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NKT225	22p
NKT229	30p
NKT237	35p
NKT238	25p
NKT240	27p
NKT241	27p
NKT242	20p
NKT243	62p
NKT244	17p
NKT245	20p
NKT261	20p
NKT262	20p
NKT264	20p
NKT271	20p
NKT262	20p
NKT274	20p
NKT275	20p
NKT278	25p
NKT281	27p
NKT401	87p
NKT402	90p
NKT403	75p
NKT404	55p
NKT405	75p
NKT406	62p
NKT451	62p
NKT452	62p
NKT453	47p
NKT713	20p
NKT717	42p
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OC16	50p
OC19	37p
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OC22	50p
OC23	60p
OC24	60p
OC25	40p
OC26	25p
OC28	60p
OC29	60p
OC35	50p
OC36	60p
OC41	22p
OC42	25p
OC44	15p
OC45	12p
OC46	15p
OC70	12p
OC71	12p
OC72	12p
OC73	20p
OC74	30p
OC75	25p
OC76	22p
OC77	30p
OC78	20p
OC81	20p
OC81D	20p
OC82	25p
OC82D	15p
OC83	25p
OC84	25p
OC139	25p
OC140	25p
OC170	25p
OC171	30p
OC200	25p
OC201	60p
OC202	75p
OC203	40p
OC204	40p
OC205	75p
OC206	95p
OC207	75p
OCP71	42p
ORP12	50p
ORP60	40p
ORP61	42p
P346A	22p
ST140	15p
ST141	20p
TI834	62p
TI843	40p
TI844	15p
TI845	27p
TI846	11p
TI847	11p
TI848	12p
TI849	12p
TI850	12p
TI851	10p
TI852	11p
TI853	22p
XB112	12p
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CA3029A	165p
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CA3035	122p
CA3036	72p
CA3039	82p
CA3041	109p
CA3042	109p
CA3043	137p
CA3044	120p
CA3045	122p
CA3046	81p
CA3047	137p
CA3048	204p
CA3049	160p
CA3050	185p
CA3051	134p
CA3052	165p
CA3053	46p
CA3054	109p
CA3055	240p
CA3059	165p
CA3064	120p
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FCH111	105p
FCH121	105p
FCH131	50p
FCH141	105p
FCH151	105p
FCH171	105p
FCH181	105p
FCH191	105p
FCH201	130p
FCH211	130p
FCH221	130p
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FJH181	25p
FJH221	25p
FJH231	25p
FJH241	25p
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SN7404	20p
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SN7409	20p
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SN7413	30p
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SN7417	84p
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SN7453	20p
SN7454	20p
SN7460	20p
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SN7473	40p
SN7474	40p
SN7475	45p
SN7476	45p
SN7483	87p
SN7486	32p
SN7490	87p
SN7492	87p
SN7493	87p
SN7495	87p
SN7496	87p
SN74107	52p
SN74153	135p
SN74154	
SN74160	200p
	180p
SN74161	260p
SN74164	220p
SN74165	285p
SN74192	175p
SN74193	175p
TAA241	162p
TAA242	425p
TAA243	150p
TAA263	75p
TAA293	97p
TAA300	175p
TAA310	125p
TAA320	72p
TAA350	175p
TAA435	147p
TAA521	132p
TAA522	360p
TAA530	495p
TAA811	445p
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50+ less 15% 100+ less 20%

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ECF82	35p
ECF86	65p
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ECH42	75p
ECH81	30p
ECH83	45p
ECL80	45p
ECL82	35p
ECL83	70p
ECL86	40p
EF37A	120p
EF39	50p
EF40	50p
EF41	65p
EF42	70p
EF80	25p
EF85	35p
EF86	30p
EF89	28p
EF91	30p
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EZ80	27p
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PC86	60p
PC88	60p
PC97	45p
PC900	48p
PCC84	40p
PCC85	40p
PCC88	55p
PCC89	50p
PCC189	55p
PCF80	30p
PCF82	34p
PCF84	60p
PCF86	60p
PCF800	80p
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PCF806	70p
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PCL83	65p
PCL84	45p
PCL85	40p
PCL86	45p
PFL200	65p
PL36	55p
PL81	50p
PL82	45p
PL83	45p
PL84	40p
PL500	75p
PL504	80p
PY32	55p
PY33	63p
PY80	40p
PY81	30p
PY82	35p
PY83	38p
PY88	40p
PY800	40p
PY801	50p
U25	80p
U26	80p
U50	40p
U52	35p
U191	75p
U281	40p
U282	40p
U301	40p
U801	180p
UABC80	40p
UAF42	55p
UBC41	50p
UBC81	40p
UBF80	40p
UBF89	35p
UCC84	49p
UCC85	40p
UCF80	55p
UCH21	60p
UCH42	70p
UCH81	40p
UCL82	35p
UCL83	60p
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UF80	35p
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AAZ13	10p	BY100	15p	OA47	8p
AAZ15	10p	BY103	22p	OA70	7p
BA100	15p	BY122	37p	OA73	10p
BA102	30p	BY124	15p	OA79	7p
BA110	25p	BY126	12p	OA81	8p
BA111	27p	BY127	15p	OA85	7p
BA112	70p	BY164	52p	OA90	7p
BA115	7p	BY210	35p	OA91	7p
BA141	32p	BYZ11	30p	OA95	7p
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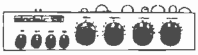

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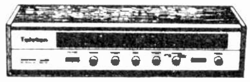

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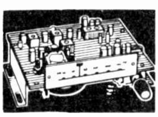

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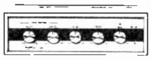

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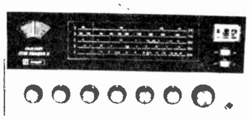

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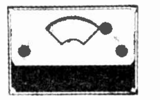

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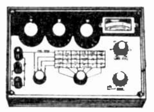

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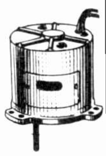

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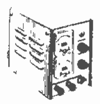

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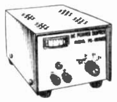

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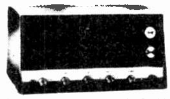

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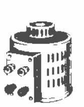

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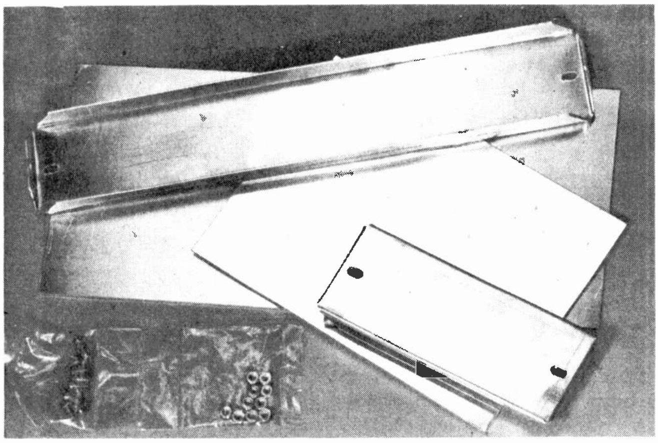

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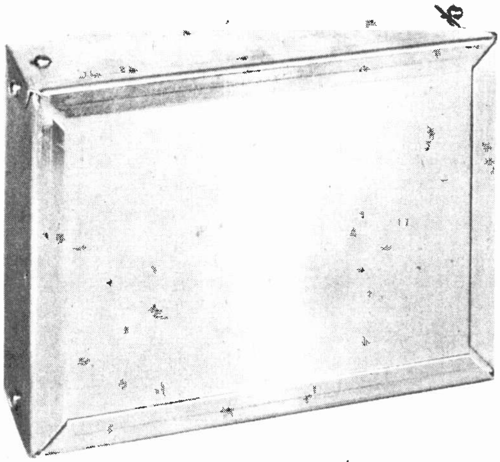

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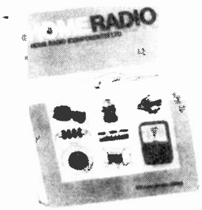

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VOL. 8 No. 11
November 1972

PRACTICAL ELECTRONICS

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OUR BUSINESS

THIS magazine has its own established editorial conventions relating to constructional projects. These have remained unaltered since we started business and we have no plans to depart from these well proven conventions in the future. Perhaps these conventions should be clarified for the benefit of our readers.

Firstly, let us deal with the "exceptional". From time to time a constructional project appears with the prefix "PRACTICAL ELECTRONICS" incorporated in its title. This distinction is not awarded haphazardly. Our name is attached to selected projects only when the following conditions are fulfilled: the project is unique, in that it offers the home constructor something not previously available in a detailed comprehensive form, and it represents a significant or important new application of electronic circuitry. The original concept for the project may have come from the staff of this magazine; or may be the result of consultation with an outside designer. In either case, the actual development and production of the first model is put in the hands of a specialist contributor.

Apart from such commissioned designs, there are examples where a completed project has been offered to us in the normal way (without prior collaboration in the initial planning stage) and upon examination the project proves to "qualify" in the terms stated above. In such an event it may be decided to "adopt" this design to bring it into a special, close relationship with this magazine. This is subject to the agreement of the contributor naturally—but none so far has raised any objections to an adoption proposal!

We are certain that every one of the selected designs published under the P.E. insignia has been a credit to the designer concerned; furthermore we believe these designs stand out as notable landmarks in the eventful story of home constructed electronics, an activity which has progressed and expanded so dramatically over the recent years.

This special singling out of certain projects in no way diminishes the merit of the other projects published in these pages. All designs are rigorously vetted before acceptance and many of these do indeed indicate a very high degree of technical inventiveness and skilful workmanship on the part of the individuals responsible for their conception and subsequent execution.

Constructional projects are obviously the life blood of this magazine. Only projects designed and built expressly for the home constructor (the designer may himself be either a professional or an amateur in the electronics sense) are considered for inclusion under this

continued on page 922

THIS MONTH

CONSTRUCTIONAL PROJECTS

SPECIAL SERIES

GENERAL FEATURES

NEWS AND COMMENT

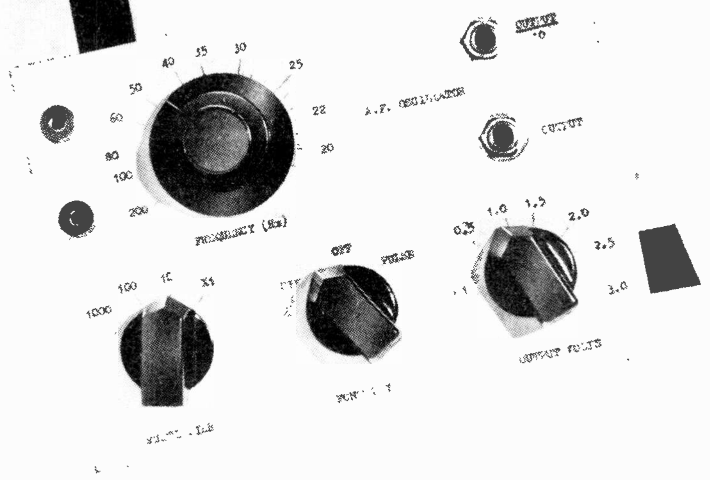
SPECIAL SUPPLEMENT

Our December issue will be published on Friday, November 10

Practical Electronics, Fleetway House, Farringdon St., London, E.C.4. Phone: *Editorial* 01-634 4452; *Advertisements* 01-634 4202

Simple A.F. Signal Generator

By D. W. Easterling



THE audio frequency signal generator to be described here produces sine waves or pulses over the frequency range 19Hz to 200kHz in four bands. The amplitude of the sine waves is sensibly constant over the entire range, and the waveform good. The pulses are square in shape, with 1 : 1 mark/space ratio over the lower three bands, that is from 19Hz to 20kHz. Above this frequency the waveform and level progressively deteriorates.

The maximum output level, both for sine and square waves is 3V peak-to-peak, just over one volt r.m.s. A constantly variable output control enables this to be reduced to zero, and is calibrated down to 100mV.

There is also a second output socket permanently attenuated by 20dB, thus permitting accurate setting of the output level to 10mV.

The complete unit operates from a self-contained 9V dry battery, and is housed in a case measuring 7in × 5in × 2½in. Costing less than £4 to build from new components, this test set will be of value to the radio experimenter and hi fi enthusiast.

WIEN BRIDGE

The circuit is illustrated in Fig. 1. Transistors TR1 and TR2 are connected as an inverted Wien bridge oscillator. To sustain oscillation positive feedback is arranged between the two emitters via network LP1 and R5.

At the same time, considerable negative feedback from TR2 emitter to TR1 base prevents the circuit from oscillating at any frequency except that selected by the Wien bridge network. This consists of VR1a, R1, VR2, R2, and VR1b; a pair of capacitors selected by the range switch S1a ganged to S1b completes the network. The variable resistors VR1a and VR1b are in fact one double-gang control which is used to provide continuous tuning over each range.

The series resistors R1 and R2 are chosen to provide a 10:1 frequency swing without permitting the minimum resistance of the network to reach such a low value that it seriously loads the emitter circuit of TR2.

The potentiometer VR2 enables both arms of the network to be balanced, particularly at the high frequency (low resistance) end of each range, otherwise there is a tendency for the output level to dip beyond the auto-control circuit. VR2 can be omitted and the values of R1 and R2 set by trial. For example, in the prototype the values of R1 and R2 were 4·7 and 5·1 kilohms respectively.

The capacitors C1 to C8 determine the frequency ranges as follows:

Capacitors	Nominal Value	Frequency Range
C1, C2	120pF	19kHz to 200kHz
C3, C4	1,500pF	1·9kHz to 20kHz
C5, C6	0·015μF	190Hz to 2kHz
C7, C8	0·15μF	19Hz to 200Hz

It will be noticed that C1 and C2 are made less than the expected 150pF, due to the effect of stray capacitances. To ensure accurate range multiplication each of these capacitors may consist of a 100pF silver mica fixed capacitor in parallel with a 30pF air spaced trimmer which is adjusted during calibration. In the prototype it was found that single fixed 120pF capacitors of close tolerance provided sufficient accuracy.

POSITIVE FEEDBACK

The amount of positive feedback in the oscillator is critical. It must be sufficient to sustain oscillation without being so large that it drives the transistors off the linear part of their characteristic and produces unwanted harmonic distortion.

Unfortunately the changing characteristics of the load, power supply, and frequency selective network, tend to cause large variations in signal level which can only be overcome by using some form of automatic level control. Changes in level due to range switching can be countered by switching in different series resistors (VR3 to VR6), but this is insufficient when, as in this case, the frequency swing on each range is in the order of 10:1, consequently a more sophisticated arrangement is employed.

The usual method of solving this problem is to use sensitive thermistors which are both fragile, and costly. The circuit in Fig. 1 achieves the same result by using a 6 volt 40 mA lamp. The lamp in series with a 150Ω resistor is connected across the oscillator output.

As the output voltage increases, so does the current through the lamp, heating the filament and causing the lamp resistance to rise. This has the effect of reducing the voltage appearing at the junction of the lamp with the resistor, and thus the positive feedback. With careful design, the circuit becomes self balancing, and the output level stable.

It will be noticed that the lamp normally runs just below the level where it produces light, although under certain conditions a glow can just be seen. The nominal current through the lamp is in the order of 20mA.

The output of the oscillator is taken direct from the emitter of TR2 as a sine wave, or via TR3 and TR4 as a pulse or square wave. TR3 is a grounded emitter amplifier with a high value collector load resistor. Squaring occurs because the input signal is sufficient to bottom the base and collector characteristics on alternate half cycles.

Resistor R8 isolates the input circuit of TR3 from the output of TR2, thus preserving the sine wave output, and with R9, regulates the input to TR3 to ensure a square wave mark space ratio of 1:1. Adjustment of these resistors provides a convenient

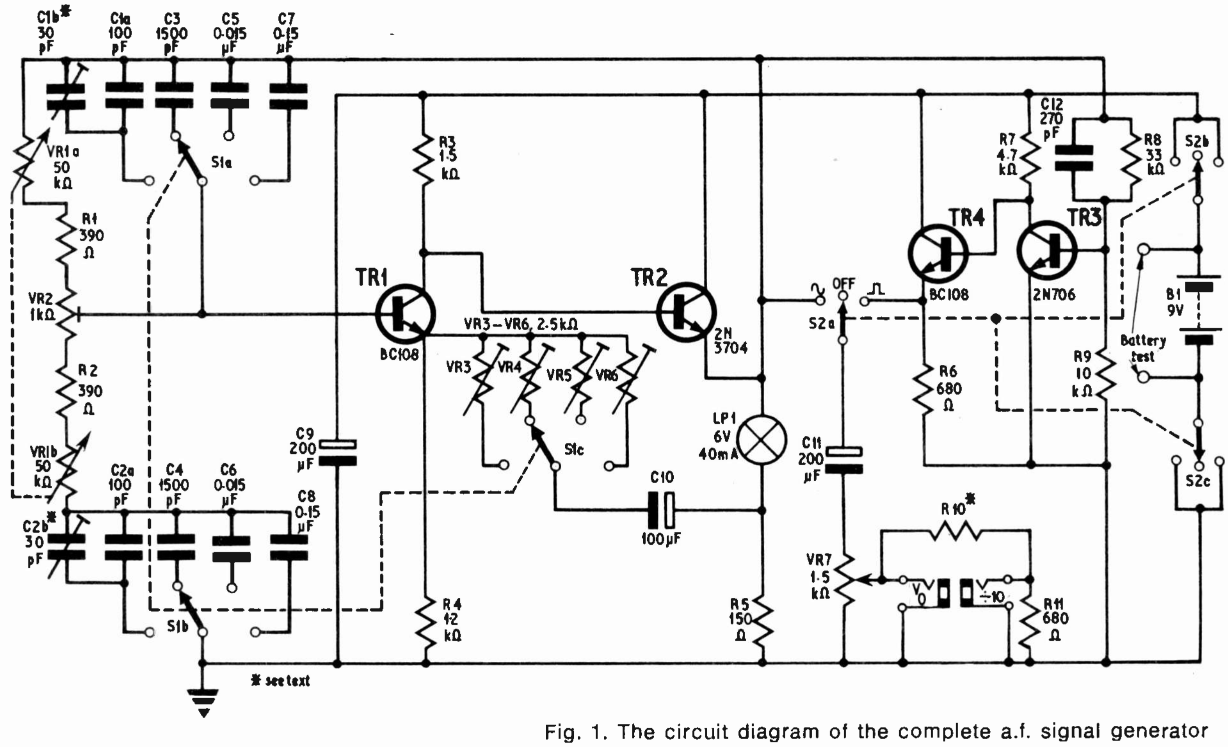


Fig. 1. The circuit diagram of the complete a.f. signal generator

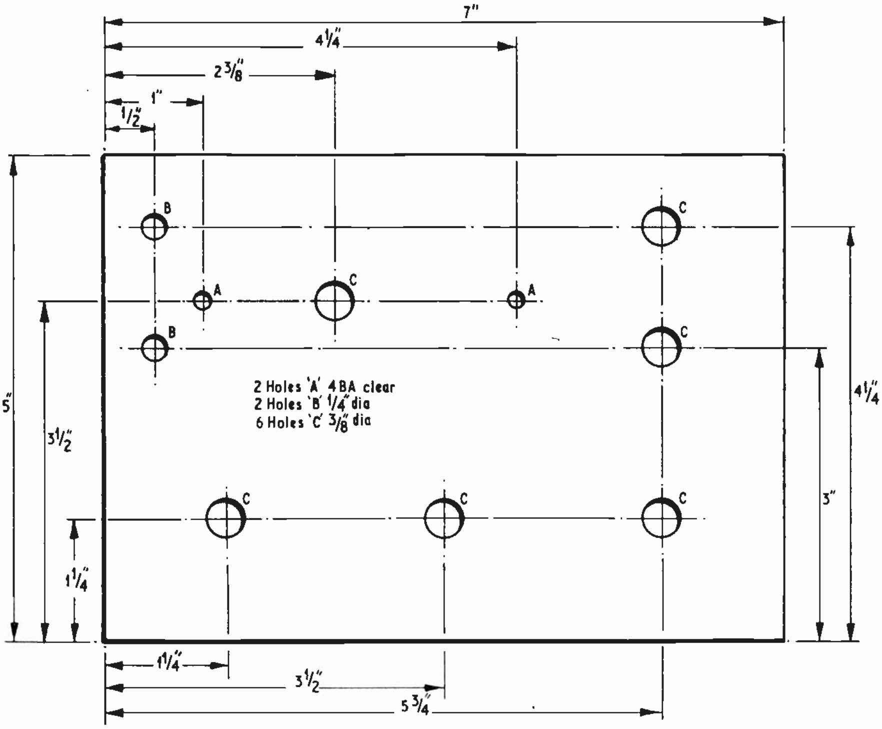


Fig. 2. The front panel drilling details to take the controls and sockets. The component board is bolted to this panel before the panel is covered with adhesive plastics sheet

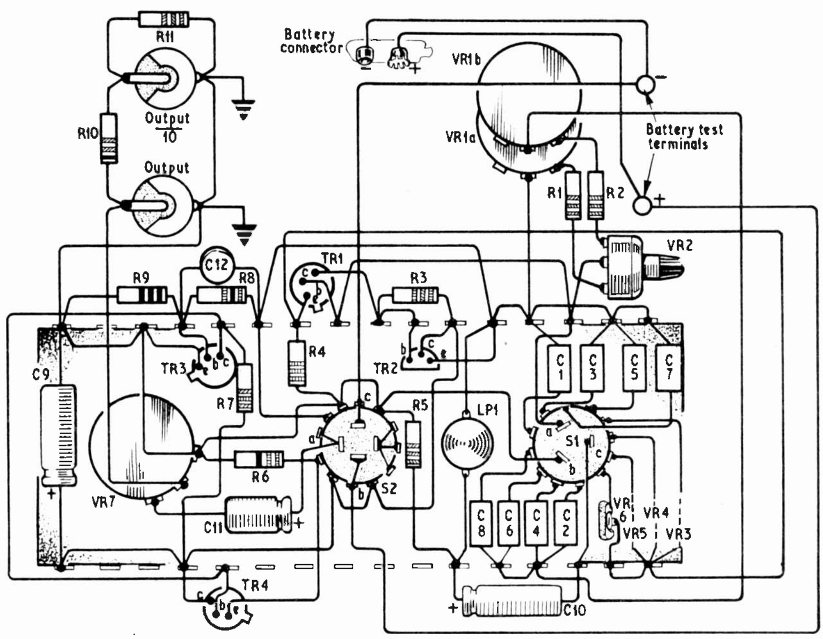


Fig. 3. The components are assembled on a tag board attached to the front panel

COMPONENTS . . .

Resistors

R1	390Ω	R6	680Ω
R2	390Ω	R7	4·7kΩ
R3	1·5kΩ	R8	33kΩ
R4	1·2kΩ	R9	10kΩ
R5	150Ω	R10	(see text)
		R11	680Ω

All ±5% $\frac{1}{4}$W carbon

Potentiometers

VR1	50kΩ linear, twin-gang
VR2	1kΩ linear preset
VR3, VR4, VR5, VR6	2·5kΩ linear preset (4 off)
VR7	1·5kΩ linear

Capacitors

C1, C2	100pF silver mica in parallel with a 30pF air spaced trimmer *or* single 120pF silver mica (see text)
C3, C4	1,500pF 400V
C5, C6	15,000pF 400V
C7, C8	0·15μF 250V
C9	200μF elect. 16V
C10	100μF 400V
C11	200μF 400V
C12	270pF ceramic disc

Transistors

TR1 BC108
TR2 2N3704
TR3 2N706
TR4 BC108

Switches

S1 3-pole, 4-way switch
S2 3-pole, 3-way switch

Battery

B1 9V dry battery

Lamp

LP1 6V 40mA lamp

Miscellaneous

Aluminium case 7in × 5in × 2½in
Jack sockets (2 off)
Wander sockets (2 off)
Battery connector
Pointer knobs
Lamp holder, m.e.s.
Component assembly board

method of tailoring the mark space ratio to individual requirements.

Capacitor C12 provides a degree of high frequency compensation. Transistor TR4 matches the high load resistance of TR3 to the comparatively low impedance output circuit.

OUTPUT TERMINALS

Selection of sine wave or pulse is by switch S2a, which is ganged to S2b and S2c in series with the battery to put the unit to "off" in the centre switch position.

The standing d.c. potentials at the emitters of TR2 and TR4 are blocked from the output by capacitor C11, which must be of sufficiently large capacitance to pass the lowest frequency without significant attenuation.

The output control VR7 can be reliably calibrated down to 100mV, but for many applications, such as testing pre-amplifiers, this is too high; hence the alternative output attenuated by network R10 and R11 which enables an output level of 10mV to be selected. Separate output sockets are preferred to a switched attenuator, as they facilitate simultaneous connection to two circuits, e.g. a test load and a monitor.

Terminals connected across the battery and brought out to the front panel facilitate battery checking, and may perhaps be useful in providing a power source for some other item of equipment but should not be allowed to interfere with the oscillator stability. The normal voltage across these terminals will be from 7·8 to 9 volts depending on the state of the battery. The battery should be replaced when the voltage falls below 7·8V on load.

CONSTRUCTION

The aluminium case was purchased ready made and consists of two "chassis" type box trays with butting corners. The shallow tray acts as a lid and becomes the front panel. All of the components are mounted on it including the battery, as shown in the photograph.

The frequency control VR1 dominates the front panel with sufficient space around it to accommodate a large pointer knob and associated calibration. It is positioned off-centre in order to provide accommodation for the battery which is mounted alongside VR1, and retained by spring curtain wire stretched between two 4B.A. bolts.

Switches S1 and S2, and the output control VR7, are mounted in line across the lower part of the panel. Their fixing also retains the tagboard on which all the other components including the transistors and preset controls are mounted. This arrangement facilitates wiring, which is kept as short as possible to minimise stray capacitance effects.

The holder for lamp LP1 is also wired on to the tagboard between S1 and S2. The output jacks and battery test terminals are fitted at opposite ends of the front panel in line with VR1.

In order to provide a suitable background for the calibration marking and switch legends the front panel is covered in self adhesive plastics sheet. The same material is used on the underside to insulate the tagboard. The panel is covered after it has been drilled and before the components were finally mounted.

A single sheet covered the whole panel including the holes, and unwanted parts were removed with a half round file. The covering will take instant lettering transfers, typewriter ink, or ball pen markings, which are then made permanent by a coating of clear varnish. Fingernail varnish is ideal. Without this protection the marks are easily removed using a clean cloth.

All the required words and figures can be typed on to a single sheet of plastics which is then varnished. It is a simple matter to cut out the appropriate word or figure as a label and attach it in the required position on the panel during the test and calibration process.

TESTING

After carefully checking the wiring, and correctly connecting the battery, switch the unit on to sine waves. For this first test a current meter was inserted in series with the battery to monitor the current, which should not exceed 25mA. With the output connected to an oscilloscope, the appropriate positive feedback preset potentiometers VR3 to VR6 were adjusted for each range so that the level at the output remained sensibly constant over the entire sweep of the frequency control without there being any apparent distortion. The aim is to produce a clean sine wave with minimum harmonic content.

Due to the thermal lag of the lamp LP1, the level tends to "bounce" if the frequency control is adjusted too rapidly. A tendancy for the change in level between the low and high frequency ends of the frequency control to be outside the control circuit was corrected by adjustment of VR2.

Having established that the sine wave generator was operating satisfactorily, the unit is switched to square waves, which should be good up to 20kHz, but thereafter deteriorate as the frequency is increased.

As an alternative to an oscilloscope, headphones or an amplifier and loudspeaker could be used for audible testing of the unit over the three lower ranges. The higher frequencies are of course outside audibility. The positive feedback preset potentiometers should be adjusted to the point where oscillation is sustained over the entire range. Remember that too much feedback will produce a distorted waveform. On sine waves the tone is clear and pure. On square waves the harmonics become noticeable, the tone harsh, and apparently louder.

CALIBRATION

Frequency calibration is most easily done using a counter. The writer used an oscilloscope to compare the low frequency end of the output against the 50Hz mains supply (via a suitable low voltage isolating transformer), and the high frequency end against a separate 100kHz oscillator beating against the carrier frequency of the transmission (BBC Radio-2 Long Wave 200kHz 1,500 metres) for the high frequencies.

An alternative method would be to compare the note heard through headphones with that from a well tuned piano. Piano keyboard frequencies based on orchestral pitch (A = 440Hz) are given in various reference books and cover the range 27·5Hz (bottom A) to 4,186Hz (top C).

The output control was calibrated in volts peak to peak because this value is meaningful for square waves as well as sine waves. Again an oscilloscope was used. An uncalibrated oscilloscope could be used for this purpose with reasonable accuracy by setting it up against the a.c. voltage range of a multimeter fed by the unit switched to sine waves at about 50 to 100Hz. One volt r.m.s. on the meter is $1 \times 2\sqrt{2} \simeq 2{\cdot}8$ volts peak to peak.

Suppose that the oscilloscope is adjusted so that 2·8V peak to peak produces a deflection of 5·6cm, then the oscilloscope sensitivity is $5{\cdot}6/2{\cdot}8 = 2$cm/volt, and so 500mV peak to peak would produce a 1cm deflection. Lower values can be measured by expanding the trace. For example, with 500mV peak to peak producing a deflection of 5cm, 100mV peak to peak would produce a 1cm deflection.

The values of the fixed attenuator network R10 and R11 are nominal preferred values and were selected on test to reduce the output to one-tenth using the methods of measurement just described. ★

OUR BUSINESS *continued from page 917*

heading. We do *not* include commercial kits in this category. Not that we have anything against kits. Some of our best advertisers are in this business, and for the man in a hurry, there's a lot to be said in their favour. But we feel it would be a mis-use of our editorial pages to describe in detail how to assemble some such kit. Provision of this kind of information is the business of the kit suppliers.

We know *our* business: encouraging genuine enthusiasts to build and learn; and encouraging individual circuit designers and application innovators to produce novel and practical projects to sustain this absorbing hobby. The steady expansion of our wide ranging readership at home and overseas convinces us that this policy is the right one. The almost insatiable demand for original designs is a challenge, but one our contributors and ourselves eagerly and willingly accept.

As stated in the opening paragraph, no changes are contemplated. (Why interfere with a successful formula?) PRACTICAL ELECTRONICS will continue as an unrivalled source of original design and construction information—conceived and planned throughout with the private constructor first and foremost in mind.

F.E.B.

POINTS ARISING

NOUGHTS AND CROSSES GAME (*Oct. 1972*)

In Fig. 6 p. 834 (caption omitted), all contacts on wafer S1e should be blank except for a "1" against position 5 instead of position 6 as shown.

The 10-pole 10-way switch can be made from "Maka-switch" components but if a ready made switch is purchased, all wafers being make-before-break, then one wafer can be converted to break-before-make as required by carefully trimming the wiper contact until it does not short two contacts as the position is changed.

COMBINATION LOCK (*Ingenuity Unlimited Oct. 1972*)

The transistors can be almost any low power *pnp* switching types or general purpose types, so long as they are all the same.

TTL EQUIVALENCE GATE (*Ingenuity Unlimited Oct. 1972*)

In the diagram the last gate before the output has two inputs. These inputs are connected to the outputs of the preceding pair of gates respectively; they should not be joined together.

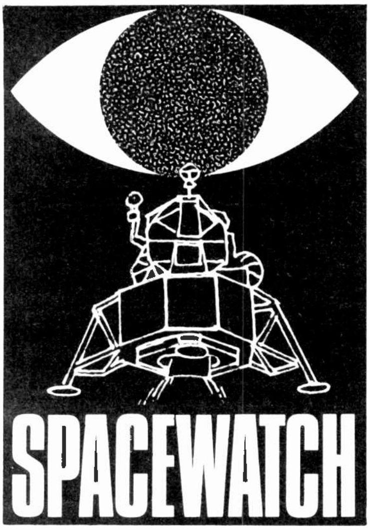
In the truth table, both "difference" conditions should have a "1" output.

TRANSELECTOR (*July 1972*)

The value of R6 is 2·2 kΩ.

WHO'S WHO

I.C. INTERCOM in the October 1972 issue has been accredited to the wrong author. The author of this article is **J. LEWIS,** to whom we offer our sincerest apologies. We regret any inconvenience which may have occurred to Mr Lewis and to Mr R. A. Penfold, who is the real author of the *CR Bridge* in this issue.



BY FRANK W. HYDE

ORBITING OBSERVATORY

The largest telescope that has ever been put into space is carried aboard the newest orbiting observatory *OAO-C*. It is to be named *Copernicus* in a tribute to Nicklaus Copernicus as the father of modern astronomy. This forms a fitting part of the celebration of the 500th anniversary of his birth.

The observatory weighs some 4,900lb and orbits at 460 miles altitude. The spacecraft is about ten feet long and the 32-inch reflecting telescope occupies the centre of the vehicle.

In an effort to save weight the mirror is made of fused quartz and has been reduced in thickness to save 250lb. The actual weight is 105lb as against a normal reflecting mirror which would amount to about 350/360lb.

