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DECEMBER 1971

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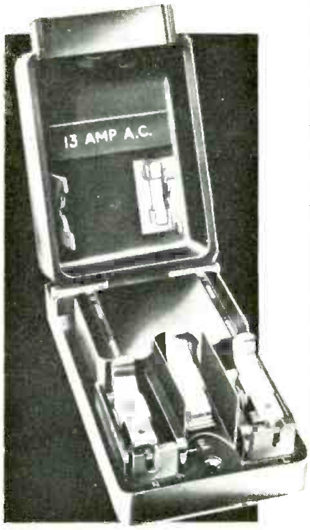

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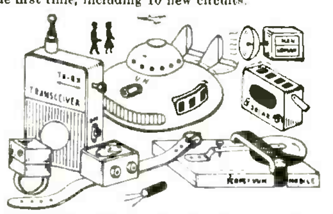

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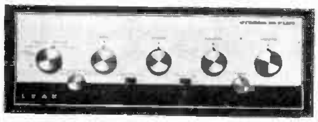

Leak Stereo 30 Plus amplifier (cased only) Power outputs (both channels sinewave driven) 15 watts r.m.s. each channel into 8 ohms loudspeakers. Music power outputs 20 watts r.m.s. each channel into 8 ohm loudspeakers. Total harmonic distortion 0·1% for all power levels up to 10 watts r.m.s. each channel at 1KHz into 8 ohm loudspeakers. Crosstalk: Between left and right channels 50dB up to 1KHz and 30dB at 10KHz. Dimensions: 13in (W) 4¾in (H) 9¾in (D). LIST PRICE £62·50 **LASKY'S PRICE £45·00** *carriage and packing £1.00.*

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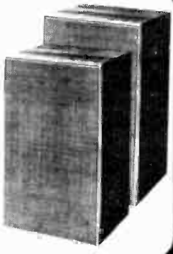

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Package 2

Stereo 70 (cased)	£75·00
Stereofetic (chassis)	£64·03
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Package A

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LEAK 200 Spks (pr)	£49·90
LEAK TruspeedT/T system	£69·50
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LASKY'S PRICE £120 post £2·00

Package B

LEAK ST70 (cased)	£75·00
LEAK 200 Spks (pr)	£49·90
LEAK Truspeed T/T system	£69·50
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LASKY'S PRICE £130 C. & P. £2·00

Package C

LEAK ST30 Plus (cased)	£62·50
LEAK Stereofetic (cased)	£69·80
LEAK 200 spks (pr)	£49·90
LEAK Truspeed, T/T system	£69·50
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Package D

LEAK ST70 (cased)	£75·00
LEAK Stereofetic (cased)	£69·80
LEAK 200 Spks (pr)	£49·90
LEAK Truspeed T/T system	£69·50
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LASKY'S PRICE £170 C. & P. £3·00

Package E

LEAK ST30 Plus (cased)	£62·50
Wharfedale Denton Spks. (pr)	£39·90
BSR McDonald MP60	£15·20
Lasky's base and cover	£4·75
AD76K magnetic cartridge	£4·35
Total Rec. Retail Price	£126·70

LASKY'S PRICE £92 C. & P. £2·00

Package F

LEAK ST70 (cased)	£75·00
Wharfedale Triton Spks (pr)	£59·90
Garrard AP76	£27·85
Garrard base and cover	£9·75
Shure M44/E magnetic cart	£11·63
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Package G

LEAK ST30 Plus (cased)	£62·50
Lasky's Criterion Mk. X Spks.	£25·00
BSR McDonald MP60	£15·20
Lasky's base and cover	£4·75
AD76K magnetic cartridge	£4·35
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Package H

LEAK ST70 (cased)	£75·00
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L709C	DIL	0·45	0·40	0·35
L710C	TO5	0·47	0·42	0·37
L710C	DIL	0·45	0·40	0·35
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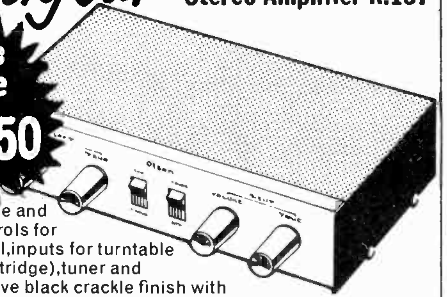
CA3022	1·30	1·16	CA3065	1·20	1·07
CA3023	1·26	1·13	CA3066	2·11	1·88
CA3026	1·00	0·90	CA3067	2·18	1·94
CA3026PRE	1·00	0·90	CA3068	2·43	2·16
			CA3070	1·70	1·51
CA3028A	0·74	0·65	CA3071	1·62	1·44
CA3028B	1·05	0·94	CA3072	1·66	1·48
CA3029	0·87	0·77	CA3075	1·13	1·00
CA3029A	1·65	1·47	CA3076	1·30	1·16
CA3030	1·37	1·23	CA3078	3·19	2·85
CA3030A	2·53	2·25	CA3080	0·79	0·70
CA3033	2.53	2.25	CA3080A	3·19	2·85

JUST BEGINNING?

Then try out

8-Watt, 10-Transistor Stereo Amplifier R.137



ROC price £10.50

Separate tone and volume controls for each channel, inputs for turntable (ceramic cartridge), tuner and tape. Attractive black crackle finish with brushed aluminium front. Frequency response: 70-20,000 Hz ±3dB. Output: 4 watts per channel @ 8 ohms. Inputs: Phono 80mV; tuner/aux 80mV.

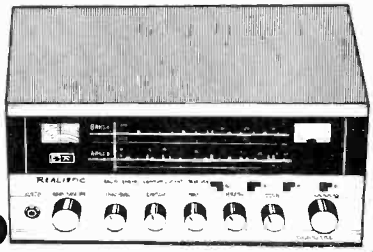
Normal retail price: £14·70

World wide reception

Professional Solid-state, Four-band Communications Receiver R.135

Fully transistorised with continuous coverage from 555K Hz to 30 M Hz in four bands (with illuminated bandspread for 160-10 metres). Incorporates internal speaker, automatic noise limiter, SSB/AM/CW switch, AVC switch, S Meter, Receive and Standby switch, external socket for headphone or speaker, bandspread control, BFO control, on/off/AF gain, band selector, antenna trimmer and RF gain. Runs off 240 v AC, batteries or any 12 v DC negative ground source. Frequency ranges (in mHz): Band A, 535-1·6; B, 1·55-4·5; C, 4·5-13; D, 13-30. Sensitivity: 0·5µV @ 30mHz. Bandspread: 10-160 metres.

Normal retail price: £65·00



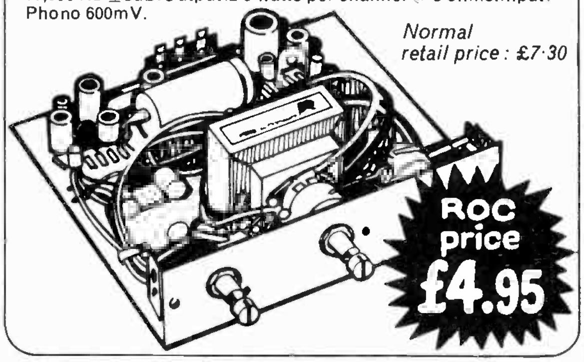
ROC price: £45.00

FIRST STEP TO STEREO!

5-Watt Transistor Stereo Amplifier Chassis R.123

Completely self-contained, fully transistorised, mains-powered (240vAC) amplifier, needing only cabinet and knobs. Ideal for adapting mono players to stereo. Frequency response: 40-17,000 Hz ±3dB. Output: 2·5 watts per channel @ 8 ohms. Input: Phono 600mV.

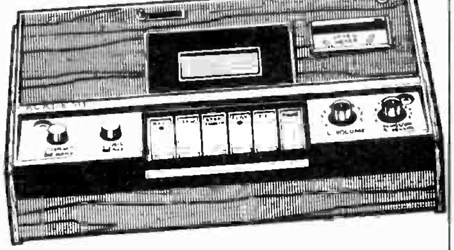
Normal retail price: £7·30



ROC price £4.95

AMAZING OFFER!

Stereo Cassette Tape Unit R.142



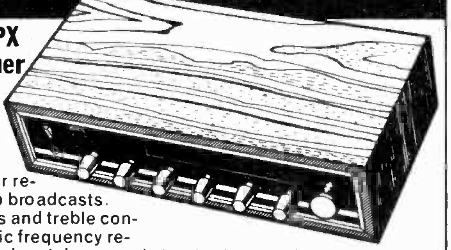
Complete stereo record and playback unit with line and microphone inputs. Fitted with tape counter, separate pause control, recording level metres for each channel, pop-up cassette ejection. Supplied complete with two pencil microphones. Wow & flutter better than 0·3%, frequency response 100-10,000 Hz. Tape speed: 1⅞ IPS, 4·75 CMS. Rewind time: Better than 60 sec (C.60 cassette).

Normal retail price: £65·00

ROC Price £49.50

SOUNDS SENSATIONAL

AM/FM/MPX Stereo Tuner Amplifier R.124



A top quality amplifier with facility for receiving stereo broadcasts. Separate bass and treble controls, automatic frequency response, stereo headphone socket, output power: 8 watts. FM frequency range 88-108 M Hz; AM frequency range 535-1605 K Hz. Inputs for turntable (ceramic cartridge) and tape. Frequency response: 50-10,000 Hz ± 3dB. Output: 4 watts per channel @ 8 ohms. Inputs: Phono 200mV, tape 100mV. FM: Sensitivity 20µV, stereo separation 26dB, image rejection 55dB. AM: Sensitivity 300µV.

Normal retail price: £42·00 **ROC price: £29.95**

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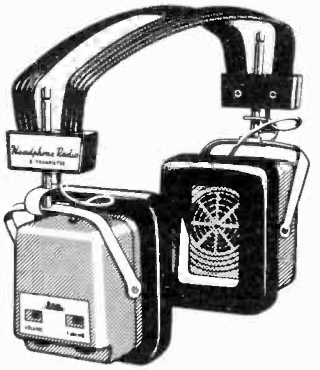


Headphone Radio R.143

For completely private listening without the distortion of the ordinary earphone adaptor. Battery operated; PP3. Fully transistorised. Frequency range: 535-1600 K Hz, Medium Wave Band. Maximum output: 300mW.

ROC price £6.90

Normal retail price: £9·40

STEREO headphones

only £2.40

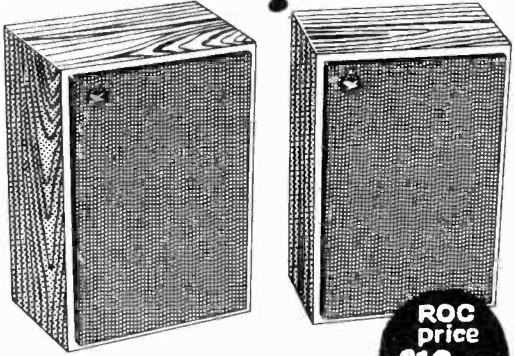
Stereo Headphones R.328

Light and comfortable, with a frequency response of 30-15,000 Hz for real listening pleasure. Complete with jack plug. Impedance 8-16 ohms.

Normal retail price: £2·95

2 for the price of one!

Matched Stereo Speakers R.446



ROC price £16.40

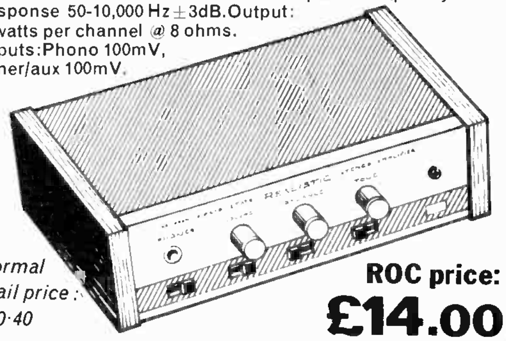
Heavily lagged teak finish cabinets each with large dual cone base unit and separate tweeter. Power handling: 10 watts peak; frequency range: 40-18,000 Hz, impedance: 8 ohms. Size: 14 x 8¾ x 6¼.

Normal retail price: £19·60

Don't read this!

10-watt Transistor Stereo Amplifier R.136

Ganged volume, balance and tone controls. Inputs for turntable (ceramic cartridge), tuner (see R.134) or tape. Oiled walnut case with satin finish aluminium front panel. Frequency response 50-10,000 Hz ±3dB. Output: 5 watts per channel @ 8 ohms. Inputs: Phono 100mV, tuner/aux 100mV.



Normal retail price: £20·40

ROC price: £14.00

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The Perfect match!

AM/FM/MPX Stereo Tuner R.134

Matching unit to the R.136 amplifier. Covers AM and FM tuning bands with automatic stereo signal light. FM frequency range: 88-108mHz; AM frequency range: 535-1605kHz. FM: Sensitivity 5μV, stereo separation 25dB@1kHz, image rejection 50dB. AM: Sensitivity 250μV.

Normal retail price: £28·60

ROC price £22

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Goldring Plinth 72	7·00
Goldring LID72	3·75
Goldring G.99	22·00
Goldring C.99	9·00
Goldring G101/p	22·00
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Data sheet supplied with device.

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NPN/PNP Silicon Planar Transistors, mixed, untested, similar to 2N706/6A/8, BSY26-29, BSY95A, BCY70, etc. **£4·25** per 500; **£8** per 1,000.

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B86	50	Sil. Diodes sub. min. IN914 and IN916 types	50p
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H10	25	Mixed volts, 1½ watt Zeners. Top hat type	50p
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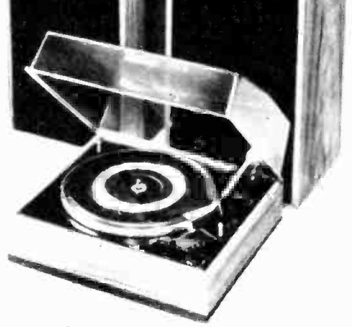

There are two stereo amplifiers—the R100 for ceramic cartridges, the R101 for magnetic and ceramic. Both incorporate FETs (FIELD EFFECT TRANSISTORS), just like top-priced units. FETs give you more of the signal you want, and almost none of the background hiss you don't. Both units have a jack socket to plug in headphones and there's a separate output for tape recorder. Filters (an unusual feature in this price range) and tone controls give a wide range of bass and treble adjustment which compensate for input deficiencies and domestic acoustic conditions.

PRICES SYSTEM 1

Viscount III R101 amplifier	£22 + 90p	P.&P.
2 × Duo Type II speakers	£14 + £2	P.&P.
Garrard SP25 Mk. III with MAG. cartridge, plinth and cover	£23 + £1·50	P.&P.
Total	£59	

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SYSTEM 2

Viscount III R101 amplifier	£22 + 90p	P.&P.
2 × Duo Type III speakers	£32 + £3	P.&P.
Garrard SP25 Mk. III with MAG. cartridge, plinth and cover	£23 + £1·50	P.&P.
Total	£77	

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SYSTEM 3

Viscount III R100 Amplifier	£17 + 90p	P.&P.
2 × Duo Type II speakers	£14 + £2	P.&P.
Garrard SP25 Mk. III with CER. diamond cartridge, plinth and cover	£21 + £1·50	P.&P.
Total	£52	

Available complete for only £49 + £3·50 P.&P.

SPEAKERS Duo Type II

Size approx. 17in × 10¾in × 6¾in. Drive unit 13in × 8in with parasitic tweeter. Max. power 10W, 3 ohms. Simulated Teak cabinet. **£14 pair + £2 P. & P.**

Duo Type III Size approx. 23½in × 11½in × 9½in. Drive unit 13½in × 8¼in with H.F. speaker. Max. power 20W at 3 ohms. Frequency range 20Hz to 20kHz. Teak veneer cabinet. **£32 pair + £3 P. & P.**

SPECIFICATION R100/101

14 watts per channel into 3 to 4 ohms. Total distortion @ 10W @ 1kHz 0·1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K equalised within ±1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power.) Tape out facilities; headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to −17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to −12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max.) R101—P.U.1. and radio—65dB. P.U.2—58dB. **R100** same as R101 but P.U.2 (for crystal cartridges) 450mV into 3 Meg. *Cross talk* better than −35dB on all inputs. *Overload characteristics* better than 26dB on all inputs. Size approx. 13¾ × 9in × 3¾in.

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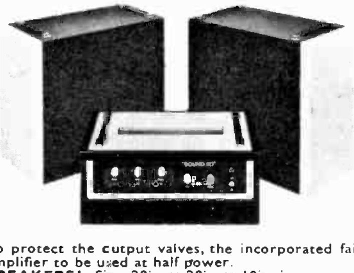

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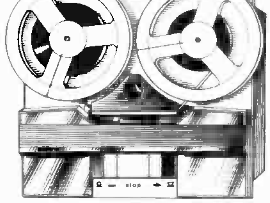

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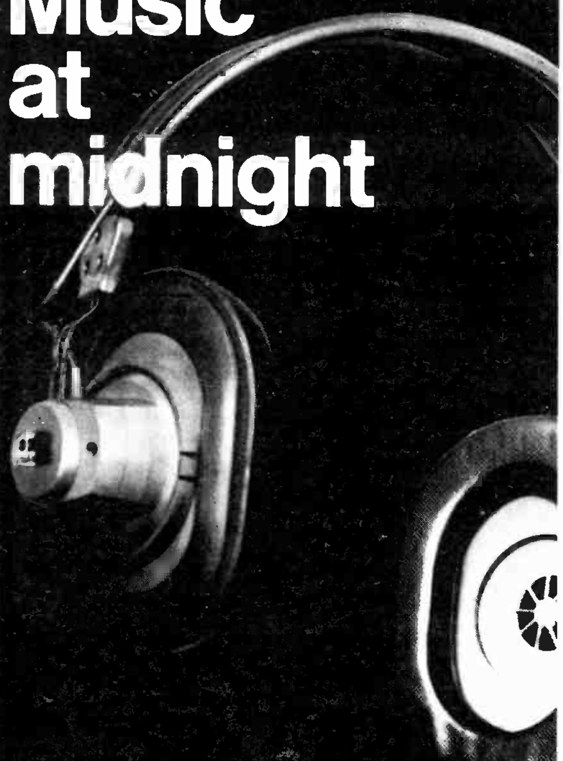

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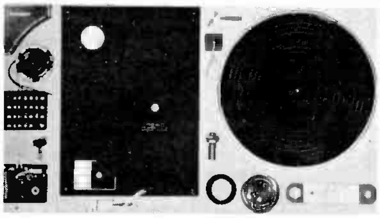

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400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
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BP104 = 74104	Single J-K flip-flop equivalent 9000 series	0·97	9·94	0·88
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BP107 = 74107	Dual Master slave flip-flops	0·40	0·38	0·36
BP110 = 74110	Gates master-slave flip-flops	0·55	0·53	0·50
BP111 = 74111	Dual data lock-out flip-flop	1·25	1·15	1·00
BP118 = 74118	Hex set-reset latches	1·00	0·95	0·90
BP119 = 74119	Hex set-reset latches. 24-pin	1·35	1·25	1·10
BP121 = 74121	Monostable multivibrators	0·67	0·64	0·58
BP141 = 74141	BCD-to-decimal decoder/driver	0·67	0·64	0·58
BP145 = 74145	BCD-to-decimal decoder/driver O/C	1·50	1·40	1·30
BP150 = 74150	16-bit data selector	1·80	1·70	1·60
BP151 = 74151	8-bit data selectors (with strobe)	1·00	0·95	0·90
BP153 = 74153	Dual 4-line-to-1-line data	1·20	1·10	0·95
BP154 = 74154	4- to 16-line decoder	1·80	1·70	1·60
BP155 = 74155	Dual 2- to 4-line decoder	1·40	1·30	1·20
BP156 = 74156	Dual 2- to 4-line decoder O/C	1·40	1·30	1·20
BP160 = 74160	Sync. decade counter	1·80	1·70	1·60
BP161 = 74161	Sync. 4-bit binary counter	1·80	1·70	1·60
BP190 = 74190	Sync. up-down BCD counter	3·50	3·25	3·00
BP191 = 74191	Sync. binary up-down counter (single clock line)	3·50	3·25	3·00
BP192 = 74192	Sync. up-down decade counter	2·10	1·95	1·75
BP193 = 74193	Sync. binary up-down counter (tow clock lines)	2·10	1·95	1·75
BP196 = 74196	Pre-setable 50MHz decade counter	1·80	1·70	1·60
BP197 = 74197	Pre-setable 50MHz binary counter	1·80	1·70	1·60
BP198 = 74198	8-bit parallel L-R shift register	5·50	5·00	4·00
BP199 = 74199	8-bit parallel access shift register	5·50	5·00	4·00

Devices may be mixed to qualify for quantity price. Larger quantities—prices on application (TTL 74 Series only).
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UIC01 = 12 × 7401N	50p	UIC50 = 12 × 7450N	50p	UIC82 = 5 × 7482N	50p
UIC02 = 12 × 7402N	50p	UIC51 = 12 × 7451N	50p	UIC83 = 5 × 7483N	50p
UIC03 = 12 × 7403N	50p	UIC60 = 12 × 7460N	50p	UIC86 = 5 × 7486N	50p
UIC04 = 12 × 7404N	50p	UIC70 = 8 × 7470N	50p	UIC90 = 5 × 7490N	50p
UIC05 = 12 × 7495N	50p	UIC72 = 8 × 7472N	50p	UIC92 = 5 × 7492N	50p
UIC10 = 12 × 7410N	50p	UIC73 = 8 × 7473N	50p	UIC93 = 5 × 7493N	50p
UIC20 = 12 × 7420N	50p	UIC74 = 8 × 7474N	50p	UIC94 = 5 × 7494N	50p
UIC40 = 12 × 7440N	50p	UIC75 = 8 × 7475N	50p	UIC95 = 5 × 7495N	50p
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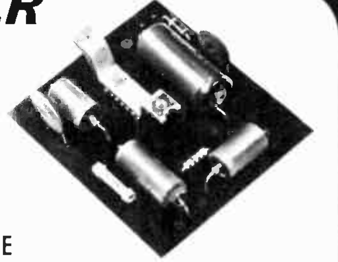

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BP936	Hex Inverter	13p	12p	11p
BP944	Dual 4-input NAND expandable buffer without pull-up	13p	12p	11p
BP945	Master-slave JK or RS	25p	24p	22p
BP946	Quad, 2-input NAND	12p	11p	10p
BP948	Master-slave JK or RS	25p	24p	22p
BP951	Monostable	65p	60p	55p
BP962	Triple 3-input NAND	12p	11p	10p
BP9093	Dual Master-slave JK with separate clock	40p	38p	35p
BP9094	Dual Master-slave JK with separate clock	40p	38p	35p
BP9097	Dual Master-slave JK with Common Clock	40p	38p	35p
BP9099	Dual Master-slave JK Common Clock	40p	38p	35p

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BP 702C—SL702C	TO-5	8	OP Amp Direct OP	63p	50p	45p
BP 702—72702	D.I.L.	14	G.P. OP Amp (Wide Band)	53p	45p	40p
BP 709 —72709	D.I.L.	14	High OP Amp	53p	45p	40p
BP 709P—μA709C	TO-5	8	High Gain OP Amp	53p	45p	40p
BP 711—μA711	TO-5	10	Dual comparator	58p	50p	45p
BP 741 —72741	D.I.L.	14	High Gain OP Amp (Protected)	75p	60p	50p
μA 703C—μA703C	TO-5	6	R.F.–I.F. Amp	43p	35p	27p
TAA 263—	TO-72	4	A.F. Amp	70p	60p	55p
TAA 293—	TO-74	10	G.P. Amp	90p	75p	70p

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VOL. 7 No. 12
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PRACTICAL ELECTRONICS

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TODAY'S ICs AND TOMORROW'S

THE profusion of integrated circuit devices on the retail market offers great opportunities for equipment designing and building. Yet the formidable lists of type numbers must be daunting to many a reader as he peruses those advertisements featuring i.c.s. Clearly there is a requirement for a guide that identifies the more common types, indicates function and provides basic application data. This need we have attempted to meet in the Linear and Logic IC Survey which is the subject of this month's special supplement.

It will be appreciated that this Survey is not, and indeed could not be, exhaustive. Only those types of integrated circuit known currently to be available via retailers are included. This in fact makes the Survey all the more valuable, since no reader is likely to be sent on a wild goose chase after some rare device that cannot be obtained, unless one has special connections within the industry.

★ ★ ★

Having (hopefully) clarified the current i.c. situation to some extent and produced two separate lists, one for linear, the other for logic devices, we learn that this orderly and simple segregation into just two clearly defined categories may not always be possible in the years to come. By strange chance, just as our Survey was completed news was released of what is claimed to be a revolutionary development in i.c. design and manufacture by a British firm. The Collector Diffusion Isolation (CDI) method now perfected by Ferranti permits both digital and linear circuits to be formed on the same monolithic chip; it combines the linear high performance and digital high speed capability of the bipolar method with the high circuit density capability offered by the MOS technique.

The developers of CDI have suggested that this new bipolar process will cause a general widening of MSI and LSI applications particularly in areas involving analogue-digital techniques; they have mentioned, specifically, desk calculators, fuel injection systems, washing machine controls, and model control as examples where CDI will have great impact.

It is good to hear of a UK firm making an outstanding contribution to the development of new i.c. techniques. Just how important and significant the CDI method actually is, time will tell. But there are already two American contenders in the field. Both Fairchild and Raytheon have developed their own methods for increasing the component density on a single chip. Are we about to witness another price war? With mammoth production runs, technical considerations tend to play a minor role—the more economical process usually wins the day.

F.E.B.

THIS MONTH

Our January issue will be published on Friday, December 10.

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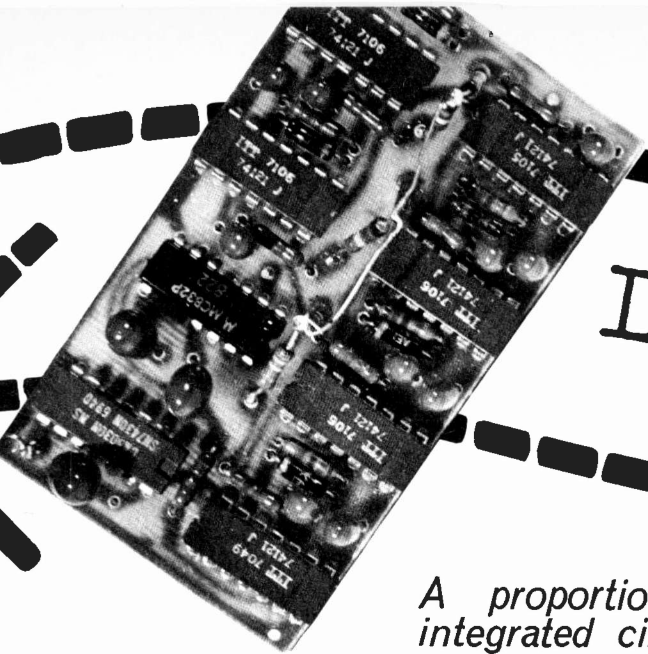


LOGICAL

By A.J. Dunn

A proportional control system, using integrated circuits, suitable for use with most types of radio control transmitter or receiver.

THE vast number of integrated circuits now on the market has lowered the cost to levels whereby they can be used for many applications Although the circuitry for the system described would be possible with discrete components, the complexity would be such as to deter many from contemplating a sophisticated system, whereas with integrated circuits, the modules are simple and easy to build.

This article deals with the coder and decoder sections only; a block diagram of a typical system is shown in Fig. 1a. These may be built and tested against each other (Fig. 1b) the interface or coupling units being simple stages allowing, for example, a transmitter with a −12V supply to be used with the coder which requires +5·2 to 5·7V.

The system is described for six channels although it can easily be varied for three to nine channels. It is not economic to have less than three channels; for more than nine channels some compromise is necessary with regard to proportionality and the time rate of control.

Printed circuit boards are necessary for this project and care should be taken to make these of a high standard since one interconnection short can cause complete malfunction and may be hard to trace; time taken wiring up is amply repaid.

Alternative forms of coder are described and it is not advisable to attempt construction without considering the corresponding decoder. Positive logic (output high = 1, low = 0) is used throughout

PULSE CONTROL TECHNIQUES

The control system involves the production of a train of (positive going) pulses, each pulse corresponding to a channel and being independently and proportionally variable in length from about 0·5 to 4ms.

As shown in Fig. 2a, the pulses occur sequentially but their position relevant to the start of the train is determined by the length of the other pulses and the interval time between pulses —$\frac{1}{3}$ms.

The pulse train is repeated at intervals τ_1 of 25 to 50ms or 20 to 40 times a second. This is the rate at which the pulse lengths are measured and changes detected. Allowing five measurements (but preferably ten) for the detection of a small change and servo initiation, this gives a system response time of about $\frac{1}{8}$ to $\frac{1}{4}$ second.

Due to the inertia of the motor and load, the servo has a response time which must be added to the above; a model aircraft flying at 60 m.p.h. would move 22ft in $\frac{1}{4}$ second before, say, the rudder servo started operating.

