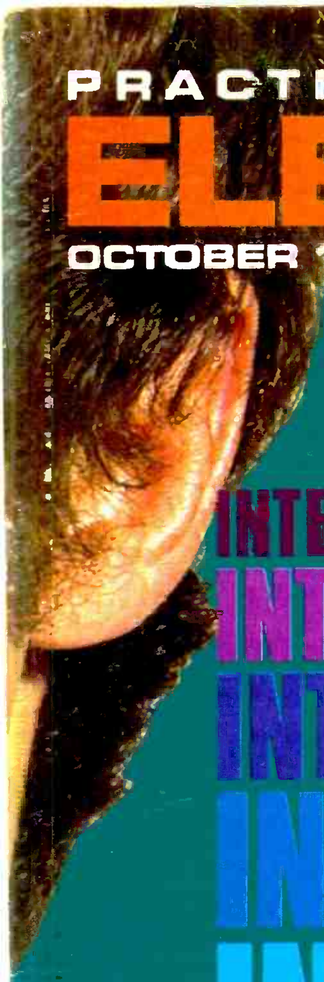
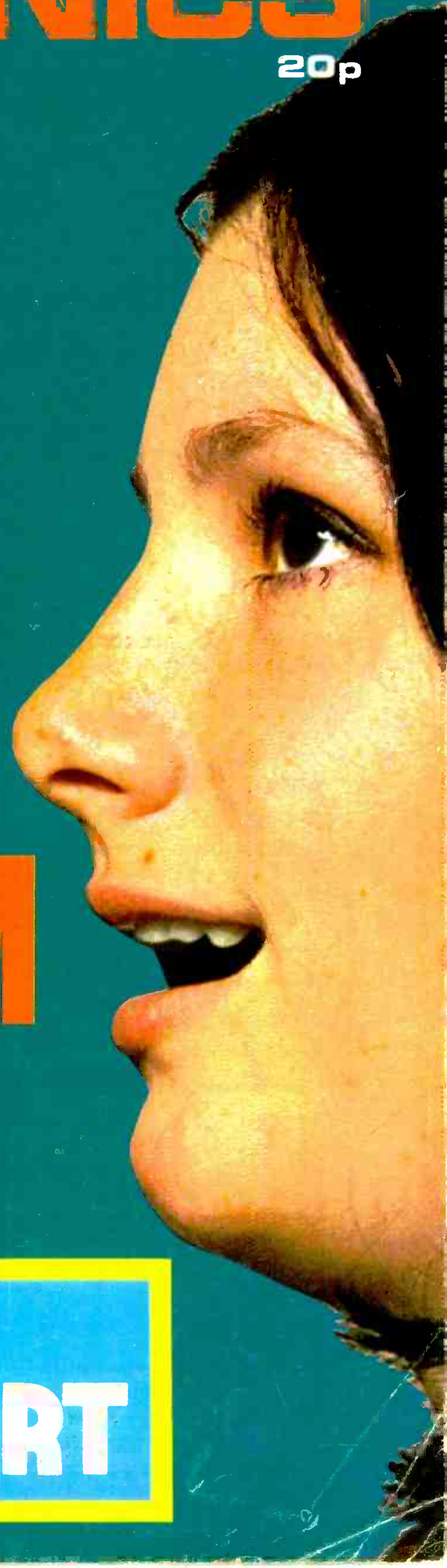
PRACTICAL

ELECTRONICS

OCTOBER 1972

20p





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FOR THE HOME

FREE INSIDE !

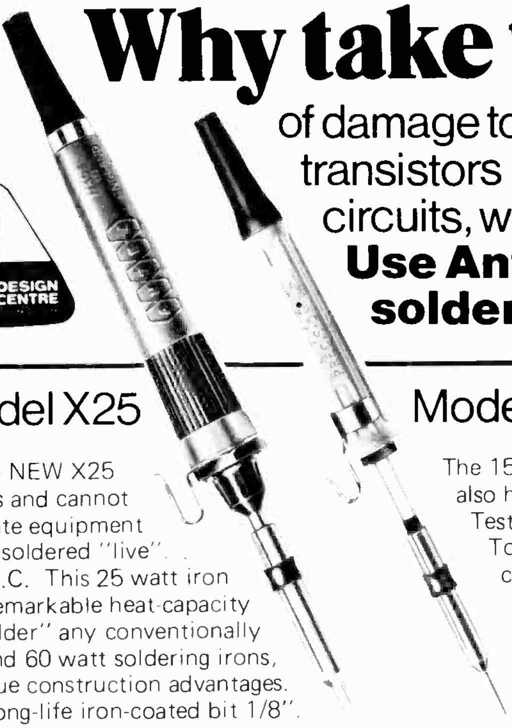
I.C. IDENTICHART

Why take the risk?

of damage to expensive transistors and integrated circuits, when soldering?

Use Antex low-leakage soldering irons

as selected for the DESIGN CENTRE



220-240 Volts or 100-120 Volts **Model X25**

The leakage current of the NEW X25 is only a few microamps and cannot harm the most delicate equipment even when soldered "live". Tested at 1500v. A.C. This 25 watt iron with it's truly remarkable heat-capacity will easily "out-solder" any conventionally made 40 and 60 watt soldering irons, due to its unique construction advantages. Fitted long-life iron-coated bit 1/8".

2 other bits available 3/32" and 3/16".

Totally enclosed element in ceramic and steel shaft. Bits do not "freeze" and can easily be removed

PRICE: £1.75 (rec. retail)

Suitable for production work and as a general purpose iron

Model CCN 220 volts or 240 volts

The 15 watt miniature model CCN. also has negligible leakage. Test voltage 4000v. A.C. Totally enclosed element in ceramic shaft. Fitted long-life iron-coated bit 3/32"

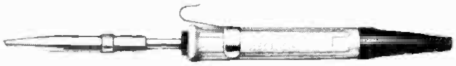
4 other bits available 1/8", 3/16" 1/4" and 1/16"

PRICE: £1.80 (rec. retail)

OR Fitted with triple-coated, (iron, nickel and Chromium) bit 1/8"

PRICE: £1.95 (rec. retail)

A SELECTION OF OTHER SOLDERING EQUIPMENT.



MODEL CN

Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 1/16" to 3/16". Voltages 240, 220, 110, 50 or 24

PRICE: £1.70 (rec. retail)

MODEL CN2

Miniature 15 watt soldering iron fitted with nickel plated bit 3/32". Voltages 240 or 220.

PRICE. £1.70 (rec. retail)

MODEL G

18 Watt miniature iron, fitted with long life iron-coated bit 3/32". Voltages 240, 220 or 110.

PRICE. £1.83 (rec. retail)

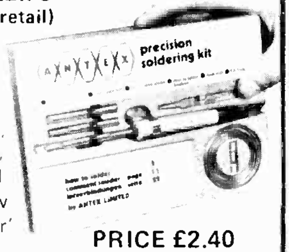
MODEL SK.1 KIT

contains 15 Watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet.

PRICE £2.75 (Rec. retail)

MODEL SK.2 KIT

contains 15 Watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder and booklet "How to Solder"



PRICE £2.40 (Rec. retail)

MODEL MES.KIT Battery-operated 12v. 25 watt iron fitted with 15' lead and 2 heavy clips for connection to car battery. Packed in strong plastic wallet with booklet "How to Solder." **PRICE £1.95 (Rec. retail)**

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PE10

The other pocket calculators fit neatly into your briefcase.

The Sinclair Executive is the world's smallest and lightest electronic calculator.

How light? Just $2\frac{1}{2}$ oz. Less than the bunch of keys you're probably carrying now.

And how small? It's $5\frac{1}{2}$ inches long, $2\frac{1}{4}$ inches wide, and an incredible $\frac{3}{8}$ inch thick – same as a cigarette.

Yet this featherlight wafer of British technology offers more than some desk-top models.

With its brilliant 8-digit display it adds and subtracts, of course. It multiplies and divides – and by a constant figure over and over again, if you want it to (to work out discounts for example, for currency conversions, or for percentages). It works to 2, 4 or 6 decimal places – or it allows the decimal point to float. It rounds off automatically to the nearest decimal place.

The Secret of the Sinclair Executive
The Executive's 'brain' is an electronic marvel – a 7,000-transistor integrated circuit (the largest ever produced for commercial use).

But the real genius lies in the circuitry linking the brain, the batteries, the keyboard and the display. Circuitry soaks up power, which is why other pocket calculators have to use large batteries – and that, in turn, makes them bulky.

In the Executive, the Sinclair flair for miniaturisation has developed circuitry which absorbs virtually no power. Tiny hearing-aid batteries take up the minimum space, allow an elegantly slim case, and give a full three-months average life.

Yet small though it is, the Executive is far from frail. Every one is covered by an unbeatable five-year guarantee.

Smallest . . . lightest . . .
and quite exceptionally powerful!
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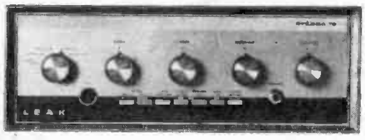
LEAK AMPLIFIER BARGAN



STEREO 70 Amp. (Cased). LIST PRICE £75·00 — LASKY'S PRICE **£49·50**

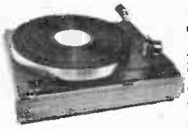
STEREO 30 plus Amp. (Cased). LIST PRICE £62·50 — LASKY'S PRICE **£39·75** C & P £1

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

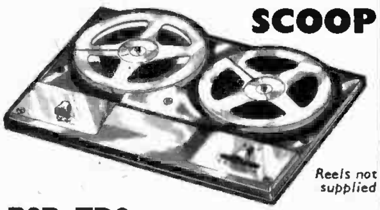


2-speed 45 and 33⅓ rpm belt drive turntable complete with plinth, cover and Shure cartridge.
LIST PRICE £69·50
LASKY'S PRICE **£47·50** C & P £1·50

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

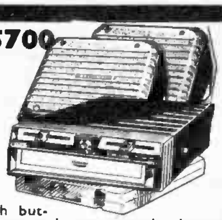
BSR TD2

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 ½ track mono heads. Incorporates fast wind and fast rewind, records at 3¾ ips. giving up to 3 hrs playing time, takes up to 5¾in. spools. Size 13in. × 8¾in. front to rear, 2¹⁵⁄₁₆in. below plate, 1¹⁵⁄₁₆in. above plate.

ALSO SUITABLE FOR USE AS A TAPE TRANSPORTER

LASKY'S PRICE **£8·95** C & P 35p

BELTEK C5700 8 TRACK



Stereo car Player
Accepts all standard pre-recorded 8 track stereo cartridges. Features include automatic head cleaner, channel select and channel repeat push buttons, slider type volume and tone controls, channel balance. Output 5 watts per channel, frequency response 50Hz-10kHz. Output imp. 4 ohms, size 4¾(W) × 1¾(H) × 6¼(D) in. Operates on 12V DC negative earth. Beautifully styled with black ivory and chrome trim.

BELTEK C5700 complete with mounting brackets and 8 track pre-recorded demonstration cartridge.

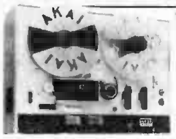
£19·75 C & P 30p

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 speakers.

AKAI TAPE RECORDER SCOOP!



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

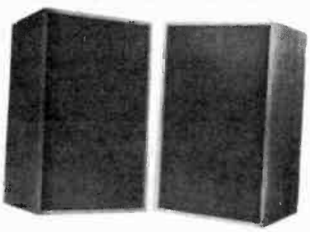
AKAI 4000D illustrated List Price £93·65	Lasky's Price £61·50
AKAI 1720L List Price £87·36	Lasky's Price £58·95
AKAI X1800SD List Price £162·79	Lasky's Price £111·50
AKAI X200D List Price £157·93	Lasky's Price £106·50
2 CSS-8 Speakers List Price £25·00 (pair)	Lasky's Price £15·95 C & P 50p

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.

FANTASTIC VALUE WHARFEDALE SCOOP!

10" BRONZE C/S
10 in. cloth surround 15 ohms.
LASKY'S PRICE **£2·45** C & P 20p

STEREOSOUND SPEAKERS

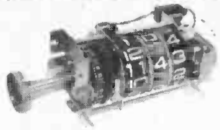


An attractive bookshelf speaker system with teak veneer finish. Imp. 8 ohms. Max. Power 12W. Size 14½ (H) × 9 (W) × 7½ (D) in.
LASKY'S PRICE (PAIR) **£15·75** C & P 25p

LEAK SPEAKERS

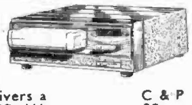
150 Speakers (pair)	£38·95	C & P
250 ,, ,,	£48·95	£2·50
600 ,, ,,	£68·75	

DIGITAL CLOCK



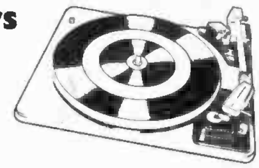
EXCLUSIVELY FROM LASKY'S
The clock measures 5¾" (W) × 2⅞" (H) × 3" (D) (overall from front of drum to back of switch). SPEC.: 210/240V a.c. 50Hz operation; switch rating 250V, 3A. Complete with instructions. **NOW WITH ILLUMINATED DIAL COMPLETE WITH KNOBS FEATURES: ● MAINS OPERATION ● 12-HOUR ALARM ● AUTO "SLEEP" SWITCH ● HOURS, MINUTES AND SECONDS READ-OFF ● FORWARD AND BACKWARD TIME ADJUSTMENT ● SILENT OPERATION ● SHOCK AND VIBRATION PROOF ● BUILT IN ALARM BUZZER**
SPECIAL QUOTES FOR QUANTITIES — LASKY'S PRICE **£6·75** 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: 8½(W) × 3½(H) × 10¼ (D) in. C & P 35p
List Price £24·20 — LASKY'S PRICE **£17·95**

Garrard Record Players



SP25 Mk. III Deck Only
4 speed Automatic Single Player
Lasky's price **£11·50**

Garrard SL95B Deck	£35·00
Add £9·00 for Garrard Base and Cover	
Garrard AP76 deck only	£18·85
Garrard 40B deck only	£9·50
complete with stereo cartridge	£11·50
Garrard SL55B deck only	£9·00
Garrard 2025TC deck only complete with KS40A stereo ceramic cartridge	£7·95
Garrard ZERO 100 Automatic	£43·50*
Garrard ZERO 100S Single Player	£42·75*

*C & P £1·50

Garrard Plinths & Covers

WB4 Mk. II Plinth	£5·45
SPC4 Mk. II cover	£4·25
Price together	£8·70
WB1 Plinth	£3·70
SPC1 cover	£3·60
Price together	£6·50

SP 25 Package

SP25 Mk. III Single Player	List	£15·85
AD76K stereo magnetic cartridge	List	£4·35
Lasky's teak plinth and cover	List	£4·75
Total List Price		£24·95

Package Price £18·50

AP 76 Package

AP76 Single Player	List	£29·26
SHURE M44E Cartridge	List	£8·59
Lasky's Base and Cover	List	£5·95
Total List Price		£43·80

Package Price £35·00

CARRIAGE—all units
DECK ONLY 50p. PLINTH & COVER ONLY 25p.
DECK WITH PLINTH AND COVER 75p.

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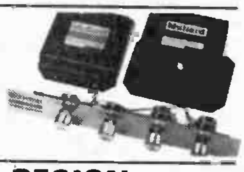
Amplifier is based on the famous Mullard Unilex system. Garrard 2025TC turntable complete with stereo ceramic cartridge, teak simulated plinth and tinted acrylic cover. Plus the big 13in. × 8in. EMI Twin-cone speakers ready for mounting in their elegant cabinets, which simply need screwing and glueing 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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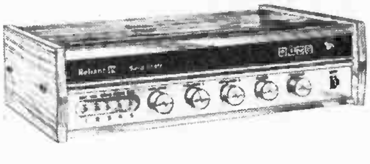
A 'NATURAL' ONLY FROM RTVC
THE TOURIST PB CAR RADIO KIT

Apart from the output stage, which is an integrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modulised IF stages which are pre-aligned before despatch. As well as electronic components, this kit also contains 2 diamond-spun aluminium knobs, elegant matching front panel, dial, washers, screws and wire.
The Tourist PB is suitable for 12 volt working on both negative and positive earth vehicles. It covers the full medium and long wave bands. Four push-buttons for medium wave, one for long wave. It is permeability tuned and sturdily constructed. Output is a full 2·5 watts into an 8 ohm speaker. But the Tourist PB will operate into any loudspeaker from 8 to 15 ohms. Power consumption is less than 1 amp.
The Tourist PB can be mounted in any standard size dash panel and it has an illuminated tuning scale for easy reading at night. Chassis size is: 7in wide, 2in. high and 4$\frac{13}{16}$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.

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.

ONLY £7.00



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★ 5 Electronically Mixed Inputs. ★ 3 Individual Mixing Controls. ★ Separate bass and treble controls common to all 5 inputs. ★ Mixer employing F.E.T. (Field Effect Transistor). ★ Solid State Circuitry. ★ Attractive Styling.

INPUTS:—1. Crystal Mic. or Guitar 9mV. 2. Moving coil Mic. or Guitar 8mV. Inputs 3, 4 & 5 are suitable for a wide range of medium output equipment (Gram., Tuner, Monitor, Organ, etc.). All 250mV sensitivity.
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. × 3¼in.

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1N4001	7p each
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Comprehensive range of Zener Diodes in stock—too many to list.

*General Purpose Transistors

***2N2926** mixed colours	9p each
***2N2926** (red)	
***2N3390** hfe 400–800	25p each
***2N5355** complement to 2N2926	22p each

Unijunction Transistors

2N2646	46p each
D5E29 low cost version	32p each
2N4870	39p each
2N4871	34p each

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TAG06 TO18 60V 0·6A	26p each
TAG1-400 TO5 400V 1A	55p each
TAG2-5-400 TO5 400V 2·5A	65p each
C106B plastic 200V 4A	43p each
C106B (400) plastic 240V ac 3A	47p each
***C20D** ¼ stud 400V 7·5A	£1·34 each
C22D/1057/2 400V 7·5A with heatsink	£1·57 each

Photo Transistor (High Gain)

***2N5777**	28p each
2N3904 } complementary pair	21p each
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Power Transistors

D40D1 1A NPN	26p each
D41D1 1A PNP	27p each
D42C1 3A NPN	31p each
D43C1 3A PNP	34p each
MJ481 4A NPN	£1·09 each
MJ491 4A PNP	£1·31 each
2N3055 10A NPN	60p each
MJ2955 10A PNP	£1·06 each

Power Darlingtons

D40C1 0·5A NPN	44p each
MJ4000 4·0A NPN	£1·10 each
MJ4010 4·0A PNP	£1·51 each
MJE1100 5A NPN	£1·12 each
MJE1101 5A PNP	£1·23 each
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D32	21p each
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*Tunnel Diodes

1N3716 4·7mA peak point	£1·78 each

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TO100 Socket A23–2015	30p each
TO110 Socket A23–2014	30p each
DIL 14-Pin Skt A23–2066Y	31p each
DIL 16-Pin Skt A23–2067Y	42p each

Plugs (Pin Headers) for DIL Sockets

A23–2048 14 pin	27p each
A23–2049 16 pin	30p each
Add suffix **TC** if deep cover required	4p extra

Integrated Circuits

Audio

PA230 Low noise mono-pre-amp	£1·31 each
MC1303 Stereo pre-amp	£2·19 each
PA263/A1286 3·5w rms amp with PC board	£1·75 each
MFC6040 Electronic attenuator	86p each

RF

***PA189** RF up to 50 MHz	£1·48 each
MC1304 Stereo De-modulator	£3·50 each
MC1350 Limiting FM IF amp	94p each
MC1310 Coil-less stereo de-mod	£2·77 each

Operational, etc.

RC709D	84p each
RC741D	68p each
JA424 Zero-voltage S/W	£1·48 each

Digital

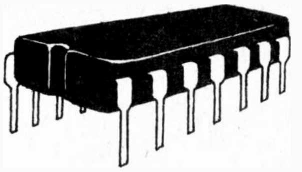
Full range of DTL, TTL and ECL

Typical prices—

MIC 7400J	25p each
MIC 7413J Dual schmitt	40p each

MC1310

Monolithic FM Stereo Decoder



Based on a unique phase-locked loop circuit (originally developed for aerospace), the Motorola MC1310 requires no external tuning inductors and is far more stable than previous IC decoders. Automatic stereo–mono switching is built-in, as well as a lamp-drive circuit. Thus a complete decoder can be built using very few discrete components and may be set up without using instruments.

Stereo channel separation 40dB at 1 kHz can be readily achieved with total harmonic distortion around 0·3% for 560mV composite input.

Price £2·77 plus 15p p. & p.

Bargain Corner

1S2120 12V Zener	7 for 50p
1N4148	12 for 50p
TD710 Tunnel Diode	66p each
2N2926 mixed	25 for 200p
2N2926 (red)	8 for 50p
2N3390	3 for 50p
2N5777	4 for 50p
C20B (our devices)	30p each
SC35D	50p each
SC46D	86p each
SCR Manual previous edition £1·00 including post and packing.	
PA189	2 for £2·00
2N5355 complement to 2N2926	3 for 50p

Tried and Tested Kits

Hot Ignition: Electronic ignition kit as described in *Practical Wireless* June/July issues 1972. £7·75 complete. State positive or negative earth 6 or 12 volt.

Cool Lighting: A new version of our popular light dimmer. 300 watt capacity. £2·80 complete with trendy knob.

Power Controller: A drill speed controller using an SCR and SUS giving continuously variable control featuring: (1) very high torque down to under 250 rpm due to back emf feedback; (2) conservatively rated up to 1,000 watts; (3) may be used for 1kW electric fire control; (4) equivalent to units costing £20. £5·00 complete.

All prices except kits subject to 15p handling post and packing.
Minimum order £1 add 25% if below.

Jermyn Industries, Sevenoaks, Kent

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

Cut these 3 pages out and keep for reference

BRAND NEW FULLY GUARANTEED DEVICES

AC107	0·20	AD162	0·33	BC148	0·10	BD137	0·45	BF188	0·40	OC19	0·35	2G371	0·16
AC113	0·20	AD161 &		BC149	0·12	BD138	0·50	BF194	0·12	OC20	0·63	2G371B	0·12
AC115	0·23	AD162 (MP)		BC150	0·18	BD139	0·55	BF195	0·12	OC22	0·38	2G373	0·17
AC117K	0·20		0·55	BC151	0·20	BD140	0·60	BF196	0·14	OC23	0·42	2G374	0·17
AC122	0·12	ADT140	0·50	BC152	0·17	BD155	0·80	BF197	0·14	OC24	0·56	2G377	0·30
AC125	0·17	AF114	0·24	BC153	0·28	BD175	0·60	BF200	0·45	OC25	0·38	2G378	0·16
AC126	0·17	AF115	0·24	BC154	0·30	BD176	0·60	BF222	0·95	OC26	0·25	2G381	0·16
AC127	0·17	AF116	0·24	BC157	0·18	BD177	0·65	BF257	0·45	OC28	0·50	2G382	0·16
AC128	0·17	AF117	0·24	BC158	0·12	BD178	0·65	BF258	0·60	OC29	0·50	2G401	0·30
AC132	0·14	AF118	0·35	BC159	0·12	BD179	0·70	BF259	0·85	OC35	0·42	2G414	0·30
AC134	0·14	AF124	0·30	BC160	0·45	BD180	0·70	BF262	0·55	OC36	0·50	2G417	0·25
AC137	0·14	AF125	0·25	BC161	0·50	BD185	0·65	BF263	0·55	OC41	0·20	2N388	0·35
AC141	0·14	AF126	0·28	BC167	0·12	BD186	0·65	BF270	0·35	OC42	0·24	2N388A	0·55
AC141K	0·17	AF127	0·28	BC168	0·12	BD187	0·70	BF271	0·30	OC44	0·15	2N404	0·20
AC142	0·14	AF139	0·30	BC169	0·12	BD188	0·70	BF272	0·80	OC45	0·12	2N404A	0·28
AC142K	0·17	AF178	0·50	BC170	0·12	BD189	0·75	BF273	0·35	OC70	0·10	2N524	0·42
AC151	0·15	AF179	0·50	BC171	0·14	BD190	0·75	BF274	0·35	OC71	0·10	2N527	0·49
AC154	0·20	AF180	0·50	BC172	0·14	BD195	0·85	BFW10	0·60	OC72	0·14	2N598	0·42
AC155	0·20	AF181	0·45	BC173	0·14	BD196	0·85	BFX29	0·27	OC74	0·14	2N599	0·45
AC156	0·20	AF186	0·45	BC174	0·14	BD197	0·90	BFX84	0·22	OC75	0·15	2N696	0·12
AC157	0·24	AF239	0·37	BC175	0·22	BD198	0·90	BFX85	0·30	OC76	0·15	2N697	0·13
AC165	0·20	AL102	0·65	BC177	0·19	BD199	0·95	BFX86	0·22	OC77	0·25	2N698	0·24
AC166	0·20	AL103	0·65	BC178	0·19	BD200	0·95	BFX87	0·24	OC81	0·15	2N699	0·35
AC167	0·20	ASY26	0·25	BC179	0·19	BD205	0·80	BFX88	0·22	OC81D	0·15	2N706	0·08
AC168	0·24	ASY27	0·30	BC180	0·24	BD206	0·80	BFY50	0·20	OC82	0·15	2N706A	0·09
AC169	0·14	ASY28	0·25	BC181	0·24	BD207	0·95	BFY51	0·20	OC82D	0·15	2N708	0·12
AC176	0·20	ASY29	0·25	BC182	0·10	BD208	0·95	BFY52	0·20	OC83	0·20	2N711	0·30
AC177	0·24	ASY50	0·25	BC182L	0·10	BDY20	1·00	BFY53	0·17	OC84	0·20	2N717	0·35
AC178	0·28	ASY51	0·25	BC183	0·10	BF115	0·24	BPX25	0·85	OC139	0·20	2N718	0·24
AC179	0·28	ASY52	0·25	BC183L	0·10	BF117	0·45	BSX19	0·15	OC140	0·20	2N718A	0·50
AC180	0·17	ASY54	0·25	BC184	0·12	BF118	0·70	BSX20	0·15	OC169	0·25	2N726	0·28
AC180K	0·20	ASY55	0·25	BC184L	0·12	BF119	0·70	BSY25	0·15	OC170	0·25	2N727	0·28
AC181	0·17	ASY56	0·25	BC186	0·28	BF121	0·45	BSY26	0·15	OC171	0·25	2N743	0·20
AC181K	0·20	ASY57	0·25	BC187	0·28	BF123	0·50	BSY27	0·15	OC200	0·25	2N744	0·20
AC187	0·22	ASY58	0·25	BC207	0·11	BF125	0·45	BSY28	0·15	OC201	0·28	2N914	0·14
AC187K	0·20	ASZ21	0·40	BC208	0·11	BF127	0·50	BSY29	0·15	OC202	0·28	2N918	0·30
AC188	0·22	BC107	0·09	BC209	0·12	BF152	0·55	BSY38	0·18	OC203	0·25	2N929	0·21
AC188K	0·20	BC108	0·09	BC212L	0·11	BF153	0·45	BSY39	0·18	OC204	0·25	2N930	0·21
ACY17	0·25	BC109	0·10	BC213L	0·11	BF154	0·45	BSY40	0·28	OC205	0·35	2N1131	0·20
ACY18	0·20	BC113	0·10	BC214L	0·14	BF155	0·70	BSY41	0·28	OC309	0·40	2N1132	0·22
ACY19	0·20	BC114	0·15	BC225	0·25	BF156	0·48	BSY95	0·12	P346A	0·20	2N1302	0·14
ACY20	0·20	BC115	0·15	BC226	0·35	BF157	0·55	BSY95A	0·12	P397	0·42	2N1303	0·14
ACY21	0·20	BC116	0·15	BCY30	0·24	BF158	0·55	Bu105	2·00	OCP71	0·43	2N1304	0·17
ACY22	0·16	BC117	0·15	BCY31	0·26	BF159	0·60	C111E	0·50	ORP12	0·43	2N1305	0·17
ACY27	0·18	BC118	0·10	BCY32	0·30	BF160	0·40	C400	0·30	ORP60	0·40	2N1306	0·21
ACY28	0·19	BC119	0·30	BCY33	0·22	BF162	0·40	C407	0·25	ORP61	0·40	2N1307	0·21
ACY29	0·35	BC120	0·80	BCY34	0·25	BF163	0·40	C424	0·20	ST140	0·12	2N1308	0·23
ACY30	0·28	BC125	0·12	BCY70	0·14	BF164	0·40	C425	0·50	ST141	0·17	2N1309	0·23
ACY31	0·28	BC126	0·18	BCY71	0·18	BF165	0·40	C426	0·35	TI843	0·30	2N1613	0·20
ACY34	0·21	BC132	0·12	BCY72	0·14	BF167	0·22	C428	0·20	UT46	0·27	2N1711	0·20
ACY35	0·21	BC134	0·18	BCZ10	0·20	BF173	0·22	C441	0·30	2G301	0·09	2N1889	0·32
ACY36	0·28	BC135	0·12	BCZ11	0·25	BF176	0·35	C442	0·30	2G302	0·19	2N1890	0·45
ACY40	0·17	BC136	0·15	BCZ12	0·25	BF177	0·35	C444	0·35	2G303	0·19	2N1893	0·37
ACY41	0·18	BC137	0·15	BD121	0·60	BF178	0·30	C450	0·22	2G304	0·24	2N2147	0·72
ACY44	0·35	BC139	0·40	BD123	0·65	BF179	0·30	MAT100	0·19	2G306	0·40	2N2148	0·57
AD130	0·38	BC140	0·80	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

2N2219	0·20	2N3054	0·46	2N4059	0·10
2N2220	0·22	2N3055	0·50	2N4060	0·12
2N2221	0·20	2N3391	0·14	2N4061	0·12
2N2222	0·20	2N3391A	0·16	2N4062	0·12
2N2368	0·17	2N3392	0·14	2N4284	0·17
2N2369	0·14	2N3393	0·14	2N4285	0·17
2N2369A	0·14	2N3394	0·14	2N4286	0·17
2N2411	0·24	2N3395	0·17	2N4287	0·17
2N2412	0·24	2N3402	0·21	2N4288	0·17
2N2646	0·47	2N3403	0·21	2N4289	0·17
2N2711	0·21	2N3404	0·28	2N4290	0·17
2N2712	0·21	2N3405	0·42	2N4291	0·17
2N2714	0·21	2N3414	0·15	2N4292	0·17
2N2904	0·17	2N3415	0·15	2N4293	0·17
2N2904A	0·21	2N3416	0·28	2N5172	0·12
2N2905	0·21	2N3417	0·28	2N5457	0·32
2N2905A	0·21	2N3525	0·75	2N5458	0·32
2N2906	0·15	2N3646	0·09	2N5459	0·40
2N2906A	0·18	2N3702	0·10	2S301	0·50
2N2907	0·20	2N3703	0·10	2S302A	0·42
2N2907A	0·22	2N3704	0·11	2S302	0·42
2N2923	0·14	2N3705	0·10	2S303	0·55
2N2924	0·14	2N3706	0·09	2S304	0·70
2N2925	0·14	2N3707	0·11	2S305	0·84
2N2926 (G)		2N3708	0·07	2S306	0·84
	0·12	2N3709	0·09	2S307	0·84
2N2926 (Y)		2N3710	0·09	2S321	0·56
	0·11	2N3711	0·09	2S322	0·42
2N2926 (O)		2N3819	0·28	2S322A	0·42
	0·10	2N3820	0·50	2S323	0·56
2N2926 (R)		2N3821	0·35	2S324	0·70
	0·10	2N3823	0·28	2S325	0·70
2N2926 (B)		2N3903	0·28	2S326	0·70
	0·10	2N3904	0·30	2S327	0·70
2N3010	0·70	2N3905	0·28	2S701	0·42
2N3011	0·14	2N3906	0·27	40361	0·40
2N3053	0·17	2N4058	0·12	40362	0·45

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		1N914	0·06
BY126	0·14	(Eq) OA70-		1N916	0·06
BY127	0·15	OA79	0·06	IN414B	0·06
BY128	0·15	OA5	0·35	IS021	0·10
BY130	0·16	OA58L	0·21	IS951	0·06

NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C 1	250	Resistors mixed values approx. count by weight	0·50
C 2	200	Capacitors mixed values approx. count by weight	0·50
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
C19	3	Relays 6—24V Operating	0·50
C20	4	Sheets Copper Laminate approx. 10" × 7"	0·50

Please add 10p post and packing on all component packs, plus a further 10p on pack Nos. C1, C2, C19, C20.

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5p to cover postage etc.

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3 Watts
R.M.S.
ONLY
£2·63 each

Modual Tested and Guaranteed. Qty. 1—9 £2·63; 10—25 £2·28 Price each. Larger quantities quoted on request. Full hook-up diagrams and complete technical data supplied free with each modual or available separately at 10p each.

SYSTEM 12 STEREO

Each Kit contains two Amplifier Modules, 3 watts RMS, two loudspeakers, 15 ohms, the pre-amplifier, transformer, power supply module, front panel and other accessories, as well as an illustrated stage-by-stage instruction booklet designed for the beginner.
Further details available on request.

ONLY £16·95 FREE P. & P.

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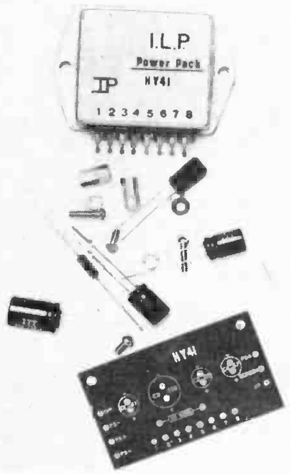


THE HY41

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.

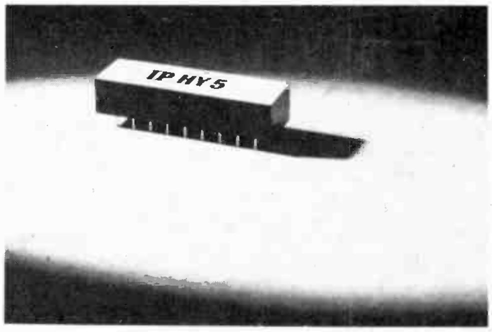
Like its predecessor the HY41 is based on conventional and proven circuit techniques developed over recent years.

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. 47K Ω
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

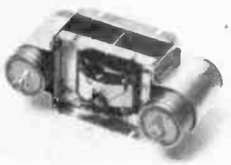
SUPPLY CURRENT
6mA approx.