To achieve the necessary rigidity and constant figure the thin main disc is supported by quartz ribs and since gravity is reduced there is a further safeguard by carrying the telescope in space. This type of construction has been put into operation before by amateurs in an effort to reduce costs using the normal glass.

The 32-inch primary mirror collects the light rays and directs them to a smaller mirror 3·9 inches in diameter and thence to a spectrometer. The received data is then telemetred to earth.

This telescope is designed for the observation of ultra-violet light which is absorbed in the atmosphere. By working at a level where the atmospheric effects are minimal very valuable observations can be made. This type of work has been continuing for some time but with much smaller telescopes.

In addition to the large telescope there are three smaller telescopes on board the main purpose of which is the X-ray observations that are to be made. These telescopes are part of the equipment provided by University College, London.

Work on the detection of X-ray sources has been going on for some time and to date some 200 sources have been identified.

In the early days X-ray studies were made with the sounding rockets and later with the famous *Explorer 42* perhaps better known as *UHURU* which was launched in December 1970. The observations confirmed that there were X-radiations from distant sources very much greater in amount than those from the sun. It is believed that these may come from the far distant parts of the universe.

The record of these orbiting observatories has been an extremely good one. Apart from the unfortunate accidents during the early stages of the series, with the first one failing three days after launch in April 1966, and the third one failing to attain orbit because of the malfunction of the shroud jettison mechanism, the programme for the four observatories in this project has had its rewards. Some 10,000 observations of celestial objects have been made including major observations of comets and in May 1972 the event of a supernova.

On board the *OAO-C* observatory will be a computer capable of storing about 1,024 commands from the ground. This gives comprehensive and fully automatic operation while within range of the ground station at Rosman, North Carolina.

Any information obtained by the *Copernicus* observatory will be freely available to researchers all over the world.

LAST OF THE APOLLO'S

The *Apollo 17* spacecraft left its berth at vehicle assembly Cape Kennedy, Florida on August 28, 1972. This spacecraft, the last of the *Apollo* series will carry the sixth team to a landing on the moon.

This last mission for this period will commence on Wednesday, December 6 at 21.53 EST (02.53 GMT Thursday) for the 12-day round trip to the moon. Three days will be spent on the surface of the moon.

Making his first space flight will be 37-year-old Harrison H. Schmitt, Ph.D., who is the first geologist to take part in an *Apollo* mission. His companion on the lunar surface will be 40-year-old Eugene A. Cernan, a veteran of some 264 hours of space flight and one of which took him to within 8 miles of the moon. Cernan will also undertake specially selected tasks during the mission.

The two astronauts will set up the fifth automatic station on the moon. The instruments to be set up are varied and one of these is the tidal gravimeter or lunar surface gravimeter. This instrument has been under development since 1964 and will be used to test the theory of gravity waves. This is at the moment a most important point in understanding the nature of the forces which celestial objects exert on each other.

Another type of gravimeter named the traverse gravimeter will be carried on the lunar rover. With this instrument the astronauts will record the changes in the gravity that take place over the lunar terrain. Thus, the anomalies will enable comparisons to be made with earth gravity changes.

Explosive measurements with seismic instruments will show the profile which will help determine the physical structure of the moon. Also operating will be instruments to check the cosmic dust and meteoritic fall-out, to see what are the effects of erosion on the moon.

The spacecraft will be launched on a *Saturn V* rocket and will be the first to be launched after dusk.

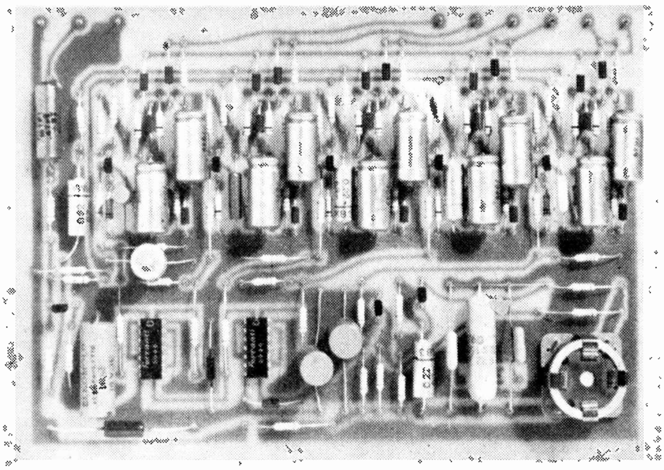
THE EXPLODED PLANET

Many people have explained the asteroid belt, the multitude of small bodies from less than egg size to chunks large enough for a space probe to land on, by the theory that there was a planet which was disrupted by the tremendous forces that exist in the solar system. This belt which lies between the orbits of Mars and Jupiter is being traversed by the Jupiter probe which may take photographs of some of them. In terms of proximity, of course, there is not likely to be many of these fragments near each other.

The problem of this debris is highlighted by the recent work of Michael Ovenden. Formerly of London and Edinburgh, Professor Ovendon is now at the University of British Columbia. He has been seeking a solution to certain celestial problems and his latest theory seems to be a satisfactory way of explaining the asteroid belt.

The various bodies which all interact with each other tend to settle to a minimum attraction position. Ovenden has checked this on such systems as Barnard's star which has planets. He has been able to get to an accuracy of 99 per cent with his theory.

To get the sums right for the earth and the rest of the solar system a planet 90 times heavier than the earth would be needed. It seems that the asteroid belt formed into a planet would be needed. It seems that the asteroid belt formed into a planet would satisfy this criterian. So he has called this planet Aztex. Though its real existence cannot yet be proved it is a good point from which to proceed.



ELECTRONIC PIANO

Part 3

By A. J. Boothman B.Sc.

THIS part of the series is devoted solely to the main circuit boards of which there are 13 containing 90 per cent of the electronic components involved in the project. For convenient reference this board has been called the pitch board.

The function of the board, as described previously, is to generate a basic pitch and sub-harmonics of the same, followed by attack, decay, mixing, and tone circuits.

PITCH OSCILLATOR

The important requirements of the pitch oscillator is that it should have good long term frequency stability, good stability under varying ambient temperatures, and that it should present a suitable waveform which will reliably drive the frequency divider circuits. The circuit used is given in Fig. 3.1 which shows the various circuit elements that go to make up a complete pitch board.

The frequency of operation is determined by the tank circuit components C48 and L1. The inductance L1 is variable and is wound on a bobbin set in a ferrite core. After initial setting up C48 is fixed and comprises a number of capacitors in parallel dependent on the pitch concerned.

The oscillator transistor (TR16) is followed by a high gain buffer stage (TR17) which squares the waveform to give sufficiently fast edges at the collector to drive the first divider IC2. The cathode of diode D34 is returned to the divider supply rail in order to limit the positive excursion of the output waveform from TR17 ensuring that the maximum voltage presented to the divider input is approximately 5·3 volts.

PITCH DIVIDERS

In order to produce sufficient tones to cover the five octaves the fundamental frequency from the buffer transistor is used for the top octave, whilst the other notes are produced at the outputs of four integrated circuit dividers which are packaged in pairs.

With the increase in availability of certain integrated circuits, the cost of these devices has dropped considerably, and to such an extent that in addition to circuit board area saving and ease of assembly, the incorporation of integrated circuits results in a significant cost reduction when compared with equivalent discrete circuitry.

The divider circuits (IC2, IC3) are dual-in-line 14 lead packages each containing two flip-flops. The type of element used is described as a D-type edge triggered JK flip-flop. From its description it follows that the input waveform must have clean fast edges for reliable operation. For second, third and fourth stages this is provided by the previous flip-flop, but for the first stage it is important that the output from TR17 should have fast edges. To ensure that this condition is met R119 is kept deliberately low.

FLIP-FLOP ACTION

The D-type flip-flop element (Fig. 3.1) operates in such a way that when a leading (positive going) edge appears at the clock input (CP) then the output at Q takes up the same state as that present at the D input immediately prior to the appearance of the clock pulse. Thus, if D was at a high voltage before the input signal rises then Q will take up the high voltage state and remain there after the input voltage falls again. If the input at D is then changed to a low voltage then Q will change to a low voltage as soon as the input waveform rises.

The state of the D input is controlled by externally connecting the $\overline{Q}$ output to the D input. By definition Q is the complement of Q and so it can be seen that when the clock input is low D is always

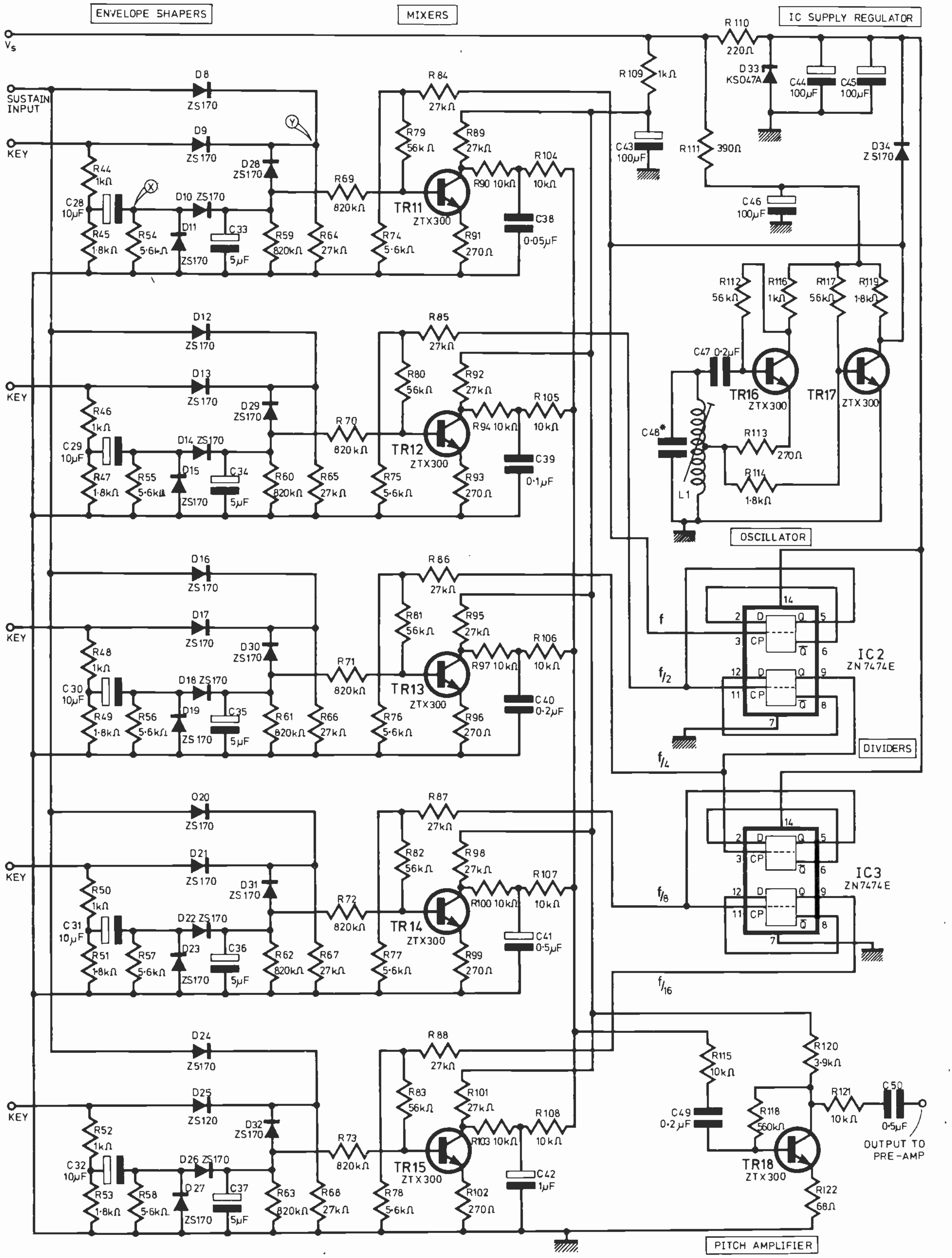


Fig. 3.1. Circuit diagram of a pitch p.c.b.

the opposite to Q, such that when the clock input rises Q will always change state, and remain in the new state until the clock has both fallen and risen again, at which point Q will again change state.

Since the clock input signal from the pitch generator is a square wave signal f, the Q output from the first flip-flop will be another square wave signal at half the frequency, f/2.

The other sub-harmonics are similarly generated by routing appropriate Q outputs to succeeding flip-flops.

ATTACK AND DECAY ENVELOPE

The most important area in determining the character of this instrument is that concerned with the envelope, or attack and decay characteristic.

In order to obtain a percussive effect a fast rate of rise is required on the leading edge, followed by a rapid decay to a medium level of sound, and further followed by a relatively slow decay. On releasing the key the decay of sound should be fast but in the case of a piano this does take a finite time.

A string piano is activated by a hammer system where the level of attack is determined by the impact velocity of the hammer on the string, which is proportional to the rate of acceleration of the finger placed on the key. In the case of the electronic piano, in addition to a simulation of the hammer velocity action on each key, the maximum level of attack is determined by a five position touch switch which presets the key voltage supply.

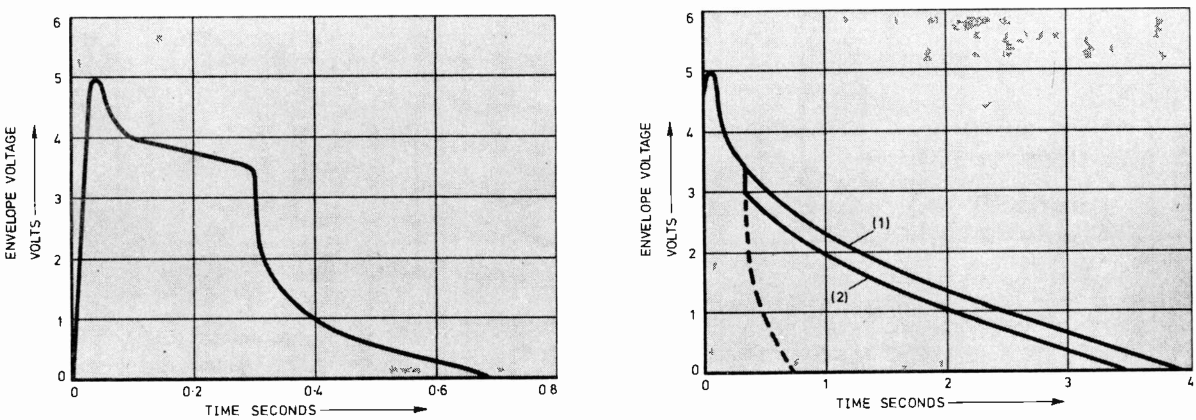


Fig. 3.2(a). Envelope circuit output characteristic in the non sustain mode with key released after 0·3 seconds. (b) Envelope circuit output characteristic with (1) key held depressed in the system or non sustain mode; (2) key released after 0·3 seconds in the sustain mode

The influencing factors involved are listed as follows:

(a) The rate of rise of the leading edge of the envelope (attack).
(b) The height of the leading edge.
(c) The amount of rapid fall following the attack.
(d) The length of decay when a key remains depressed.
(e) The length of decay after the key is released (non-sustained).
(f) The length of decay after the key is released with the sustain pedal on.

It is of course possible to display the output waveform of a string piano on an oscilloscope, and this could be followed by a point by point attempt at electronically simulating the envelope. In experimenting in this way, combined with straightforward comparative ear tests, the author noted certain features of the electronic equivalent which made it desireable to depart from an identical copy of the string piano envelope.

SLOW DECAY ENVELOPE

The curve shown in Fig. 3.2a indicates the envelope required under non-sustaining conditions, i.e. when a key is depressed and released fairly quickly without use of the sustain pedal.

The level of initial attack on a string piano, when compared with the mean level of sound output, is very high, and a similar ratio is difficult to reproduce electronically if economical amplifier and loudspeaker capacities are to be used. This is the first point of compromise which has to be considered. Having recognised the need for a clear pip at the commencement of the envelope it is then necessary to consider the rate of decay in the medium level of sound region mentioned above. This is clearly coupled with the full decay period and again due to peak/mean power considerations it is somewhat slower than on a string piano.

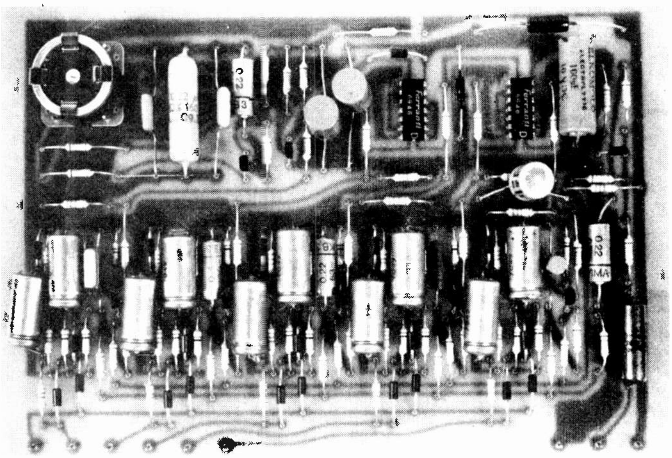
Finally, when the key is released on a string piano a damper comes into operation immediately and quickly kills the vibration of the string. This action is reproduced realistically by an analogous electronic circuit.

LONG DECAY ENVELOPE

The curve shown in Fig. 3.2b indicates the other two possible conditions.

1. When the key is held depressed for a considerable time.
2. When the key is released quickly, but the sustain pedal is depressed.

In both cases the first part of the envelope is



A completely assembled pitch p.c.b.

required to be exactly the same as in Fig. 3.2a. If the key remains depressed then the output decays slowly to zero in a time that is easily varied by the suitable choice of one resistor value in each envelope circuit. In the prototype this provides a decay of approximately 3·5 seconds, which is somewhat larger than for a string piano.

In the key released, sustain pedal on condition, it is more important to have a large amount of rapid fall following the attack in order to retain the percussive characteristic of the instrument when repeatedly playing the same note at a fast rate. As mentioned earlier a string piano has a very high peak capability and a fast initial decay. This allows fast repetition of one note whilst, even under sustain conditions, maintaining the discrete identity of each impact via its attack characteristic.

The attack characteristic of the first curve in Fig. 3.2a is insufficient to reveal differentiation between consecutive notes in the sustain condition, and a second characteristic is therefore introduced whereby a second fall in level occurs as the key is released, followed by a shorter decay time of approximately 3 seconds.

THE ENVELOPE CIRCUIT

Each of the d.c. key inputs in Fig. 3.1 are shaped by envelope circuits. As can be seen there are five duplicated circuits that precede the mixers to fulfil this function. To understand the action of these let us look at the topmost shaper of Fig. 3.1.

A note is initiated when a d.c. level of between 11 and 18 volts, depending on the touch setting, is applied to the input of the circuit via the keyboard. Capacitor C33 is charged via R44 and C28, with R44 providing some slight slowing of the rise time in order to protect against key noise, and also being a factor in determining the height of the attack pip.

Following the relatively quick charging of C33, C28 is charged which means that point "X" falls towards ground potential. The presence of D10 isolates the input circuitry from C33 and there is no further interaction between the two circuits. Removal of the key voltage results in the discharge of C28 via the diode D11 and resistor R45.

It is important that R54 should be sufficiently low to provide fairly rapid charging of C28, and that R45 should be sufficiently low to allow complete discharge of C28 before the next key voltage is applied. However, both resistors are involved in determining the voltage applied to C33 during attack (voltage sharing with R44), and all values are therefore both important and interrelated.

TOUCH SENSITIVITY

In order to give touch sensitivity R45 can be replaced by a grounded switch contact in the key-switch action which becomes a double throw switch between a zero volt potential and the supply voltage on the second pole.

During the interval when the switch is changing over, C28 is charged by a bleed resistor between rail voltage and the centre contact of the change-over switch. This reduces the attack voltage excursion at the point when the changeover is complete, by an amount dependent on the time taken over the movement between the two poles. Further details on this will be given later.

SUSTAIN AND DAMPING

Now, ignoring the input circuit, we can consider the sustain and damper portion of the envelope. The keying operation had charged C33 to approximately 5 volts, and whilst the key remains depressed point "Y" is held at approximately 14 volts, thus isolated from the output line by diode D28.

In this condition C33 is slowly discharged by the combined effect of R59 and the load placed across the output. If at any point during this decay the key should be released then D28 and R64 would appear across the output, and since R64 is made very low compared to R59 this provides the damper action.

When the sustain pedal is in operation D8 is held at approximately 4·5 volts which causes a quick drop in the output voltage on release of the key, but then holds off the action of R64 during the remaining part of the sustain period.

TONE FORMING

Tone forming in the system is very simple and consists only of a low pass capacitive filter after each transistor. The complete circuit of the combined envelope and tone forming section is shown in Fig. 3.1.

As stated in the first article the prime purpose of the project is to provide a reliable portable keyboard instrument with a percussive characteristic similar to that of the piano. The tone of a piano is of course extremely variable from one instrument to another, and whilst it is possible to incorporate involved tone circuits to match one particular piano colouring, the author decided that the simple filter above produced a sound which is completely acceptable for both the home and band applications.

TONAL CHARACTERISTICS

It is difficult for the author to give an objective description of the sound produced by the instrument, but generally the piano type characteristics are most noticeable above middle C, and the attack becomes less apparent in the lower registers, where a fuller more organ like sound is evident.

When driving an external amplifier of course, using the appropriate output socket, the tonal

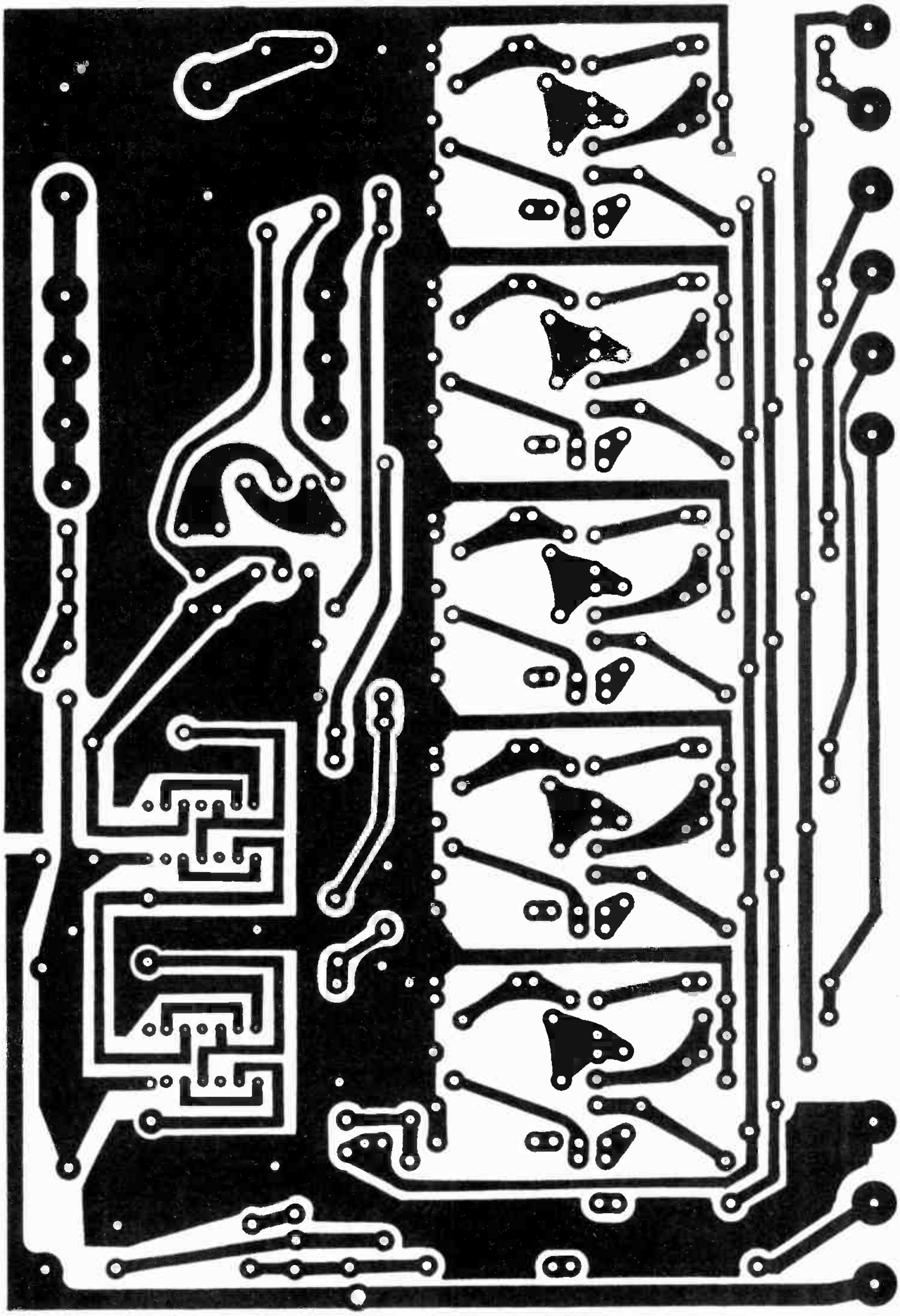


Fig. 3.3. Etching details for pitch p.c.b. This is full size

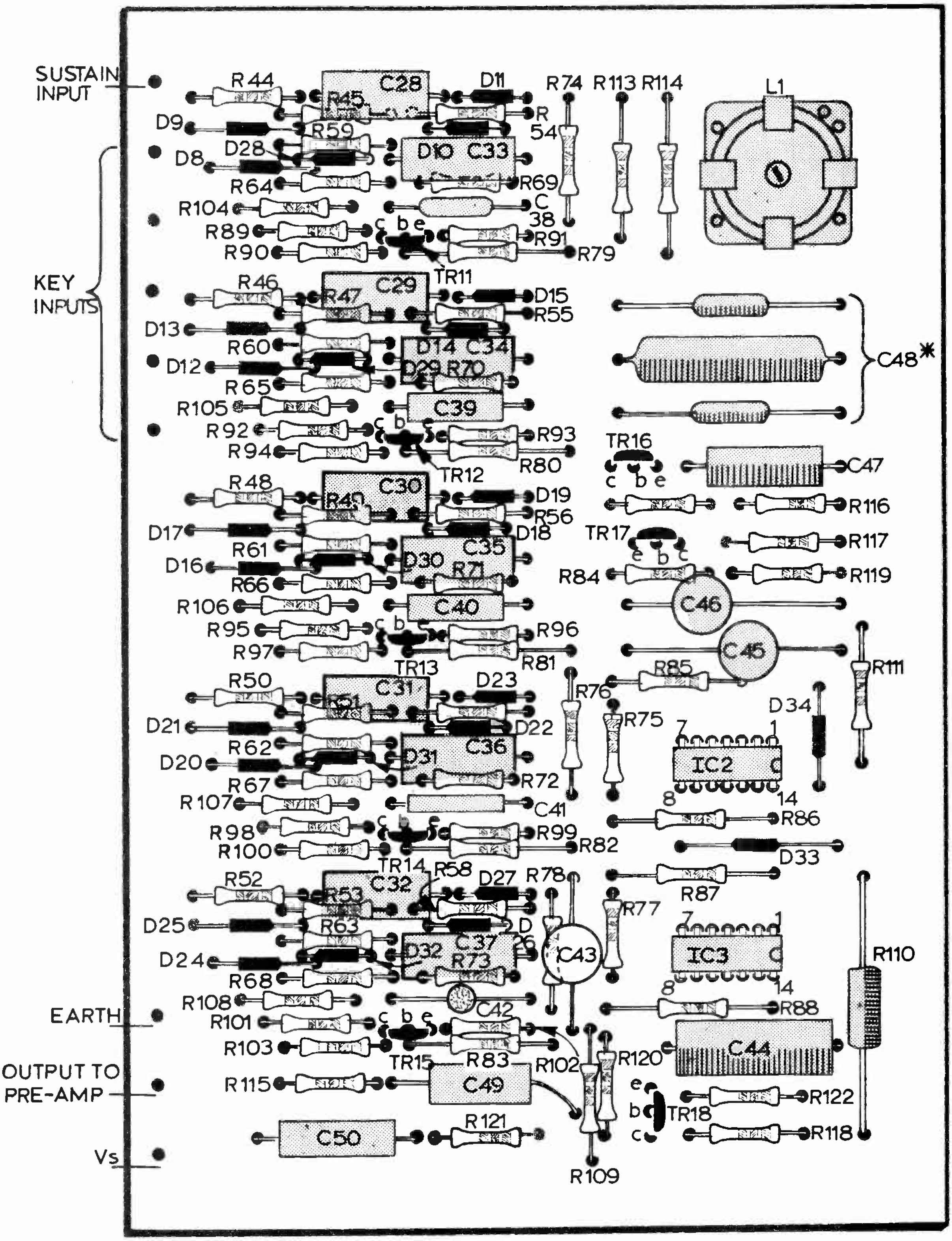


Fig. 3.4. Component layout for pitch p.c.b.

characteristics can be varied over a wide range by variation of the tone control settings on the external amplifiers.

The piano has been used in this manner on a number of occasions and exhibits the characteristics of piano, vibraphone and electric guitar depending on the chosen bass and treble positions, and the way in which it is played.

PITCH AMPLIFIER

Each printed circuit board contains five envelope circuits which are then fed into a pitch amplifier which in turn is followed by the pre-amplifier described last month.

The values of C49, R121 and C50 are important, as up to this point all coupling has been direct, and it is necessary in the amplifier to filter out the large very low frequency excursions due to the keying action.

ETCHING DETAILS OF PITCH P.C.B.

The 8in × $5\frac{3}{8}$in printed circuit board is etched according to the pattern of Fig. 3.3. Thirteen such boards are required. Fig. 3.4 shows the component layout for the boards.

COMPONENTS

All transistors specified are Ferranti type ZTX300. It is of course possible that other equivalent transistors could perform the same functions, but no work has been carried out to prove this. The diodes contained in the prototype were a mixed batch of

COMPONENTS . . .

PITCH BOARD

(12 are required with a full component complement as listed. The thirteenth requires components as shown asterisked)

Resistors

R44*	1kΩ
R45*	1·8kΩ
R46	1kΩ
R47	1·8kΩ
R48	1kΩ
R49	1·8kΩ
R50	1kΩ
R51	1·8kΩ
R52	1kΩ
R53	1·8kΩ
R54*–R58	5·6kΩ (5 off)
R59*–R63	820kΩ (5 off)
R64*–R68	27kΩ (5 off)
R69*–R73	820kΩ (5 off)
R74*–R78	5·6kΩ (5 off)
R79*–R83	56kΩ (5 off)
R84*–R88	27kΩ (5 off)
R89*	27kΩ
R90*	10kΩ
R91*	270Ω
R92	27kΩ
R93	270Ω
R94	10kΩ
R95	27kΩ
R96	10kΩ
R97	270Ω
R98	27kΩ
R99	270Ω
R100	10kΩ
R101	27kΩ
R102	270Ω
R103	10kΩ
R104*–R108	10kΩ (5 off)
R109*	1kΩ
R110	220Ω 3W
R111*	390Ω
R112*	56kΩ
R113*	270Ω
R114*	1·8kΩ
R115*	10kΩ
R116*	1kΩ
R117*	56kΩ
R118*	560kΩ
R119*	1·8kΩ
R120*	3·9kΩ
R121*	10kΩ
R122*	68Ω

All resistors ±5% $\frac{1}{4}$W carbon except where otherwise stated

Capacitors

C28*–C32	10μF elect. 15V (5 off)
C33*–C37	5μF elect. 15V (5 off)
C38*	0·05μF
C39	0·1μF
C40	0·2μF
C41	0·5μF elect. 15V
C42	1μF elect. 15V
C43*	100μF elect. 15V
C44	100μF elect. 15V
C45	100μF elect. 15V
C46*	100μF elect. 15V
C47*	0·2μF
C48*	See text
C49*	0·2μF
C50*	0·5μF

Transistors

TR11–TR18 ZTX300 (8 off)
(4 required for p.c.b. 13)

Diodes

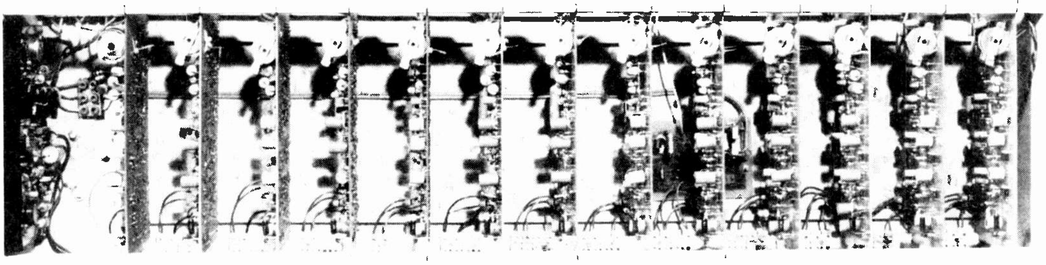
D8–D32 ZS170 (25 off) (see text)
(6 required for p.c.b. 13)
D33—KS047A 4·7V 400mW Zener (or equivalent)

Integrated Circuits

IC2–IC3 Z7474E (2 off)

Inductor

L1—260 + 260 turns of 36 s.w.g. enamelled copper wire. S.E.I. pot core assembly for this can be obtained from Clef Products (Electronics Division), Yew Tree Lane, Poynton, Stockport, Cheshire



The thirteen pitch boards mounted in a wooden sub-frame

rejects from the Ferranti ZS170 and ZS100 series production lines. *Reject devices are not available from the manufacturer*, but similar diodes are available from a number of suppliers.