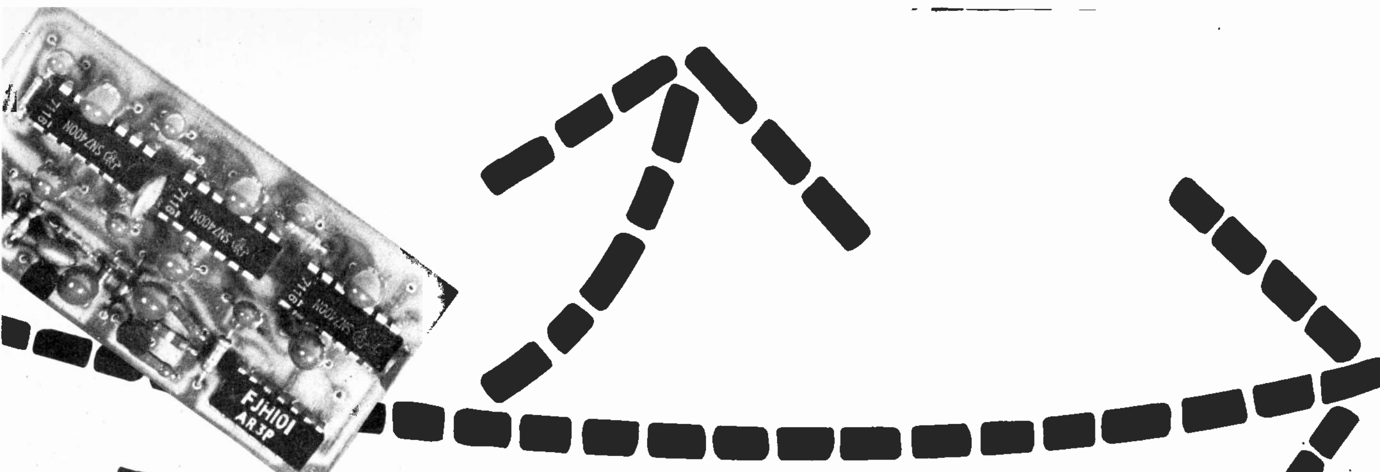
PULSE LENGTH

The pulse train repetition time τ_1 for n channels is made up of $(n - 1) \times \frac{1}{3}$ms intervals, n pulses of maximum length $\tau_3$ms and a synchronising period τ_2 used in the decoder to determine the start of the pulse train. This synchronising period τ_2 must be $1\frac{1}{2} \times \tau_3$ or preferably $3 \times \tau_3$.

A four-channel system with a maximum pulse length (τ_3) of say 4ms would therefore give as a minimum $(4 \times 4) + (3 \times \frac{1}{3}) + (1\frac{1}{2} \times 4) = 23$ milliseconds.

The sharp-edged pulses used in the coder and decoder are "softened" to approximately sine wave shape, before actual transmission and reception (as shown in Fig. 3), the pulse interval period being then approximately 0·5ms wide corresponding to a 2kHz tone. This allows a factor of approximately two for the bandwidth performance of any existing receiver, it being equally convenient to use a tone modulator transmitter or to use the i.c.w. mode and to detect the 27MHz carrier only in the receiver.

The maximum pulse length (τ_3) is determined as a reasonable relationship with regard to the interval time, being restricted to contain τ_1 to less than 50ms. If a slower system response time can be tolerated, as in the case of a scale model boat, the maximum pulse length could be increased to 10ms or alternatively more channels could be used.



RADIO CONTROL

Use integrated circuits to simplify control functions

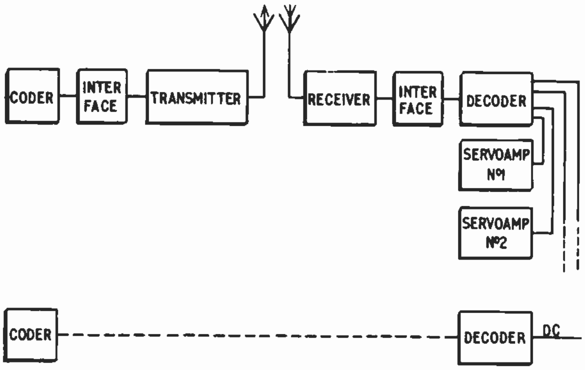


Fig. 1. Block diagram of a typical radio control installation

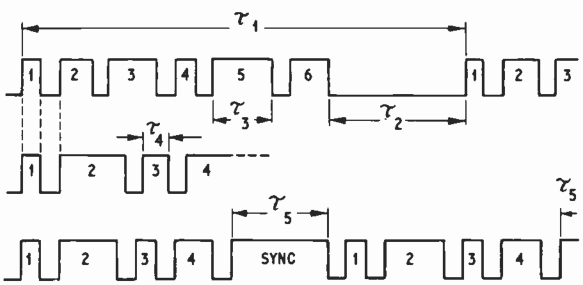


Fig. 2. Variable pulse lengths for proportional control

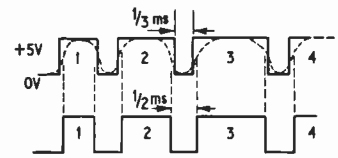


Fig. 3. The coder pulses are "softened" to almost sine wave shape for transmission to avoid troubles with short propagation times of square wave pulses

If only one channel, e.g. rudder, was required for maximum sensitivity, the corresponding maximum pulse length could be increased provided that the other channels in use were restricted operationally to prevent all the pulses being at maximum length, hence encroaching into the sync period τ_2.

CODER VARIANTS

Three variants of coder are described: coders 1 and 2A are similar in form providing alternative construction dependent upon the use of components that may be to hand. The cost of the timing capacitors becomes comparable with that of the "active" components. In these cases, the period τ_1 is fixed by using a multivibrator.

The coder 2B simply uses a longer positive-going pulse to provide the synchronising period shown as τ_5 in Fig. 2b; the channels are no longer being completely independent, τ_1 not being fixed. In this case the end of the synchronising pulse τ_5 is used to initiate the next pulse train.

The particular advantage is that, with some of the channel controls at minimum, a shorter system response time is possible. The disadvantage is that, operating any control, the corresponding pulse length is changed, in turn changing the total cycle time, and hence changing the measurement rate of the other pulses and their corresponding output.

Considering the case of a six-channel coder with all controls in the mid-position a pulse length of 2ms cycle time = $(6 \times 2) + (6 \times \frac{1}{3}) + 6$ (synchro pulse) = 20ms. If one control is changed to maximum and its corresponding pulse length to 4ms, then the cycle time becomes 22ms.

The output signal derived from these pulses changes in the ratio $\frac{2}{20} : \frac{4}{22}$ not 2 : 4 and the other channels outputs change by 20 : 22.

The greater the number of channels used, the less marked the loss of complete channel independence, and the greater the gain with respect to cycle and system response time.

Table 1: MAKERS LOGIC I.C. TYPE NUMBERS

Description	Logic type	Ferranti	Motorola	Mullard	SGS	Signetics	S.T.C.-I.T.T.
Quad 2-input NAND gate	TTL	ZN7400E	MC7400P	FJH131	6900259		
	DTL	ZN346E	MC846		6994659		MIC9495D
8-input NAND gate	TTL	ZN7430E	MC7430P	FJH101		N7430A	
Dual JK flip-flop	TTL	ZN7473E	MC7473P	FJJ121		N7473A	
Monostable	TTL	ZN7470E		FJJ101		N7470A	
Retriggerable Monostable	TTL				9601		
	DTL				T118		
Dual 4-input NAND gate with node	DTL	ZN330E	MC830P		6993059		MIC9305D

DECODER

The decoder consists of two parts, the sync separator using a retriggerable monostable, and a shift register formed from a chain of JK flip-flops.

The received positive-going pulses repeatedly trigger the special monostable which has a full back-off time of at least 1½ × the maximum signal pulse length. It can change state therefore only during the sync period, this change of state being used to produce a special pulse which is applied to all the "clear" inputs of the JK flip-flops.

During the sync period the outputs of the flip-flops are set to "0", awaiting the train of signal pulses which are applied to all the "clock" inputs. One flip-flop is used to store a "1" which is successively moved down the chain (shift register) in steps coincident with the signal pulses.

The final individual output pulses from each flip-flop output is equal to the period of the signal pulse together with the following interval (½ms). Either one more flip-flop than the number of channels is used (to store a "1") or the last output is gated out as shown, the gating being associated with the decoder or one servo unit as desired.

SUPPLY VOLTAGE

For reliable operation the supply should be constant and between + 5·2 and + 5·7V. The most convenient way of obtaining this voltage for the coder is by the use of a good 6V battery in series with a 150mA diode. Precaution should be taken to prevent more than 6V being applied even momentarily, a Zener diode being used with the decoder.

CODER 1

The first coder is for six channels of positive going pulses. Four i.c.s only are used, one being an 8-input NAND gate (SN7430) to collate the outputs derived from an array of NAND gates (Fig. 4).

Pairs of these gates are used with a timing resistor and capacitor to give the signal pulse (for example, input 3 from G5 and G6 to G13) or the interval period (½ms) from G4 and G5.

The quad 2-input gate i.c. (SN7400) is used, therefore, to produce three timing periods and the series can be extended as desired. Eight channels would be a convenient limit unless G13 in IC7 is replaced by two or more gates followed by further grouping.

continued on page 1003

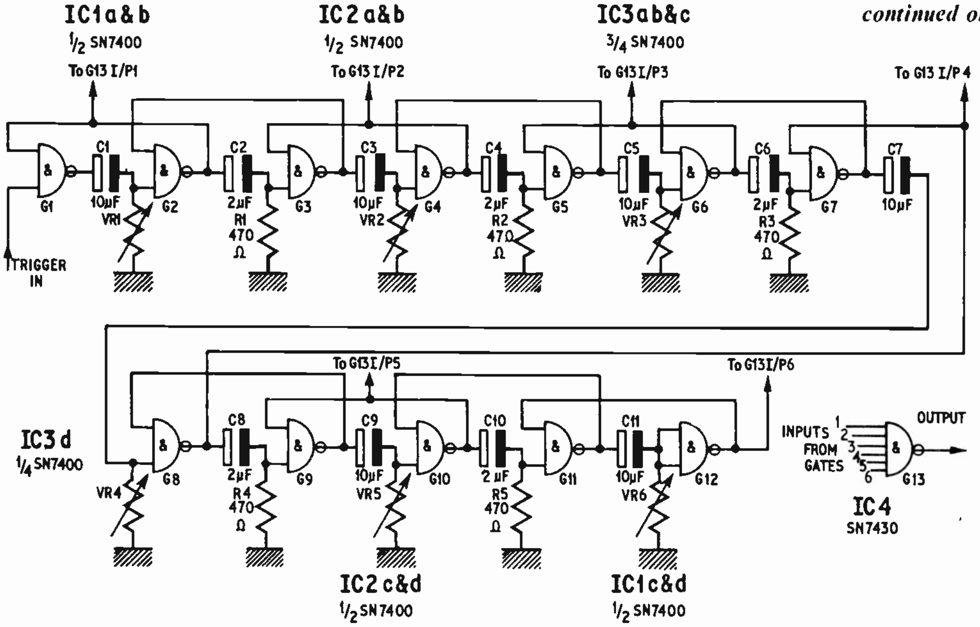


Fig. 4. The pulse lengths are determined and set by the potentiometers in the timing circuits. NAND gates are used to determine the timed sequence of pulses being fed to the master control gate G13

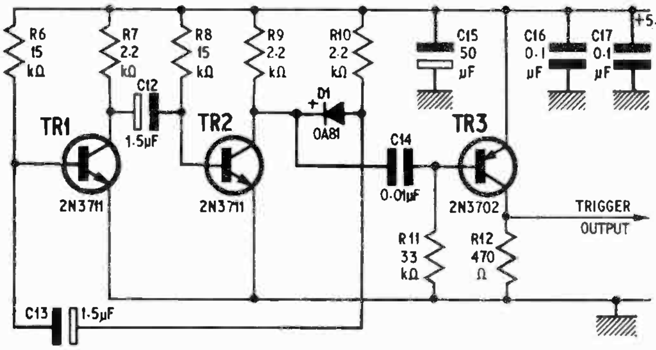


Fig. 5. Triggering is dependent on coincidence of an incoming clock pulse from this multivibrator and trigger circuit

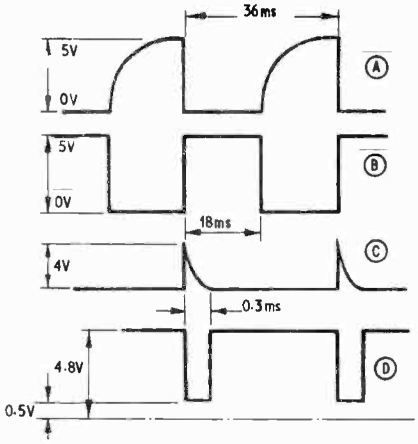


Fig. 6. The waveforms appearing at (a) TR1 collector, (b) TR2 collector, (c) TR3 base, (d) TR3 collector

COMPONENTS . . .

CODER I (Figs. 4, 5, and 8)

Resistors

R1 to R5 470Ω (5 off)
R6 15kΩ
R7 2·2kΩ
R8 15kΩ
R9 2·2kΩ
R10 2·2kΩ
R11 33kΩ
R12 470Ω
All ±5%, ¼W carbon

Potentiometers

VR1 to VR6 2·5kΩ for pre-selection of values, then replacement by fixed resistors (see text)

Capacitors

C1, C3, C5, C7, C9, C11 10μF tantalum or elect. 20V (6 off)
C2, C4, C6, C8, C10 2μF polarised tantalum or elect. 25V (5 off)
C12, C13 1·5μF elect.
C14 0·01μF disc ceramic
C15 50μF elect. 15V
C16, C17 0·1μF disc ceramic (2 off)

Intergrated circuits

IC1, IC2, IC3 SN7400 quad 2-input NAND gate (3 off)
IC4 SN7430 8-input NAND gate

Transistors

TR1, TR2 2N3711 *npn* silicon
TR3 2N3702 *pnp* silicon

Diode

D1 OA81 or any 100mA signal diode

Miscellaneous

Fibreglass printed circuit board (see Fig. 7)

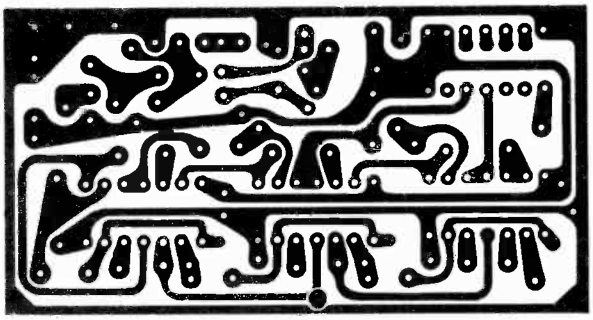


Fig. 7. The whole of "Coder I" and clock pulse generator is made up on fibreglass printed circuit board; the pattern here is reproduced full size

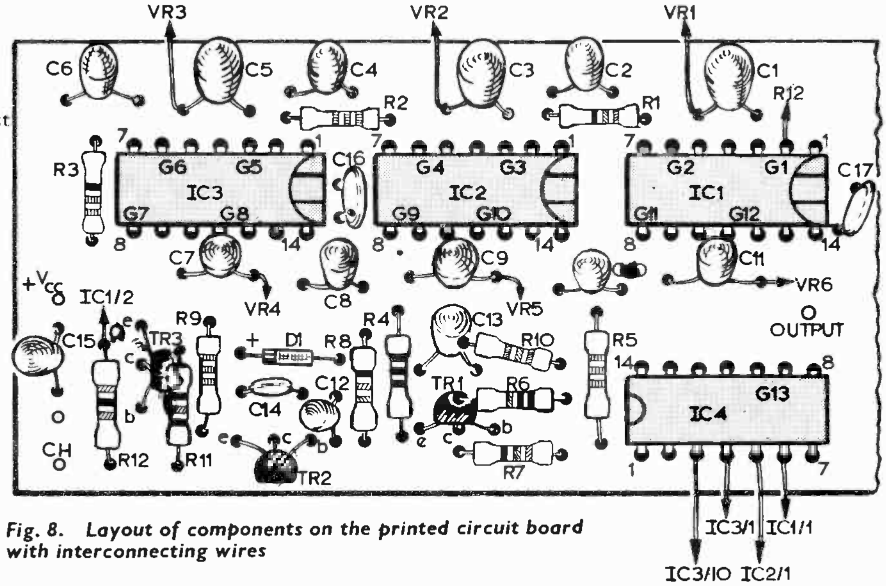


Fig. 8. Layout of components on the printed circuit board with interconnecting wires

PATENTS REVIEW...

INFLAMMABLE LIQUID LEVEL MONITOR

AN interesting new use of fibre optics occurs in BP 1 223 769 which is in the name of Maria and Giuseppe Panerai. Their Patent Specification is predominantly concerned with gauging the level of liquids in tanks.

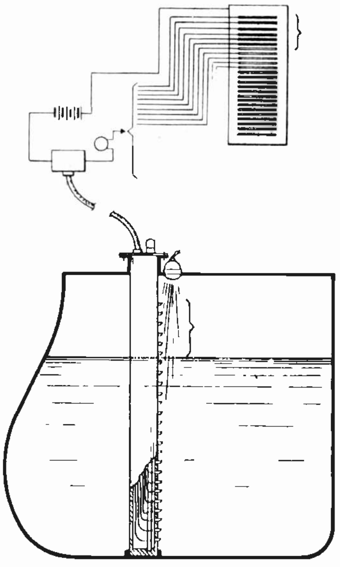
Reading between the lines their main interest is in sensing the level of highly inflammable liquids such as petroleum where it is obviously far from ideal to use any electrical system in contact with the liquid. Of course, simple mechanical systems tend to be unreliable, especially if they are gravity dependent

What these Italian inventors suggest is to arrange a sequence of prisms or equivalents in a vertical line, up from the base of the liquid tank, so that as the tank fills more and more prisms are submerged.

The prisms protrude from a removable pipe, each one backing onto a photosensitive cell. A lamp is fixed to the top of the tank so as to illuminate the interior. It is quite easy to see that, as the liquid level goes down, so more and more prisms will be exposed and illuminated and more and more photocells activated. The cells can be linked to any simple electronic circuitry outside the tank by wires with a consequent minimal risk of sparking and explosion.

But none of this concerns fibre optics so far. It turns up almost as an afterthought in one of the examples given in the specification where it is suggested that instead of putting the photocells directly behind the prisms, i.e. in the pipe which is submerged in the liquid, the photocells can be arranged elsewhere and the light from the prisms taken to them by light pipes or optic fibres.

BP 1 223 769



AUTOMATIC FINGERPRINT IDENTITY

THE North American Rockwell Corporation have a new British Patent BP 1 225 083 which applies to the automation of fingerprint checking. Rockwell start their specification with some sobering facts.

For instance, the FBI in America has a fingerprint file of over 182 million fingerprint cards, each having ten prints on it. So, if checking a suspect's prints against the records is to be finished in his lifetime, sophisticated automation is obviously necessary. What's more, with lost or stolen credit cards being an escalating problem, it may well be necessary one day to identify a legitimate card-holder by his fingerprints at the time of purchase.

Rockwell remind us that recognising the minutiae of a fingerprint is basically a problem in pattern recognition, which is complicated by the obvious fact that the minutiae occur at arbitrary orientations.

Whereas others have tended to concentrate on new techniques such as holography (matching prints with known masks), Rockwell propose a system which uses straightforward "off-the-shelf" electronics to provide means for scanning the fingerprint area. The major scan pattern has a minor scan pattern repeatedly superimposed over it.

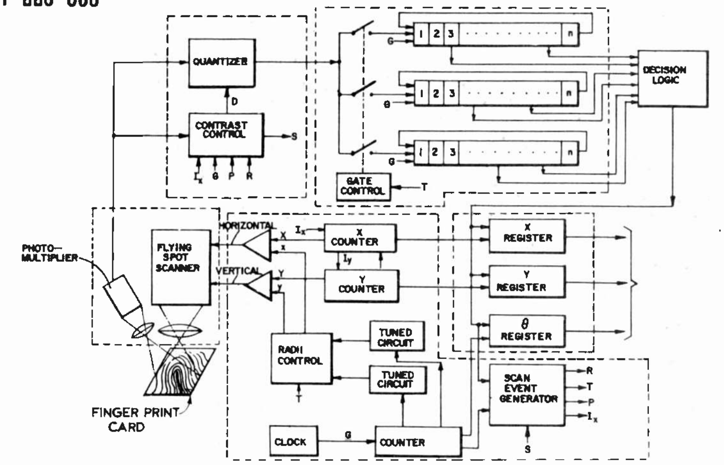
The major scan pattern is a pre-determined linear pattern, which scans through a succession of relatively small area portions, and the minor pattern scans over each of these portions in a polar mode. This minor scan produces signals indicative of the pattern at that portion and these are stored in a bank of storage elements. The states of selected signals in these storage elements are then sensed.

In more detail, Rockwell suggest the use of a flying spot scanner to derive an electrical analogue signal indicative of the fingerprint pattern at each small portion. This analogue signal is converted into digital form for storage and there is constant circulation of the signal in the memory through each of the storage elements so as to help the recognition of minutiae regardless of angular orientation.

An automatic contrast control circuit adjusts the detection process as a function of the general overall fingerprint image so that characteristics like ridge endings will produce distinctive light and dark areas to be encountered by the flying spot scanner moving in the orbits suggested.

Rockwell give plenty of details on suitable scanning techniques giving a total of 300,000 individual locations scanned on a single print. For present purposes, their block diagram gives the general picture.

BP 1 225 083



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92	1000	40	0	17·8 × 17·1 × 21·6	17·94	*
128	2000	63	0	24·1 × 21·6 × 15·2	29·66	*
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64	75	1	14	7·0 × 6·4 × 6·0	0-115-210-240	1·44	30
4	150	3	0	8·9 × 6·4 × 7·6	0-115-200-220-240	1·74	36
66	300	6	0	10·2 × 10·2 × 9·5	,, ,,	3·38	52
67	500	12	8	14·0 × 10·2 × 11·4	,, ,,	5·03	67
84	1000	16	0	11·4 × 14·0 × 14·0	,, ,,	9·12	82
93	1500	28	9	13·5 × 14·9 × 16·5	,, ,,	13·22	*
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70	6	3	3	12	10·2 × 7·6 × 8·6	0-12V at 3A × 2	1·95	42
72	10	5	6	3	7·9 × 10·8 × 10·2	0-12V at 5A × 2	2·56	52
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115	20	10	11	13	12·1 × 11·4 × 10·2	0-12V at 10A × 2	5·03	67
187	30	15	16	12	13·3 × 12·1 × 12·1	0-12V at 15A × 2	9·28	82
226	60	30	34	0	17·0 × 14·5 × 12·5	0-12V at 30A × 2	17·05	*

30 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	£	P & P Np
112	0·5	1	4	8·3 × 3·7 × 4·9	0-12-15-20-24-30V	0·88	22
79	1·0	2	0	7·0 × 6·4 × 6·0	,, ,,	1·18	36
3	2·0	3	2	8·9 × 7·0 × 7·6	,, ,,	1·75	36
20	3·0	4	6	10·2 × 8·9 × 8·6	,, ,,	2·16	42
21	4·0	6	0	10·2 × 10·0 × 8·6	,, ,,	2·56	52
51	5·0	6	8	12·1 × 10·0 × 8·6	,, ,,	3·18	52
117	6·0	7	8	12·1 × 10·0 × 10·2	,, ,,	3·79	52
89	10·0	12	2	14·0 × 10·2 × 11·4	,, ,,	6·21	67

50 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	£	P & P Np
102	0·5	1	11	7·0 × 7·0 × 5·7	0-19-25-33-40-50V	1·16	30
103	1·0	2	10	8·3 × 7·3 × 7·0	,, ,,	1·69	36
104	2·0	5	0	10·2 × 8·9 × 8·6	,, ,,	2·34	42
105	3·0	6	0	10·2 × 10·2 × 8·3	,, ,,	3·18	52
106	4·0	9	4	12·1 × 11·4 × 10·2	,, ,,	4·20	52
107	6·0	12	4	12·1 × 11·1 × 13·3	,, ,,	6·21	67
118	8·0	18	9	13·3 × 13·3 × 12·1	,, ,,	8·10	97
119	10·0	19	12	16·5 × 11·4 × 15·9	,, ,,	10·15	97

60 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	£	P & P Np
124	0·5	2	4	8·3 × 9·5 × 6·7	0-24-30-40-48-60V	1·18	36
126	1·0	3	0	8·9 × 7·6 × 7·6	,, ,,	1·64	36
127	2·0	5	6	10·2 × 8·9 × 8·6	,, ,,	2·56	42
125	3·0	8	8	11·9 × 9·5 × 10·0	,, ,,	3·90	52
123	4·0	10	6	11·4 × 9·5 × 11·4	,, ,,	5·03	67
120	6·0	16	12	13·3 × 12·1 × 12·1	,, ,,	7·28	82
122	10·0	23	2	16·5 × 12·7 × 16·5	,, ,,	12·05	*

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5	4·0	3	11	10·2 × 7·0 8·3		1·77	42
86	6·0	5	12	10·2 × 8·9 × 8·3		2·67	52
146	8·0	6	4	8·9 × 10·2 10·2		3·04	52
50	12·5	11	14	13·3 × 10·8 × 12·1		4·52	67

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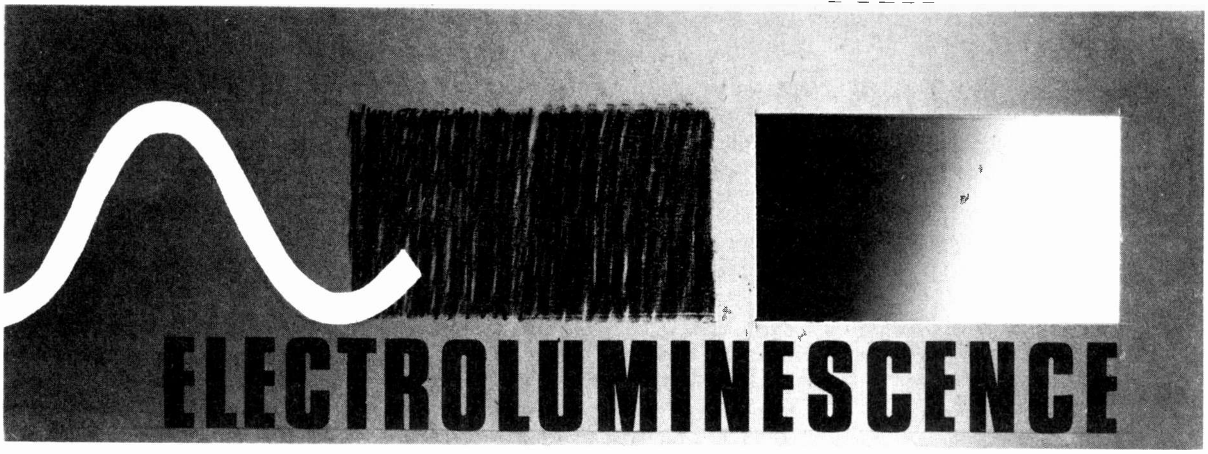

By K. J. Matthews M.Sc.

LUMINESCENCE is the general term which is applied to the production of light, either visible or infra-red, by the direct conversion of some other form of energy. The general term is then subdivided to denote the particular energy conversion involved.

Therefore, the production of light from heat, an effect which has been known for some considerable time, is designated thermoluminescence. A more modern, but very popular effect, is cathodoluminescence. This is light from kinetic energy or particle bombardment and keeps millions of T.V. screens active.

ELECTROLUMINESCENCE

Other forms include chemiluminescence, and bioluminescence, which is a division of chemiluminescence and occurs in some deep sea fish and in glow-worms. Photoluminescence is a special case as it involves a light to light conversion, the emitted light differing from the stimulating radiation in frequency.

Finally, electroluminescence is the emission of light by direct conversion of electrical energy. The standard abbreviation for the effect is written EL. This process is not to be confused with the ordinary tungsten filament bulb, where there is an intermediate stage of heat making the process thermoluminescent.

A few EL devices are now available to the public. Unfortunately these are as yet only infra-red emitters, but visible light devices do exist and are certain to become available in the near future.

USES

Uses for these devices are self evident. In most cases they can be substituted wherever small panel lamps are employed, and their higher efficiency will make them suitable for use with battery powered equipment. Numerical displays have been fabricated and because conventional read-out tubes require high voltages, EL devices of this type are likely to become very popular.

At the present stage in the development of EL devices, their use for general lighting seems a little remote. They cannot compete with fluorescent lighting for efficiency and only give monochromatic light.

It is not the aim of this article to describe practical applications but to give some insight into the mechanism of EL and of trends in present day research.

SEMICONDUCTOR BAND STRUCTURE

Some knowledge of semiconductor band theory is necessary before any understanding of electroluminescence is possible. Unfortunately this can be very complex and it is only possible to scratch the surface of the topic.