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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ONLY **£3·25**

Do you wake up in the night and can't get off to sleep again? Would you like to be gently soothed off to satisfying sleep every night? Then build this ingenious electronic sleep inducer. *It even stops by itself so you don't have to worry about it being on all night!* The loudspeaker produces soothing audio-frequency sounds, continuously repeated—but as time goes on the sound gradually becomes less and less—until they eventually cease altogether, *the effect it has on people is amazingly very similar to hypnosis.* All transistor. No knowledge of electronics or radio needed. Step-by-step instructions. *No soldering necessary.* Kit includes case, nuts, wire, screws, etc. **SEND £3·25** + 25p p & p. (Parts available separately.)

FIND BURIED TREASURE!

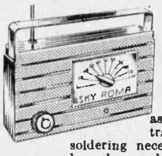
Transistorised Treasure Locator

ONLY **£2·85**

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

SHORTWAVE TRANSISTOR RADIO

ONLY **£2·75**



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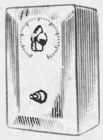
SOOTHE YOUR NERVES RELAX WITH THIS AMAZING RELAXATRON



CUTS OUT NOISE POLLUTION—SOOTHES YOUR NERVES! The RELAXATRON is basically a pink noise generator. Besides being able to mask out extraneous unwanted sounds, it has other very interesting properties. IF YOU WORK IN NOISY OR DISTRACTING SURROUNDINGS, IF YOU HAVE TROUBLE CONCENTRATING, IF YOU FEEL TENSED, UNABLE TO RELAX—then build this fantastic Relaxatron. Once used you will never want to be without it—TAKE IT ANYWHERE. Uses standard PP3 batteries (current used so small that battery life is almost shelf-life). **CAN BE EASILY BUILT BY ANYONE OVER 12 YEARS OF AGE** using our unique, step-by-step, fully illustrated plans. No soldering necessary. All parts including case, a pair of crystal phones, Components nuts, Screws, Wire, etc., no soldering. **Send only £2·75** + 25p p. & p. (Parts available separately.)

ONLY **£2·75**

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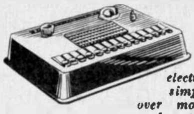

Don't confuse with ordinary electric organs that simply blow air over mouth-organ type reeds, etc. Fully transistorised. **SELF-CONTAINED LOUDSPEAKER.** *Fifteen separate keys span two full octaves—play the "Yellow Rose of Texas", play "Silent Night", play "Auld Lang Syne", etc. etc.* You have the thrill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

READY BUILT AND TESTED TREASURE LOCATOR MODULE

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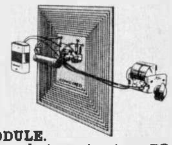

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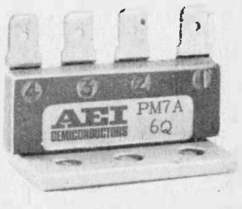
	250	PM7A4
	375	PM7A6
15 when mounted	60	PM7A1Q
	125	PM7A2Q
	250	PM7A4Q
	375	PM7A6Q



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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
As reviewed in "POPULAR HI-FI" February 1972
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.
ROC PRICE £35.20
Normal Price £55·50
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 Sensitivites: FM, 3µV; AM, 250µV. Stereo separation 30dB at 1kHz, image rejection 60dB. Size: 11 7/16" wide, 4" high, 7½" deep.
ROC PRICE £31.20
Normal Price £50·00
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.
ROC PRICE £12.45
Normal Price £21·00
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
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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 7/16" wide, 4" high, 7½" deep. The specification reads well – sounds even better!
ROC PRICE £24.10
Normal Price £39·60
ROC PRICE £28.00
Normal Price £30·70.
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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Now your amplifier that could only reproduce ceramic or crystal pick-up cartridges, can accept signals from moving-magnet cartridges! The R.307 steps up signals from between 5-20mV to 200-800 mV. Input: 5-20mV. Equalisation: RIAA. Output: 200-800mV flat. Frequency range: 20-22,000 Hz. Dimensions: 3¼" × 1⅝" × 2 5/16". Supply: 240 VAC. ROC PRICE £4·92
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STEREO HEADPHONE "Y" ADAPTOR
R.361 Enables you to use two sets of stereo headphones from a single socket. Fitted with male plug and two female sockets. ROC PRICE £1·30
ROC PRICE £17.80
Normal Price £25·00 per pair.
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, 6¼" deep.
ROC PRICE £10.50
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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, 2⅝" 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.
ROC PRICE £27.25
Normal Price £39·95 each.
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Normal Price £42·00
PALACE AM/FM/MPX STEREO TUNER AMPLIFIER SSA-16
This is one of the lowest priced stereo 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-16 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, 4¼" high, 8" deep.
ROC 7-WATT STEREO AMPLIFIER CHASSIS SK-317
This exclusive ROC Stereo Chassis is completely self-contained, and it costs £2·25 less than the normal retail value! The SK-317 is a really compact unit measuring only 5½" wide, 1¾" high and 6¾" deep. It contains its own mains power supply, and has a ganged volume control and separate treble controls for each channel. Specification: frequency response 40-17 000 Hz ± 3dB; output 3·5 watts music power per channel into 8 ohms; input, phono, 600mV; signal-to-noise ratio better than 45dB.
ROC PRICE £5.50
Normal Price £7·75
ROC PRICE £15.10
Normal Price £25·20
OLSON AM-372 16-WATT STEREO AMPLIFIER
Here's a really good amplifier at a really down-to-earth price – nearly £7 less than the normal retail value! Just look at what the AM-372 will do for you – reproduce signals from ceramic or crystal cartridges, AM and FM tuners, and tape recorders. And it gives you outputs for two sets of speakers, headphones and tape recorders. Frequency response is 30 to 20,000 Hz ± 3dB. Output 8 watts r.m.s. per channel music power into 8 ohm speakers. Phono input 200mV. Tuner input 200mV. Size: 12¼" wide, 3¼" high, 7½" deep.
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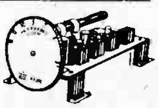
LOUDSPEAKER CABINET WADDING 18in. wide, 15p ft



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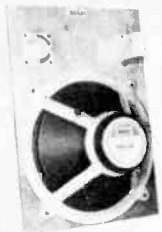

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4 inputs speech and music. Mixing facilities. Response 10–30,000 cps. Matches all loudspeakers. A.C. 200/250V. Separate Treble and Bass controls. Guaranteed. Details S.A.E. **£49** Post Free

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A die, punch and Allen Screw

$\frac{3}{8}$in. Round .. 68p	$\frac{15}{16}$in. Round 98p	Key "B" for above 8p
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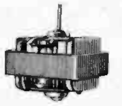

E.M.I. TAPE MOTORS. 120v. or 240v. AC. 1,200 r.p.m. 4 pole 135mA. Spindle 0·187 × 0·75in. Size $3\frac{1}{4} \times 2\frac{1}{2} \times 2\frac{1}{4}$in. (illustrated). Post 15p. **£1·25**

BALFOUR GRAM. MOTORS. 120v. or 240v. AC. 1,200 r.p.m. 4 pole 50mA. Spindle $\frac{3}{8}$ × 3/20. Size. $2\frac{1}{4} \times 2\frac{1}{4} \times 1\frac{1}{2}$in. Post 15p **85p**

E.M.I. GRAM MOTORS. 120V or 240V a.c. 2,400 rpm. 2-pole 70mA. Spindle $\frac{3}{8} \times \frac{1}{16}$in. Size $2\frac{3}{4} \times 2\frac{1}{4} \times 2\frac{1}{4}$in. **75p** Post 15p

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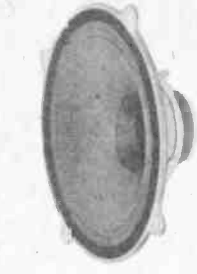
12in. 15 watts



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

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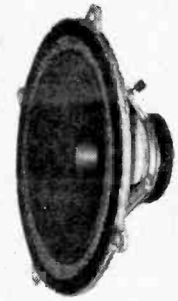
12in. 15 watts



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

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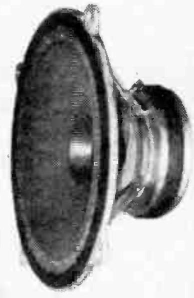
12in. 20 watts



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.

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

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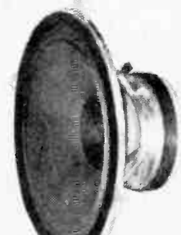

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Flux Density	15,000gauss
Useful response	25-16,000cps

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Flux Density	15,000gauss
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VOL. 8 No. 10
October 1972

PRACTICAL ELECTRONICS

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PROBLEMS OF PROGRESS

THE pace of technical progress has become so accelerated that many interesting developments and techniques, especially in the field of integrated circuits, hardly see the light of day before their demise is threatened by yet another new development. Innovation leap-frogs innovation, and consequently valuable and thought-provoking devices become redundant long before they have been fully exploited. This poses problems to industrial users of such components, and despite crystal-ball gazing and shrewd planning ahead, many equipment makers have been caught out by this explosive state of the art.

The break-through in small calculator designs based on the single-chip i.c. is an outstanding case at this particular time. Commercial desk calculators costing in the region of £250 have been replaced overnight by new instruments selling at one third the price. Business people who purchased their calculator last year must be wringing their hands and wishing they had waited until the spring of '72. But it is easy to be wise after the event.

The same problem, although on a smaller scale, affects a magazine such as ours, catering for the private constructor. Does one sit back neglecting contemporary and readily available devices, just waiting for the "ultimate" one to turn up? For example, to have knowledge of impending changes in i.c. design that are likely to revolutionise the commercial calculator in the near future is one thing; it is quite a different thing, though, to predict with any certainty if and when these new l.s.i. chips will be made available to private individuals —and if so at what cost.

In such circumstances the P.E. Digi-Cal desk calculator was commissioned. The abundance of cheap TTL devices seemed to justify such a project being presented to the private constructor. The total cost of material for this project made it a most favourable proposition in view of the then prevailing cost of a comparable commercial instrument. However, between the completion of this design and the publication of the first article, the big break-through in cheap commercial calculators occurred.

Though "priced out of the market" the Digi-Cal remains a unique and valuable contribution to the record of design information published expressly for the benefit of private constructors and electronics enthusiasts. As an education exercise, the real worth of this project cannot be denied. Certainly it offers the technically inquisitive far more than the mere assembly of any commercial kit can possibly provide.

F.E.B.

THIS MONTH

CONSTRUCTIONAL PROJECTS

SPECIAL SERIES

GENERAL FEATURES

NEWS AND COMMENT

SPECIAL DATA SHEET

We apologise for any slight loss of quality of print in this month's issue. Supplies of the normal paper were not available due to the Docks Dispute.

Our November issue will be published on Friday, October 13

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

I.C. INTERCOM

Most of the cheaper intercoms on the market at the present time have a low output which can be very distorted. In order to overcome these difficulties it was decided to build a battery powered intercom using an integrated circuit chosen from the General Electric range of audio amplifiers.

The i.c. chosen was the PA234 which has a quoted output of just under one watt when working from an 18V supply with a typical distortion of three per cent. A preamplifier is needed to drive this i.c. and a simple, one transistor, common base type is used.

Even though the basic system described here is only a simple master/slave one it is very easy to extend it to master/master or master and two or more slaves, with or without call facilities; the necessary alterations for these additions are given at the end.

As no commercial cases could be found which looked right, it was decided to build these as well.

CIRCUIT OPERATION

The amplifier circuit diagram is shown in Fig. 1. It will be seen that TR1 is connected in the common base mode which is relatively rare.

In this configuration the signal is applied to the emitter producing the advantages of low input impedance—of the order of approximately 50 ohms, and a high output impedance, thus making it ideally suited to its purpose.

The microphone/speaker is a 25 ohm loudspeaker and this is easily matched to the preamplifier stage, another advantage being that this configuration prevents inductive pickup from TV sound. Whilst experimenting with the prototype a standard high gain common emitter preamplifier was used and the TV pickup drowned all other signals.

The purpose of C1 is to filter out any TV or other radiated interference; the final version gives no mains hum even though the cables run alongside mains leads for some distance.

The biasing for TR1 is provided by R1, R2 and C2 which ensures that the base is near earth potential as far as alternating signals are concerned. R3 serves a dual purpose in that it reduces the supply of 18V down to 9V for the preamplifier and in conjunction with C3 decouples the two stages preventing any feedback via the supply.

Potentiometer VR1 is a volume control and should be adjusted to give the best output. The signal is then fed via C4 and R4 to the input terminal, pin 3, of the i.c. The ratio of R5 to R6 is determined from the manufacturer's data sheet and controls the correct biasing of the i.c., whilst the gain is determined by the ratio R5 to R4.

The output is stabilised against oscillation by the capacitor C5, and C7 further stabilises the arrangement.

The circuit for the call oscillator is given in Fig. 2 and it will be seen that it is a conventional multivibrator working at about 1kHz. Other frequencies can be selected by varying R8, R9 and C8, C9.

The power supplies are two PP6 batteries connected in series to give 18 volts.

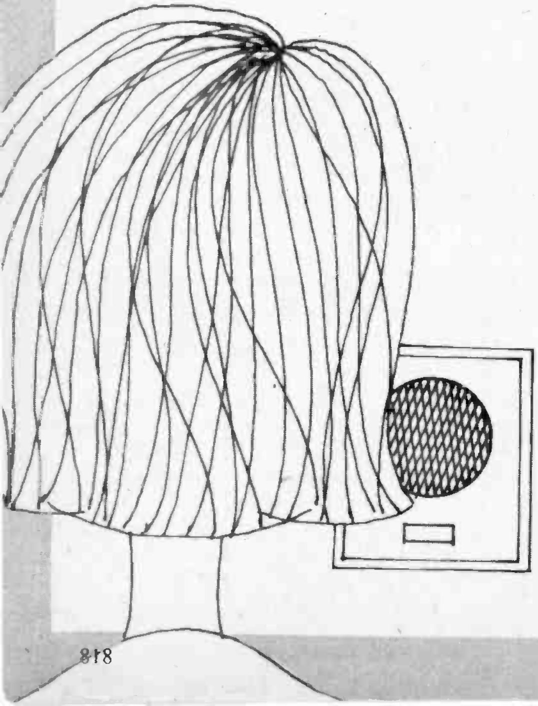
MASTER/SLAVE SWITCHING

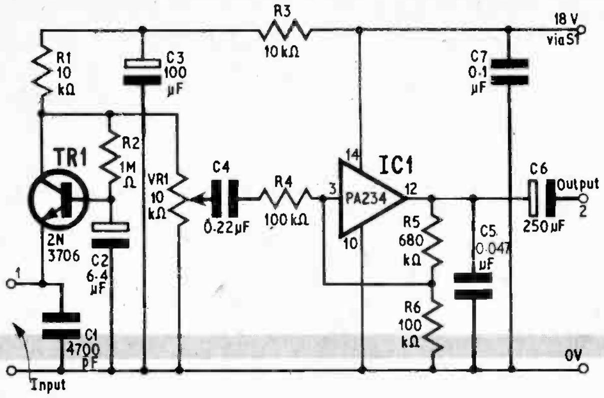
Fig. 3 shows a simple master/slave set up. S1 is a miniature lever key switch having four sets of changeover contacts on each side. This switch is wired so that when the key is in the central position the master loudspeaker is in the listen mode. If now S2 is operated then power is applied to the amplifier and the slave can talk to the master.

Should the master wish to call the slave then pushing the key one way the oscillator which provides the calling tone and the amplifier are both powered and the output is fed to the slave speaker.

Pushing the key the other way switches the slave to the listen position thus enabling the master station to speak. This arrangement of switching ensures that privacy is enjoyed by the slave station—the master can not easily listen in, though, if desired, by mounting S2 at the master end one can control all functions from the one position.

The wiring of the switch is shown in Fig. 7.





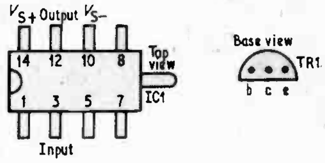


Fig. 1. Circuit diagram of the main amplifier

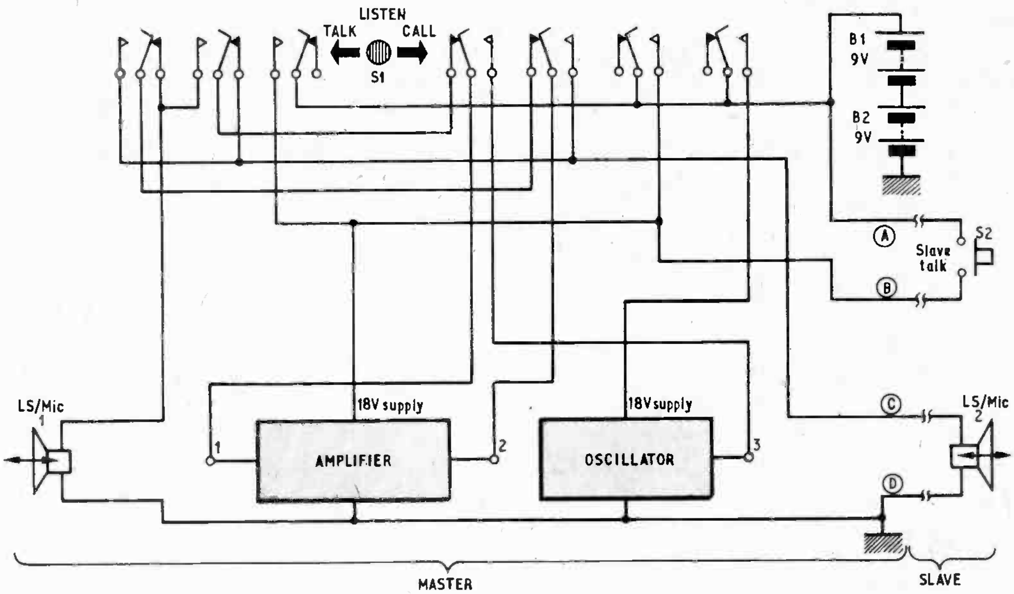


Fig. 3. Diagram showing the switching arrangement for a simple master/slave system. Only four wires connect the master to the slave (labelled A, B, C, D). Switch S2 and loudspeaker LS/MIC2 are in the slave

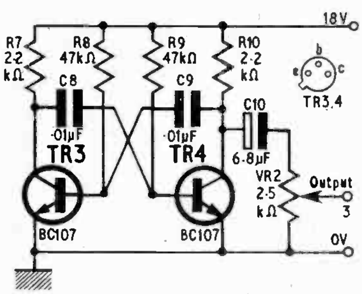
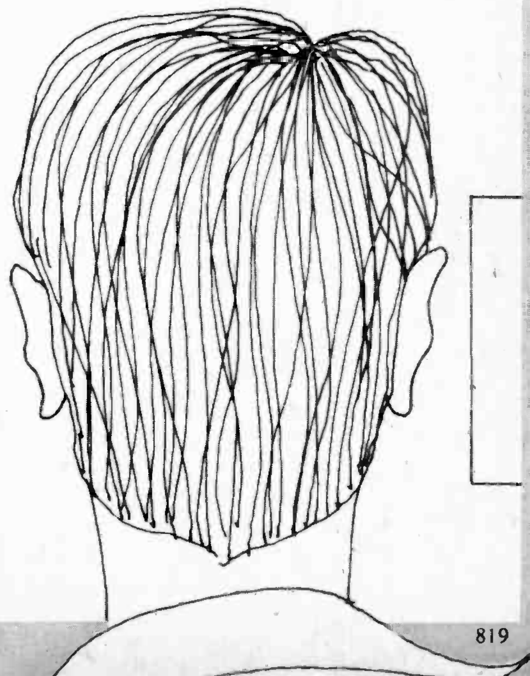


Fig. 2. Circuit diagram of the call oscillator



By R. A. PENFOLD

COMPONENTS . . .

AMPLIFIER BOARD

Resistors
- R1 10kΩ
- R2 1MΩ
- R3 10kΩ
- R4 100kΩ
- R5 680kΩ
- R6 100kΩ
- All ±10%, ¼W carbon

Potentiometer
- VR1 10kΩ log.

Capacitors
- C1 4,700pF
- C2 6·4μF 25V elect.
- C3 100μF 25V elect.
- C4 0·22μF
- C5 0·047μF
- C6 250μF 30V elect.
- C7 0·1μF

Semiconductors
- TR1 2N3706
- IC1 PA234 (General Electric)

Speakers
- LS/MIC1, LS/MIC2 22Ω 3in (2 off)

Switches
- S1 Miniature lever Keyswitch, 4 pole changeover in each position
- S2 Push on, release off push button

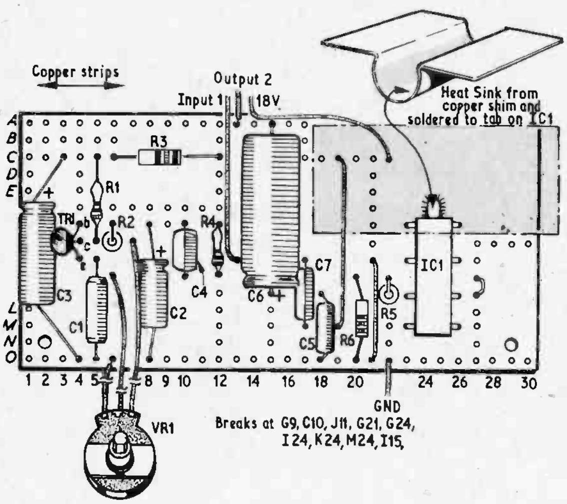


Fig. 4. Layout of the components on the amplifier board. The copper heatsink is carefully soldered to the i.c. tab

COMPONENT ASSEMBLY

The components are mounted on 0·1in pitch Veroboard as shown in Fig. 4 and Fig. 5, and special care is needed to ensure that no solder bridges are formed between adjacent strips. No real trouble should be encountered in the construction providing the diagrams showing the layout are followed carefully and that all breaks are made.

When soldering the i.c. in position do not leave the iron in place for too long. The i.c. needs a heat sink of at least 1 sq in and this can be made from an offcut of phosphor bronze draught strip though any copper or tin sheet will do. This heat sink, which should be bent so that it does not touch other components, is soldered directly onto the tab attached to the i.c.—take great care not to bend this tab too much or else it will break off and render the i.c. useless.

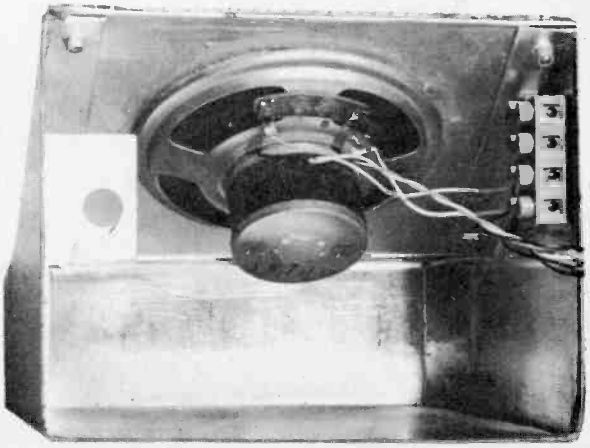
CASE CONSTRUCTION

The case for the master station was made from 20 gauge aluminium sheet. Fig. 6 gives the various details of sizes and cuts to be made.

A number of home constructors are put off making their own cases by the thought that it is too difficult and that the finished job will look "home made". Provided that the aluminium is marked out accurately and carefully before any cuts or bends are made no difficulty should be encountered.

When all the various bits have been cut out an Abra-file can be used to cut the hole for the loudspeaker and key switch. The exact size of these will depend on the actual components obtained. The holes for fixing the key switch should be drilled at the same time.

The inside of the master box is seen here with the components removed from their positions. The brackets which hold the potentiometer and the call oscillator board can be seen fixed to the inside



COMPONENTS . . .

OSCILLATOR BOARD

Resistors
R7 2·2kΩ
R8 47kΩ
R9 47kΩ
R10 2·2kΩ
All ±10%, ¼W carbon

Potentiometer
VR2 2·5kΩ miniature skeleton preset

Capacitors
C8 0·01μF
C9 0·01μF
C10 6·8μF 35V elect.

Transistors
TR3, TR4 BC107 or similar

Miscellaneous
B1, B2 9V battery (2 off)
0·1in matrix Veroboard (see text for sizes)
Aluminium for cases
Terminal block, copper for heatsink, four way connecting wire

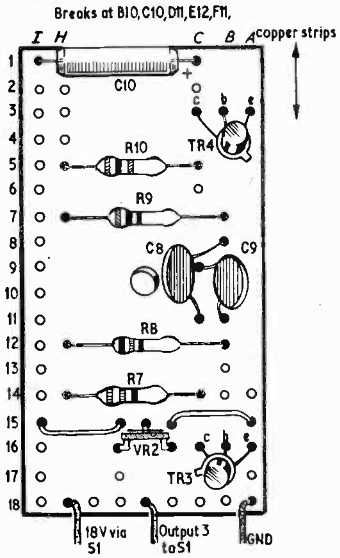


Fig. 5. Layout of the components on the call oscillator board

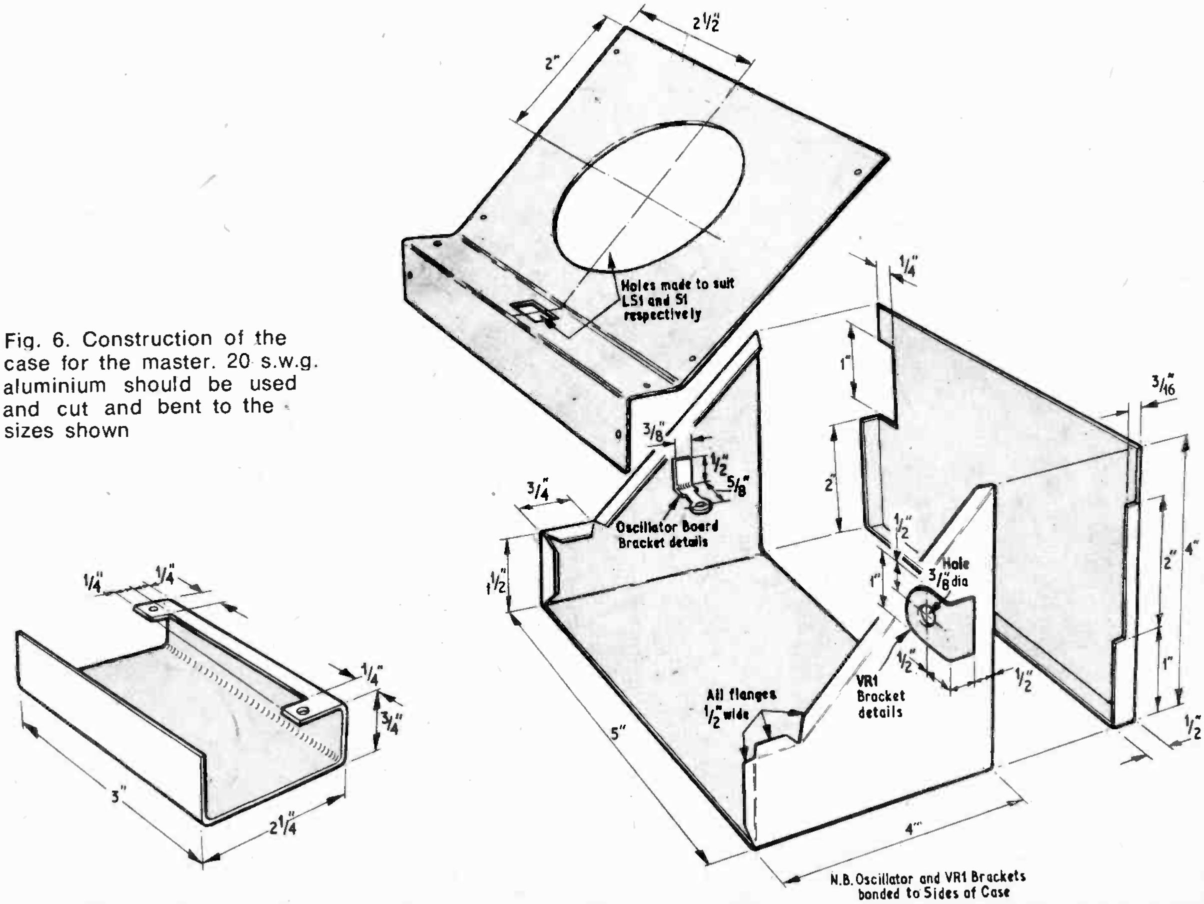


Fig. 6. Construction of the case for the master. 20 s.w.g. aluminium should be used and cut and bent to the sizes shown

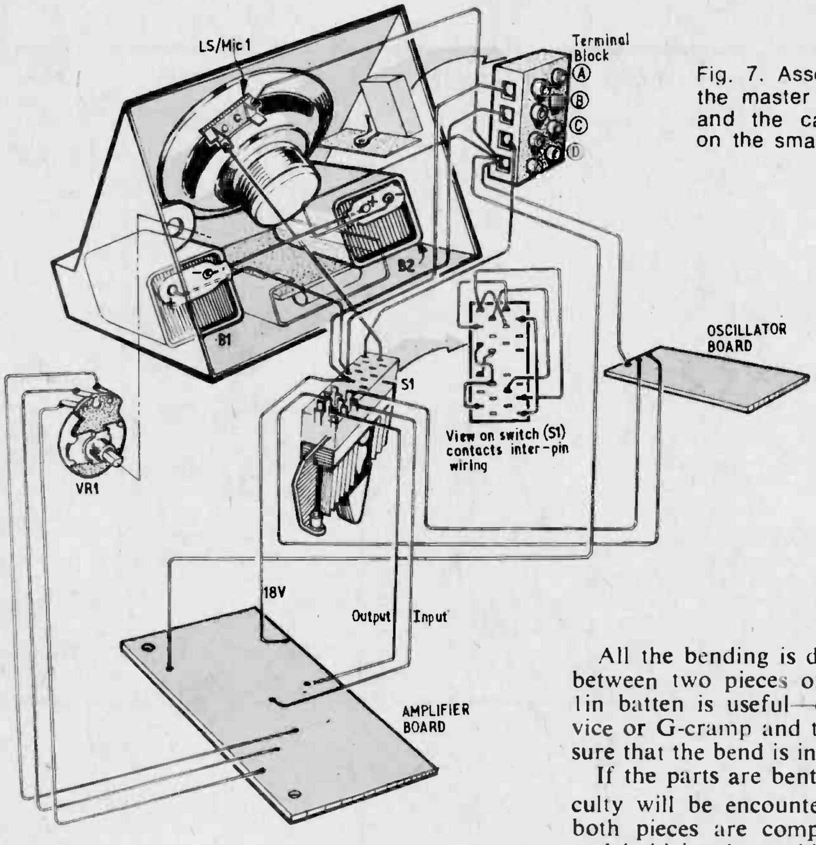
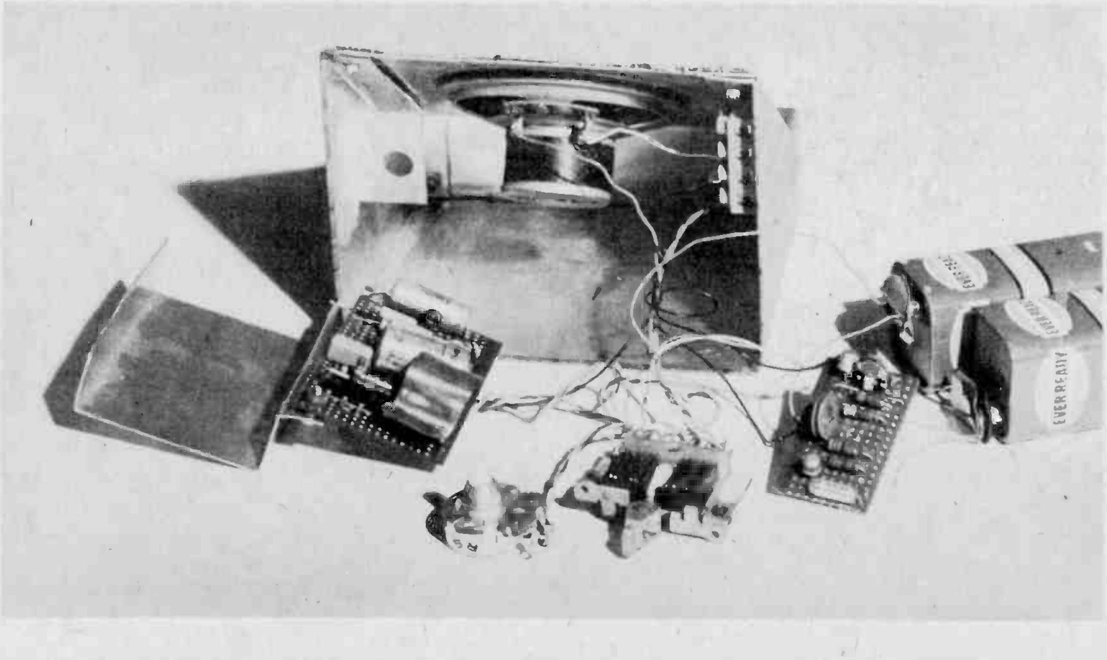


Fig. 7. Assembly and interwiring of the master box. The potentiometer and the call oscillator are mounted on the small brackets as shown

All the bending is done by placing the aluminium between two pieces of suitable sized wood—2in × 1in batten is useful—clamping the ends either in a vice or G-cramp and then carefully bending, making sure that the bend is in the correct direction!

If the parts are bent in a logical sequence no difficulty will be encountered with the overlaps. When both pieces are completed offer them up together and hold in place whilst you drill suitable holes for holding them together; self tapping screws or pop rivets are ideal. Then cover the sloping front with speaker cloth and the rest with Fablon or similar.



ASSEMBLY OF THE UNIT

When fitting the switch it is necessary to wire it up first and then fit it in position.

Any offcuts left can be used to make the bracket for VR1 which is glued in position using Evostick or Araldite. Other pieces can be used to make the circuit board support. The terminal block is also glued to the inside of the case on the opposite side to VR1 as shown in Fig. 7.

The case for the slave station can be purchased, adapted from an available tin or constructed from aluminium. It should be covered in the same way as the master station.

The amplifier circuit board should then be mounted on the bracket shown using insulating washers to ensure that the Veroboard strip is not shorted. The call oscillator can be mounted on its bracket which is then glued to the inside of the case behind the terminal block; to aid adjustment it helps if the preset on this board is easily accessible.