The specification required is that all diodes should have a breakdown in excess of 20 volts, and be reasonable low leakage, which should be adequately covered by the use of silicon types.

The 4·7 volt Zener diodes were Ferranti type KSO47A, but again a number of equivalents should also be available.

PITCH BOARD LAYOUT

In arranging a component layout for the pitch board an attempt was made to match the physical to the circuit arrangement. This can be seen by comparing Figs. 3.1 and 3.4.

Thirteen boards are required in total. Of these 12 are required containing the full circuitry and they cover bottom F to top E.

It must be obvious, however, that in a five octave 61 key system a single note generator is required to produce top F. In general the only requirements for the thirteenth board are an oscillator, single envelope circuit, mixer and pre-amplifier. No divider circuitry is required.

The components required for this particular board are marked with an asterisk in the components list.

WINDING THE TUNING COIL

To make up the tuning inductors for the oscillators, simply pile wind 260 turns of 36 s.w.g. enamelled copper wire onto the bobbin. With even layers this works out at about 33 turns/layer. When this is done bring the wire end out through one of the slots on the bobbin on the same face as entry. Doubling the wire back, continue to wind on an additional 260 turns. The point where the wire is doubled is, of course, the centre tap and this and the two ends should be cleaned prior to tag soldering.

To hold the coil in place on the bobbin, wrap round a piece of insulation tape. With the pot core clamped round the bobbin and lead outs soldered to the tag board the inductor can be assembled to the p.c.b.

Details on the tuning process and choice of capacitor will be provided later.

Note: All enquiries for Kimber-Allen keyboard should be directed to Alan Douglas, 4 Lees Barn Road, Radcliffe-on-Trent, Notts.

AUDIO FESTIVAL AND FAIR

FOR the fourth consecutive year PRACTICAL ELECTRONICS is exhibiting at the International Audio Festival and Fair, held at Olympia, London from October 24 to 28, 1972. Equipment on display on **Stand 19** includes the P.E. Electronic Piano (currently being described in the magazine) and a number of other exciting projects to be published in the coming months; these are:

Sound Synthesiser

The P.E. Music Synthesiser is a completely self-contained sound effects unit whose composition possibilities extend as far as the user's imagination. The modular construction of the various electronic sub-assemblies means that the synthesiser can provide a limited facility for sound source production and treatments even in early stages of construction. This, of course, offsets the total production cost and enables the constructor to build, test and play with the separate modules according to his effects requirement.

A fascinating feature is that the synthesiser can be programmed to play by itself for as long as the listener wishes. (*See Lecture-Demonstration below.*)

Rhythm Generator

This variable-tempo rhythm generator can be programmed to any required rhythm to accompany a piano, organ or other musical instruments.

The percussive effects available are bass drum, high and low bongos, blocks, snare drum, cymbals and long and short brushes. Besides the programmed facility a selector switch provides a choice of a number of popular rhythms.

High Quality Tape Link

Forthcoming articles will describe how to build new stereophonic electronics for an existing tape transport deck or for a complete recorder.

The Tape Link employs separate record and replay amplifiers, the latter being driven via an extremely low current bias f.e.t. stage from a low impedance head; consequently noise and distortion figures are kept to a very low level. Replay equalisation is achieved with an integrated circuit operational amplifier, which also provides frequency compensation for circuit stability and output short circuit protection. Power amplifiers are not included. Tape speeds catered for are $1\frac{7}{8}$, $3\frac{3}{4}$, $7\frac{1}{2}$ inches per second.

Lecture-Demonstration

Visitors to the Audio Fair should note the P.E. Sound Synthesiser is being demonstrated during a special lecture entitled "Sound Synthesis for the Amateur", presented in the exhibition lecture theatre on Tuesday, October 24 and again on Saturday, October 28, at 2 p.m.

We welcome all readers in London in October to see our exclusive designs in the flesh. Only at Olympia, October 24 to 28, 1972.

SINCE few component manufacturers use really indelible identification markings on their components, it is inevitable that sooner or later the home constructor will require a piece of equipment, which will enable him to measure the value of a component from which these markings have been erased. Such a unit is also extremely useful when trying to locate a faulty component, or when trying to identify one with an unfamiliar colour coding. The bridge described in this article will fulfil all these functions.

CIRCUIT DESCRIPTION

An extremely simple circuit with only three transistors is used. Ranges of the bridge cover capacitance from 100pF to $10\mu F$ and resistance up to 100 kilohms, in five ranges of capacitance, and five ranges of resistance.

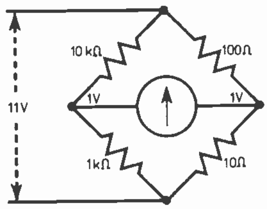
These ranges are as follows:

Range	Capacitance	Resistance
1	100pf–1000pf	0–10Ω
2	1000pf–0·01μF	0–100Ω
3	0·01μF–0·1μF	0–1kΩ
4	0·1μF–1μF	0–10kΩ
5	1μF–10μF	0–100kΩ

THE WHEATSTONE BRIDGE

The circuit is based on the Wheatstone Bridge, and a short explanation of the operation of this will be given.

The circuit of a basic Wheatstone Bridge is given in Fig. 1. It will be seen that the bridge consists of four resistors and a meter. There will be no indication on the meter when the circuit is balanced, that



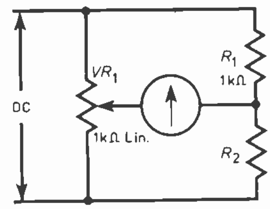
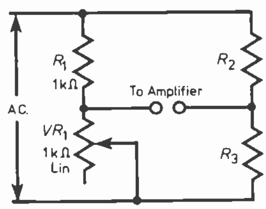


Fig. 1. The basic Wheatstone Bridge circuit (left)

Fig. 2. A modification of the Wheatsone Bridge circuit normally used for resistance measurement (right)



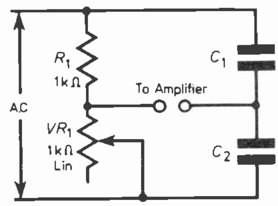
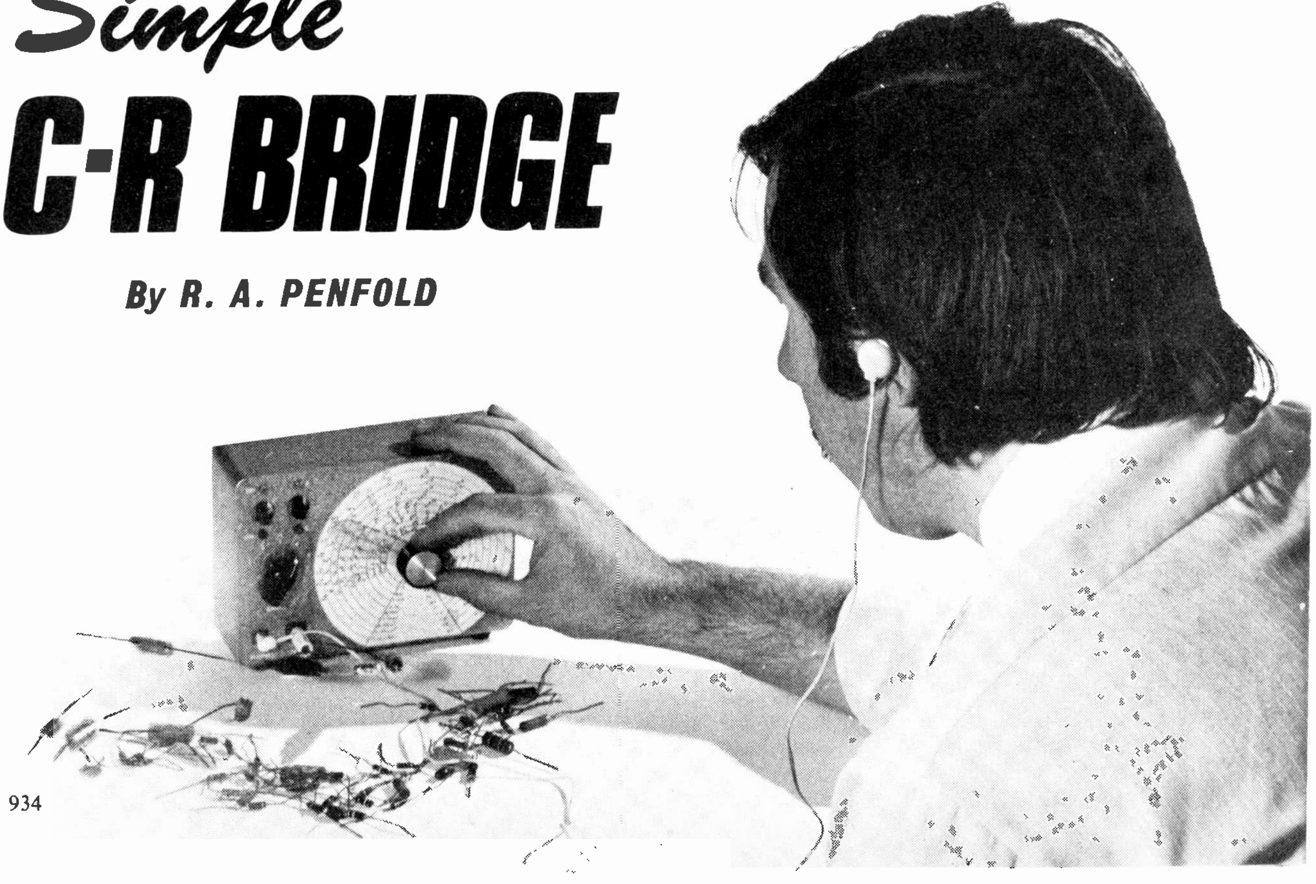


Fig. 3. An improvement of the previous circuit which produces a linear scale (left)

Fig. 4. A modification of the basic bridge circuit used to measure capacitance. This system does not produce a linear scale (right)

Simple C-R BRIDGE

By R. A. PENFOLD



is, when there is the same voltage at the junction of the 1 kilohm and the 10 kilohm resistors as there is at the junction of the 10 ohm and 100 ohm resistors.

The meter will read the difference between the two potentials at these points. As there is one volt across both points, there is no difference in potential, and there can be no deflection on the meter.

Should one of these resistors be altered in value, even very slightly, then there would be an indication on the meter. If R_1 and R_2 were replaced by a potentiometer, as in Fig. 2, then it would be possible to adjust this component so that the circuit was once again balanced.

The voltage on the slider of the potentiometer would be variable from zero to the supply voltage, and could therefore be adjusted for zero reading on the meter, whatever the ratio of R_1 to R_2.

If the variable resistor is fitted with a suitable scale, then when this component is adjusted for a null on the meter, the value of the resistor under test may then be read off the scale.

This is of course only possible if R_1 is a fixed, and known value, or a series of resistors of known value. Whatever the value given to R_1, the same value will appear at the centre of the scale of VR_1.

IMPROVED METHOD

Theoretically the circuit is capable of measuring any resistance from zero to infinity, but in practise, the scale would become so cramped at the ends, that it would be impossible to use.

Therefore if R_1 is made of several switchable resistors, then the resistor to be tested can be measured near the centre of the scale, where it is less cramped.

An improved arrangement is shown in Fig. 3. This will measure resistance from zero to the value of R_3 with a linear scale. There is no cramping of the scale, which covers a far smaller range than the arrangement of Fig. 2.

This arrangement is also different in that the d.c. source has been replaced by an a.c. source, and the meter has been replaced by an audio amplifier, which would be connected to an earpiece.

Using an a.c. source enables capacitance to be measured by changing the resistor, R_2, for a capacitor. Fig. 4 shows the arrangement for the measurement of capacitance.

Unfortunately, when measuring capacitance a linear scale is not obtained. This is due to reactance (resistance to an a.c. flow) decreasing as capacitance increases.

This means that the bridge will measure from the value of C_1 to infinity, with a centre scale of double the value of C_1. The scale does become rather cramped at the high value end, but this is far less so than the arrangement of Fig. 2.

THE PRACTICAL CIRCUIT

A circuit diagram of the complete C-R Bridge is given in Fig. 5.

A multivibrator using two BSY95A transistors is used to provide the a.c. source. The audio amplifier uses a single type 2N2926 transistor, which feeds into a high impedance crystal or magnetic earpiece.

The range switch is a two-pole five-way wafer switch which selects one of five resistors from 10 ohms to 100 kilohms and one of five capacitors from 100pF to 1μF. A second switch is used to select either resistance or capacitance.

Separate power supplies have to be used for the amplifier and the multivibrator, to prevent the amplifier from picking up the output from the multivibrator through the supply lines. This also makes the coupling between the bridge, and the oscillator and amplifier much simpler.

Two torch batteries are used to supply the power.

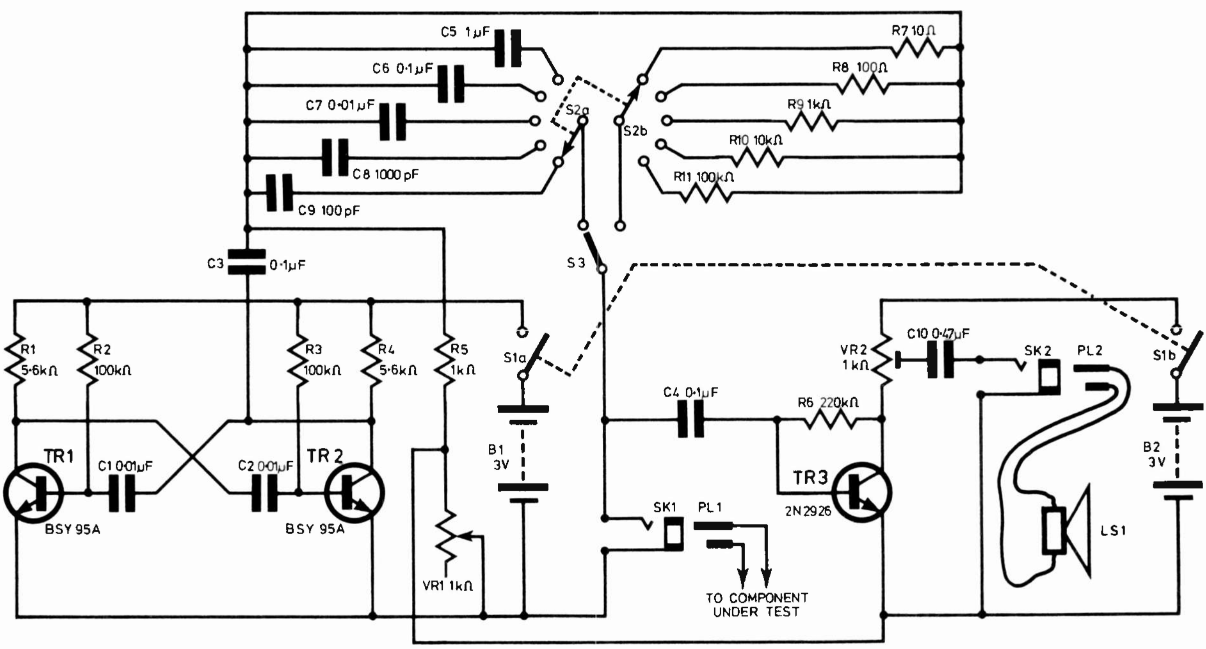


Fig. 5. Circuit diagram of the complete unit with the oscillator, bridge and amplifier

COMPONENTS . . .

Resistors
R1 5·6kΩ
R2 100kΩ
R3 100kΩ
R4 5·6kΩ
R5 1kΩ 2%
R6 220kΩ
R7 10Ω }
R8 100Ω }
R9 1kΩ } 2%
R10 10kΩ }
R11 100kΩ }
All ±10% ½W unless otherwise stated

Potentiometers
VR1 1kΩ linear wirewound
VR2 1kΩ miniature skeleton preset

Capacitors
C1, C2 0·01μF ceramic (2 off)
C3, C4 0·1μF ceramic (2 off)
C5 1μF }
C6 0·1μF }
C7 0·01μF } 5% or better
C8 1000pF }
C9 100pF }
C10 0·47μF

Transistors
TR1, TR2 BSY95A *or* similar (2 off)
TR3 2N2926

Switches
S1 2 pole on/off slide
S2 2 pole 5-way rotary
S3 1 pole changeover slide

Miscellaneous
PL1, PL2 and SK1, SK2 Miniature jack plugs and sockets (2 off)
LS1 High impedance earpiece
B1, B2 3V torch batteries (2 off)
3¾in × 1¾in 0·15in matrix Veroboard
Aluminium case, battery clips, crocodile clips

COMPONENTS

As the sensitivity of the earpiece may vary according to which particular type is used, a one kilohm preset potentiometer is incorporated, so that the output may be reduced, should it be found to be excessive. The circuit is unsuitable for use with a low impedance earphone.

Although adequate results may be obtained using a carbon potentiometer for VR1, better results will almost certainly be obtained using a wirewound type. Other components for the bridge should preferably be one or two per cent tolerance types, with a high stability, if a reasonable accuracy is to be attained.

Transistors other than the types specified have been found to work in the circuit, and it would operate using almost any transistors.

CONSTRUCTION

The prototype was built in an aluminium case, measuring 6¼in × 4¼in × 2$\frac{5}{32}$in, but almost any case of about these dimensions could be used, although the unit could not easily be made much smaller than this.

If a metal case is used, neither the oscillator or the amplifier should be earthed to it as this would encourage oscillator breakthrough.

A small piece of Veroboard (0·15in matrix) 21 × 7 holes, was used as a basis on which to construct the main circuit. A wiring diagram for this is given in Fig. 6.

The best method for connecting the component under test into circuit was found to be a lead with a jack plug one end, and a couple of crocodile clips the other end.

The jack plug may be plugged into the bridge, while the crocodile clips connect to the leads of the component under test.

INTERWIRING

All wiring associated with VR1, switches S1 and S2, and the two crocodile clip leads, should be as short as possible otherwise breakthrough of oscillations may make it impossible to locate a proper null point on some ranges, and capacitance in the wiring could make capacitance Range 1 wildly inaccurate.

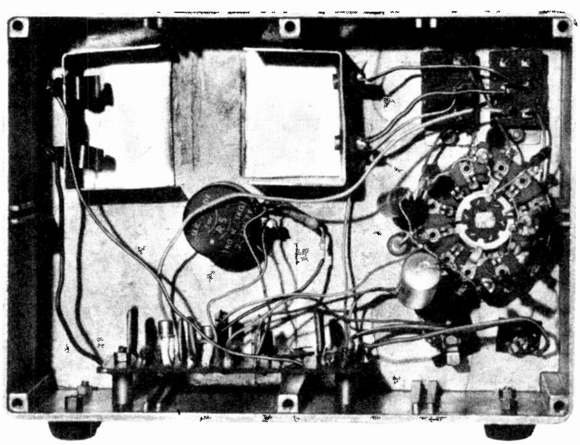
Both the earphone socket and the test lead socket have to be insulated from the front panel to prevent them from being electrically connected, and to prevent breakthrough. This may be achieved by drilling the mounting holes slightly too large, and then fitting bakelite washers either side of the panel.

Capacitor C10 is only required if the bridge is to be used with a magnetic earpiece. If a crystal type is used, C10 may be omitted, and the earpiece connected directly to the slider of VR2.

CALIBRATION ACCURACY

Although both the resistance and the capacitance scales can be calculated mathematically this is unnecessarily complicated, and is unlikely to be as accurate as the following method. This method is to calibrate the scale against a number of close tolerance components of suitable values.

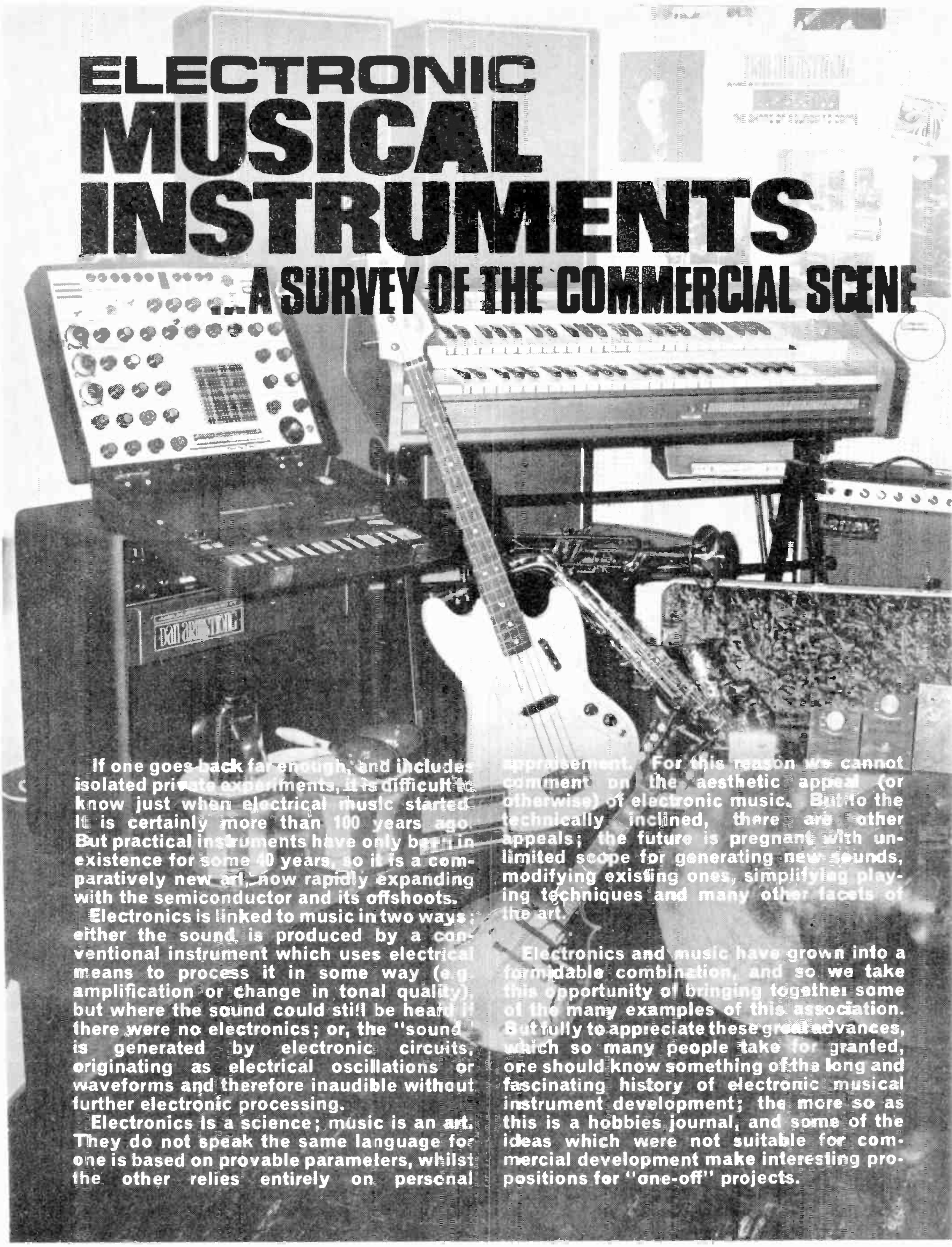
An individual scale is required for each range. The resistance scales will read in the opposite direction to the capacitance scales. They should be marked in preferred values, from 10 to 100. At the end of each scale there should be added a multiplier. For example. On Range 4 resistance × 100 should be added at the end of the scale, so that if



Rear view of the unit showing the disposition of the batteries, component board and switches

ELECTRONIC MUSICAL INSTRUMENTS

...A SURVEY OF THE COMMERCIAL SCENE



If one goes back far enough, and includes isolated private experiments, it is difficult to know just when electrical music started. It is certainly more than 100 years ago. But practical instruments have only been in existence for some 40 years, so it is a comparatively new art, now rapidly expanding with the semiconductor and its offshoots.

Electronics is linked to music in two ways; either the sound is produced by a conventional instrument which uses electrical means to process it in some way (e.g. amplification or change in tonal quality), but where the sound could still be heard if there were no electronics; or, the "sound" is generated by electronic circuits, originating as electrical oscillations or waveforms and therefore inaudible without further electronic processing.

Electronics is a science; music is an art. They do not speak the same language for one is based on provable parameters, whilst the other relies entirely on personal appraisement. For this reason we cannot comment on the aesthetic appeal (or otherwise) of electronic music. But to the technically inclined, there are other appeals; the future is pregnant with unlimited scope for generating new sounds, modifying existing ones, simplifying playing techniques and many other facets of the art.

Electronics and music have grown into a formidable combination, and so we take this opportunity of bringing together some of the many examples of this association. But fully to appreciate these great advances, which so many people take for granted, one should know something of the long and fascinating history of electronic musical instrument development; the more so as this is a hobbies journal, and some of the ideas which were not suitable for commercial development make interesting propositions for "one-off" projects.

ELECTRONIC ORGANS

We begin with electronic organs, because these instruments represent the most ingenious combination of mechanics and electronics, can often be built at home, and are capable of endless development. All such instruments are played from keyboards and the controls follow internationally recognised methods to a great extent, but certainly not exclusively. The whole concept of organs has changed in the last 20 years. There is now no resemblance (in the popular mind) to the conventional organ with pipes. Yet, incredibly, the same conventional names for the sounds appear on the stops!

Harking back to the days when valve circuits tended to be unstable, mechanical systems with transducers seemed the best answer; of these, two survive today, Hammond and Compton. Such organs are permanently in tune but require complex circuitry and switching devices. With the increasing cost of manufacture it seems probable that they will disappear in time. Already solid state circuitry is taking the place of mechanical switching in pipe organs, although slowly, but for other kinds of electronic organ, semiconductors are paramount.

It is easier to start from the top and work downwards, so we give an example of an imitative organ by Conn as representing the "real thing". Fig. 1 illustrates a church or concert organ having tonal and control properties exactly corresponding with pipes.

This instrument has independently tuned oscillators for each note and these can give at least three different waveforms for tonal synthesis. As the sound in a pipe organ comes from a widely dispersed source, so this class of electronic organ requires many channels of amplification and many loudspeakers—a minimum of perhaps 25.

Multiple oscillators are never exactly in tune, but perhaps more important is the fact that there are trifling differences in the harmonic content of each oscillator. This gives a close resemblance to organ pipes, which have the same properties. The sound is full and rich, excellent for a real organ, but quite useless for pop or jazz.

Nine out of ten organs of the popular domestic type which can be seen in any music shop use a quite different generating system. The 12 top notes are produced by tuned master oscillators, but all other pitches downwards are obtained by frequency division. Since the octave is an exact doubling or halving of any frequency, 2 : 1 bistables or flip-flop circuits serve admirably. Readers will recall that this was the method used in the P.E. organ. It lends itself to mass production especially now that i.c.s are becoming so cheap; and with diode or transistor keying, cheap single contacts per key suffice.

If properly designed, this kind of organ can be very satisfying more especially at the low output levels demanded in the home. Unfortunately it is commonly found in forms which have neither the proper playing facilities of imitative organs, or the "new" sounds associated with rhythmic organs. Excessive amplification makes these organs lose what character they possess, and underlines the old saying that you can't get a quart out of a pint pot.

However, the prompt attack and the easy application of rhythm units to this kind of instrument makes them eminently suitable for pop groups and this has led to a form of tonal synthesis which contrasts well with guitar or voice. To a great extent they must be treated

Fig. 1. The three manual Conn Custom organ has independently tuned oscillators for each note. These can provide at least three different waveforms for tonal synthesis of a church or concert pipe organ.

The Kentucky Challenger with string, flute and woodwind voicing available via the 4-octave solo and accompaniment manuals.

The effects include solo manual and pedal sustain, variable attack, reverberation, vibrato and Hawaiian glide.

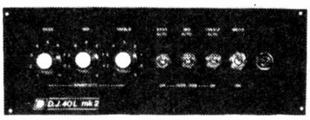
Disco SOUND & LIGHTING EQUIPMENT from 4 SPECIALISED DISCO STUDIOS

HIGH POWER SPEAKER SYSTEMS

Strong leather cloth finish ¾" board, fully lagged. Fitted high efficiency 8 or 16 ohm speakers.

PRINCE. 50 watt rms. 12". Size 24" × 16" × 12".
CONSORT. 100 watt rms. 2-12" speakers. Size 36" × 18" × 12".
MAJESTIC. 100 watt rms. 15" Crescendo. Size 38" × 24" × 15".
SOVEREIGN. 100 watt rms. 18" Bass. 12" Full range. Size 50" × 26" × 14".

FULL RANGE OF MICROPHONES, STANDS, ETC. ALWAYS IN STOCK



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Mid, Treble and Bass Channels, up to 1kw of lamps per channel plus override switching.

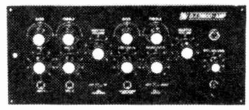
DJ30L. Sound to light. Takes output from most amplifiers. Adjustable levels.

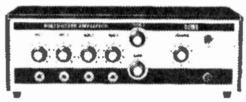
DJ40L. Sound controlled version. Built in microphone, no connections required.

ASSEMBLED DISCOTHEQUES

DISCO-PLINTH. Consists of 2 turntables fitted with high quality ceramic cartridges. The unit has a built in cross-fade rotary control for transferring the sound from left to right decks. The unit has no amplification built in and must be used with amplifiers such as the D.J. 105S or D.J. 70S. Size 32" × 14½" × 7" (incl. lid). **£55·00**
DISCO-IMP. The latest addition to the Disco-sound Range of discotheques. Even smaller and more compact than the Disco-Mini, it contains all the necessary features for the smooth running of a mobile unit. Size 29" × 18½" × 7". **£79·00**
DISCO-MINI. Complete portable Disco with built-in full function preamplifier/mixer. For use with any power amplifier such as "Discmaster". Size 30" × 20" × 8". **£98·50**
DISCO-STANDARD. Has all the facilities of the Disco-Mini with the addition of a built-in 100 watt power amplifier making it a completely self contained disco unit. A V.U. meter gives visual indication of output levels. Size 32" × 27" × 7½". **£180·00**
DISCO-SUPER. A slightly larger version of the Disco-Standard. Fitted individual controls for both mic. and deck inputs plus a cross-fade for deck to deck transfer. A built in P.F.L. cueing system, mic. over-ride, also a V.U. meter gives visual indication of output levels. DJ. 30L (3000w) 3-channel psychedelic light unit is a standard fitting. Deck cut out switches are also featured for ease of cueing. Size 38" × 27" × 10". **£224·00**
DISCO-SUPREME. All facilities of the Disco-Super plus a third turntable which can be used for Jingles or other effects without using the main deck system. Flexi lights are also fitted. Size 50" × 27" × 10". **£261·00.**

PA—DISCO AMPLIFIERS





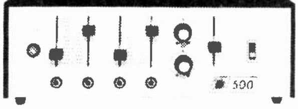
DISCO-AMP. 100 watt rms. output for 8-16 ohms, 4 channel inputs, 2-mic, 2 decks. Separate volume control plus masters. Response 30Hz –30KHz, distortion less than 1%. Treble/Bass/PFL/Mic over-ride etc. Panel size 16½" × 7".

DJ.70S MIXER/AMPLIFIER. 70 watt rms. output for 8-16 ohms. 2-mic, 2-aux/decks. Master volume/Bass/Treble. Size 15½" × 5" × 6".

DJ.105S. 30 watt rms. version. Size 11¾" × 5" × 6".
DISCMASTER SLAVE AMPLIFIER. 100 watt rms. for 8-16 ohms. **£59·50**

NEW D.J. 500 SERIES P.A. AMPLIFIERS 50 WATT, 70 WATT & 100 WATT MODELS

This new range incorporates many features that make them ideal for the professional user, clubs, discotheques, factories etc. Fibre glass P.C. Boards are used throughout with low noise silicon transistors, high stability resistors, generously rated components and hand wired assembly to ensure reliability and quality.



★ Exclusive "Fail Safe" Electronic Protection circuit.
★ Fault Condition warning lamp.
★ Built in bass boost below 30 Hz.
★ 4 channel mixer with slider controls.

All three amplifiers have a built in emitter follower output socket for connecting a slave amplifier to enable the power output to be increased up to 1000 watts or more if required. A matching range of slave power amplifiers and a separate matching 100v line transformer is available

SPECIFICATION

Frequency Response	50-20,000 Hz ± 3db (10dB Bass Boost at 10 Hz)
Signal/Noise Ratio	better than −50db.
Harmonic Distortion	less than 1%
Speaker Impedance	8–16 ohms.
Inputs: Mic 1 & 2	5mV at 50K ohms (50 or 600 ohm to order)
Aux 3 & 4	100mV at 1 meg ohm.
Size (all models)	15½" × 5" × 6".