Fig. 1 depicts a semiconductor in energy band form. It consists of two bands, the conduction band and the valence band with an energy gap separating them. Electrons cannot exist with energies within this gap, and for this reason it is known as the forbidden gap or region.

For an electron to move from a valence band to a conduction band, it must "jump" the energy gap. A gradual transition is not allowed.

If the semiconductor has no energy, the conduction band will be void of electrons and the valence band full. In this state it is electrically inert—an insulator. However, a semiconductor always has some energy by virtue of its temperature, and this causes electrons to be propelled across the gap into the conduction band.

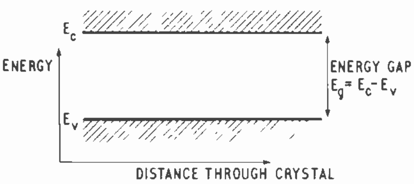

Fig. 1. Simple energy band diagram of a semiconductor

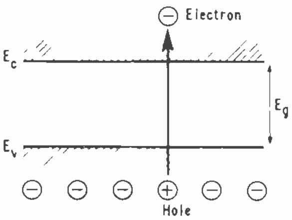

Fig. 2. The excitation process

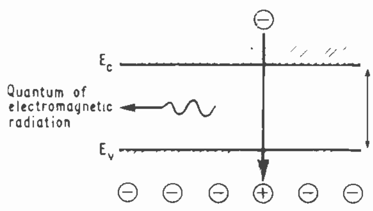

Fig. 3. Radiative recombination

To do this it is necessary that an electron receives an amount of energy at least equal to the energy represented by the width of the forbidden gap to enable it to make the jump. If it receives less it will not be able to do so. As we will see later, the size of the gap is constant for a particular semiconductor and is measured in terms of energy, in electron-volts (eV).

EXCITATION

When an electron receives sufficient energy to jump the gap to the conduction band, it leaves behind in the valence band a vacancy known as a "hole." See Fig. 2. It is convenient to think of these holes as positive electrons, but with reduced mobility.

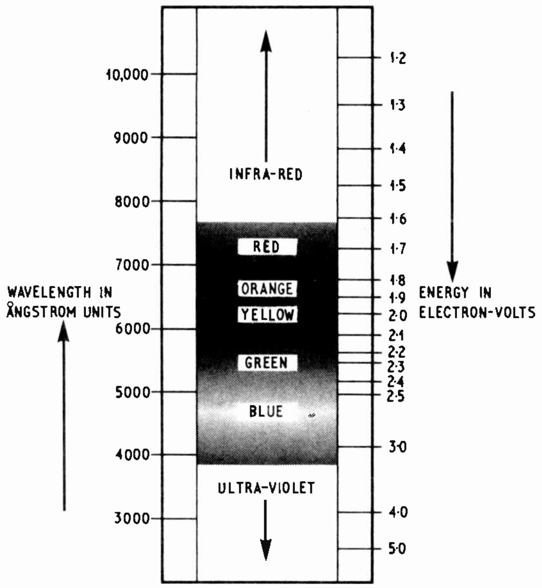

Fig. 4. Wavelength to energy conversion chart

If energy is now injected into the semiconductor for a short time and then removed, the internal equilibrium of the semiconductor is upset. There will be too many electrons in the conduction band and the semiconductor is said to be in an excited state.

There are many ways in which equilibrium may be restored. Here are three of the more important processes:

(1) the electrons may be ejected from the material entirely—similar to thermionic emission.

(2) the electrons may impart their energy to the crystal lattice of the semiconductor causing its atoms to vibrate. These vibrations are known as phonons.

(3) the electrons may fall back across the gap to occupy holes in the valence band, emitting as it does so, quanta of electromagnetic radiation, the frequency of which is determined by the width of the forbidden gap. This process, known as electron-hole recombination, is illustrated in Fig. 3.

These three processes, and others unmentioned, all occur in any semiconducting material simultaneously competing with each other. It is obviously the latter radiative process which is of interest to EL, and it is desired that this be the main process if good light emitting efficiencies are to be obtained.

CRITERIA FOR ELECTROLUMINESCENT MATERIAL

In some semiconducting materials a radiative transition can only be achieved after a process of the phonon type has occurred. This is a characteristic of the material and cannot be altered. As this process is a two stage one, the energy gap of the semiconductor is known as indirect, or the material is called an indirect semiconductor.

In other materials, known consequently as direct semiconductors, the radiative transition occurs singly. Other processes still compete but these are minor compared to the serious drawback of an indirect energy gap. They can in any case often be minimised by reducing the temperature of operation of the semiconductor if super-efficiency is required.

Clearly then, the first criterion for an electroluminescent material is that it be direct. The second is the width of the energy gap, as this determines the frequency of the emitted light.

According to quantum physics, energy and frequency of light are related by the equation.

$$\text{Energy} = h \times \text{frequency}$$

where h is Planks constant $= 6{\cdot}62 \times 10^{-27}$

$$\text{Since frequency} = \frac{\text{velocity}}{\text{wavelength}}$$

the energy equation becomes

$$\text{Energy} = \frac{h \times \text{velocity of light}}{\text{wavelength of light}}$$

Substituting for h and velocity of light and converting to convenient units yields

$$\text{Wavelength in angstrom units (Å)} = \frac{12{,}400}{\text{Energy in electron volts (eV)}}$$

The visible spectrum runs from 8,000Å (red) to 4,000Å (blue) which on conversion gives red as equivalent to 1·55eV and blue to 3·0eV.

To recapitulate, the semiconductor must have a direct gap, and this must lie within the range, 1·55 to 3·00eV for visible light emission. If the gap is narrower than 1·55eV, infra-red emission will be obtained. See Fig. 4.

DEVICES

Before investigating the available EL materials consideration must be given to the method of its use in the production of a useful device.

As we have seen the trick lies in the method by which non-equilibrium conditions are set up in the semiconducting material. This can be done by any form of energy input, but for EL it must obviously be brought about by electrical energy. There are two known ways of doing this, and this causes a split in the research into EL devices as the resulting products are so unalike.

The older method is the electroluminescent panel in which excitation is brought about by a high electric field although the full theory is not understood.

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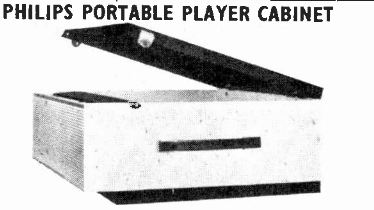

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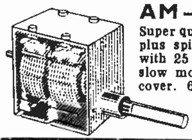

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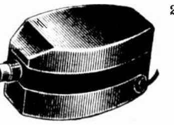

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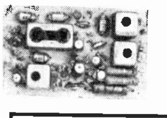
TWIN GANG. "0-0" 208pF + 176pF, 65p; Slow motion drive 365pF + 365pF with 25pF + 25pF, 50p; 500pF slow motion, standard 45p; small 3-gang 500 pF £1·60.
SHORT WAVE SINGLE. 25pF, 50pF, 55p.
CHROME TELESCOPIC AERIALS 23in. Swivel base 20p.
TUNING. Solid dielectric. 100pF, 500pF, 35p each.
TRIMMERS. Compression 30, 50, 70pF, 5p; 100pF, 150pF, 8p; 250pF, 10p; 600pF, 750pF, 10p; 1250pF, 10p.
SILICON REC. 40-LUCAS 2DS500 Bridge 70p. 5 amp £1.
RECTIFIERS CONTACT COOLED half wave 60mA 38p; 85mA 48p. SILICON BYZ13 30p; BY100 30p; BY127 30p.
Full wave Bridge Rectifiers 75mA 50p; 150mA 98p.
EX-GOVT. RECTIFIERS 250V 200mA 30p.
NEON PANEL INDICATORS 250V AC/DC Red or Amber 20p.
RESISTORS. ¼ w., ½ w., 1 w., 20% 1p; 2 w. 5p. 10 Ω to 10M.
HIGH STABILITY. ½ w. 2% 10 ohms to 1 meg., 10p. Ditto 5%. Preferred values 10 ohms to 10 meg., 4p.
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt, 10 ohms to 100K 10p each; 2½ watt, 1 ohm to 8·2 ohms 10p.

PHILIPS TRANSISTOR FM STEREO MULTIPLEX DECODER



As used in LEAK Troughline Tuner. Brand New. Pre-aligned with 9 semiconductors. 24V d.c. at 6mA. Complete with circuit and connection details. 3¼ × 2 × 1 in. **£4** Post Free

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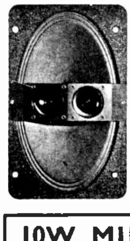
All post 25p each

250-0-250 80 mA. 6.3 v. 4 amp.	£1·40
250-0-250 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a. or 5 v. 2 a.	£2
350-0-350 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a. or 5 v. 2 a.	£2
300-0-300 v. 120 mA., 6.3 v. 4 a. C.T.; 6.3 v. 2 a.	£2·50
MINIATURE 200 v. 20 mA., 6.3 v. 1 a. 2¼ × 2¼ × 2in.	75p
MIDGET 220 v. 45 mA., 6.3 v. 2 a. 2¼ × 2¼ × 2in.	90p
P.E. AURORA TRANS. 12 + 12v., 500mA	£1·50
MINI-MAINS 20v. 100mA. 1¾ × 1¾ × 1¼in.	50p
HEATER TRANS. 6.3 v. 3a.	60p
Ditto tapped sec. 1.4 v., 2, 3, 4, 5, 6.3 v. 1½ amp.	80p

GENERAL PURPOSE LOW VOLTAGE. Tapped outputs at 2 amp., 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. £2
1 amp., 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60. £2
2 amp., 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60. £3
AUTO TRANSFORMERS. 115v to 230v or 230v to 115v. Input/Output, 150w. £2; 500w. £5; 1000w. £12
CHARGER TRANSFORMERS. Input 200/250v. for 6 or 12v., 1½ amp. £1·20; 2 amp £1·50; 4 amp. £2
FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12v. outputs. 1½ amp. 40p; 2 amp. 55p; 4 amp. 85p.
All Transformers Postage 25p each

E.M.I. 13½ × 8in. LOUDSPEAKERS



With twin tweeters. And crossover. 10 watt. State 3 or 8 or 15 ohm. As illustrated. **£4** Post 15p

With flared tweeter cone and ceramic magnet. 10 watt. Bass res. 45-60 cps. Flux 10,000 gauss. State 3 or 8 or 15 ohm. **£2·25** Post 15p

Recommended Teak Cabinet Size 16 · 10 · 9in. Post 25p. **£5**

10W MINI-MODULE LOUDSPEAKER KIT £3·25

Post 25p

Triple speaker system combining on ready cut baffle. ½ in. chipboard 15 in. 8½ in. Separate Bass, Middle and Treble loudspeakers and crossover condenser. The heavy duty 5 in. Bass Woofer unit has a low resonance cone. The Mid-Range unit is specially designed to add drive to the middle register and the tweeter recreates the top end of the musical spectrum. Total response 20-15,000 cps. Full instructions for 3 or 15 ohm.
TEAK VENEERED BOOKSHELF ENCLOSURE. 16½ × 10½ × 6in. Modern design, dark grey Tygan covered baffle. Or with Fluted Wood Front. 16 × 10 × 9in. **£5** Post 25p

ALL MODELS "BAKER SPEAKERS" IN STOCK

BAKER 12in MAJOR £9

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

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

BAKER "BIG-SOUND" SPEAKERS

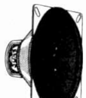
'Group 25'	'Group 35'	'Group 50'
12 inch 25 watt **£7**	12 inch 35 watt **£9**	15 inch 50 watt **£19**
3 or 8 or 15 ohm	3 or 8 or 15 ohm	8 or 15 ohm

TEAK HI-FI SPEAKER CABINETS. Fluted wood front.
For 12in. dia. speaker 20 × 13 × 9in. £9 Post 25p
For 13 × 8in. speaker 16 × 10 × 9in. £5 Post 25p
For 10 × 6in. speaker 16 × 8 × 6in. £4 Post 25p
LOUDSPEAKER CABINET WADDING 18in. wide, 15p ft

GOODMANS HI-FI 6in. WOOFER

8 ohm, 10 watt. Large ceramic magnet. Special Cambric cone surround. Frequency response 30-12,000 cps. Ideal P.A. Columns. Hi-Fi Enclosure Systems, etc. **£4**

ELAC CONE TWEETER



The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 cps to 18,000 cps. Size 3½ × 3½ × 2in. deep. Rating 10 watt. 3 ohm or 15 ohm models. **£1·90** Post 10p

Horn Tweeters 2-16Kc/s. 10W 8 ohm or 15 ohm £1·50.
De Luxe Horn Tweeters 2-18 Kc/s, 15W, 8 ohm £3.
TWO-WAY 3,000 c.p.s. CROSSOVERS 3 or 8 or 15 ohm 95p.
SPECIAL OFFER! 80 ohm. 2¾in. dia.; 35 ohm, 2in.; 3 in. 25 ohm, 2½in. dia.; 3in. dia.; 6 · 4in; 8 · 5in. 15 ohm, 3½in. dia.; 7 · 4in; 8 · 5in. **£1** EACH TYPE
8 ohm, 6 × 4in.; 3 ohm, 2½in. 3in. 5in. 5 · 3in, 7 · 4in.
LOUDSPEAKERS P.M. 3 OHMS. 6½in. £1·10; 8 × 5in. £1·25; 8 × 2½in. 90p; 8in. £1·75; 10 × 6in. £1·90.
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ELAC 10in. 10w. Twin Cone. De Luxe Ceramic 8 ohm £4.
RICHARD ALLAN TWIN CONE LOUDSPEAKERS 8in. dia. 4 watt; 10in. dia. 5 watt; 12 in. dia. 6 watt, 3 or 8 or 15 ohm models £1·95 each. Post 15p.
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SPEAKER COVERING MATERIALS. Samples Large S.A.E.
GOODMANS OUTPUT TRANSFORMER 5 watt push pull for valves EL84, etc., 3, 8 and 15 ohms 85p. Post 20p.

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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. **£39** Post Free

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

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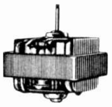
BARGAIN FM TUNER as above. Chassis only, less cabinet. **£7·50**

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

COAXIAL PLUG 6p, PANEL SOCKETS 6p. LINE 18p.
OUTLET BOXES. SURFACE OR FLUSH 25p.
BALANCED TWIN FEEDERS 5p yd. 80 ohms or 300 ohms.
JACK SOCKET Std. open-circuit 14p. closed circuit 23p; Chrome Lead Socket 45p. Phono Plugs 5p. Phono Socket 5p.
JACK PLUGS Std. Chrome 15p; 3·5mm Chrome 14p. DIN SOCKETS Chassis 3-pin 10p; 5-pin 10p. DIN SOCKETS Lead 3-pin 18p; 5-pin 15p. DIN PLUGS 3-pin 18p; 5-pin 25p. VALVE HOLDERS, 5p; CERAMIC 8p; CANS 5p.



E.M.I. TAPE MOTORS. 120v. or 240v. AC. 1,200 r.p.m. 4 pole 135mA Spindle 0·187 × 0·75in. Size 3½ × 2½ × 2¼in. (illustrated). Post 15p. **£1·25**
BALFOUR GRAM. MOTORS. 120v. or 240v. AC. 1,200 r.p.m. 4 pole 50mA. Spindle ¾ × 3/20. Size. 2¼ × 2¼ · 1¼in. Post 15p **85p**

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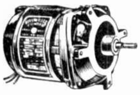
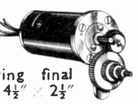
BODINE TYPE N.C.I. GEARED MOTOR



(Type 1) 71 r.p.m. Torque 10lb. inch. Reversible. 1/70th h.p., 50 cycle, 0·38 amp. (Type 2) 28 r.p.m. Torque 20lb. inch. Reversible. 1/80th h.p., 50 cycle, 0·28 amp. "As new" condition. Input voltage of motor 115V a.c. Supplied complete with transformer for **230/240V a.c. input.** Price, either type **£3·15** plus 35p P. & P. or less transformer **£2·13** plus 27p P. & P.

12 VOLT DC MOTOR

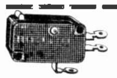


Powerful 1 amp. REVERSIBLE motor. Speed 3,750 RPM complete with external gear train (removable) giving final speed of 125 RPM. Size: 4½" × 2½" dia. Price **95p** inc. post.

230V/240V COMPACT SYNCHRONOUS GEARED MOTORS

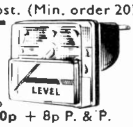
Manufactured by either Sangamo, Haydon or Smith. Built-in gearbox.
1 rev. per hour. Clockwise rotation.
1 rev. per hour. Anti-clockwise rotation.
2 revs. per hour. Clockwise rotation.
3 revs. per hour. Anti-clockwise rotation.
60 revs. per hour. 1 r.p.m. Clockwise.
Fraction of makers' price. All at **75p** incl. P.&P

MICRO SWITCH



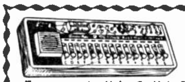
5 amp. c/o contacts. Fitted with removable push button assembly. Ex. P.O. 20 for **£1** inc. post. (Min. order 20)

MINIATURE LEVEL METER



Approximately 300 micro amp basic, as fitted to Tape Recorders, etc. Strip type dual coloured dial. **50p** + 8p P. & P.

ELECTRONIC ORGAN KIT



Easy to build, Solid State. Two full octave (less sharps and flats). Fitted hardwood case. Powered by two penlite 1½V batteries. Complete set of parts including speaker, etc., together with full instructions and 10 tunes. Price **£3·00.** P. & P. 22p.

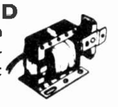
50 in 1 ELECTRONIC PROJECT KIT

50 easy to build Projects. No soldering, no special tools required. The kit includes Speaker, Meter, Relay, Transformer, plus a host of other components and a 56-page instruction leaflet. Some examples of the 50 possible Projects are: Sound Level Meter, 2 Transistor Radio, Amplifier, etc. Price **£7·75.** P. & P. 30p.

CRYSTAL RADIO KIT

Complete set of parts, including: Crystal Diode, Ferrite Aerial, Drilled Chassis, and Personal Ear Piece. No soldering, easy to build, full step by step instructions. **£1·75** inc. post.

230v AC SOLENOID



Extremely powerful with approx. 14lb. pull, 1" travel. Fitted with mounting feet. Size: 4" long, 2¾" wide, 3" high. **£2·00** incl. P. & P.

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200/250V Ex GPO. Tested. Manually set 2 on, 2 off every 24h. Override switch: 10A **£2·75,** 15A **£3·25,** 20A **£3·75.** P. & P. 20p. Also available with solar dial ON dusk, OFF dawn. Price as above.

VARIABLE VOLTAGE TRANSFORMERS

INPUT 230/240V a.c. 50/60 OUTPUT VARIABLE 0-260V.

All Types (and Spares) from ½ to 50 amp from stock.

2·5 AMP

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10 amp, £22·50.	20 amp, £49·00.
15 amp, £25·00.	25 amp, £58·00.
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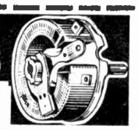
OPEN TYPE (Panel Mounting) ½ amp, **£4·75.** 1 amp, **£7·00.** 2½ amp, **£8·05.**

Superior Quality Precision Made NEW POWER RHEOSTATS



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, 230 mA; 2·5 kΩ, 2A; 5kΩ, 140 mA. Diameter 3½in Shaft length ⅜in, dia. 5/16in. All at **£1·50** each. P. & P. 5p.
50 WATT. 1/5/10/25/50/100/250/500/1/1·5/2·5/5kΩ. All at **£1·12 each.** P. & P. 11p.
25 WATT. 10/25/50/100/250/500/1/1·5/2·5/3·5/5kΩ. All at **78p each.** P. & P. 15p.

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

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Speed adjustable 1 to 36 Flash per sec. All electronic components including Veroboard S.C.R. Unijunction Xenon Tube and instructions **£6·30** plus 25p P. & P.

NEW INDUSTRIAL KIT
Ideally suitable for schools, laboratories, etc. Roller tin printed circuit. New trigger coil, plastic thyristor. Speed adjustable 1–80 f.p.s. Price **£10·50.** P. & P. 50p.

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This strobe has been designed and produced for use in large rooms, halls and the photographic field, and utilizes a silica plug-in tube for longer life expectancy, printed circuit for easy assembly, also a special trigger coil and output capacitor. Speed adjustable 0–30 f.p.s. Light output approx. 4 joules. **£12·00.** P. & P. 50p.

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AND NOW!

THE 'SUPER' HY-LYGHT KIT

Approx. four times the light output of our well proven Hy-Lyght strobe. Incorporating:
- Heavy duty power supply.
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7-inch POLISHED REFLECTOR
Ideally suited for above Strobe kits. Price **53p.** P. & P. 13p or post paid with kits.

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MINIATURE RELAYS · COMPETITIVE PRICES

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45	6–9	2 HD M	**50p**	700	15–35	2 c/o HD	**73p***
185	6–12	4 c/o	**73p***	700	16–24	6M	**63p***
230	9–12	4 c/o	**78p***	1,250	24–36	4 c/o	**63p***
280	9–12	2 c/o	**73p***	2,500	36–45	6M	**63p***
600	18–32	4 c/o	**78p***	2,400	30–48	4 c/o	**50p**
700	16–24	4M 2B	**63p***	5,800	40–70	4 c/o	**63p***
700	16–24	4 c/o	**78p***	9,000	40–70	2 c/o	**50p***
700	12–24	2 c/o	**63p***	15k	85–110	6M	**50p***

(1) Coil ohms; (2) Working d.c. volts; (3) Contacts; (4) Price
(HD) Heavy Duty. All Post Paid. *Including Base.

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230V a.c. coil 3 c/o. 10 amp a.c. contacts, **50p** plus 8p P. & P.

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Useful black, crackle finish, metal case. Size 9½" × 5" × 2½". Containing, One 12V LT transformer, three OC170, one AC128, one AF186, one 38·334 MHz crystal, mains neon, S.P. toggle, miniature fuse holder, pots, etc., etc. Sold for component value only, we have no details regarding usage or circuits. Bargain price ONLY **80p** + 30p P. & P.

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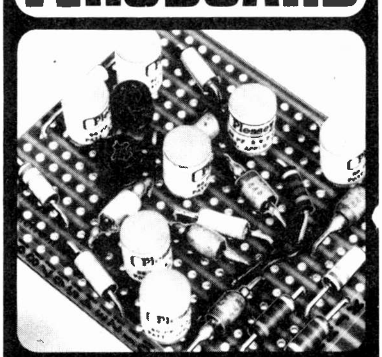

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4-STATION INTERCOM

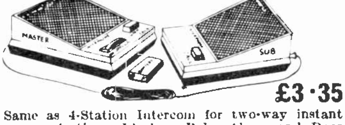
£7·25

Solve your communication problems with this **4-Station Transistor Intercom** system (**1 master** and **3 Subs**), in de-luxe plastic cabinets for desk or wall mounting. Call/talk/listen from **Master** to **Subs** and **Subs** to **Master.** Ideally suitable for Business, Surgery, Schools, Hospital, Office and Home. Operates on one 9V battery. On/off switch. Volume control. Complete with 3 connecting wires each 66ft. and other accessories. P. & P. 40p.

MAINS INTERCOM

No batteries—no wires. Just plug in the mains for instant two-way, loud and clear communication. On/off switch and volume control with lock system. Price **£14·50.** P. & P. 55p extra.

INTERCOM/BABY ALARM



£3·35

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

Transistor TELEPHONE AMPLIFIER

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Why not boost business efficiency with this incredible De-Luxe **Telephone Amplifier.** Take down long telephone messages or converse without holding the handset. A useful office aid. On/off switch. Volume control. Battery **14p** extra. P. & P. 22p. Full price refunded if not satisfied in 7 days.

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This method has been known for some time but modern materials research has improved the EL panel vastly, making d.c. operation feasible where before only a.c. was possible.

STRUCTURE OF PANEL

The basic construction of a panel is simple, see Fig. 5, although more complicated, and more efficient geometries have been produced. In a d.c. display, the backing electrode which is the cathode is made of aluminium.

The anode, through which the light must pass, is of glass treated in such a way as to make it conductive. This is accomplished by placing a very thin coating of tin oxide on its surface, by vacuum evaporation or by a chemical method, so that it remains transparent.

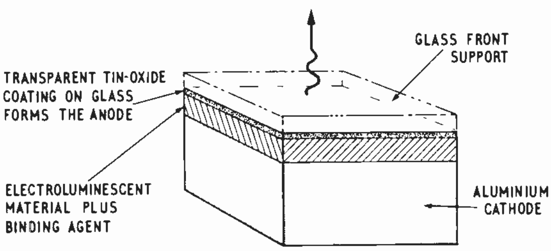


Fig. 5. Structure for a simple type of EL panel

The electroluminscent material is then mixed with a binding agent and spread very thinly between these electrodes, so that a high field is produced by a comparatively low voltage, typically 50 microns for 20 to 30 volt operation.

A newer method of stimulating EL and one which has been causing a great deal of interest, is based on the pn junction. The theory of this method of operation is better understood than the EL panel which still presents large areas of mystery.

If we suppose that a suitable material is available in both forms, i.e. *p*- and *n*-type, then a pn junction may be formed to make a diode.

In any junction diode, recombination of electrons and holes occurs at the junction when the diode is conducting in the forward direction as this is basic to its operation. If the semiconductor favours radiative recombination then the result will be light emission from the junction, produced directly by the passage of electric current through the diode.

To enable the light to escape the device, special geometries have to be employed in the manufacture of a crystal lamp if the bulk of the material is not to re-absorb it. Basically this means making a large area junction and arranging the emitting surface so that total internal reflection does not occur, which is by no means an easy job with the high refractive indices of most semiconductors. One type of arrangement is shown in Fig. 6.

MATERIALS FOR ELECTROLUMINESCENCE

How many materials are useful or potentially useful semiconductors? Germanium and silicon certainly and gallium arsenide is by now fairly well known, but the list doesn't stop there. Hundreds more are possible of which only a few as yet have been investigated. It would seem therefore that suitable EL materials would be commonplace but, unfortunately, this does not appear to be the case.

In the crystal lamp field if not in EL panels there is a desperate need for a good semiconductor. This shortage has led to the employment of one or two sophisticated tricks but the problem is by no means satisfactorily solved.

Consider the common semiconductors to see how they conform to the criterion laid down earlier. Germanium—indirect gap of 0·66eV, silicon—indirect gap of 1·08eV, both clearly of little use being so far in the infra-red as to make them inconvenient even if they were direct.

Gallium arsenide however is clearly much more

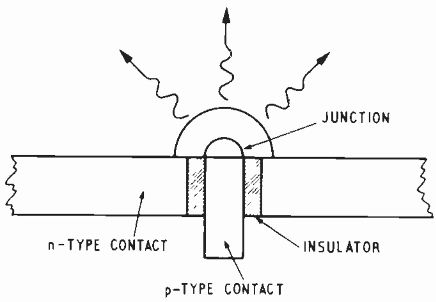


Fig. 6. Hemispherical structure of crystal lamp

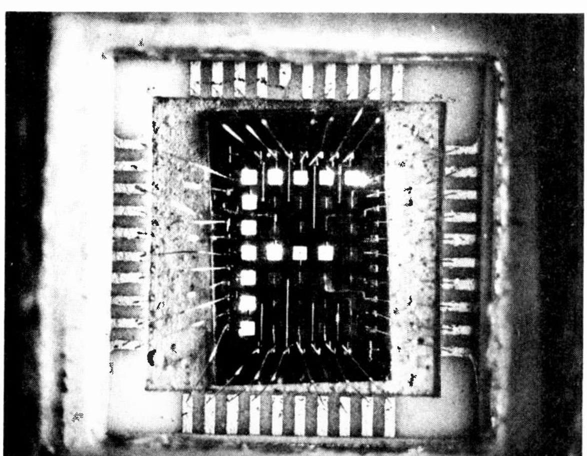
promising, having a direct gap of 1·5eV, tantalisingly close to visible. The available devices, 56CAY, MGA100, are made from gallium arsenide.

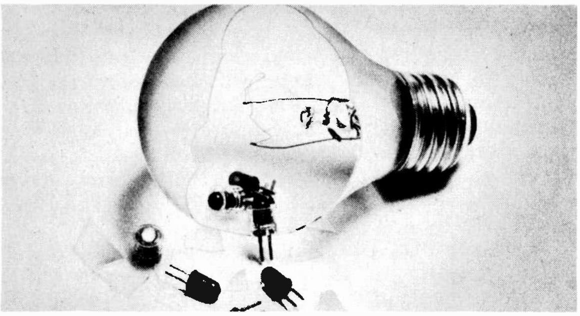
PERIODIC TABLE

Why is gallium arsenide a semiconductor? A glance at a section of the periodic table of the elements, Fig. 7, throws some light on this question and indicates where we may look for additional material.