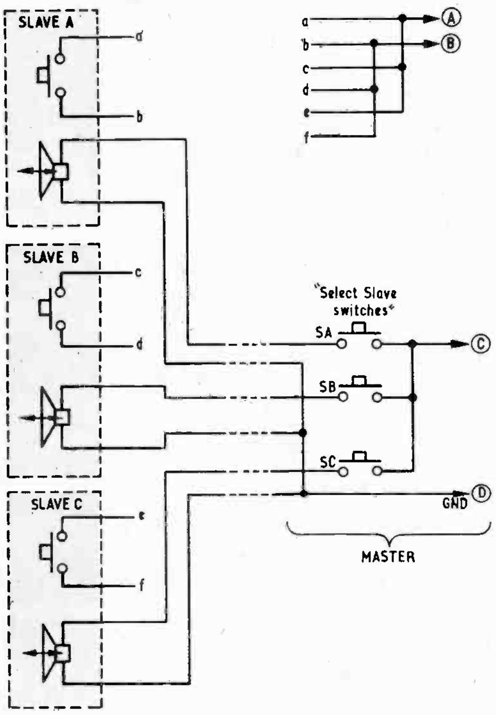


Fig. 8. Switching arrangement to give multiple slave operation, though none of the slaves has a call facility. The "select slave" switches are push buttons mounted on the master box

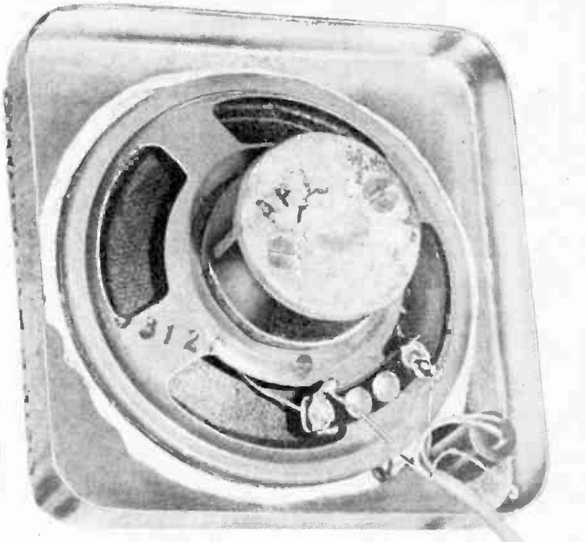
TESTING THE FINISHED UNIT

Before commencing testing ensure that all components are in the correct position, that their values and polarities are as in the diagram and also that you have made all the breaks. Trace all wires to see that they do go to the right terminals and most important that no solder bridges are present.

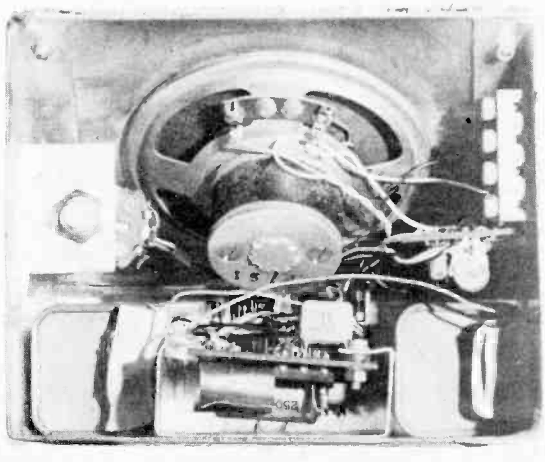
When you are completely satisfied connect the external speaker and plug the batteries in. It helps if a working transistor radio is placed near the slave station, when the switch is pushed one way you should hear the radio—adjust VR1 to give the best results. If testing is carried out with the stations too close together, feedback will occur giving an almighty howl.

Should you have no helper available you can short the two terminals taking power to the slave button at the master terminal block, this will be the same as pressing the "talk" button at the slave. Should there be a lot of distortion occurring when the slave talk button is pressed and the only cure is to reduce the volume you can try decoupling the two power lines going to the slave with a capacitor—say 50μF—connected across the appropriate terminals at the station end. When the lever key is pushed towards "call" the tone should sound in the slave speaker. The volume and quality can be adjusted to some extent by altering the value of the preset on the oscillator board.

continued on page 839



The internal construction of the slave showing the speaker and the push button in place



Completed master unit

BY FRANK W. HYDE

GRAVITATIONAL WAVES

Some time ago details of an experiment to detect gravitational waves by radio was described. This experiment, which was originally suggested by Dr John Jelley, made some stir when the results were reported in *Nature*. There were two series of the experiments but the results were negative. There were certain difficulties mainly due to the high level of noise on the frequency of operation.

The original paper on gravitational waves was put forward by Joseph Weber in 1969. He claimed at that time that he detected these waves as coming from the centre of the Galaxy.

The possibility of these waves was predicted by Einstein in 1916 but nothing much was attempted in the way of investigation. The principle which underlies the theory is that gravitational waves are a form of radiation which affects mass. Small displacements of mass are caused by the radiation setting up a definite vibration. If they are in line with the radiation the masses do not move with respect to each other.

Professor Weber's experiment was made with two huge aluminium cylinders deep down in the earth. Though Weber is satisfied that his results are positive, and indicate quite definitely that these waves come from the galactic centre, not all the scientific community accepts this.

SOURCE CONFIRMED

It is, therefore, quite a move forward when independent experimenters confirm the source of the waves. Three physicists from Israel have published some work on their experiments and it seems to be a big step forward in this field. They are using the earth itself as the detector. Its great mass is much more sensitive than arrays of discs or cylinders.

If these waves are in fact coming from a specific point in the galaxy, then using the earth as a detector, all those points in line with the waves would vibrate the earth. Since the earth revolves on its axis this particular point on the earth would show a peak of activity twice in a sidereal day.

This effect will occur every 11hr 58min and has been detected by Dr Sadeh of Tel Aviv and Dr A. Ben-Menahem of the Weizmann Institute. They have set up a seismometer in the fairly noise free area on the Gulf of Aqaba.

The team set out to discover if pulsars were the cause of the gravitational waves; pulsars are dense stars and revolve very rapidly. Since it is unlikely that they are completely homogeneous, there will be angular moments which will show as a variation of the gravitational effect. In other words there will be a certain frequency of change which could be detected.

FIRST EVIDENCE

The first evidence that this was right thinking came in 1971. The Israeli physicists found that there was a peak in the recording which corresponded to a periodicity of 0·53–0·60 seconds. Moreover, as each day passed the event came a little earlier in time. This was a clear indication that the origin of this event was outside the earth.

The twice a day response confirmed that the position of the source was at a celestial longitude of Right Ascension 11hr 33min. This position corresponded to the pulsar known as CP 1133.

As a check on this the team have examined the radio period of the pulsar and find that their events are in agreement. According to the present model of the pulsar, the radio pulses occur once with each revolution of the star. Gravity waves however would be emitted twice every revolution. Measurements confirmed that the seismometer events did occur at twice the rate of the radio pulses from CP 1133. The actual period of the gravitational waves is 0·594 seconds.

It would seem that there is a chance for confirmation of Weber's untiring efforts in this field. Certainly the benefits to astrophysics will be very great.

EARLY LINK-UP

It would seem possible that the planned space link-up exercises between America and Russia will be undertaken earlier than was previously expected. While the main exercise remains set for 1975 between a *Soyus* and *Apollo* vehicle, it is possible that a *Salyut* orbital station might be used.

The problems that have to be solved are many. Not the least of these is that of communications. The languages are different, the mode of procedures between the crews and ground will have to be rationalised to name two aspects.

There is also the problem of the airlock system. The *Apollo* atmosphere is nearly pure oxygen, at a pressure of 5lbs per square inch, while the Russians use a mixture of nitrogen and oxygen at the normal atmospheric pressure of sea level.

LUNA-20

Some new evidence about the lunar rock formation has been brought back by *Luna-20*, the automatic probe sent by the USSR to collect samples from the Moon.

The samples came from the highland area between the Mare Crisium and the Mare Fecunditatis. The soil in this region is much lighter and contains fragments of minerals and crystalline rocks. It is rich in aluminium, calcium and magnesium oxide and the surfaces are well preserved. The iron and titanium content is less than that brought back from the actual maria by *Luna-16*.

Altogether some 70 elements have been detected in the lunar soil by Soviet scientists. They are particularly interested in the nature of the lunar iron.

It seems that the lunar iron is even more rust proof than the meteoritic iron, and attempts are being made to simulate lunar conditions on earth with the possible benefits to industry. Already some success has resulted from the sublimation of iron from basalts which have been heated to a high temperature in a vacuum.

MYSTERY MOON

There are some rather puzzling features about Titan, Saturn's largest moon. Theoretically the gases should have boiled off, since this body has a low escape velocity.

The present low density atmosphere of molecular hydrogen and methane, from which the gases must be escaping quite rapidly into space, must have come into being long after the solar system was formed. This means that there must be a constant replenishing probably by evaporation and gassing from the solid surface.

Measurements made by L. Tafton of the McDonald Observatory suggest that there is some other major constituent in the atmosphere. It also seems probable that methane is present in the solid as well as in the gaseous state.

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.

TTL EQUIVALENCE GATE

	A	B	output
same	0	0	0
different	1	0	1
different	0	1	0
same	1	1	0

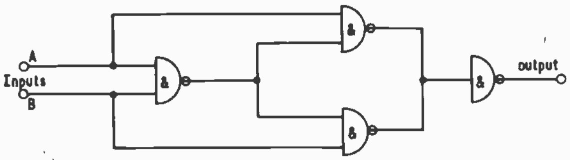


Fig. 1. TTL equivalence gate and truth table

I HAVE built and tested an equivalence gate for use in TTL circuitry, see Fig. 1. It uses one inexpensive integrated circuit package, type SN7400, a quadruple 2-input NAND gate.

If the inputs A, B are the same, the output goes low ("0" in positive logic). If the inputs are different the output goes high ("1" in positive logic), see truth table in Fig. 1.

S. L. Thompson,
Rainham.

VARIABLE ATTACK AND DECAY

ANY audio circuit which produces a simulation of an instrument has not only to copy the frequency and waveform produced by the instrument but also has to emulate the general shape of the envelope, because the sound produced from any instrument, when it is played, does not immediately attain full volume but is a gradual build up. It also dies away slowly afterwards. It is in this respect that most simple electronic devices are inaccurate, as they produce an envelope with virtually no rise or decay time.

The circuit shown in Fig. 1 will produce a note with a rise and decay time variable between two limits. With the values given the note produced is approximately 830Hz.

The first stage TR1 and TR2 are in the normal multivibrator configuration and the waveform which should be obtained from point A is shown in Fig. 2. Transistor TR3 is an overdriven amplifier to produce a good square wave and Fig. 3 shows the waveform that should be obtained at the output, point B. Transistor TR4 acts as an attenuator and is controlled by C3, VR1 and VR2 connected to its base.

The output from the circuit is taken from TR4 collector (R_L), and if a resistive load is used its value should be 5·6kΩ, but other loads can be used to give different tones. An inductive load gives a sawtooth waveform and has a peculiar metallic tone. Other loads, such as capacitive, could be tried.

The envelope produced is shown in Fig. 4; t_r is the rise time, which will occur if S1 is pressed at time 0. Potentiometer VR2 gives a rise time variable between 0-50 milliseconds. The decay time t_d is controlled by VR1 and starts at point (a) in Fig. 4 and can be varied between 0-200 milliseconds.

The output should be attenuated before (if desired) it is amplified as it is in the region of 7V.

Switch S1 should be of the push-on, release-off type with position 1 normally closed and position 2 normally open. The switch should be the break-before-make type because if the rise and decay time were both set at 0, the battery could be shorted out.

N. R. Adams,
Colehill,
Dorset.

Fig. 2

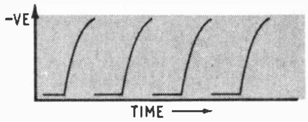


Fig. 3

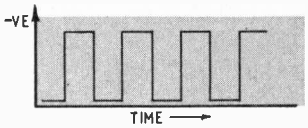


Fig. 4

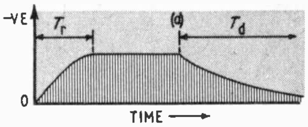
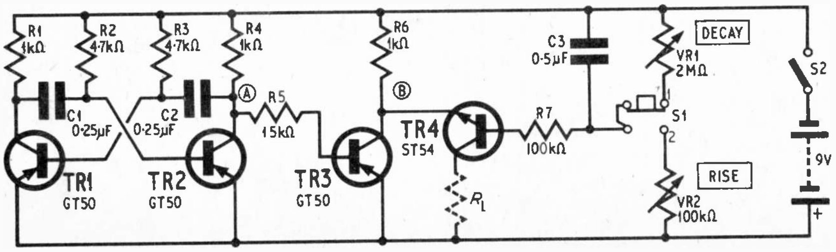
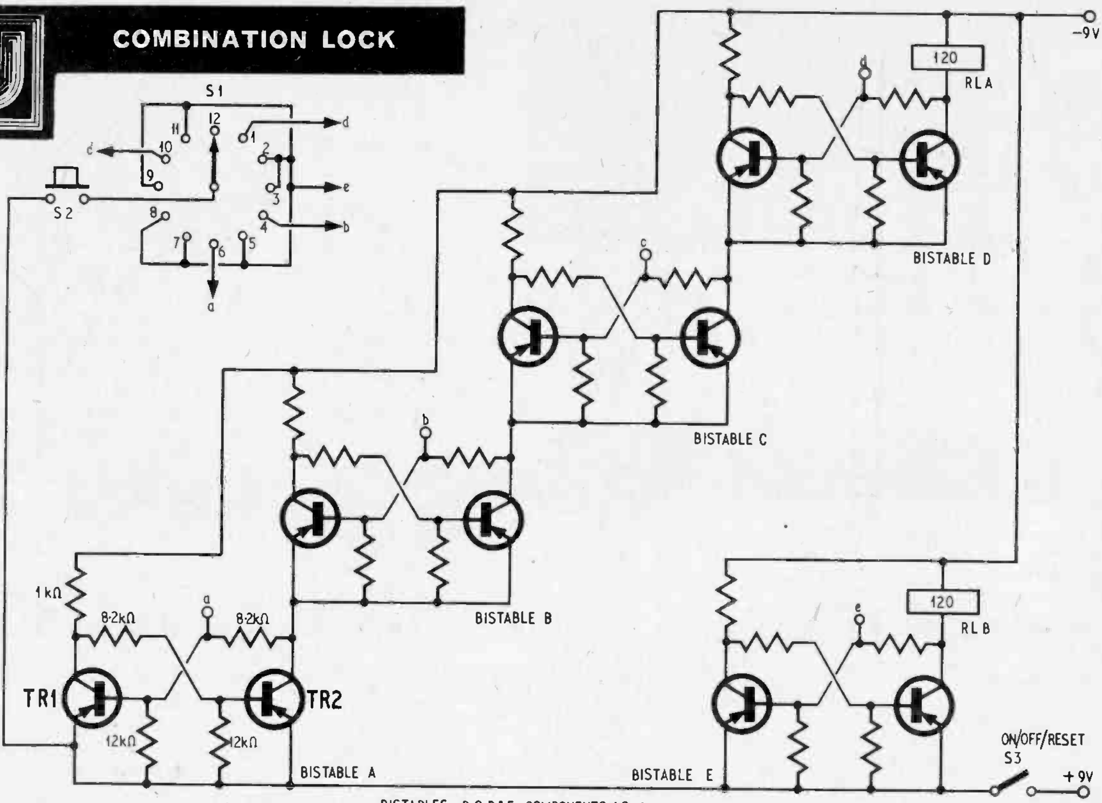


Fig. 1. Circuit of variable attack and decay



COMBINATION LOCK



BISTABLES B,C,D&E. COMPONENTS AS A

The circuit shown above is a 4-digit combination lock, against which the chances of finding the correct sequence of operation is 1 in 19,958,400, which is about 0·000 000 05, making it quite hard to pick!

Fundamentally, it consists of a four stage binary computer, the fifth stage being the alarm flip-flop which is only activated when the wrong digits are dialled. Each flip-flop, when switched, provides the power supply for the proceeding flip-flop and so on up the chain until the relay is activated, and thus driving the lock mechanism.

The flip-flops of the computer are simple bistables, i.e. it has two stable states. When one transistor is conducting the other one is not. The non-conducting transistor is made to conduct by applying a pulse to the base of conducting transistor.

In the combination lock this is accomplished by shorting the base of the first transistor of each stage to the positive line. When the power supply to a flip-flop is switched on, one transistor will always conduct first. This must be the first in each stage (due to inequalities in the circuit).

Operation of the combination lock is quite simple. The first number is dialled in this case number 6, and the pushbutton switch S2 is pressed momentarily switching on bistable A. The second number is dialled and the procedure is repeated. This procedure is repeated with the last two numbers till the lock is operated.

Resetting of the bistable is accomplished by disconnecting the power supply and then reconnecting it.

G. E. Kaparnick,
Swindon, Wilts.

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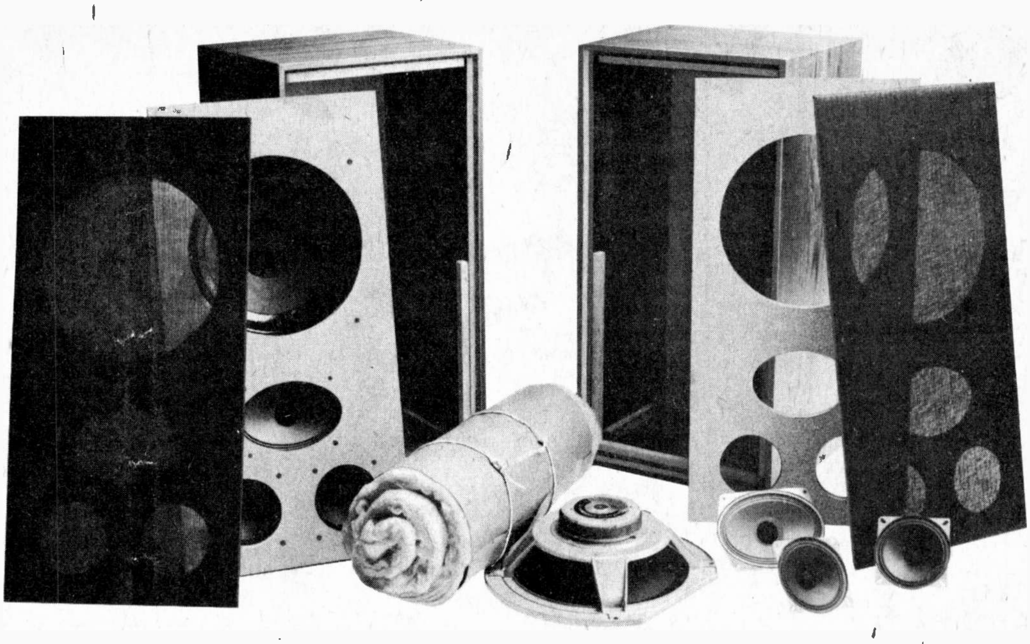
September, November 1970, February 1971, February 1972
Mr. C. P. Newton, Broadmead House, Broadmead Road, Send, Woking, Surrey.

January, February 1969, January, April 1970, January 1972
Mr. M. B. Firth, Pine Cottage, Pontardulais Road, Gorseinon, Swansea, Glam.



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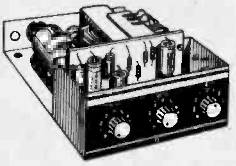

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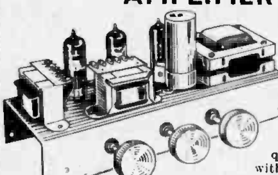

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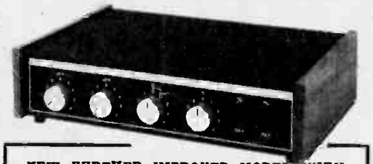

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Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

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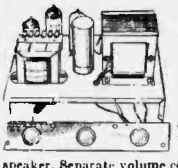

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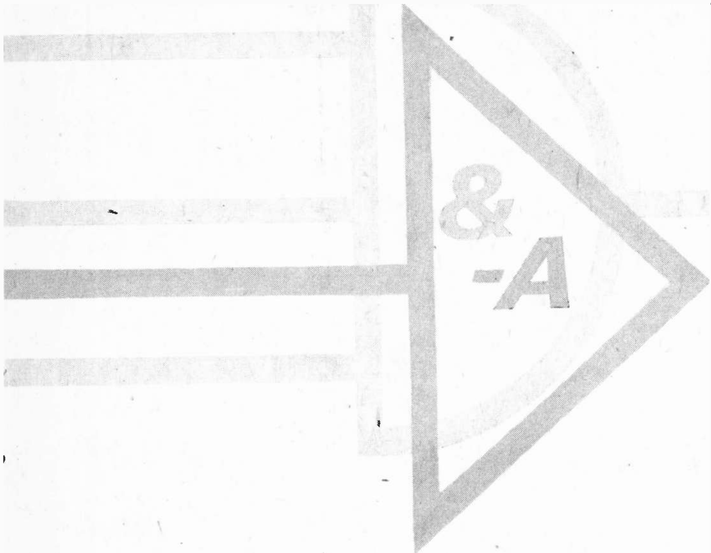


Designing with Integrated circuits

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.

1 The 741 as an ASTABLE

THERE are literally thousands of different integrated circuits on the market, and it would take every page of every issue of the magazine to make any impression in reviewing the complete field. Integrated circuits can be divided into two very broad categories, those intended for general applications and those designed with a specific function in mind.

The state of the art is such that many integrated circuits are so complex as to prohibit experimentation. Those for TV signal processing, for example, cannot adequately be used unless we are prepared to rewire a TV! Where appropriate such i.c.s usually appear in constructional articles.

In general research and development a selection of TTL and a few linear circuits allows much "routine" work to be achieved quickly. Manufacturers short form catalogues show where to go for "state-of-the-art" circuits if they become necessary.

Rather than extract up to the minute information from data sheets and application notes, we hope to show how the "standard" integrated circuits can be used in many cases. We will place the emphasis on designing circuits using integrated circuits and not necessarily on reviewing a different one each month. We feel that this is more useful for the reader who wishes to experiment because he will often be able to use the same integrated circuit more than once.

Readers requiring further details of individual i.c.s and their performance, are recommended to consult manufacturers' data sheets.

OPERATIONAL AMPLIFIERS

The first generation of linear integrated circuits were the μA702 and 709 operational amplifiers and the 710 comparator. Both the 702 and 709 have their own disadvantages. The 702 has the limited input voltage range of +1·5V to −6V and can "latch up" if this is exceeded. It can however be used for many feedback applications from d.c. to 30MHz.

The 709 is an improvement on the 702's performance by providing a higher input impedance, a large input common mode range of ±10V and a high output swing. It has its own characteristics (cross-over distortion, for example) and is not short-circuit proof. It can be used for high performance applications from d.c. to 5MHz or so.

Both the 702 and 709 require several external components to provide frequency compensation so that they are stable under closed loop conditions, and do not become unstable when overall feedback is applied. This compensation can be chosen to obtain the best bandwidth for a given closed loop gain.

The first of the "second generation" of integrated circuits was the μA741 which overcomes many of the disadvantages of the 702 and 709 series. It is very suitable for general work where a wide bandwidth and a fast slew rate are not required.

This month we introduce the 741C amplifier and will use it again later in the series. Although it is convenient for demonstration purposes its bandwidth restricts its use and the 702 or 709 circuits can be used, within their limitations, when we wish to work outside the frequency limit of the 741.

The 702, 709, 741 integrated circuits are available, under slightly different numbers, from many manufacturers. (Some guidance on these numbers can be seen in the table on the P.E. I.C. Identichart in this issue.)

THE 741C OPERATIONAL AMPLIFIER

The 741C is a high performance operational amplifier intended for a wide range of analogue applications from d.c. to 1MHz. Its high common mode range and absence of "latch up" make it ideal for a voltage follower.

It requires no external components for frequency compensation and is stable under closed loop conditions including unity gain and integrator applications. It is protected against an indefinite short circuit to ground or to either supply rail. The input offset voltage is typically 2mV and this may be nulled by a simple circuit.

Its connections are shown in the diagrams for the various package outlines. Typical parameters are shown in the Table 1.1. Versions without the "C" suffix have slightly improved parameters, such as working temperature range.

LOW FREQUENCY MULTIVIBRATOR

To start the series, let us look at the 741 wired in an astable multivibrator configuration. Although not necessarily the best application for the 741, it does illustrate how very simple the external circuitry of an i.c. can be to provide a useful application.

Fig. 1.1 shows a basic astable multivibrator suitable for generating a fixed frequency square wave for test purposes. It has a negative feedback loop from the output to the inverting input via R3 and a positive feedback loop from the output to the non-inverting input via R1 and R2. The circuit changes state regeneratively each time the two inputs are at the same potential.

If we assume that the circuit is operating and that the output has just switched to $+V_0$ (the positive saturated output level) then the voltage V_1 at the non-inverting input (marked +) will depend on R1 and R2. The voltage V_2 at the inverting input (marked −) will be rising exponentially towards $+V_0$ from an initial negative value.

Let constant $k = \dfrac{R_1}{R_1 + R_2}$ Initially $V_1 = +kV_0$, $V_2 = -kV_0$

When V_2 reaches V_1 the amplifier will change state with the output switching to $-V_0$, V_1 switching to $-kV_0$, while V_2 now falls exponentially towards $-V_0$ from its initial value of $+kV_0$. When V_2 reaches V_1 (which is now $-kV_0$) the circuit changes state again and the cycle repeats.

Table 1.1: Typical Characteristics of the 741C

Large signal open loop gain	100dB
Input resistance	1 Megohm
Differential input offset voltage	2mV
Differential input offset current	30nA
Input voltage range	±13V
Maximum output voltage swing	±13V
Common mode rejection ratio	90dB
Input bias current	200nA
Output resistance	75 ohms
Supply voltages	±15V
Slew rate at unity gain	0·5V/µs

GLOSSARY

ANALOGUE COMPUTING Computing system where continuous signals represent mechanical (or other) parameters.

COMMON MODE REJECTION RATIO A common mode input is one applied to both inputs of an operational amplifier. In theory this should produce no output, since only the difference between the inputs is amplified. The CMRR is a measure of this rejection to a common input signal, and should be large.

COMPARATOR An amplifier designed for comparing two inputs and giving a 0 or 1 output. Usually the output is compatible with logic levels.

DIFFERENTIAL INPUT An input applied between two terminals, neither of which is at earth potential.

DIFFERENTIAL INPUT RATING The maximum differential input which may be applied between the two terminals.

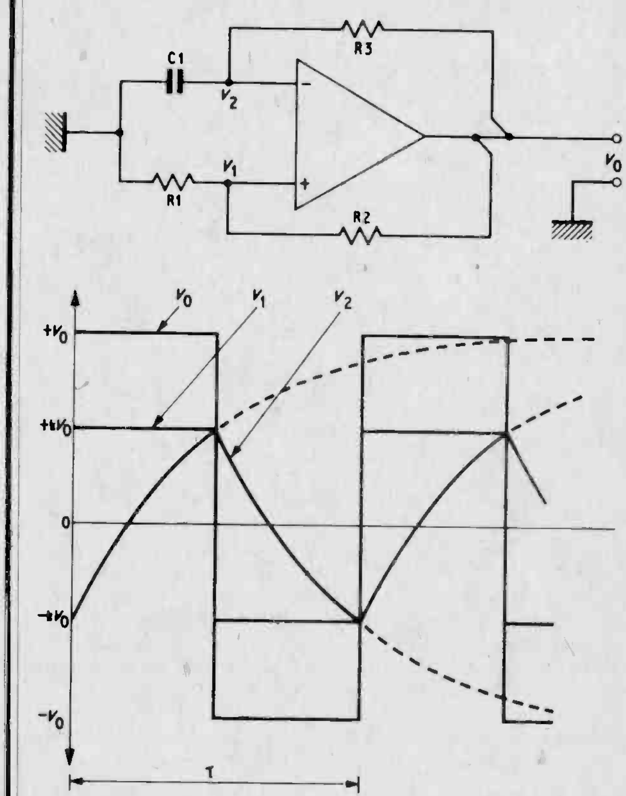


Fig. 1.1. The basic astable multivibrator using a 741

DIGITAL COMPUTING Computing system where two valued signals represent mechanical (or other) parameters.

FREQUENCY COMPENSATION The compensation required in feedback amplifiers to ensure stability and prevent unwanted oscillations.

INPUT COMMON MODE RANGE The maximum input which can be applied to either input without causing damage or abnormal operation.

INPUT OFFSET CURRENT The difference in input bias current requirements for the two inputs.

INPUT OFFSET VOLTAGE That voltage which must be applied between the input terminals to obtain a zero output voltage.

INTEGRATED CIRCUIT An electronic device containing several elements, active or passive, which perform all or part of a circuit function.

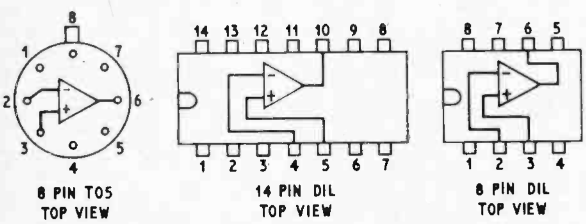
LATCH UP The switching of an electronic circuit to an unintended mode by improper voltage application.

OFFSET ERRORS Errors produced by input offset voltage and input offset current.

OPEN LOOP GAIN The gain of an amplifier before negative feedback is applied.

OPERATIONAL AMPLIFIER Originally a direct coupled high performance amplifier used in analogue computing to perform mathematical operations (summation, scaling, subtraction, integration, etc.). Today a low frequency packaged amplifier (about d.c. to 1MHz)

SLEW RATE The maximum rate of change of the output voltage for large signals. Usually in V/μs.



Basic connections (looking at top) of inputs and output for the 741. For details of other connections, see the I.C. Lead-out Identichart

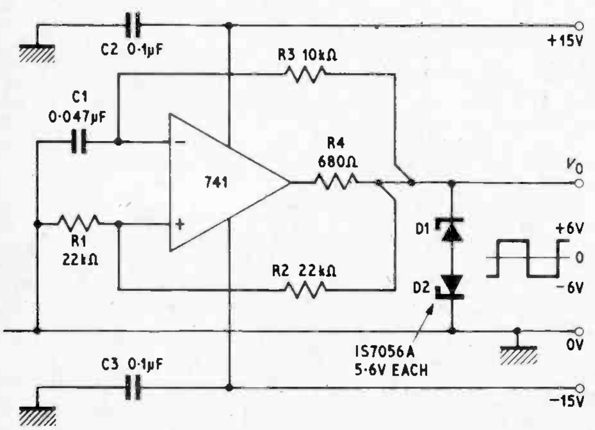


Fig. 1.2. A practical circuit for 1kHz operation

PERIOD OF OSCILLATION

If we assume that the inputs of the amplifier draw no current and that the positive and negative saturation levels are equal, then the period of oscillation is given by:

$$\tau = 2C_1R_3 \log_e \frac{(1 + k)}{(1 - k)}$$

For R_1 equal to R_2, this becomes $\tau = 2{\cdot}2C_1R_3$ secs.

Although there is no need to do so, it is convenient to make R_3 equal to the parallel combination of R1 and R2 to minimise offset errors. The maximum allowable value for k depends on the differential input rating of the amplifier. For the 741, values for k of up to 0·9 are suitable. For a 709 with $\pm$ 12V supplies a k of 0·2 would be used.

PRACTICAL CIRCUIT

A practical circuit for a nominal 1kHz operation is shown in Fig. 1.2. The Zener diodes clip the output level at $\pm$ 6V to aid slew rate slightly. The measured frequency was 844Hz. This is 13 per cent lower than the nominal value, probably due to the 20 per cent tolerance of the capacitor.

Rise and fall times were 10μs, equivalent to a bandwidth of 35kHz. Although this is noticeable for a 1kHz square wave, it is still good enough for simple audio testing to illustrate the effects of tone controls, instability and ringing, or filters. For higher frequencies a 709 can be used with a value of 0·2 for k.

At frequencies lower than 1kHz, or if slightly longer rise and fall times can be tolerated, the Zener diodes may be removed and R4 shorted out, so that the circuit relies on the symmetrical limiting characteristics of the amplifier.

Part 2 Next month: Introduction to basic logic gates

NOUGHTS & CROSSES

By R. K. Johnson B.Sc.

A novel entertainment for parties and fêtes

NOUGHTS and crosses is a simple but fascinating game whose rules can be understood even by young children. Two players alternately place noughts and crosses in a three by three grid in an attempt to obtain a complete line of their own symbol either diagonally, horizontally or vertically.

With this machine the player is given the advantage of starting first and makes his play by using a pen to "write" a nought on to a colourful illuminated screen. The computer instantly replies by displaying a cross. Two anti-cheat devices are included to foil baffled players.

Most of the 945 different games that can be played against the computer will be drawn or lost, but in two per cent of the games the player can get three noughts in a line. Finding these winning games is not easy and presents an interesting problem in logic for the player. Schoolchildren will play for hours trying to find one or more ways of beating the computer.

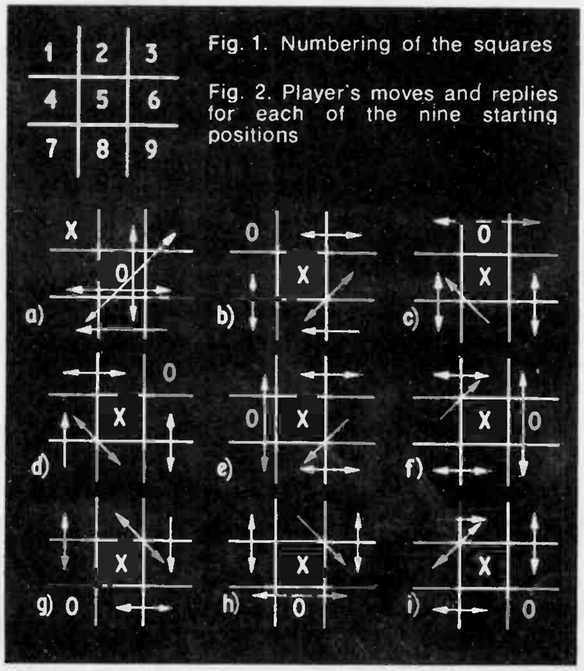


Fig. 1. Numbering of the squares

Fig. 2. Player's moves and replies for each of the nine starting positions

ANALYSIS OF THE GAME

The object of the game is to obtain a row (horizontally, vertically or diagonally) of three noughts, while preventing the computer from obtaining a row of three crosses.

In the usual game using pencil and paper the first player has a choice of nine places, his opponent then has a choice of eight places, and so on. Thus there are $9\times8\times7\times6\times5\times4\times3\times2\times1 = 362{,}880$ ways of filling the places. Though not all of these represent interesting games, the number is too large for a simple computer and so must be reduced.

This is done by allowing the player any choice of position, but limiting the machine to just one reply. The total is then $9\times1\times7\times1\times5\times1\times3\times1 = 945$ possible games, a number which allows simplified circuitry but still provides variety of play.

For further analysis of the game the squares are numbered 1 to 9 as in Fig. 1.