Power Output: (at 8 ohms)	Model D.J.500	50 watts R.M.S.	£56·25
	Model D.J.700	70 watts R.M.S.	£67·50
	Model D.J.1000	100 watts R.M.S.	£79·00

DISCO MINI

Hardly larger than a suitcase yet contains all the necessary features for a high quality mobile unit. The pre-amp has separate tone controls for both mic. and decks, and each input has its own individual volume controls and inputs, plus the addition of a cross fade for deck to deck sound transfer. A built in P.F.L. system for cueing, together with mic-over-ride facility are standard on all units. Response 20-20,000 Hz. Mic. input 5mV. 50K. Output 1 volt.
McDonald M.P.60 Turntables are used with high quality ceramic cartridges, and each deck has its own individual cut out switch fitted. This unit is suitable for Discos or Clubs having a power amplifier, or for use with the 'Discmaster' 100 watt power amplifier as above. Size 32" × 20" × 8". **£98·50.**

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DISCO COLT. 150 watt.
LIQUIMATIC MINI, 50 watt Q1 with 6" wheel.
DISCOWHEEL, 50 watt Q1 with quick change Cassette.
GNOME 150, 150 watt Q1 with Cassette.
LIQUIMATIC, 150 watt Q1 with 6" wheel.
PLUTO TUTOR-2, 250 watt Q1 with Cassette and 6" wheel.
TUTOR-2, with Liquisplode Tank.
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High efficiency 12" speakers. Ferrite magnets. Heavy duty voice coils and cones for Disco and Group use.
12" 50 watt rms. 8 ohm Full range.
12" 25 watt rms. 15 ohm Mid-Treble.
15" 50 watt rms. 15 ohm. Full range.
15" 100 watt rms. 15 ohm. Bass.
18" 100 watt rms. 15 ohm. Bass.

DISCO SPOT BANK

Designed to take three E/S Type spot or colour bulbs up to 150 watts each. The unit is of all metal construction and has one 3-pin mains input socket plus one 3-pin mains output socket for connecting more than one bank together if required. The unit can be left free-standing or wall mounted if needed. Black crackle finish gives the unit a very professional appearance.

Size 18" × 6" × 7" (excluding bulbs)

Also in stock: Ultra Violet Spot Lamps and Fluorescent Lamps, Standard and Colour Spot Lamps and Fittings. Rotating Colour Displays. Flexilights, Fibre Optics, Dimmers, Flashers Effects Foils, etc. Your enquiries invited.

MIXER UNITS

DJ.101. Battery powered, 6-channel, variable levels, 3 × 50k mic., 1 × 100mV. aux., 2 × 100mV p.u. Output 250mV.

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as new sound devices and we show one of the most modern and effective examples in Fig. 2. This is made by Jennings Electronic Instruments, and bristles with ingenious features.

In this organ, the emphasis is on facilities for rhythmic playing rather than on simulation of conventional organ tonecolours; a special training and a special mentality is required to conform to the needs of a purely rhythmic group, and this is an excellent example of an instrument specially designed to this end.

The foregoing organs have all had tuned oscillators for each primary function and once these are adjusted, it is not possible to alter them easily. But now, it is possible to design and make an organ having only one master oscillator from which all pitches are derived. One great advantage is clearly that transposing is easily carried out—i.e., if one presses just one key, the pitch can be changed by a single adjustment so that one passes through a succession of keys. The player who can only use the white keys can now accompany say, a B flat clarinet whilst still using his white keys.

There are several ways of doing all this, mostly very complex, and all a tribute to microminiature circuits; for without these it would be quite impossible to build such an organ within any console or case. Modern i.c. component density can reach 2,000 elements in a chip only $\frac{1}{8}$in square and so the very complex circuitry required to steer and smooth the pulses of such a system can be made quite small. Two of the present methods for generating the frequency spectrum from a single source have been described in Practical Electronics for July 1972 but in the picture of the Philips generator the actual size was not obvious; in Fig. 3 you can see the relative size of this unit.

An organ built from half a dozen of these units would have amazing powers of synthesis.

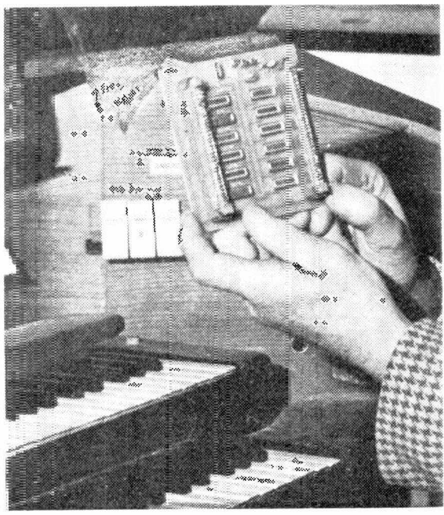
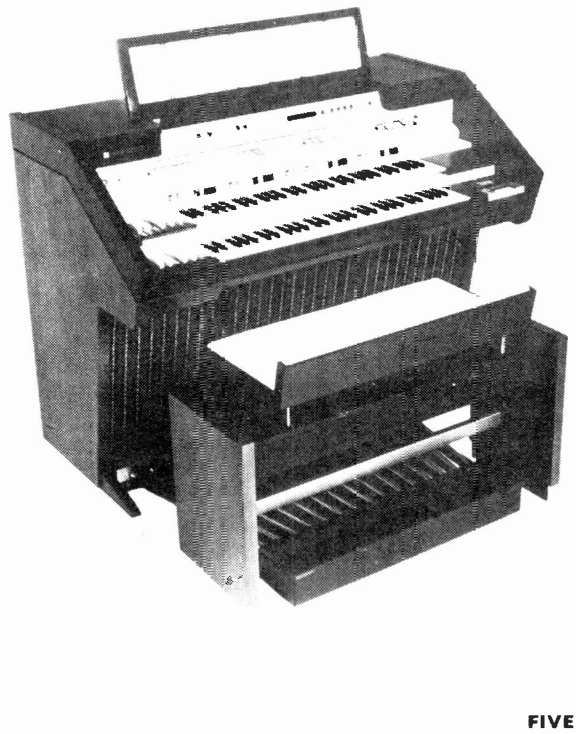


Fig. 3. Demonstrating the small size of the N.V. Philips' digital organ generator.

Fig. 2. The three manual, portable, Jennings J.71 with drawbar control of harmonics from 16′ to 1′ pitch and percussive attack. This, with the provision of dual waveforms, enables the organist to reproduce any mixture of sound required.

Other features include separate by-pass tabs for Theatre and Baroque organ. The top manual covers three octave providing 16′-8′- and 2′ pitch with controls for tonal effects which include vibraharp, piano, string, percussion and sustain.



One of Hammond's new models, the Concorde, incorporates custom built LSI packages. This harmonic tone-bar organ has two 61 note keyboards and such features as polysynthesis percussion, manual and pedal sustain, automatic accompaniment and automatic rhythm, lower manual to pedal couples and cassette recorder.

Talking about synthesis, we find small keyboard controlled devices mounted in the Wurlitzer organs on which many effects not obtainable with any ordinary organ circuits can be produced. For instance, gliding tones, wah-wah, touch sensitive vibrato, extended pitch range and other effects are some of the attributes of the Orbit synthesisers on this organ. Certainly it is time that double touch was more used on organs, especially since it was an integral fitment of all cinema organs since the 1920s. So many things can be done with a second touch.

Now we have seen three kinds of tone generating systems for organs of a more or less conventional kind. But for the beginner, or one who does not wish to lay out much money on a single-purpose instrument, there are other ways of making musical sounds. Perhaps the simplest device is the stylophone, shown in Fig. 4. This is a simple multivibrator, played by using a metallic stylus to make the connection for changing the pitch. It is a continuously re-tuned system, capable of only one note at a time, but having a vibrato circuit which relieves the monotony. Constructional articles for something of this kind have appeared in various journals and it is a nice project for the beginner.

A more sophisticated device is the Pianomate. This assumes ownership of a piano, although it could be energised by a separate keyboard. It can be seen in Fig. 5 lying over the keys of a piano. Again, it is a simple generator, but chords can be played with care. The system uses one generator for every three notes, but if played with the piano, which of course is fully polyphonic, it appears that the organesque sounds from the generator are also fully polyphonic.

A small mains unit which stands on the floor contains all the electronics and allows changes of tone-colour; a volume control pedal is also available. Incidentally, as the contact unit for the four octaves of keys only rests on the back of the piano keyboard, it can be removed or placed on another make of piano in a moment and cannot damage the woodwork.

We find many people interested in playing music who are not satisfied with synthetic tone colours; certainly many organs become very trying to listen to for long and rely heavily on vibrato to break up the lifeless sounds. Many attempts have been made to bring the actual sounds from organ pipes or orchestral instruments to the keyboard, culminating in the Mellotron. Originally this instrument was much more complex but the present version is easily portable and just as accurate tonally.

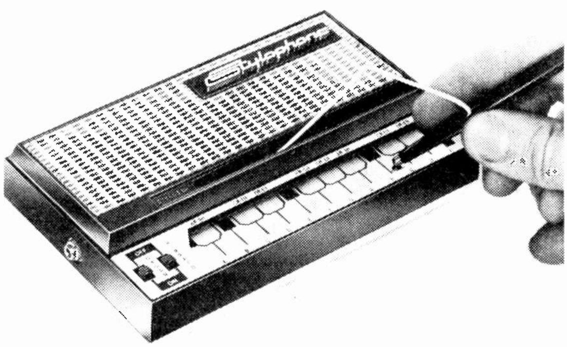
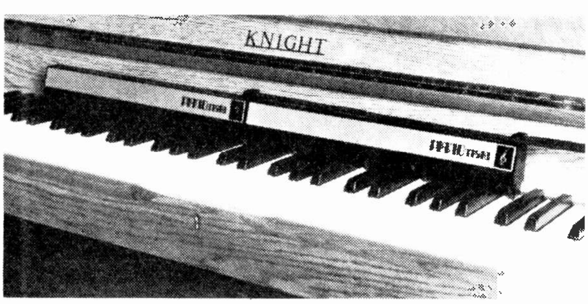


Fig. 4. The Dubreq Stylophone has a reedy voice, derived from a multivibrator circuit. To this vibrato can be added if desired. This instrument is only capable of producing one note at a time, each being selected with a metal stylus which constitutes part of the electronic circuit. In concert the sound produced can be very pleasant.



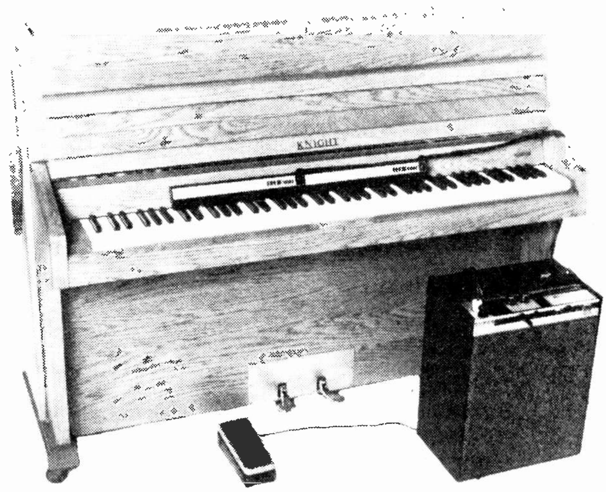
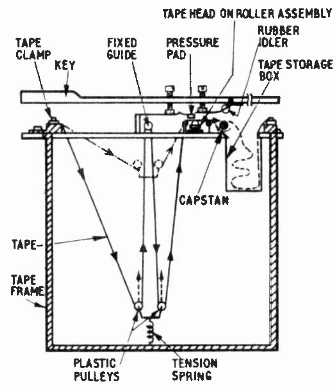


Fig. 5. The Dubreq Pianomate in position on a conventional pianoforte keyboard. This consists of two double octave unit whose contacts move with the piano key to augment the piano sounds with organesque tone colours. A tone selector switch provides three different colours: flute, church organ and jazz buzz. A two speed vibrato is also included. The Pianomate is completely tuneable via a single control for pianos which may be out of pitch by as much as a semitone

The system uses pre-recorded tapes but these are not in the form of loops as might be thought; the ingenious mechanism is too complex to describe here, but in essence when a key is pressed, a tape head is brought into contact with a record of the selected sound and continues to sound (so long as the key is held down) for up to 8 seconds. The tape then rewinds at once and is ready again. All the sounds provided are of course as authentic as the fidelity of the reproducer, all can be mixed, and many effects sounds can be brought in on other tapes; indeed, the Mellotron is popular as a pure effects machine, from which every conceivable noise can be obtained at will. Fig. 6 illustrates the action of this instrument.

Fig. 6 A pure effects machine, the Mellotron is a source for every conceivable noise. The system uses prerecorded tapes of other instrumental sounds or special effects which can be mixed at will by the performer making him, in effect, a one man band. The action of the Mellotron can be understood by referring to the profile drawing of the key and tape transport system;when the key is depressed the idler engages with the capstan pulling the tape into the storage box; the tape is kept in tension by the rising pulleys; with the key released the tape is made ready for replay as the tension spring returns to its original position pulling the stored tape with it.



The RIHA Largo, besides having the normal footages in the upper and lower manual, has fractional number stops to provide more colourful registration. Playing features include a two-speed Leslie tremulant (a spatial effect achieved by feeding the loudspeaker output into a rotatable drum), vibrato delay, which provides a much more natural vibrato sound and solo percussion which gives the choice of many effects such as banjo and Hawaiian guitar.

The sustain feature on the pedals provides a string-bass effect on the pedal 8′ stops so giving rhythmic support to melody on the manuals. The sustain can also be used to play legato on the 13 note pedalboard.

The Harmonics Solette organ with a specification designed to cover all aspects of organ music from the classics to pop. It has a full size 61 note keyboard and a total of 19 registers.

INSTRUMENT TRANSDUCERS

Electric guitar pick ups have been with us for a long time; more recently the use of transducers has spread to other instruments such as clarinets, saxophones, violins and accordions. The aim of these methods is twofold; to amplify the original sound, and to be able to alter the waveform of the sound by electronic means, e.g. to remove harmonics or to add extra octaves by frequency division; or to modify the steady tone in some other way. But firstly let us look at how the guitar operates.

The diameter of a string is so small compared with the wavelength of any frequency within the range of that string that the back wave from the vibration would at once neutralise the front wave and nothing would be heard; the string produces no sound, it drives the belly or resonating body of the guitar and this couples with sufficient air to make the resultant vibrations audible as sound. However, it is costly to make a good acoustic guitar and the resulting sound is not loud enough to compete with other sounds in a modern group; the acoustic guitar is therefore reserved for the classical player, since it is many times more sensitive to fingering than its electrical counterpart, and the tone is not coloured by amplifiers or loudspeakers.

For the pop scene, it is desirable to convert all sounds into electrical waveforms and hence have complete control over them. So all we need is the vibrating string with suitable pick-ups. This means a simpler instrument in theory, but by the time that electronic controls and perhaps multiple pick-ups are fitted, it may well be more complex. Constructional data for pick-ups has been published and it is very easy to amplify this sound; one can then add simple tone controls and so alter the effect. If, therefore, it is possible to use steel strings or strings wrapped with steel wire over the pick-up location, magnetic pick ups are easily applied to any stringed instrument.

Note that the string pick-up is to be preferred to any form of microphone attachment; because the latter is sensitive to air pressure waves as well, and can pick up breathing and scratching noises from fingering the string. But when one comes to other instruments, in which the same amount of energy is not required of the player (or in a different form, such as blowing a clarinet), then it is possible to use noise cancelling types of microphone to amplify the tone. Certainly this has advantages if only because the waveform of the generated sound can be changed and one may get the effect of several different kinds of instrument from the one. An excellent example of this is the electric mouth organ or harmonica.

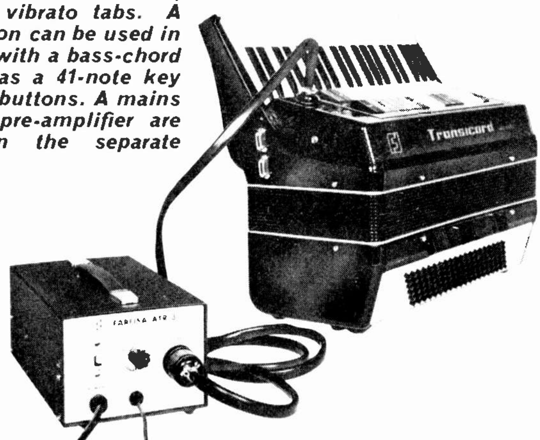
There are examples of amplified accordions and a number of purely electronic ones, using the circuitry of a miniature organ and connected to external amplifiers and loudspeakers. Then again, it is possible to obtain an electronic string bass unit, buttons producing all the effects from normal bowing to pizzicato or col legno (playing with the back of the bow). This is made by Hohner.

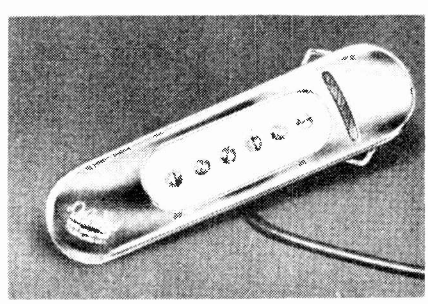
Many of these existing tone qualities can be completely transformed by, say, a percussion unit; this enables some sound which would normally be smooth and sonorous to be made aggressive and staccato. This kind of percussion unit can be wired in anywhere between a pick-up and its amplifier. It is not to be confused with a rhythm unit, which is a quite independent source of percussive sounds acting as rhythm markers and non-musical in effect. Many such rhythm boxes are on the market now, nearly every large domestic organ has one as an integral part and many can be bought to add to whatever sound source would benefit.

Hornby-Skewes accordion microphone is connected to the side of the accordion and picks up sound for feeding to an amplifier

Magnetic type contact pick-up with fingertip control. Suitable for nylon string guitar.

Farfissa Transicord electric accordion with seven voices, sustain and vibrato tabs. A rhythm section can be used in conjunction with a bass-chord facility. It has a 41-note key and 120 bass buttons. A mains supply and pre-amplifier are contained in the separate module





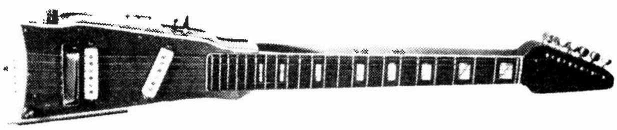
Six magnet pick-up for flat top guitars.

The Farfisa Super Piano with keyboard and decay as on the conventional piano. The effects which can be obtained on the first 24 notes are, for the bass: bass, string bass and bass guitar. For the chords: pianoforte, guitar and banjo. Also available is automatic bass and chord rhythms. Output available is 25 watts.

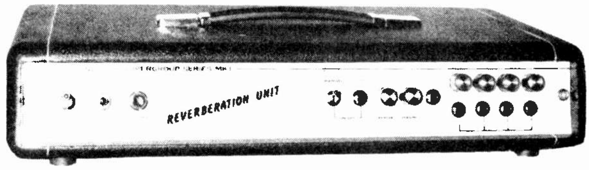
A Yamaha electric guitar.

The Harmony Baroque electric mandoline with a body shape that departs from the classical for ease of playing.

Maestro ring modulator.



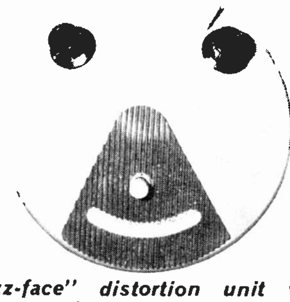
The Jennings Winchester "Rifle" guitar with a body which is constructed entirely of metal providing a crisp, pure tone. Apart from the normal guitar sound this instrument has internal electronics to provide bass, treble, fuzz, presence and repeat.



Typical reverberation unit from the Laney Sound Supergroup Series.

Soundimension: a device for providing echo and reverberation affects when used with an amplifying system.

A "Cry-baby" wah-wah pedal.



"Fuzz-face" distortion unit with separate volume and fuzz controls.

SPECIAL EFFECTS

The continual search for new effects has led to the electronic controls known as wah-wah, growl, glide, etc. All of these do something not normally expected from the instrument to which they are attached. Once associated solely with the guitar, they are now found on electronic organs and other complex devices. Readers will be familiar with the effects on the tone, and constructional details for most have been described in the press.

The wah-wah is a tuned circuit, the resonance of which can be altered at will; some band of frequencies is then accentuated and moves progressively to another band by the manipulation of a foot control. The growl is almost identical, but operates at lower frequencies. A glide circuit is found on some organs, usually it provides a limited frequency shift by altering the base biasing of a transistor oscillator through a voltage control; again the foot is used to move a variable resistor of some form.

Since some of these effects may be needed at short notice, it is possible to combine the controls on a single foot pedestal where the toe selects the function, whilst the heel operates a rotary volume or similar control. A commercial multiple control unit is shown in Fig. 7. There is clearly a limit to the number of controls which can be used by someone who is usually playing an instrument at the same time.

The vibrato produced by a violinist, which is an important part of his technique, may be imparted by a mechanism which alters the tension of the guitar strings by a lever; but it can also be done by an electronic circuit—commonly a form of adjustable speed multivibrator. This again can be inserted between the pick-up and the amplifier but naturally it is not so expressive or controllable as manipulation of the strings. However, playing finesse is not so important with groups.

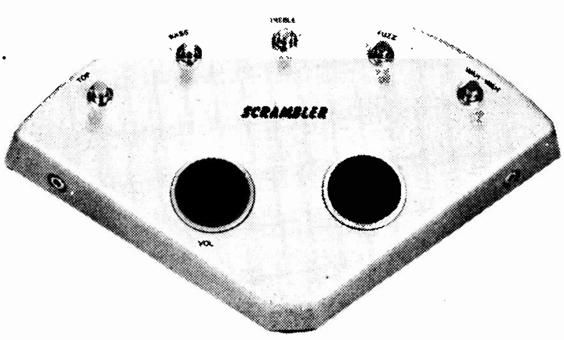
Since power is such an essential ingredient with today's performers, we find large amplifiers which are now sophisticated in that they have mixing and vibrato circuits incorporated; however, we shall not discuss these or loudspeakers at this time. Suffice it to say that many groups prefer valves, since they stand such overloads and misuse.

There is room for improvement in the means for connecting units together, there still are casualties from time to time and it is difficult to understand why Ministry of Defence or Home Office approved connectors are not compulsory.

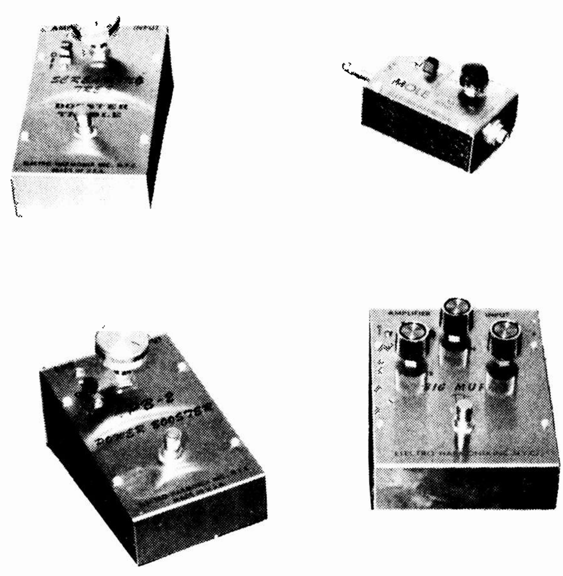
One final piece of apparatus which has effects uses is the ring modulator. This is a circuit artifice whereby two applied signals are combined to form sum and difference frequencies, one of which is extracted and used as a final signal. For this reason the device should be fed from sine waves, but since these do not exist outside the laboratory, some very peculiar sounds result—always discordant.

The ring modulator is often fed from a musical source, a singing voice via a microphone, a pick-up from a saxophone, etc. Many intriguing effects are possible with care, certainly all are novel and often incapable of analysis by the hearing system yet of too short a duration to give rise to irritation. It is in fact interesting to note that distortion is deliberately sought, so intense is the search for novelty. The clipping amplifier or fuzz box is a good example of such techniques. Of course, as the ambient noise level around us increases, discomfort arising from other noises has less effect and we come to accept it.

Fig. 7. The Jennings Scrambler is a complete remote foot control of effects associated with amplification. Besides the quadrant of foot switches the Scrambler has two rotary turntable controls for intensity volume and wah-wah.



A quartet of effects units that can be used with almost any kind of electronic musical instrument.



SYNTHESISERS

The idea of compounding sounds from their bare ingredients is far from new; indeed, one of the most successful synthesisers was built 20 years ago; but, it occupies a whole room! So for a more general acceptance of these devices, we had once again to wait for the semiconductor.

Now a synthesiser is nothing more than a number of units which represent the basic parameters of sounds, so organised that they are easily controlled by the operator and of such a nature that the absolute values of these parameters can be set up again and again with accuracy; in other words, so far as is possible, the elements are calibrated.

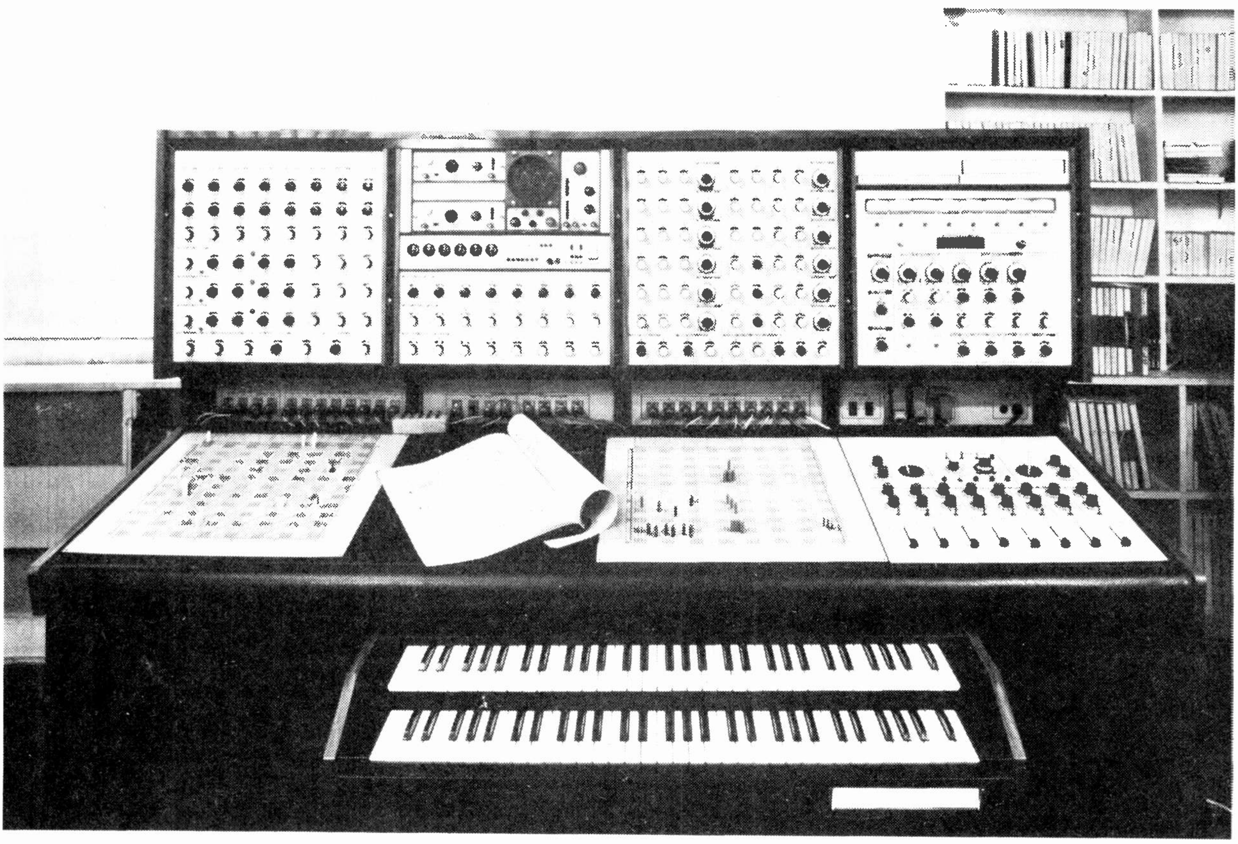
One can compose music with a range of tonal qualities, but cannot write this down in conventional musical notation, although it can be written in terms of instrument settings. It was never possible to write the composition of, say, a trumpet sound on a conventional music score, but one can write this electronically in terms of the values of the constituents; so in this way, the actual nature of a sound can be put in black and white so that someone else can recreate the same sound and this has never before been possible.

Clearly the facilities of a synthesiser relate to its use. An amateur experimenter may not need the many duplicated oscillators, noise sources, amplifiers and treatments which are called for by a professional musician or composer. So it is useful that simple modules can be made or bought and added to as required. One must have at least one good tape recorder for the weakness of all synthesisers of low cost is that they have no storage facilities; all work involves short-term events and constant re-recording.

Most if not all modern synthesisers are voltage controlled; that is, the conduction properties of the transistors are set by applied d.c. voltages; in this way, several advantages follow at once, the principal ones being linearity of signal with applied voltage change; low impedance of control circuits; and complete absence of hum pick up because one does not trail base (or grid) circuits out from the main apparatus. Hundreds of feet of signal control cable can in this way be run out.

Voltage control is also convenient for a keyboard, since at no time would the voltage across any part of the system exceed about 30V. By controlling the frequency

The Synthi 100 synthesiser made by EMS of London has almost unlimited facilities for sound synthesis and serious composition. It has provision for storage and immediate recall of sounds devised. Compare the elaborate patch panels with that of the VCS3 synthesiser.



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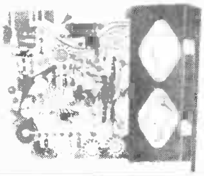

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25 WATTS R.M.S. 7 transistors, 7 diodes.

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ALL THREE MODULES HAVE OPEN AND SHORT CIRCUIT PROTECTION, AND THE SA100 IS PROOF AGAINST OVER-DISSIPATION AND FAULTY INDUCTIVE LOADS.

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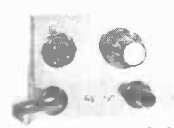
This compact and reliable unit operates from amplifiers with outputs from 5–100W. Does not impose a heavy load on the amplifier, or, if connected in the wrong polarity, cause any damage, as with some units.



Operation is simplicity itself and the unit is fully fused. The unit is supplied to function from bass notes but may easily be converted to respond only to treble or mid-range notes by the addition of components costing less than 5p.

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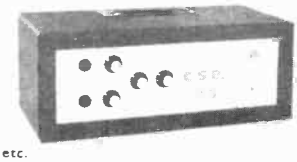
(As illustrated left. S.A.E. details. 9V operation)

OUTPUTS UP TO 1V RMS

Two decks, and full headphone monitoring. The unit is mains operated and measures 17½in × 3in × 4in deep and is finished with a smart white on black facia. The controls are: Left/Right deck fader, volume, bass, treble, headphone selector and volume, microphone volume, bass, treble, mains on/off. **THIS IS A MUST FOR THE HOME BUILT HIGH QUALITY DISCOTHEQUE AND IS COMPARABLE TO UNITS AT OVER TWICE THE PRICE.**

COMPLETE AMPLIFIERS

THE CS 100. £34·90 carr. free



This versatile unit is now available in a black vynide case and so represents even better value than ever, delivering speech and music powers of up to 100W R.M.S. and continuous sine wave outputs of 70W. Two individually controlled inputs with wide range bass and treble controls. Ideal for small groups, D.J's, etc.

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of an oscillator by adjustment of the base voltage from a resistor chain contacted by playing keys, intervals other than those of the equally tempered scale can be produced. This is very useful for exploring the possibilities of the quarter or tenth tone scale—or other subdivisions. This is an approach to the continuous or gliding scale, available on certain instruments like the violin or trombone, but only to a very limited extent; there is no limit to electronic glissando.

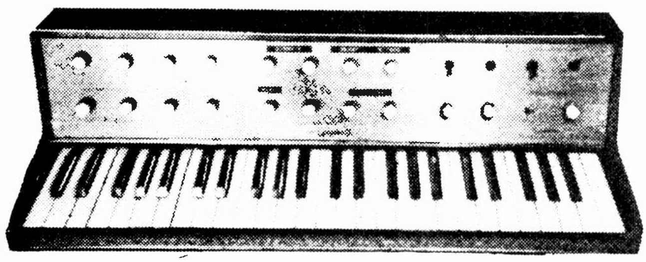
Synthesisers have envelope controls; the overall shape of a waveform is called its envelope. By altering the rate at which the wave starts, or stops, or both, profound changes in the character of the sound emerge. One could thus determine, for instance, if it would be a good thing to make the attack of a 'cello longer or shorter, by simply feeding the pick up on the 'cello into the envelope shaper circuit. These methods have been used on the continent to try to improve the properties and characteristics of some instruments of the orchestra.