We see that germanium and silicon lie in group IV as do tin and carbon. As diamond can be regarded as a semiconductor and so, under certain

An array of 35 gallium phosphide lamps within a package overall size ¼in × ¼in approximately. In this photograph, the lamps have been illuminated to form the initial letter of the maker's name, Ferranti





Plastic encapsulated gallium arsenide phosphide red light emitting diodes made by Hewlett-Packard. These solid state lamps are designed for panel mounting or for printed circuit board mounting

conditions, can tin, there seems to be something about group IV elements which have some connection with semiconducting properties.

If one element from group III is combined with one from group V, this also produces a semiconductor. These are known as compound semiconductors or compounds and gallium arsenide falls into this class.

II	III	IV	V	VI
	B	C	N	O
	Al	Si	P	S
Zn	Ga	Ge	As	Se
Cd	In	Sn	Sb	Te
Hg	Tl	Pb	Bi	Po

Fig. 7. Section of the Periodic table of the elements

In a similar fashion II-VI compounds are possible. Thus many semiconducting materials are possible and the more well known ones are listed in Table I. with their relevant parameters.

Confining ourselves to direct gap materials restricts the field considerably. All of the group IV elements are excluded, as well as three of the III-V compounds, the potentially useful three moreover. This leaves gallium arsenide as the compound with the largest direct gap, but this as we have seen is not good enough for visible EL.

At first sight the II-VI compounds are much more promising, zinc and cadmium sulphides both seem ideal, and indeed they are employed in the EL panel form of device. These materials, however, resist all attempts to grow them in both *p* and *n*-type forms and therefore crystal lamps cannot be constructed from them.

DOPING

The position for visible light crystal lamps would appear then to be hopeless, but two tricks are possible which partially solve the problem. Firstly, an indirect gap material with a larger than necessary gap can be used. Doping agents can be added to them which will create energy levels in the forbidden gap, effectively reducing it in size and giving it the characteristics of a direct gap.

Gallium phosphide doping in this way with zinc and oxygen will give a red emitting diode and the highest efficiency that has recently been obtained is in the order of 7 per cent. Inefficient green luminescence may also be produced from gallium phosphide, of approximately 0·1 per cent but this is stretching the material's capabilities. Gallium phosphide of the high quality needed cannot, as yet, be consistently produced.

MIXED CRYSTALS

The second trick consists of the formation of a mixed crystal. Most of the III-V compounds are intermixable, that is, they can be grown together as a single, homogenous crystal. If in the growing of gallium arsenide for example, a proportion of phosphorus is added to the molten material, the resultant crystal contains a percentage of gallium phosphide.

This is a mixed crystal and should not be considered to be a mixture of gallium arsenide and gallium phosphide, but as a crystal of gallium arsenide phosphide, written $Ga\,As_x\,P_{1-x}$, the x indicating a whole range of compositions from pure gallium arsenide to pure gallium phosphide.

As gallium arsenide is direct and gallium phosphide is indirect, somewhere in the mixed crystal composition there must be a change over from the one type of de-excitation to the other, and it is possible to increase the energy gap for a considerable way before it becomes indirect.

Red emitting lamps from gallium arsenide phosphide are possible if the crystal is grown with the correct composition. These lamps are becoming quite common in professional areas and it must only be a mater of time before they are generally available.

This is the state of the art at present as regards the crystal lamp field. Several other mixed systems have been tried and are workable propositions but they still only produce red light diodes. Present research is searching, rather desperately, for an efficient green emitter.

Table I: PROPERTIES OF THE BETTER KNOWN SEMICONDUCTORS

Material	Type	Formula	E_g (eV)	De-Excitation Process
Diamond	IV	C	5·2	indirect
Silicon	IV	Si	1·08	indirect
Germanium	IV	Ge	0·66	indirect
Silicon Carbide	IV	SiC	2·9	indirect
Gallium Arsenide	III–V	GaAs	1·5	direct
Gallium Phosphide	III–V	GaP	2·25	indirect
Gallium Antimonide	III–V	GaSb	0·67	direct
Indium Arsenide	III–V	InAs	0·36	direct
Indium Phosphide	III–V	InP	1·29	direct
Indium Antimonide	III–V	InSb	0·17	direct
Aluminium Phosphide	III–V	AlP	3·00	indirect
Aluminium Antimonide	III–V	AlSb	1·62	indirect
Zinc sulphide	II–VI	ZnS	3·7	direct
Cadmium Sulphide	II–VI	CdS	2·6	direct
Cadmium Telluride	II–VI	CdTe	1·45	direct
Cadmium Selenide	II–VI	CdSe	1·74	direct

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40362	68p	2N2905A	47p	2N4292	15p	BC149	10p	BFX88	26p
2N696	17p	2N2924	20p	AC107	46p	BC153	19p	BFY50	23p
2N697	18p	2N2925	22p	AC126	20p	BC154	20p	BFY51	20p
2N706	12p	2N2926	11p	AC127	20p	BC157	12p	BFY52	23p
2N930	29p	2N3053	27p	AC128	20p	BC158	11p	BSX20	16p
2N1131	29p	2N3055	60p	AC153K	22p	BC159	12p	C407	17p
2N1132	29p	2N3702	13p	AC176	16p	BC167	11p	MC140	25p
2N1302	19p	2N3703	13p	ACY20	20p	BC168	10p	MPS6531	35p
2N1303	19p	2N3704	13p	ACY22	16p	BC169	11p	MPS6534	30p
2N1304	26p	2N3705	13p	AD140	63p	BC177	14p	NKT211	25p
2N1305	26p	2N3706	13p	AD142	50p	BC178	13p	NKT212	25p
2N1306	33p	2N3707	13p	AD149	58p	BC179	14p	NKT214	23p
2N1307	33p	2N3708	10p	AD161	33p	BC182L	11p	NKT274	18p
2N1308	36p	2N3709	11p	AD162	36p	BC183L	10p	NKT403	65p
2N1309	36p	2N3710	13p	AF114	24p	BC184L	11p	NKT405	79p
2N1613	23p	2N3711	13p	AF115	24p	BC212L	16p	OC71	38p
2N1711	26p	2N3819	23p	AF117	22p	BC213L	16p	OC81	25p
2N1893	54p	2N3904	35p	AF124	24p	BC214L	16p	OC81D	25p
2N2147	95p	2N3906	35p	AF127	22p	BCY70	18p	ZTX300	14p
2N2218	34p	2N4058	13p	AF139	33p	BCY71	33p	ZTX301	16p
2N2218A	44p	2N4059	10p	AF239	36p	BCY72	15p	ZTX302	22p
2N2219	38p	2N4060	11p	ASY26	27p	BF115	23p	ZTX303	22p
2N2219A	53p	2N4061	11p	ASY28	27p	BF167	18p	ZTX304	27p
2N2270	62p	2N4062	12p	BC107	12p	BF173	19p	ZTX500	18p
2N2369A	19p	2N4124	18p	BC108	11p	BF194	14p	ZTX501	21p
2N2483	35p	2N4126	27p	BC109	12p	BF195	15p	ZTX502	25p
2N2484	42p	2N4284	15p	BC125	15p	BFX29	31p	ZTX503	22p
2N2646	47p	2N4286	15p	BC126	22p	BFX84	25p		
2N2904A	42p	2N4289	15p	BC147	10p	BFX85	52p	ZTX504	52p

RESISTORS

Code	Power	Tolerance	Range	Values available	1 to 9 (see note below)	10 to 99	100 up
C	1/20W	5%	82Ω–220KΩ	E12	9	8	7
C	1/8W	5%	4·7Ω–470KΩ	E24	1	0·8	0·7
C	1/4W	10%	4·7Ω–10MΩ	E12	1	0·8	0·7
C	1/2W	5%	4·7Ω–10MΩ	E24	1·2	1	0·9
C	1W	10%	4·7Ω–10MΩ	E12	2·5	2	1·9
MO	1/2W	2%	10Ω–1MΩ	E24	4	3·5	3
WW	1W	10%±1/20Ω	0·22Ω–3·9Ω	E12	7	7	6
WW	3W	5%	12Ω–10KΩ	E12	7	7	6
WW	7W	5%	12Ω–10KΩ	E12	9	9	8

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

Prices are in pence each for quantities of the same ohmic value and power rating. NOT mixed values. (Ignore fractions on total value of resistor order.)

Values:
E12 denotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24 denotes series: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

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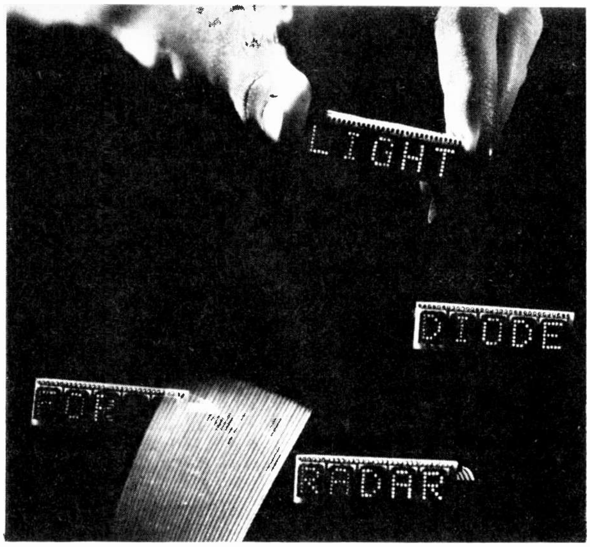


A data display developed by Marconi. Tiny slices of glass ceramic each carry a 7 × 5 matrix of gallium arsenide phosphide light emitting diodes; can be switched on to provide a pattern of high contrast letters, numbers, or symbols. The complete five letter words shown occupies only 32·5mm by 8·5mm

The crystal systems $In_xGa_{1-x}P$ and $In_xAl_{1-x}P$ are the most promising materials as yet investigated as they can provide direct energy gaps of the order of 2·2eV. These materials are exceptionally difficult to grow, however, and while InP-GaP can be grown to the right composition, InP-AlP has not yet been produced.

Even if these materials were available, they only give green, what do we do to obtain blue? At this stage we enter the realms of conjecture, the nitrogen III-V compounds, largly unknown, appear to hold out some promise although they have a different crystal structure to all of the other semiconductors mentioned here. Aluminium nitride and gallium nitride appear to be the favourites for investigation.

FOR THE FUTURE

With their limitations therefore, both crystal lamps and EL panels are working propositions. The red crystal lamp is quite well established and will undoubtedly become a part of the vast range of common semiconducting devices, but the EL panel is held up by one snag—its short working lifetime. This is caused by impurities slowly diffusing into the luminescent material and is a major problem, which until it can be overcome, will limit its usefulness seriously.

The "flat" television screen seems to be a very long term project indeed. A panel's electrodes can be patterned so that any particular part of the screen may be addressed in a similar manner to a computer memory matrix, but the definition possible by this method is severely limited and in any case only one colour is possible.

When green and blue crystal lamps are available perhaps this will provide the answer, but the interconnection problems with such a vast number of individual elements is enough to make even the bravest engineer apprehensive.

However, these problems are not insurmountable since the Sony Corporation have shown, by presenting full colour TV on a large screen consisting of a vast array of red, green and blue light bulbs. It remains therefore to obtain the devices and then await the consequences. ★

IN this the second and final part, constructional details for the electronic ignition system are given together with installation instructions and testing procedures, for both positive and negative earth cars.

CONSTRUCTION

The prototype system was housed in a $7\frac{1}{4}$in × $4\frac{1}{2}$in × 2in Eddystone die-cast box. All the components are mounted on the printed circuit board (Fig. 11) with the exception of the transformer, TR4, TR5 and the thyristor. These are bolted to the case which acts as a heatsink.

PRINTED CIRCUIT BOARD

It is strongly recommended that turret tags be used to make connection to the printed circuit board and these should be inserted and soldered before any of the components are mounted. Fig. 12 shows the component locations.

INVERTER TRANSFORMER

The inverter transformer T1 is wound on a Mullard FX2243 pot core with a DT2206 bobbin and should preferably be impregnated when finished to keep out moisture which could cause leakage or damage to the windings of the transformer.

The first job is to wind on 400 turns of 34 s.w.g. enamelled wire in eight neat layers of fifty turns, with thin insulation between each layer. Take great care not to cross adjacent turns. This high voltage winding is now insulated from the others with about four layers of insulation tape.

Now wind on 12 turns of 20 s.w.g. bifilar (i.e. two wires wound together) in two layers, and lastly the three turns of 30 s.w.g. bifilar feedback winding. The wires should be colour coded with sleeves as shown in Fig. 13 and another layer of insulation tape wrapped around the bobbin. Try to ensure that the sleeves go as far as possible into the bobbin so that when it is placed inside the ferrite cups the enamel insulation is not scratched by the core.

If the core cannot be impregnated then it is recommended that the faces are firmly joined with a thin layer of Araldite or the transformer may shriek objectionably. This does not happen of course if the transformer is impregnated.

The reliability of the whole system depends on the care with which the transformer is made.

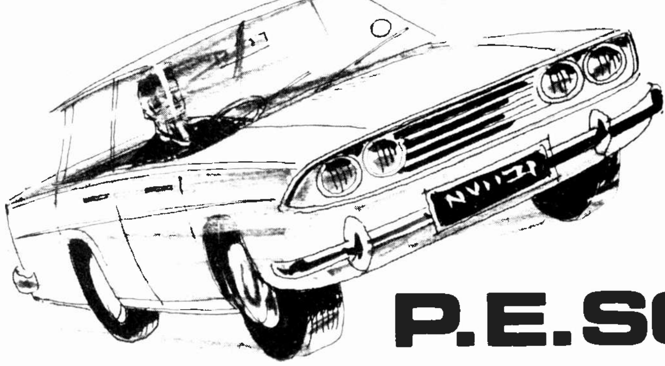
UNIT ASSEMBLY

The box should be drilled as shown in Fig. 14 and the holes deburred with larger drills, taking care to remove any roughness where the mica washers are to be placed for TR4, TR5 and the thyristor.

All the components can now be assembled in the box ready for the final wiring. Cadmium plated nuts and bolts should be used, with the exception of the bolt securing the thyristor, since steel ones will soon rust.

Interwiring details for the ignition system are given in Fig. 15.

The thyristor should be mounted with a nylon bolt to remove the possibility of any flash over at this point due to the high voltages. The transistors



P.E. SCORPIO CAR IGNITION

By D. S. GIBBS and I. M. SHAW (Ferranti Ltd)

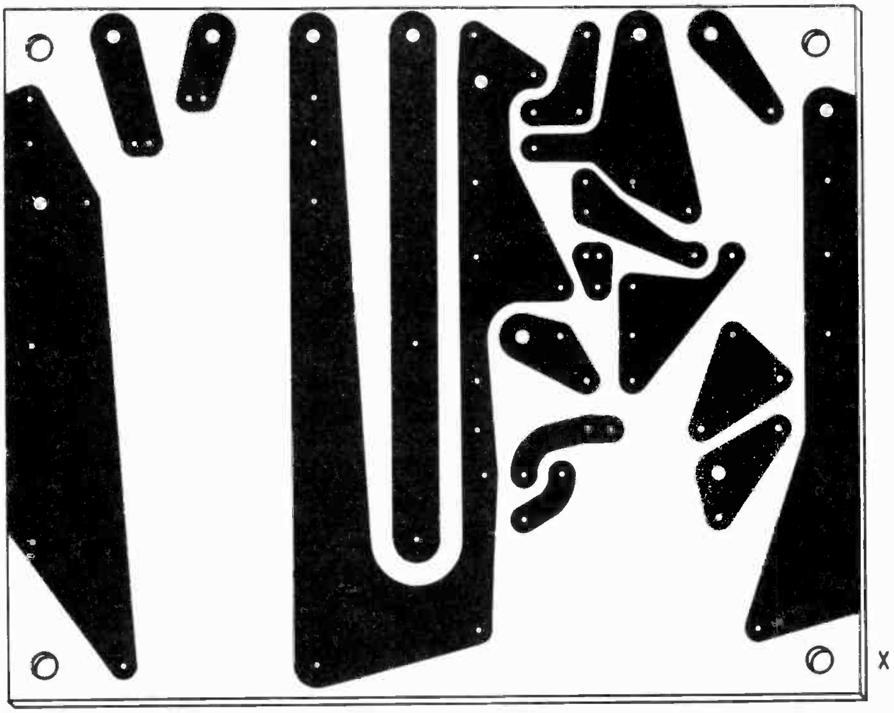


Fig. 11. Printed circuit board for ignition system, shown full size

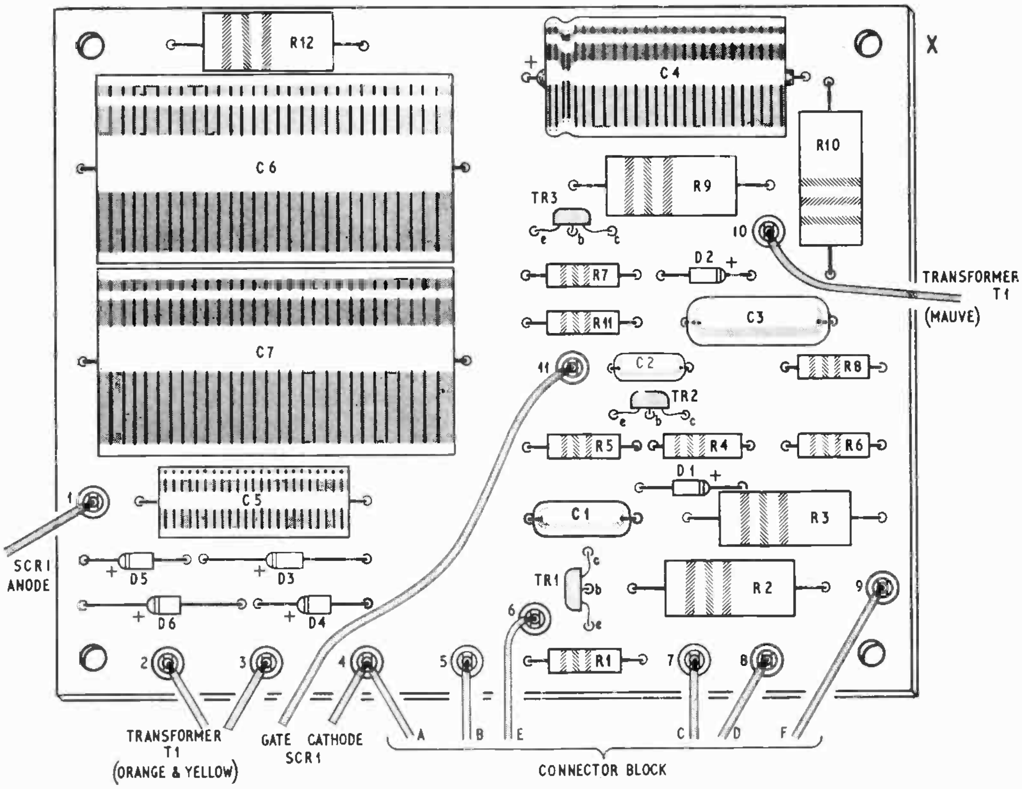


Fig. 12. Component layout and wiring for printed circuit board

. . . . reliability depends on careful transformer construction

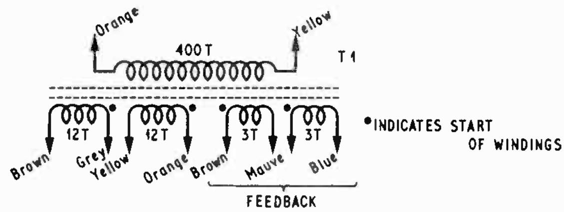


Fig. 13. Winding details, for inverter transformer

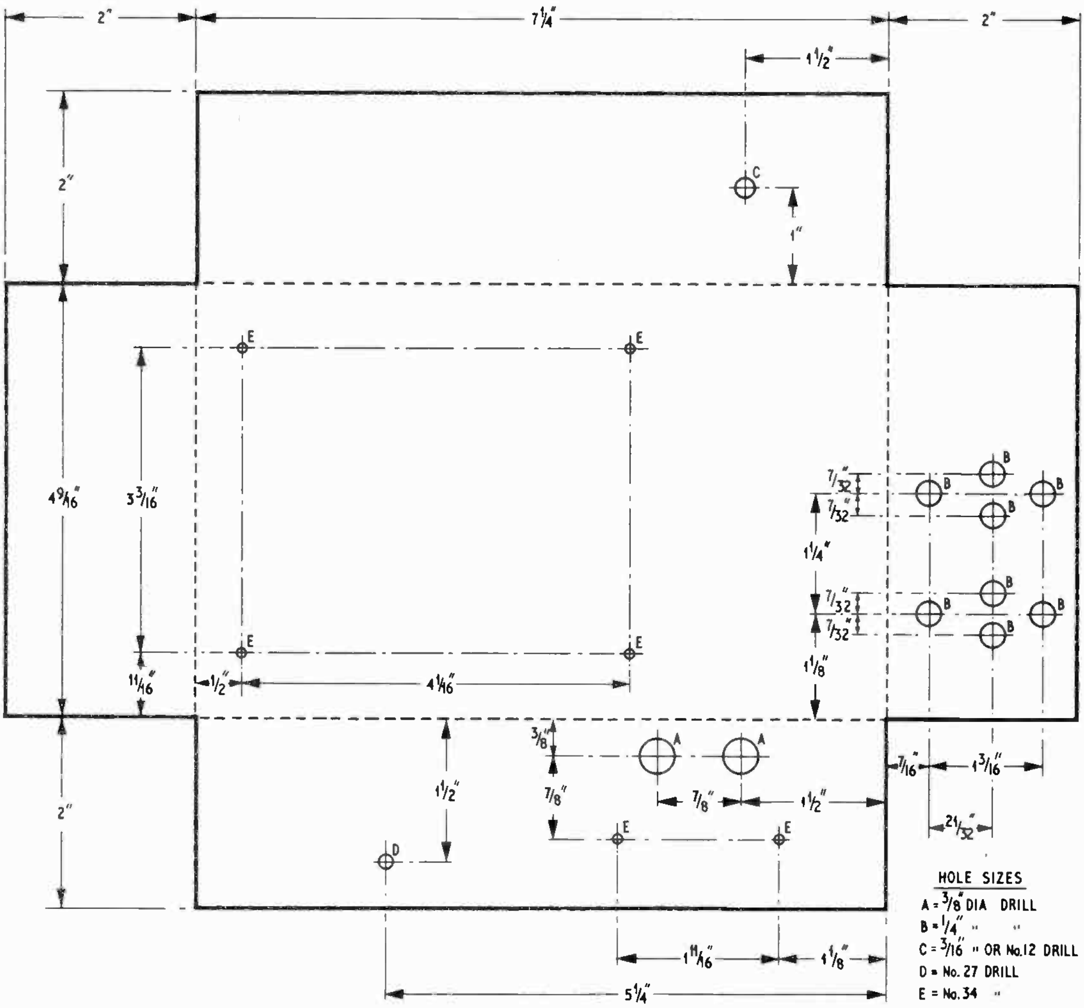
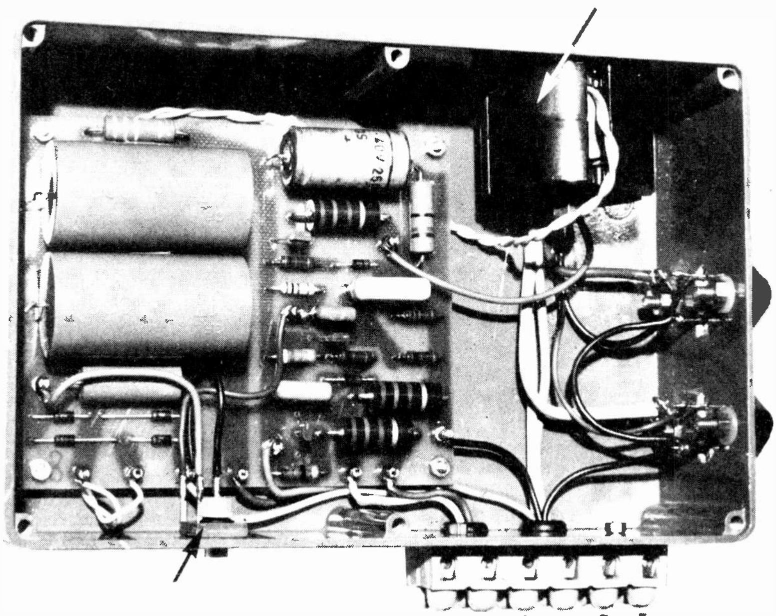


Fig. 14. Drilling details for die-cast box



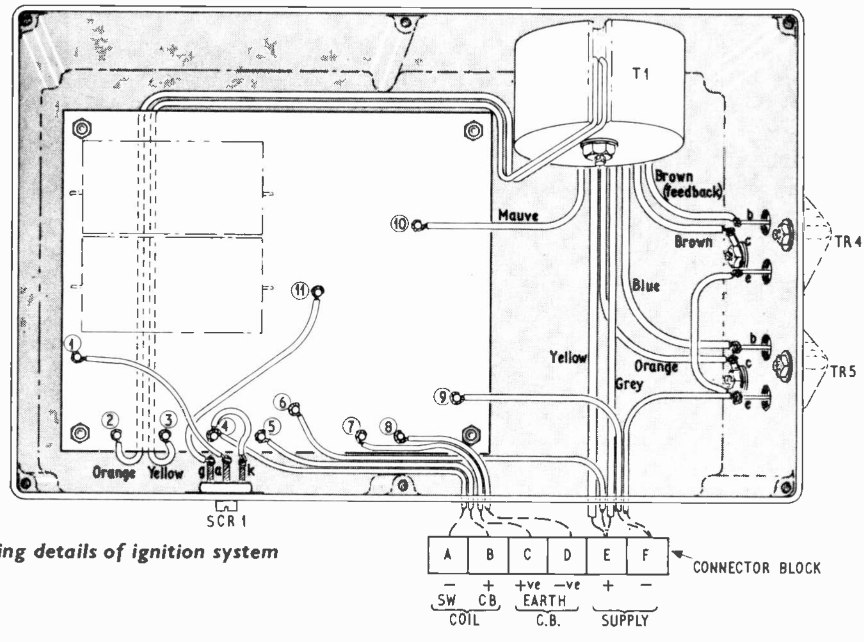


Fig 15. Interwiring details of ignition system

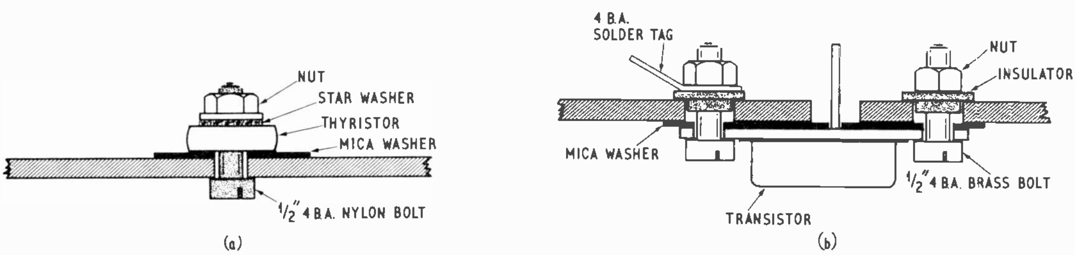
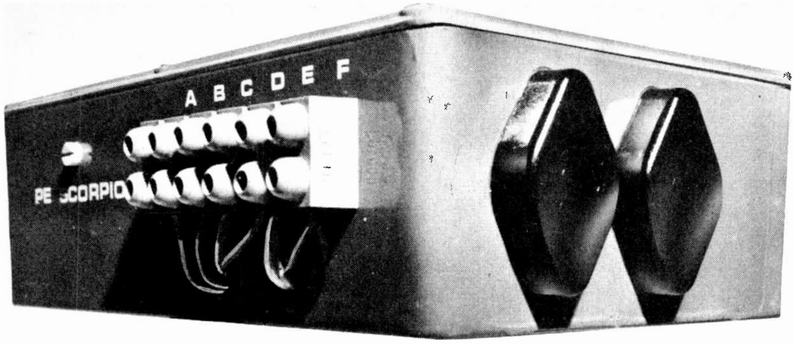


Fig. 16. (a) Mounting details for thyristor. (b) mounting details for inverter transistors



Plastic covers are fitted over the inverter transistors to prevent accidental short circuits

TR4 and TR5, and the thyristor, must be mounted on mica insulating washers as indicated in Fig. 16 with solder tags on the lower two transistor fixing screws for the collector connections. Plastic covers should be fixed to the transistors to prevent accidental short circuits when the unit is installed in the car.

The printed circuit board is mounted on spacers of about ¼in in length. Use a spring washer between the transformer mounting bolt and the core so that the transformer can be secured firmly without danger of cracking the ferrite core.

The unit can now be wired with 14/·0076 wire in assorted colours for identification. Care must be taken to connect the transformer windings correctly or the inverter will not oscillate.

The wires to the six-way connector block are brought out via two grommets just below it.

CHECKING THE UNIT

After checking the wiring carefully some simple checks should be performed before installation, if the constructor does not have facilities to fully test the operation of the unit.