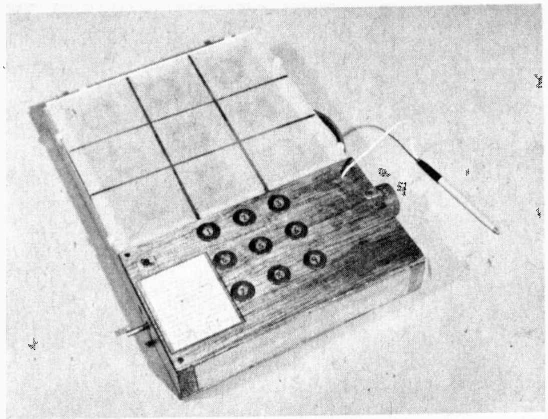
Square 5 is the most important because it controls four of the eight possible rows of three. Squares 1, 3, 7 and 9 each control three rows. Least important are squares 2, 4, 6 and 8 because each can only block two rows.

TACTICS OF THE MACHINE

The first basic principle of play is that if the player's first move is in one of squares 1, 2, 3, 4, 6, 7, 8 or 9, then the computer's best reply is square 5. If the player's first move is square 5, then the computer's reply should be either 1, 3, 7 or 9, but in practice it is made to be always square 1.

The player's first move determines the computer's reply for each successive move in that game. These moves and the corresponding replies are shown in Fig. 2(a) to (i).

Consider Fig. 2(a). The player has started with square 5 and the computer has replied with square 1.



The completed prototype showing the general appearance of the unit with the "how to play" notice in position

The double-headed arrows indicate reversible positions; for example if the player plays square 2 the computer answers with square 8 (to block the row), while if the player plays square 8, the computer replies with square 2 (to block the row).

This illustrates the second design principle: when the player fills in a second "0" in any line, the computer should block the line with an "X".

It will be seen in Fig.2(a) that one of the arrows is single-headed indicating an irreversible play. If the player plays square 9 the reply is square 7, whereas if square 7 is played the reply is not square 9, but square 3.

This illustrates the third principle: if the player is just about to start a line of "0"s, the computer should reply with a second "X" in a line so as to force the player on to the defensive.

If these three principles are followed in the usual pencil and paper game then the player cannot lose.

Possible moves and replies for the eight other starting positions can be followed by reference to Figs. 2(b) to (i).

INPUT UNIT

The player makes each move by touching the pen to one of nine 1in diameter brass washers (corresponding to the nine squares). Each washer is connected to the gates of two thyristors (SCRs).

When a washer is touched, one of these thyristors switches on a lamp indicating the player's "0", and the other thyristor, by means of the memory store, switches on the computer's reply "X".

Once on, the thyristors will stay on until the power supply is interrupted. Thus the use of thyristors has the important advantage that once a move is made, it cannot be changed either accidentally or deliberately. If toggle switches were used instead, players could cheat by flicking the switches to find the best move at each stage.

Fig. 3 shows the circuit diagram for these thyristors and Fig. 4 shows how they may be mounted on a piece of Veroboard. Eighteen 50 p.i.v. 1A SCRs were used in the prototype, but thyristors with other ratings may be used providing they are all of the same type to ensure that the lamps light equally brightly.

Also needed for the input unit is the pen and a resistor which may be fitted inside the pen. The resistor should be the highest value that will give reliable triggering of the thyristors. A 150 ohm $\frac{1}{4}$W resistor was suitable in the prototype.

The pen is a plastic ballpoint of the kind that unscrews in the middle and has a retracting button at the top end. With the ink tube and button removed, flexible cable may be led in at the top hole, knotted, and soldered to the resistor which in turn is soldered to a thick wire which is then soldered or glued with "Araldite" epoxy resin, so as to protrude through the lower hole as in Fig. 5.

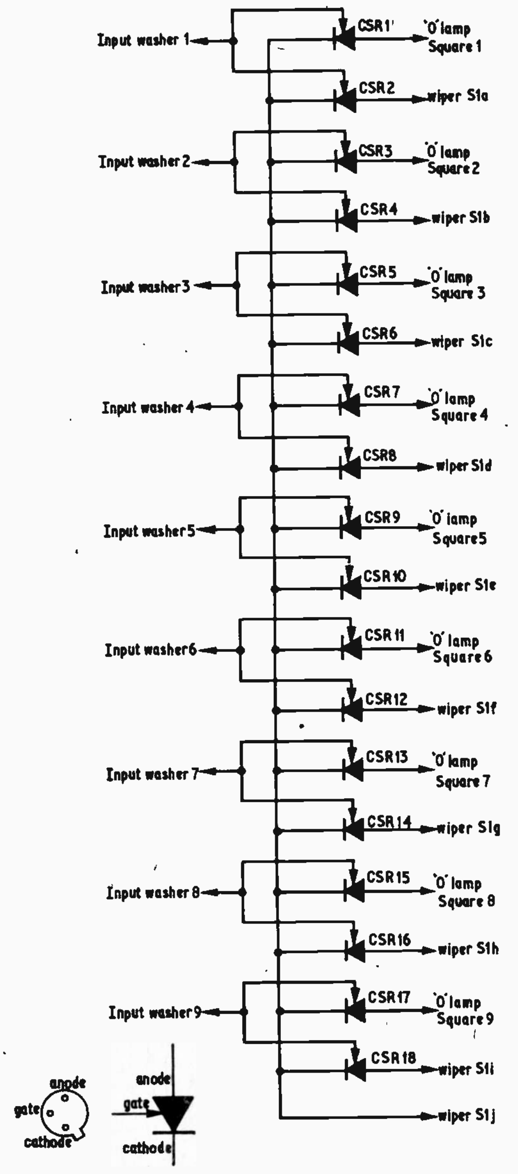


Fig. 3. Circuit diagram of the input unit. The thyristors can be any 50V, 1A type

COMPONENTS . . .

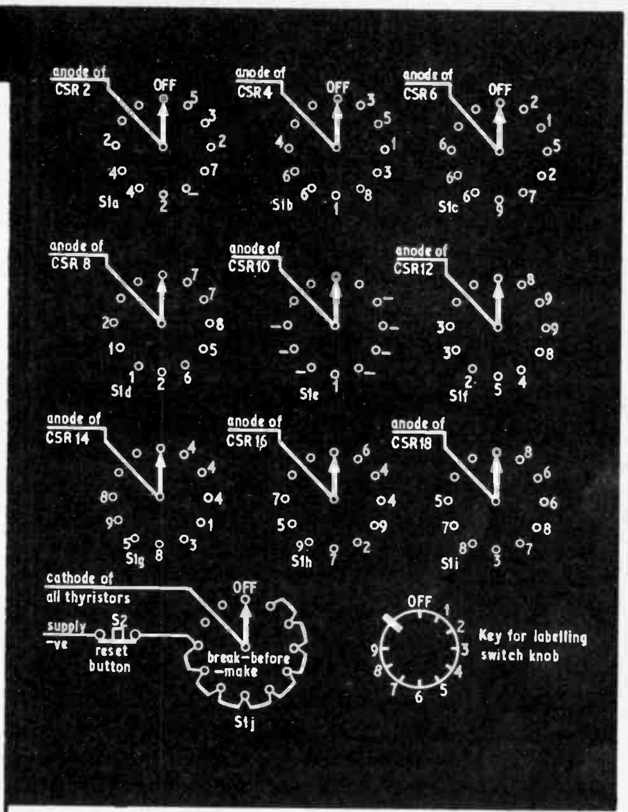
Resistor
R1 150Ω ¼W carbon (see text)

Thyristors
CSR1-CSR18 Any 50V 1A type (18 off)

Switches
S1 10 pole 10 way wafer switch (1 wafer must be a break-before-make type)
S2 Push-to-break push button switch

Lamps and holders
LP1-LP18 M.E.S. lamps and holders (for voltage ratings see text) (18 off)

Miscellaneous
1in dia. brass washers (9 off), ballpoint pen, large knob, mirror clips (6 off), two pieces of glass or Perspex, plywood or hardboard, 2in×1in softwood, red and green cellophane or cinemoid, tracing paper, Araldite (for details of these materials see text), 5in×1¼in 0·15in matrix Veroboard



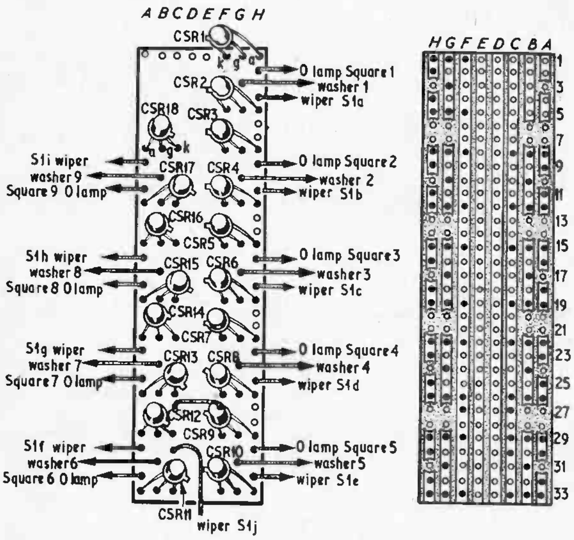


Fig. 4. Layout of the thyristors on the Veroboard panel

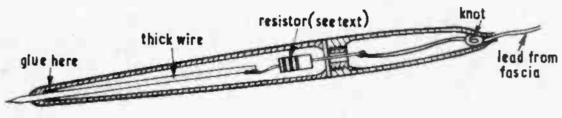


Fig. 5. Internal construction of the "pen"

MEMORY SWITCH

The memory switch consists of a 10 pole 10 way wafer switch. One way is used as an "off" position and the other nine positions of the switch are used to set the initial play number (i.e. select the required programme).

Nine of the wafers are used to route current to the correct lamps and the tenth wafer forms another anti-cheat device. This tenth wafer must be "break-before-make" type. This ensures that if a player tries to cheat by turning to a different programme part way through a game, the power supply to the thyristors is cut off momentarily and the display unit is wiped clean.

Fig. 6 shows the ten wafers. Wafers S1a to S1i must be wired together by reference to the numbers shown round each wafer in Fig. 6. All the contacts marked "1" must be wired together (for connection later to the "X" lamp in square 1 of the display unit). Similarly all the contacts marked "2" are wired together (for connection later to the "X" lamp in square 2 of the display unit), and so on. Great care should be taken at this stage to ensure correct wiring.

All except one of the contacts of wafer S1j are wired together, as shown in Fig. 6.

OUTPUT DISPLAY UNIT

This consists basically of 18 m.e.s. lamps in lampholders under a translucent screen. Nine lamps (green) are used to indicate the "0"s and the other nine (red) to indicate the "X"s using filters as described later.

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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	*

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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		1·34	30
5	4·0	3	11	10·2 × 7·0 × 8·3	Please note, these	2·03	42
86	6·0	5	12	10·2 × 8·9 × 8·3	units do not in-	3·07	52
146	8·0	6	4	8·9 × 10·2 × 10·2	clude rectifiers	3·49	52
50	12·5	11	14	13·3 × 10·8 × 12·1		5·20	67

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ACOS GP67/2C mono crystal 65
ACOS GP101 compatible crystal 75
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2,000 ohms/volts £2·75
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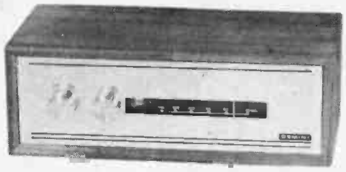

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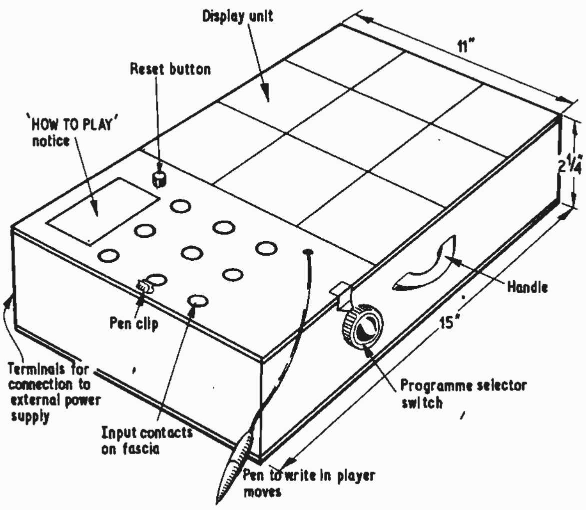


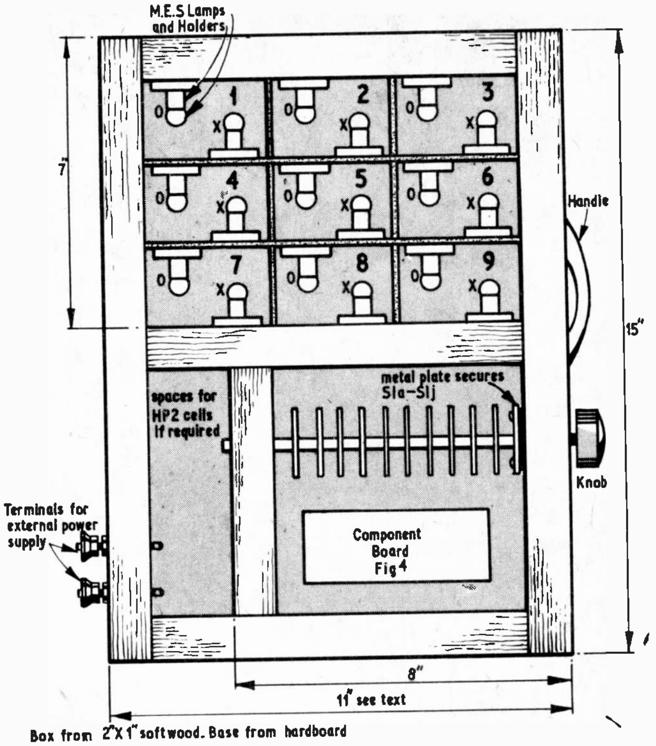
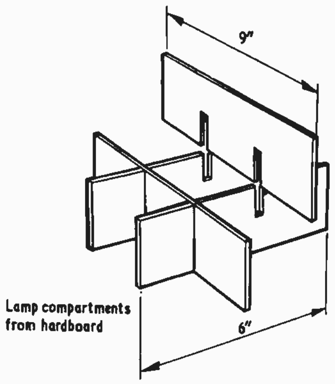


Fig. 7. General layout and dimensions of the complete unit (above)

Fig. 8. Construction of the cabinet and display unit (right)

Fig. 9. Arrangement of the "0" and "X" filters under the tracing paper (bottom right)



CONSTRUCTION OF CABINET AND DISPLAY UNIT

Fig. 7 shows the general layout. Fig. 8 shows the fascia and glass panels removed.

The dimensions are not critical except that the cabinet must be deep enough (at least $2\frac{1}{4}$in) to take the wafer switch with all its wiring.

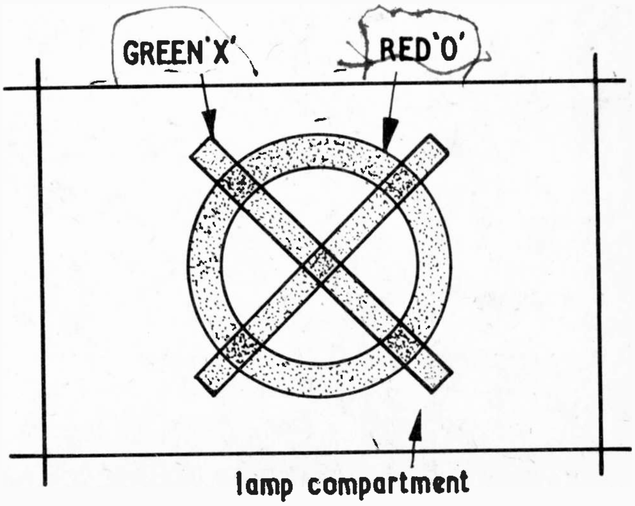
The lamp compartments should be as small as possible to give a bright display while ensuring that there is enough room to unscrew and replace lamps.

If a compartment is needed for HP2 cells (see "Power Supply" section below) then a maximum size of 11in × 15in overall may be used. If an external power supply is to be used then 8in × 15in will give a better, brighter display.

The cabinet may be made by glueing and pinning four pieces of 2in × 1in softwood to each other and to a rectangular (11in × 15in) hardboard base, see Fig 8.

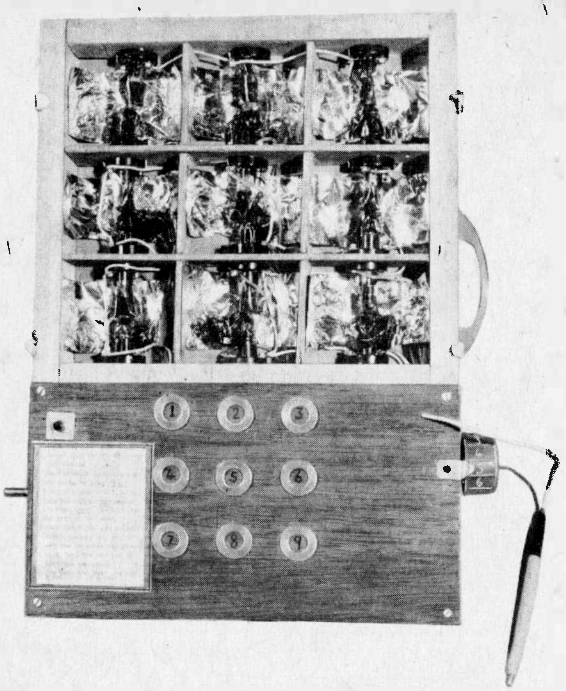
Four slotted partitions for the lamp compartments can be cut as shown, the m.e.s. lampholders screwed in position and the partitions slotted together and held in position by a 9in crosspiece.

A metal plate, drilled to take the fixing bolt of the wafer switch can be screwed in position as shown. A short piece of softwood may be necessary to steady the end of the switch shaft if a battery compartment is required. Terminals or a power lead may be fitted for connection to an external power supply.



NOUGHTS AND CROSSES

The nine "0" lamps are each wrapped in one or more layers of green cellophane and the nine "X"



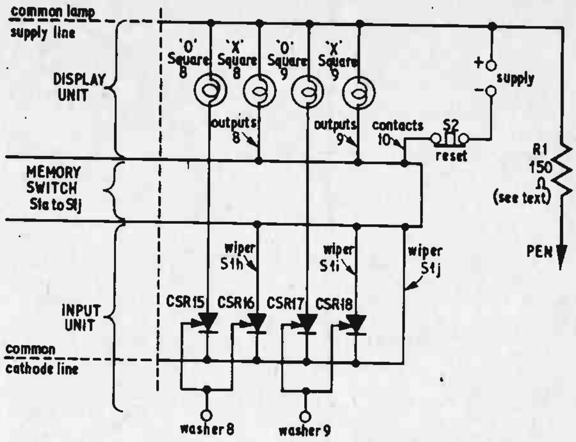


Fig. 10. Part of the complete circuit to show the method of interwiring the display, memory and input units

lamps are similarly wrapped in red cellophane or cinemoid. (Cellophane is obtainable from artists' supply shops and cinemoid, used in stage lighting, is obtainable from large electrical lighting shops.)

The lamp compartments are covered by two sheets of glass or Perspex which sandwich a sheet of tracing paper between them. Also sandwiched (under the tracing paper) are nine large red "0"s and nine large green "X"s cut out of cellophane, one of each over each lamp compartment (see Fig. 9). Thus when a green "0" lamp lights, it illuminates that square with green light except where the red "0" shape absorbs the green light and so appears as a black "0". Similarly when a red "X" lamp lights, a red square with a black "X" appears.

The cellophane or cinemoid should be chosen so that when a red and a green piece are overlapped and held to the light, it should appear as dark as possible without the individual colours being too dense for the lamps. In the prototype it was found that six layers of pale green cellophane and one layer of primary-red cinemoid were most suitable.

The brightness of the display is improved by fitting reflectors of aluminium kitchen foil behind the lamps, taking care not to cause a short circuit between the lampholder terminals.

The two sheets of glass may be held in place by mirror clips.

FASCIA PANEL

The fascia is cut from ¼in or ⅛in plywood or hardboard. Nine holes are drilled under the positions of the nine brass 1in washers (see Fig. 7). Leads are soldered to the washers, passed through the holes and the washers are glued in position using "Araldite" epoxy resin. They should be numbered 1 to 9 as in Fig. 1.

The "push-to-break" reset switch is fixed to the fascia. A hole is also drilled for the lead to the pen. The wood may be finished with varnish or stain. A carrying handle, and a pen clip may be added.

A large 12-faced plastic knob is needed for the wafer switch. The knob should be marked from 1 to 9 plus an "off" position corresponding to the switch positions shown in Fig. 6. A small metal pointer may be fixed to the fascia to facilitate reading the knob.

INTERWIRING OF THE UNITS

Fig. 10 shows part of the complete circuit.

One side of all the lamps is connected to the positive terminal using thick wire and a circuit similar to a ring main to keep the resistance to a minimum.

The pen lead is also connected to the positive terminal.

The negative terminal is connected through the reset switch to all the contacts on the tenth wafer, using thick wire.

The wiper of the tenth wafer is connected to the common cathode lines on the Veroboard (Fig. 4) again using thick wire.

The lead from washer 1 is connected to the gates of thyristors CSR1 and CSR2 (Fig. 4 and 10) and similarly with the leads from the other eight washers. Heat shunts should be used to protect the thyristors while soldering.

The anode of thyristor CSR2 is connected to the wiper of wafer S1a (see Figs. 4 and 10). The anodes of the eight other even numbered thyristors are similarly connected. If possible colour coded wire shoul be used here.

A lead from all the switch contacts marked 1 in Fig. 8 is connected to lamp 1 "X" (i.e. the red lamp in square 1). Similarly all the contacts marked 2 are wired to lamp 2 "X" and so on.

Finally each of the anodes of the "0" thyristors is wired to the corresponding green "0" lamp (Fig. 4).

POWER SUPPLY

This must be capable of lighting up to nine lamps in parallel, with least reduction in brightness.

Lead-acid accumulators or a tapping off a car battery or Nife alkaline cells give a bright display and can be re-charged.

Table 1: POWER SUPPLIES AND LAMPS

POWER SUPPLY	LAMPS
1 lead-acid accumulator (2·2V)	1·25V, 0·25A
2 lead-acid accumulators (4·4V)	2·5V, 0·3A *or* 3·5V, 0·3A
3 lead-acid accumulators (6·6V)	5·5V, 0·3A *or* 6V, 0·3A
2 NiFe cells (2·4V)	1·25V, 0·25A
4 HP2 dry cells (2 pairs in parallel) (3V)	1·25V, 0·25A
Mains driven d.c. power pack	bulb to suit voltage (allow 1V drop across thyristors)

Table 2: "TRUTH TABLE" FOR CHECKING COMPUTER'S REPLIES

SWITCH POSITION	WASHER TOUCHED WITH PEN								
	1	2	3	4	5	6	7	8	9
1	5	3	2	7	–	8	4	6	8
2	3	5	1	7	–	9	4	4	6
3	2	1	5	8	–	9	4	4	6
4	7	3	2	5	–	8	1	9	8
5	–	8	7	6	1	4	3	2	7
6	2	1	9	2	–	5	8	7	3
7	4	6	6	1	–	2	5	9	8
8	4	6	6	1	–	3	9	5	7
9	2	4	6	2	–	3	8	7	5

Table 1 shows which lamps to use depending on the available power supply. If more powerful lamps are used, make sure that the thyristors can carry the necessary current.

If a power-pack is used, it must have a low internal resistance and be capable of delivering enough current for nine lamps.

High power U2 dry cells can be used, but have a limited life and the display will not be very bright.

TESTING

Table 2 shows the "truth table" for checking the computer's replies. For example with the switch set to position 1, if the pen is touched to washer 1 the green lamp in square 1 and the red lamp in square 5 should light. If the pen is then touched to washer 2, the green lamp in square 2 and the red lamp in square 3 should light. In this way the circuit should be carefully and methodically tested for each switch position, using the reset button where necessary.

METHOD OF PLAY

The player decides at the beginning of a game which position he will play initially and then moves the memory switch to indicate that position. This switch must be left in that position for the rest of the game. The player then uses the pen to write in his initial play and carries on with the rest of the game.

A notice suitable for fixing to the fascia near the reset button is shown in the photographs.. The aim of the game should be given as "to get three noughts in a line".

It is left to the constructor to find the 18 winning games. ★

I.C. INTERCOM

continued from page 823

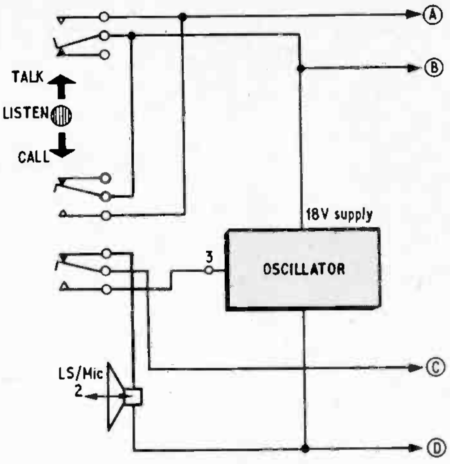


Fig. 9. A call oscillator identical to the one in the master can be used to give the slave a call facility. The switch is a miniature lever switch as used in the master. The letters to the right show how the modified slave is connected to the master

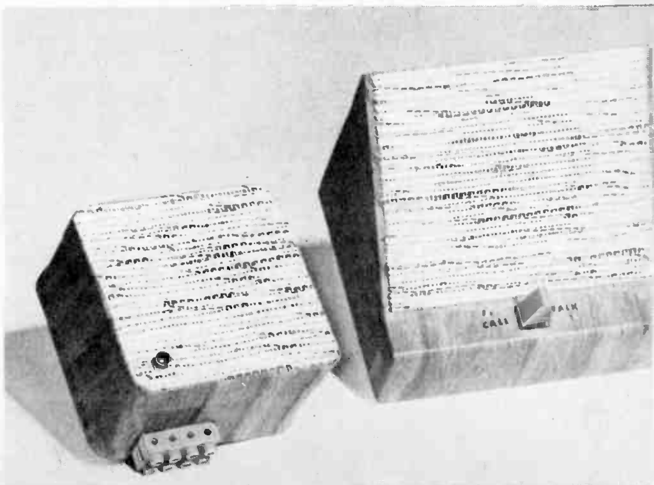
MODIFICATIONS TO THE BASIC SYSTEM

The basic system can easily be extended by connecting slaves in parallel. Fig. 8 shows a typical set up with three slaves none of which have call facilities to the master; in this case it is the master station which has to initiate any communication by pressing the relevant button. If it is wished to give the slave a call facility then Fig. 9 shows the arrangement and this can easily be wired in if the master/slave set up is sufficient.

If any of the configurations using two or more slaves are built then the cases may have to be redesigned. For example, if it is decided to build the master/two slaves with call facilities then the slaves will have to have a case large enough to accommodate the speaker, the call oscillator and the lever key whilst the master will need to be enlarged so that the multi-button switch and the indicator lights can be fitted.

Depending on what loudspeaker is finally used will dictate the method of fixing; the easiest is to glue them to the case making the hole a little smaller than the speaker. ★

The completed intercom



PART 2

POWER SUPPLY . . .

PRE-AMPLIFIER . . .

TREMOLO . . .

ELECTRONIC PIANO

By A. J. Boothman B.Sc.

To achieve a logical building sequence the order of construction presented will be the power supply unit, pre-amplifier and tremolo unit, main amplifier and pitch printed circuit boards. The mounting of the keyboard and other assembly details will round off the series.

To assist in lining up the p.c.b.s the power unit and amplifier are used as test gear, hence the order of construction.

POWER SUPPLY CIRCUIT

The circuit of the power supply is shown in Fig. 2.1 and is based on well established design principles. A transformer using the 20 volt secondary tap produces an open circuit voltage of approximately 30 volts across a large reservoir capacitor, and this reduces to about 26 volts at 2 amps. Two 6·8 volt Zener diodes connected in series act as the reference voltage with which a portion of the output voltage at the emitter of a ZT3055 is compared. Any error is amplified and fed to the output transistor, thus regulating the output voltage. Capacitor C4 produces a slow rise in output voltage at switch on, whilst C3 and R3 give high negative feedback of any ripple voltage which might be developed at at the output.

The output voltage range of the supply is 16–21 volts, controlled by VR1, and the maximum output current is 2 amps. Worst case dissipation in the output transistor TR3 is 18W with 700mW in the driver transistor TR2. Two Zener diodes are used rather than one high voltage type in order to reduce the power requirement in one package. TR1 and each Zener diode have maximum power dissipation levels of approximately 75mW.

The earth connector allows the earth to the piano circuits to be disconnected in the event of any instabilities which might occur when the piano is connected to a self earthed external amplifier.

P.S.U. ASSEMBLY

The small components for the power supply unit are mounted on a simple printed circuit an etching and drilling pattern for which is given in Fig. 2.2.

With the p.c.b. completed and terminal pins inserted first the pre-set potentiometer is mounted, then the resistors, diodes, transistors, capacitors and finally the a.c. input terminal strip as in Fig. 2.3.

The two regulator transistors are mounted on a heatsink and the assembly completed using the transformer for mounting the board. The large capacitors, heatsink and transformer are mounted on a baseboard as seen in the photograph.

After assembly the power supply can be checked for correct operation by measurement of voltage at

POWER SUPPLY

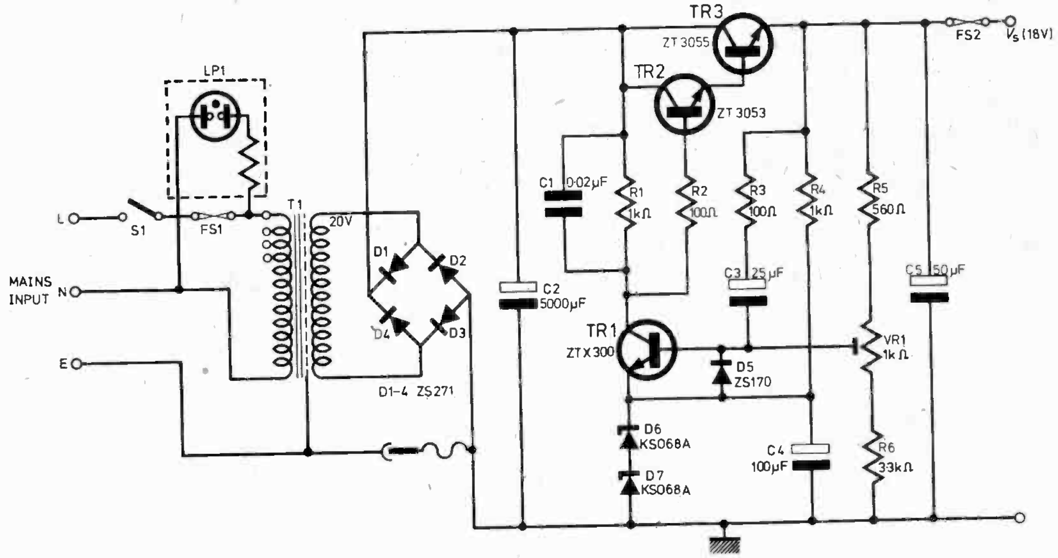


Fig. 2.1. Circuit diagram of power supply unit

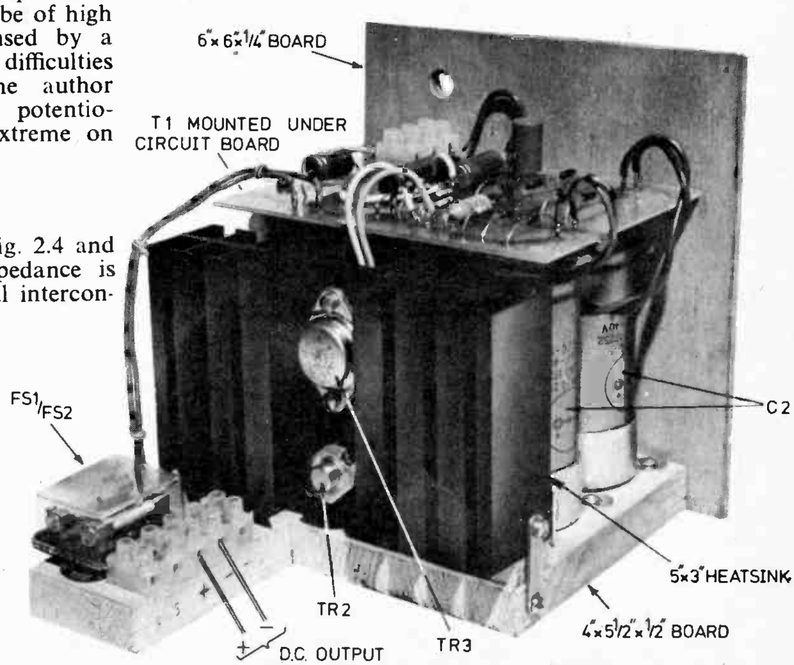
a number of points. The voltage across the 5000µF capacitor (two 2,500µF capacitors, connected in parallel, were used in the prototype) on no load should be approximately 29 volts with a voltage on load of 25V at 1·5A. The emitter voltage of TR1 is 13 volts, with 18·5 volts at the collector for an output voltage of 17 volts.

The voltage on the slider of the preset potentiometer is 14 volts. This component should be of high quality as severe damage could be caused by a faulty condition. After experiencing some difficulties with cheap skeleton potentiometers the author decided to use a multi-turn linear track potentiometer which is probably at the other extreme on cost.

PRE-AMPLIFIER CIRCUIT

The pre-amplifier circuit is shown in Fig. 2.4 and consists of three stages. The input impedance is very low, and allows an unscreened signal interconnection between the pitch boards.

It is essential that the amplifier should be able to handle a wide range of signals, since the peak level for one note is approximately 80mV peak-to-peak on maximum attack. The maximum input signal which can be presented at the input is approx. 2·6 volts peak-to-peak which represents 32 notes in the maximum attack position.