Then there are noise generators. Electronic noise is very controllable and can be useful to augment the impact of certain musical effects. It is also valuable to imitate storm, rain or wind and for this latter purpose can be coloured by a tone superimposed, rather like the sound of wind in telegraph wires. In short, if the synthesiser has enough parameters, almost any musical or abstract array of waveforms can be achieved and recorded; and there are commercial examples of disc records based on purely electronic sound.

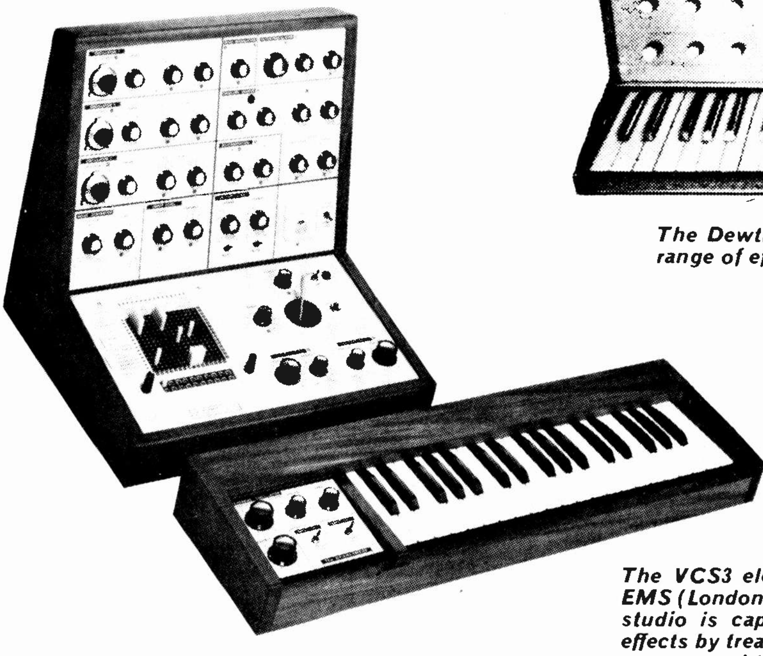
Today there are many synthesisers on the market; most have similar parameter facilities, but some are much easier to patch or cross-connect than others. As experience was gained in their use, controls became simpler and more accurate. The one time room full of gear became a table-top unit as we can see in the illustration of the EMS portable synthesiser.

The ultimate in versatility is the Synthi 100, as used by the BBC and other broadcasting authorities, and made by EMS of London. It has storage facilities and quite elaborate compositions can be realised and performed on it. There is provision to call up anything previously recorded, erase or add to it, and play it at any time. In short, it has all the facilities one could reasonably demand.

Supplement cover picture by courtesy of St. Giles Music Centre.

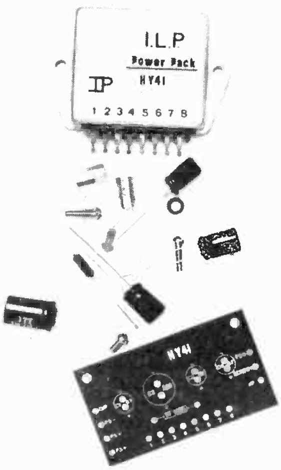


The Dewtron synthesiser which combines a whole range of effects in a simplified unit.



The VCS3 electronic music synthesiser produced by EMS (London) Ltd. This small scale voltage controlled studio is capable of producing a great many sound effects by treatment of three oscillatory sources. Signal sources and treatments are labelled down the left-hand side of the patch board. These may be connected in any permutation to the signal input and control input listed along the top by simple jack plugs. Effects produced can then be applied to the keyboard if required.

I.L.P. (Electronics) Ltd



THE HY41

The HY41 supersedes the popular HY40 introduced by ILP last year. This highly improved module achieves true High Fidelity with a dramatic reduction in distortion (typically 0.05% at 1KHz into 8 ohms!) and is electronically and mechanically compatible with the HY40.

With this important improvement the HY41 retains all of the quality characteristics found in the earlier version and P.C. board, Resistor, Capacitors, Hardware Mountings and comprehensive manual are included in the basic kit. No further components are required to construct a complete power amplifier of extremely high performance sufficiently versatile to provide power not merely for Hi-Fi but also for public address systems and industry.

The free manual gives a full circuit diagram of the HY41 and its various applications including a complete stereo amplifier.

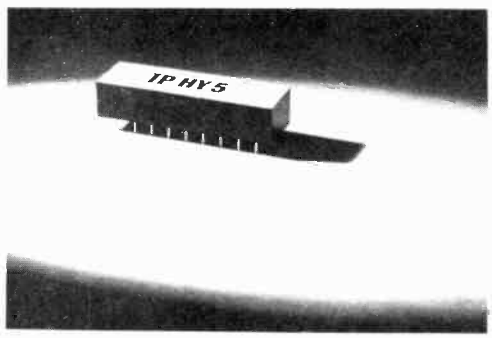
Like its predecessor the HY41 is based on conventional and proven circuit techniques developed over recent years.

OUTPUT POWER: British Rating 40 WATTS PEAK, 20 watts R.M.S. continuous.
LOAD IMPEDANCE: 4–16 ohms.
INPUT IMPEDANCE: 30K ohms at 1KHz.
VOLTAGE GAIN: 30db at 1KHz

TOTAL HARMONIC DISTORTION: less than 0.15% (typical 0.05%) at 1KHz.
FREQUENCY RESPONSE: 5Hz–50KHz ± 1db.
SUPPLY VOLTAGE: ± 22.5volts D.C.
SUPPLY CURRENT: 0.8 amps maximum.

PRICE: inc. comprehensive manual, P.C. board, five extra components and P. & P.:–
MONO: £4.90 STEREO: £9.80

UNIQUE HYBRID PRE-AMPLIFIER



The HY5 has rapidly established a position in the WORLD as the sole hybrid pre-amplifier to contain all feedback and equalization networks within an integrated pre-amplifier circuit.

Supplied with the HY5 are two stabilizing capacitors and by the addition of volume, treble and bass potentiometers it is ready for use.

Internally the HY5 provides equalization for almost every conceivable input, the desired function is achieved by use of a multi-way switch or by direct interconnection.

Two distinctive features of the HY5 are its inbuilt stabilization circuit, allowing it to be run off any unregulated power supply from **16–25** Volts and a balance circuit which, when linked by a balance control to a second HY5, forms a complete stereo pre-amplifier.

Specifically and critically designed to meet exacting Hi-Fi standards, the HY5 combines extremely low noise with a high overload capability. When used in conjunction with the HY41 and PSU45 forms a completely intergrated system.

INPUTS
Magnetic Pick-up (within ±1db RIAA curve) 2mV 47K Ω
Tape Replay (external components to suit head). 4mV. 47KΩ
Microphone (flat) 10mV. 47K Ω
Ceramic Pick-up (equalized and compensatable) 20–2000mV. variable.
Tuner (flat) 250mV. 100K Ω
Auxiliary 1 250mV. 47K Ω
Auxiliary 2 2–20mV. 100K Ω

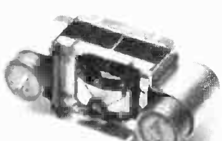
OUTPUTS
Main Pre-amp output 500mV.
Direct tape output 120mV.

ACTIVE TONE CONTROLS (Bexendall)
Treble ± 12db.
Bass ± 12db.
INTERNAL STABILIZATION
Enables the HY5 to share an unregulated supply with the Power Amplifier.
SUPPLY VOLTAGE
16–25 volts

SUPPLY CURRENT
6mA approx.
OVERLOAD CAPABILITY
better than 26db on most sensitive input infinite on tuner and auxl.
OUTPUT NOISE VOLTAGE: 0.5mV.

PRICE: MONO: £3.60 STEREO: £7.20

POWER SUPPLY PSU45



The versatile P.S.U.45 is designed to supply your HY41's +HY5's in stereo or mono format.

Specification

Input: 200–240 Volts.
Output: ± 22.5 Volts at 2 amps.
Overall Dimensions: L. 7"; D. 3.8"; H. 3.1"

PRICE: £4.50 inc. P. & P.

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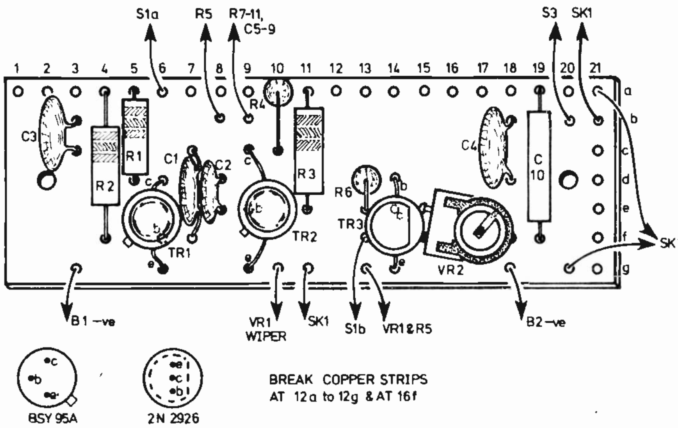


Fig. 6. Layout of the components on the Veroboard

82 is read off the scale, this multiplied by 100 to give 8200, which is the value in ohms of the resistor under test.

MARKING THE SCALE

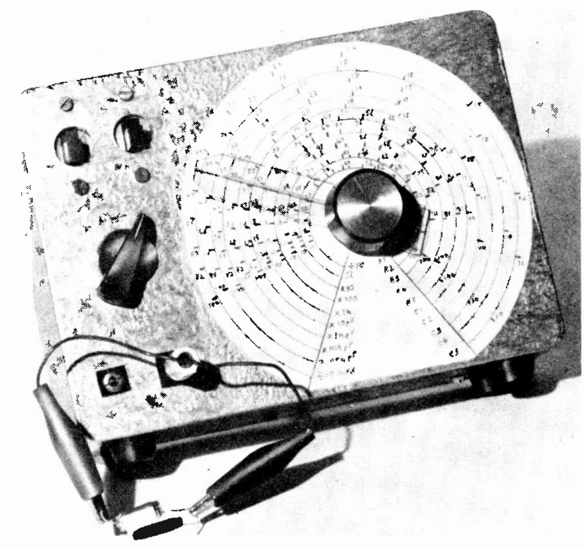
The procedure for calibrating the unit is as follows. With the unit switched to resistance, a resistor of the same value as that switched in by S2 should be connected across the test leads. The control knob of VR1 should be swung towards the high value of the scale until the bridge balances, and then the scale should be marked 100 at this point.

A resistor one tenth of the value of that switched in by S2 should then be connected across the test leads. The knob of VR1 should then be swung to the low value end of the scale until the bridge balances, and the scale marked 10 at this point.

A full range of components should then be used to fill in all the numbers of preferred values between these two points. The same procedure should be used for all five resistance ranges.

CAPACITANCE RANGES

Suitable scales for the capacitance ranges may then be marked by the same method, except the components required to mark the ends of the scales will have to be ten times the value, and the same value as that switched in by S2.



The completed C-R Bridge showing the scale fixed to the front panel and calibrated

The accuracy of the unit will depend almost entirely on the tolerance of the components used in its calibration. The only other factors affecting this, being, the stability of the components used in the bridge, and the care taken when marking the scales.

Most potentiometers have fairly large tolerances, and it is possible that this could cause the unit to be unable to cover the full ranges quoted. If this should occur, it may be corrected by reducing the value of R5 to 910 ohms, or if full coverage is still not obtained, 820 ohms.

USING THE BRIDGE

Adjustment of VR2 has to be made before the unit may be used. The range switch should be switched to resistance Range 1, and the earphone plugged in. VR1 should then be adjusted for maximum output in the earphone. VR2 is then adjusted so that the volume is fairly loud, but not excessively so.

To measure the value of a component it is merely connected to the two crocodile clips, and then the bridge switched to read resistance or capacitance as appropriate. If the component under test is wired into a circuit, one of its leads must be disconnected, to prevent other components in the circuit from affecting the reading.

If the value of the component is known, and it is merely to be checked, then the bridge should be switched to the appropriate range, and then balanced (VR1 set for minimum output in the earphone).

COMPONENTS OF UNKNOWN VALUE

If a component of an unknown value is to be measured, then the bridge should be switched to a middle range such as Range 3, and then balanced if possible.

Should the bridge balance with the pointer of VR1 on the scale, then a reading may be taken. If the bridge will not balance and it is a capacitor under test, then a lower range should be tried.

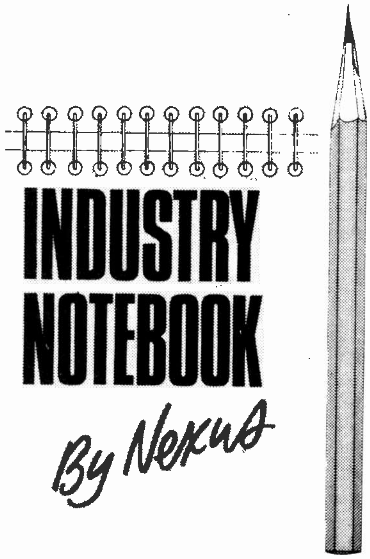
Should this occur when a resistor is under test, then a higher range should be tried. If the bridge balances, but is off the scale, then either a higher range of capacitance, or a lower range of resistance is required. ★

THE BIG INDUSTRIAL "TRANSFER" MARKET

THE past few weeks have seen a spate of activity in takeovers and mergers.

As forecast in this column in the July issue, Racal were in fact in negotiation at the time and the result was the acquisition of the communications division of S. G. Brown Ltd. from the Hawker Siddeley Group for a reported cash sum of about £1 million.

Unitech Group have acquired APT Electronics from the Bonochord Group. APT's range of



power supplies will now complement those already manufactured by the Unitech subsidiary, Coutant, although I understand that APT and Coutant will continue to operate as separate companies. Having hived off APT, the Bonochord Group then acquired Livingston Hire and its subsidiary companies for a sum in excess of £1 million.

RATIONALISATION

The old-established Dubilier, itself only acquired a few months ago by a consortium headed by Hambro's Bank and Slater Walker Securities, has now acquired Greenpar Engineering and Kenneth E. Beswick. Greenpar was acquired by Thorn Group not all that number of years back—was it two or three?—and Beswick, who has been in the fuse business for fifty years was a subsidiary of Tremletts.

Then there was the merger of Gresham Recording Heads with Information Magnetics Corporation of California, a company little known in the U.K. but well-esteemed in the U.S.A. even though it has been in business only since 1969 manufacturing disc recording heads in competition with IBM and other U.S. giants.

All this flurry of activity (and the examples I have given are by no means all) shows a general trend towards re-grouping in the face of increasing competition and the need to decide which market sector is appropriate to the business you think you are in.

CALCULATED RISK

Advance Electronics has gone the whole hog in the competitive electronic calculator market by following up the Executive 8, announced at this year's I.E.A. exhibition, with a further five models including a pocket machine which sells at £52·50 for which Advance expect sales of at least 25,000.

It has been generally thought that the Japanese had the bulk of the world market for electronic calculators nicely sewn up. Not so. See what has happened in the United States when some of the more enterprising manufacturers decided to take the plunge in the low-price consumer field. They are choc-a-bloc with orders. So much so that they are now in trouble.

Computer Design Corporation, one of the entrepreneurs, has been complaining that the semiconductor manufacturers have let them down on the supply of the LSI MOS chips which are the heart of the machines. Computer Design has been reported as having over 4,000 machines on the shelf waiting for components. Computer Design has three suppliers of LSI memory circuits to be on the safe side but delivery dates have been seriously under-estimated, in some cases it is reported the delay is six months.

Another U.S. manufacturer of calculators is complaining not only of late delivery of circuits but also that rejects were as high as 70 per cent although the figure has now improved to 10 per cent.

Nobody has extolled the virtues of LSI more than the semiconductor manufacturers. Now they find they can't cope with the demand. The supply of LSI chips is in the hands of a very few multinational manufacturers who can dictate where available supplies should go. Such is their power that they could make or break a calculator manufacturer if they so wished.

ELECTRO-OPTICS

In our September issue I wrote that nobody has yet made a fortune out of lasers, but they could become big business. I now record that the enterprising Munich Trade Fair Company is promoting a *Laser '73* exhibition in their city next September with the forecast that this no-longer novel technology (the laser was first demonstrated in 1960 by Theodore H. Maiman in Hughes Research Laboratories) will have a civil market alone worth billions of dollars. Be that as it may, the exhibition should itself prove a profitable affair because despite its title it will cover the whole field of electro-optics which is about the fastest growing sector of electronics.

. . . AND MICROWAVES

If electro-optics is a booming industry so is microwaves judging from the response to the *Microwave '73* international exhibition and conference scheduled to be held at Brighton next June. Stand area has just been increased by 40 per cent to cope with the demand for space. So far, nearly 80 companies from U.S.A. and Europe have booked space as exhibitors and the accompanying conference, I understand, will be heavily slanted towards applications of microwave technology rather than theory.

"FAX" MARKET OPENS UP

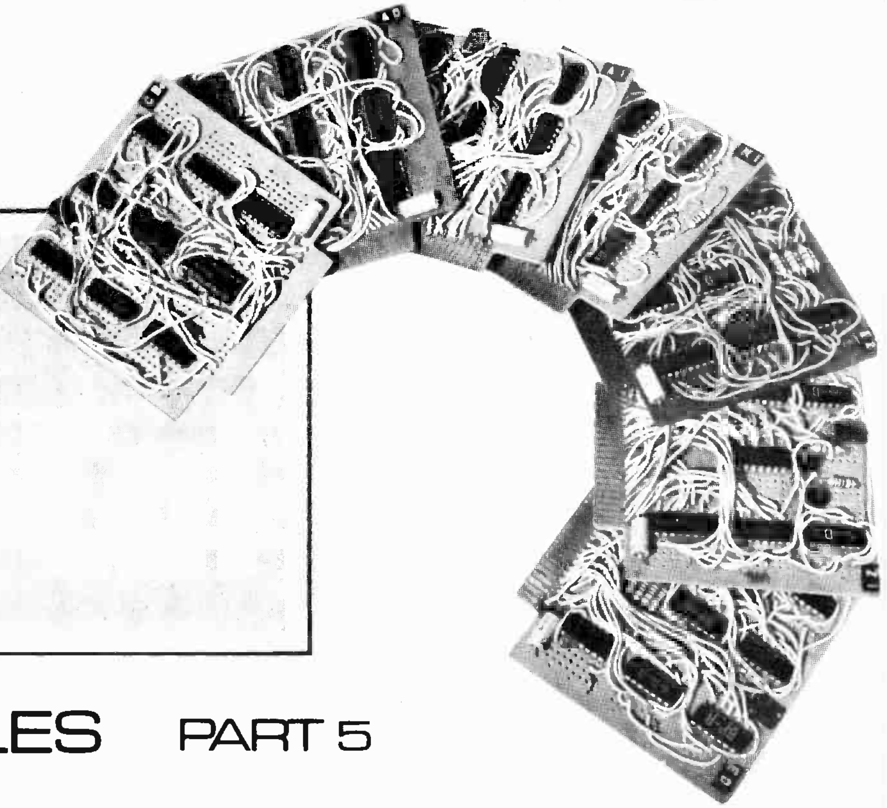
Facsimile transmission was first demonstrated—at least in principle—by Alexander Bain, a Scottish clockmaker, way back in 1842. Now, 130 years later it is really beginning to be big business and the high-powered companies are already moving in.

Plessey is one of the recent entrants with an American designed machine built in Japan. Plessey did a test marketing operation last year before deciding to go ahead. The operation is already swinging and Plessey expect to be selling over 5,000 a year by 1976.

Most unusual use for the Plessey "Remotecopier" was in "British Steel" during the recent single-handed transatlantic yacht race when skipper Brian Cooke had one aboard for reception of weather charts from which he was able to predict wind changes several hours ahead of his competitors. But the big market is in offices where it is being promoted as "business tool".

But, as the market opens up, so the competition increases. There are seven major manufacturers in the field. In the U.K., latest entry is EMI who is marketing EMIfax machines through its subsidiary company SE Computer Peripherals. The machine is produced by the German company Rudolph Hell which happens to be a subsidiary of Siemens.

PE



By R.W.COLES PART 5

ENTRY REGISTER LOGIC AND HARDWARE

LAST month we dealt with the construction of the keyboard logic panel which has the function of converting each key depression into suitable logic signals for entry and control of data.

As stated in the first part, entries of up to six digits can be made. The subject of this month's part is the Entry register and associated logic which has the function of storing these six entered digits in their correct order for use in calculation to come. A six digit number can also be placed in a memory for use at any number of times during the calculation.

This part also discusses the possibility of a "fixed constant" key whereby a single depression of an extra key causes a chosen number (such as π) to be entered into the entry register.

ENTRY REGISTER LOGIC

A block diagram of the ENTRY register complex is shown in Fig. 5.1, which is an expansion of the ENTRY register section of the overall arithmetic section block diagram from Part 1 (Fig. 1.3).

The operation of the ENTRY register and its associated constant store and display multiplexer is relatively straightforward, each of the possible six decimal entry figures being stored as a four-bit parallel B.C.D. code, requiring a total of 6×4 ($= 24$) separate storage bistables.

The 24 bistables or flip-flops are arranged as a shift register six decimal digits long and four B.C.D. digits wide, so that with each clock pulse a complete B.C.D. group (i.e. one decimal digit) is shifted into, or down, the register.

Each time a number key is pressed, the keyboard circuits (which were described last month) staticise the corresponding B.C.D. code and generate a single clock pulse, which is used to clock the four bit code into the ENTRY register.

Pressing a second or subsequent number key causes the first group to shift down the register to the "left," its place being taken by the new entry. This process can continue until the first entered number ends up in the extreme left-hand location of the register, after which any further entries will cause that first number to be destroyed by being shifted out of the end of the register.

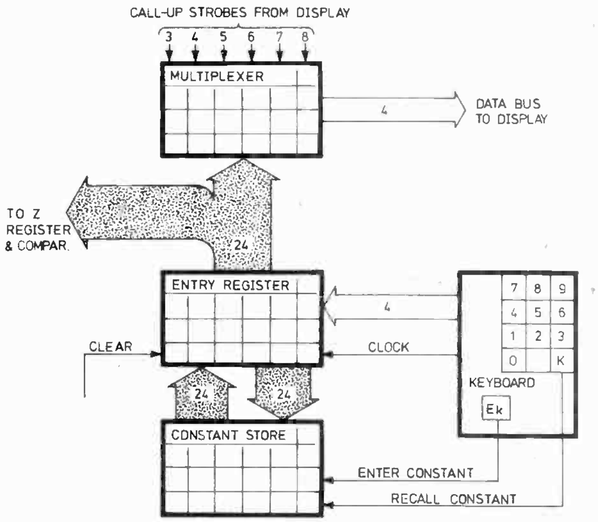


Fig. 5.1. Block diagram of the Entry Register complex showing the inputs and outputs

Note that the ENTRY register accepts the most significant digit of the complete figure entry *first*, just as we write figures ourselves. This makes the ENTRY register a "left-shift" register and distinguishes it from the other registers which normally accept the least significant digit (L.S.D.) first, and are thus termed "right-shift" registers.

CIRCUIT PARTITIONING

The ENTRY register and associated constant store and multiplexer, are built on three separate plug-in cards. The way in which the circuit is divided among the four cards is shown in Fig. 5.2., where it is immediately apparent that three of the cards are identical.

In effect partitioning the circuit in this way results in three independent shift-registers, each two decimal digits long and four B.C.D. digits wide, and each having a proportionate amount of constant storage.

In use these small units are connected in series, via the edge connector wiring, but because each card is identical they can be freely interchanged and this is a great help in tracing any faults which may occur.

The display multiplexer is built on a separate card with a 44-way edge contact instead of the 22-way type used for the other three cards, and although not shown on the block diagram, this card also houses two SN7440 buffer gate packages used to drive the CLOCK and CLEAR lines of the register.

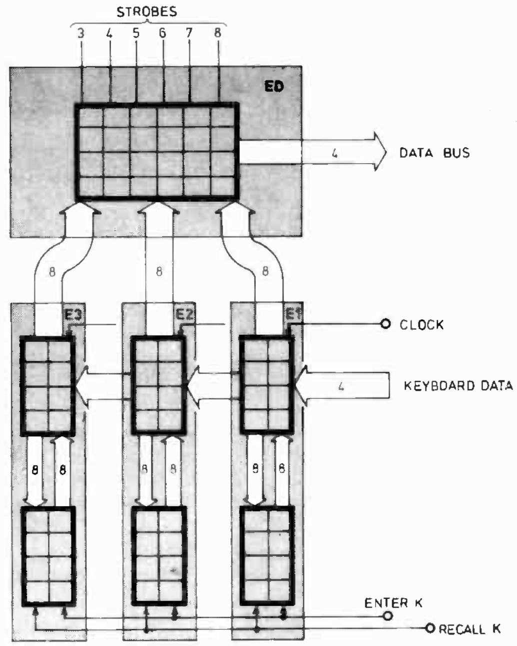


Fig. 5.2. Partitioning of the entry Register onto the four boards. Boards E1, E2, E3 are identical and each contain two digits of the entry and two digits of the stored constant. Board ED contains the multiplexer

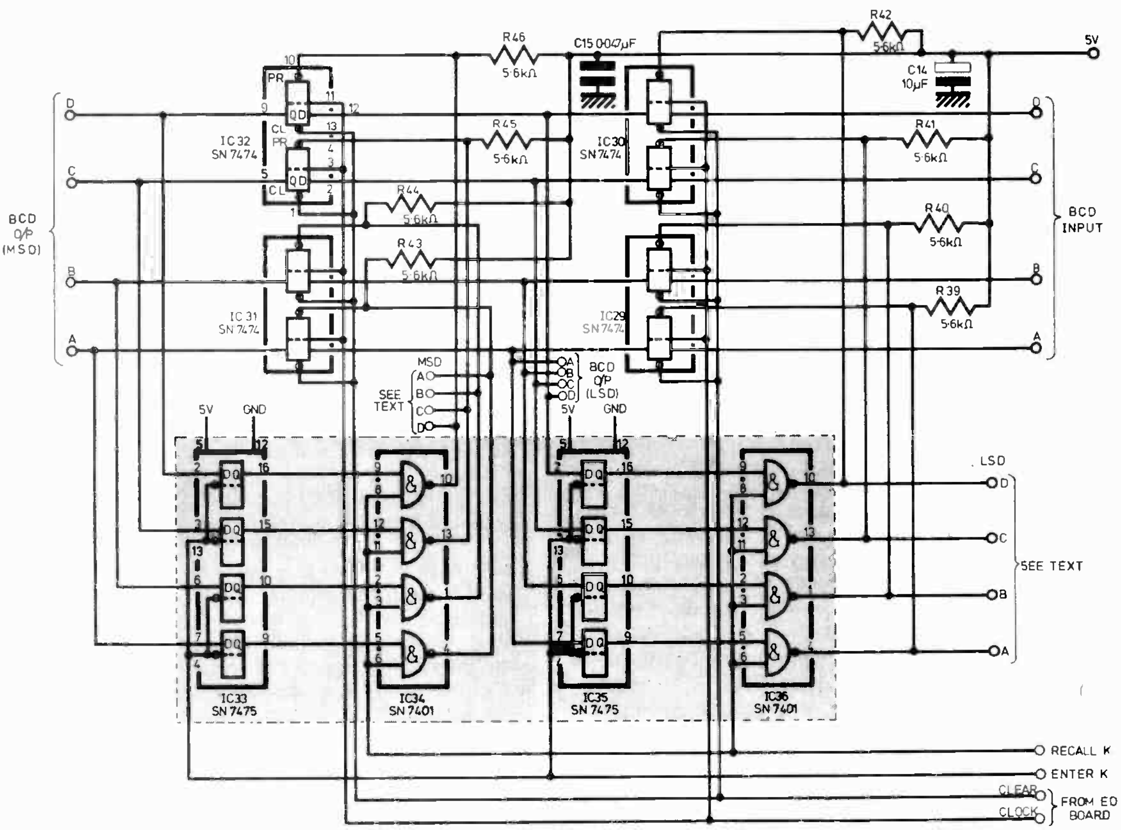


Fig. 5.3. Circuit of the Entry Register board E1. Boards E2 and E3 are identical to this. The dotted line encloses the constant store which may be omitted if not needed

REGISTER CIRCUIT

The full circuit diagram of an individual register board is shown in Fig. 5.3, three of these sections being required to form the complete register.

The circuit splits horizontally into two logical sections, the upper four i.c.s forming the shift register proper, and the lower four forming the constant store.

The components forming the constant store are enclosed in a dotted box for easy identification, and it is these i.c.s which may be left out if required, along with their associated wiring.

The eight bistables which comprise the shift register itself are SN7474 dual D-type elements, chosen because of their flexibility and low power dissipation.

Both of the two bistables in each package have independent clock, data, preset and clear inputs, together with true and inverted outputs. D-type flip-flops are more suitable than the J-K types for shift register application because they only require a single data (D) input which has the effect of reducing wire interconnections and leaving pins available for the independent preset function without recourse to the more expensive 16-pin package.

To form the register the flip-flops are connected in series pairs, there being four such pairs on each board to cater for the four separate digits (A, B, C, D) of the B.C.D. code.

Each vertical group will contain four binary digits which, taken together, represent one of the decimal numbers zero to nine.

The clock input to the register has to drive all of the flip-flop clock inputs in parallel so that after each pulse the data in a particular four bit group move one place to the left, and are themselves replaced by new data.

It is necessary to clear all the data from the ENTRY register simultaneously when required by the programme, and to this end all the CLEAR inputs are connected together to a common input, a low level, or "ground" condition on this input will set the Q outputs of all the flip-flops to zero, and the $\overline{Q}$ outputs to one.

CLEARING OPERATION

The contents of the ENTRY register are transferred in parallel to the z register early in the arithmetic programme, except during MULTIPLY, when they remain to be compared with the contents of the counter.

When the register contents are finished with the ENTRY register is cleared by a signal from the programme, ready for subsequent entries to be made by the operator.

Any errors made during figure entry (e.g. pressing "8" instead of "6") can be corrected by pressing the CLEAR ENTRY key which also has the effect of clearing the contents of the register ready for new data.

CONSTANT STORE

The constant store is shown beneath the ENTRY register, and is of the same 24 position capacity, so that any entry made can be stored for further use in a calculation.

This store is not essential to the correct operation of Digi-Cal and can be left out permanently or temporarily if desired, without the need for any modification to the rest of the circuit.

In operation, with the desired constant entered in the usual way into the ENTRY register, the ENTER K (EK) key is pressed, which duplicates the contents of the ENTRY register in the constant store by means of a single, parallel, 24 bit transfer.

Constants stored in this way remain available until they are either replaced by a new number or the machine is switched off, there being no requirement or provision for clearing this store, other than by entering a constant which consists of all zeros.

Constant recall is carried out by pressing the K key in the numeral section of the keyboard whereupon a reverse transfer occurs, in parallel, from the constant store to the ENTRY register. This operation does not destroy the contents of the store so that any constant can be used as many times as required in a calculation.

The constant store need not be used simply for storing constants in the accepted sense, since it will act as a memory of any result or intermediate answer if required, provided these numbers are entered through the keyboard in the usual way.

This mode of operation really acts as a substitute for pencil and paper, and can be most useful at times in long calculations.

DISPLAY MULTIPLEXER

The display board, described in Part 3, will display either entries or answers depending on a signal from the programme, entry and answer data being routed to the display via two four-line "buses."

Timing signals, in the shape of "character call-up" strobes are produced by the display board to enable the four line buses to carry all the data in their associated register to the display in a time-shared sequence, the sequence being produced in a multiplexer circuit.

There are two multiplexers in Digi-Cal, one for the eight digit answer and the other, which we are interested in here, to handle the six digit entries.

Only strobes three to eight inclusive are used by the ENTRY multiplexer, each of these allowing only one four-bit B.C.D. digit on to the bus at any instant in time, the strobe direction being from most to least significant digit (M.S.D. to L.S.D.).

CONSTANT CIRCUIT

Simpler storage elements can be used for the constant store since there is no requirement for PRESET or CLEAR inputs, and the devices chosen to fulfil this function are the SN7475 four bit latches.

Like the SN7474s these quad latches require only single "D" inputs, the data to be stored being of course the outputs from the shift register flip-flops.

Clocking is controlled by the ENTER K key, via a buffer gate mounted off the board. There is no need to "debounce" the output of this switch because of the simple "gated latch" operation of the SN7475 flip-flops and the static nature of the inputs during the entry operation.

Stored constants are returned to the shift register via the SN7474 PRESET inputs, transfer being controlled by the SN7401 quad NAND gates, which have a common input enabled by the RECALL K key, via a buffer gate. The PRESET inputs of the SN7474s are "active low," i.e. they set the Q output to "1" when an "0" input is present, and so require inverted data from the constant store. This inversion is provided by the SN7401 gates.