If the construction has been carried out as described using only good quality components the only check necessary is that the inverter transformer windings have been correctly connected and that it delivers the correct output voltage.

To do this connect the car battery between (E) and (F) on the connector block. The transformer should be heard to "sing" immediately and approximately 500 volts d.c. can be measured between tags 1 and 4 on the printed circuit board (positive on tag 1). If this is not correct then the phases of the transformer windings will have to be examined and corrected before installation.

The current taken from the battery is approximately 500mA when the inverter is operating correctly.

INSTALLATION

All connections from the car for both positive and negative earth are made to the connector block, but since there are some differences they will be explained separately.

First, a suitable place in the engine compartment should be found to mount the unit so that the wires can be cut to the correct lengths. In both systems the wire connecting the ignition coil to the contact breaker must be removed but kept, so that the car can be reconstructed to the conventional system if necessary at any time.

POSITIVE EARTH CARS

The wire or wires connected to the SW or negative terminal of the ignition coil for positive earth systems, must be connected instead to the negative supply input to the unit (F) since this supply is via the ignition switch.

The two connections between the unit and the coil are made next; SW or negative to (A) and CB or positive to (B). These must be the only connections to the coil terminals.

The contact breaker is connected to (C) and good earth from the car chassis or positive battery terminal to (E). There are a total of five wires to the unit for positive earth cars with contact (D) left disconnected.

NEGATIVE EARTH CARS

The connections for negative earth cars are somewhat simpler since the wires to the positive terminal of the coil can be left connected and the positive supply terminal of the unit (E) connected to it.

The contact breaker is connected to (D) and the negative coil terminal to (B). Contact (F) is earthed making a total of four wires to the unit with contacts (A) and (C) left unconnected.

The astute reader will deduce that the first half cycle of the spark in the negative earth system is positive and not negative as is usually recommended. This can be corrected by reversing the connections to the coil. In some cases this may be inconvenient as the positive terminal is sometimes used as a junction point for leads from other equipment and the coil is supplied with more than one tag on the positive side to accommodate them. It is not really necessary to go to the trouble of reversing the initial spark polarity since the unit generates a dual polarity spark (Fig. 6a, Part One).

The unit can now be fitted to a convenient place in the engine compartment by drilling at least two suitable holes in the bottom of the box, and the car, and screwing the unit in place with self tapping screws.

COLD START COILS

Some cars are fitted with a "cold start" coil, which is a low voltage coil with a series ballast resistor that is shorted out when starting, to give an increased spark voltage under cold starting conditions. The ballast resistor is usually attached to one of the terminals of the coil but it may take the form of a resistance cable between the ignition switch and the coil.

. . . . never attempt to remove spark plug leads while engine is running

It does not actually make any significant difference to the spark produced by the unit whether the resistor is left in series with the coil or not, but the resistance cable should not be used to supply power to the unit as there will be a considerable loss of voltage along it. In this case it is best to remove the resistance cable and replace it with a length of wire. In all cases the connection between the coil and the starter solenoid *must* be removed.

PRECAUTIONS

Because of the high open circuit voltage produced by this unit *never* attempt to remove the spark plug leads whilst the engine is running, since not only is there a danger of breaking down the insulation of the coil but the experimenter stands a good chance of getting a nasty shock.

In addition the thyristor can be exposed to transient voltages of up to 1,000V under these conditions and may be destroyed.

PERFORMANCE

In most capacitor discharge ignition systems the usual fault is for the thyristor to "latch on" with the short circuit current available from the inverter, especially when an iron cored transformer is used. This cannot occur in the system described here as explained in Part One.

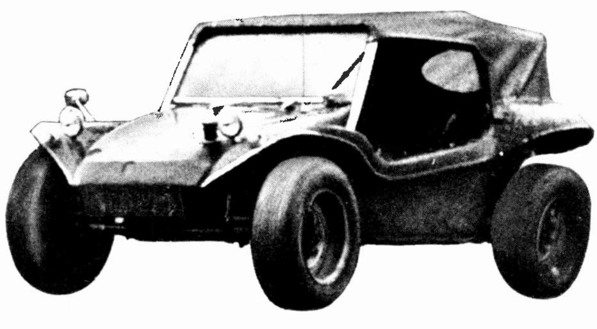
The spark gap of the plugs may be increased with advantage for smoother idling, but not above 0·04in or the insulation of the ignition coil will be unduly taxed, especially in cars with high compression engines ($>$ 10 : 1).

The unit will perform satisfactorily down to at least 8 volts thus giving a good spark at the plugs even under very cold starting conditions when the battery is at its lowest capacity.

The points and timing should be checked when installing the unit since from now on they can be left for many thousands of miles. Cars fitted with this unit can be expected to operate more economically since the car is kept in "peak tune" all the time. This is because the points do not wear and the timing and dwell angle do not change with time, except for the very slight wear on the heel of the contact breaker.

Four units as described in this article have been built and tested in various types of British car under different driving conditions and it can be stated that "P.E. Scorpio" is without doubt an effective transistor ignition system achieving improved performance.

Brake horse power has been measured on a "rolling road" and has shown to be about 5 per cent higher with a subsequent improvement in the "liveliness" of the car. One particular feature is the more consistent performance of the car after tuning has occurred from thousands of miles of driving. ★



LOGICAL RADIO CONTROL

continued from page 985

TIMING COMPONENTS

The interval timing resistors R1 to R5 have a maximum value of approximately 490 ohms due to the input threshold of the gates; lower values may be used with a corresponding change (increase) in the capacitors C2, C4, C6, C8, C10 but the *CR* product must remain the same.

The signal pulse timing potentiometers VR1 to VR6 will provide a maximum and minimum value. The minimum value of approximately 200 ohms corresponding to a pulse length of approximately 0·5ms and the point at which the following gate will just open. The maximum value is given as 1·2 kilohms. With 10μF capacitors for C3, C5, C7, C9, C11, a pulse of 2ms will be given, while 800 ohms setting for the potentiometers will provide 6ms pulses.

The recommended arrangement is 240Ω in series with a 500Ω potentiometer to ground. The cycle time is derived from the trigger circuit (Fig. 5) in which TR1 and TR2 form a multivibrator, the period of which is approximately 1·4*CR*. If C12 is 1·5μF and R6 and R8 are both 15 kilohms, the pulse time will be approximately 18ms (Fig. 6).

The positive going edges at the collector of TR1 are slowed by the action of the timing capacitors, so the output is taken from TR2. Diode D1 and R10 form an isolation circuit so that C13 will not discharge through the trigger circuit. The output waveform is differentiated by C14 and R11 to give a positive pulse of time constant approximately 0·3ms (Fig. 6c). The trigger transistor TR3 switches off producing the sharp-edged negative going pulse (Fig. 6d) to the trigger output every 36ms.

LAYOUT

Fig. 7. shows the printed circuit layout full size; it is recommended that extra space along one side is provided for mounting purposes. All holes should be drilled clean and vertical from the copperside with an HSS or tungsten carbide number 58 drill, and a small clean tipped soldering iron used.

Fig. 8 shows component layout, the i.c.s being inserted and soldered in first, followed by the fixed resistors and capacitors. Using thin flexible covered wire the four final interconnections to IC7 should be made as shown in Fig. 9, together with the trigger connections, supply leads and six various coloured wire leads which go to the control panel for connection to VR1 to VR6.

Next month: Two more coders and a decoder

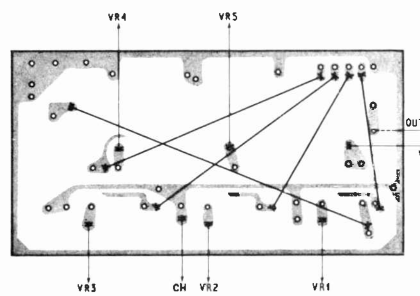


Fig. 9. Potentiometer connections to Coder I

BY J. D. CROFT

I.C. DIGITAL DICE

THIS circuit is a revised version of the circuit published in "Ingenuity Unlimited," April 1971, now using integrated circuits.

When re-designing the circuit to use integrated circuits it was found that not only is the finished dice smaller and neater, but by using the low price i.c.s. now available, it is also cheaper to build.

THEORY

The logic diagram of this dice is shown in Fig. 1.

The circuit is basically a divide-by-six counter driven via the control gate G11 by a 4·8kHz clock pulse.

The count is stopped by the control gate when the player presses the play button, and the binary output of the counter is decoded by gates one to nine to light lamps LP1-LP7 set in the usual dice pattern.

The binary output is decoded into four lamp outputs, the first of which decides "even or odd." If the count is odd, the centre lamp, LP3, lights. Next, gate G1 decides "NOT 1" which lights two diagonally opposite lamps LP6 and LP7—except during a "1."

A third gated output, gates G5, G6 and G7 decide 4. 5, or 6 and lights the two remaining diagonally opposite lamps, LP4 and LP5 on these counts. The last output, gates G8 and G9, decide "6" and lights the two remaining lamps on this count. A little thought will show that these combinations will automatically light the correct number of bulbs in the correct patter for each dice position.

Player intervention is prevented in two ways. Firstly, by extinguishing the display lights while the counter is operating, and secondly, by the high clock pulse speed adopted which is far higher than any human reflex.

CIRCUIT CONSTRUCTION

The circuit is built on a piece of Veroboard (0·1in matrix) as shown in Fig. 2. The board should be cut to size and some strips cut as shown in Fig. 3, before the integrated circuits are fitted.

It is recommended to leave the soldering of the i.c.s. until all the other components and straps have been fitted as it is almost impossible to remove them should they be soldered in the wrong position.

When soldering on 0·1in matrix Veroboard great care should be taken as the solder easily bridges the closely spaced strips, and if the strips are overheated they could come adrift from the laminate causing intermittent faults.

COMPONENTS . . .

Resistors
R1, R2, R3, R4 4·7kΩ (4 off)
R5 47Ω
R6 100Ω
All 5%, ¼W carbon

Capacitors
C1, C2 0·1μF 15V (2 off)

Semiconductors
TR1, TR2, TR3, TR4 2N3704 (4 off)
D1, D2 OA91 (2 off)

Integrated circuits
IC1, IC3, IC4 SN7400 (BPOO) Quad 2-input gates (3 off)
IC2 SN7492 (BP92) ÷ 12 counter
IC5 SN7410 (BP10) triple 3-input gate

Switches
S1 Single pole on/off toggle
S2 Single pole push button

Lamps
LP1–7. 6V 0·3W l.e.s. type (7 off)

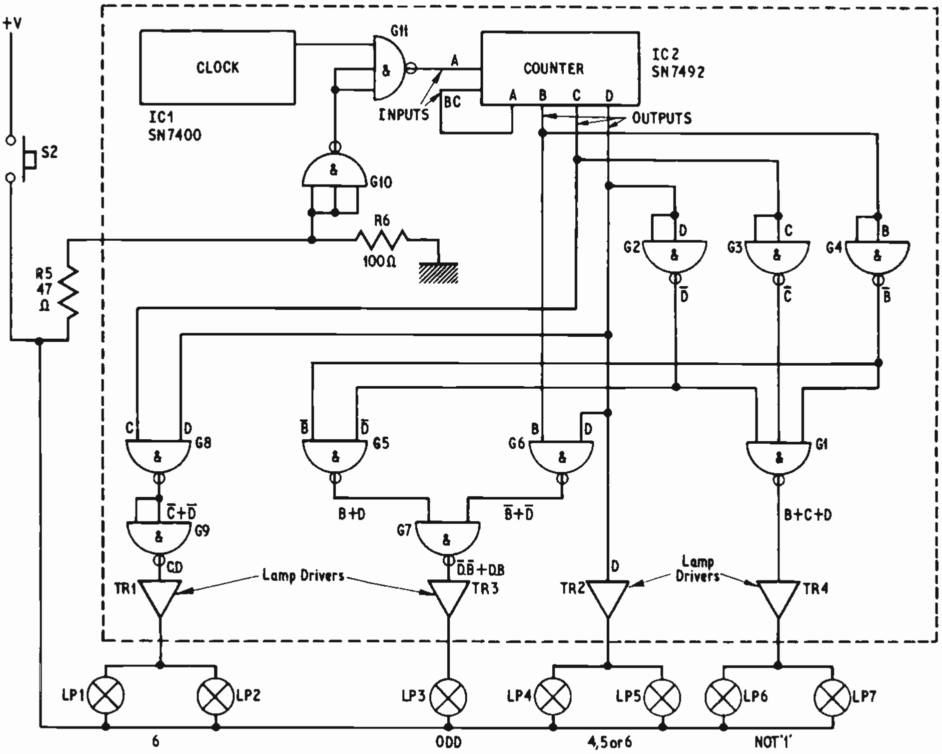
Miscellaneous
Lampholders for lamps (7 off)
Veroboard, 2½in × 2⅛in (0·1in matrix)
Battery 6V (4 × 1·5V in series, type HP7)

CASE

The dice case may be varied to suit individual requirements and materials available. The case in the suggested design is a standard M.E.M. plastics box for mounting a double mains socket, fitted with the appropriate blanking plate. This will make a neat, strong case, which will accommodate the circuit board and lamp display and also four pen-light cells in a four-cell battery holder.

If due to anticipated prolonged use a larger battery or 6V mains power unit is required, a larger case should be used which can be constructed from wood or Perspex.

The lamp display in the author's unit was wired for miniature 6V l.e.s. lamps and lampholders held in position by using stout copper wire, which acts as both support and electrical common positive bus bar. If required the lampholders could be secured in their correct position by using Araldite.



COUNT	D	C	B
1	0	0	0
2	0	0	1
3	0	1	0
4	1	0	0
5	1	0	1
6	1	1	0

Fig. 1. Circuit diagram of the electronic dice with the logic gates "taken out" of the integrated circuit packs. Circuitry within the grey area is mounted on the 0·1in matrix Veroboard

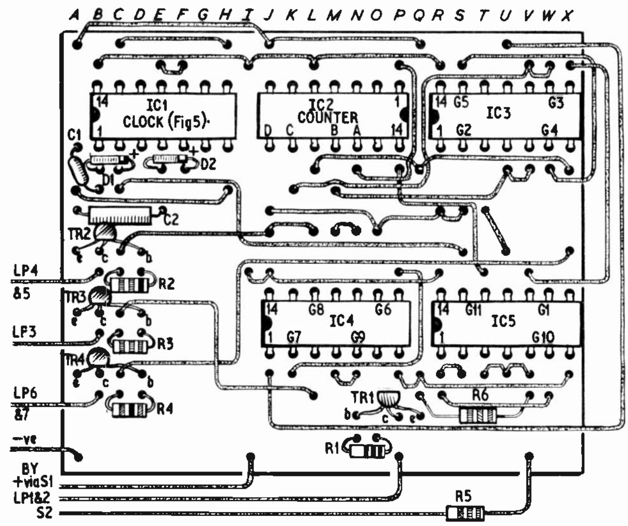


Fig. 2. Wiring and layout of the logic integrated circuits and lamp drivers

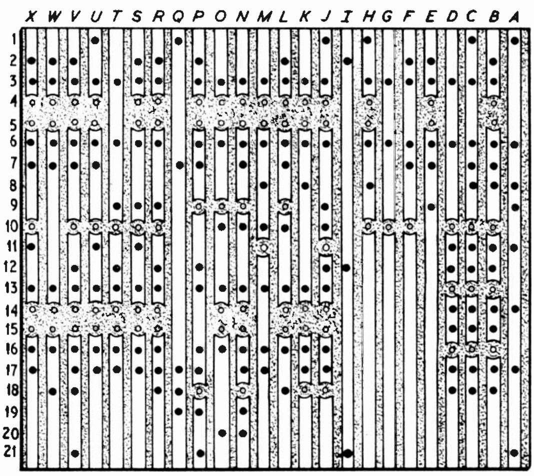


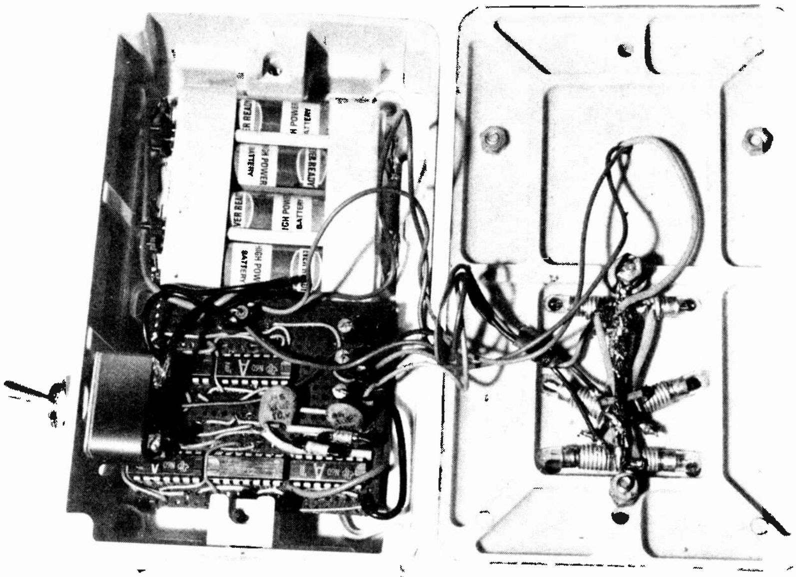
Fig. 3. View of the underside of the Veroboard showing the copper regions that must be removed

DISPLAY PANEL

The holes for the display are covered by a piece of ⅛in translucent Perspex to hide the non-illuminated holes.

This Perspex should be chosen with care, as some colours tend to diffuse the light spots making reading of the display panel difficult.

The Perspex may be selected by holding a sample against a piece of cardboard with a small hole in it and viewing it against background illumination to check that a clean-edged spot can be seen. A blue or violet Perspex was found to be best.



CHECKING

After assembling the dice, the connections should be rechecked before fitting the batteries since a single wrong strap could easily permanently damage an integrated circuit.

If desired the correct working of the dice can be verified in the following manner.

CLOCK CHECK

The clock output can be checked by connecting an oscilloscope between holes 8C and 8A on the Veroboard where a 4·8kHZ square wave should be observed. In the absence of an oscilloscope, a pair of high resistance headphones in series with an 0·1μF capacitor may be used to detect the output from the clock which will be observed as a high pitch whistle.

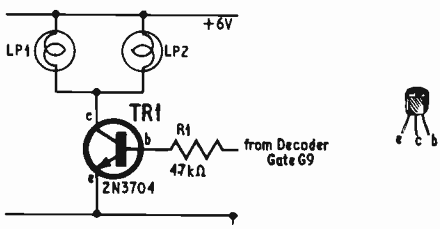


Fig. 4 (a). The lamp driver circuit that amplifies the output from the 4 decoders to light the lamps; (b) Pictorial view of the transistor used in this circuit showing base connections

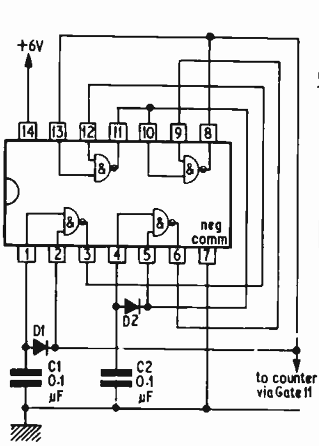


Fig. 5. Wiring of the SN7400N Quad 2-input nand gate to give a 4·8kHz multivibrator for use as clock

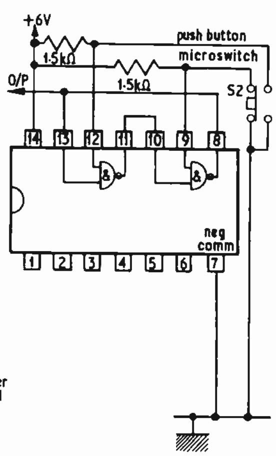


Fig. 6. Use of half a SN7400N to provide test input signals to the counter

TESTING COUNTER AND DECODER

The counter and decoding gates may be checked by injecting test signals into the counter.

This is done by the use of a microswitch buffered by a bistable to remove switching transients. The bistable is constructed from half a SN7400N quad 2-input gate i.c. connected as shown in Fig. 8. This circuit is worth building as a permanent unit as it is invaluable in all testing work on TTL and DTL circuits.

The output from the bistable should be connected to hole *7P* on the Veroboard with the wire to *13T* temporarily removed. On operating the microswitch the display should be found to advance one count for every two depressions of the microswitch. The reason why two pulses are required to step the display by one count is that the SN7492N is a divide-by-twelve counter, and in the present application the "A" stage output is not used. The reset line of the counter SN7492N is disabled by applying a permanent "O" on pin 7 of the reset gate, which is the R_0 gate in this package.

SWITCHING TRANSIENTS

If any trouble is experienced due to an uneven count, noise on the supply line may be the cause, in which case this is rectified by connecting 0·1μF capacitors between the negative and positive supply lines as near to the i.c.s as possible. This should remove the sharp fronts of any switching transients transmitted on to the supply lines.

This expedient should not be required if the unit is powered by batteries but may be required if the unit incorporates a mains power supply.

As the i.c.s are already working at 0·75 volts over the manufacturers' recommended working voltage, on no account must the supply voltage be raised above six volts.

Providing this value is not exceeded, no damage to the i.c.s should occur. ★

LINEAR & LOGIC I.C SURVEY

A look at most of the linear and logic integrated circuits now readily available to experimenters, private constructors and designers. More detailed technical information and pin connection diagrams are usually to be found in manufacturers' literature, often available from i.c. suppliers. Devices shown as being in TO5 packages may also be in similar packages (e.g. TO99, TO100, etc.) but with a different number of lead-outs.

PART 1 LINEAR I.Cs

THE first linear integrated circuits to be produced were operational amplifiers designed for instrumentation and similar applications. Introduced by Fairchild in 1963 the μA702 gave a performance equal to or better than the available discrete component amplifiers at a similar cost. The first "high performance" operational amplifier was the μA709 which Fairchild introduced in 1965. It had more gain, a reduction of input offset current, and allowed a higher output level.

While all operational amplifiers have many characteristics in common, some conditions peculiar to individual amplifiers may be found. For example, the μA702 has a limited input voltage range of +1·5V to −6·0V indicating the possibility of "latch-up" if this is exceeded.

The μA709 output stage uses complementary emitter followers with no bias between the two bases. This produces a dead zone which can cause an excessive distortion of the output signal when only a small amount of overall negative feedback is used.

The first of the "second generation" amplifiers was the μA741. This has built-in frequency compensation, short-circuit protection, no crossover distortion, an offset voltage null capability, low power consumption, no latch-up, and a large common-mode and differential voltage range.

At first sight this built-in frequency compensation appears to solve the problems of operating down to an overall gain of unity, without instability occurring and without using external components. However, it means that the frequency compensation is NOT optimum for overall gains greater than unity.

For a 40dB gain the 741 has a bandwidth of 10kHz compared with the 1MHz bandwidth obtainable with the 709 and recommended compensation.

Circuit Function	*Package	Ferranti	Motorola	Mullard	National Semi-conductor	RCA	RS Com-ponents	Siemens	SGS	Texas
High speed differential comparator 710C	TO5 DIL		MC1710CG MC1710CP		LM710C LM710CN		710MOPA 710 OPA		U5B771039X U6E7710393	SN72710L SN72710N
General purpose operational amplifier 702C	TO5 DIL		MC1712CG MC1712CP	TAA241		CA3032			U5B771239X U6E7712393	SN72702L SN72702N
High performance operational amplifier 709C	TO5 DIL	ZLD709C ZLD709CE	MC1709CG MC1709CP	TAA521	LM709C LM709CN		709MOPA 709OPA	TAA251	U5B770939X U6E7709393	SN72709L SN72709N
Dual version of 709C in one package	DIL		MC1437P							SN72709DN
Frequency compensated high performance operational amplifier	TO5 DIL	ZLD741C ZLD741CE	MC1741CG MC1741CP	TBA221	LM741C LM741CN	CA3056	741OPA	TBA221	L141T1 L141B1	SN72741L SN72741N
Version 741C without compensation 748C	TO5			TAA811	LM748C					SN72748L
Dual version of 741C	DIL				LM747C				L147B1	SN72747N

* DIL packages here are 14-lead versions except 741OPA which has 8 leads. Texas also make SN72709P. SN72741P. SN72748P in 8-lead DIL
Most manufacturers make operational amplifiers and comparators

FERRANTI

A.C. AMPLIFIERS

TYPE	FUNCTION	CASE
ZLA10	Wideband linear amplifier for video and i.f. stages	T05
ZLA15	Wideband linear amplifier, improved version of ZLA10	T05

D.C. AMPLIFIERS

TYPE	FUNCTION	CASE
ZLD2S/T/U	Differential d.c. amplifiers	T05
ZLD12C/D	Complementary output stages for ZLD2 series	T05
ZLD709C	Operational amplifier	T05
ZLD709CE	Operational amplifier	DIL
ZLD741C	Operational amplifier	T05
ZLD741CE	Operational amplifier	DIL

OTHER CIRCUITS

TYPE	FUNCTION	CASE
ZN400E	Analogue switch	DIL
ZN402E	Gated operational amplifier	DIL
ZN403E	Servo amplifier	DIL

GENERAL ELECTRIC

A.C. AMPLIFIERS

TYPE Old Number	TYPE New Number	FUNCTION
PA222	GEL222F1	800mW audio amplifier. 22Ω load
PA230	GEL230F1	Low level audio preamplifier. 72db gain
PA234	GEL234F1	1W audio amplifier. 22Ω load
PA237	GEL237F1	2W audio amplifier. 16Ω load
PA239	GEL239F1	Stereo version of PA230
PA246	GEL246S1	5W audio amplifier. 16Ω load
PA263	GEL263S1	3·5W audio amplifier
PA266	GEL266F1	1·6W audio amplifier

OTHER CIRCUITS

TYPE	TYPE	FUNCTION
PA264	GEL264S1	Voltage regulator
PA265	GEL265S1	Voltage regulator
PA424	GEL300F1	Zero voltage switch
PA436	GEL301F1	Phase controller for SCR
PA494	GEL304A1	Threshold detector

All the above devices have a special package

MOTOROLA

A.C. AMPLIFIERS

TYPE	FUNCTION	CASE
MC1303L	Stereo pre-amplifier. 68dB gain. 60dB separation	DIL
MC1304P	Stereo demodulator for f.m.	DIL
MC1305P	Stereo demodulator for f.m.	DIL
MC1306P	Complementary amplifier and pre-amplifier	DIL
MC1307P	Stereo demodulator for f.m. No audio mute	DIL
MC1330P	Low level video detector	DIL
MC1350P	I.F. amplifier with a.g.c.	DIL
MC1445L	Wideband amplifier circuits 16dB gain	DIL
MFC6010	F.M./I.F. differential amplifier 40dB gain at 10MHz	S
MFC8000	Dual differential amplifiers designed for input stage of stereo power amplifiers	S
MFC8001		S
MFC8002		S
MFC8010	1W audio amplifier and preamp	S
MFC8020	Class B driver	S
MFC8030	Flexible differential amplifier, 32dB gain	S
MFC8040	Audio preamp 3dB noise, 80dB gain	S
MFC9000	4W audio amplifier and preamp	S
MFC9010	2W audio amplifier and preamp	S

S Special package
* 9-lead small power transistor case

D.C. AMPLIFIERS

TYPE	FUNCTION	CASE
MC1430P	Operational amplifier 69dB gain	DIL
MC1433G	Operational amplifier 89dB gain	T05
MC1435G	Dual operational amplifiers of 71dB gain	T05
MC1435L	Dual operational amplifiers	DIL
MC1435P	Dual operational amplifiers	DIL
MC1437L	Dual MC1709	DIL
MC1439G	Internally compensated operational amplifier of 84dB gain	T05
MC1709CP	Operational amplifier	DIL
MC1710CP	Differential comparator	DIL
MC1712CP	Operational amplifier	DIL
MC1741CP	Fully compensated op. amplifier	DIL

OTHER CIRCUITS

TYPE	FUNCTION	CASE
MC1460G	Voltage regulator 2·5 to 17V 250mA	T05
MC1461G	Voltage regulator 2·5 to 32V 250mA	T05
MC1463G	Voltage regulator 3·8 to 32V 250mA	T05
MC1466L	Wide range voltage and current regulator	DIL
MC1469R	Voltage regulator 2·5 to 32 volts 600mA	*
MFC4060	Regulator 4V 200mA	S
MFC6030	Regulator 4V 200mA	S
MFC6040	Electronic attenuator	S

NATIONAL SEMICONDUCTOR & SILICON GENERAL

D.C. AMPLIFIERS

TYPE	FUNCTION	CASE
LM709CN/SG709CN	Operational amplifier	DIL
LM710CN/SG710CN	Differential comparator	DIL
LM711CN/SG711CN	Core memory sense amplifier	DIL
LM741C/SG741CT	Fully compensated operational amplifier	T05
LM748C/SG748CT	As LM741C without compensation	T05

OTHER CIRCUITS

TYPE	FUNCTION	CASE
LM103*	Voltage regulator 1·8V to 5·6V available	T046
LM305/SG305T	Positive voltage regulator 4·5 to 30V 20mA	T05
LM309/SG309T	Voltage regulator 5V 200mA. No external components	T05
LM309K/SG309K	Voltage regulator 5V 1A. No external components	T03

*LM103 is specified as "LM103—1·8" etc. depending on voltage required.