Perspective view of power supply module

POWER SUPPLY BOARD

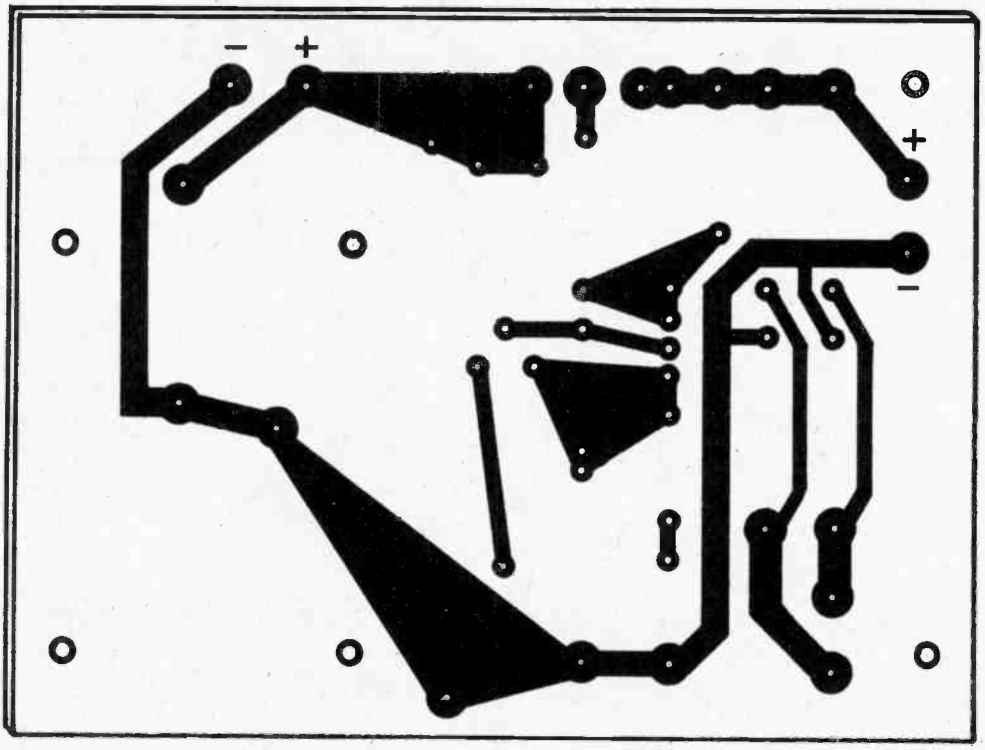


Fig. 2.2. Etching and drilling details for p.s.u. printed circuit board (full size)

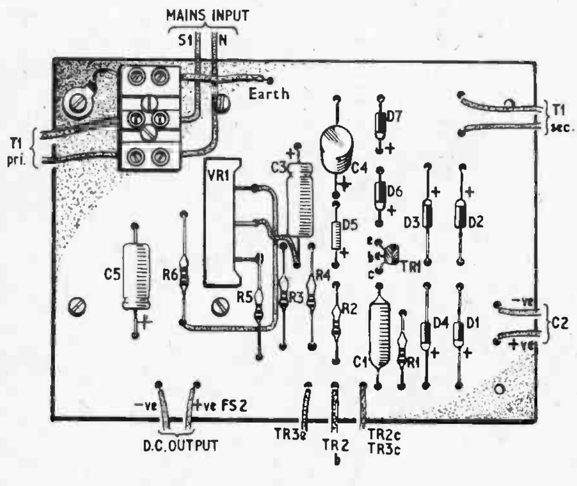


Fig. 2.3. Component assembly on p.s.u. printed circuit board

COMPONENTS . . .

POWER SUPPLY UNIT

Resistors

R1 1kΩ
R2 100Ω
R3 100Ω
R4 1kΩ
R5 560Ω
R6 3·3kΩ
All 5% $\frac{1}{3}$W carbon

Potentiometer

VR1 1kΩ preset

Capacitors

C1 0·02μF polyester 125V
C2 5,000μF elect. 35V
C3 25μF elect. 15V
C4 100μF elect. 15V
C5 50μF elect. 25V

Diodes

D1–D4 ZS271 (Ferranti) 4 off
D5 ZS170 (Ferranti)
D6–D7 K5068A (Ferranti) 6·8V 400mW Zener (2 off)

Transistors

TR1 ZTX 300 Ferranti
TR2 ZT 3053 Ferranti
TR3 ZT 3055 Ferranti

Transformer

T1 Mains transformer, Douglas type MT3AT

Miscellaneous

FS1 — 200mA fuse, FS2 — 1·5A fuse, S1 — Main toggle switch, heatsink, LP1 — Mains neon

The output from the first stage is fed via a resistor network to a compound emitter follower containing two transistors (TR5, TR6). The design of this portion of the circuit is determined by the condition required for the tremolo effect. The tremolo circuit, which is described later, acts as a shunt modulator by presenting a variable impedance across VR2, so giving a variable degree of attenuation of the signal between the first and second stages.

Output from the emitter follower is again at low impedance and the nominal attenuation (tremolo off) for the second stage is a factor of two. Thus the overall voltage gain to the output of the emitter follower is approximately 1·5.

LEVEL CONTROL SETTINGS

The second stage is followed by the two level determining elements, the first being the foot soft pedal control, whilst the second is the keyboard level control. The latter item consists of a five position switch with fixed resistors giving stepped attenuation levels.

PRE-AMPLIFIER & TREMOLO

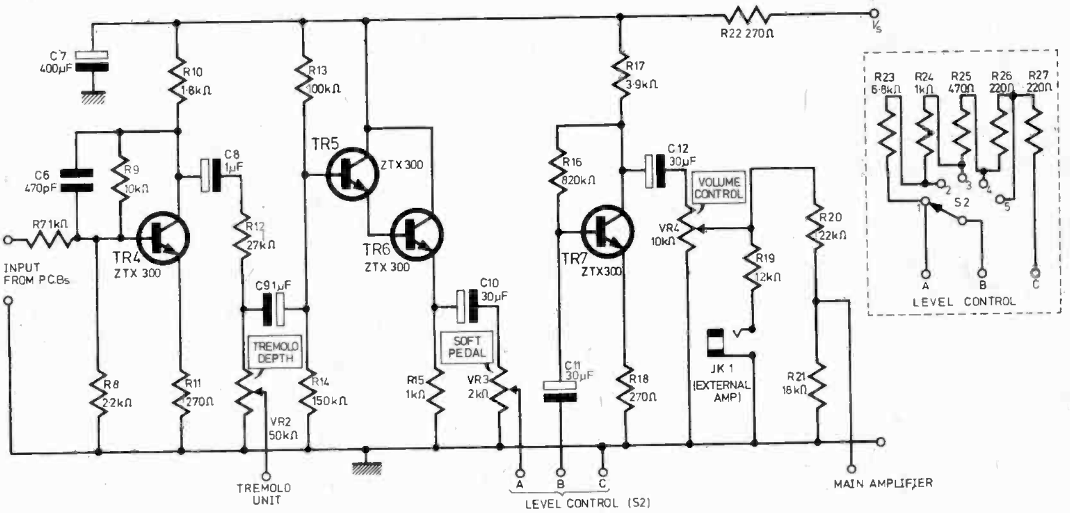


Fig. 2.4. Circuit diagram of pre-amplifier

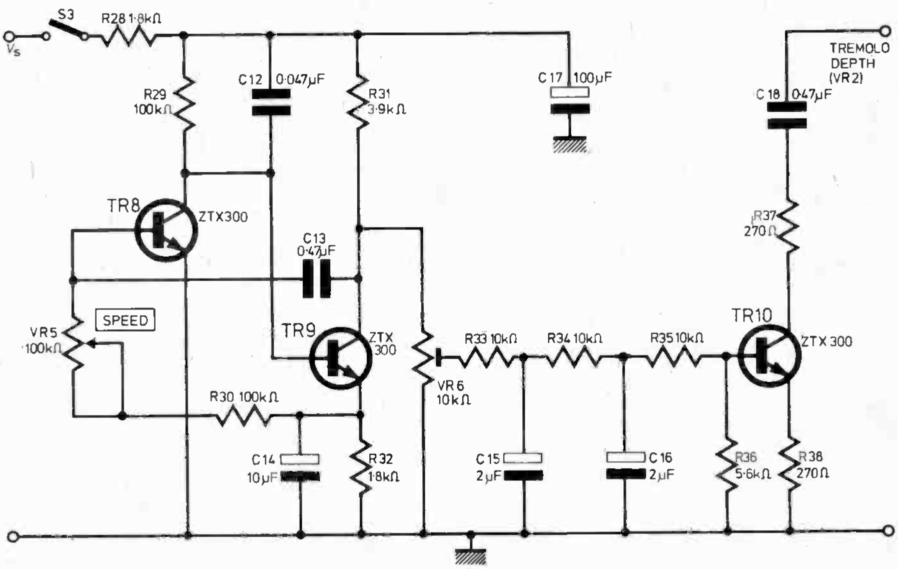


Fig. 2.5. Circuit diagram of tremolo unit, S3 is the keyboard on/off control switch

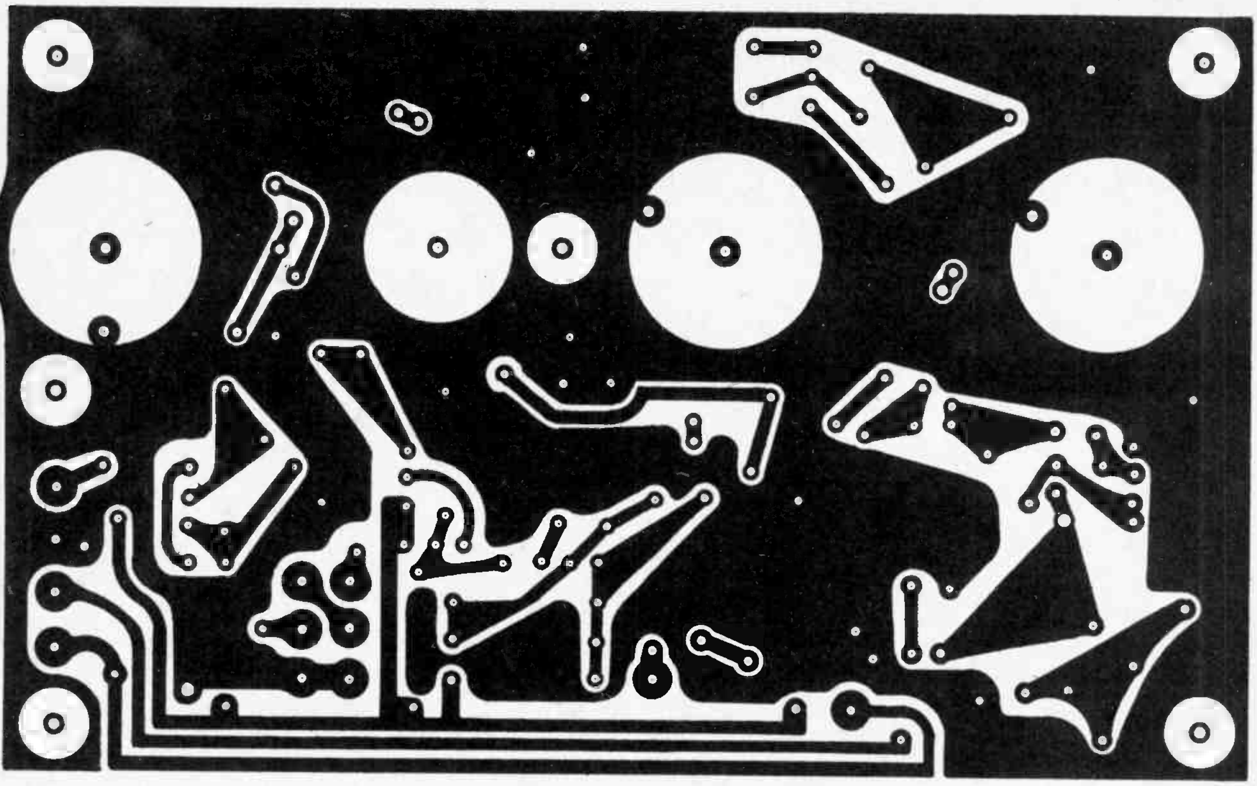


Fig. 2.6. Etching and drilling details for pre-amplifier and tremolo printed circuit board (full size). The white circles for JK1, VR2, VR4 and VR5 should be only ⅜in diameter

COMPONENTS . . .

PRE-AMPLIFIER

Resistors

R7	1k Ω	R18	270 Ω
R8	2·2k Ω	R19	12k Ω
R9	10k Ω	R20	22k Ω
R10	1·8k Ω	R21	18k Ω
R11	270 Ω	R22	270 Ω
R12	27k Ω	R23	6·8k Ω
R13	100k Ω	R24	1k Ω
R14	150k Ω	R25	470 Ω
R15	1k Ω	R26	220 Ω
R16	820k Ω	R27	220 Ω
R17	3·9k Ω		

All resistors ±5% ⅓W carbon

Capacitors

C6 470pF polyester 125V
C7 400μF elect. 15V
C8–C9 1μF elect. 15V (2 off)
C10–C12 30μF elect. 15V (3 off)

Transistors

TR4–TR7 ZTX300 (Ferranti) (4 off)

Potentiometers

VR2 50k Ω carbon lin.
VR3 2k Ω carbon log.
VR4 10k Ω carbon log.

Miscellaneous

S2—5-way single pole rotary switch
JKI—Standard jack socket

TREMOLO UNIT

Resistors

R28	1·8k Ω	R34	10k Ω
R29	100k Ω	R35	10k Ω
R30	100k Ω	R36	5·6k Ω
R31	3·9k Ω	R37	270 Ω
R32	1·8k Ω	R38	270 Ω
R33	10k Ω		

All resistors ±5% ⅓W carbon

Capacitors

C12 0·047μF polyester 125V
C13 0·47μF polyester 125V
C14 10μF elec. 15V
C15 2μF elect. 15V
C16 2μF elect. 15V
C17 100μF elect. 25V
C18 0·47μF polyester 160V

Transistors

TR8–TR10 ZTX 300 (Ferranti) (3 off)

Potentiometers

VR5 100k carbon lin.
VR6 10k Ω preset

Switch

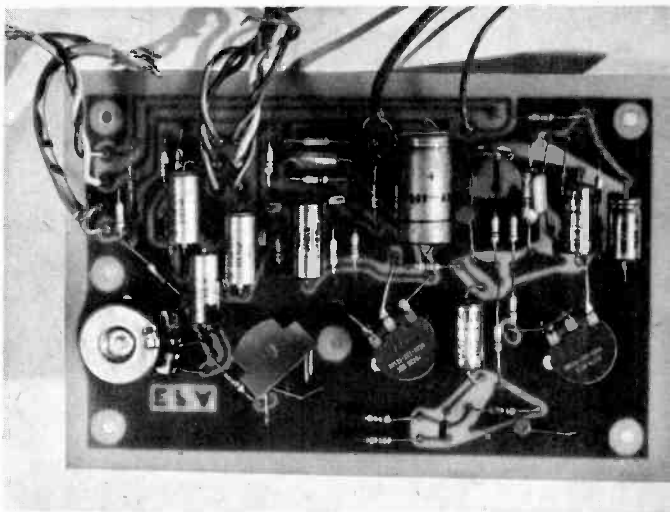
S3—On/off switch

Normal setting is position 2 which gives the nominal output, on maximum master volume, for a five note input. Position 1 gives the nominal output when a single note is played and is only for special single note solo effects.

Positions 3, 4 and 5 give quick operation attenuated levels as required. In position 2 the attenuation between stages two and three is a factor of five.

The single transistor third stage has a gain of approximately ten, and again has a high dynamic range, such that the maximum output swing capability is 8V peak-to-peak.

Overall pre-amplifier voltage gain with the level control in position 2 totals a factor of three, and is followed by a master volume control which feeds the external amplifier jack socket, and a fixed attenuation network prior to the main internal amplifier.



Photograph of the completed pre-amplifier and tremolo board

TREMOLO CIRCUIT

The tremolo circuit is shown in Fig. 2.5. and consists of a multivibrator (TR8, TR9) supplying a square wave output across a preset potentiometer in the range of 5-10Hz. The output from the preset feeds two low pass filters to give a ramp waveform at the base of TR10.

Preset adjustment ensures that the transistor operates from the off condition and provides maximum voltage change at the collector. In turn the degree of voltage swing is controlled by VR2 when applied to the pre-amplifier.

PRE-AMPLIFIER AND TREMOLO ASSEMBLY

The pre-amplifier and tremolo circuits are mounted on the same printed circuit board, which also acts as the panel to hold the external amplifier output socket, the master volume control, and the tremolo rate and depth controls.

Figs. 2.6 and 2.7 give details of the printed circuit board and component assembly. As before all holes should first be checked against the diagrams, and any missed holes should be drilled before proceeding. This may be particularly necessary in the case of the potentiometer peg location holes which will vary in position for different types and sizes of potentiometer.

PRE-AMPLIFIER & TREMOLO BOARD

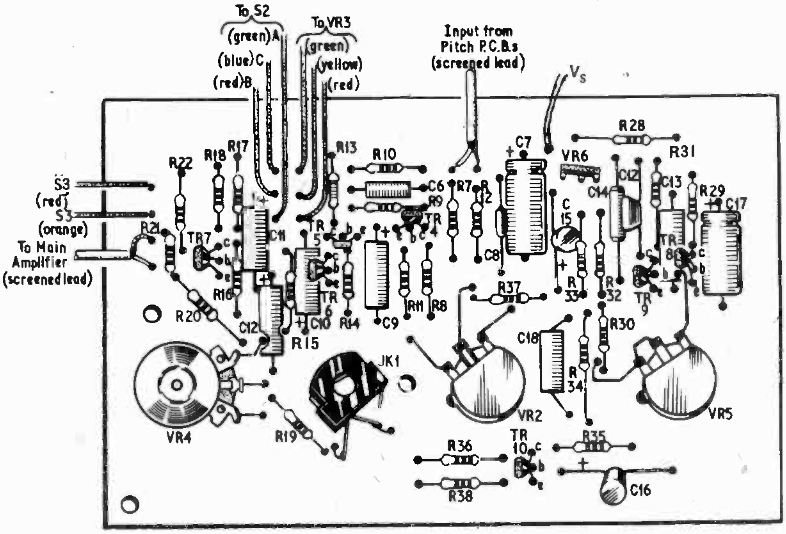


Fig. 2.7. Component assembly detail for pre-amplifier and tremolo unit

Next the terminal pins should be fitted, followed by the potentiometers, jack socket, and preset potentiometer. Fit the resistors, transistors and capacitors in that order, and finally wire the potentiometers and output socket.

MAIN AMPLIFIER

The circuit of the main amplifier is shown in Fig. 2.8 and is based on the Sinclair integrated circuit type IC-12.

The amplifier is intended as a low power unit to drive the two small internal loudspeakers, or the headphones. Whilst the power is adequate for home use in a small or medium size room, an external amplifier is recommended for any serious use of the instrument outside the domestic circle.

The circuit within the package is fully explained in the Sinclair booklet which is supplied with the unit. If you should purchase a unit which includes the earlier simple two page leaflet the booklet can be obtained by writing to Sinclair Radionics Limited.

COMPONENT CHANGES

A printed circuit card is supplied with each unit and the photograph shows the assembled unit. Some of the component values have been changed from those suggested by Sinclair for the average application. The components affected are marked with an asterisk in Fig. 2.8 and the associated components list.

C19 (0·5μF) has been chosen for the input coupling capacitor since, as explained later, the input impedance has been reduced such that bass response could suffer if this capacitor were not increased. C20 (0·01μF) has been used to provide a small amount of treble cut as a form of tone shaping on the internal amplifier setting. C25 (400μF) prevents any possible instabilities due to the length of the supply lines.

MAXIMUM BASS

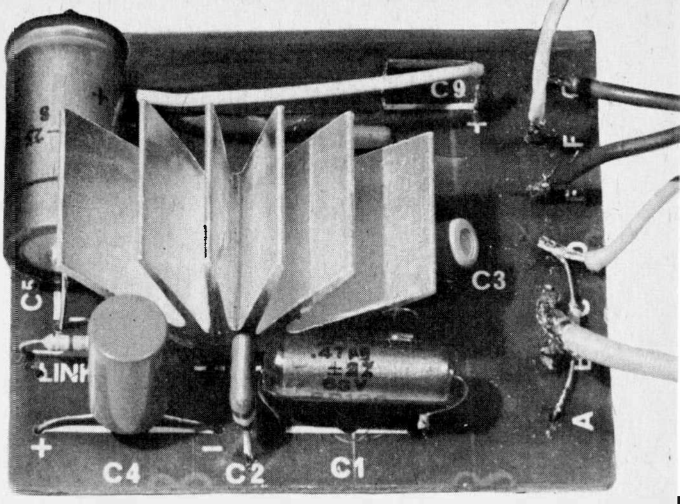
To provide maximum bass response a 1,000μF coupling capacitor (C27) is connected at the output. Due to the large size of this capacitor it has been removed from the p.c.b. as supplied by Sinclair. It will also be noted that the connection of this capacitor within the circuit has been removed from the ground side of the speakers and inserted on the live side. This prevents the possible shorting out of C27 to earth by the insertion of a jack plug into the headphone socket where the jack plug is connected to some other equipment which is earthed.

This rearrangement means, that is is necessary to connect a wire link across the connections intended for C27, thus making pin F an earth point.

The input impedance is reduced by the choice of R39 which minimises pick-up between the pre-amplifier board and main amplifier. R41 (470Ω) is used to hold the amplifier gain at 60. This gives an input sensitivity of approximately 200mV peak-to-peak for a 3 watt output into 6 ohms.

Sinclair Radionics state that it is very important that the i.c. only be used mounted on the printed circuit board which is supplied with it. Due to the very high gain of the device, the slightest coupling between output and input can cause trouble in the way of distortion and instability.

Next month: Pitch Board



Proprietary board assembly for the main amplifier

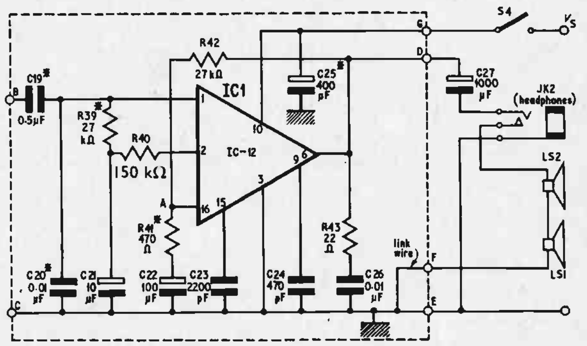


Fig. 2.8. Circuit diagram of main amplifier

COMPONENTS . . .

MAIN AMPLIFIER

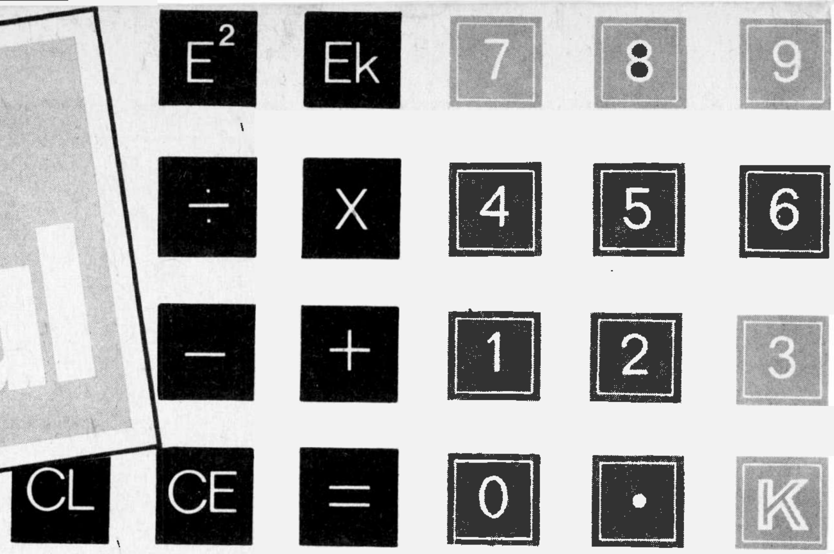
Resistors
R39* 27k Ω
R40 150k Ω
R41* 470 Ω
R42 27k Ω
R43 22 Ω
All resistors ±5% $\frac{1}{3}$W carbon

Capacitors
C19* 0·5μF polyester 125V
C20* 0·01μF polyester 125V
C21 10μF elect. 15V
C22 100μF elect. 15V
C23 2,200pF polyester 125V
C24 470pF polyester 125V
C25* 400μF elect. 25V
C26 0·01μF polyester 125V
C27 1,000μF elect. 15V

Integrated Circuit
IC1—Super IC-12 with printed circuit board. (Sinclair Radionics Ltd.).

Miscellaneous
JK2—Jack socket to match headphones
LS1–LS2 3 Ω elliptical loudspeakers 8in × 2½in.
S4—On/off switch

PE Digi-Cal



By R.W.COLES PART 4

KEYBOARD LOGIC AND HARDWARE

SATISFACTORY functioning of the keyboard is vital for correct calculator operation and to make things as easy as possible for the user, a great deal of thoughtful design has been carried out as regards key-top labels, keyboard layouts, the required function of each of the keys, and compensation for possible "finger-trouble"! The author's solutions to these problems are embodied in the Digi-Cal keyboard, but should any constructor wish to alter either the physical layout or the logic there is plenty of scope for modifications to produce a "custom" design.

KEYBOARD DEFINITION

The keyboard circuitry can be split up into a number of independent or interlocking sub-circuits, and each of these performs a different function, corresponding to one of the following list of keyboard requirements:

1. Convert figure key depressions into a four bit B.C.D. code and generate a single coincident clock pulse to enter the B.C.D. data into the (separate) entry register.
2. Convert arithmetic key depressions into a static two bit code suitable for use by the programme and arithmetic sections.
3. Record the number of decimal places in each figure entry and control the final alignment of the number so that it has the correct number of decimal places as entered on the thumb-wheel switch.
4. Produce a three bit code representing the number of decimal places to be displayed, dependent upon whether entries or answers are being read out.
5. Generate a single pulse to start the programme when the EQUALS key is pressed.
6. Switch on the overflow lamp when an OVERFLOW input is received from the arithmetic section.

BLOCK DIAGRAM

The circuit of the keyboard panel can be subdivided into a number of relatively straightforward logic groups.

Fig. 4.1 shows these groups laid out in the form of a functional block diagram and it is best to understand the keyboard using this diagram before studying the full circuit in detail.

In the block diagram the circuit has been simplified as far as possible and the symbol consisting of a switch in a box with an arrowed input is used to represent gating functions which control the switched path, the arrow showing the input which has control.

ARITHMETIC KEYS

Starting at the top of the diagram, the four main arithmetic keys are fed to an encoding circuit which generates a unique binary code for each depression. This code is "staticised" in two latch flip-flops so that the code remains on the output wires until overridden by a future (different) arithmetic selection.

The E^2 key is in parallel with the "MULTIPLY" key since squaring is simply a modified multiplication sequence; a separate E^2 output is also produced to modify the programme.

The narrow START pulse required by the programme is generated by a monostable triggered by the EQUALS key, and this monostable is also used to start the second half of the multiply and divide sequences on command from the arithmetic section.

NUMERAL KEYS

The number keys are encoded to their B.C.D. equivalent in a diode matrix, the outputs of which are also staticised by four flip-flops so as to present a steady logic output during the clock pulse which enters the data into the entry register, the data in the latches remaining until either a different number key is pressed, or the EQUALS key is pressed in which

KEYBOARD LOGIC

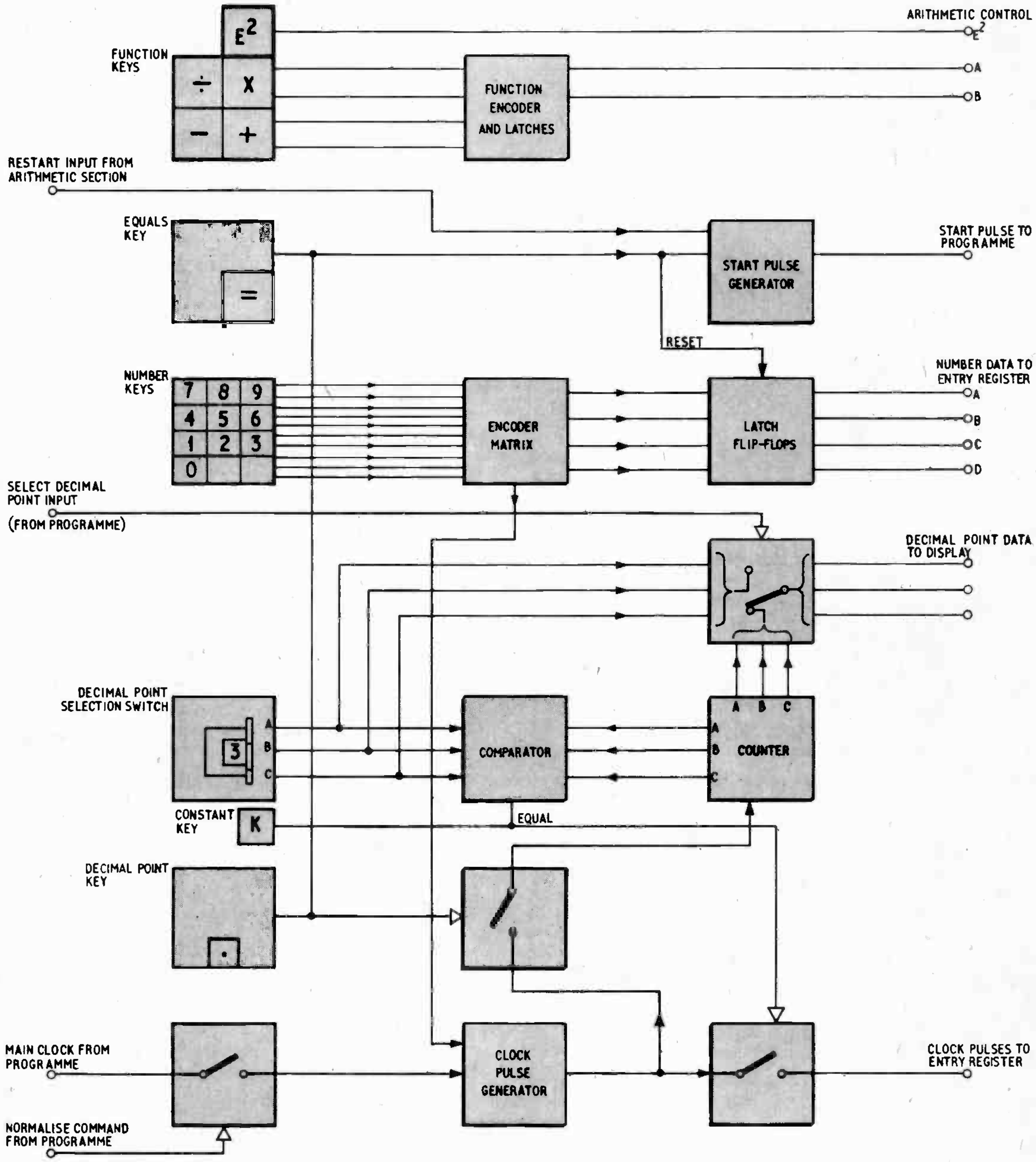


Fig. 4.1. Simplified block diagram of the keyboard logic. The symbol of a switch in a box with an arrowed input represents a group of logic gates, the arrow being the input which has control

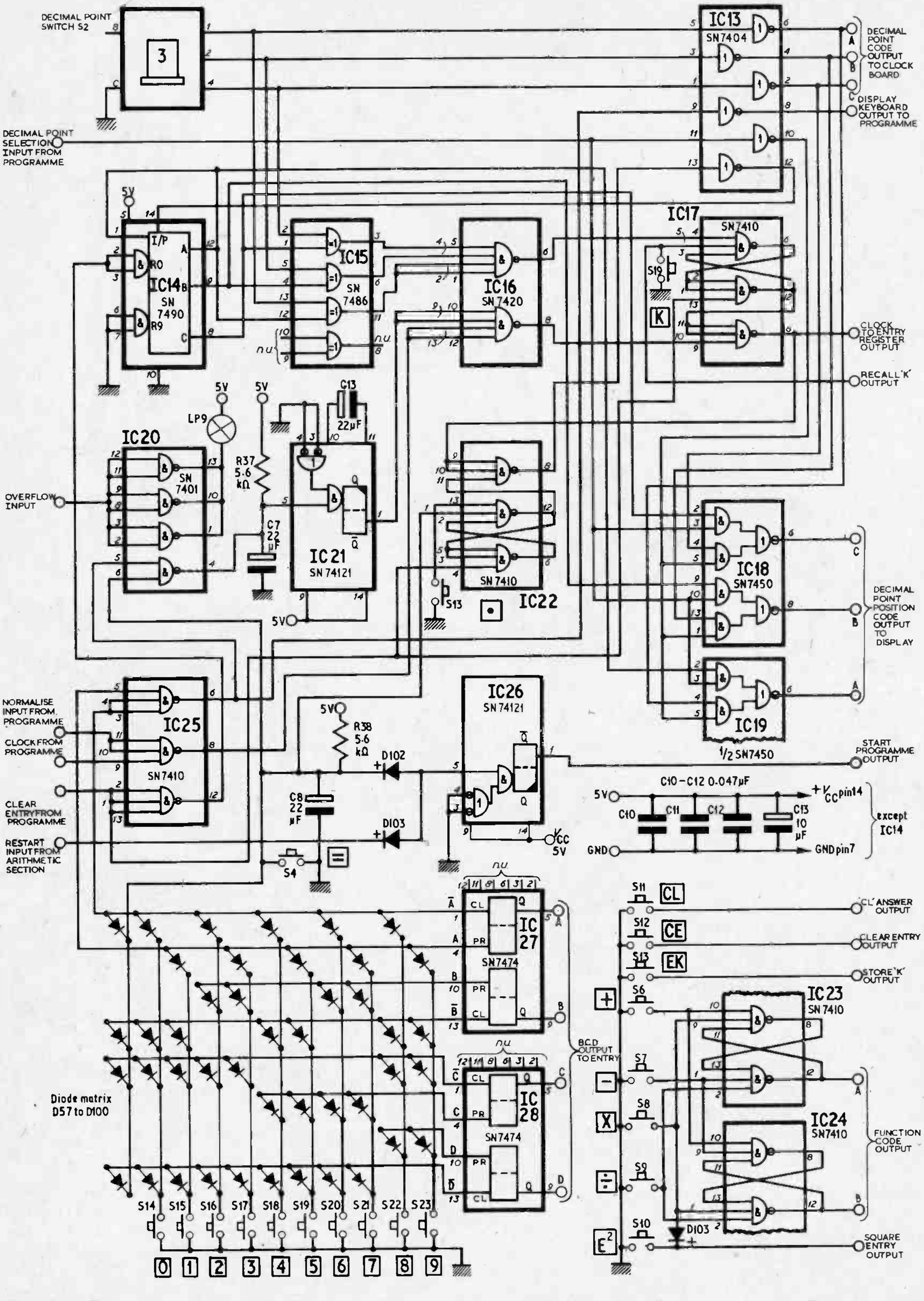


Fig. 4.2. The complete circuit diagram of the keyboard logic panel. All i.c.s have pin 7 as ground and pin 14 as 5V except IC14 whose power supplies are shown

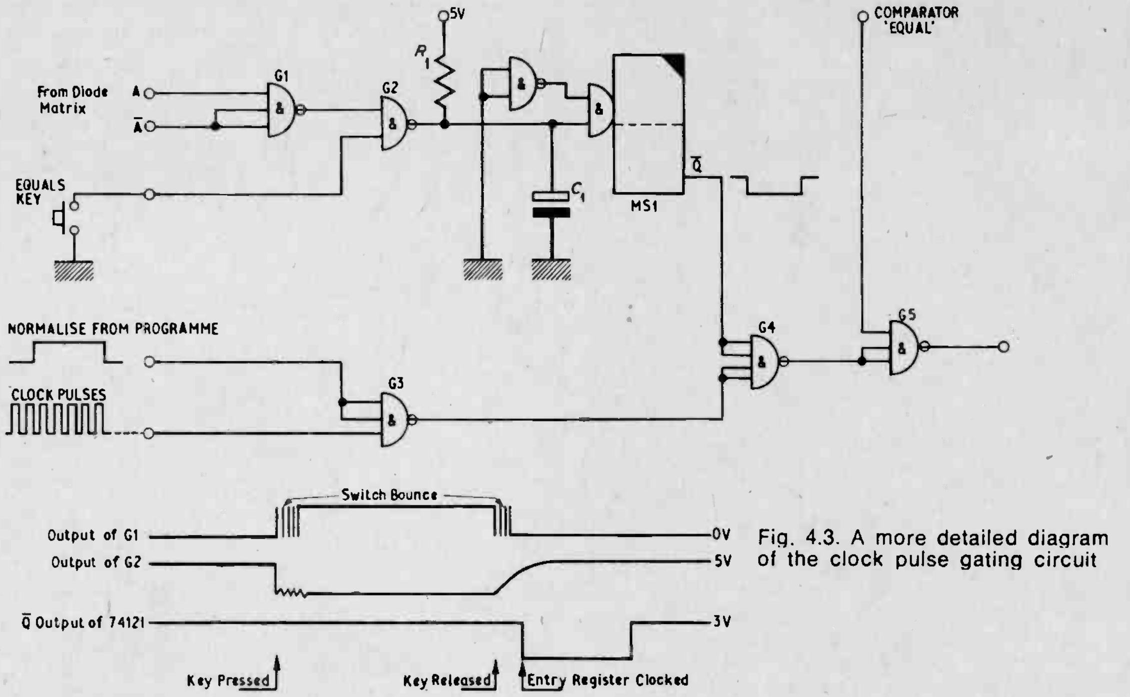


Fig. 4.3. A more detailed diagram of the clock pulse gating circuit

case the latches are cleared. An output is also generated from the matrix whenever any key is pressed, and this signal is used to trigger the clock pulse generator, but more of this later.