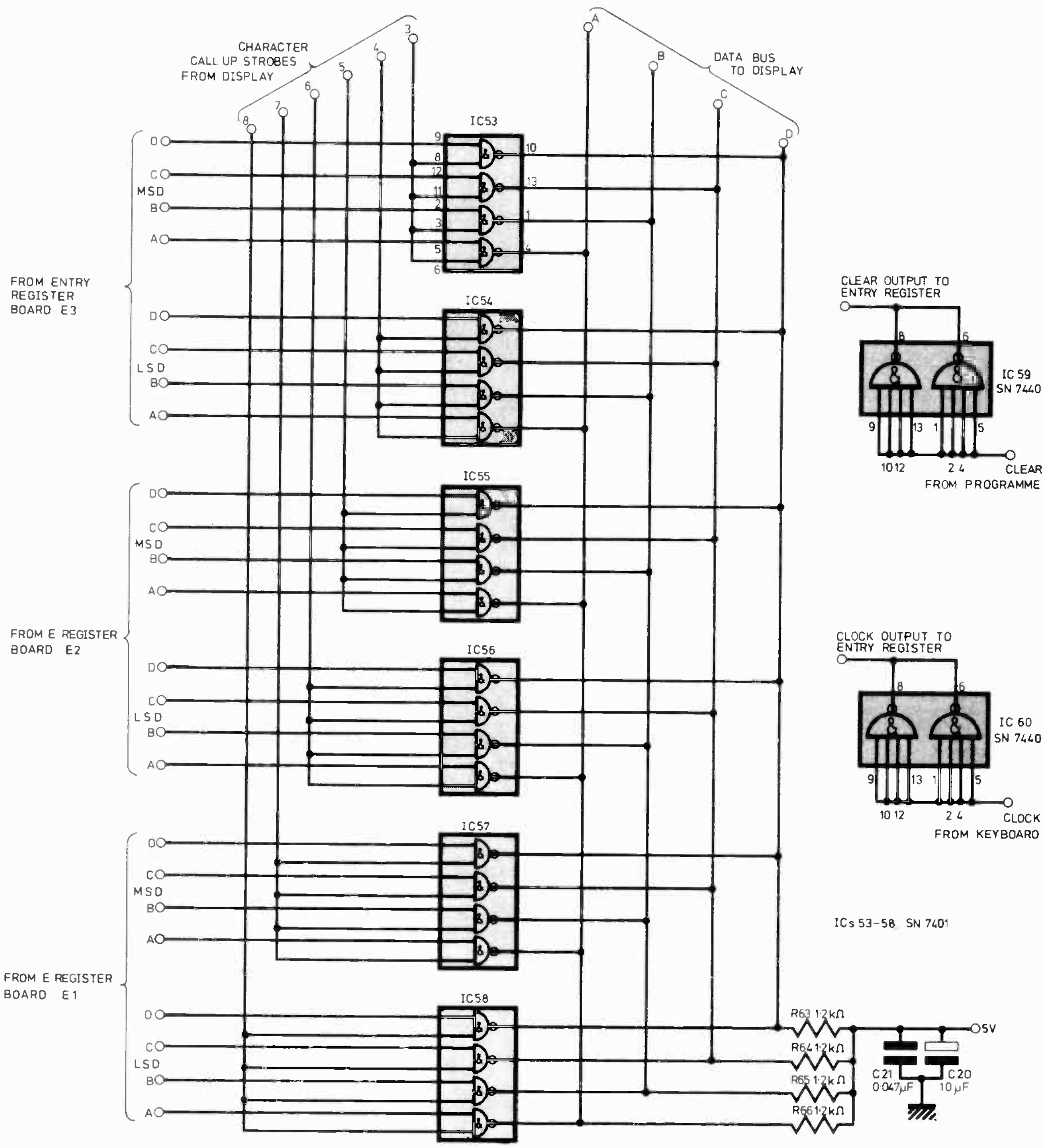


Fig. 5.4. Circuit of the Entry Register Board ED. The two SN7440 i.c.s are simply buffers and only placed on this board for convenience

MULTIPLEXER CIRCUIT

The circuit of the display multiplexer, Fig. 5.4, is quite straightforward, it being formed only from gates and resistors. Each SN7401 gate package has its four inputs wired to the corresponding four B.C.D. output pins on the appropriate register board, there being a separate gate i.c. for each decimal digit.

The common input to the four gates in each i.c. is driven by the "character call-up" strobe appropriate to that digit.

All the "A" outputs from the gate packages are wired together, as are the B, C, and D outputs, to form the four line display bus, which is referenced to the 5V line by the four 1·2 kilohm resistors.

Note that SN7401 open collector gates are essential for this circuit, SN7400 gates being unsuitable due to the fact that several gate outputs are connected directly together to provide the "Wired OR" function.

Interconnection of outputs is not permitted with the basic TTL gate because of the "active pull-up"

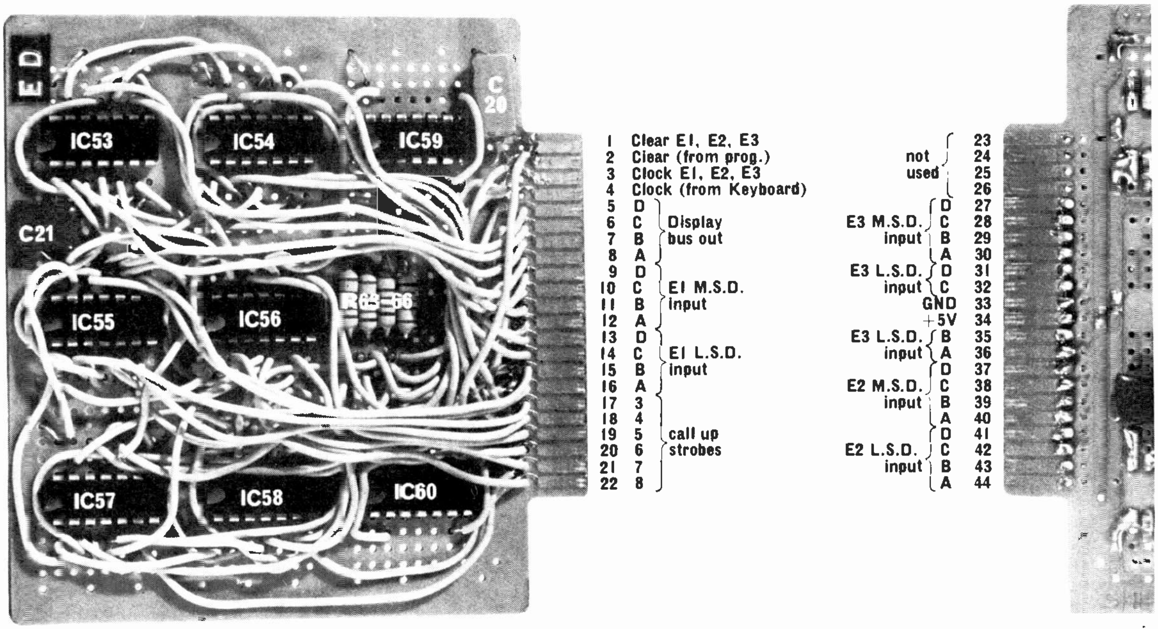


Fig. 5.5. Layouts of the components on the register board ED and functions of edge contacts

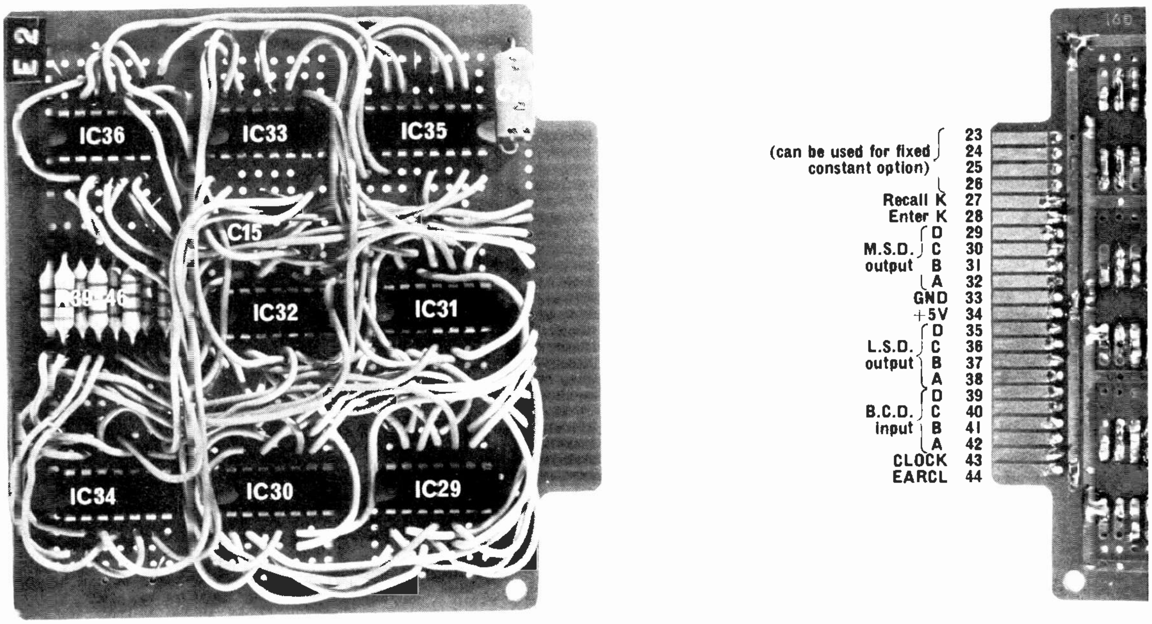


Fig. 5.6. Layout of the components on the Entry Register Boards E1, E2, and E3 and functions of edge contacts which only appear on the underside

COMPONENTS . . .

REGISTER BOARDS E1, E2, E3

Resistors
R39–R62 5·6kΩ ±10% ¼W carbon (24 off)

Capacitors
C14, C16, C18 10μF 15V elect. (3 off)
C15, C17, C19 0·047μF (3 off)

Integrated Circuits

IC29–IC32, IC37–IC40, IC45–IC48	SN7474 (12 off)
IC33, 35, 41, 43, 49, 51	SN7475 (6 off)
IC34, 36, 42, 44, 50, 52	SN7401 (6 off)

Printed circuit boards and sockets
Type DL109/22 (3 off) (Available from Shirehall Electronics Ltd., Station Yd., Borough Gn., Sevenoaks, Kent)
SK2–4 DPK165 edge connectors (Shirehall) (3 off)

(Note that the three boards are identical, each board taking one third of each group of components shown above)

REGISTER BOARD ED

Resistors
R63–R66 1·2kΩ ± 10% ¼W carbon (4 off)

Capacitors
C20 10μF 15V elect.
C21 0·047μF

Integrated Circuits
IC53–IC58 SN7401 (6 off)
IC59, IC60 SN7440 (2 off)

Printed circuit board and socket
Type DL109/44 (Shirehall)
SK1 DPK165 edge connector (Shirehall)

output stage. The SN7401 is a gate specially produced to allow "Wired OR" function in TTL systems, and has no pull-up device incorporated.

The two SN7440 buffer gates are positioned on the multiplexer board but have no direct connection with the multiplexer circuit. The two buffers in each package are wired in parallel to give sufficient drive capability (or "fan-out") to handle the large load represented by the ENTRY register CLOCK and CLEAR lines (48 loads and 72 loads respectively).

CONSTRUCTION

Wiring up is carried out in the same fashion as the display board described last month, though the plug-in cards are much easier to work with because of the pre-tinned finish and the ready formed i.c. pads which obviate the need for "spot face" cuts.

By referring to the appropriate circuit diagram and the i.c. layouts shown in Fig. 5.5 and Fig. 5.6 wiring is quite straightforward, the only points to remember being the need for links from the power buses to each i.c. and from these power buses to the appropriate edge contacts, along with the need to orientate the i.c.s correctly before soldering into circuit.

All wiring up is carried out on the blank side of the boards, using single core wire.

The best order to complete the construction of the boards is as follows: ED board (display multiplexer) including the buffer gates, on a Shirehall DL109/44; then the register section (SN7474s) of boards E1, 2, 3, on Shirehall DL109/22 cards; and finally when the above sections are operating correctly, the constant store and if required, the fixed constant option, may be added.

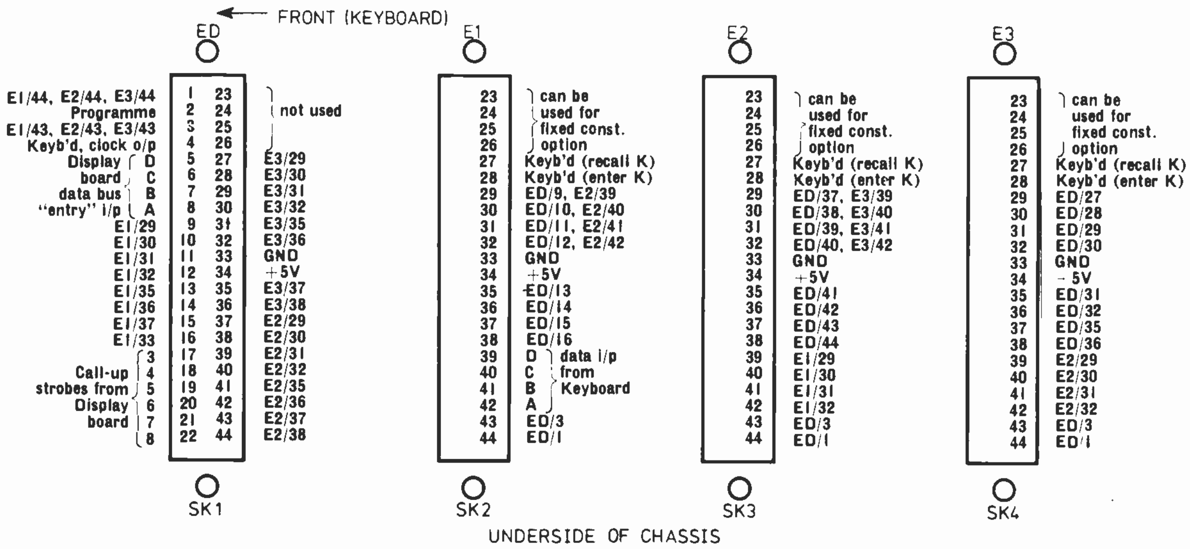


Fig. 5.7. Interwiring of the four entry register boards is carried out using the edge connectors fitted in the large hole cut in the chassis plate. The edge connectors are fitted so that the boards plug in from above. Destinations of wires are shown next to each contact (e.g. contact 30 on socket E1 should be wired to contact 10, board ED, and contact 40, board E2)

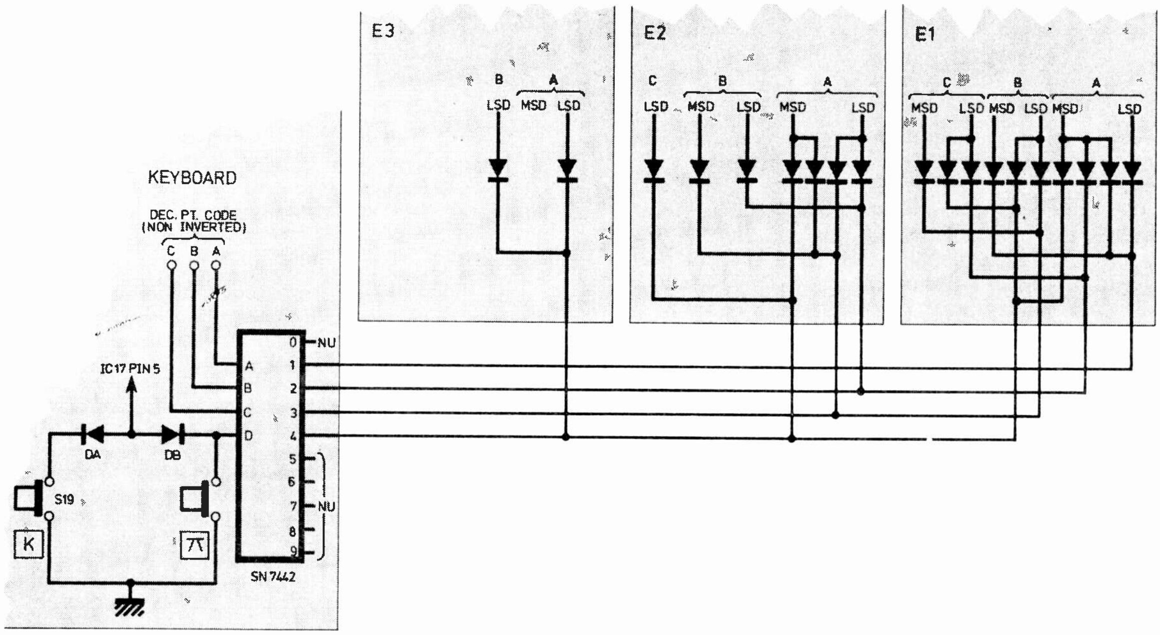


Fig. 5.8. Extra wiring to allow for a fixed constant key in addition to the K key. The diodes shown allow for the number π or a close approximation, to be placed in the entry register when a single key is depressed. The SN7442 is an extra i.c., space for which can be found on the Keyboard panel

INTERCONNECTION AND TESTING

Under chassis edge connector wiring can be started early in the construction sequence to allow operational testing to be carried out as necessary, and this task can be readily completed by referring to the edge connector layout and wiring tables (Fig. 5.7).

The tables are easier to use than wiring diagrams their instructions being implemented by simply wiring the edge connector pin required to all (or any part as required) of the destination listed.

When the register section of one or more of the boards is completed, keyboard entries should be possible by pressing a sequence of number keys, provided of course that the display and keyboard are already functioning, and that the required CLOCK, CLEAR, and data interconnections have been made.

Table 5.1 EXAMPLE OF FIXED CONSTANT KEY DIODE PLACING

Dec. pt setting	Required "π" value	Decimal digit identification: Board E3 M.S.D.	Board E3 L.S.D.	Board E2 M.S.D.	Board E2 L.S.D.	Board E3 M.S.D.	Board E3 L.S.D.	B.C.D. digit
1	3·1							D
								C
						×		B
						×	×	A
2	3·14							D
							×	C
					×			B
					×	×		A
3	3·142							D
						×		C
				×			×	B
				×	×			A
4	3·1416							D
					×		×	C
			×				×	B
			×	×		×		A

The only temporary test connection required to render the circuit operational is a ground connection to the CLEAR buffer gate input to prevent a permanent CLEAR signal being produced.

FIXED CONSTANT OPTION

SN7401 open collector gates are used in the RECALL K path in preference to SN7400 gates because they can be used to perform the "Wired OR" function at their outputs. In practical terms this means that it is possible to "get at" the SN7474 PRESET inputs for use with other data sources than the constant register without altering existing logic.

This possibility opens the door to all sorts of custom modifications to enhance the usefulness of Digi-Cal, and to show how simple some improvements can be, let us consider a scheme for entering a constant which is very commonly used, without taking up space in the constant store itself.

The constant is the ubiquitous Pi (π), but in fact any constant which is likely to be often used is suitable for our purposes, the object being to have the chosen constant always available at the press of its own *separate* key, without interfering with the operation of the constant store which remains available for routine use.

This modification requires only the incorporation of a number of diodes into the ENTRY register boards and the addition of an extra "PI" key on the keyboard with a single extra i.c. The circuit for such a scheme is shown in Fig. 5.8.

An extra diode must be connected to the keyboard logic panel (Fig. 4.2), between the top of the "K" switch S19 and pin 5 on IC17, the previous direct connection being broken. This diode, marked DA in Fig. 5.8, together with diode DB forms an OR gate so that pressing either key "K" or "π" causes the automatic normalisation to be inhibited.

OPERATION OF CONSTANT FACILITY

The principle of operation is that when the "PI" key is pressed one of the outputs of the SN7442 decoder will go low, depending on the setting of the decimal point switch.

The energised output is used to PRESET a number into the ENTRY register via diodes wired in wherever a "1" is required. The diodes are connected to the PRESET inputs at the points marked in Fig. 5.3, and perform the "Wired OR" function with the SN7401 outputs.

The whole circuit acts as a diode "Read Only Memory," where the contents of the memory are programmed at the construction stage by wiring in diodes where required.

The memory contains four separate numbers to allow for the four possible decimal place selections. Table 5.1 shows how the placing of the diodes is determined, a cross marking the position of each.

This circuit can be very useful if Digi-Cal is to be used for calculations containing an often used constant, and can be substituted for the constant store *or* used to complement it. If this option is never likely to be taken up it would be possible to use SN7400 gates in the RECALL path instead of the SN7401s and resistors, but note that the pin connections for the SN7400s are different.

Next month: Logic and construction of A and Z registers.

NEWS BRIEFS

New Data Transmission Technique

A NEW technique of data transmission is to be tested in a forthcoming experiment involving the Post Office and computer manufacturers and users. The system is known as "packet switching" and is basically the transmission of computer data in self-contained, addressed blocks like a series of high speed telegrams.

The user of such a system sends out the data together with the address of its destination and the data is automatically routed to that destination by the system. The need to set up a direct link between sender and receiver before transmission is thus eliminated.

Circuits connecting packet switching exchanges can be used for carrying packets sent by other customers in the time intervals between packets in a series making up a complete message. Because many signals travel on the same wire a large number of low capacity connections to a multi-access computer can be replaced by a single high capacity connection.

The system has the advantage of lower error rates than conventional systems and enables two terminals with different data transmission rates to be connected.

New Range of Calculators

A RANGE of five new electronic calculators has just been announced by the British firm Advance Electronics Ltd.

Because of large scale integration whereby all the electronics can be placed in a handful of discrete packages, assembly costs of complex instruments have been reduced drastically. The features which Advance are promoting are reliability and value for money rather than such dubious advantages as extreme miniaturisation.

The new range consists of four desk-top calculators known as the Executive 16 range and a pocket-sized calculator known as the Executive.

The Executive 16 range all feature 16 digit capability and a keyboard specially designed for high speed work. The keyboard allows a key to be pressed even when another has already been pressed providing that they are released in the correct order.

The basic model (retailing at £95) has the four basic arithmetic operations as well as a "%" key.

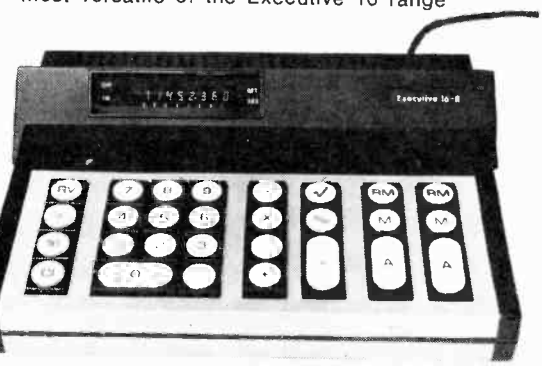
The 16 + 1 (at £115) has a versatile memory with full 16 digit capacity which can also function as an accumulator for automatic list totalling.

The 16 + 2 (at £145) is specially suitable for V.A.T. calculations featuring two memories.

The 16R (at £175) has all the features of the 16 + 2 but also includes a square root key.

The fifth member of the range is an eight-digit portable (at £52·50) with a plinth for desk use and mains power supply option extras.

Shown here is the Executive 16R which is the most versatile of the Executive 16 range



PATENTS REVIEW...

AUDIO FREQUENCY ANALYSIS

THE analysis of audio frequencies by separating a selected frequency component from a complex signal can be useful for any number of purposes. In BP 1 282 487 The Standard-Triumph Motor Company Limited describe an analysis system which they have found particularly suitable for checking the audible noise from a gear box to isolate gears which are unduly noisy.

Past practice, directed at separating the noise of the gear in question from the overall gear noise, has been to compute the main frequency of sound produced by any two gear wheels by considering their teeth number and speed. With the main frequency component thus known it is isolated by applying a reference signal (from a tone wheel) to "beat" with the selected frequency.

A simple bridge and capacitor arrangement is used to measure the amplitude. But the snag has been poor low frequency response and confusion due to ripple in the output waveform due to the presence of rectified a.c.

In the new invention a tone wheel produces an audio frequency signal which is fed to the tone input. The noise signal to be analysed is applied to the noise input and the tone and noise signals are respectively amplified and applied to three transformers which constitute a balanced modulator.

The secondary of one transformer is applied to the primary of another via a ring modulator. The secondary of the latter is fed to a 100Hz low-pass filter which passes the beat signal only and blocks all other residual signals (reference and noise).

The filter output is amplified, rectified and fed to a voltage comparator. Two gate drive transistors control a gate, which is opened once every half cycle, allowing a storage capacitor to sample the smoothed beat signal voltage available when the gate is open.

The criterion of the invention is the feature whereby the storage capacitor mentioned above is connected after the gate so that it can only sample the smoothed voltage available when the gate is open. Previously the storage capacitor would have been connected across the output of the rectifier and so responded to a low frequency ripple. This will of course confuse the true response.

ELECTRONIC CONTROL OF SORTING

BP 1 279 134

IN BP 1 279 134 Gunson's Sortex Limited of London E3, describe a fairly simple method of detecting the difference between mixed objects to be sorted, e.g. between scrap polyethylene and scrap copper. They claim that if modified their device can also be used to sort objects made from different types of plastics material.

The basic feature is that the mixed objects falling down a chute pass through a coil (in Fig. 1) with a small number of turns. This coil is part of a tuned circuit connected into an oscillator circuit.

The output of the oscillator is used to control a sorting deflector which pneumatically deflects objects of one type.

The circuit (Fig. 2) shows the coil together with the tuning capacitors and transistor functioning as a Colpitts oscillator. The frequency produced is usually within the range 200 to 300 MHz.

When an object passes through the coil a positive going change occurs in the output signal from the oscillator. The change in output signal is amplified and fed to a magnitude detector stage. This transistor amplifies and inverts to provide a negative-going signal which can be used to drive a power amplifier for controlling the deflector mechanism.

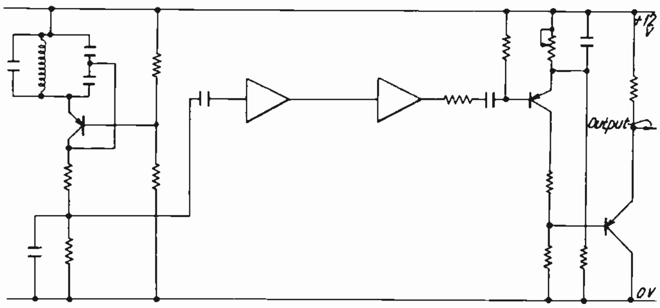


Fig. 2. Basic amplifier and switching circuit

To distinguish between different objects of similar material, the detector transistor switches according to the signal rate of change. Fig. 3 shows an arrangement whereby an "object presence" sensor makes sure that the deflector operates only when required by one object.

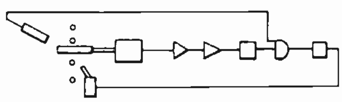


Fig. 3. Gating for one object at a time.

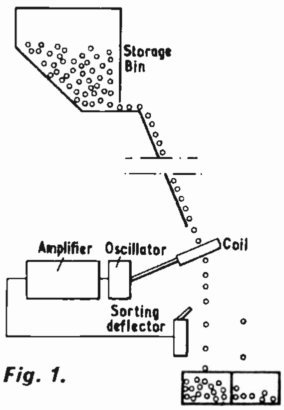
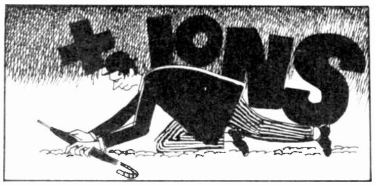


Fig. 1.

Gerry Brown . . .

ON THE FRINGE



CHARGE

Back in Queen Anne's time, the superstitious held that "air electricity" could have a profound influence on both behaviour and on general disposition. Indeed, such expressions as, "he has the wind in his tail" probably originated this long ago, since it was common practice in European courts to treat felonies with more tolerance whenever the Ides of March were blowing.

In common with many old beliefs which have subsequently become contemporary facts, air electricity is no exception. Apparently it is ions which are responsible for this effect on people. Ions are atoms (more likely, in this case, molecules) which have either lost or gained a number of electrons; those with extra electrons become negative ions, and those losing electrons, positive ions. For some obscure reason the positive ions make us feel tired and lower our capacity for work, while negative ions produce just the reverse; as when, for example, a thunderstorm has just passed.

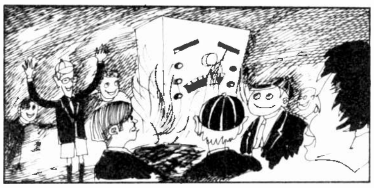
Prior to a storm it has been noticed, though, that the air charge is predominantly positive so if the theory is right this would correlate with feeling "lifeless" and "headachey" at such times.

Thunder and lightning aside, in spite of our technical enlightenment *we* probably do more to make our lives uncomfortable than the "superstitious" people of yesterday. Consider what we wear. Nearly all our clothing is prepared from synthetic material; shirts and dresses are made from nylon, rayon, or similar fibre, while the soles of our shoes are generally fashioned from some form of man-made "leather", all of which cause us to acquire a relatively permanent high-voltage charge.

This charge is positive and, *what's more, according to some researchers causes most of the fatigue and general debility experienced these days.* The question is, should we drag around discharging chains in order to maintain equilibrium, or would we be better off minimising "droop" under a d.c. version of the National Grid?

FIRE WITHOUT SMOKE

Since we have had every opportunity to become fully hyperconscious about pollution and its effects, it is staggering to think that most of us are quite uncritical of the quantity of such belched into the atmosphere during that evening



on November the 5th. This is particularly hard to bear when one considers that fireworks have advanced little, technically, for the thousand or so years since the Chinese began using them; albeit, the bangers were likely better then!

So, since this burning sense of fun remains with us to relive the next year, and generally costs more per shower of sparks than it did the year previously, a nagging feeling is left that perhaps the time has now come to rethink the Guy Fawkes night phenomenon. And who could be more fortunate than us to enjoy a relatively luxurious imagination in this respect. While there's still a little time left before this year's "big burn", and before Dad sets light to the poplars again, let's see how realistic a smokeless 5th might be.

For starters, we could do-away with the conventional Catherine wheel and substitute it for a spinning frame of lights, faded electronically in sequence from the centre, and fed via slip rings on the drive shaft. Then add a bit of novelty to roman candles by employing solenoid-released, spring-ejected, miniature mercury cell powered micro-lamps. Or what about capacitor discharge "canon crashers" with extra large xenon flash tubes for realistic back-up?

Occasional bursts of envelope shaped white noise would not come amiss, particularly in synchronism with periodically operated, brightly lit water fountains. Realistic smoke would be produced with solid CO_2.

With a philosophy like this fireworks could be arranged to have a virtually indefinite "burning time", and would hardly ever wear out. Honestly, when you consider just how much electrical power is available for the really enthusiastic, it's a wonder someone hasn't done a back-garden Son et Lumière already!

EYE-AYE!

Sensory deprivation still remains a bit of an enigma; indeed, the discovery of every new effect has raised an even greater number of questions about its possible mechanism.

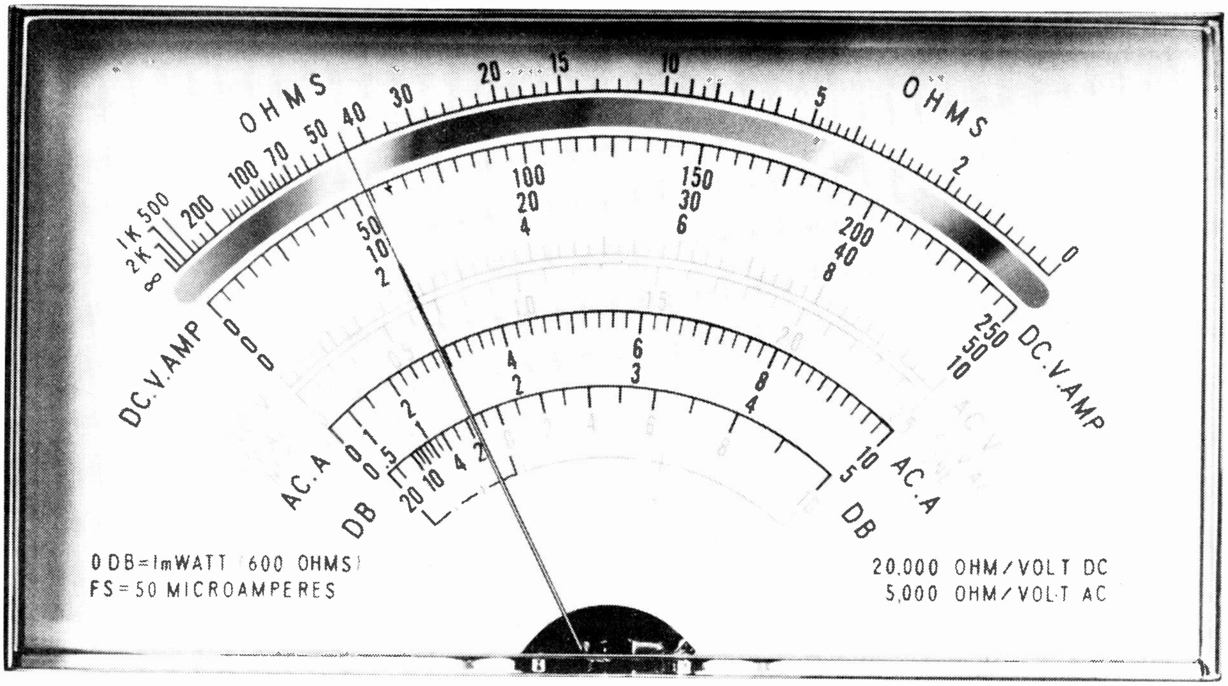
Many of the problems associated with experiments up until now could well have been attributed to the rather general nature of the experiments, and further complicated by interaction (or lack of it) between large numbers of unstimulated areas in the brain.