MULLARD

A.C. AMPLIFIERS

TYPE	FUNCTION	CASE
TAA263	Three stage cascade amplifier	TO72
TAA293	Medium frequency, general purpose amplifier	TO74
TAA300	Audio amplifier. 1 watt into 8ohms	TO74
TAA310	Low noise audio preamplifier for tape recorders	TO74
TAA320	Metal oxide silicon l.f. preamplifier	TO18
TAA350	Wideband limiting f.m./l.f. amplifier	TO74
TAA570	Limiter—amplifier with f.m detector	TO5
TAA960	Three stage active filter amplifier. 39dB gain per stage	TO74
TAA970	Microphone amplifier	TO74
TAB101	Four transistor ring modulator/demodulator	TO74
TAD100	A.M. receiver circuit	DIL
TAD110	A.M./F.M. i.f. amplifiers, three gain blocks	DIL

D.C. AMPLIFIERS

TYPE	FUNCTION	CASE
TAA241	Operational amplifier (702C)	TO5
TAA242	Operational amplifier (702)	TO5
TAA521	Operational amplifier (709C)	TO5
TAA811	Operational amplifier (741C without compensation)	TO5
TBA221	Fully compensated operational amplifier (741C)	TO5
TBA222	Fully compensated operational amplifier (741)	TO5

OTHER CIRCUITS

TYPE	FUNCTION	CASE
TBA281	Voltage regulator 2 to 37V 150mA	TO74
TBA673	Modulator/demodulator. Ring of four transistors	TO74
TBA750	Limiter amplifier	16DIL

PLESSEY

A.C. AMPLIFIERS

TYPE	FUNCTION	CASE
SL201B	Video amplifier, current gain 26, 15MHz BW	TO5
SL301B	Matched pair of transistors, h_{FE} 25 to 250, f_T 600MHz	TO5
SL303B	Matched trio of transistors, h_{FE} 25 to 250, f_T 600MHz	TO5
SL403D	3 watt audio amplifier 8 ohms load, 18V supply	*
SL610C	R.F./I.F. amplifiers. 18dB gain at 30MHz. 4dB noise. 85MHz BW	TO5
SL611C	R.F./I.F. amplifiers. 24dB gain at 30MHz. 4dB noise. 50MHz BW	TO5
SL612C	R.F./I.F. amplifiers. 32dB gain at 1·7MHz. 3dB noise. 10MHz BW	TO5
SL620C	Voice operated gain adjusting device used with SL630C	TO5
SL621C	SSB a.g.c. generator used with SL610/11/12	TO5
SL630C	Microphone/headphone amplifier with a.g.c. Gain 40dB	TO5
SL640C	Double balanced modulator	TO5
SL641C	Receiver mixer, double balanced modulator	TO5

* Special package with heat sink, DIL style
SL201 B/C are now maintenance types

D.C. AMPLIFIERS

TYPE	FUNCTION	CASE
SL701B/C	Operational amplifier, output symmetrical about earth	TO5
SL702B/C	Operational amplifier, output not symmetrical. The minimum gain is 66dB, open loop bandwidth 250kHz on all SL701, 702 i.c.s	TO5

TEXAS

Texas Instruments produce all the common operational amplifier circuits (702, etc.)
SN76013N 4W audio amplifier similar to Sinclair IC12

R.C.A.

A.C. AND D.C. AMPLIFIERS

TYPE	FUNCTION	CASE
CA3000	Differential amplifier gain 28dB BW 650kHz	TO5
CA3001	Differential amplifier gain 16dB BW 16MHz	TO5
CA3002	R.F./I.F. amplifier gain 19dB BW 11MHz	TO5
CA3005	R.F./I.F. differential amplifier gain 16dB BW 120MHz	TO5
CA3007	Differential audio amplifier gain 20dB BW 20kHz	TO5
CA3010	Operational amplifier gain 57dB BW 200kHz	TO5
CA3011	Wideband amplifier gain 65dB BW 20MHz	TO5
CA3012	Wideband amplifier gain 65dB BW 20MHz	TO5
CA3013	Wideband amplifier gain 65dB BW 20MHz	TO5
CA3014	Wideband amplifier gain 65dB BW 20MHz	TO5
CA3015	Operational amplifier gain 66dB BW 200kHz	TO5
CA3018	Package with transistors h_{FE} of 30 f_T 300MHz	TO5
CA3019	Package with six diodes	TO5
CA3020	Wideband amplifier gain 75dB BW 8MHz	TO5
CA3021	Wideband amplifier gain 50dB BW 800kHz	TO5
CA3022	Wideband amplifier gain 50dB BW 3MHz	TO5
CA3023	Wideband amplifier gain 50dB BW 10MHz	TO5
CA3026	Two darlington transistor pairs h_{FE} of 110 f_T of 550MHz	TO5
CA3028A	R.F./I.F. differential amplifier gain 35dB BW 5MHz	TO99
CA3029	Operational amplifier gain 57dB BW 200kHz	DIL
CA3030	Operational amplifier gain 66dB BW 200kHz	DIL
CA3035	Wideband amplifier gain 40dB BW 2·5MHz	TO5
CA3036	Two darlington pair transistors h_{FE} 82 f_T 150MHz	TO5
CA3039	Six diodes 5V p.i.v. 25mA max. current	TO5

R.C.A.

TYPE	FUNCTION	CASE
CA3040	Wideband amplifier gain 34dB BW 40MHz	T05
CA3041	Wideband amplifier/f.m. detector/a.f. preamp	14Q
CA3042	Wideband amplifier/f.m. detector/a.f. preamp	14Q
CA3043	I.F. amplifier/limiter/f.m. detector/audio preamp	T05
CA3044	Wideband amplifier/phase detector, for a.f.c. systems	T05
CA3045	Five transistors h_{FE} 110 f_T 300MHz	DIL
CA3046	Five transistors h_{FE} 110 f_T 300MHz	DIL
CA3047	Operational amplifier gain 84dB BW 20kHz	DIL
CA3048	Audio amplifier 53dB gain BW 250kHz	DIL
CA3049	Six npn transistors f_T 1·3GHz	T05
CA3050	Two darlington differential amplifiers f_T 600MHz	DIL
CA3051	Two darlington differential amplifiers f_T 600MHz	DIL
CA3052	Audio amplifier gain 53dB BW 300kHz	DIL
CA3053	R.F./I.F. differential amplifier gain 35dB BW 5MHz	T099
CA3054	Differential amplifier gain 32dB	DIL
CA3055	Voltage regulator 1·8 to 34V 115mA	T05
CA3056	Operational amplifier gain 86dB (741C)	T05
CA3059	Zero voltage switch for thyristor control 105mA	DIL
CA3060	Operational amplifier, characteristics can be varied by user	DIL
CA3062	Photo detector and power amplifier	T05
CA3065	I.F. amplifier, limiter, f.m. detector, audio driver	14Q
CA3070	Television chroma system, chroma signal processor	DIL
CA3071	Television chroma system, chroma amplifier	DIL
CA3072	Television chroma system, chroma demodulator	DIL
CA3075	F.M./I.F. amplifier, limiter, detector, audio preamplifier	14Q
CA3078	Operational amplifier gain 80dB BW 20MHz	T05

Most of the values given for RCA i.c.s are minimum values, except that in some cases the bandwidth figures for wideband devices are the maximum useful frequency, not the 3dB down frequency

S.G.S. A.C. AMPLIFIERS

TYPE	FUNCTION	CASE
TAA611B	2W audio amplifier	S
TAA611C	3W audio amplifier	S
TAA621	3W audio amplifier	S
TAA621A	4W audio amplifier	S
TAA661B	F.M./I.F. amplifier and detector	S
TBA231	Dual low noise operational amplifier gain 70dB	DIL
TBA271	Voltage stabiliser for varicap diode	T018
TBA311	Television signal processing	DIL
TBA581	I.F./F.M. amplifier, detector, preamp	S
TBA591	I.F./F.M. amplifier, detector, preamp	S
TBA641A	2·5W audio amplifier	S
TBA641B	4W audio amplifier	S
TBA651	A.M. receiver circuit	S
TBA631	Television sound circuit	S

D.C. AMPLIFIERS

TYPE	FUNCTION	CASE
μA710C	High speed differential comparator	T05
μA702C	General purpose operational amplifier	T05
μA709C	High performance op.-amplifier	T05
μA741C	Fully compensated op.-amplifier	T05

Q = quad-in-line

SIEMENS A.C. AMPLIFIERS

TYPE	FUNCTION	CASE
TAA141	Three stage audio amplifier 70dB gain 20kHz BW	T072
TAA151	Three stage audio amplifier 70dB gain 600kHz BW	T0100
TAA420	Low noise five stage amplifier 70dB gain 20kHz BW	T0100
TAA435	Audio amplifier for driver stages	T0100
TBA120	F.M./I.F. amplifier and demodulator 60dB gain	DIL
TBA400	Broadband amplifier r.f./i.f. 75dB power gain at 35MHz	S
TBA450	Stereo decoder	S
TBA460	A.M./F.M. i.f. l.f. amplifier	S

D.C. AMPLIFIERS

TYPE	FUNCTION	CASE
TAA521	Operational amplifier (709C)	T05
TAA522	Operational amplifier (709)	T05
TAA861	Operational amplifier 70mA output current 90dB gain	T078

S = Special package

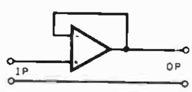
APPLICATIONS OF LINEAR I.C.s

Both the 709 and 702 require several external components to frequency-compensate the amplifier so that it is stable under closed-loop conditions and cannot oscillate. The 702, 709 and the 710 comparator were the "first generation" amplifiers.

Although fully compensated, operational amplifiers can be used in any feedback circuit without instability occurring, and without external compensation components, bandwidth and slew rate are reduced. The 710, 702, 709, 741 are produced by many manufacturers. A "C" suffix (for example 702C) has a slightly reduced temperature range and specification over the version without the suffix.

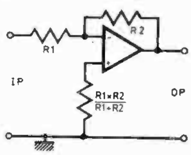
SERIES 741C OPERATIONAL AMPLIFIER

Although operational amplifiers are perhaps the most useful of the vast range of available linear integrated circuits, with varied applications from multivibrators to active filters, many circuits are designed for specific applications. A glance at this survey will reveal a small part of the range available to commercial and industrial organisations. Most of those listed are also readily available to the home constructor.



UNITY GAIN VOLTAGE FOLLOWER

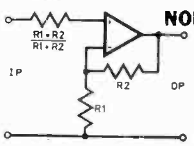
Input impedance	400MΩ
Output impedance	1Ω
Bandwidth	1MHz



INVERTING AMPLIFIER

Gain	R1	R2	BW
1	10kΩ	10kΩ	1MHz
10	1kΩ	10kΩ	100kHz
100	1kΩ	100kΩ	10kHz
1000	100Ω	100kΩ	1kHz

R_{in} <10kΩ



NON-INVERTING AMPLIFIER

Gain	R1	R2	BW
10	1kΩ	9kΩ	100kHz
100	100Ω	9·9kΩ	10kHz
1000	100Ω	99·9kΩ	1kHz

R_{in} >50MΩ

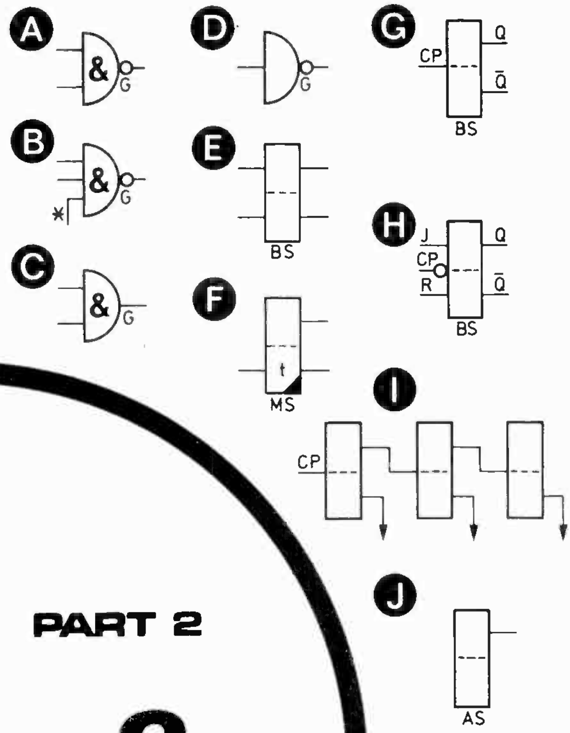
Logic integrated circuits have opened up a whole new science in systems design that does not necessitate deep technical knowledge of the circuit inside the package. Given a basic set of parameters, logic i.c.s can be built into large systems with little difficulty.

PART 2
& LOGIC I.Cs

REPRESENTING almost unbelievable value for money in terms of components per penny (the 7400 TTL gate, for example, can be purchased for as little as 15p and contains sixteen transistors, sixteen resistors and four diodes), the logic i.c. families are now available to the amateur from many suppliers who stock an incredibly wide range of types.

To those readers put off by such mystic terms as "fan-out", "flip-flop" and "truth-table", take heart, almost anything that can be built with logic i.c.s can also be built (mentally at least) using relays. Logic gates are simply switches with an "on" and "off" state, and all the more complicated devices, such as bistables, can be built with gates. Logic really is easy to pick up and after a start has been made, the subtleties can be appreciated one by one.

For those who have always wanted to design something electronic, but have been put off by simultaneous equations and slide rules, this is the scene for you; after a comprehension of the principles is obtained, all you need to start designing is common sense; all the maths has been done by the manufacturers.



POSITIVE LOGIC

A—2-INPUT NAND GATE
B—2-INPUT NAND GATE EXPANDABLE
C—2-INPUT AND GATE
D—INVERTER
E— BISTABLE WITH NORMAL INPUTS AND OUTPUTS
F— MONOSTABLE MULTIVIBRATOR
G—BISTABLE WITH CLOCK INPUT
H—BISTABLE WITH CLOCK INPUT, SET AND RESET
I— MULTI-STAGE BISTABLE USED AS DIVIDER OR COUNTER
J— ASTABLE MULTIVIBRATOR

LOGIC FAMILIES

The three main families are RTL, DTL, and TTL, while MSI (medium scale integration) uses TTL methods and incorporates several TTL circuits in each package to give a complex function, for example, a counter.

The tables given here are far from exhaustive because of the several manufacturers' different type numbers, but they do represent the majority of devices available through retail outlets.

RTL is gradually losing favour because of the competitive lowering of prices of the DTL and TTL.

In the DTL range, although a common coding can be found among many manufacturers, it is also worth obtaining the leaflets and handbooks on other types. Mullard and Siemens operate Pro Electron codings but they are not always interchangeable equivalents in all cases. Ferranti use different codings again for their Micronor series, prefixed ZS, which is divided into a 20ns range, medium speed range (15ns), and a high speed range (9ns).

Readily available types in the DTL range are mostly given a coding which includes digits 930 and 9090 upwards, other letters and figures being added according to manufacturers' choice. The Mullard range uses Pro Electron numbering prefixed by FC.

The widest range is TTL which extends into medium scale integration MSI. Again because of space limitations we have listed the most common in the 74 series, various manufacturers adding their own personal identity prefix. It is worth pointing out here that although many of the Mullard and Siemens TTL types (prefix FJ) are similar to the 74 series, they are not all identical.

FAIRCHILD	FERRANTI	ITT	MOTOROLA	MULLARD	NATIONAL	SIEMENS	TEXAS
9002	ZN7400E	9002	MC7400P	FJH131	DM8000N	FLH101	SN7400N
	ZN7401E		MC7401P	FJH231	DM8001N	FLH201	SN7401N
	ZN7402E		MC7402P	FJH221	DM8002N	FLH191	SN7402N
				FJH291	DM8003N		SN7403N
	ZN7404E	9016	MC7404P	FJH241	DM8004N		SN7404N
9003	ZN7410E	9003	MC7410P	FJH121	DM8010N	FLH111	SN7410N
9004	ZN7420E	9004	MC7420P	FJH111	DM8020N	FLH121	SN7420N
	ZN7430E		MC7430P	FJH101	DM8030N	FLH131	SN7430N
9009	ZN7440E	9009	MC7440P	FJH141	DM8040N	FLH141	SN7440N
	ZN7441E			FJL101	DM8840N		SN7441AN
				FJH261	DM8842N		SN7442N
9005	ZN7450E	9005	MC7450P	FJH151	DM8050N	FLH151	SN7450N
	ZN7451E		MC7451P	FJH161	DM8051N	FLH161	SN7451N
	ZN7453E	9008	MC7453P	FJH171	DM8053N	FLH171	SN7453N
	ZN7454E		MC7454P	FJH181	DM8054N	FLH181	SN7454N
9006	ZN7460E	9006	MC7460P	FJY101	DM8060N	FLY101	SN7460N
	ZN7472E		MC7472P	FJJ111	DM8540N	FLJ111	SN7472N
	ZN7473E		MC7473P	FJJ121	DM8501N	FLJ121	SN7473N
	ZN7474E		MC7474P	FJJ131	DM8510N	FLJ141	SN7474N
	ZN7475E		MC7475P	FJJ181	DM8550N	FLJ151	SN7475N
	ZN7476E		MC7476P	FJJ191	DM8500N	FLJ131	SN7476N
				FJJ141	DM8530N	FLJ161	SN7490N
				FJJ251	DM8532N		SN7492N
			MC7493P	FJJ211	DM8533N		SN7493N

RESISTOR TRANSISTOR LOGIC RTL

General Characteristics

Gate speed 30ns, power 20mW
Supply + V_{CC} 3·6V ± 10%
Frequency range 8MHz
Noise immunity 0·3V

These RTL circuits are suitable for many simple switching operations where relatively medium speed operation is acceptable, for example, as an electronic relay.

FAIRCHILD

μL 910	Single inverter/driver	T05
μL 914	Dual 2-input gate, positive NOR, negative NAND	T05
μL 923	Single JK flip-flop with preset and clear	T05

MOTOROLA

MC711G		4-input OR/NOR gate
MC714G		Dual 2-input NOR gate
MC715P		Dual 3-input NOR gate
MC717P	MC817P	Quad 2-input NOR gate
MC718P		Dual 3-input NOR gate
MC719P	MC819P	Dual 4-input NOR gate
MC722P		JK flip-flop
MC723P		JK flip-flop
MC724P	MC824P	Quad 2-input NOR gate
MC726P		JK flip-flop
MC7269		JK flip-flop
MC778P		Dual D-type flip-flop

MC780P		Decade counter
MC785P		Quad 2-input expander
MC787P		1 JK flip-flop, 1 inverter, 2 buffers
MC788P		Dual 3-input buffer, non-inverting
MC789P	MC889P	Hex inverter
MC790P	MC890P	Dual JK flip-flop
MC791P		Dual JK flip-flop
MC792P	MC892P	Triple 3-input NOR gate
MC793P		Triple 3-input NOR gate
MC799P		Dual buffer
	MC825P	Dual 4-input NOR gate

Suffix G = T05 P — plastic DIL MC700 Series + 15°C to + 55°C MC800 Series 0 to + 75°C

DIODE TRANSISTOR LOGIC DTL

General Characteristics

The following type characteristics apply to all manufacturers' DTL i.c.s using the coding given in the DTL tables.

Gate speed 25ns, power 5mW
Supply + V_{CC} 5V ± 5%
Frequency range 20MHz
Input forward current — 10mA
Input reverse current 1mA
Noise immunity 0·7V at 25°C
Temperature range 0°C to 75°C
Case outline DIL

DTL is suitable for most medium speed applications and is compatible with TTL. Positive logic usually applies to DTL circuit descriptions.

MC830P	Expandable dual 4-input NAND gate
MC831P	Clocked flip-flop
MC833P	Dual 4-input expander
MC836P	Hex inverter
MC846P	Quad 2-input NAND gate
MC848P	Clocked flip-flop
MC849P	Quad 2-input NAND gate
MC851P	Monostable multivibrator
MC856P	Dual JK flip-flop
MC862P	Dual 2-input NAND gate and inverter
MC886P	Dual 4-input expander

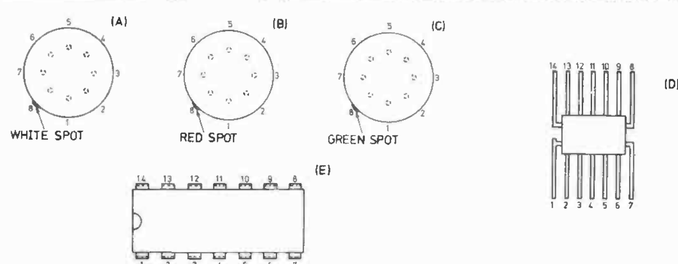
Temperature range −55°C to + 125°C

Common Code Digits

930	Dual 4-input NAND gate (expandable) fan-out 8
932	Dual 4-input NAND driver gate (exp) fan-out 25
933	Dual 4-input expander
935	Hex inverter (expandable)
936	Hex inverter fan-out 8
944	Dual 4-input NAND with open collector, lamp/relay driver fan-out 27
945	RS flip-flop with preset and clear (master/slave) fan-out 14
946	Quad 2-input NAND gate fan-out 8
948	RS flip-flop with preset and clear (master/slave) fan-out 13
951	Monostable multivibrator fan-out 10
962	Triple 3-input NAND gate fan-out 8
9093	Dual JK flip-flops with preset inputs
9094	Dual JK flip-flops with preset inputs
9097	Dual JK with preset inputs and common clear
9099	Dual JK with preset inputs and common clear

CASE OUTLINES (view from above case)

A — T05 — RTL μL900
B — T05 — RTL μL914
C — T05 — RTL μL923
D — Flat-pack — 14 leads
E — Dual-in-line — 14 leads
F — Dual-in-line — 16 leads
G — Dual-in-line — 24 leads



TRANSISTOR TRANSISTOR LOGIC TTL

General Characteristics

The following type characteristics apply to all manufacturers' TTL i.c.s using the 74 series coding given in the TTL table.

Gate speed 10ns, power 10mW
Fan-out 10
Supply + V_{cc} 5V ± 5%
Frequency range 10MHz
Input forward current −1·6mA (logic 0)
Input reverse current 1mA
Noise immunity 1V
Temperature range (74 series) 0°C to +70°C
Temperature range (54 series) −55°C to +125°C

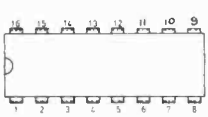
Case outlines: mainly DIL (suffix N), flat pack, TO5 can. TTL is the most comprehensive range of logic i.c.s. It is used in high speed low power applications, where very short connecting lines (12in) can be used to avoid unwanted triggering from noise spikes. Positive logic applies to TTL circuit descriptions. TTL is compatible with DTL, ECL, MSI, using current sinking logic.

Suffix H indicates high speed (6ns) series, 22mW per gate, and fan-out of 8. Suffix L indicates low power (1mW) series, low speed (33ns), high fan-out 40.

Suffix N indicates a dual-in-line package although not shown in this list. Some suppliers omit the N in their lists so check before buying whether DIL or flat-pack is available; DIL is usually cheaper and easier to use. DIL package holders are recommended for easy insertion and removal of the i.c.

TTL GATES, BUFFERS, DRIVERS

7400	Quad 2-input positive NAND
7401	As 7400 but with open collector outputs
7402	Quad 2-input positive NOR
7403	As 7401 but pin connections as in 7400
7404	Hex inverters
7405	Hex inverters, open collector outputs
7406	Hex inverters, open collector buffer/drivers
7407	Hex buffers/drivers, open collector outputs
7408	Quad 2-input positive AND gates
7409	As 7408 but with open collector outputs
7410	Triple 3-input positive NAND gates
7413	Dual 4-input Schmitt triggered positive NAND gates
7420	Dual 4-input positive NAND gates
7430	Single 8-input positive NAND gate
7440	Dual 4-input positive NAND buffer
7450	Dual two-wide, 2-input AND-OR-INVERT (expandable)
7451	As 7450 but not expandable
7453	Single four-wide, 2-input AND-OR-INVERT (expandable)
7454	As 7453 but not expandable
7460	Dual 4-input expander for 7450 or 7453
7486	Quad 2-input exclusive—OR gates



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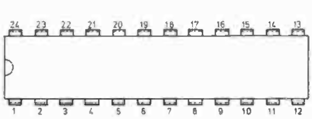


(G)

TTL FLIP-FLOPS

7470	Single edge-triggered JK with preset and clear
7472	JK master/slave flip-flop with preset and clear
7473	Dual JK master/slave flip-flops with clear inputs
7474	Dual D-type edge-triggered flip-flops with preset and clear
7475	Quad D-type 4-bit bistable latches with paired clocks (no clear)
7476	Dual JK master/slave flip-flops with preset and clear
74107	Dual JK master/slave flip-flops as 7473, different connections
74118	Hex set/reset latch with common reset
74119	Hex set/reset latch with common and separate reset
74121	Gated or d.c. triggerable monostable multivibrator

MSI

TTL MEDIUM SCALE INTEGRATION

7441A	BCD to decimal decoder/drivers
7442	BCD to decimal decoders
7445	BCD to decimal decoder drivers high power 30V output
7446	BCD to seven segment display decoder/drivers open collector outputs 30V
7447	As 7446 but 15V output
7448	As 7446 but with passive pull-up outputs
7449	BCD to seven segment display decoder/drivers, open collector outputs, blanking input
7480	Gated full adder
7481	Sixteen-bit active-element read/write memory
7482	Two-bit binary full adder
7483	Four-bit binary full adder
7484	As 7481 but with gated write-amplifier inputs
7488	256-bit read-only memory
7490	Decade ripple counter with reset and preset to 9
7491A	Eight-bit shift register (serial-in, serial-out)
7492	Divide-by-two and divide-by-six counter (÷12) with reset
7493	Four-bit binary counter with reset (÷16)
7494	Four-bit shift register, dual entry parallel-in, serial-out
7495	Four-bit right-shift left-shift register
7496	Five-bit shift register, parallel-in, parallel-out
74100	Eight-bit bistable latches
74141	Improved version of 7441 to minimise switching transients
74145	Four-line to ten-line decoder, open collector outputs
74150	16-bit multiplexer with strobe input
74151	8-bit multiplexer with strobe input
74153	Dual 4-bit multiplexer with strobe inputs
74154	Four-line to sixteen-line decoder with strobe input
74155	Dual two-line to four-line decoder with strobe inputs
74156	As 74155 but with open collector outputs
74160	Synchronous decade counter with parallel inputs
74161	Synchronous binary counter with parallel inputs
74190	Synchronous up/down decade counter
74191	Synchronous up/down binary counter
74192	Synchronous up/down BCD counter
74193	Synchronous up/down 4-bit binary counter

APPLICATIONS OF LOGIC I.C.s

Fig. 1 shows a simple double pulse detector using a couple of DTL devices, especially handy for detecting index marks in position sensing equipment. If the input trigger pulses are derived from slowly changing sources a couple of gates will be required ahead of the circuit shown to speed up the edges ready to fire the monostable (these are available anyway in the 946 range of DTL).

Fig. 2 shows a scheme for a solid state stepping switch which could be useful for example for channel selection in a radio or television receiver.

The operation is simple, the single push-button control is pushed an appropriate number of times until the required channel number is displayed on the readout. At this point the selected output of the 74145 is low, and can be used to drive a wide variety of external circuitry.

Many variations of this circuit are possible, and the whole thing can be made little larger than a cigarette packet. This example illustrates an interesting substitute for a wafer switch for some applications.