DECIMAL POINT POSITIONING

If the decimal point key is pressed during an entry then a latch is set which in turn opens a gate to allow any subsequent clock pulses through to a counter. This counter counts the clock pulses after the point entry and gives an output which is compared with the setting of the decimal point thumbwheel in a comparator circuit.

When the correct number of decimal places have been entered the comparator registers the equality and shuts off the clock pulses from the clock pulse generator. It is this mechanism which prevents entry of too many decimal places in any figure entry.

If the number entered has too few decimal places then when the programme is started a NORMALISE command from the programme allows the main calculator clock pulses through to the clock generator in the keyboard, and the entry register data is rapidly shifted along until the comparator again registers equality then shuts off the clock.

This process ensures that all numbers can be entered without regard to the position of the point, normalisation being automatically carried out by the calculator itself.

OTHER FUNCTIONS

There are two additions to the clocking circuit to allow for special conditions. The EQUALS key is allowed to close the path connecting the clock pulses to the counter, this being done to cater for the occasions when only whole numbers are entered, the decimal point being unused.

Also, the RECALL CONSTANT (K) key is allowed to shut off the clock path to the entry register so as to inhibit normalisation, this being necessary because the constant in store is correctly aligned to start with.

The three bit output of the thumbwheel switch is used to define decimal point position when the answer to a calculation is being displayed, and the three bit output of the counter is used to define it when an entry is being displayed. Switching between the two sources is carried out by a gating arrangement controlled primarily by the programme.

Any keys not shown on the simplified diagram have no associated logic circuitry and are passed out to the rest of Digi-Cal as switch closures to earth.

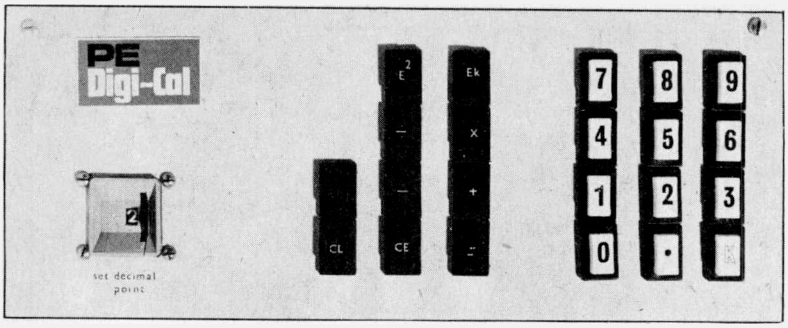
The full circuit of the keyboard is given in Fig. 4.2, and with the knowledge of its operation gained from the simplified diagram it should be possible to pick out the various logic groups previously discussed. One particular group may still be a little difficult to trace out, and that is the clock generation and gating.

To see this circuit in a clearer light it has been redrawn in Fig. 4.3 in an integrated way, and because this section is so important we can go through it step by step.

CLOCK CIRCUIT

The clocking is initiated by detecting any output from the diode matrix which is an indication of a key depression. Because the normally high A, B, C, and D outputs of the matrix will always have either their true or their complement output active (i.e. low) for any one of the ten relevant key depressions a detection circuit can be made by "ORing" together the true and complement version of any one of them.

In Fig. 4.3 G1 performs the detection by using the two "A" outputs from the matrix. The "logic 1"



The upper side of the keyboard showing the arrangement of the switches in the slots

output from G1 is applied to G2 which is an open collector gate with R_1 and C_1 in its collector circuit to give a slow "0" to "1" transition. The other input to G2 is an inhibiting input from the EQUALS key which prevents a clock pulse being generated by the latch reset when the EQUALS key is pressed.

The output of G1 is shown for a typical key depression and as you can see it carries with it a faithful (though inverted) representation of the switch bounce which is a feature of all mechanical switch operations, and which must be removed before the signal is used to trigger the monostable.

The output of G2 is "cleaned-up" by R_1 and C_1 to give the output pulse shown, and the slow transition after the key is released is used to activate the level sensitive trigger input of the SN74121. The fairly long negative going pulse from the monostable is "ORed" with the possible output of G3 and fed out to the entry register via G5 which is controlled by an inhibitory input from the COMPARATOR EQUAL latch. Gate G3 is used to control the main clock input used during the normalising cycle, being enabled by a long pulse from the programme.

DIODE MATRIX

The diode matrix used to encode the figure keys into their binary equivalent is so named because of its physical construction, the logic it performs being simply that of eight multi-input OR gates, the number of inputs to each gate being set by the number of diodes connected to its output line.

In the circuit diagram the eight horizontal lines represent the gate outputs, the requisite inputs being made by the diode links to the eleven vertical lines from the number keys and the reset line.

The matrix is built using the same technique as was employed for the display matrix (Part 3) with a small piece of Veroboard providing the vertical output lines to the latches and the key inputs being wired to the horizontal strips on the mother board.

Remember that it is necessary to make guide funnels on the blank side of the small piece of Veroboard to ease the location of the diodes prewired to the mother board, and most important, the cathode end of the diodes should be mounted next to the mother board.

The outputs from the matrix drive the PRESET and CLEAR inputs of the four latch bistables, which do not use their D inputs or CLOCK inputs in this application (IC27, IC28).

The use of SN7474 flip-flops in this position is a bit extravagant, since a couple of SN7400s cross coupled to form four latches would work just as well and can be incorporated if desired, the more versatile SN7474s being used in the prototype to allow for possible future modification to enter data automatically from a source such as a tape reader.

FUNCTION CODER

Unlike the number coder and latches, the function coder and latches do not need a separate set of coding gates, the latches being built from SN7410 three input NAND gates, ICs 23 and 24, and the two inputs to each gate left after making the latch coupling are sufficient to provide the gating required to encode the arithmetic keys.

The E^2 key is coded in the same way as MULTIPLY and a diode D103 is used to facilitate this.

EQUALS KEY

Pressing the EQUALS key is the signal to start the selected arithmetic programme, and as may be expected, when it is pressed several things happen at once.

The earth appearing on the EQUALS line:

(a) resets the number latches via the matrix;

(b) inhibits the generation of a clock pulse which would normally result from the previous reset (see G2, Fig. 4.3);

(c) sets the decimal point latch IC22 to allow subsequent clock pulses through to the counter (this latch may have already been set by operation of the DECIMAL POINT key during figure entry).

When the key is released and the earth disappears the resulting positive going signal on the line is "debounced" and used to trigger the START PROGRAMME monostable IC26 via a simple diode gate D101, D102. The output from the monostable is a very narrow pulse which is used to initiate the programme sequence. The diode gate is required so that the programme can also trigger the monostable to generate a "RESTART" pulse required in some arithmetic sequences.

DECIMAL POINT NORMALISATION

When the decimal point latch is set clock pulses are allowed through to the SN7490 decade counter IC14, which in effect counts the number of figures after the point in a number entry. The contents of this counter are continually compared with the decimal point switch output so as to detect a state of equality.

The thumbwheel switch output is already in a binary code though of an inverted form so that a logic "1" is represented by an earth connection and

COMPONENTS . . .

KEYBOARD PANEL

Resistors
R37, R38 5·6kΩ $\frac{1}{4}$W ±10% carbon

Integrated Circuits

IC13	SN7404
IC14	SN7490
IC15	SN7486
IC16	SN7420
IC17	SN7410
IC18, IC19	SN7450 (*or* SN7451) (2 off)
IC20	SN7401
IC21	SN74121
IC22, 23, 24, 25	SN7410 (4 off)
IC26	SN74121
IC27, IC28	SN7474 (2 off)

Diodes
D57–D103 West Hyde type "red" (47 off)

Capacitors
C7, C9 22μF 15V elect. (2 off)
C8, C13 10μF 15V elect. (2 off)
C10, C11, C12 0·047μF (3 off)

Switches
S2 Birch Stolec EB10N 1248 and a pair of end plates
S3-S23 On/off push button (Bulgin type MP22, white 12 off, black 9 off)

Lamp and holder
LP9 6V 40mA lamp and holder (Bulgin type D22)

Miscellaneous
9·5in×3·3in 0·1in matrix Veroboard

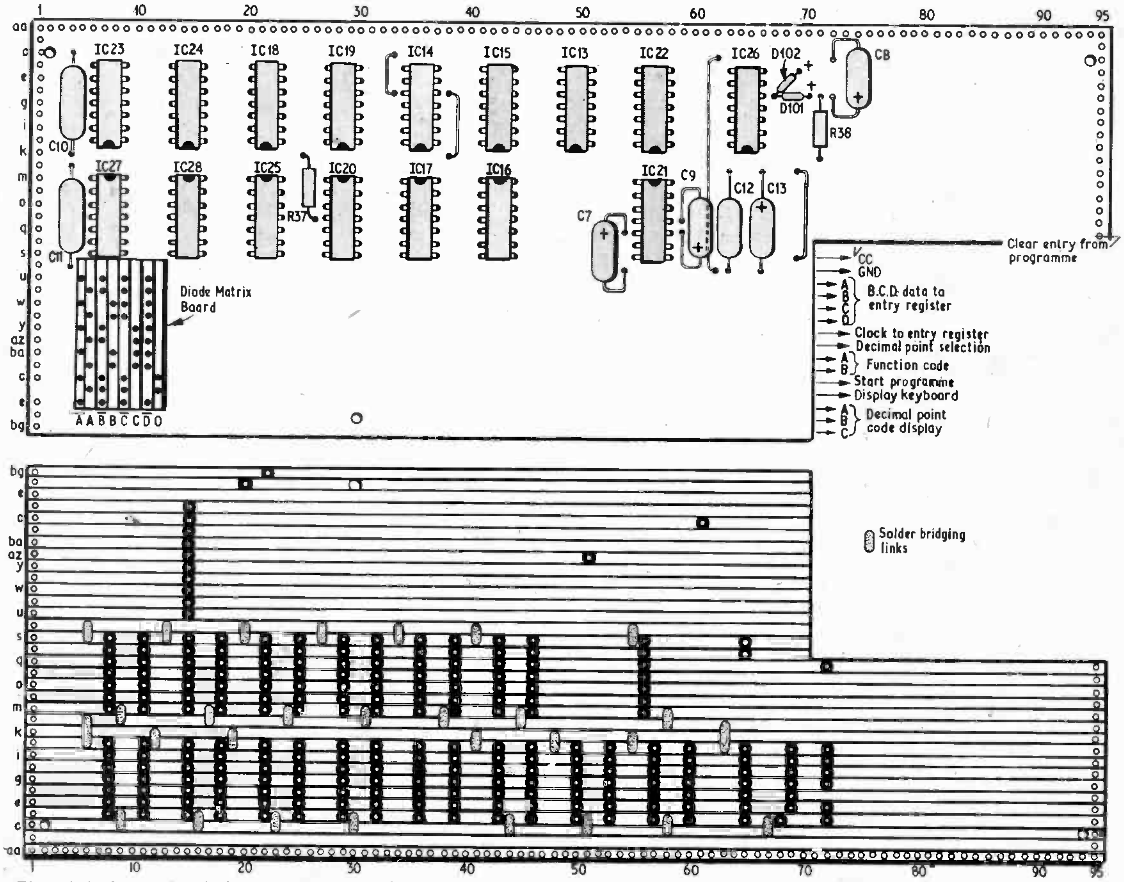
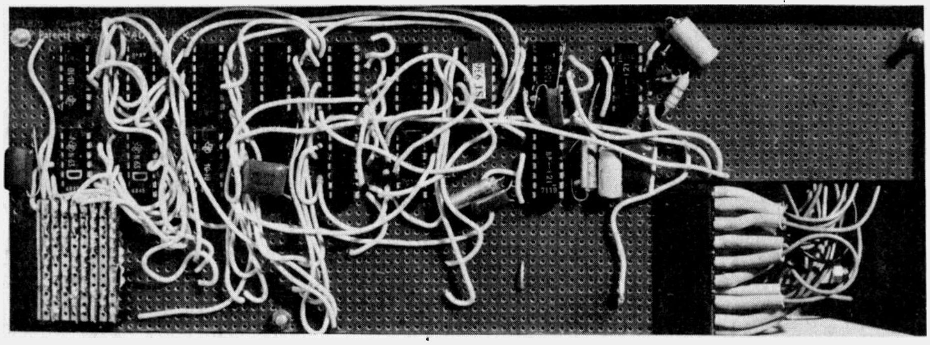


Fig. 4.4. Layout of the components on the Veroboard panel and the cuts which must be made in the copper strips. The links shown are for the power supply lines only and can either be made above or below the board. The black dots on the "diode matrix" board show the positions of the diodes which are arranged with the cathodes towards the main panel



A photograph of the keyboard logic panel in the prototype. The edge connector is an optional extra as wires can be soldered directly to the board

logic "0" by an open circuit. This suits our purpose admirably since the SN7486 used as a comparator, IC15, gives a "1" from each of its gates when its inputs are exactly opposite.

By comparing the true counter outputs with the complement switch outputs a comparator is formed which gives three "1" outputs when the count equals the switch setting. These three ones are used to enable a gate IC16, which in turn sets a latch, IC17, the output of which forms the input to G5 of Fig. 4.3 and serves to shut off the supply of clock pulses to the entry register.

DISPLAY CONNECTIONS

The position of the decimal point in the display can be governed either by the contents of the counter, IC14, or by the thumbwheel switch setting depending on a command from the programme.

Switching between these two sources is carried out by the AND OR INVERT gates IC18 and IC19, but note that for this purpose the outputs from the thumbwheel switch are inverted by IC13, to make them compatible with the counter outputs. The selected point data is fed to the display via a three line bus.

OVERFLOW INDICATION

If an OVERFLOW condition is detected during an arithmetic operation a "1" input on the OVERFLOW line drives three SN7401, IC20, gates in parallel to switch on the panel indicator bulb. The correct procedure is then to use the CLEAR key to erase all data and then re-enter the problem in a rescaled form. It is necessary to parallel connect three gates for this job because of the current requirements of the bulb.

PROGRAMME RESET

To return the keyboard to its correct state for a further calculation it is necessary to rest the DECIMAL POINT and EQUALS latches and the decimal point position counter. This is carried out by a CLEAR ENTRY command from the programme which, as its name implies, also clears the contents of the entry register.

CONSTRUCTION

The layout of the Veroboard panel is shown in Fig. 4.4, the panel itself being cut to size from a West Hyde type 122 board.

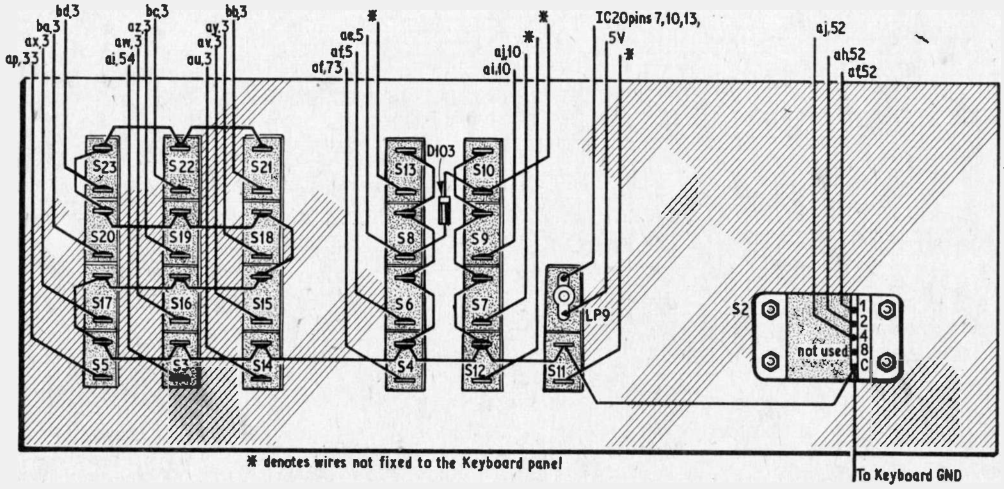


Fig. 4.5. The switches are wired as shown. All wires except those with an asterisk go to the panel shown in Fig. 4.4

The finished panel will be mounted upside down under the keyboard proper, affixed to the recessed wooden blocks either by means of wood screws, or, as in the prototype, by captive 6B.A. bolts cemented into the blocks with Araldite.

Needless to say, it is advisable to make all the board fixing arrangements before commencing the wiring.

Wiring up is carried out as before with thin single core wire, using terminal pins where necessary to increase the wire handling capacity of a particular pad.

Off board wiring is achieved with thin flexible stranded wire left long enough that the board can be easily removed for access, but not too long that stray pick-up could become a problem.

An edge connector was used to carry some of the off-board wiring in the prototype to help with development, this would not be necessary, or even advantageous to any significant extent with later versions, due to the very large number of interconnections required in all.

The switches are wired up as shown in Fig. 4.5.

TESTING

As with the display board last month it is advisable to wire up the keyboard logic a section at a time, testing each block before proceeding. In this way small mistakes can be easily discovered and dealt with before they become buried in several different circuit blocks.

Almost all the logic can be tested at the wiring stage without undue complication, outputs being monitored with a multimeter or by connecting them temporarily to the display board input if desired. If the latter course is chosen remember that the display board requires an inverted B.C.D. input, which while easily accommodating the decimal point outputs and function code outputs, will require temporary connection to the $\overline{Q}$ rather than the Q outputs of the figure latches for correct display.

The clock pulse output is long enough to be detected on a meter which is an advantage for tests of this type, the EQUALS triggered START pulse is however far too short to be detected in this way but fortunately this part of the circuit is quite simple and can be left unchecked at this stage.

Next month: Entry Register (constant store, entry register and multiplexer)

POINTS ARISING

SQUARE WAVE GENERATOR ***(Sept. 1972)***

In the lower half of Fig. 6, the connections for the switch should read as follows reading from top to bottom:

(a) Top group is S1b numbered 1,2,3,W,4;
(b) Bottom group is S1a numbered 4,3,2,1;
(c) S1b wiper should read S1a wiper.

NEWS BRIEFS

TECHNICAL INFORMATION SERVICE

A NEW technical information service, aimed at giving firms, corporate bodies, instructors, students, and others engaged in educational work, advice on correct electrical installation practice according to I.E.E. "Regulations" has been established by the National Inspection Council for Electrical Installation Contracting.

The service is confined to technical matters and excludes advice on commercial or trading aspects, industrial or labour relations, and information relating to manufacturers' products.

The aim is to promote a high standard of installation and maintenance safety of electrical wiring and appliances. The subscription fee is £3·50 per year to cover the services offered. Further information is available from the Council at Trafalgar Buildings, 1 Charing Cross Road, London SW1A 2DT.

NEW POCKET CALCULATOR

WHAT is claimed to be the world's smallest electronic calculator has just been announced by the British company Sinclair Radionics Ltd. At only just over ¼in thick and 5½in × 2in this can really claim to be a pocket sized calculator.

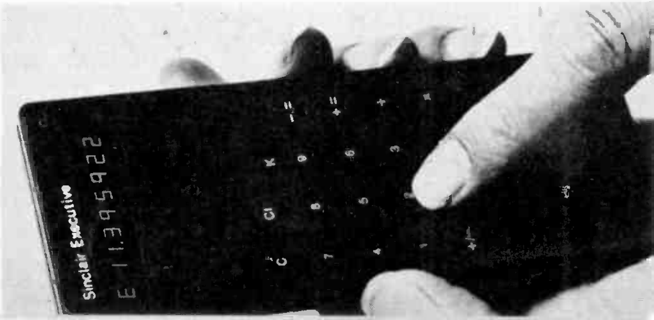
Known as the Sinclair Executive this calculator embodies many new techniques. Firstly the single MOS chip which forms the calculator consumes a mere 20 mW of power making it possible to run the whole machine from three mercury cells of the type used in hearing aids. This is made possible by switching off the i.c. completely between clock pulses relying on the capacitance of the MOS elements to store the information. Secondly the clock rate is reduced when the calculator is not performing a calculation so as to conserve power.

The battery voltage is just sufficient to drive the display thus eliminating the usual dropper resistors which consume power.

The keyboard was specially developed for the calculator being only 4mm in depth. The contacts are gold plated and the keys are arranged so that it is virtually impossible to touch two at the same time.

The L.E.D. display has a capacity of eight digits. The calculator can perform all the usual arithmetic functions as well as automatic squaring, reciprocals and can operate in either fixed or floating decimal point mode. It also has a memory for calculations with a predetermined factor.

Although at £79 this calculator is not the cheapest on the market, it must pose quite a threat to the present Japanese domination of the calculator field.



report from AUSTRALIA

BY J. M. WALDIE

In this report, the main theme will be the audio scene, which again should be of interest to intending migrants and visitors.

Audiophiles here have a very large range of components from which to choose; it is likely that the range encountered in the average store will be greater than in a similar situation in the U.K. The possession of a respectable audio system, at least in the large cities, appears to be the rule rather than the exception, despite the "outdoor life" philosophy of the average Australian.

LOCAL PRODUCTS

The number of companies producing audio systems is relatively small. There are about six brands of Australian-made amplifiers (including Leak and Philips); only two very simple belt-driven turntables are produced here; I understand that there are only two locally produced reel-to-reel recorders and only one cassette system. There are, of course, several brands of "mid-Fi" modular grams and radiograms, including such brands as Kreisler (division of Philips); AWA (Amalgamated Wireless Australia), Thorn, Pye and HMV.

IMPORT TRADE

However, there is sufficient industry to warrant relatively high import surcharges—designed to protect local manufacturers (which, in some areas, are non-existant). Despite this, Japanese equipment dominates the retail trade, followed by British, German, Scandinavian and — to an increasing degree — American audio components.

For example, of the 30,000 reel-to-reel mains-operated recorders and decks imported in 1970–71, 26,000 came from Japan. Some $A 2 million worth (F.O.B. values) of amplifiers also arrived in the same period, of which well over half also came from Japan, and approximately one-quarter (in terms of value) from the U.K.

The British, however, have the lion's share of the turntable market: of the 200,000 units imported in the year ending June 1971, 176,000 came from the U.K. This is largely due to the practice of installing Garrard and BSR decks in mass-produced "unit-audio" systems.

There is a very wide range of loudspeakers—both imported and home-grown—available, and the Australian audiophile has a bewildering selection from which to choose. There are three locally-made brands of any consequence, and some very presentable designs have been issued. Japanese cabinets again dominate the imported systems. It is in this area that the Americans have been active, promoting the more expensive brands such as JBL, A.R., Marantz and Advent.

QUADRAPHONY

Largely due to the Japanese dominance in Australia in the audio field (Japan is one of Australia's largest customers for ore and coal; consequently the trade relations between the companies are maintained at a very close level), the current interest among audiophiles is the idea of 4-channel sound.

The battle between proponents for the CD-4 discrete system of quadraphonic disc reproduction (JVC/National/RCA) and the various matrix methods for obtaining more or less the same result (dominated by Sony's SQ system), is now in full swing.

Records produced by both methods are now available; the record manufacturers appear to be taking sides but showing apparent preference for the matrix method. It has been announced, for example, that EMI, with CBS, have opted for the Sony SQ system, but the decision to market SQ records will depend on demand. This demand will presumably originate from new owners of SQ equipment, but who would buy such equipment without a guaranteed source of quadraphonic records?

This chicken-and-egg situation is likely to delay still further the final decision. On the other side of the fence, aurally speaking, RCA have announced, in America, that eventually all records issued by that particular stable will be "in discrete" quadraphony, a move that must be followed not only here but world-wide. And to confuse matters even more, according to local sources of information, A&M records are being matrixed to the Sansui QS method (not necessarily compatible with Sony's SQ) and two big German companies, Polydor and Deutsche Grammophon, are opting for a discrete system not necessarily similar to JVC/Nivico.

Record manufacturers I spoke to locally all indicated that the outlook was in such confusion that nobody really knows what is happening next.

ORIENTAL CUSTOM

Australian audiophiles may have an extensive selection of audio equipment available but they don't grow on trees. For English equipment, the list retail price is likely to be double that in the U.K. For example, a Garrard Zero 100 deck has a list price here of $A 269 (about £120) which compares with the U.K. list price of £54. On the other hand, the difference in price of Japanese equipment is very much less; a Sansui SD 5000 deck is listed here at $A 756 (£345) which compares to £328 in the U.K.

This, of course, explains to some extent why Japanese equipment is so popular. However, we not only import oriental equipment but, to some extent, their methods of selling; it is usual to "haggle" over prices and the published list prices are something of a myth. Moreover, it is always possible to "trade-in" an article, which might not even be electrical.

COLOUR TELEVISION

It was recently announced that Australia will "go colour" in March 1975. The system to be adopted will be the 625-line PAL format and all four Sydney stations (1 national, 3 commercial) are in the process of preparing their studios and transmitting equipment.

The manufacturers, however, are treating the news with some trepidation; on the one hand, it could be regarded as a shot in the arm for the electronics industry, but a real concern is being expressed regarding imported receivers which, at the current import rates, could possibly be landed and sold at prices below those expected for locally-produced sets.

The matter will be discussed with the Tariff Board, who decide the magnitude of import duties applicable to any imports. And there are a number of critics who feel that, at an anticipated price of £500 for a 25in set, the sales to Australians, who for the most part regard television as a distraction rather than as a necessary part of life, may just not warrant the large initial outlay.

NEXT MONTH

SPECIAL SUPPLEMENT

Electronic MUSICAL INSTRUMENTS

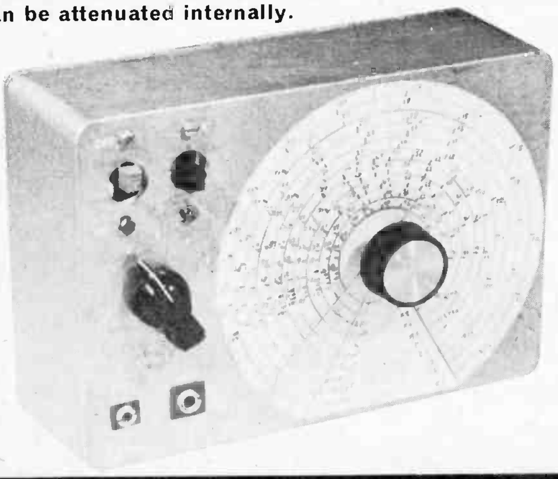
A SURVEY OF THE COMMERCIAL SCENE

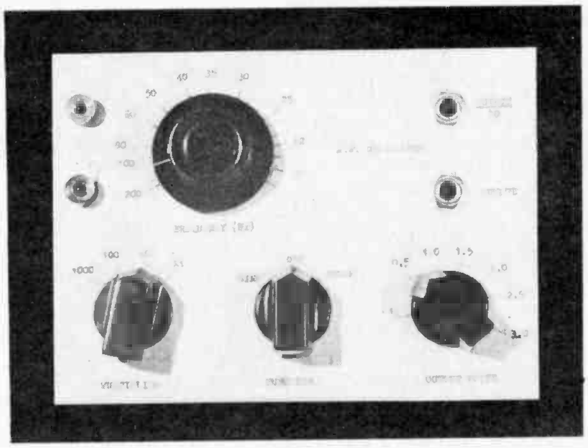
- ORGANS
- GUITARS
- EFFECTS UNITS
- SYNTHESISERS

A.F. SIGNAL GENERATOR

For checking and measuring the characteristics of audio equipment, including frequency response, distortion, power output, signal to noise ratio, and dynamic range, one of the most important aids is an a.f. signal generator.

This instrument provides a sine wave output in the frequency range 19Hz to 200kHz in four bands. Square wave pulses from 19Hz to 20kHz are also available. Maximum output is just over 1V r.m.s. and can be attenuated internally.





SIMPLE C-R BRIDGE

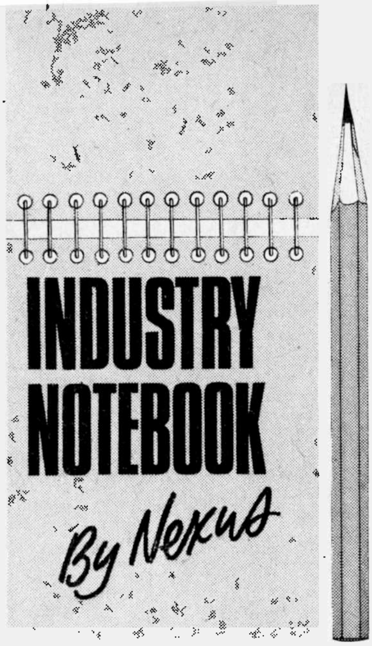
Ever had the frustration of finding a capacitor or resistor whose only fault is that the marked value is indecipherable? Now your problems can be over with this simple C-R Bridge.

Values of resistor or capacitors can be determined simply by turning a pointer until the signal from an audio generator is reduced to a minimum.

There is no meter so the unit is inexpensive and robust. The components are readily available and the instrument is easy to construct.

PRACTICAL ELECTRONICS

NOVEMBER ISSUE ON SALE OCTOBER 13



VALUE ON THE BRIDGE

There was a bumper gathering of 300 delegates at the I.E.E. conference on *Advances in Marine Navigational Aids*. They came from all over the world to hear and discuss 55 papers.

It was a heady occasion embracing just about every navigation technique all the way from visual aids (the earliest known lighthouse was at Alexandria about 265 B.C.) to such twentieth century exotica as "System of location of balloons, ships or buoys by means of a low-orbiting satellite".

For the student of marine electronics the occasion was fascination itself. For the practical mariner, expected to foot the bill for equipment as well as understand and evaluate all the rival and complementary systems available, it was more like a nightmare.

The Chief Marine Superintendent of the B.P. Tanker Company Ltd., Mr R. Maybourn, put his finger on the shipowner's problem in his paper "Cost benefit and related factors—a shipowner's point of view". A navigation outfit for a modern tanker has an installed cost of almost £45,000 using fairly conventional equipment. Using some of the sophisticated systems described at the conference could result in a doubling of the cost with only dubious advantages.

EXOTIC IDEAS

Mr Maybourn criticised the electronics industry for developing expensive and exotic ideas without adequate reference to the shipowners, and which are not clearly related to adequately defined problems or needs. He suggested that we often seem to have the solution first and the problem becomes one of finding a need to which to match it.

On computerised anti-collision systems, he wondered whether the problem had been adequately identified or even if the current problem is being solved. He referred to the computer as something which mesmerises the electronics engineer "itching to use its spare capacity in much the same way as an idle hand does a work study practitioner".

What Mr Maybourn asked of the industry was for far more reliability in existing equipment, and some element of standard design in equipment in regard to dimensions, methods of fitting and presentation of data which, he said, was chaotic and certainly would not be tolerated in the aircraft industry.

This point of view deserves some sympathy but should be examined in an historical perspective. Most of the exciting new concepts such as satellite navigation and the v.l.f. Omega system have their origin in military developments as, indeed, did marine radar and Decca Navigator before them. These last two items are now accepted as standard fit and comparatively inexpensive aids. What Mr Maybourn and the shipping industry are getting is the best of both worlds.

HIGH RELIABILITY

If the electronics industry demonstrated anything at all at the Conference it was that today's technology is available with high reliability and at a bargain price, while tomorrow's technology is being seriously considered and will be available in due course to merchant shipping at a fair price.

Timing is terribly important. The Marconi "Predictor" anti-collision radar system has been available for four years, yet less than a dozen have been sold. It was, and is, a brilliant example of electronic engineering and necessarily expensive. Decca Radar brought out a simple anti-collision radar with limited capability about the same time at about half the price and have sold some 700 equipments. It was what the shipowner wanted at a price he could afford. But the outlook for "Predictor" remains bright and Marconi still expect it to do well. It was only the timing that was seriously adrift.

TOUGH COMPETITION

On the other hand, you don't need to invent new technology to invent new systems. I was at the inauguration of the Southampton Harbour Radar system, said to be the finest in Europe if not in the whole world. I searched in vain for completely new technology in both the operations room and the equipment areas. Decca Radar, the prime contractors, hád done a wonderful systems engineering job using off-the-shelf equipment freely available on the open market.

I was also at the unveiling of a new marine radar display concept introduced by Kelvin Hughes and reviewed at the Conference by marine consultant Captain J. P. Stewart. The system uses television techniques and is a notable advance, yet the only device in any way unusual for a radar is a light-sensitive "image retaining panel". This panel has been commercially available for ten years but nobody had apparently thought of using it in a radar application until Kelvin Hughes originated the idea.

What is worrying the marine electronics industry is an unrealistic pricing policy. Competition is so severe that few companies are making sufficient money to support future civil (as distinct from naval) R and D at a reasonable level.

TXE2 TAKES TO THE ROAD

The Post Office is always fair game for the knockers and I have knocked away in my time with the best of 'em. SDS Components Ltd, the Portsmouth-based component distributors have gone one step further than knocking by abandoning postal delivery and employing Securicor to make all deliveries.