Although the days are not yet past when experimental volunteers need be suspended in tanks of warm water for hours at a time, there does appear to be a modest breakaway toward more systematic examination by limited deprivation of inputs to individual senses.

Employing this technique, two workers at the University of Manitoba have recently discovered an effect very similar to that which occurs following actual severence of sensory nerves. For their experiment each of 15 students were asked to wear a light-blocking patch over one eye during a working day on the campus. The uncovered eye was checked periodically for sensitivity to flickering, rather than continuous light.

On aggregate, uncovered eyes were intially less sensitive, but, given several hours, subsequently began to increase in sensitivity, eventually exceeding even the normal level. In some instances students reported that this hypersensitivity lasted for days afterwards.

These odd happenings could, by implication, be no mere trifle, especially in the context of stimulus withdrawal for any great length of time. Paradoxically, though, an additional effect was that the covered eye maintained normal sensitivity throughout the tests. Perhaps Nelson, bless his heart, really didn't see any ships after all!



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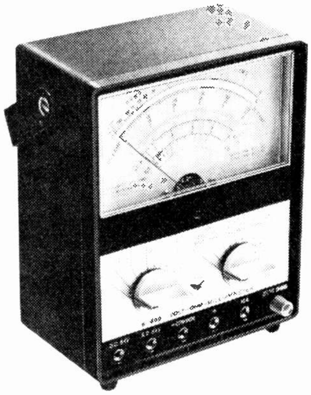

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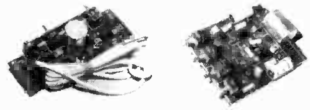

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Plessey I.C.'s Type SL403D complete with circuit diagram, **£1·25** each.

Trade enquiries invited. Post and packing 20p for speakers and amplifiers.

CIRTEC PRINTED CIRCUITS LTD
HIXON INDUSTRIAL ESTATE, HIXON
STAFFORD

SINGLE SHOT FOR OSCILLOSCOPES

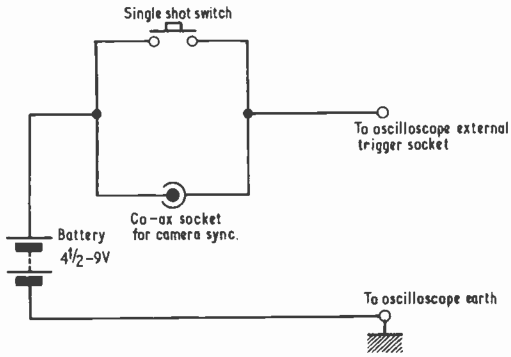


Fig. 1. Final circuit for adding a one shot facility to an oscilloscope

INGENUITY UNLIMITED

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

HAVING a double beam oscilloscope which does not have an integral single shot facility, it was felt that single shot operation would be useful in photographing traces. Inspection of the circuit diagram of the 'scope had shown that with a judicious choice in the setting of the trigger level and stability controls together with the application of external trigger pulses, a very simple system could be used to initiate single sweeps.

The external input to the trigger circuit of my 'scope (D51) can be a positive or negative going waveform of amplitude greater than three volts. The current required was small, so an old PP3 battery could be used until corrosion rendered it useless.

All that was thus required was a battery and a push on/release off switch connected in series with the external trigger socket of the 'scope.

It was realised that the switch could be replaced by the flash contacts of a camera. Use of a slow shutter speed and X (or electronic flash) synchronisation allows the trace to be recorded on film even under fairly high levels of ambient illumination.

The final circuit is shown in Fig. 1, the flash contacts being wired in parallel with the push on/release off switch to allow setting up and single shot operation without unnecessary wastage of film.

To set the equipment up, turn the trigger selector to external. Next turn the stability control from the free-run portion of its range until the trace just disappears. Turning the trigger level control from "auto" through the set level area of its range should at some point produce one trace. With the control in this position apply the external trigger pulses and optimise the settings of the stability and trigger level controls for reliable single shot triggering. The 'scope is then set up.

R. A. Shackleford,
Glasgow.

SENSITIVE LIGHT SWITCH

I ENCLOSE a circuit diagram, Fig. 1, of a very sensitive light operated switch which may be of interest to readers.

When the light dependent resistor PCC1 is illuminated its resistance is low making the inverting input of the i.c. positive with respect to the non-inverting (the potentiometer VR1 is adjusted to ensure this) so the output will be at 0V and the transistor TR1 will be cut off. As the light level falls the l.d.r.'s resistance increases until the inverting input is more negative than the non-inverting. This causes the amplifier to saturate and the output rises to +12V, which switches on TR1 and operates the relay.

The point at which the relay operates is controlled by VR1, and is really stable as supply voltage variations have small effect because both voltages vary together (l.d.r. junction and VR1 wiper).

If the reverse operation is required (i.e. relay operates as light increases) connect the l.d.r. to 0V and resistor R1 to +12V.

R. S. Girdwood,
Norwich.

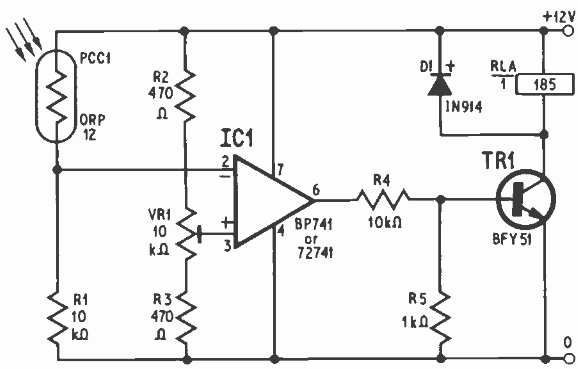


Fig. 1. Circuit diagram for a very sensitive light switch

Readout—

A SELECTION FROM OUR POSTBAG

Correspondents wishing to have a reply must enclose a stamped addressed envelope. We regret we are unable to guarantee a reply on matters not relating to articles published in the magazine. Technical queries cannot be dealt with on the telephone.

True values

Sir—Messrs. Bobker, Harrison, and Barrett have a rather strange sense of values (*Readout*—Oct. 1972). They seem to have been caught by the general malaise that is creeping over many sections of society that if you cannot make something for a "profit" then its not worth bothering. They seem to have blinded themselves with the financial matters of the subject and have forgotten that your magazine is not designed with commercial interests in mind but to offer amateur enthusiasts a source of up-to-date knowledge on all aspects of electronics coupled with instructions on how to make equipment.

You cater for amateur hobby interests and the value of a hobby is beyond price if you are sufficiently interested in the subject. The price it costs to make something and learn from it is irrelevant—provided one can actually *afford* the expenditure. If one cannot afford the price of making something then one can still get a high degree of satisfaction out of reading and understanding, in a very practical sense, the workings of a sophisticated piece of equipment.

Digi-Cal is the first publicly issued inside story of the workings of a desk calculator and as such is a long waited for event on the amateur front; the three correspondents named above should be thankful that at last someone has gone to the trouble of designing such a piece of equipment and is also capable of explaining its workings in a clear and straightforward manner.

Your correspondents have got the wrong end of the stick. If they want something cheap then they should buy it. If they want real value for money then they should make an effort to scrape together the money to do something worthwhile. Just for a moment let's consider whether they have their commercial facts right. Let's assume they have bought their cheap commercial instrument; something goes wrong with it that is outside the guarantee. What do they do (assuming no inside information regarding *Digi-Cal*)?

Of course they have to lay out more money to get the equipment repaired. If they had dropped or crushed their pocket sized instrument it is quite likely that they will have cracked the single i.c. element. How much does this cost to replace?—probably in the order of £24 to £40 depending on the type. How much would it cost if a similar thing happened to *Digi-Cal*? Certainly a lot of time sorting out the fault—but in material costs probably not more than a few pence!

I'm afraid I do not agree with the last paragraph of your editorial. *Digi-Cal* is NOT "priced out"—if anything it is absurdly cheap. An annual subscription to P.E. costs £2·65; the electronics, mathematical knowledge, and logic experience that can be gained from a series such as this is far beyond the learning one can gain in a whole year of university work in the same field.

My interest is in the field of digital electronics, but I know very little about calculators. This hole in my knowledge is now being filled. I would like to congratulate Mr. Coles for making such an effort in designing a topical, useful and educative project, and I measure that most enthusiastic readers would agree with me.

Michael J. Hughes,
Westerham, Kent.

Raudive voices

Sir—Mr Morton (September, '72) would appear not to have read "Breakthrough" as well as he might have. I quote, "Scientific tests have shown (in a Faraday cage, for example) that these voices originate outside the experimenter and are not subject to auto-suggestion or telepathy." Also, "They are twice the speed of human speech and of a peculiar rhythm which is identical in the 72,000 examples so far examined." Would different experimenters all have the same style of modulation?

There is the possibility that the tape irregularities themselves, when passed through a high-gain amplifier, might sound like words to anyone who expected (however unconsciously) words to be there. However it sounds unlikely, but, until we know more, it must be an open question.

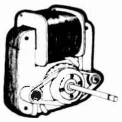
Michael Fleming,
Solihull, Warwicks.

Michael Fleming raises three issues: one trivial and two worth a closer look. I will try to deal with them in turn.

First, the "tape irregularity" explanation, which is in fact a politer way of saying "imagination" or even "fraud". Can we doubt that a phenomenon so seemingly preposterous as the Raudive voices would have been examined by reputable technicians well used to the vagaries of magnetic tape? If we are going to accuse Raudive of trickery then let's do so openly—and be ready to say how it is done—without invoking explanations which don't explain.

Secondly, the two quotations Mr Fleming gives certainly do not deal a deathblow to the psychic/electronic interaction hypothesis I proposed. Admittedly we have little real knowledge of the laws behind parapsychological activity: but all the evidence says that neither telepathy nor telekinesis are electromagnetic radiation; do not obey the known principles of propagation; and cannot be blocked by any shielding. Therefore the fact that Raudive voices appear on recordings made inside a Faraday cage is quite irrelevant to the present argument.

I will not try to answer the point about the "identical peculiar rhythm" of the recordings because I believe little sense can be said without more facts to go on. But I would point out that brains are not so dissimilar in *some* of their manifestations as Mr Fleming suggests; for example the alpha rhythms in most normal brains are too alike for it to be possible to distinguish between them by these traces alone; and one of the important things about psychical research is that its evidence suggests all minds are linked "under the surface" in a way we don't understand. Therefore it's not too surprising if all brains react with electronic circuitry in much the same way: or at least seem to with our relatively crude equipment. In any case, if Raudive is to be believed, the voices *are* quite distinctive in pitch and timbre. This is not to say that because the voices are recognised, they may therefore be taken to be those of dead people: I hate to think of any of *my* dead relatives being forced to utter the kind of imbecilities we have immortalised in "Breakthrough". We do know from research into mediums and their activities that



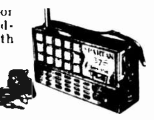
MAINS MOTOR

Precision made—as used in record decks and tape recorders—ideal also for extractor fan, blower, heaters, etc. New and perfect. Snip at **65p.** Postage 20p for first one then 10p for each one ordered.

MINIATURE WAFER SWITCHES

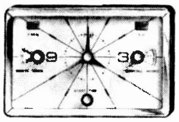
2 pole, 2 way—4 pole, 2 way 3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at **20p** each, **£1·80** for ten, your assortment.

SPARTAN Portable RADIO



£1·99 Only. Six transistor medium wave pocket loud-speaker radio. Loud and with good tone will make wonderful Christmas present. Buy while stocks last. Full money back guarantee. Renitone med. wave only, 7 transistors **£1·95.**

ELECTRIC CLOCK WITH 20AMP SWITCH



These units are as fitted to many top quality cookers to control the oven. The clock is mains driven and frequency controlled so it is extremely accurate. The two small dials enable switch on and off times to be accurately set—also on the left is another time or alarm—this may be set in minutes up to 1 hour. At the end of the period a bell will sound. Offered at only a fraction of the regular price—**£2·50**, less than the value of the clock alone—post and ins. 15p.

WATERPROOF HEATING ELEMENT
26 yards length 70W. Self-regulating temperature control. **50p** post free.

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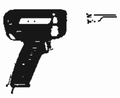
How long does it take you to renew a fuse? Time yourself when next one blows. Then reckoning your time at £1 per hour see how quickly our resettable fuse (auto circuit breaker) will pay for itself. Price only **£1** each or **£11** per dozen, specify 5, 10 or 15 amp—*simply fit in place of switch.*

FLUORESCENT CONTROL KIT

Each kit comprises seven items—Choke, 2 tube ends, starter, holder and 2 table clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin filled. Kit A—15-20 w. **£1.** Kit B—30-40 w. **£1.** Kit C—80 w. **£1·20.** Kit E—65 w. **£1·20.** Kit F for 8ft. 125 w. tube **£1·75.** Kit MF1 is for 6in., 9in. and 12in. miniature tubes **£1.** Kit MF2 for 21in. 13 w. miniature tube **£1.** Postage on Kits A and B 23p for one or two kits then 23p for each two kits ordered. Kits C, D and E 23p on first kit then 18p for each kit ordered. Kit F 33p then 23p for each kit ordered. Kit MF1 18p on first kit then 15p on each two kits ordered.

DOOR INTERCOM

Know who is calling and speak to them without leaving bed. or chair. Outfit comprises microphone with call push button, connectors and master intercom. Simply plugs together. Originally sold at **£10.** Special snip price **£3·50** plus 20p postage.



SOLDER GUN

A must for every busy man, gives almost instant heat also illuminated job. 100 watt **£2·25** plus post and ins. 20p. BIG JOB 250 watt model **£4·75** plus post and ins. 40p.

MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer rectifier, smoothing and load resistor condensers and instructions. Real snip at only **83p,** plus 20p postage.

MULLARD AUDIO AMPLIFIERS. All in module form, each ready built complete with heat sinks and connection tags, data supplied.
Model 1153 500m watt power output **75p.**
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Model EP9000 4 watt power output **£1·45p.**
10% discount if 10 or more ordered.

MULLARD 4+4 STEREO AMPLIFIER

We demonstrate these daily and almost always a sale results; it really is a cracking amplifier. Only Mullard with their know how could have made it possible at this low price. SPEC:—Mains operated. 4 watts music or speech per channel. Double wired power supply eliminates cross talk. Harmonic distortion less than 2%. Frequency response 50hz-16Khz. Input suitable for pick-up tuner or microphone. 6 month guarantee. Only **£9·95p** + 30p postage and insurance.

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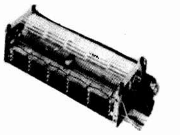
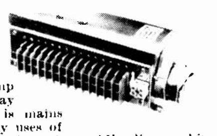


TANGENTIAL HEATER UNIT

This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. We have a few only. Comprises motor, impeller, 2kW element and 1kW element allowing switching 1, 2 and 3kW and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only need control switch. **£3·50,** 3kW. Model as above except 2 kilowatts **£2·50.** Don't miss this. Control Switch **35p.** P. & P. 40p.

HONEYWELL PROGRAMMER

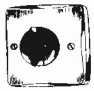


This is a drum type timing device, the drum being calibrated in equal divisions for switch setting purposes with trips which are infinitely adjustable for position. They are also arranged to allow 2 operations per switch per rotation. There are 15 changeover micro switches each of 10 amp type operated by the trips thus 15 circuits may be changed per revolution. Drive motor is mains operated 5 revs per min. Some of the many uses of this timer are Machinery control, Boiler firing, Dispensing and Vending machines Display lighting animated and signs, Signalling, etc. Price from makers probably over £10 each. Special snip price **£5·75** plus 25p post and insurance. Don't miss this terrific bargain.

THIS MONTH'S SNIP

TIMAC 24 hour 15 amp Clock Switch. Self-contained unit for flex connection to the mains. Clock switches 2 on/offs per 24 hours. Operates a 15 amp switch. All neatly made up in an ivory moulded case with outlet socket. The only snag is that the outlet socket is the continental type. Plugs for these can be brought in this country alternatively you could fit a connector strip in place of the outlet socket. Overall size of this unit is approx. 4" × 2¼" 3" and the clock has a clear perspex cover which is easily removable for reprogramming. Ideal for blanket controller, etc. Price **£2·75** each.

THYRISTOR LIGHT DIMMER



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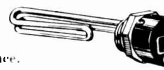

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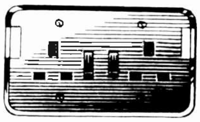

13 AMP TWIN GANG SOCKETS

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

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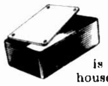
Test continuity of any low resistance circuit, house wiring, car electrics. Tests polarity of diodes and rectifiers. Also ideal size for conversion to signal injector (circuit supplied). **30p** or 2 for **50p** post paid.

AMPLIFIER IN CASE WITH SPEAKER

Marketed by British Relay under the name Luxistor. This is in a very neat looking cabinet and is ideal around the home or in the workshop for trouble shooting or for testing out a quick lash up. Size approx. 9¼" × 6¼" × 3½" deep. Input is via a matching transformer and volume control and amplifier may be powered by an internal 9v battery or an external 110v source. Speaker is an R-A eliptical 6" × 3½" 10,000 gauss. The amplifier proper is a Newmarket model ref. P.C.4. Price **£3·50** each, 10 for **£31·50.** Post and insurance 20p.

BAKELITE INSTRUMENT CASE



Size approx. 6¼" × 3¼" × 2" deep with brass inserts in four corners and bakelite panel. This is a very strong case suitable to house instruments and special rigs, etc. Price **45p** each.

TELEPHONES

Complete as illustrated. Save your legs, time and temper, simply by putting in some telephones. Ex-G.P.O., not new—but guaranteed in good condition and serviceable. Supplied with diagram and instructions showing how to connect. Price **75p** each +50p post or 2 for £2 post paid. Also available separately, dials and handsets **50p** each + 20p post.

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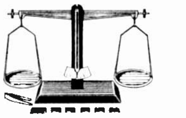
13 amp self-fixing into an oblong hole, size approximately 1" × 1" **6p** each, 10 for **54p.**

SLIDE SWITCHES

Slide Switch. 2-pole changeover panel mounting by two 6B.A. screws. Size approx. 1in. × ⅜in. rated 250V lamp. **6p** each, 10 for **54p.** 100 for **£5·10.** 500 for **£24.** Ditto as above but for printed circuit **5p** each. 10 for **45p.** 100 for **£4·25.** **Sub Miniature Slide Switch.** DPDT 19mm (¾in. approx.), between fixing centres. **18p** each or 10 for **£1·08.**

EDUCATIONAL KITS—all with pictorial instructions



THIS BALANCE KIT **FREE**

Eagle educational kits, Japanese made these are excellent value for money. We do not expect to be able to repeat this offer once stocks are sold. Brief description of each kit is given below and with 3 kits or more we give FREE an accurate 11 piece balance kit. Price of kits **40p** each post paid. Special price for all 8 kits **£3** with free balance kit.

KA2 Lens Kit. Eleven parts, including candle, one concave lens, one convex lens, stage and slit frame, etc. Watch light rays bend as they pass through different lenses.

KA3 Water Pump Kit. Thirteen parts. Top of pump is transparent so that operating parts may be observed. Small parts are brightly coloured to be seen easily while working. Three types of pump may be made: Lift pump. Force Pump and Force Pump with reservoir and nozzle.

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KA6 2-Pole Motor Kit. Twenty-four parts including enamel wire, armature and pole piece, etc. Motor operates from 1½ volt battery. Illustrates and teaches how electro-magnetism operates a motor.

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KA8 Current and Resistance Kit. Twenty-nine parts, including bench and light bulb. Conduct interesting and educational projects to learn the application of "OHMS LAW" and see the difference in current and resistance with different types and lengths of wire.

KA9 Bell Kit. Eight parts, including bell and push button switch. Build a complete electric bell and see how the hammer is triggered to make the bell ring.

KA10 Morse Key trigger and bell kit. 25 part kit easy to construct, simple to operate.

Where postage is not stated then orders over £5 are post free. Below £5 add 20p. Semi-conductors add 5p post. Over £1 post free. S.A.E. with enquiries please.

J. BULL (ELECTRICAL) LTD.

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Callers to 102/3 Tamworth Road, Croydon.

Readout—
A SELECTION FROM OUR POSTBAG

the subconscious mind is capable of generating all kinds of personas (synthetic personalities) to give substance to its longings, hopes, hatreds, etc. That these figments should then escape into the "mental ether" and come to react with electronic equipment I find quite plausible, especially when supported by other experimental evidence.

And there *is* experimental evidence. If any readers are ready to jib at the notion of mere thoughts directly affecting electronic circuitry I would direct them to the work of Helmut Schmidt, a physicist of international repute. He has devised an apparatus on which trained subjects can both predict *and control* random events at the sub-atomic level (the decay of Strontium-90 nuclei) at a high level of probability by willing alone. There is a good summary of his work in Arthur Koestler's "The Roots of Coincidence". 1972.

— Peter R. Morton

Amongst the white noise

Sir—After reading Mr Peter Moreton's letter in the September edition of P.E. on "Psi-Tronics". I wondered if your readers would be interested in similar experiences of my own?

I have a temperamental (!) v.h.f. receiver which I use in a radiotelescope aerial system, and during tuning up of this receiver and its associated preamp to the required band, it was left switched on for long periods producing nothing but what has become to be known as "white noise". The preamp being very difficult to align, I was often switching the signal generator off and on, making adjustments, and trying again. On many occasions, during range testing of my aerial, I am *sure* I heard the signal generator whilst it was switched off, i.e. all the radio was receiving was the usual v.h.f. spurious noise. This happened so frequently that I had to keep checking that the signal generator *was* switched off, before I tried to properly "tune in" this figment of my imagination!

I put it to Mr Brown and Mr Morton that the mind has some mechanism whereby it hears amongst the white noise what it *wants* or *expects* to hear, and that this explains the phenomena, since in my case, the familiar note of my signal generator is unmistakable, and I certainly was fully conscious of the fact I was hearing something that *couldn't* be there!

I must confess to being still sceptical about such things as the "Raudive Voices", but when it happens to you personally, it's something quite different!

L. M. Newell,
Woodbridge, Suffolk.

Road choir!

Sir—In connection with the recent interest shown in "Raudive voices" I should like to give an example of my own subjective interpretation of white noise.

Some years ago, while riding on the cab of a noisy long-distance lorry I was enveloped by the sound of the engine, the sound of other cars on the road and the various vibrations and rattles from parts of the lorry, i.e. a broad band frequency spectrum somewhat resembling white noise. I hummed a pop tune to myself and to my surprise I heard the pop song coming from somewhere inside the cab sung, as it seemed to me, by a choir of out-of-tune voices. There was no radio in the cab and it seems that the voices were a purely subjective interpretation of the random noise spectrum reaching my ears. With practice it was possible to hear the voices "sing" any tune at will, there being a period of some seconds between conceiving a tune and actually "hearing" it. Since that time I have met one or two people who have had the same experience. The moral seems to be that if it is possible for some people to hear pop songs in white noise, then it is equally possible for others to hear voices from the dead if they so wish.

An explanation may be as follows. When a memory comes to mind the brain cells that correspond to the sensual experience of that memory become active. If (when the memory is of a noise) the ears perceive white noise simultaneously, then the same mechanism that allows concentration on one conversation when several may be going on will come into effect, only allowing the memory of the noise to come into consciousness. This memory will, however, appear to come directly from the senses since the white noise components corresponding to the noise will be allowed to pass by the brain's "filters".

It may be interesting for psychologists to carry out experiments in this area, and perhaps with other senses. (Is there any capacity to project visual images when in an environment of completely white light for example) perhaps even ending up with "White taste" and "White smell".

I would, of course, be interested to hear other people's interpretations and experiences in this area.

K. Willson, B.Sc.,
London S.W.16.

Unconvinced

Sir—I was interested to read in the September issue that the phenomenon of "Raudive Voices" had cropped up again under the general heading of Psitronics. The hypothesis on the origin of this phenomenon suggested by your correspondent, Peter Morton, is most ingenious but is open to criticism on one simple count.

It is now generally recognised that the operation of the brain is related to a measurable form of electrical activity. Thus it is reasonable to assume that telepathic communication is, ipso facto, electrical in origin also. If this assumption is accepted as being substantially correct it becomes increasingly difficult to explain the positive results from experiments into the phenomenon which were conducted with the recording apparatus sealed within a Faraday Cage.

If we accept that the phenomenon exists, and there appears to be plenty of evidence that it does, then it seems that we must resort to the explanation tendered by one of Raudive's original witnesses—"that it transcended the *known* laws of Physics'. All of which leaves a wide open field for future experimenters.

Having read "Breakthrough" shortly after its publication a friend and I decided to carry out a number of experiments to prove the existance of the phenomenon for ourselves. My colleague in this, besides being a highly qualified electronics engineer, has had a genuine "feel" for what might be termed supra-normal phenomena all his life, and thus felt that everything was on our side.

We built two forms of each type of detector described in the book and combined these, in turn, with six types/models of tape recorder. In addition we tried the microphone and radio methods of recording, but after many hours and several miles of tape had recorded only one voice which could not be directly attributable to spurious "E" propagation or something similar. Our prize voice resisted all attempts of filtration and re-amplification to

Readout—
A SELECTION FROM OUR POSTBAG

become intelligible so we decided to retire unconvinced.

I too would be interested to learn of the experiences of others in this field.

Douglas Shaw,
Eaton Socon, Hunts.

Authoritative opinion appears to be opposed to the view that telepathy is a form of electromagnetic radiation. Dr Grey Walter in his book, "The Living Brain" (1961) states: "if we consider the largest rhythms of the brain as casual radio signals, we can calculate that they would fall below noise level within a few millimetres from the surface of the head".

There is evidently much general interest in this topic. Many readers have written describing their own experiences and experiments, but no one has reported a success in recording "Raudive voices".

Retort from Australia

Sir—I read with great interest the article *Report from Australia* and I am sure that the article was written with the best of intentions in the world. However, the Australians in general tend to gloss over many things, and literally hate comparisons when it comes down to earth, i.e. hard cash! This particularly so in the radio field.

I go green with envy when I read the cost of components, transistors and integrated circuits in the U.K. and I compare them with those available here. For example, take the BC108 listed in P.E. at 10p or 20 cents Australian, the BC108 here is 45 cents and on top of that there is up to 27% sales tax, depending on the State in which you live. This tax is very crippling when you come to build any of the available projects. So my advice to any intending migrant is to do two things: forget most of what the brochures from Australia House tell you, and if you still intend to come, take things as they are and you'll make out. The second thing is to bring out as much gear as you possibly can.

This is a mighty big country, so its a little unfair to classify most radio sets as made for local station reception. There are areas (fewer now than they used to be) of poor reception in the U.K. Well England from top to bottom is approx. 560 miles. Folks here often drive this distance, and more, just to visit friends at a weekend. It has to be a really good quality radio set to pull in inter-state radio stations during the day. At night of course it's not so bad. In the more thickly populated areas this situation may not arise as transmitters are closer together, but it is certainly true of South Australia.

It's all very well to say that Australia is as technically advanced as its contemporaries, but I have found that when dealing with i.c.'s the manufacturers' applications notes are so technical that they are for boffins only—and I include all American manufacturers — so I am indebted to your magazine for *Making The Most Of Logic* and subsequent articles on i.c.'s and most important the way these articles have been presented.

Talking of f.m. I bought a German radiogram in Singapore in 1959. I arrived in this country in 1966. F.M. was, as it is now, being talked about but I'll believe it when I see it! I am told they had a few f.m. stations in the Sydney area of N.S.W., but they died through lack of interest as far back as 1966.

Well, this letter was prompted for two reasons, my personal dislike of half truths, and the fact that I'm in the radio field and I did migrate to Australia. So if this does anything to put the record straight I'll be happy.

P. Hickman,
Greenacres, South Australia.

Musician's ambition

Sir—As another of your younger readers I fully agree with Neville Powell's letter in your September issue. It would be nice to see designs for transistorised sound effects apart from the more common tremolo and fuzz, etc. These things are fairly easy for the average constructor to design whereas more complicated effects such as echo, reverb, and waa-waa are harder to design and build.

It is every musician's ambition (I am no exception!) to own a synthesiser, but the prices of commercially made instruments are out of this world! I am sure it would be possible to make a synthesiser using cheap and easily obtained i.c.'s.

Hoping to see something of this kind in the future issues of Practical Electronics.

Andrew Copsey,
Gildersome, Nr. Leeds.

You will! The P.E. Synthesiser will be on display at the Audio Fair, Olympia, London, October 24-28.

All of the sound effects mentioned in your first paragraph have been covered as constructional projects in past issues of this magazine.

BACK NUMBERS WANTED

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

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

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Mr. T. Svenell, Östra Farmvägen 40B, S-21441 Malmö, Sweden.

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Mr. G. Paine, 21, Estridge Way, Tonbridge, Kent.

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Mr. B. L. Codd, 46, Woodrows, Woodside, Telford, Shropshire.

April 1970
Mr. M. Dowding, 89, Beresford Road, Lowestoft, Suffolk.

February 1971
Mr. B. Whiting, Fellands Gate, Old Leake, Boston, Lincs.

November 1964 to March 1965, October to December 1970, February and March 1972
Mr. P. U. Sukhadia, 1-16, Shantinath Bhuvan, 427, Sion Road, Matunga, C.Rly. Bombay-19, India.

May 1969 to March 1970
Mr. V. T. Brown, 242, Little Wakering Road, Wakering, Southend SS3 0JN.

March 1968, January 1971, April 1971, June and July 1972
Urs Bachofner, Wulflingerstrasse 92, CH-8400 Winterthur, Switzerland.

August 1969
Mr. M. Latter, 45, Wortley Road, W. Croydon, Surrey.

April-May 1972
Mr. G. Slack, 87, Upham Road, Swindon, Wiltshire.

Designing with Integrated circuits

BY A.FOORD

A new series designed to help the experimenter to use I.C.s in practical applications. The circuits provided are not intended as definitive designs, but rather as a basis on which to experiment further.

2 Digital I.C. Gates

A BINARY information signal in logic i.c.s has only two possible states: a logic level 1 of about 4 volts and a logic level 0 of about 0 volts. Each logic circuit produces an output logic level that is a logical function of the input logic levels. These levels are not critical provided that they are clearly recognised as 0 or 1, and small changes in levels cannot accumulate to cause loss of accuracy.

Simple logic functions are achieved by using gates while more complex functions use specifically designed circuits, which may include gates but not necessarily so.

TTL SERIES

Several classes of integrated circuit logic are available, including RTL, DTL, TTL and ECL. However, now that TTL logic is available in a variety of speeds and a considerable range of functions, no other type need be considered for general use in this series of articles.

The Series 74 integrated circuits available from many sources are designed and characterised for general purpose high speed digital applications where a high d.c. noise margin and medium power dissipation are important. The series includes gates, bistables, complex logic functions, and many other circuits.

Four compatible TTL families are available to allow switching speed (and hence power dissipation) to be chosen according to the system requirements. The largest and most widely used family is the SN7400 series which has a 10ns propagation delay per gate. (Alternative types are made by various manufacturers and details of equivalents were given in the P.E. I.C. Identichart last month.)

The 74H00 or 74S00 series can be used for minimal propagation delay times, with the 74L00 series reserved for low speeds. A comparison between these familes is shown in Table 2.1.

The speed differences over the range are not a matter of selection as the circuits differ, although the logic functions and levels are compatible. The SN74S00 series, for example, have Schottky barrier-diode clamping to achieve ultra high speeds with the best speed-power product of any high speed logic family.

Table 2.1

Series Code	Power Dissipation	Propagation Delay	Approx. Relative Price Factor
SN74L00	1mW per gate	33ns delay	1·8
SN7400	10mW per gate	10ns delay	1·0
SN74H00	23mW per gate	6ns delay	2·4
SN74S00	19mW per gate	3ns delay	6·7

The Schottky barrier-diode clamping prevents the transistors from going into saturation and eliminates the effect of excess charge storage and subsequent recovery times. These recovery times contribute significantly to the overall propagation delays obtained with conventional saturated TTL circuits.

GUIDELINES WHEN USING TTL

Power Supplies. Ripple and spikes should be kept to 5 per cent or less and regulation should be maintained to better than 5 per cent. Every five to ten packages should be bypassed to r.f. with ceramic capacitors of 0·1 to 0·01μF.

A ground plane is desirable especially in large systems, or make the earth line as wide as possible on a printed circuit board and return both ends of long ground wires to a common point.