Fig. 1

DOUBLE LINE PULSE DETECTOR

Gives an output pulse when a double pulse occurs. Monostable triggers on negative edge of input pulse. One application is to detect a double slot in rotating discs using a photo-electric cell

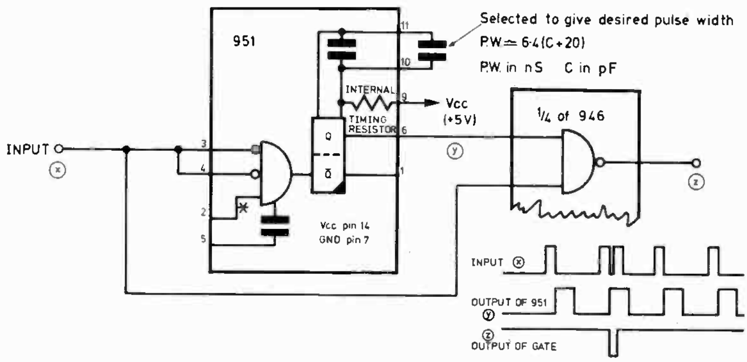
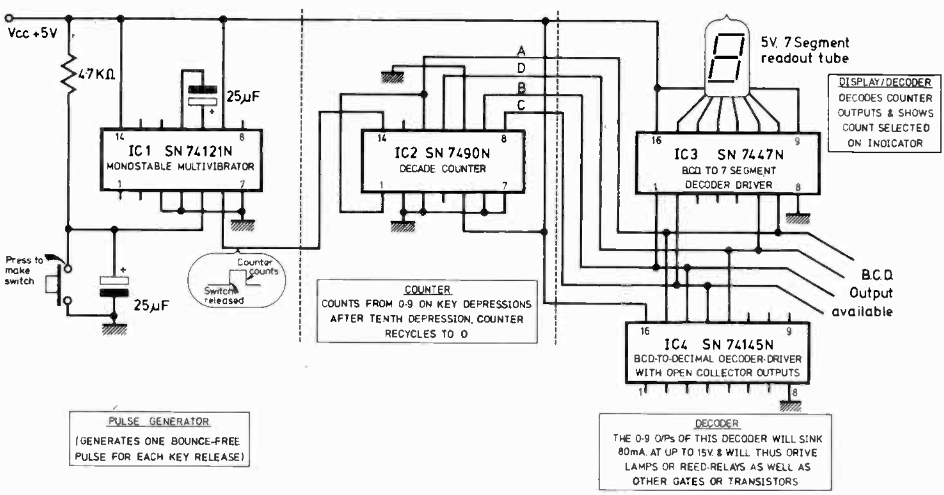


Fig. 2

SOLID STATE STEPPING SWITCH

This switch uses four TTL/MSI integrated circuits and provides seven segment digital readout for ten position channel selection



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G. W. Smith & Co (Radio) Ltd
Bi-Pak
Distronic Ltd
Distributors for Newmarket Transistors Ltd
Diotran Sales
Electrovalue
Bi-Pre-Pak Ltd
LST Electronic Components Ltd
Sinclair Radionics Ltd
Chromasonic Electronics Ltd
Distributors for Ferranti Ltd

An example of a complex group of sunspots. This was an extremely active area on the sun which lasted for several days. The small spot below the main group is about the size of the earth. The magnitude of the group is apparent from this comparison.

RADIO ASTRONOMY TECHNIQUES

By F. W. Hyde PART 7

HAVING now had some experience in the operation of the simple radio telescope, the "feel" of the subject will no doubt have been acquired. After the experience of sorting out what is interference, what is random noise, and what is the real signal to be acquired, the limitations of the simple unit will be apparent. However, although this article will begin the description of interferometers and details of their construction, it is recommended that the observer should continue with the programme of the first project for two reasons.

The first reason is that it takes some time to become facile at recognition of the many different forms of interference, some of which will be man-made and some random signals due to odd reflections from the upper atmosphere. The second reason is that the data acquired and entered in the log will be of considerable importance when compared with the measurements made with the interferometer.

Of course, some constructors will not have the space to set up an interferometer and so must in any case continue with the single aerial unit. Bearing this in mind, some suggestions that may help these people will be given in the last article of this series.

IDENTIFICATION OF SPACE SIGNALS

If the unit has been used during the night with the aerial pointed upwards, it is certain that there will be some signs of the radiation from the sources in Cygnus and Andromeda, and also the Crab Nebula. Also, the general rise in level of the recording at different times during each successive day and night will enable the positive identification of extra terrestrial radiation.

This was, in fact, the way in which the original pioneer Karl Guthe Jansky identified the existence of signals or radiation from space. To quote from his original paper, "In conclusion data have been presented which show the existence of electromagnetic waves in the Earth's atmosphere which apparently come from a direction that is fixed in space. The data obtained give for the coordinates of this direction a right ascension of 18.00 hours and a declination of $-10°$."

Bearing in mind that the width of the aerial beam is quite wide in the vertical direction, tip the aerial so that the dipoles are directed at the Milky Way. Let the system run for a week every night or every three nights if this is more convenient. After the run compare the recordings by laying them side by side with the time marks aligned so that the same time is shown. Examine them for some significant event and check the difference in time that has elapsed. There should be a change of some 15 minutes in three days and some 30 minutes in a week. The exact times can be checked from the charts and the figures given are for the purpose of guidance only.

If it is possible obtain a copy of the *Ephemeris* issued by the Nautical Almanack Office. This may be available from the library or it can be obtained from the Stationery Office Bookshop in Holborn, London.

Table 7.1 indicates some of the radio sources that should be detectable quite easily on the simple radio telescope. Since there are bound to be satellites recorded, it will be quite clear from the table which these are, because they can be compared with the tracings shown in Part 6 of this series.

SIDEREAL TIME

The table gives the usual astronomical coordinates of hour angle and declination. This involves certain corrections on the part of the observer for the hour angle or right ascension. This hour angle is in *Sidereal Time* which differs from ordinary astronomical time by an acceleration of 10 seconds in each hour, or approximately four minutes per day. The time is reckoned from the entry of the first point of ARIES which occurs between the twenty-first and twenty-third of March each year. This is the Vernal Equinox, 00.00 hours right ascension. All of this may appear a little complicated but it can be reduced to fairly simple terms for the purpose of the project.

In Table 7.2 a summary is given of the sidereal time for noon G.M.T. for each day of the year. This is approximate, but will not vary by more than about five minutes for each day and this error is insignificant with the system being used. In any case the source will be well within the beam of the aerial.

SIMPLE INTERFEROMETER

The simple two-aerial interferometer was briefly described in Part 2 of this series, and the modification required to convert the existing simple telescope is really one of addition. Firstly the existing aerial must be duplicated, together with the pre-amplifier if this is located at the aerial. The two aerials should be set up preferably on an east to west baseline. Within certain limits this is not an absolute requirement, but this will be dealt with later in this article. The distance between the aerial centres should be, if possible, at least five wavelengths. At the frequency that has been adopted this will mean a distance of 36 feet.

It is necessary to connect the aerials together. This may be done at the observing point, or if this distance is greater or about the same length as the distance between the aerials, then the following alternative arrangement is possible.

Having set up the aerials, cut two lengths of cable which will leave sufficient slack for the aerials to be moved further apart and to facilitate stowage. These two lengths of cable must be exact to within about one half inch, and of the same type of cable. These two points are very important. As both ends of the cables will terminate in coaxial plugs the equality of length includes the plugs. At the junction of the two aerial cables there will be a connection box as shown in Fig. 4.6 of Part 4. The outlet from this box will go to the converter in the same way as for the simple telescope, that is, with the matching section of 50 ohm cable followed by the 75 ohm cable. The diagram in Fig. 7.1 gives the layout.

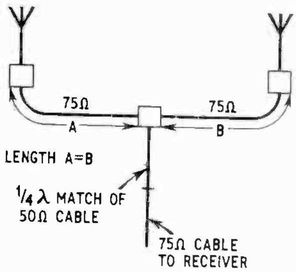


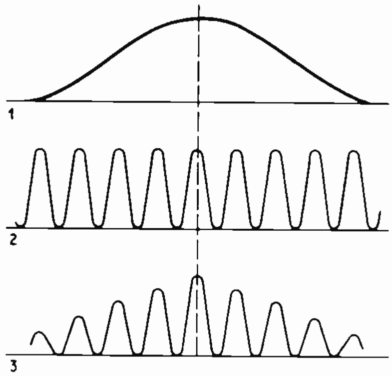
Fig. 7.1. Coupling two aerials together as a simple interferometer

The importance of the length of the cables has been stressed because the operation of the two aerial system depends on the combining of the signals which are alternately in phase and out of phase with the other.

TABLE 7.1. LIST OF RADIO SOURCES

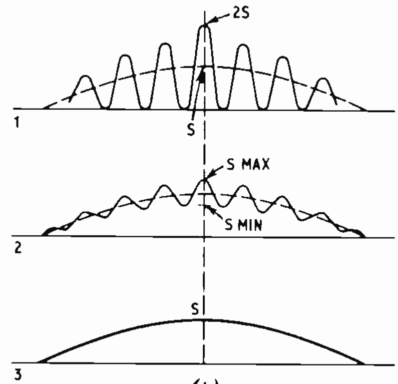
CONSTELLATION	I.A.U. NO.	RIGHT ASCENSION	DECLINATION	IDENTIFICATION
**Cassiopeia*	00N6A	00h 22m ± 2m	64° 15′ ± 35′	(12) Supernova 1572 (no visible remnants)
Andromeda	00N4A	00h 40m 15s ± 30s	40° 50′ ± 20′	(11) M31 NGC224
Perseus	03N4A	03h 16m 37s ± 4s	41° 25′ ± 6′	(17) NGC1275 Colliding galaxies?
Auriga	04N4A	05h 08m ± 4m	46° ± 1°	(13) Angular size of source is 1°·4 Identified with galactic nebulosity
**Taurus*	05N2A	05h 31m 35s ± 5s	22° 04′ ± 5′	(4) M1 NGC1952 Crab Nebula
Orion	05S0A	05h 33m·0 ± 0m·2	−05° 27′ ± 5′	(18) Orion Nebula M42 NGC1976
Gemini	06N2A	06h 13m 37s ± 4s	22° 38′ ± 5′	(19) IC443
Monoceros	08S0A	08h 08m ± 10m	−06° ± 30°	(13)
Lynx	08N4A	08h 09m ± 2m	48° ± 1°	(8)
Puppis	08S4A	08h 20m ± 4m	−42° 30′ ± 1°	(13) Galactic nebulosity
Lynx	09N4A	09h 16m ± 4m	47° ± 1°	(8)
Hydra	09S1A	09h 16m ± 2m	−12° ± 2°	(13)
Ursa Major	09N6A	09h 51m 20s ± 2m	69° ± 1°	(15) NCG3031
Vela	10S4A	10h 10m ± 4m	−42½° ± 20′	(2)
Ursa Major	10N5B	10h 30m ± 2m·5	57° ± 2°	(11)
Crater	11S1A	11h 38m ± 8m	−15° ± 2°	(13)
Canes Venatici	12N4A	12h 15m ± 3m	47° ± 1½°	(11) NGC4258
Virgo	12N1A	12h 28m 11s ± 37s	12° 41′ ± 10′	(1) M87 NGC4486
Centaurus	13S4A	12h 22m 24s ± 1m	−42° 37′ ± 8′	(1) NGC5128
Canes Venatici	13N4A	13h 27m 30s ± 3m	47° ± 1°	(11) NGC5195
Boötes	14N5A	14h 10m ± 2m	51° 30′ ± 1°	(11) NGC5457
Serpens Caput	15N1A	15h 10m ± 4m	11° ± 1½°	(2)
Triangulum Australe	16S6A	16h 10m ± 8m	−60¾° ± 5′	(2)
Hercules	16N4A	16h 36m ± 10m	41° ± 2°	(13)
Hercules	16N0A	16h 45m ± 2m	6° ± 1°·5	(2)
Sagittarius	17S2A	17h 42m ± 1m	−28°·5 ± 0°.2	(21) May be associated with the galactic nucleus. The presence of neighbouring intense emission regions makes the measurements of flux density difficult
Ophiuchus	18S0A	18h 16m ± 4m	−8° ± 2°	(13)
Sagittarius	18S1A	18h 17m·9 ± 0m·2	−16° 14′ ± 5′	(18) Omega Nebula M17 NGC6618
**Cygnus*	19N4A	19h 57m 44s ± 2½s	40° 35′ ± 1½′	(3) Colliding galaxies
**Cygnus*	20N4A	20h 22m	40°	(11) Cyg X extended source possibly associated with galactic nebulosity
**Cassiopeia*	23N5A	23h 21m 36s ± 30s	58° 35′ ± 10′	(11) Galactic nebulosity

* Very strong sources



(a)

Fig. 7.2a. The effects of differing aerial parameters. (1) Single aerial pattern. (2) Two aerial pattern. (3) Interferometer pattern (point source)



(b)

Fig. 7.2b. (1) Point source pattern. (2) Uniform extended source comparable but smaller than lobe spacing. (3) Uniform extended source equal to or greater than lobe spacing

When using an interferometer it is usual to have the aerials aligned and fixed in azimuth facing south in the northern hemisphere and north in the southern hemisphere. The altitude will depend on the section of sky to be observed, but each will normally be at the same angle of altitude. This will apply to each sweep of the sky. The sweeping will be done by the rotation of the earth so that in the course of 24 hours the whole 360 degrees of sky, as seen from the earth, will be scanned by the width of the aerial beam.

RESOLUTION

The resolution or ability to distinguish between sources will be dependent on two parameters. One is the distance between the aerials, for this governs the width of the fringes, and the width of a fringe determines the size of the smallest source that can be recognised. The diagrams in Fig. 7.2a and b illustrate the effects of these varying conditions.

It is essential that the beginner goes through this step of the simple interferometer in order to make practical observations and again have experience of the working conditions.

FRINGE WIDTH

Before moving on to the more complicated phase-switched interferometer there are one or two points which need to be covered. Firstly, the simple calculation to be made to determine the fringe width. The relationship between the fringes and the distance between the two aerials is in this form. The beam width between first null points (the fringe spacing) is $1/D\lambda$ radians which equals $57{\cdot}3^\circ/D\lambda$.

TABLE 7.2

DAY	JAN.	FEB.	MAR.	APR.	MAY	MONTH JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1	18 40	20 43	22 33	00 35	02 33	04 36	06 34	08 36	10 38	12 37	14 39	16 37
2	44	46	37	39	37	40	38	40	42	41	43	41
3	48	50	41	43	41	43	42	44	46	44	47	45
4	52	54	45	47	45	47	46	48	50	48	51	49
5	56	58	49	51	49	51	50	52	54	52	55	53
6	19 00	21 02	53	55	53	55	54	56	58	56	59	57
7	04	06	57	59	57	59	58	09 00	11 02	13 00	15 02	17 01
8	08	10	23 00	01 03	03 01	05 03	07 01	04	06	04	06	05
9	12	14	04	07	05	07	05	08	10	08	10	09
10	16	18	08	11	09	11	09	12	14	12	14	13
11	20	22	12	15	13	15	13	16	18	16	18	17
12	24	26	16	18	17	19	17	19	22	20	22	20
13	28	30	20	22	21	23	21	23	26	24	26	24
14	32	34	24	26	25	27	25	27	30	28	30	28
15	35	38	28	30	29	31	29	31	34	32	34	32
16	39	42	32	34	33	35	33	35	37	36	38	36
17	43	46	36	38	36	39	37	39	41	40	42	40
18	47	50	40	42	40	43	41	43	45	44	46	44
19	51	53	44	46	44	47	45	47	49	48	50	48
20	55	57	48	50	48	51	49	51	53	52	54	52
21	59	22 01	52	54	52	54	53	55	57	55	58	56
22	20 03	05	56	58	56	58	57	59	12 01	59	15 02	18 00
23	07	09	24 00	02 02	04 00	06 02	08 01	10 03	05	14 03	06	04
24	11	13	04	06	04	06	05	07	09	07	10	08
25	15	17	08	10	08	10	09	11	13	11	13	12
26	19	21	11	14	12	14	12	15	17	15	17	16
27	23	25	15	17	16	18	16	19	21	19	21	20
28	27	29	19	22	20	22	20	23	25	23	25	24
29	31		23	26	24	26	24	27	29	27	29	28
30	35		27	29	28	30	28	30	33	31	33	31
31	39		31		32		32	34		35		35

SIDEREAL TIME FOR NOON G.M.T. FOR 0° LONGITUDE

Using three examples of spacing, the first five wavelengths, the second 10 wavelengths, and a third 20 wavelengths, the approximate figures are 11·5 degrees, 5·73 degrees, and 2·86 degrees respectively. Since this is the point of the nulls the actual fringe width is half each value given at the half power points. The half power points were explained in Part 1 and illustrated in Fig. 1.4.

CHART SPEED

The second point to be noted is the appropriate speed of the chart on the pen recorder consistent with obtaining a useful trace.

Taking the case of the least spacing 11·5 degrees, it will take 46 minutes for passing from the one null to the next, since it takes about four minutes of time for the earth to move 1·0 degree of arc. Therefore in this instance it will be wise to choose a slow speed for the recorder in order that the fringes may be clearly visible. A preferred speed would be 0·5 inches per hour, though 1·0 inch per hour would be permissible. For the widest spacing quoted a speed of 3·0 inches per hour would give best results. It will be clear from this that the greater spacing offers a better chance of detecting sources than the lesser spacing.

THE BASE LINE

Finally the setting up of the base line must be considered—for those who have the space to accommodate the interferometer. It is not sufficient to set up the south point using a compass, though this is a first step. The south point required is *geographical south* and this differs by several degrees. The exact amount of difference is obtainable for each year from ordnance survey maps. It was 8 degrees 40 minutes West in 1948, and decreasing by about 8 minutes annually.

Next month's article will be concerned with the phase-switched interferometer.

NEWS BRIEFS

TRAFFIC SPEED METER

A completely new road traffic speed measurement system is being developed by GEC-Marconi Electronics, under contract to the Director of Telecommunications, Home Office.

The new system uses an optical method of measurement and the complete system can be contained in a single unit which can be placed at the side of the road. The unit looks at right angles to the traffic flow and as soon as a vehicle passes, and comes within the field of view of the optical system, its speed will be measured almost instantaneously, and shown on a three-digit display, probably using a liquid crystal system.

The image of the vehicle is split into a succession of vertical strips, which are viewed by a photodiode. Any irregularities in the image, whether bright spots or shadow, will move across the slits of the "virtual" grating and produce a fluctuation of the light falling on the diode. The frequency of this fluctuation is measured and, from it, solid-state micrologic circuitry calculates the speed of the vehicle.

EUROPE'S FIRST FULLY AUTOMATIC NAVIGATIONAL BUOY

In almost every field nowadays man is rapidly being replaced by electronic equipment. This is the case at Portland Bill, Dorset, where a fully automatic navigational buoy has recently replaced the manned Shambles lightship.

The 84 ton buoy, made by Hawker Siddeley Dynamics and named Lanby (Large Automatic Navigational Buoy) has a 40ft lattice mast topped with a main light beacon giving a luminous range of 16 miles. Also on board is a powerful fog signalling device, with an audible range of more than 3 miles.

The buoy is monitored every 30 minutes by a shore control station using a radio telemetry link. Should any failure occur, standby services operate automatically, and the nature of the fault is relayed to the control station.

The buoy can be moored in depths from 30 to 300ft, and can withstand winds up to 100 mph, waves up to 40ft and tidal currents up to seven knots.

UNDERWATER TELEVISION EQUIPMEMT

The present system of searching for and locating underwater wreckage, such as crashed aircraft and sunken ships by use of drag lines towed by surface craft seems soon to be superseded by a more efficient electronic method. This is evident following recent trials carried out by EMI Systems & Weapons Division, Middlesex, with their newly developed "low light" television equipment.

The television camera can quickly scan large underwater areas where visibility is poor and transmit clear pictures of the sea bed to a mother ship on the surface where they can be viewed and recorded. The television equipment will be housed in a midget submarine capable of depths down to 3,000ft.

The "low light" television camera used in the trial is claimed to be the smallest in Britain, measuring 128 × 128 × 152mm. Its ability to obtain clear pictures in very low lighting conditions is provided by an E.M.I. Ebitron tube. This intensifier-vidicon is 300 times more sensitive than a normal 26mm vidicon tube.

COMPUTER NURSE

The United Birmingham Hospitals have received approval from the Department of Health and Social Security to proceed with the purchase of a UNIVAC 418-111 computer as part of the Department's experimental programme in hospital computing. Delivery will be made early in 1972 and specially designed accommodation to house it is nearing completion at the Queen Elizabeth Medical Centre. The first real-time application is expected to go live early in 1973.

The initial configuration will provide for complete patient administration and laboratory reporting systems for the Queen Elizabeth Hospital. It is planned to introduce other experimental systems such as laboratory requesting, drug prescribing, nursing records, physical examination of the patients and other medical applications at later stages in the project.

NORTH MIDLANDS READERS *Please note*

A short course of six evening lectures entitled "Practical Electronics" will be held at North Staffordshire Polytechnic, College Road, Stoke-on-Trent, commencing Wednesday, January 12. The lecturers include well-known contributors to this Magazine.
Further details will be given next month.

SPECIAL PURCHASE !

BRAND NEW FM MULTIPLEX STEREO DECODER UNITS. Manufactured by PHILIPS. Size 2" · 3½" × 1". All transistor 24V, at 6mA. Supplied pre-aligned with full circuit diagram and connection details. £4 each. Post free.

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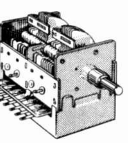

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A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. × 3 d. × 6 h. Ready built and tested. PRICE **£3·75.** P. & P. 40p. ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit cabinet below. PRICE **£4·88.** P. & P. 50p.

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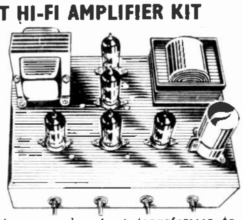
10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3–15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet **13p** (Free with parts). **All parts sold separately.** ONLY **£7·97.** P. & P. 55p. Also available ready built and tested complete with std. input sockets, **£9·97.** P. & P. 55p.

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Size only 11¾in × 14¾in × 1³⁄₁₆in deep. Weight only 19oz. Can replace cone speakers in any application and is particularly useful for those with limited space. Extremely rugged and shockproof. Operating temperature −20°F to +175°F. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz–20kHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details. Only **£5·75** each. P. & P. 25p.

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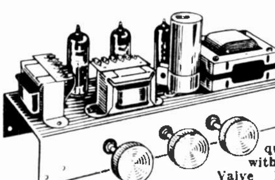

A.c. mains 200–240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w × 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. Price **£8·92.** P. & P. 45p.

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LATEST B.S.R. C109/A21 4-SPEED AUTOCHANGER. With latest mono compatible cartridge **£6·97.** Carr. 50p. With stereo cartridge **£7·97.** Carr. 50p.
SUITABLE PLINTH UNIT FOR ABOVE with rigid plastic cover. **£5·75** complete. P. & P. 50p.
LATEST GARRARD MODELS. All types available 1025, 2025, SP25, 3000, AT60, etc. S.A.E. for Latest Prices!
PLINTH UNITS cut out for Garrard Models 1025, 2025, 2000, 3000, 3500, etc. With rigid transparent plastic cover. Special design enables above models to be used with cover in position. Also suitable for housing AT60 and SP25. OUR PRICE **£5·75** complete. P. & P. 50p.

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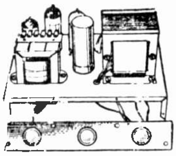
TONE STAHC COMPATIBLE STEREO CARTRIDGE stylus. Diamond Stereo LP and Sapphire 78. ONLY **£2·50.** P. & P. 10p. Also available fitted with twin Diamond T/O stylus for Stereo LP. **£3.** P. & P. 10p.
LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. **£1·63.** P. & P. 10p.
LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono or stereo records on mono equipment. **£1·50.** P. & P. 10p.

3-VALVE AUDIO AMPLIFIER HA34 MK II



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in w. × 4in. d. × 4½in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4·75.** P. & P. 35p.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **£3·98.** P. & P. 40p.

HARVERSON'S SUPER MONO AMPLIFIER

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

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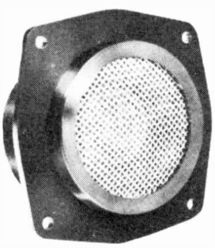
NEW from Goodmans for constructors

Din 20 Kit

20 watt, high fidelity loudspeaker kit contains all parts necessary to complete the system, except timber and other material for the cabinet itself, with detailed, illustrated instructions.

Specification: 20 Watts DIN, 4 ohms impedance, 8 ins bass unit, dome HF radiator, crossover frequency 4,000 Hz.

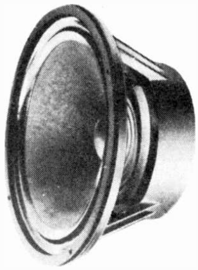
Axent 100



Dome HF Radiator with integral crossover. Capable of high frequency sound reproduction with negligible distortion in systems rated up to 30 Watts DIN, this 'state of the art' drive unit has an integral crossover which cuts frequencies below 3kHz at a rate of 12dB/Octave.

Audiom 100

12 inch high fidelity bass loudspeaker. For use as a bass unit in two-way systems, the sensitivity and high frequency roll-off of the Audiom 100 has been tailored to match the Axent 100.



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Post and packing 10p for 1 or 2 packs; 3 packs or more post free.

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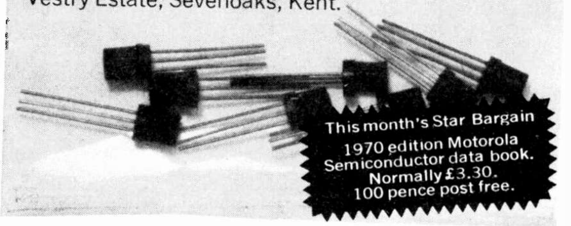

JUST A SECOND
HOME CONSTRUCTOR

Yes, about a second, to remove dual-in-line I.C. and T.O.5 type transistor from those ex-computer printed-circuit boards, experimental circuits, etc.

DILKIT comprises a high performance soldering iron, long-life bits specially shaped to unsolder all leads of a component in a single operation, and a length of solder-absorbing wick.

Automatic component extractors also available.

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SURPRISE SURPRISE!!

The decision by RCA to pull out of the computer mainframe business sent a chill down the spine of the United States' electronics industry—and of Europe too.

Everyone was taken by surprise. It happened almost exactly a year after RCA chairman Robert W. Sarnoff had announced firm plans for a frontal attack on the market held so lucratively by IBM. As recently as July, Sarnoff was still denying that RCA had any intention of pulling out.

The RCA debacle follows a similar withdrawal by U.S. General Electric a year earlier. GE's move, however, was well regulated and involved lengthy negotiations before the sale of its computer interests to Honeywell.

Industry experts on both sides of the Atlantic are asking themselves: if giants like U.S. General Electric and RCA can't stand the pace, who can? Except, of course, the almighty IBM.

Unstoppable IBM has 70 per cent the U.S. domestic market and not far short of that figure in the rest of the world. RCA's share was under 4 per cent with a growth target of 10 per cent of the market by 1975. The crunch came when it was realised that another £200 million of capital, on top of the £200 million already spent, would be required before breaking into profit.

Now the RCA market share will be distributed among the survivors with the bulk going to IBM, still further tightening IBM's stranglehold.

THE AFTERMATH

Britain's ICL is involved only through System 4, a development of RCA's Spectra 70 Series. ICL say they will remain unaffected. But Siemens in Germany will be affected because they rely strongly on close technical links with RCA.

RCA customers have been told that all existing orders and service contracts will be honoured. But the demise of two major mainframe manufacturers in a period of 16 months will influence new buyers toward the most stable source which means even more business for IBM.

Component suppliers to RCA such as Motorola, Signetics and Advanced Memory Systems will all suffer from the closure. Some smaller suppliers stand to lose 10 per cent of their total business.

At the time of writing there was no firm news that RCA had been able to sell its computer interests either in whole or in part. In the present depressed state of the computer market few firms are interested in acquiring extra plant and manufacturing capacity.

One possibility emerging from the debacle is that Britain's ICL and Germany's Siemens could now get together to form a new and potentially extremely powerful computer force in Europe.

DATA SATELLITE

The computer industry may be suffering at the moment but the demand for data processing and data transmission will continue to increase at a growing rate. In 1970 there were 14,000 data terminals in Britain. By 1980 there might be, and probably will be, 300,000. This figure will be matched by other major European nations and so far no international agreements on data network standards have been made.

An interesting new development is a study contract awarded to Marconi Communications Systems Ltd. by the European Space Research Organisation (ESRO). The idea is that data links should be through a geo-stationary satellite used in conjunction with large numbers of small and inexpensive earth terminals.

The earth terminals would have dishes no larger than 9ft in diameter sited within 100yds of the data terminal. Use of such a system, dedicated entirely to data transmissions, would obviate many of the difficulties of international connections through existing public telephone and data networks where data rates are comparatively low due to line variations.

The preliminary study, involving analysis of present and future traffic, prospective users and costs of the system, should be completed by April 1972

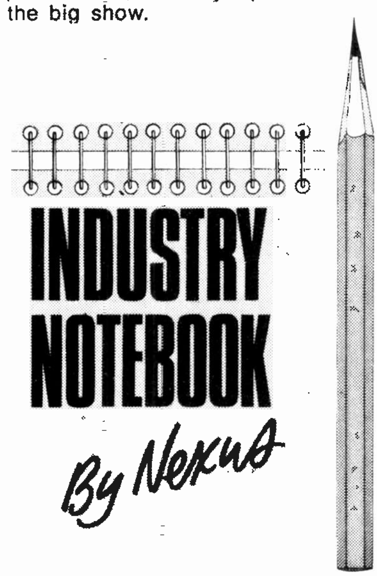
WHERE THE GIANTS MAY GO

Although the great electronic exhibitions aimed at industry such as the IEA and ILECS at Olympia are by no means on the way out, increasing costs have been forcing companies to look more closely at the less expensive small shows which tend to be more cost-effective.