But the Post Office is not all that bad, although you might still think so when out driving and you get stuck behind one of the eighty or so 27ft long trailers now being built to house mobile electronic telephone exchanges. Each of these will house a Plessey TXE2 equipment and will be on the move to a site where 1,000 would-be telephone subscribers can stop biting their nails with frustration and get hooked into the network.

The Post Office already has 250 mobile exchanges of conventional types but these can only handle 400 lines each. The TXE2 electronic exchange in two trailers can handle 1,000 and a dual installation housed in three trailers will serve 2,000 subscribers.

Deliveries commence next May and the investment by the Post Office is £3 million. At least they are trying to keep pace with a demand that seems insatiable.

GOONHILLY 3

I was sorry to see that the 10th anniversary of the Post Office satellite station at Goonhilly Downs passed with so little notice. The occasion was marked by the inauguration of Goonhilly 3 making the station the busiest satellite terminal in Europe.

It seems more than ten years since we were all startled by *Telstar 1* and *Relay* before *Early Bird*, the first of the *Intelsat* satellites, really got going with a full commercial service.

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ONLY 95p

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TELEPHONE DIALS

Standard Post Office type. Guaranteed in working order.

ONLY 50p

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TESTED AND GUARANTEED PAKS

B2	4	Photo Cells, Sun Batteries. 0·3 to 0·5V, 0·5 to 2mA	50p
B79	4	IN4007 Sil. Rec. diodes. 1,000 PIV 1 amp. plastic	50p
B81	10	Reed Switches, mixed types large and small	50p
B99	200	Mixed Capacitors. Approx. quantity, counted by weight	50p
H4	250	Mixed Resistors. Approx. quantity counted by weight	50p
H7	40	Wirewound Resistors. Mixed types and values	50p
H8	4	BY127 Sil. Recs. 1000 PIV 1 amp. plastic	50p
H9	2	OCP71 Light Sensitive Photo Transistor	50p
H12	50	NKT155/259 Germ. diodes, brand new stock clearance	50p
H28	20	OC200/1/2/3 PNP Silicon uncoded TO-5 can	50p
H30	20	1 Watt Zener Diodes, Mixed Voltages 6·8–43V	50p
H35	100	Mixed Diodes, Germ. Gold bonded, etc. Marked and Unmarked	50p
H38	30	Short lead Transistors, NPN Silicon Planar types	50p

UNMARKED UNTESTED PACKS

B1	50	Germanium Transistors PNP, AF and RF	50p
B66	150	Germanium Diodes Min. glass type	50p
B83	200	Trans. manufacturers' rejects all types NPN, PNP, Sil. and Germ.	50p
B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	50p
B86	50	Sil. Diodes sub. min. IN914 and IN916 types	50p
B88	50	Sil. Trans. NPN, PNP equiv. to OC200/1 2N706A, BSY95A, etc.	50p
H6	40	250mW. Zener Diodes DO-7 Min. Glass Type	50p
H15	30	Top Hat Silicon Rectifiers, 750mA. Mixed volts	50p
H16	8	Experimenters' Pak of Integrated Circuits. Data supplied	50p
H17	20	3 amp. Silicon Stud Rectifiers, mixed volts	50p
H20	20	BY126/7 Type Silicon Rectifiers 1 amp. plastic. Mixed volts	50p
H34	15	Power Transistors, PNP, Germ. NPN Silicon TO-3 Can	50p

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TYPE "A" PNP Silicon alloy, TO-5 can.
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	£p		£p
AC107	0·15	OC170	0·23
AC126	0·15	OC171	0·23
AC127	0·17	OC200	0·25
AC128	0·15	OC201	0·25
AC176	0·20	2N1302-3	0·15
ACY17	0·20	2N1304-5	0·17
AF239	0·30	2N1306-7	0·20
AF186	0·20	2N1308-9	0·22
BC148	0·10	2N3819FET	0·40
BC154	0·20	2N4416FET	0·35
BC107	0·10		
BC108	0·10	**Power**	
BC109	0·10	**Transistors**	
BC169	0·12	OC20	0·40
BF194	0·15	OC23	0·25
BF274	0·20	OC25	0·25
BFY50	0·15	OC26	0·25
BSY25	0·13	OC28	0·30
BSY26	0·13	OC35	0·25
BSY27	0·13	OC36	0·37
BSY28	0·13	AD149	0·35
BSY29	0·13	AUY10	0·75
BSY95A	0·10	2S034	0·25
OC41	0·15	2N3055	0·40
OC44	0·13		
OC45	0·10	**Diodes**	
OC71	0·10	AAY42	0·10
OC72	0·10	OA95	0·07
OC81	0·13	OA79	0·07
OC81D	0·13		
OC83	0·18	OA81	0·07
OC139	0·13	OA95	0·07
OC140	0·15	IN914	0·06

F.E.T. PRICE BREAKTHROUGH!!

This field effect transistor is the 2N3823 in a plastic encapsulation, coded as 3823E. It is also an excellent replacement for the 2N3819. Data sheet supplied with device. 1-10 **30p** each, 10-50 **25p** each, 50+**20p** each.

A CROSS HATCH GENERATOR FOR £3·50!!!

YES, a complete kit of parts including Printed Circuit Board. A four position switch gives X-hatch, Dots, Vertical or Horizontal lines. Integrated Circuit design for easy construction and reliability. This is a project in the September edition of Practical Television.

This complete kit of parts costs £3·50, post paid.

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Quantity	*1–10*	*10-50*	*50+*
BB105 Varicap Diodes	10p	8p	6p
OC71 or 72 Fully Tested Unmarked	5p	5p	4p
Matched Sets 1–OC44 and 2–OC45's. Per Set.	25p	20p	15p
Matched Sets of OC45's 1st and 2nd IF	15p	12p	10p
OA47 Gold-Bonded Diodes, Marked and Tested	3p	3p	2p
1-watt Zener Diodes 7·5, 24, 27, 30, 36, 43 Volts	5p	4p	3p
10-watt Zener Diodes 5·1, 8·2, 11, 13, 16, 24, 100 Volts	20p	17p	15p
Micro Switches, S/P, C/O	25p	20p	15p
1-amp Bridge Rec's 25-volt	25p	22p	20p

INTEGRATED CIRCUITS

Quantity	*1-10*	*10-50*	*50+*
SL403D Audio Amp., 3-watts	£1·50	£1·37	£1·32
709C Linear Opp. Amp.	25p	20p	15p
Gates, Factory Marked and Tested by A.E.I.	25p	22p	20p
J. K. Flip-Flops Factory, Marked and Tested by A.E.I	40p	35p	30p
SN7490 Decade Counter	65p	60p	55p
UL914 Dual 2 I/P Gate	40p	35p	30p

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PATENTS REVIEW...

MOVEMENT DETECTOR

BP 1 267 194

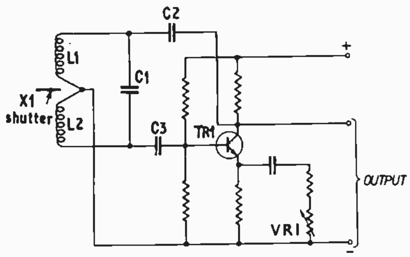


Fig. 1

British Patent 1 267 194 from Rotameter Manufacturing Co Ltd describes a simple but probably very effective circuit for sensing and registering very small physical movements of objects.

The basic circuit is shown in Fig. 1 and relies on a Hartley oscillator with two magnetically coupled inductors L1, L2, a bridging capacitor C1 and d.c. blocking capacitors C2, C3. The variable resistor VR1 controls, along with the mutual inductance of inductors L1, L2, the amplitude of the circuit oscillations. The frequency of the oscillations depends upon the values chosen for the inductors L1, L2 and capacitor C1.

A small shutter X1, formed from non-magnetic but electrically conductive material (e.g. copper, brass, etc), is movable into and out of a small gap which is left between the magnetically coupled ends of the inductors L1, L2.

If the object whose movement is to be sensed is mechanically coupled to the shutter, then any movement, however slight, will cause a change in the amplitude of oscillation. This change may in some cases be reasonably linear.

By amplifying TR1 output a direct dial readout can be obtained or, alternatively, the amplified output can be fed to a "pot coil" electromagnet arranged to apply a restoring force to the object which has moved. This restoring force will tend to move everything back to the original or null position, i.e. seek equilibrium in this state.

Component values are suggested which will detect and register a 0·025mm movement with a transistor output change of 200 millivolts.

ELECTRONIC SPEEDOMETER

In conventional electronic speedometers there is sometimes a problem in raising sufficient control voltage to not only display the speed, but also record the maximum speed obtained. Mechanical systems can introduce an inaccuracy of around 15 per cent which can be hopeless when the engine speeds are in the order of 10,000 r.p.m.

Porsche KG now claim (BP 1 254 486) a form of electronic speedometer which should be free from such problems. In Fig. 1 Porsche show how pulses derived from the ignition coil (at a frequency directly proportional to the engine speed) are shaped, integrated by the filter circuit and fed via the servo amplifier to a reversible servo motor. This motor drives the speedometer pointer through gearing to provide a direct readout indication of speed.

The car battery voltage is fed to the stabiliser to give a stabilised output voltage which is fed to the shaper and is also tapped by the servo motor to provide a feedback voltage to the servo amplifier. The servo motor also drives a maximum speed indicator through a ratchet which can be released for zeroing by a spring loaded button.

If it is thought wise, and safe, to provide an automatic switch-off for the engine, e.g., to avoid stripping the car gears, the speed voltage signal at the filter can be compared by the critical speed circuit with a predetermined limiting value to operate an ignition interrupter switch.

Instead of sensing pulses derived from the ignition coil, an independent inductor associated with the engine shaft can be used to produce the necessary pulses.

PATENT ACTIVITY IN THE OPTICAL FIBRE FIELD

At least two different uses for light fibres in motor cars have now been patented by Joseph Lucas (Industries) Ltd.

In the first patent, published a few months ago (BP 1 258 395) Lucas described and claimed as novel the use of a light fibre with one end set in the door frame and the other behind a dashboard warning indicator. The door itself carries a mirror which is arranged so that light is reflected from a lamp into the doorframe end of the fibre only when the door is closed. Light thus emerges from the other end of the fibre to illuminate the dashboard indicator when the door is safe.

In their more recent patent (BP 1 264 325) Lucas claim as novel, the use of fibres extending variously from all the crucial car driving lights (headlights, sidelights, etc.) to various dashboard instruments. Thus any unlit instrument on the dashboard is a fail-safe signal of an extinguished driving light.

The above patents are only reported briefly, because they are technically simple. But in view of recent published correspondence on this topic they may be interesting references for anyone working in the field. Incidentally, it should be borne in mind that although the patents have only recently been published, they were applied for several years ago.

BP 1 254 486

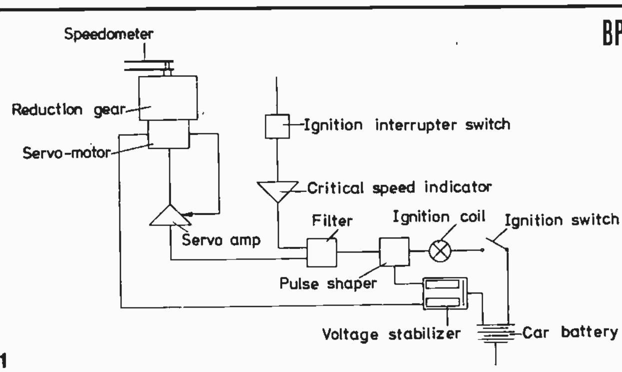


Fig. 1

MARKET PLACE

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

FIRE ALARM KIT

The new fire regulations require all properties which provide overnight accommodation for more than six people to be fitted with an acceptable fire alarm system. To meet this need **Ramick Security Services** have developed a new "Fire Alarm Kit" complete with instruction and wiring diagram to enable the handyman or an electrician to install a system for the smaller size hotel or boarding house.

The kit costs £30 complete and comprises a Control Unit; Heatswitch; Preswitch; Testswitch and a 12V d.c. 4in gong alarm bell.

The control unit operates from the mains a.c. supply but the voltage to the sensors is only 12V d.c. A battery is incorporated in the unit together with an automatic changeover circuit so that in the event of a mains failure the installation remains operative and changes back to a.c. supply when reconnected.

Whenever the alarm bell rings it continues until the control unit is reset manually. The control unit is contained in a pressed steel case, suitable for wall mounting, and has a mains indicator light and an on/off switch on the front panel.

The Heatswitch is a bi-metallic switch with a combined rate of rise and fixed temperature automatic fire detector to B.S. 3116. The contacts close when the temperature reaches 135°F (57°C) or if there is an unusally rapid increase in temperature. The unit can be mounted in any position and provides coverage of approximately 500 square feet per heatswitch.

The Preswitch is a push button unit with a cast aluminium front plate and can be supplied for surface mounting or flush mounting. Breaking the glass front operates the button which activates the alarm.

The Testswitch has a manually biased push button and indicator light complete with housing and is designed for fitting at the end of the twin wire circuit connecting the sensors to the control unit. When the switch is operated the indicator light is energised (and remains energised until the control unit is reset) and the control circuit, external wiring and alarm bell is checked.

Further details can be obtained from Ramick Security Services, The Lodge, Randalls Road, Leatherhead, Surrey.

PRINTED CIRCUIT BOARDS

Sometime ago we mentioned a versatile printed circuit board called Nippiboard marketed by **NIP Electronics.**

Although these boards have proved very successful, from the response of users they seem to suffer from two limitations. These limitations are that the boards are not pre-drilled and, more important, do not take integrated circuits.

Now, NIP Electronics have introduced a new range of boards called "NIP-E-Boards." These boards are available pre-drilled and are suitable for transistor circuits, integrated circuit designs or a combination of both.

The integrated circuit range of boards were designed in order to cater for the vast expansion of component manufacture in standardised DIL packages, such as relays, readout devices, as well as integrated circuits and transistor arrays.

All boards are made from s.r.b.p. or glass fibre and are available predrilled or undrilled according to choice.

The designs of the boards are such that they will all accept edge connectors; a range of card handles, stand-off mounting pillars, and edge connectors is also available.

Further details and prices of the NIP-E-System can be obtained from NIP Electronics, P.O. Box 11, St. Albans, Herts.

POCKET METER

Readers should find the TS-60R Multimeter from **West Hyde Developments** an excellent purchase.

This pocket multimeter makes no pretentions to be up to professional standard but still covers most ranges needed for checking out the majority of circuits published in this magazine.

The meter movement is a 1000Ω/V type and the ranges covered are: a.c. voltages 0-15V, 0-150V, 0-1000V; d.c. voltages 0-15V, 0-150V, 0-1000V; d.c. current 1mA, 150mA; resistance 100kΩ. A feature of the meter is the "printed circuit" rotary switch.

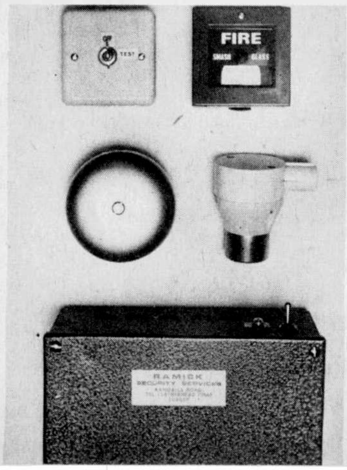
The meter costs only £2 and in the event of a meter breakdown it is probably cheaper to throw it away and buy a replacement, whereas with the more expensive counterpart it would cost more to repair than the purchase price of the TS-60R.

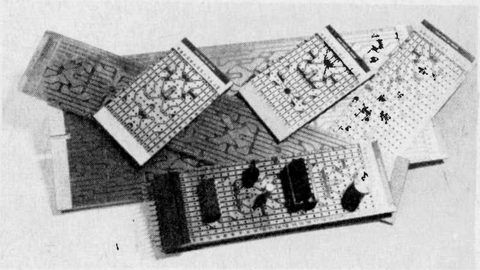
Further details of the TS-60R multimeter can be obtained from West Hyde Developments Ltd., Ryefield Crescent, Northwood Hills, Northwood, Middlesex.

Whilst on meters, a comprehensive range of Avometer spare parts is always held in stock by **Instrument Services** and they are able to offer a rapid Avometer repair and recalibration service.

Complete refurbishing to "as new" is claimed to take approximately seven days. The company also offers a similar service to users of G.E.C. "Selectest" and "Minitest" instruments.

Further information of the meter repair service can be obtained from Instrument Services Company (London) Ltd., 208 Maybank Road, London E18.

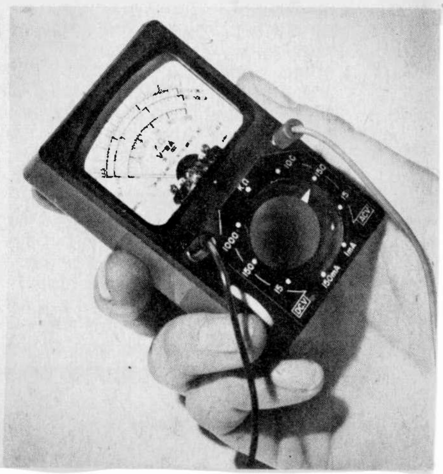




(above) NIP-E-Boards from NIP Electronics

(left) Ramick Fire Alarm Kit

(right) TS-60R Multimeter from West Hyde



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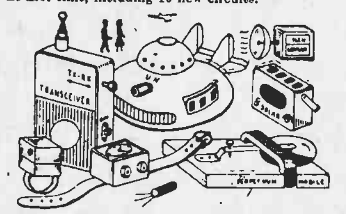

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Readout— A SELECTION FROM OUR POSTBAG

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.

Strong objection

Sir—I object strongly to the article *Digi-Cal.* Whilst I can understand people building their own electric organ or colour TV, I am sure nobody with any sense will build this machine at £110. These calculators can be purchased from about £60. Further to this, the cost of a simple counter with Nixie tube readout is approx. £5 per unit, i.e. with a six digit readout this section is approx. £30. Careful design should therefore give a complete calculator for £60. Still not worth making.

As a "Practical" magazine the very least I would expect is for articles to be practical propositions.

G. A. Bobker,
Unsworth, Bury, Lancs.

I am sorry to hear that Mr Bobker objects so strongly to the *Digi-Cal* series, and though in the light of the latest developments in the field of m.o.s. technology I can sympathise with his comments on price differential, his letter does point to one very important advantage of these current articles.

The logic operations involved in any calculator are necessarily complex, and the new "single-chip" devices are valuable simply because the complex logic has been "wired-up" entirely by the i.c. manufacturer. Mr Bobker's concept of a calculator made from SN7490's and Nixies shows, I am afraid, a lamentable grasp of the way machines of this type operate, and since he himself is active in the circuit design field he could learn a tremendous amount about logic in general and calculating circuits in particular by following the *Digi-Cal* series. I am sure many readers will be glad of the chance to delve into this interesting and relevant field of electronics before the rapid march of technology reduces us all to mindless "wirer-uppers" of a circuit which can be built in half an hour but which is far too involved to be explained to "mere amateurs".

It does seem to be true that calculators are going the way of medium-wave transistor pocket radios, where the vast quantities which can be sold reduce prices to a level where amateur designs are difficult to justify on economic grounds, and to those readers who want a cheap calculator to use immediately without knowing what makes it tick, I can thoroughly recommend the new ready made machines available from retailers at low cost.

For those of us who also want to know what's going on inside, I hope *Digi-Cal* will help. After all, now that single-chip organs, f.m. tuners, and even computers are with us, it may be our last chance.

—R. W. Coles.

What is the point?

Sir—Over the years I have successfully constructed many of the circuits published in P.E. The amount of enjoyment derived from assembling these projects has been twofold. Firstly, the satisfaction of building something with one's hands and seeing it working and secondly, knowing you have saved quite a bit doing it.

Therefore when you announced the P.E. *Digi-Cal,* which is the sort of project right up my street, I could hardly wait for the August issue to get cracking. Imagine my dismay at seeing the total cost as being approx. £110 when one can buy a ready built article to the same specification for £43·25.

Even if your design had cost the same I would have built it for the satisfaction to be obtained, but I cannot see anyone wanting to construct Digi-Cal with such a price difference. So really, what is the point of publishing a design like that.

This is my only criticism so far of an otherwise excellent magazine which I have taken since it first came out.

Brian Harrison,
Settle, Yorks.

Beyond reason

Sir—I have been reading PRACTICAL ELECTRONICS since its inception in November 1964 and on average consider about 50 per cent of the constructional projects of interest to me (not that that figure relates to the quantity constructed!). But aren't we getting a little above ourselves with the introduction of a project to build an electronic calculator?

Now I am not one to decry the technical capabilities of your readers (quite the opposite) but what astounds me is the cost. Your author quotes a bulk component cost £110 yet one can buy an equally sophisticated machine (with all the trimmings like leading zero suppression, floating DP, constant key, etc.) for £56 and no extras like replacing over-soldered transistors or mis-wired ic's!

My point, to which I laboriously come, is *what is the function of the constructional feature?* I think it should be a medium through which constructors can promulgate their brainchildren so that readers can build a piece of equipment which is impossible to buy either because it is prohibitively expensive or because no manufacturer's specification matches that of the constructors. The intrinsic pleasure of building is enhanced when one notices that there are still pennies in the pocket.

Come on P.E. Continue to disseminate the superb features that you do but let us keep our exuberant competition with the pros within the bounds of reason.

J. E. Barrett,
London, S.W.6.

We recognise and understand the bewilderment caused to some readers because of the relatively high cost of building the P.E. Digi-Cal. This very creditable project provides a dramatic illustration of the far-reaching effects of rapid and stupendous advances in technology. See Editorial Comment, page 817.

Advance information

Sir—Could you please inform me if it is possible to purchase a full copy of PRACTICAL ELECTRONICS,

Readout—
A SELECTION FROM OUR POSTBAG

Digi-Cal drawings and layout diagrams in advance, so that our apprentices may build as a project this very interesting and useful unit.

We would also like to know if it is possible to extend the readout to ten digits without more complex circuitry.

The advance purchase of the drawings, etc. will in no way effect our desire for obtaining further copies of PRACTICAL ELECTRONICS every month. As the Instructor in this Apprentice School I advocate all our electrical apprentices to get this magazine as it is so useful to them. For myself I have every copy since November 1964 having read ninety per cent of their contents (including—"Pleased to meet you") and all these have been bound into books year by year.

G. Bolsover,
Apprentice School,
Perkins Engines Co.,
Peterborough.

This is not an uncommon request, but we must explain that it is just not possible to supply either individuals or organisations with full details of constructional projects prior to publication in the magazine. The division of the text for all major projects is carefully planned and the various parts of such articles presented in the most logical sequence to permit the construction work to proceed steadily, month by month.

Regarding your second point, the existing design cannot be readily modified to accommodate the extra i.c.'s and other components required to increase the readout as suggested.

P.E. Scorpio ignition system

Sir—I have installed the P.E. Scorpio ignition system in a car to which I had previously fitted an impulse tachometer.

The instrument is a "Smiths" for which the fitting instructions refer to models 1T4, 1T4C and 1T6. I have connected it into the lead from the coil to capacitors C6/C7 (tag 5) as suggested in *Readout*, March issue.

Some of your readers may be interested to know that this appears to work satisfactorily.

H. R. M. Foster,
Beverley,
Yorks.

Logic identifier

Sir—With reference to Mr T. P. Schofield's "Logic Semiconductor Identifier" in the July issue.

Mr Schofield recommends the use of 7440's as lamp driving logic. Although these have a normalised fan-out of 30, I would recommend the use of 7407's. The latter are hex. buffer/drivers, capable of sinking 40mA per buffer, and their cost per package is less than the average price of one 2N1305 of which four are required in the equipment as designed.

Fig. 1 shows the use of a 7407 device in the circuit.

P. Lockerby,
Nelson, Lancs.

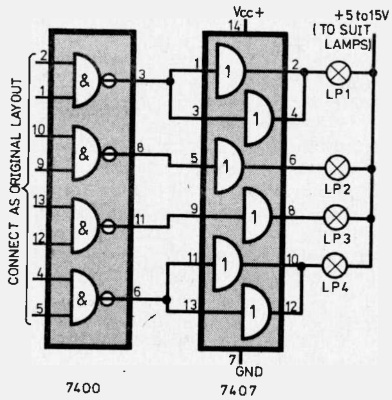

Fig. 1. Suggested circuit for a logic identifier. Note two pairs of buffers are paralleled solely to save tying unused inputs with resistors

Live wire

Sir—Mr W. A. Rawcliffe (the exceptional caravanner—July *Readout*) seems to have forgotten that PRACTICAL ELECTRONICS readers pride themselves in their ingenuity.

Having reached the same conclusion as W. A. R. that some indication was required that the flasher bulbs had not gone open circuit, I very simply wound 300 turns of 24 gauge plastic covered wire (about 30 feet) on to an old P.O. 3000 relay former and wired it in series with the extra "live" lead he talks about.

This gives ample magnetism to operate the relay and through it contacts an additional pilot lamp on the dashboard while at the same time having a resistance of less than ½Ω, drops less than 1 volt in doing so—thus not affecting the brightness of the flasher bulb by any noticeable amount.

This system could also be easily adapted for brake light if anyone should so decide and slightly less turns on the former would indicate when only one brake light has gone open circuit ! !

H. G. Hearn,
Sussex.

Be specific

Sir—I have been reading PRACTICAL ELECTRONICS for two years now, and find it difficult to obtain many of the parts specified in your constructional projects. This applies particularly to transistors, as a lot of your work is done around "Ferranti" transistors, which I cannot find at reasonable prices in Australia. Equivalents lists are a great help, as most of the transistors I want are either not listed, or have a CV equivalent only, or a type which is itself out of production, or otherwise unavailable here.

I think that the publication of the characteristics of the transistors used, specifying any necessary parameters, e.g. power dissipation, maximum and minimum beta, and so on, and then go on to give one or two examples. Perhaps when "or similar" appears, you might like to put a few "or similars".

This practice is not confined to transistors, so please don't specify a specific component, just its characteristics and tolerances on those characteristics.

A. Wright,
New South Wales,
Australia.

Wigan radio club

Sir—I would be obliged if you could find space in P.E. to publicise the forthcoming formation of the Wigan and District Amateur Radio Society.

A temporary committee has been set up and I would like to hear from prospective members.

V. T. Brooks,
8, Sutherland Road,
Worsley Mesnes,
Wigan, Lancs.

COURSES . . .

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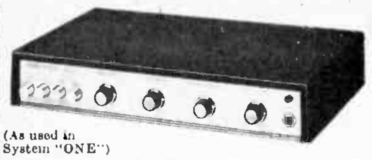

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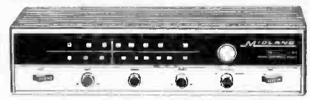

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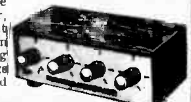

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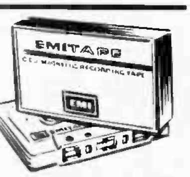

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2N3819	0·25	BC184L	0·11
2N4286	0·15	BC212L	0·14
2N4289	0·15	BD130	0·65
2N4443	0·88	BD131	0·77
2N5062	0·42	BD132	0·81
2N5088	0·46	BD135	0·25
2N5192	0·77	BD136	0·27
2N5195	0·90	BDY20	0·97
2N5457	0·30	BFY51	0·20
40361	0·45	BRY39	0·30
40362	0·45	BY164	0·45
40432	1·60	MJ481	1·20
40512	1·79	MJ491	1·35
40669	1·20	MJE3055	0·68
AC128	0·26	OA91	0·06
AD142	0·50	OC35	0·63
AD149	0·68	S2CN1	0·12
AD161	0·42	SD4	0·09
AD162	0·40	TO3 Transistor covers, ea.	7p

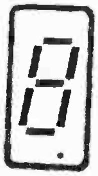
RESISTORS 10%—5%—2%

Code	Power	Tolerance	Range in ohms	Values	1 to 9	10 to 99	100 up (see note below)
C	1/20W	5%	82–220K	E12	9	8	7
C	1/8W	5%	4·7–470K	E24	1	0·8	0·7
C	1/4W	10%	4·7–10M	E12	1	0·8	0·7
C	1/2W	5%	4·7–10M	E24	1·2	1	0·9
C	1W	5%	4·7–10M	E12	2·5	2	1·9
MO	1/2W	2%	10–1M	E24	4	3	2 net
WW	1W	10% ±1/20Ω	0·22–3·9	E12	7	7	6
WW	3W	5%	1–10K	E12	7	7	6
WW	7W	5%	1–10K	E12	9	9	8

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

Values:
E12 denotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades. E24: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 72, 91 and their decades. Prices *are in pence each for same ohmic value and power rating, NOT mixed values.* (*Ignore fractions of* 1p *on total value of resistor order.*)

Minitron DIGITAL INDICATOR



TYPE 3015F Seven segment indicator compatible with standard logic modules and power supplies. Figs. 0–9 from well illuminated filament segments to give character of 9mm height plus decimal point. Power requirement 8mA from 5V d.c. per segment. A limited number of alphabetical symbols also available. In 16 lead DIL case **£2**

Suitable BCD decoder driver type FLL121T nett **£1·36**

DIL Socket; 16 lead 30p. No. 3015G showing + or — and fig. 1 and decimal point £2.

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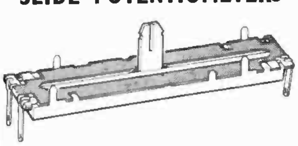
Resistors by Rivlin, 0·1% to 0·01%, £1 to £2. Capacitors by MFD, 0·1 μF to 22 μF, 70p to £3·50. *Prices and delivery times on request.*

SLIDE POTENTIOMETERS



Robust construction, smooth silent action. In values from 4k7Ω to 1MΩ, linear or log, 26p each. Escutcheon, light grey, 10p.

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PUBLICATIONS

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FLH191 (7402)	20p	FLJ151 (7475)	45p
FLH291 (7403)	20p	FLJ131 (7476)	45p
FLH211 (7404)	25p	FLH221 (7480)	68p
FLH271 (7405)	25p	FLH281 (7482)	87p
FLH381 (7408)	25p	FLH241 (7483)	1·32
FLH391 (7409)	25p	FLH341 (7486)	33p
FLH111 (7410)	20p	FLJ161 (7490)	80p
FLH351 (7413)	35p	FLJ221 (7491A)	1·28
FLH121 (7420)	20p	FLJ171 (7492)	85p
FLH181 (7430)	20p	FLJ181 (7493)	80p
FLH141 (7440)	24p	FLJ231 (7494)	1·13
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FLJ111 (7472)	32p		

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47/50, 47/63, 100/35, 220/16, 8p each; 100/50, 220/35, 10p each; 100/63, 470/25, 1000/10, 12p each; 220/63, 470/35, 1000/16, 17p each; 1000/25, 20p each; 470/63, 1000/35, 23p each; 2200/25, 36p each; 1000/63, 2200/35, 4700/16, 40p each.