Gates. Gates should preferably be driven from a low impedance source. If the source impedance is greater than 100 ohms (for example, non TTL circuits) then the input rise and fall times should be less than 1μs to avoid instability and oscillation occurring when the gate goes through its active region of operation. Data pulse widths should be 30ns or more.

The unused inputs of AND and NAND gates and unused presets and clears of bistables can be treated as follows:

(a) They can be tied directly to $+V_{cc}$ where V_{cc} is guaranteed to be *always* equal to or less than 5·5V.

(b) Connected to $+V_{cc}$ through a resistor of 1 kilohm which protects the input if the supply exceeds 5·5V. Up to 25 unused inputs can be connected to one resistor.

(c) Connected to an independent supply of between 2·4 and 3·5V.

(d) Connected in parallel with a used input of the same gate if the maximum fan-out of the driving output will not be exceeded. Each input presents a full load in the logical 1 state to the driving stage.

Completely unused gates can be taken to ground for the lowest power dissipation, or left floating (unconnected).

Unused inputs of NOR gates can be tied to the used input of the same gate (if the maximum fan-out of the driving gate is not required) or returned to ground.

Bistables. If a clock pulse is present maintain the preset or clear pulse until the clock goes low. Rise and fall times of the clock pulse should be less than 150ns to aid noise immunity.

In general the input data of a master/slave JK bistable should not be changed while the clock pulse is high, but exceptions are given in manufacturers' data sheets.

BASIC GATES

Five logic functions are summarised in Table 2.2. Their interrelationship can be seen by comparing the

GLOSSARY

BUFFER An integrated circuit with a higher fan-out than usual, for driving heavy loads.

CHARGE STORAGE Energy stored in a transistor when it is heavily saturated.

DTL A logic circuit using diodes for the input coupling to a common emitter amplifier.

ECL A logic circuit consisting of an *npn* current mode switch.

FAN-OUT The number of inputs which can be driven by the output of a logic gate.

NOISE IMMUNITY A measure of the ability of a logic gate to reject noise pulses. It is the smallest 1 level output voltage minus the minimum effective 1 level input voltage, or the minimum effective 1 level input voltage minus the maximum 0 level output, whichever is the smaller.

PROPAGATION DELAY A measure of the time taken for a change in logic level to be transmitted through an element.

RTL A logic circuit using resistors for the input coupling to a common emitter amplifier.

TTL A logic circuit having all inputs connected to the multiple emitters of a single, common base connected transistor.

Table 2.2: The basic logic functions

INPUTS		OUTPUTS				
		AND	NAND	OR	NOR	EXCLUSIVE-OR
A	B	A.B	$\overline{A.B}$	A + B	$\overline{A+B}$	$A \oplus B$
0	0	0	1	0	1	0
0	1	0	1	1	0	1
1	0	0	1	1	0	1
1	1	1	0	1	0	0

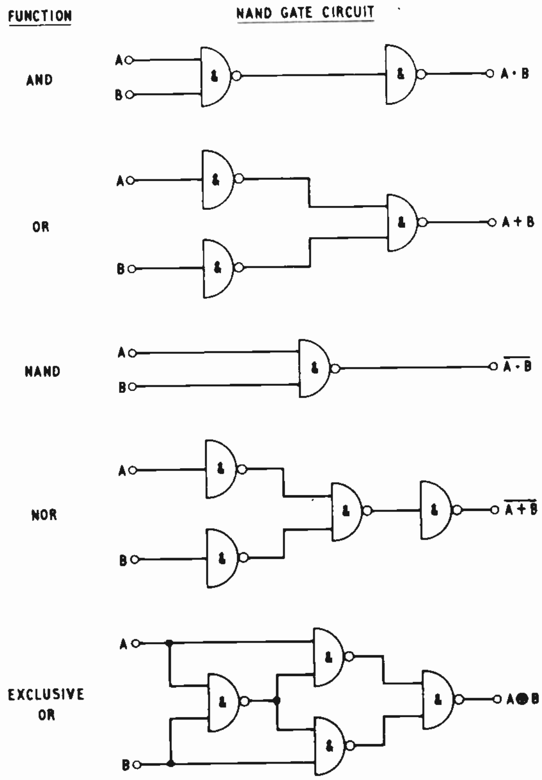


Fig. 2.1. Some logic functions obtained by using only NAND gates

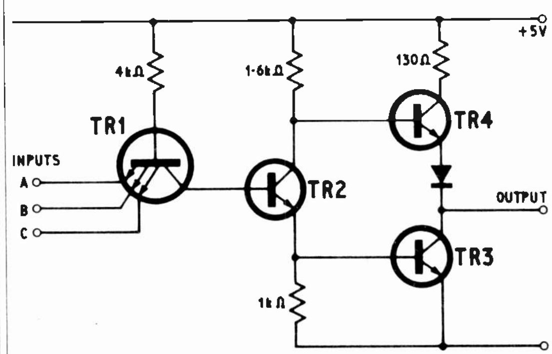


Fig. 2.2. The circuit for a 3 input NAND gate

Table 2.3: Some of the available NAND gate i.c.s

SN7400	Quadruple 2-input NAND gates
SN7401	Quadruple 2-input NAND gates with open collector output
SN7410	Triple 3-input NAND gates
SN7420	Dual 4-input NAND gates
SN7430	8-input NAND gate
SN7437	Quadruple 2-input NAND buffer
SN7440	Dual 4-input NAND buffer

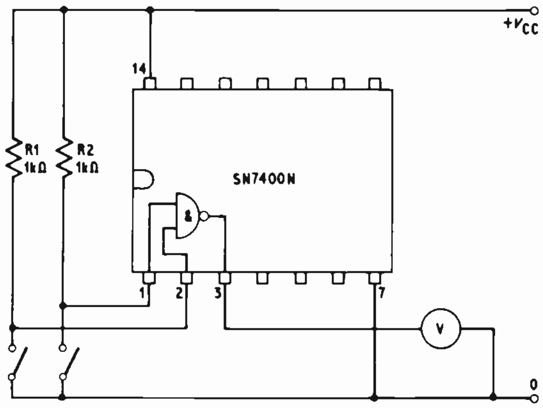


Fig. 2.3. Static tests on a 2 input NAND gate

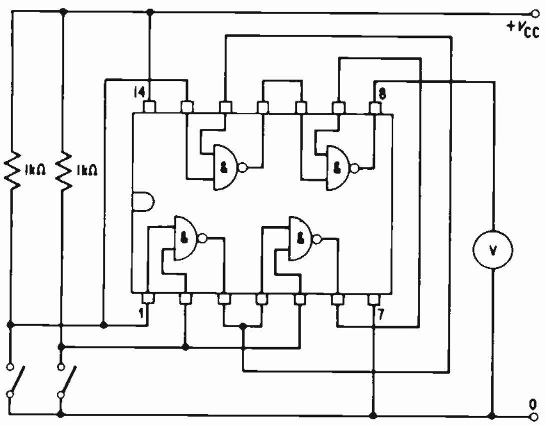
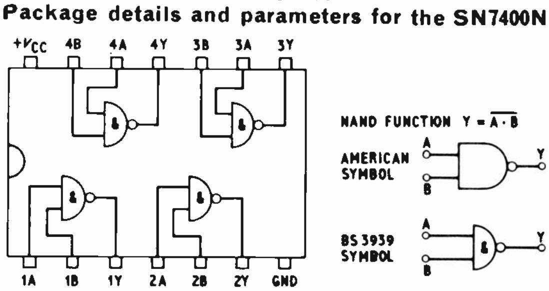


Fig. 2.4. An EXCLUSIVE-OR circuit realised with NAND gates. $V_{cc} = +5V$

Table 2.4: Package details and parameters for the SN7400N



PACKAGE DETAILS FOR SN7400N (TOP VIEW)

Supply Voltage V_{cc}	5V 0·25V
Fan-out from each output	10
Logical 1 input voltage required	2V min.
Logical 0 input voltage required	0·8V max.
Logical 1 output voltage	3·3V typical
Logical 0 output voltage	0·4V max.
Propagation delay time to logical 0 level	7ns typical
Propagation delay time to logical 1 level	11ns typical

output columns. The NAND is obtained by inverting the AND output, while the OR function is the NAND column upside down and can be obtained by inverting the A and B inputs.

It can be seen that the AND function gives a 1 when both A and B are at 1, and so on. The EXCLUSIVE-OR function has a symmetry of its own and is sometimes considered as a separate basic logic function.

Most of the logic functions can be achieved by using only NAND or only NOR gates at the expense of speed and package count, so that for experimental work it is not necessary to maintain a complete stock of all types. This is shown in Fig. 2.1.

NAND GATES

The internal circuit for a three-input TTL NAND gate is shown in Fig. 2.2. TR1 is a multiple emitter transistor. If one or more emitters are grounded the transistor is forward biased, the collector is at a low potential, and TR2 is turned off. This allows TR3 to turn off and TR4 to conduct, resulting in a logic 1 output level.

If, however, all inputs are high the base-collector junction of TR1 will conduct, forward biasing TR2. This turns TR4 off and TR3 on, giving a logic 0 at the output.

The standard TTL gate has a 10ns propagation delay time, a fan-out of about 10 and a noise immunity of at least 1V, making it suitable for most applications. Table 2.3 lists some of the common NAND gates available.

The SN7400 is a quadruple two-input positive NAND gate, package details and parameters are shown in Table 2.4. Although the logic functions can be worked out from the circuit in this case, for more complex packages the corresponding truth table would have to be used.

EXPERIMENT TO VERIFY THE NAND FUNCTION

For experimental work it is convenient to wire several dual-in-line type i.c. holders to pins on a patch board or experimental wiring board; six holders would be enough for many applications and facilitates replacing i.c. packages for other purposes.

The circuit in Fig. 2.3 could be made up to confirm the truth table, the meter indicating go or no-go conditions (or 1 and 0).

EXPERIMENT TO VERIFY THE EXCLUSIVE-OR FUNCTION

The circuit is shown in Fig. 2.4. This function gives an output when A and B are not equal. If one input is inverted the overall function will give an output when A and B are equal. Both arrangements are similar to the upstairs-downstairs light switching found in many homes where a lamp can be switched on or off from either of two places.

Although in this case an EXCLUSIVE-OR package is available (the SN7486) the circuit shows how a simple logic function can be obtained using NAND gates when a suitable package is not to hand.

This article has concluded with two experiments illustrating the static characteristics of the NAND gates. Future articles will deal with further applications of the TTL logic families.

Next month: Basic operational amplifiers

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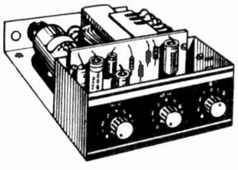

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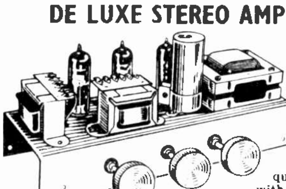

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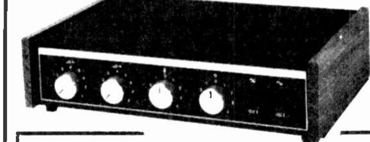


NEW FURTHER IMPROVED MODEL WITH HIGHER OUTPUT AND INCORPORATING HIGH QUALITY READY DRILLED FIBRE GLASS PRINTED CIRCUIT BOARD WITH COMPONENT IDENTIFICATION CLEARLY MARKED FOR EVEN EASIER CONSTRUCTION

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

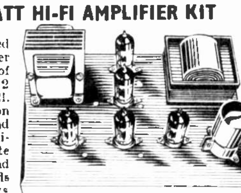
Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in w. × 4in. d. × 4¾in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control 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 **£4·75.** 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. **£3·98.** 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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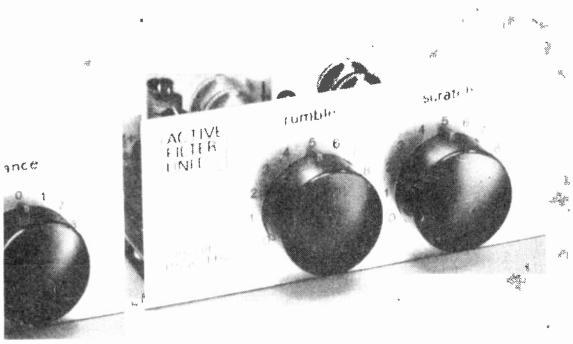
Sinclair Project 60



Active Filter Unit

(A.F.U.)

Built and tested post free
£5.98

The value of an efficient filtering system cannot be over emphasized in these days of very high quality reproduction since there are so often occasions where its use can mean the difference between comfortable and uncomfortable listening. On the low pass side the Sinclair A.F.U. will effectively reduce hiss from radio or tape, cut out heterodyne whistles on A.M. reception, greatly reduce record surface noise and other imperfections; on the high-pass side it will cut out motor rumble and other spurious low frequency intrusion. The unit is for use between pre-amp (including tape pre-amps) and power amplifiers, and operates in two sections, both stereo. The cut-off frequencies are continuously variable, and since attenuation in the rejection band is rapid (12dB/octave) there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is as easy to mount as the stereo 60 pre-amp/control unit which it matches in styling, along with the Stereo FM Tuner.

SPECIFICATIONS

The A.F.U. employs two Sallen and Key type active filter stages, one rumble (high pass) and one scratch (low pass). The two stages use complementary transistors to minimise distortion

Supply voltage: 15 to 35 volts. Current 3mA maximum

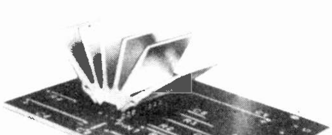
Gain at 1kHz: Filters flat 0 98 (—0 2 dB)

HF cut off: (—3dB) variable from 28 kHz to 5 kHz at 12 dB/octave.

LF cut off: (—3dB) variable from 25Hz to 100Hz at 12dB/octave.

Distortion: at 1kHz (35 volt supply) 0.02% at rated output.

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

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1T4	·16	30F5	·64	EBC41	·54	EM84	·32	PCL82	·30	UABC80	·32
3S4	·26	30FL1	·65	EBC81	·30	EM87	·50	PCL83	·57	UAF42	·50
3V4	·47	30FL12	·69	EBC90	·22	EY51	·36	PCL84	·34	UBC41	·45
5U4G	·31	30FL14	·68	EBF80	·32	EY86	·29	PCL85	·38	UBF80	·34
5V4G	·35	30L1	·29	EBF83	·39	EY87	·29	PCL86	·38	UBF89	·32
5Y3GT	·34	30L15	·70	EBF89	·29	EZ40	·43	PCL88	·68	UCC84	·32
5Z4G	·35	30L17	·67	ECC81	·17	EZ41	·43	PCL800	·89	UCC85	·35
6/30L2	·54	30P4	·65	ECC82	·20	EZ80	·22	PCL805	·38	UCF80	·32
6AL5	·11	30P12	·69	ECC83	·35	EZ81	·23	PENA4	·77	UCH42	·58
6AM6	·13	30P19	·65	ECC85	·34	EZ90	·25	PEN36C	·70	UCH81	·32
6AQ5	·22	30PL1	·60	ECC804	·54	GZ30	·34	PFL200	·52	UCL82	·32
6AT6	·20	30PL13	·89	ECF80	·31	GZ32	·40	PL36	·49	UCL83	·55
6AU6	·20	30PL14	·68	ECF82	·26	KT41	·77	PL81	·44	UF41	·52
6BA6	·20	35L6GT	·45	ECH35	·55	KT61	·55	PL81A	·47	UF89	·30
6BE6	·21	35W4	·25	ECH42	·59	KT66	·78	PL82	·31	UL41	·53
6BJ6	·41	35Z4GT	·25	ECH81	·29	LN319	·63	PL83	·33	UL84	·30
6BW7	·52	50CD6G	·68	ECH83	·40	LN329	·72	PL84	·30	UM84	·22
6F14	·40	807	·49	ECH84	·36	LN339	·65	PL500	·63	UY41	·39
6F23	·68	AC/VP2	·77	ECL80	·35	N78	·87	PL504	·63	UY85	·25
6F25	·53	B349	·65	ECL82	·31	P61	·40	PM84	·33	VP4B	·77
6J7G	·24	B729	·62	ECL86	·35	PABC80	·34	PX25	·95	W77	·43
6K7G	·12	CCH35	·67	EF39	·38	PC86	·47	PY32	·52	Z77	·22
6K8G	·17	CY31	·30	EF41	·60	PC88	·47	PY33	·52	Transistors	
6Q7G	·35	DAF91	·22	EF80	·23	PC96	·42	PY81	·25	AC107	·17
6SL7GT	·30	DAF96	·36	EF85	·28	PC97	·36	PY82	·25	AC127	·18
6SN7GT	·30	DF91	·16	EF86	·30	PC900	·29	PY83	·26	AD140	·37
6V6G	·28	DF96	·36	EF89	·26	PCC84	·29	PY88	·33	AF115	·20
6V6GT	·28	DH77	·20	EF91	·13	PCC85	·23	PY800	·34	AF116	·20
6X4	·28	DK32	·33	EF92	·27	PCC88	·38	PY801	·34	AF117	·20
6X5GT	·28	DK91	·28	EF98	·65	PCC89	·45	R19	·30	AF125	·17
10P13	·53	DK92	·50	EF183	·28	PCC189	·48	R20	·70	AF127	·17
12AT7	·17	DK96	·45	EF184	·31	PCC805	·70	U25	·73	OC26	·25
12AU7	·20	DL35	·40	EH90	·34	PCF80	·28	U26	·70	OC44	·12
12AX7	·22	DL92	·26	EL33	·55	PCF82	·33	U47	·73	OC45	·12
19BG6G	·80	DL94	·47	EL34	·45	PCF86	·46	U49	·70	OC71	·12
20F2	·67	DL96	·38	EL41	·54	PCF800	·58	U52	·31	OC72	·12
20P3	·75	DY86	·24	EL84	·23	PCF801	·28	U78	·24	OC75	·12
25L6GT	·19	DY87	·24	EL90	·26	PCF802	·40	U191	·68	OC81	·12
25U4GT	·57	DY802	·33	EL95	·33	PCF805	·58	U193	·42	OC81D	·12
30C1	·28	EABC80	·32	EL500	·62			U251	·64	OC82	·12
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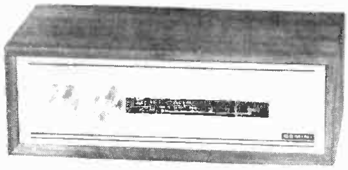
"GEMINI" FM STEREO TUNER



All components to build this outstanding phase lock easily aligned tuner as described in April/May/June P.E. We are offering an optional chassis and solid wood sleeve in ready to assemble form. S.A.E. for details and itemised prices. Complete kit **£33·90**.

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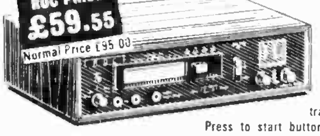
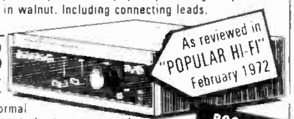


8-TRACK STEREO CARTRIDGE TAPE DECK MODEL RP-1000ST
The popular Lear-Jet type recording unit is the heart of the fantastic RP-1000ST, which has full record and playback facilities. Automatic track change with manual over-ride. Press to start button. Stereo headphone and Left and Right Mic sockets on front 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.



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 14½" 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$\frac{7}{16}$" 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.

EAGLE LC.05 STEREO MAGNETIC CARTRIDGE
For fabulous reproduction at a very low price, you'll find it hard to beat. 0·7 mil diamond stylus. Output: 6mV per channel. Frequency range: 30-18,000 Hz. Channel balance: ± 1·5dB. Channel separation: 20dB. Recommended stylus pressure: 2-4 grams. Compliance: 9 × 10-6 cm/dyne. **ROC PRICE £4·75**

EAGLE LC.07 STEREO MOVING-MAGNET CARTRIDGE
Here's your opportunity to own a transcription cartridge for the price of a ceramic! Is 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**

OLSON AM-395 40-WATT STEREO AMPLIFIER
An ideal unit for your new stereo separate system. It is more than £10·00 below the normal retail price! Making the AM-395 one of Britain's best hi-fi buys. It takes in signals from magnetic or ceramic pick-ups, tuners (see Olson RA-310) and tape decks. And it's got outputs for taping and for headphones. There are separate bass and treble controls, separate Left and Right channel volume controls. And a loudness switch for boosting the bass and treble notes when listening at low output levels. Frequency response: 20-20,000 Hz ± 3dB. Output: 20 watts r.m.s. per channel into 8 ohms. Inputs: magnetic phono 3·0mV RIAA, crystal phono 100mV, tape 160mV; tuner 160mV. Size 11$\frac{7}{16}$" wide, 4" high, 7½" deep. The specification reads well – sounds even better!

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.

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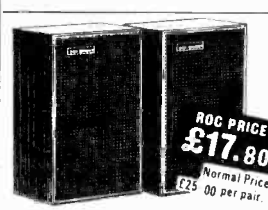
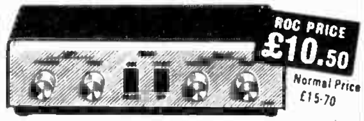


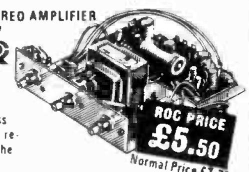
R.446 3-WAY MATCHED SPEAKERS
These will do justice to your amplifier – and to your pocket. At only £16·40 a pair, they are real value-for-money. Each cabinet is heavily lagged and teak finished. They handle 16 watts rms (8 watts rms each). Each loudspeaker contains a large dual cone base unit, plus a separate tweeter. Frequency range: 40 to 19,000 Hz. Size 14" high, 9" wide, 6½" deep.



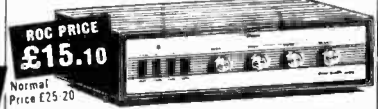
OLSON AM-357 4-WATT STEREO AMPLIFIER
Here's marvellous value for someone just starting to set themselves up in audio! At only £10·50, you get a fine amplifier in a scratch resistant metal cabinet, with a smart brushed aluminium front panel. It incorporates separate tone and volume controls for each channel. 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.

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, 1½" 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.



OLSON AM-372 16-WATT STEREO AMPLIFIER
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2N706A	0·12	BC116	0·25	GD5	0·33	OC30	0·40	7405	0·20
2N708	0·15	BC116A	0·30	GD8	0·25	OC35	0·50	7406	0·30
2N709	0·63	BC118	0·25	GD12	0·05			7407	0·30
2N1091	0·33	BC121	0·20	GET102	0·30	OC36	0·60	7408	0·20
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2N1132	0·25	BC125	0·68	GET113	0·20	OC42	0·30	7410	0·20
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2N1303	0·18	BC140	0·55	GET115	0·45	OC44	0·17	7412	0·42
2N1304	0·22	BC147	0·15	GET116	0·50	OC44M	0·17	7413	0·30
2N1305	0·22	BC148	0·13	GET120	0·25	OC45	0·12	7416	0·30
2N1306	0·25	BC149	0·15	GET872	0·30	OC45M	0·18	7417	0·30
2N1307	0·25	BC157	0·15	GET875	0·25	OC46	0·27	7420	0·20
2N1308	0·25	BC158	0·12	GET880	0·37	OC57	0·60	7422	0·48
2N2147	0·75	BC160	0·68	GET881	0·25	OC58	0·60	7423	0·48
2N2148	0·60	BC169	0·13	GET882	0·25	OC59	0·65	7425	0·48
2N2160	0·60	BCY31	0·35	GET885	0·25	OC66	0·50	7427	0·42
2N2218	0·20			GEX44	0·08	OC70	0·12	7428	0·50
2N2219	0·20	BCY32	0·55	GEX45/1	0·10	OC71	0·12	7430	0·20
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2N2444	1·99	BCY34	0·30	GJ3M	0·25	OC73	0·30	7433	0·70
2N2613	0·28	BCY38	0·40	GJ4M	0·38	OC74	0·30	7437	0·65
2N2646	0·45	BCY39	1·00	GJ5M	0·25	OC75	0·25	7438	0·65
2N2904	0·20	BCY40	0·50	GJ7M	0·37	OC76	0·25	7440	0·20
2N2904A	0·25	BCY42	0·25	HG1005	0·50	OC77	0·40	7441AN	0·75
2N2906	0·20	BCY70	0·15	HS100A	0·20	OC78	0·20	7442	0·75
2N2907	0·23	BCY71	0·20	MAT100	0·25	OC79	0·22	7450	0·20
2N2924	0·28	BCZ10	0·35	MAT101	0·30	OC81	0·20	7451	0·20
2N2925	0·15	BCZ11	0·50	MAT120	0·25	OC81D	0·20	7453	0·20
2N2926	0·10	BD121	0·65	MAT121	0·30	OC81M	0·20	7454	0·20
2N3054	0·50	BD123	0·80	MJE520	0·87	OC81DM	0·18	7460	0·20
2N3055	0·75	BD124	0·75	MJE2955	1·37	OC81Z	0·40	7470	0·30
2N3702	0·10	BDY11	1·62	MJE3055	0·87	OC82	0·25		
2N3705	0·10	BF115	0·25	NKT128	0·35	OC82D	0·20	7472	0·30
2N3706	0·23	BF117	0·50	NKT129	0·30	OC83	0·25	7473	0·40
2N3707	0·12	BF167	0·25	NKT211	0·25	OC84	0·25	7474	0·40
2N3709	0·10	BF173	0·25	NKT213	0·25	OC114	0·38	7475	0·55
2N3710	0·10	BF181	0·35	NKT214	0·15	OC122	0·60	7476	0·45
2N3711	0·10	BF184	0·20	NKT216	0·37	OC123	0·65	7480	0·80
2N3819	0·35	BF185	0·20	NKT217	0·35	OC139	0·25	7482	0·87
2N5027	0·53	BF194	0·17	NKT218	1·13	OC140	0·85	7483	1·00
2N5088	0·33	BF195	0·15	NKT219	0·33	OC141	0·60	7484	0·90
2S301	0·50	BF196	0·15	NKT222	0·20	OC169	0·20	7486	0·45
2S304	0·75	BF197	0·15	NKT224	0·22	OC170	0·25	7490	0·75
2S501	0·37	BF861	0·28	NKT251	0·24	OC171	0·30	7491AN	1·00
2S703	0·62	BFS98	0·28	NKT271	0·25	OC200	0·40	7492	0·75
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AC188	0·25	BFX86	0·25	NKT403	0·75	OC470	0·30	74111	1·45
ACY17	0·30	BFX87	0·25	NKT404	0·55	OCP71	0·97	74118	1·00
ACY18	0·25	BFX88	0·20	NKT678	0·30	ORP12	0·50	74119	1·90
ACY19	0·25	BFY10	1·00	NKT713	0·25	ORP60	0·40	74121	0·60
ACY20	0·20	BFY11	1·25	NKT773	0·25	ORP61	0·42	74122	1·35
ACY21	0·20	BFY17	0·25	NKT777	0·38	S19T	0·80	74123	2·70
ACY22	0·10	BYF18	0·25	O78B	0·38	SAC40	0·25	74141	1·00
ACY27	0·25	BFY19	0·25	OA5	0·20	SFT308	0·38	74145	1·50
ACY28	0·17	BFY24	0·45	OA6	0·12	ST722	0·38	74150	3·35
ACY39	0·50	BFY44	1·00	OA47	0·10	ST7231	0·68	74151	1·10
ACY40	0·15	BFY50	0·22	OA70	0·10	SX68	0·20	74154	2·00
ACY41	0·15	BFY51	0·20	OA71	0·10	SX631	0·30	74155	1·55
ACY44	0·25	BFY52	0·22	OA73	0·10	SX635	0·40	74156	1·55
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AD149	0·50	BFY64	0·42	OA79	0·10	SX641	0·55	74170	4·10
AD161	0·37	BFY90	0·65	OA81	0·08	SX642	0·60	74174	2·00
AD162	0·37	BSX27	0·50	OA85	0·12	SX644	0·75	74175	1·35
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AF126	0·17	BTY42	0·92	OAZ201	0·50	XA161	0·25	74198	4·60
AF127	0·17	BTY79/100R		OAZ202	0·42	XA162	0·25	74199	4·60
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AF181	0·42	BY126	0·15	OAZ207	0·47	XB113	0·12		0·15
AF186	0·40	BY127	0·17	OAZ208	0·32				
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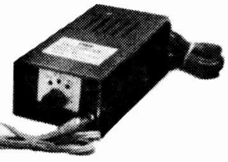

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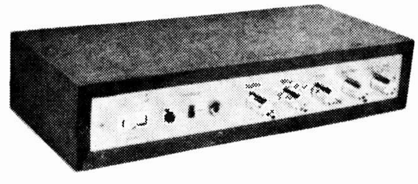

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13	6"	x 4"	x 2"	50p	10p
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AC176	20p	BC147	10p	MPF104	37p	2N3055	49p	BA155	14p
AC187	25p	BC148	10p	MPF105	40p	2N3702	12p	BA156	15p
AC187K	25p	BC149	10p	MPF106	45p	2N3704	17p	OA47	10p
AC188	25p	BC157	12p	OC28	40p	2N3819	35p	OA79	9p
AC188K	25p	BC158	10p	OC35	40p	IN914)	6p	OA81	7p
AD140	40p	BC159	12p	OC44	15p	IN4148)		OA90	7p
AD149	40p	BC169	15p	OC45	15p	IN4001	6p	OA91	7p
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0.01μF	3p	0.22μF	5p
0.015μF	3p	0.33μF	6½p
0.022μF	3p	0.47μF	8p
0.033μF	3p	0.68μF	11p
0.047μF	3p	1μF	13p
0.068μF	3½p	1.5μF	20p
0.1μF	4p	2.2μF	24p
0.15μF	4p		

Mullard C281 - 400V

0.01μF	4½p	0.1μF	7p
0.015μF	4½p	0.15μF	8p
0.022μF	4½p	0.22μF	10p
0.033μF	5½p	0.33μF	14p
0.047μF	6p	0.47μF	15p
0.068μF	6p		

Mullard C426, 015 & 016 all 6p each

Voltage			10	16	25	40	63
2.5	4	6.4	10	16	25	40	64
Capacity μF			22	15	10	6.8	1
			47	68	22	47	2.2
			100	150	47	100	4.7
			220		100		10
					150		
10	8	6.4	4	2.5	1.6	1	0.64
40	32	25	16	10	6.4	4	2.5
80	64	50	32	20	12.5	8	5
160	125	100	64	40	25	16	10
320	250	200	125	80	50	32	20
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Mullard C437 & 017

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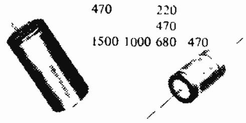
1600	1250	1000	640	400	250	160	100	10p
2500	2000	1600	1000	640	400	250	160	13p
4000	3200	2500	1600	1000	640	400	250	16p
			470		220			10p
					470			12p
			1500	1000	680	470		18p



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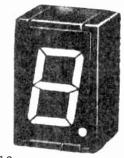

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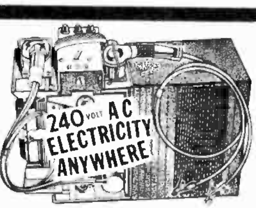

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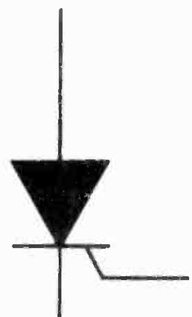

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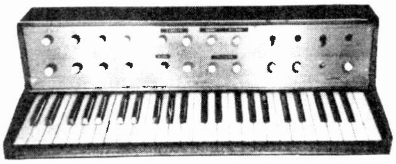

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AT indicates open universal fixing with tags; CT is open U-clamp fixing with tags; CS is open U-clamp fixing with P.C. spills; *with interwinding screen; † untapped 240V Primary; ‡ Primary tapped at 210-240V; other Primaries tapped at 200-220-240V.

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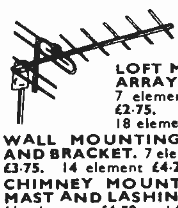

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0·033μf 20V	0·39μf 35V	3·3μf 15V	12μf 35V	56μf 20V
0·056μf 50V	0·47μf 35V	4·7μf 35V	15μf 20V	82μf 20V
0·068μf 35V	0·68μf 35V	5·6μf 6V	22μf 15V	150μf 6V
0·068μf 50V	0·68μf 50V	5·6μf 35V	22μf 75V	180μf 10V
0·07μf 20V	1·5μf 20V	5·6μf 50V	18μf 35V	270μf 6V
0·12μf 35V	2·7μf 15V	6·8μf 20V	27μf 20V	
0·15μf 35V	2·7μf 35V	6·8μf 50V	27μf 35V	

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10,000μF 25V	**35p**
60μf +200μF 300V	**30p**
10μf 6V	**2p**
10μf 25V	**4p**
16μf 250V	**8p**
32μf 275V	**8p**

Miniature type. Both wires same end.

5μf 10V	3p each
30μf 10V	3p each
50μf 10V	3p each
220μf 25V	3p each

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500μf 25V	**13p**
1,000μf 25V	**16p**
2,000μf 25V	**25p**
2,500μf 50V	**30p**
400μf 40V	**20p**
125μf 4V	3p each
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