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SN7425	0·48	0·42	SN74109	1·06	0·93
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SN7486	0·45	0·40	SN74191	1·95	1·75
SN7488	12·40	11·80	SN74192	1·70	1·50
SN7489	4·97	4·40	SN74193	1·70	1·50
SN7490	0·80	0·75	SN74194	2·00	1·80
SN7491	1·20	1·00	SN74195	2·00	1·80
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CA3004	2·26	1·86	CA3047	1·59	1·31
CA3005	1·50	1·24	CA3047A	2·92	2·41
CA3006	3·47	2·86	CA3048	2·34	1·93
CA3007	3·28	2·71	CA3049	1·96	1·62
CA3008	1·98	1·64	CA3050	2·28	1·88
CA3008A	3·24	2·67	CA4051	1·73	1·43
CA3010	0·56	0·47	CA4052	1·80	1·48
CA3010A	0·69	0·57	CA3053	0·52	0·43
CA3011	0·92	0·76	CA3054	1·19	0·98
CA3012	1·11	0·91	CA3058	3·32	2·74
CA3013	1·30	1·07	CA3059	1·84	1·52
CA3014	1·52	1·26	CA3060AD		
CA3015	1·40	1·15		3·47	2·86
CA3015A	1·82	1·50	CA3060BD		
CA3016	2·61	2·15		5·93	4·89
CA3016A	3·90	3·22	CA3060D	4·70	3·88
CA3018	0·88	0·72	CA3060E	2·74	2·26
CA3018A	1·19	0·98	CA3062	2·97	2·45
CA3019	0·94	0·78	CA3064	1·42	1·17
CA3020	1·55	1·28	CA3065	1·42	1·17
CA3020A	2·01	1·65	CA3066	2·61	2·15
CA3021	1·90	1·57	CA3067	2·72	2·24
CA3022	1·61	1·33	CA3068	3·01	2·48
CA3023	1·55	1·28	CA3070	2·15	1·78
CA3026	1·25	1·03	CA3071	2·01	1·65
CA3028A	0·88	0·72	CA3072	2·07	1·71
CA3028B	1·17	0·97	CA3075	1·46	1·21
CA3029	0·52	0·43	CA3076	1·67	1·38
CA3029A	0·63	0·52	CA3078AT		
CA3030	1·08	0·89		4·68	3·86
CA3030A	1·64	1·35	CA3078T	2·80	2·31
CA3033	2·92	2·41	CA3079	0·94	0·78
CA3033A	4·93	4·07	CA3080	0·58	0·48
CA3035	1·52	1·26	CA3080A	1·90	1·57
CA3035V1	1·52	1·26	CA3081	1·80	1·48
CA3036	0·90	0·74	CA3082	1·80	1·48
CA3037	1·68	1·39	CA3083	1·36	1·12
CA3037A	2·60	2·14	CA3084	1·71	1·41
CA3038	2·60	2·14	CA3085	0·94	0·78
CA3038A	3·40	2·80	CA3085A	1·44	1·19
CA3039	1·00	0·83	CA3085B	3·78	3·12
CA3040	2·95	2·43	CA3086	0·46	0·38
CA3041	1·30	1·07	CA3088E	1·38	1·14
CA3042	1·30	1·07	CA3089E	2·18	1·80
CA3043	1·73	1·43	CA3090Q	4·70	3·88
CA3044	1·42	1·17			

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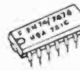

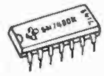

Type	1/11 p	12/24 p	25/99 p
SN7400	0·20	0·18	0·16
SN7401	0·20	0·18	0·16
SN7402	0·20	0·18	0·16
SN7403	0·20	0·18	0·16
SN7404	0·20	0·18	0·16
SN7405	0·20	0·18	0·16
SN7406	0·30	0·27	0·25
SN7407	0·30	0·27	0·25
SN7408	0·20	0·19	0·18
SN7409	0·45	0·42	0·35
SN7410	0·20	0·18	0·16
SN7411	0·23	0·22	0·20
SN7412	0·42	0·40	0·35
SN7413	0·30	0·27	0·25
SN7416	0·30	0·27	0·25
SN7417	0·30	0·27	0·25
SN7420	0·20	0·18	0·16
SN7422	0·48	0·44	0·40
SN7423	0·48	0·44	0·40
SN7425	0·48	0·40	0·35
SN7427	0·42	0·39	0·35
SN7428	0·50	0·45	0·42
SN7430	0·20	0·18	0·16
SN7432	0·42	0·39	0·35
SN7433	0·70	0·61	0·44
SN7437	0·65	0·60	0·50
SN7438	0·65	0·60	0·50
SN7440	0·20	0·18	0·16
SN7441AN	0·75	0·72	0·70
SN7442	0·75	0·72	0·70
SN7443	1·00	0·95	0·90
SN7445	2·00	1·75	1·60
SN7446	2·00	1·75	1·60
SN7447	1·75	1·60	1·45
SN7448	1·75	1·60	1·45

Type	1/11 p	12/24 p	25/99 p
SN7450	0·20	0·18	0·16
SN7451	0·20	0·18	0·16
SN7453	0·20	0·18	0·16
SN7454	0·20	0·18	0·16
SN7460	0·20	0·18	0·16
SN7470	0·30	0·27	0·25
SN7472	0·30	0·27	0·25
SN7473	0·40	0·37	0·35
SN7474	0·40	0·37	0·35
SN7475	0·55	0·52	0·50
SN7476	0·45	0·42	0·39
SN7480	0·80	0·75	0·67
SN7481	1·25	1·15	1·10
SN7482	0·87	0·80	0·70
SN7483	1·00	0·90	0·85
SN7484	0·90	0·85	0·80
SN7486	0·45	0·41	0·38
SN7490	0·75	0·70	0·65
SN7491AN	1·00	0·95	0·90
SN7492	0·75	0·70	0·65
SN7493	0·75	0·70	0·65
SN7494	0·80	0·75	0·70
SN7495	0·80	0·75	0·70
SN7496	1·00	0·97	0·95
SN7497	6·25	5·50	5·00
SN74100	2·50	2·30	2·00
SN74104	1·45	1·35	1·20
SN74105	1·45	1·35	1·20
SN74107	0·50	0·45	0·40
SN74110	0·80	0·70	0·60
SN74118	1·00	0·95	0·90
SN74119	1·90	1·78	1·65
SN74121	0·60	0·55	0·50
SN74122	1·35	1·25	1·10
SN74123	2·70	2·55	2·47
SN74141	1·00	0·95	0·90

Type	1/11 p	12/24 p	25/99 p
SN74145	1·50	1·40	1·30
SN74150	3·35	2·95	2·15
SN74151	1·10	0·95	0·90
SN74153	1·35	1·27	1·20
SN74154	2·00	1·75	1·55
SN74155	1·55	1·47	1·35
SN74156	1·55	1·47	1·35
SN74157	1·80	1·70	1·50
SN74160	2·60	2·40	2·25
SN74161	2·60	2·40	2·25
SN74162	3·40	3·25	2·70
SN74163	3·40	3·25	2·70
SN74164	2·75	2·30	2·10
SN74165	4·00	3·50	3·00
SN74166	4·00	3·50	3·00
SN74167	6·25	5·60	5·10
SN74170	4·10	3·55	3·05
SN74174	2·00	1·75	1·30
SN74175	1·35	1·27	1·15
SN74176	1·60	1·35	1·20
SN74177	1·60	1·35	1·20
SN74180	1·55	1·30	1·20
SN74181	7·00	6·00	5·50
SN74182	2·00	1·80	1·60
SN74184	2·40	2·00	1·80
SN74185A	2·40	2·00	1·80
SN74190	1·95	1·85	1·75
SN74191	1·95	1·85	1·75
SN74192	2·00	1·90	1·80
SN74193	2·00	1·90	1·80
SN74194	2·50	2·25	1·90
SN74195	1·85	1·70	1·60
SN74196	1·50	1·40	1·30
SN74197	1·50	1·40	1·30
SN74198	4·60	3·70	3·35
SN74199	4·60	3·70	3·35

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1 amp miniature		
IN4001	50	6
IN4002	100	7
IN4003	200	8
IN4004	400	8
IN4005	600	10
IN4006	800	12
IN4007	1000	15
1·5 amp miniature		
PL4001	50	8
PL4002	100	9
PL4003	200	10
PL4004	400	10
PL4005	600	12
PL4006	800	15
PL4007	1000	16

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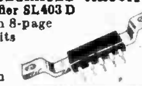

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SC40E	500	£1·20
10 AMP RANGE (TO48)		
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SC45B	200	£1·00
SC45D	400	£1·25
SC45E	500	£1·45
15 AMP RANGE (TO48)		
SC50A	100	£1·25
SC50B	200	£1·35
SC50D	400	£1·65
SC50E	500	£1·85

DIAC D32 25p
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40430 (TO66) 85p
40669 (Plastic) £1·00
40486 (TO5) 80p

3 Amp T048

15 Amp T048

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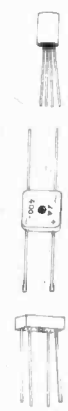
Type	Volts P.I.V.	Price 1-11
HALF AMP		
BO5/05	50	20p
BO5/10	100	25p
ONE AMP ¼ × ¾ H TUBULAR		
B1/05	50	25p
B1/10	100	25p
B1/20	200	30p
B1/60	600	35p
ONE AMP (G.I.) TUBULAR		
W005	50	30p
W01	100	35p
W02	200	40p
W06	600	45p
TWO AMPS ½ H × ½ L × 3/16		
B2/05	50	35p
B2/100	100	40p
B2/200	200	45p
B2/600	600	50p
B2/1000	1000	60p
FOUR AMPS ½H × ½L × 3/16		
B4/100	100	60p
B4/200	200	65p
B4/400	400	70p
B4/600	600	75p
B4/800	800	£1·00
SIX AMPS ½H × ½L × 3/16		
B6/100	100	70p
B6/200	200	75p
B6/400	400	90p
B6/600	600	£1·00



SILICON CONTROLLED RECTIFIERS

Type	Volts P.I.V.	Price 1-11
ONE AMP		
CRS 1/05	50	25p
CRS 1/10	100	30p
CRS 1/20	200	30p
CRS 1/40	400	35p
CRS 1/60	600	45p
THREE AMP (TO48)		
CRS 3/05	50	30p
CRS 3/10	100	30p
CRS 3/20	200	35p
CRS 3/40	400	45p
CRS 3/60	600	55p
FIVE AMP (TO66)		
CRS 5/400	400	60p
SEVEN AMP (TO48)		
CRS 7/100	100	60p
CRS 7/200	200	65p
CRS 7/400	400	70p
CRS 7/600	600	95p
SIXTEEN AMP		
SCR 16/100	100	65p
SCR 16/200	200	70p
SCR 16/400	400	80p
SCR 16/600	600	£1·00

1 Amp T05

3 Amp T048

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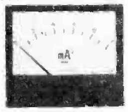
50-0-50µA	£3·45	1mA	£3·10
100µA	£3·45	20V d.c.	£3·10
100-0-100µA	£3·35	50V d.c.	£3·10
		300V d.c.	£3·10
		1A d.c.	£3·10
		5A d.c.	£3·10
		300V a.c.	£3·10
		VU Meter	£3·75

BAKELITE PANEL METERS

TYPE S-80
80 mm square fronts



50µA	£3·20	1A d.c.	£2·60
50-0-50µA	£3·10	5A d.c.	£2·60
100µA	£3·10	300V a.c.	£2·60
100-0-100µA	£3·00	VU Meter	£3·37
500µA	£2·75		
1mA	£2·60		
20V d.c.	£2·60		
50V d.c.	£2·60		
300V d.c.	£2·60		

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100µA	£3·10	500mA	£2·80
100-0-100µA	£3·00	1A	£2·80
200µA	£3·00	5A	£2·80
500µA	£2·90	15A	£2·80
500-0-500µA	£2·80	30A	£2·80
1mA	£2·80	20V d.c.	£2·80
1-0-1mA	£2·80	50V d.c.	£2·80
5mA	£2·80	150V d.c.	£2·80
10mA	£2·80	300V d.c.	£2·80
		15V a.c.	£2·80
		300V a.c.	£2·80
		S Meter 1mA	£2·87
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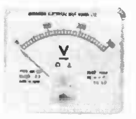
		30A a.c.*	£2·80

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



50µA	£2·10	150mA	£1·60
50-0-50µA	£1·90	200mA	£1·60
100µA	£1·90	300mA	£1·60
100-0-100µA	£1·75	500mA	£1·60
200µA	£1·75	750mA	£1·60
500µA	£1·65	1A	£1·60
500-0-500µA	£1·60	2A	£1·60
1mA	£1·60	5A	£1·60
1-0-1mA	£1·60	10A	£1·60
2mA	£1·60	3V d.c.	£1·60
5mA	£1·60	10V d.c.	£1·60
10mA	£1·60	15V d.c.	£1·60
20mA	£1·60	20V d.c.	£1·60
50mA	£1·60	100V d.c.	£1·60
100mA	£1·60	150V d.c.	£1·60
		300V d.c.	£1·60
		500V d.c.	£1·60
		750V d.c.	£1·60
		15V a.c.	£1·70
		50V a.c.	£1·70
		150V a.c.	£1·70
		300V a.c.	£1·70
		500V a.c.	£1·70
		S Meter 1mA	£1·70
		VU meter	£2·10

Type MR.52P. 2½in square fronts.

50µA	£3·10	20V d.c.	£2·00
50-0-50µA	£2·60	50V d.c.	£2·00
100µA	£2·60	300V d.c.	£2·00
100-0-100µA	£2·50	15V a.c.	£2·10
500µA	£2·30	300V a.c.	£2·10
1mA	£2·00	S Meter 1mA	£2·10
5mA	£2·00	VU Meter	£3·20
10mA	£2·00	1A a.c.*	£2·00
50mA	£2·00	5A a.c.*	£2·00
100mA	£2·00	10A a.c.*	£2·00
500mA	£2·00	20A a.c.*	£2·00
1A	£2·00	30A a.c.*	£2·00
5A	£2·00		
10V d.c.	£2·00		

Type MR.45P. 2in square fronts.

50µA	£2·25	10V d.c.	£1·70
50-0-50µA	£2·10	20V d.c.	£1·70
100µA	£2·10	50V d.c.	£1·70
100-0-100µA	£1·87	300V d.c.	£1·70
200µA	£1·87	15V a.c.	£1·80
500µA	£1·75	300V a.c.	£1·80
500-0-500µA	£1·70	S Meter 1mA	£1·85
1mA	£1·70	VU Meter	£2·25
5mA	£1·70	1A a.c.*	£1·70
10mA	£1·70	5A a.c.*	£1·70
50mA	£1·70	10A a.c.*	£1·70
100mA	£1·70	20A a.c.*	£1·70
500mA	£1·70	30A a.c.*	£1·70
1A	£1·70		
5A	£1·70		

Type MR.65P. 3½in × 3½in fronts.

50µA	£3·37	20V d.c.	£2·20
50-0-50µA	£2·75	50V d.c.	£2·20
100µA	£2·75	150V d.c.	£2·20
100-0-100µA	£2·65	300V d.c.	£2·20
200µA	£2·65	15V a.c.	£2·30
500µA	£2·40	50V a.c.	£2·30
500-0-500µA	£2·20	150V a.c.	£2·30
1mA	£2·20	300V a.c.	£2·30
5mA	£2·20	500V a.c.	£2·30
10mA	£2·20	S Meter 1mA	£2·37
50mA	£2·20	VU meter	£3·37
100mA	£2·20	50mA a.c.*	£2·20
500mA	£2·20	100mA a.c.*	£2·20
1A	£2·20	200mA a.c.*	£2·20
5A	£2·20	500mA a.c.*	£2·20
10A	£2·20	1A a.c.*	£2·20
15A	£2·20	5A a.c.*	£2·20
20A	£2·20	10A a.c.*	£2·20
30A	£2·30	20A a.c.*	£2·20
50A	£2·50	30A a.c.*	£2·20
5V d.c.	£2·20		
10V d.c.	£2·20		

"SEW" BAKELITE PANEL METERS

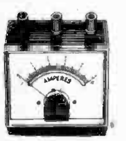
Type MR.65 3½in square fronts.

25µA	£3·50	500mA	£1·95
50µA	£2·37	1A	£1·95
50-0-50µA	£2·35	2A	£1·95
100µA	£2·35	5A	£1·95
100-0-100µA	£2·25	15A	£1·95
500µA	£2·20	30A	£1·95
1mA	£1·95	50A	£1·95
1-0-1mA	£1·95	5V d.c.	£1·95
5mA	£1·95	10V d.c.	£1·95
10mA	£1·95	20V d.c.	£1·95
50mA	£1·95	50V d.c.	£1·95
100mA	£1·95	150V d.c.	£1·95
		300V d.c.	£1·95
		30V a.c.*	£1·95
		50V a.c.*	£1·95
		150V a.c.*	£1·95
		300V a.c.*	£1·95
		500mA a.c.*	£1·95
		1A a.c.*	£1·95
		5A a.c.*	£1·95
		10A a.c.*	£1·95
		20A a.c.*	£1·95
		30A a.c.*	£1·95
		50A a.c.*	£1·95
		VU meter	£3·10

*MOVING IRON — ALL OTHERS MOVING COIL

Please add postage

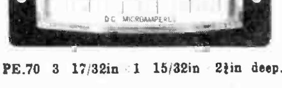
"SEW" EDUCATIONAL METERS



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	£5·00	20V d.c.	£4·40
100µA	£4·65	50V d.c.	£4·40
1mA	£4·40	300V d.c.	£4·40
50-0-50µA	£4·65	Dual range	
1-0-1mA	£4·40	500mA/5A d.c.	£4·65
1A d.c.	£4·40	5V/50V d.c.	£4·65
5A d.c.	£4·40		
10V d.c.	£4·40		

EDGEWISE METERS

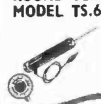


PE.70 3 17/32in × 1 15/32in × 2¼in deep.

50µA	£3·10	500µA	£2·75
50-0-50µA	£3·00	1mA	£3·45
100µA	£3·00	300V a.c.	£3·45
100-0-100µA	£2·90	VU meter	£3·40
200µA	£2·90		

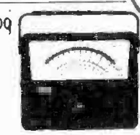
MULTIMETERS *for EVERY purpose!*

ROUND SCALE TYPE PENCIL TESTER MODEL TS.68



Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V AC and DC at 2,000 o.p.v. Resistance 0-20K ohms. ONLY £1·97. P. & P. 13p.

SKYWOOD SW-500

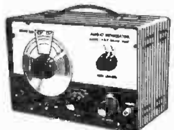


50 K Ω/Volt. Mirror scale DC Volts 0.6/3/12/30/300/600. AC Volts 3/30/300/600. DC Current 20uA/6/60/600mA. Resistance 10K/100K/1Meg/10 Meg. Decibels —20 to +57dB. £7·50. P. & P. 15p.

TMK LAB TESTER.

100,000 O.P.V. 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 × 6½in × 3¼in. £18·90. P. & P. 25p.

TE22 SINE SQUARE WAVE AUDIO GENERATORS



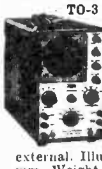
Sine: 20c/s to 200 kc/s on 4 bands. Square: 20c/s to 30 kc/s. Output impedance 5,000 ohms. 200/250V a.c. Supplied brand new and guaranteed with instruction manual and leads. £17·50. Carr. 37½p.

TE-20RF SIGNAL GENERATOR

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.

TO-3 PORTABLE OSCILLOSCOPE

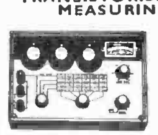


3in tube. Y amp. Sensitivity 0·1V p-p/CM. Bandwidth 1·5 cps-1·5MHz. Input imp. 2megΩ 25pF X amp. sensitivity 0·9V -800KHz. Input imp. 2 megΩ 20pF. Time base, 5 ranges 10cps-300KHz. Synchronisation. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½lb 220/240V a.c. Supplied brand new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

240° WIDE ANGLE 1mA METERS

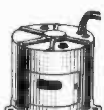
MW1·6 60mm square £3·97½. MW1·8 80mm square £4·97½. P. & P. extra.

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



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

230/240V SMITHS SYNCHRONOUS MOTORS



Built in gearbox. All brand new and boxed. 60RPM CW; 30RPH CW; 2R/HR ACW; 2R/HR CW; 8R/DAY CW; 10RPM CW; 20R/HR ACW;
50p each. Post 12p

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 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.

MODEL 500.

30,000 O.P.V. with overload protection, mirror scale 0/·5/2·5/10/25/100/250/500/1,000 V d.c. 0/2·5/10/25/100/250/500/1,000 V. a.c. 0/50 µA/5/50/500 mA. 12 amp. d.c. 0/60K/6 Meg./60 MegΩ. £8·87½. Post paid.

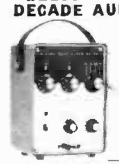
MODEL 5025.

57 ranges, giant 5½in 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.

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.

BELCO DA-20 SOLID STATE DECADE AUDIO OSCILLATOR



New high quality portable instrument. Sine 1Hz to 100kHz. Square 20Hz to 20kHz. Output max. +10dB (10kΩ). Operation 220/240V a.c. Size 215mm × 150mm × 120mm. Price £27·50. Carr 25p.

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: 5¼in. × 2 13/16in. × 8 3/16in AVAILABLE BRAND NEW AND FULLY GUARANTEED.
£35.00 Carr. 50p

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

SEMI-CONDUCTORS/VALVES

ALL DEVICES BRAND NEW AND FULLY GUARANTEED

Transistors

Type	Price
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2G302	20p
2G303	20p
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2G308	30p
2G309	30p
2G371	15p
2G374	20p
2G381	22p
2N388A	49p
2N404	20p
2N696	15p
2N697	15p
2N698	25p
2N699	30p
2N706	10p
2N706A	12p
2N708	15p
2N709	62p
2N718	25p
2N718A	30p
2N726	30p
2N727	30p
2N914	17p
2N916	17p
2N918	30p
2N929	22p
2N930	20p
2N987	40p
2N1090	22p
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2N1639	27p
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2N1893	37p
2N2147	72p
2N2160	57p
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2N2220	25p
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2N2222	20p
2N2222A	25p
2N2297	30p
2N2368	15p
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2N2484	32p
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2N2540	22p
2N2613	35p
2N2614	[illegible]
2N2646	40p
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2N2712	25p
2N2713	27p
2N2714	30p
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2N2906A	25p
2N2907	23p
2N2923	15p
2N2924	15p
2N2925	15p
2N2926G	10p
2N2926O	10p
2N2926Y	10p
2N3011	20p
2N3014	[illegible]
2N3053	18p
2N3054	[illegible]
2N3055	60p
2N3133	30p
2N3134	30p
2N3135	25p
2N3136	25p
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2N3405	45p
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2N3605	27p
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2N3638A	20p
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2N3713	187p
2N3714	200p
2N3715	123p
2N3716	130p
2N3773	240p
2N3791	[illegible]
2N3819	34p
2N3820	55p
2N3823	50p
2N3854	27p
2N3854A	27p
2N3855	27p
2N3855A	30p
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2N3856A	35p
2N3858	25p
2N3858A	30p
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2N3859A	32p
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2N3866	150p
2N3877	40p
2N3877A	40p
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2N3900A	40p
2N3901	97p
2N3903	20p
2N3904	25p
2N3905	30p
2N3906	25p
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2N4061	12p
2N4062	12p
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2N4255	42p
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2N4288	15p
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2N4291	15p
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2N4294	17p
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2N5249	67p
2N5265	325p
2N5305	37p
2N5306	40p
2N5307	37p
2N5308	37p
2N5309	62p
2N5310	42p
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2N5355	27p
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2N5367	57p
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Type	Price
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2S103	25p
2S104	25p
2S301	50p
2S302	50p
2S303	60p
2S304	75p
2S501	32p
2S502	35p
2S503	27p
3N83	40p
3N128	70p
3N140	77p
3N141	72p
3N142	55p
3N143	67p
3N152	87p
40050	55p
40250	50p
40251	32p
40309	32p
40310	45p
40311	35p
40312	47p
40314	37p
40315	37p
40316	47p
40317	37p
40319	55p
40320	47p
40323	32p
40324	47p
40326	37p
40329	30p
40344	27p
40347	57p
40348	52p
40360	40p
40361	40p
40362	50p
40370	32p
40406	57p
40407	40p
40408	52p
40409	55p
40410	62p
40412	[illegible]
40467A	57p
40468A	35p
40528	[illegible]
40600	57p
40603	50p
AC107	30p
AC126	20p
AC127	24p
AC128	20p
AC151	18p
AC152	22p
AC154	22p
AC176	20p
AC187	[illegible]
AC188	25p
ACY17	27p
ACY18	24p
ACY19	24p
ACY20	20p
ACY21	20p
ACY22	10p
ACY28	17p
ACY39	47p
ACY40	20p
ACY41	15p
ACY44	25p
AD140	47p
AD149	47p
AD150	62p
AD161	35p
AD162	35p
AF109	45p
AF114	25p
AF115	25p
AF116	25p
AF117	20p
AF118	60p
AF121	30p
AF124	22p
AF125	19p
AF126	19p
AF127	16p
AF139	28p
AF178	42p
AF179	45p
AF180	50p
AF181	40p
AF186	[illegible]
AF239	30p
AF279	[illegible]
AF280	47p
AFZ11	32p
ASY26	25p
ASY27	30p
ASY28	24p
ASY29	27p
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
BC126	20p
BC134	12p
BC135	12p
BC136	15p
BC137	15p
BC138	20p
BC140	35p
BC141	35p
BC147	10p
BC148	10p
BC149	12p
BC152	17p
BC153	20p
BC154	20p
BC157	15p
BC158	11p
BC159	12p
BC160	35p
BC167	11p
BC168B	10p
BC168C	11p
BC169B	11p
BC169C	12p
BC170	12p
BC171	15p
BC172	15p
BC175	22p
BC177	20p
BC178	20p
BC179	20p
BC182	10p
BC182L	10p
BC183	9p
BC183L	9p
BC184	11p
BC184L	11p
BC186	25p
BC187	27p
BC212L	12p
BC213L	12p
BC214L	15p
BCY10	27p
BCY30	27p
BCY31	30p
BCY32	50p
BCY33	25p
BCY34	30p
BCY38	40p
BCY39	60p
BCY40	50p
BCY41	15p
BCY42	15p
BCY43	15p
BCY54	32p
BCY58	22p
BCY59	22p
BCY60	[illegible]
BCY70	[illegible]
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	[illegible]
BF115	25p
BF117	[illegible]
BF152	28p
BF154	20p
BF158	15p
BF159	35p
BF163	35p
BF167	18p
BF170	33p
BF173	19p
BF177	30p
BF178	25p
BF179	30p
BF180	35p
BF181	32p
BF182	30p
BF184	20p
BF185	20p
BF194	15p
BF195	15p
BF196	15p
BF197	15p
BF198	15p
BF200	35p
BF224	14p
BF225	19p
BF237	22p
BF238	22p
BF244	23p
BFW61	47p
BFW87	25p
BFW88	23p
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	30p
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	47p
BSX28	20p
BSX60	82p
BSX61	62p
BSX76	15p
BSX77	20p
BSX78	25p
BSY24	15p
BSY25	15p
BSY26	17p
BSY27	15p
BSY28	17p
BSY29	17p
BSY32	25p
BSY36	25p
BSY37	25p
BSY38	20p
BSY39	22p
BSY43	50p
BSY51	20p
BSY52	32p
BSY53	37p
BSY54	40p
BSY56	90p
BSY79	45p
BSY90	57p
BSY95A	12p
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	80p
MJE370	80p
MJE371	80p
MJE520	60p
MJE521	70p
MPF102	42p
MPF103	35p
MPF104	37p
MPF105	37p
MP83638	32p
NKT124	42p
NKT125	27p
NKT126	27p
NKT128	27p
NKT135	27p
NKT137	32p
NKT210	30p
NKT211	30p
NKT212	30p
NKT213	30p
NKT214	20p
NKT215	22p
NKT216	35p
NKT217	40p

Type	Price
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NKT223	27p
NKT224	22p
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
NKT272	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
NKT734	27p
NKT736	35p
NKT773	25p
NKT781	30p
OC16	50p
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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	15p
OC71	12p
OC72	12p
OC73	30p
OC74	30p
OC75	22p
OC76	22p
OC77	30p
OC78	20p
OC81	20p
OC81D	20p
OC82	25p
OC82D	25p
OC83	25p
OC84	25p
OC139	25p
OC140	32p
OC170	25p
OC171	30p
OC200	40p
OC201	60p
OC202	75p
OC203	40p
OC204	40p
OC205	75p
OC206	95p
OC207	75p
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ORP12	50p
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TI843	40p
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TI846	11p
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TI848	12p
TI849	12p
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CA3021	156p
CA3022	130p
CA3023	126p
CA3026	100p
CA3028A	74p
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CA3029	87p
CA3029A	165p
CA3030	137p
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
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SN7417	84p
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SN7495	87p
SN7496	87p
SN74107	52p
SN74153	135p
SN74154	200p
SN74160	180p
SN74161	260p
SN74164	220p
SN74165	225p
SN74192	175p
SN74193	175p
TAA241	162p
TAA242	425p
TAA243	150p
TAA263	75p
TAA293	97p
TAA300	175p
TAA310	125p
TAA320	72p
TAA350	175p
TAA435	147p
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TAA522	360p
TAA530	495p
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100PIV 2A	50p
200PIV 2A	55p
400PIV 2A	60p
50PIV 4A	40p
100PIV 4A	[illegible]
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400PIV 4A	65p
600PIV 4A	70p
50PIV 6A	45p
100PIV 6A	55p
200PIV 6A	65p
400PIV 6A	75p
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4002 100PIV	7p	9p	[illegible]
4003 200PIV	8p	10p	22p
4004 400PIV	8p	10p	25p
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3·3–33V	2·4–100V	3·9–100V
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6BR7	90p
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6BW6	85p
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6CD6	125p
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6F15	65p
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6SJ7	40p
6SK7	40p
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6SN7	35p
6SQ7	40p
6U4	65p
6V6G	25p
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12BA6	40p
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Type	Price
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30FL1	75p
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30FL14	95p
30L15	85p
30L17	80p
30P12	80p
30P19	85p
30PL1	75p
30PL13	93p
30PL14	90p
35L6	50p
35W4	35p
35Z4	35p
35Z5	50p
50B5	50p
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807	50p
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DK96	50p
DL92	35p
DL94	48p
DL96	45p
DM70	40p
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DY87	33p
E88CC	100p
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EAF42	35p
EB91	20p
EBC41	55p
EBC81	30p
EBF80	40p
EBF83	40p
EBF89	32p
EBL21	60p
EC86	60p
EC88	60p
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ECF82	35p
ECF86	65p
ECH21	57p
ECH35	100p
ECH42	75p
ECH81	30p
ECH83	45p
ECL80	45p
ECL82	35p
ECL83	70p
ECL86	40p
EF37A	120p
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EF40	50p
EF41	65p
EF42	70p
EF80	25p
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EF89	28p
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PCC84	40p
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PCC88	55p
PCC89	50p
PCC189	55p
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PCL82	35p
PCL83	65p
PCL84	45p
PCL85	40p
PCL86	45p
PFL200	65p
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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
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UBF89	35p
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UCC85	40p
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BY164	52p
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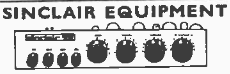

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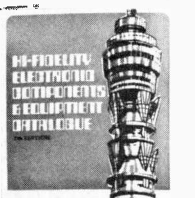

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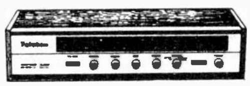

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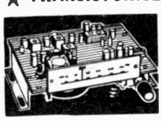

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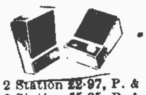

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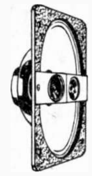

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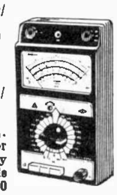

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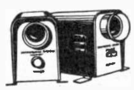

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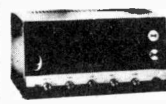

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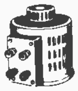

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100V	0·47μF	10p	25V	100μF	9p
100V	0·68μF	15p	25V	220μF	11p
			25V	470μF	14p
250V	0·01μF	5p	25V	1,000μF	22p
250V	0·015μF	5p	25V	2,200μF	42p
250V	0·022μF	5p	35V	4·7μF	7p
250V	0·033μF	6p	35V	220μF	14p
250V	0·047μF	6p	100V	10μF	8p
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BC147	8p	7p	NKT223	26p	20p	2N1302	16p	15p
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BC149	8p	7p	NKT242	14p	12p	2N1613	14p	13p
BCY70	14p	13p	NKT243	51p	44p	2N1711	15p	14p
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6·4	50	3p	1000	50	35p
10	40	4p	2000	12	10p
16	15	3p	2500	12	10p
25	15	3p	2500	25	30p
25	25	3p	2000	25	20p
32	50	4p			
40	6	3p	Panel Neon Red		
50	10	3p	Int. Res. 240V		
50	50	7p			15p
64	10	4p			
64	15	4p	IN4001		6p
64	25	4p	IN4002		7p
64	40	5p	IN4003		8p
100	6	3p	IN4004		9p
100	50	8p	IN914		6p
250	6	4p	2N706		10p
250	10	4p	2N708		13p
250	15	6p	2N1303		17p
250	25	8p	2N3866		80p
400	10	5p	2N3055		60p
500	10	5p	BC108		11p
500	12	8p	BCY30		[illegible]
500	25	10p	BFY51		20p
500	50	12p	BSX21		[illegible]
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pF	V	
40	750	2p
75	750	2p
100	750	2p
120	750	2p
220	750	2p
1000	50	2½p
4700	30	2p
0·01	30	3p
0·01	350	2p
0·022	30	2p
0·047	30	2p

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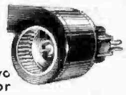
6	6, 12, 20V at 20A	£6·88	55p
7	24V at 10A	£5·23	45p
8	4, 6, 24, 32V at 12A	£7·15	45p
9	6 and 12V at 10A	£3·75	45p

220/240 VOLT A.C. CENTRIFUGAL FAN/BLOWER

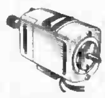


Smooth, balanced running unit. Two pole shaded pole Mycalex motor gives approximately 90 cubic ft./min. but draws only 240mA on run. Weight 2½lb. Case dia. 3·1in, width (case only) 3·125in, width overall (inc. motor) 5·25in, aperture 3·125in × 1·85in. Price only £2·95. P. & P. 25p.

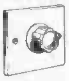
12 VOLT D.C. MOTOR

Powerful 1 amp. REVERSIBLE motor. Speed 3,750 r.p.m. complete with external gear train (removable) giving approx. final speed of either 125 r.p.m. or 240 r.p.m. Size: 4½in × 2½in dia. Either type price 95p inc. post.

PARVALUX TYPE SD2. 200/250 VOLT A.C./D.C. HIGH SPEED MOTOR



Speed 9,000 r.p.m. approx. or 3,200 r.p.m. if used with built-in governor, or variable speed over a wide range if used in conjunction with our Dimmer Switch, illustrated below. PRICE £1·75. P. & P. 25p.

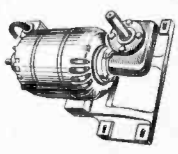


600 WATT DIMMER SWITCH. Easily fitted. Fully guaranteed by makers. Will control up to 600W of all lights except fluorescent at mains voltage. Complete with simple instructions. £3 incl. P. & P.

CONSTANT SPEED, PRECISION MADE 6 VOLT D.C. GOVERNED MOTOR

Seven pole armature, ballrace bearing. 2,750 r.p.m. Length 2⁹⁄₁₆, Dia. ⁹⁄₁₆, Shaft length ⅛, Shaft dia. 5/64. No load 40 mA. Normal load 350 mA. Ideal for portable recorders, etc., etc. Price £1·25 P. & P. 10p.

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



30 r.p.m. 40 lb. ins. Position of drive spindle adjustable to 3 different angles. **Mounted on substantial cast aluminium base.** Ex-equipment. Tested and in first-class running order. A really powerful motor offered at a fraction of maker's price. £6·30. P. & P. 50p.

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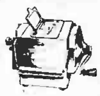
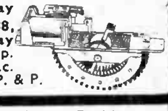


Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L.8in, W.4in, H.6in, weight 6lb. 1,000V, 1,000 megohms, £34·00 carriage paid.
500V, 500 megohms, £28 incl. P. & P.

UNISELECTOR SWITCHES



NEW 4 Bank 25 Way 24V d.c. operation. £5·88, P. & P. 25p. 6 Bank 25 Way 24V d.c. £6·50, P. & P. 25p. 8 Bank 25 Way, 24V d.c. operation. £7·62 plus 25p. P. & P.

230V A.C. SOLENOID

Extremely powerful with approx. 14lb pull, 1in travel. Fitted with mounting feet. Size: 4in long, 2⅜in wide, 3in high. £2·00 incl. P. & P.

230-250 VOLT A.C. SOLENOID
Manufactured by Westool Ltd. (similar in appearance to above illustration). Approx. 1½lb pull. Feet size 1⅝in × 1¼in. Price 85p incl. P. & P.

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Size: O.A.L. 3⅜in × 1¼in × 1in. Max. push ½ at 1lb. approx. PRICE: 75p incl. P. & P.

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OUTPUT CONTINUOUSLY VARIABLE 0-36V
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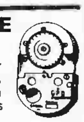
VENNER ELECTRIC TIME SWITCH 200/250V Ex. GPO.



Tested. Manually set 2 on, 2 off every 24h. Override switch: 15A £3·25, 20A £3·75. P. & P. 20p. Also available with solar dial ON dusk, OFF dawn. Price as above.

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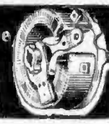

100 WATT. 1 ohm, 10A; 5 ohm, 4·7A; 10 ohm, 3A; 25 ohm, 2A; 50 ohm, 1·4A; 100 ohm, 1A; 250 ohm, 0·7A; 500 ohm, 0·45A; 1 kΩ, 280 mA; 1·5 kΩ, 230mA; 2·5 kΩ, 2A; 3·5kΩ, 5 kΩ, 140mA. Diameter 3½in Shaft length ⅝in, dia. ⁵⁄₁₆in. All at £1·65 each. P. & P. 7½p.
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Col. (2) Working d.c. volts
Col. 3 Contracts
Col. (4) Price
HD = Heavy duty
*Incl. Base
Post paid.

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700	16–24	6M	65p*
700	6–12	1 c/o HD	50p*
700	20–30	6 c/o	75p
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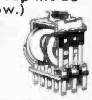

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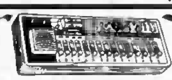

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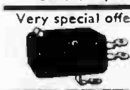

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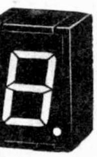

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