One of the brightest operators in the field is John McNeill, managing director of Electromation Exhibitions Ltd. I have just seen the company's forward programme with electronics shows starting at Birmingham in November and moving round the country to Harrogate, Southend, Stevenage, Portsmouth, Croydon, Glasgow, Dublin, Bristol, Manchester and back to Birmingham in November 1972. This is an impressive programme which includes, apart from exhibitor stands at each venue, a technical convention. Admittance is reserved for professional engineers and you need an invitation before you can get admission.

Another bright operator in small exhibitions is Evan Steadman who has already sold out for his Seminex due to be held next April. This one is for semiconductor manufacturers. Yet another is Gordon Johns who organised the successful Compec '71 computer peripheral exhibition in London last September.

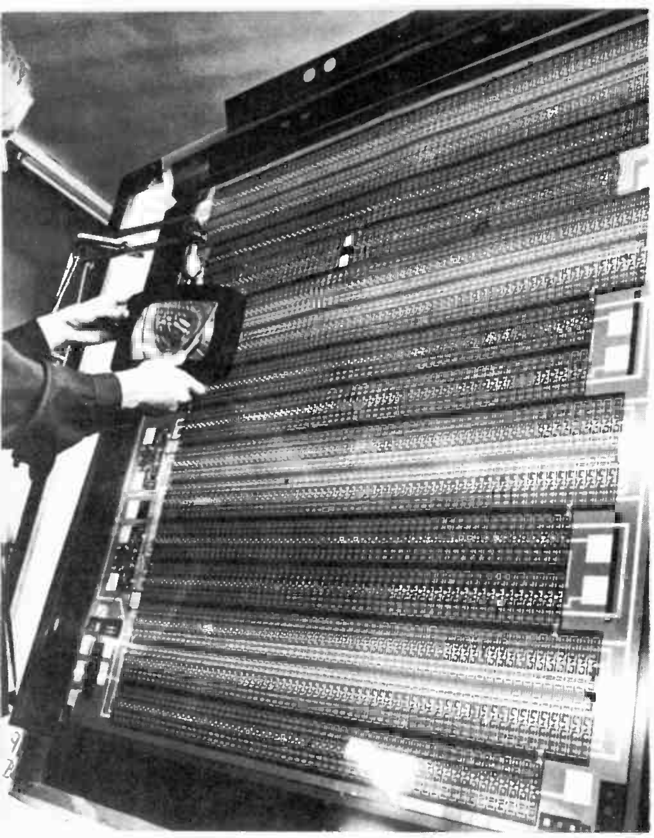
It is too early to predict the effect of this type of exhibition on the IEA at Olympia next year but one thing seems certain. With Mullard, TI, Fairchild, RCA, Emihus, Ferranti, to name but a few who have already booked for Seminex and its accompanying technical symposium, it seems clear that the bulk of the semiconductor companies have already opted out of the big show.



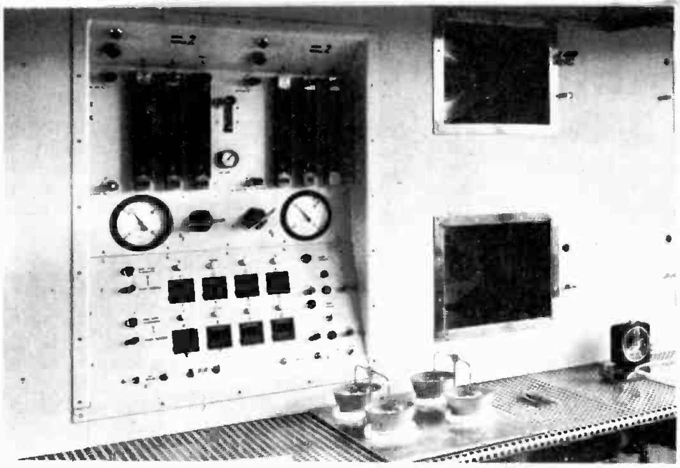
BRIGHTER OUTLOOK—BUT SLOW

Sir John Clark, chairman of Plessey, thinks the worst may be over but it will be a long haul back to the halcyon days of pre-recession. Ernie Harrison, Racal chairman, believes that it could be another 18 months before business takes off in any big way. Dr F. E. Jones, managing director of Mullard was not exactly cheerful when we last met despite the boom in colour TV sales.

On the whole, however, I have found most industry leaders optimistic. Smaller companies with their greater level of flexibility have in many cases proportionately weathered the storm better than the giants. But 1972 could see further "re-structuring" of the industry through takeover or merger. On one thing they all agree. Even if the bottom has now passed, don't expect a dramatic revival. Recovery will be slow.



Physical inspection of rubyliths (artwork) of a 1,024-bit CDI shift register



Part of the pre-production line for CDI

New LSI Combines Logic and Linear Functions on one chip

How does the thought of a high performance computer on a single slice or even a chip strike you—impossible? Well it is not as far fetched as it may seem. While we are just getting accustomed to MOS integrated circuit technology, along comes another—the CDI process of producing LSI (large scale integration).

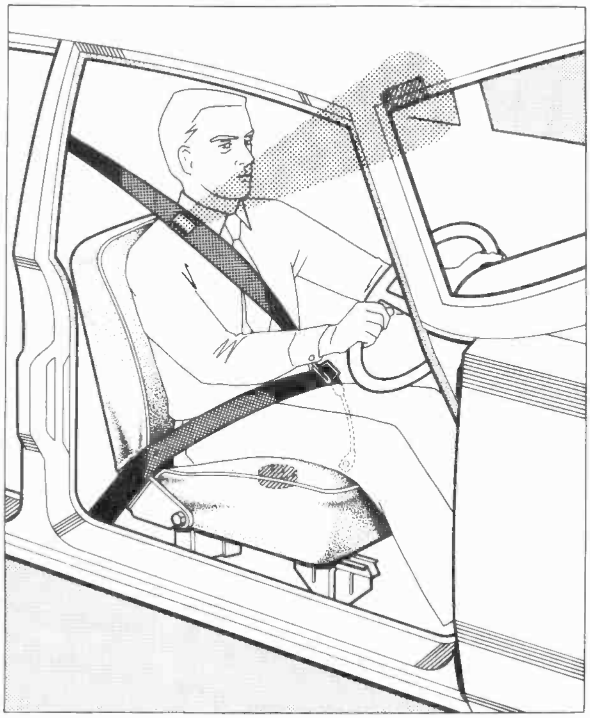
CDI (collector diffusion isolation) is a simple bipolar process originally developed in the Bell Laboratories in the U.S.A. and has now been further developed by Ferranti at Manchester for large scale

ELECTRO

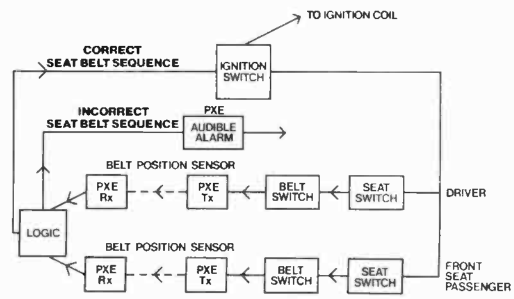
Ultrasonic Car Safety Belt System

One of the results of a new car safety belt system, developed by Mullard and the Ford Motor Co., means that even the car thief will have to strap himself in if he wishes to make off with his "booty". The belt must not only be fastened but also be correctly positioned across the wearer.

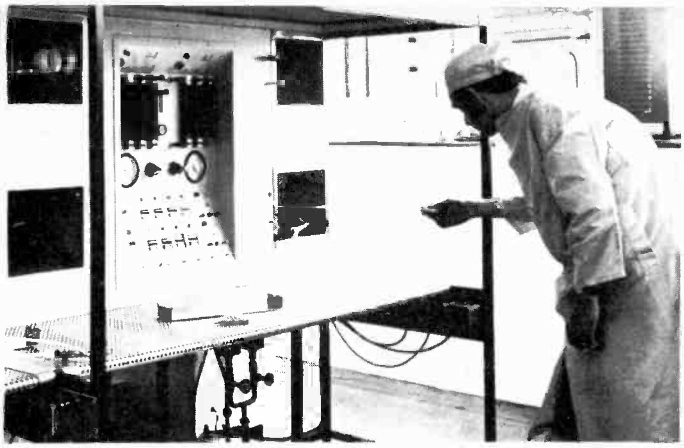
As the block diagram shows, before the ignition will function the driver must occupy his seat, activating a pressure switch fitted beneath it, buckle the belt across his lap and close the belt switch. Provided the belt is worn correctly a 40kHz signal emitted from an ultrasonic transmitter, mounted in the belt, is received by a detector built in the windscreen pillar, which in turn completes the ignition circuit. If the front passenger seat is occupied then a 50kHz signal must be received from the passenger's



Layout of the car safety belt system as installed in a car. Note the narrow ultrasonic beam directed at the receiver mounted in the windscreen pillar



Block diagram of the car safety belt system



bipolar integrated circuits at Ferranti

production at an economic cost. This is said to be the first time that LSI has become a practical proposition, combining the high complexity of MOS with the performance advantages of bipolar technology.

The breakthrough is in the combination of both high speed switching logic and linear capability for a common supply of 5V on the same monolithic chip. The system is completely compatible with existing TTL i.c.s.

Only five masking operations are required compared with nine steps involved in current bipolar processing. It is expected that this new bipolar LSI technology will be used where digital and analogue control, computers and telecommunications already require complex and sophisticated circuitry.

NORAMA

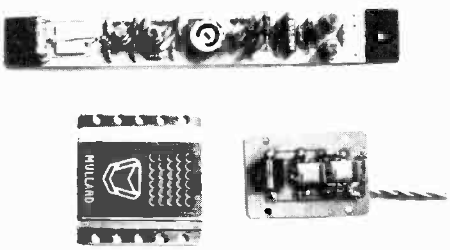
safety belt before the ignition switch will be functional.

If the correct sequence has not been carried out a logic circuit will trigger an audible and visible alarm mounted on the dashboard.

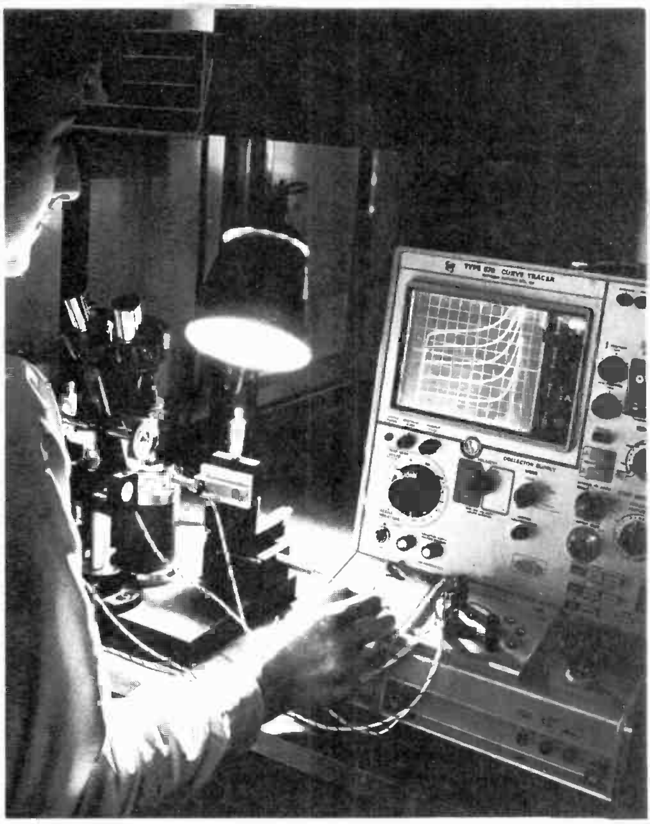
The system can be arranged so that if the belt is unfastened while the car is moving the ignition is not immediately affected. Instead, the alarm is sounded and if, at the end of a specified time, the belt still remains unfastened, the ignition will then be cut out.

For very short operations, such as parking or garaging the car, the logic arrangement can be adjusted to allow for car movement in first or reverse gear for a specified time without the driver being belted.

As a method of enforcing the wearing of safety belts by driver and passengers, thus cutting down the death and injury toll on the roads, this contribution to road safety should be closely looked at by the Police and the Ministry of Transport.

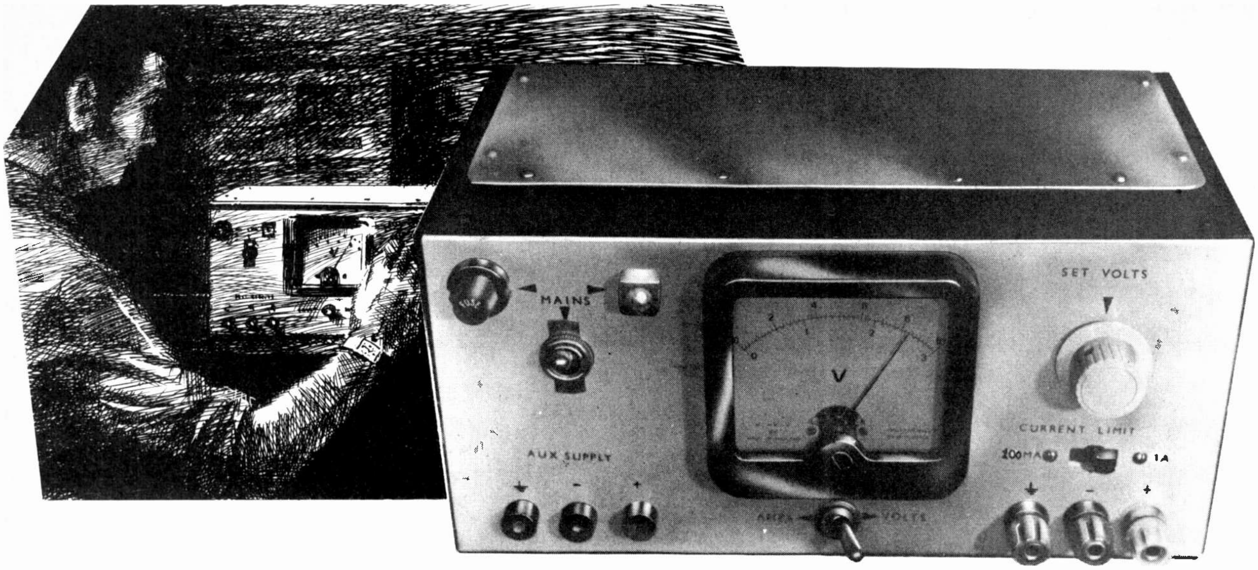


The ultrasonic transmitter (top) and receiver circuit boards



An operator carrying out a process control check using a curve tracer which shows the collector-emitter characteristics of a CDI transistor in a digital array

The ultrasonic transmitter mounted on a car safety belt



Labpack Power Supply

BY H. T. KITCHEN

THE stabilised power supply to be described was designed and built to provide a power source for transistorised equipment undergoing development. As such, it had to fulfil certain basic requirements.

A long and varied experience of development and service work had shown the need for a power supply capable of being varied from near zero to a maximum of some 25V, with a maximum current capacity, within this voltage range, of 1A.

A further requirement was that the output voltage had to be regulated. The output current also had to be controlled, so that even if the load terminals were made short circuit, the maximum current rating could not be exceeded.

The final requirement was that the maximum current output should be capable of being adjusted to values less than the 1A maximum. In the prototype, two switched ranges of 1A and 100mA are provided.

A block diagram of the power supply is shown in Fig. 1 which should be studied in conjunction with the circuit diagram of Fig. 2.

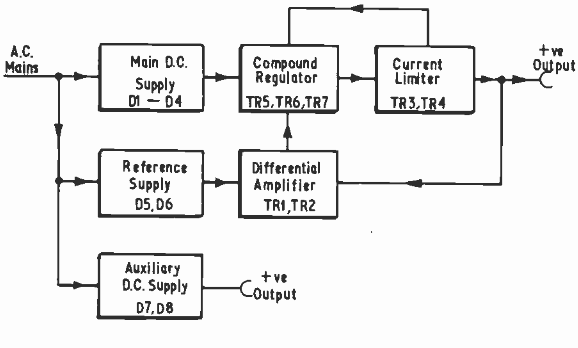


Fig. 1. Block diagram of power supply

SERIES REGULATOR

The regulator element of this design is of the series type and is made up of the transistors TR5, TR6 and TR7.

This is a compound configuration where TR5 controls the base to emitter voltage of the output pair TR6 and TR7. The base feed resistor of TR5 also functions as the collector load of TR2. This transistor, together with TR1, constitute a differential amplifier.

DIFFERENTIAL AMPLIFIER

The differential amplifier provides an output voltage which is proportional to the difference of the input voltages applied to the transistor bases. At the base of TR1 is connected a fixed Zener voltage which is derived from a double diode rectifier and filter circuit.

This stable reference at one base means that any changes in the output voltage—either up or down—will be fed back by way of VR2 to provide a collector current change through R5. If the current flow is low the volt drop at this resistor is low, which corresponds to a movement of the base potential of TR5 towards the collector potential. Increased emitter current therefore flows, and as this current is into the bases of TR6 and TR7, their emitter currents also increase.

If the output load is a resistive one, this will result in an increase of output voltage. A converse feedback action will decrease the output.

The overall gain of TR2, TR5 and the output pair is very high, and very small changes in output voltage can be sensed and automatically corrected. Rapid changes in output voltage, corresponding to a residual 100Hz ripple, or the signal frequency of a connected high power amplifier, can also be sensed and corrected. In this instance, feedback is via C5, again to the base of TR2 which treats it also as an error signal.

CURRENT LIMITING

The current limiter circuit comprises TR3 and TR4, in conjunction with VR3, R8 and VR4 and R10.

The transistor TR3 is connected so as to function as a cheap form of Zener diode which fixes the emitter potential of TR4. Under no load or small load conditions TR4 is reverse biased and does not pass any collector current.

Dependent on the switch position of S2 and limit setting of VR3 or VR4, load current limiting occurs when the voltage drop across these resistance combinations is sufficient to drive TR4 out of its cut-off state.

With TR4 conducting the volt drop across its shared load resistor R5 will increase. The polarity of this voltage is such as to reduce the V_{be} of TR5 and so reduces the emitter current passed by TR6 and TR7.

By controlling the V_{be} of TR5 it is possible to set a limit to the maximum current that can be drawn from TR6 and TR7, even if the output is short circuited.

CHOICE OF LIMITING RESISTANCE

Since any volt drop across R8 and R10 is lost to the output voltage, and since a certain minimum voltage at the base of TR4 is necessary for reliable current limiting, the absolute minimum resistance

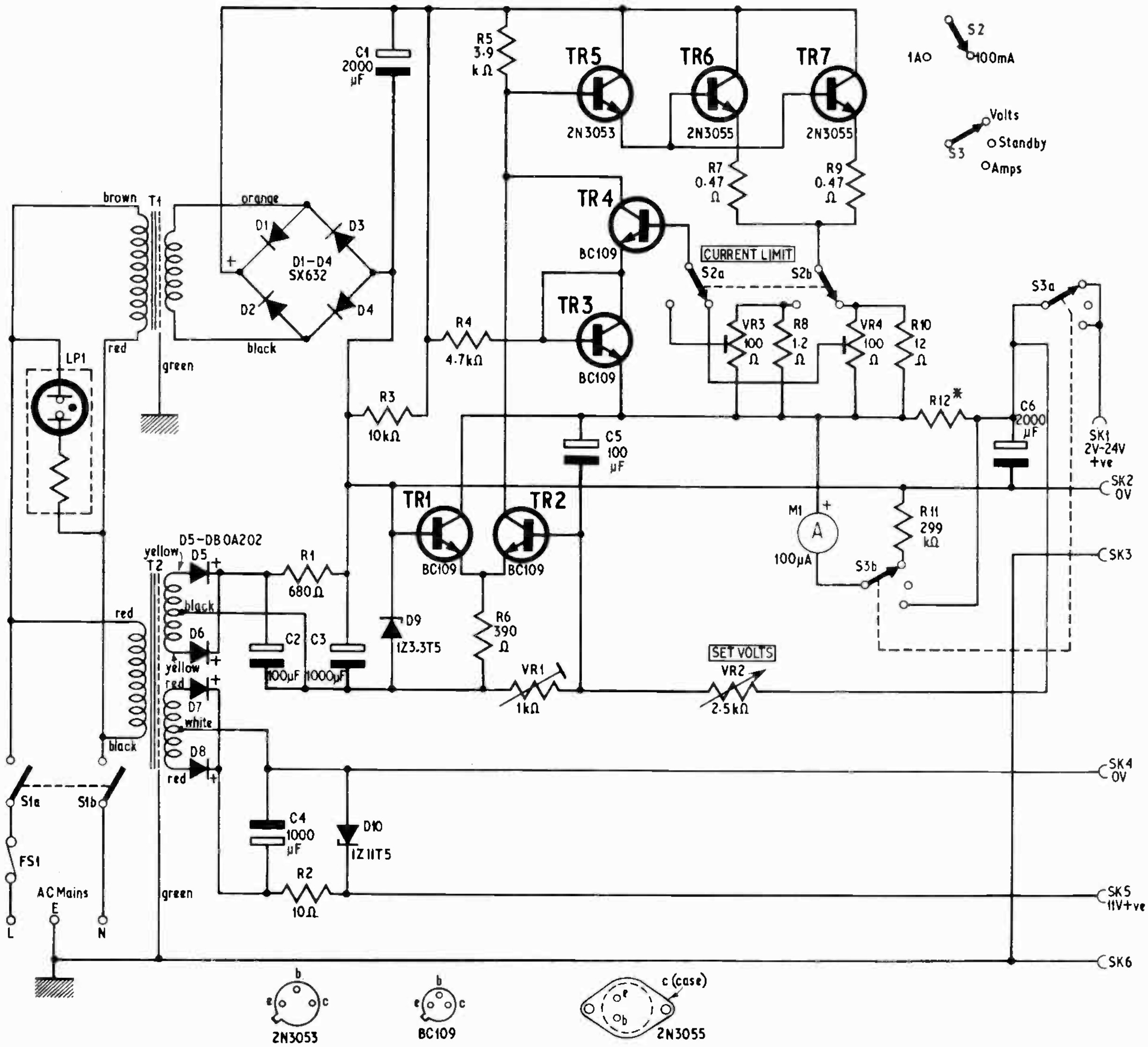
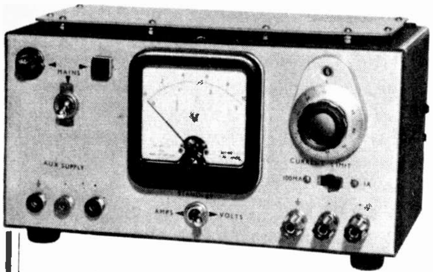


Fig. 2. Circuit diagram of power supply

SPECIFICATION . . .

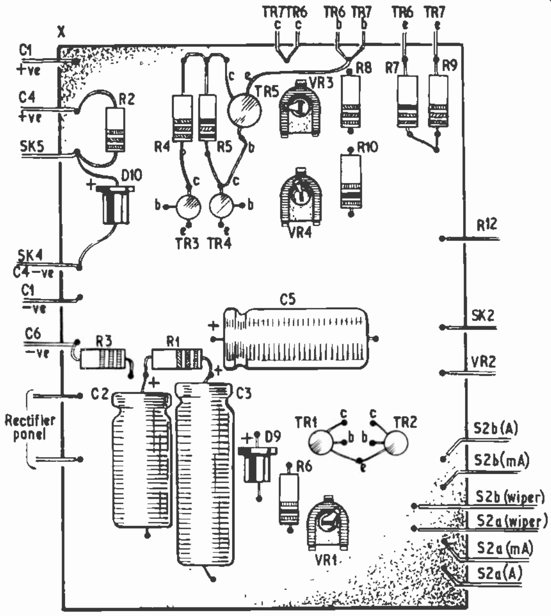


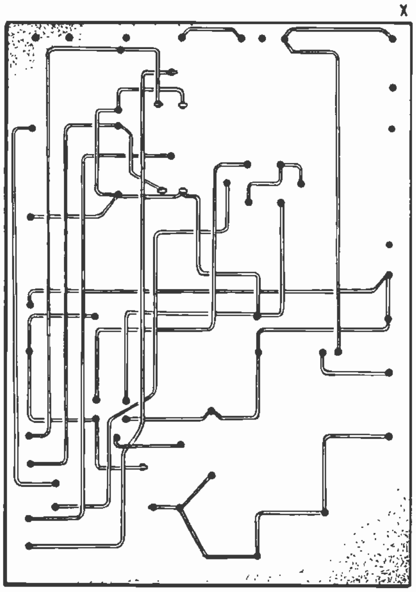
MAIN SUPPLY

Output Voltage	2V to 24V
Output Current	1A max
Current Limiting	1A and 100mA
Output Resistance	50 milliohms at 1A
A.C. Ripple	With no load is 250μV r.m.s.
A.C. Ripple	At 20V, 1A is 5mV r.m.s.
Output Variation	0·1% for 10% mains variation

AUXILIARY SUPPLY

Output Current	30mA max
Output Voltage	11V ± 5% at 30mA





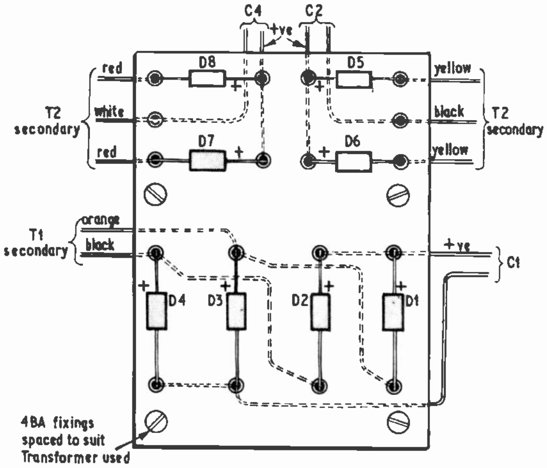
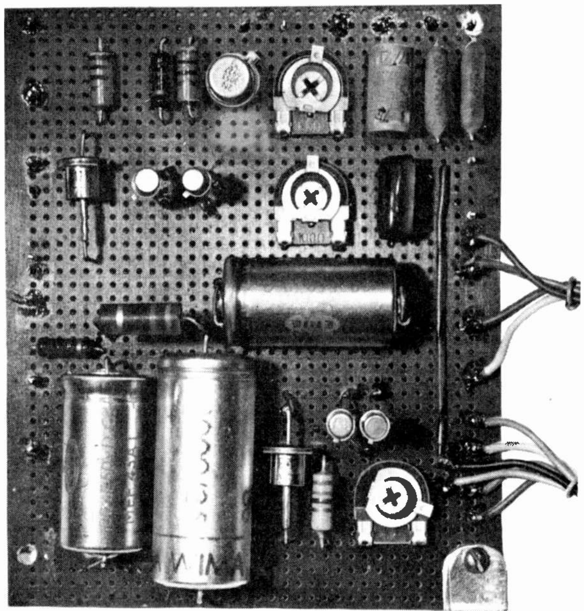


Fig. 4. Component layout and wiring of rectifier panel



values must be selected. The exact values used may require some adjustment, dependent on the gains of the transistors used in individual versions.

The action of the limiting circuit is not an abrupt one. The limiting process on the 1A range begins at about 0·8A and gradually increases. This will affect the output resistance above and below about 1A.

AUXILIARY SUPPLY

The transformer T2 has two windings, one of which provides the reference voltage for the differential amplifier, the other provides a stabilised 11V at 33mA and can be used for powering any permanently attached piece of equipment, provided it does not draw current in excess of the rated figure.

METER CIRCUIT

For monitoring purposes a fairly large 100μA meter is used. The one on the prototype was arbitrarily scaled 0–3 and 0–10, which is convenient, since with the multiplier R11 and shunt R12 no scale marking is necessary for the ranges 0–30V and 0–1A.

A two pole, two way, "centre-off" switch (S3) provides the measurement requirement. The centre position provides a standby facility which can be used when changing connections or reversing supply polarities.

The multiplier resistor R11, should ideally have a resistance of 299 kilohms and can be ordered with the meter. It is possible to use a 300 kilohm, 1 per cent type as the loss of accuracy is not severe.

The construction of the meter shunt will be dealt with later.

OUTPUT TRANSISTORS

The more knowledgeable constructor will have noticed the use of two 2N3055 transistors for the series regulator TR6 and TR7, when one would suffice.

For maximum dissipation to occur in these transistors requires the output to be made short circuit and is approximately 45W. Clearly, a good heatsink and ample ventilation are required, for even under normal load conditions the dissipation can be as much as 30W.

Since the unit was intended to be used for long periods at fairly high dissipations, it was decided to use two output transistors for the reliability offered.

CONSTRUCTION

The disposition of the components, whilst permitting the use of a relatively small cabinet, does result in a high packaging density.

Most of the semiconductors, capacitors and resistor are mounted on a 3¾in × 4¾in plain piece of 0·1in pitch pegboard as in Fig. 3. Veroboard can be used if desired.

The rectifier panel of Fig. 4 is a 2½in × 3½in plain pegboard of 0·15in pitch. This should be drilled for mounting to the frame of T1 (see photograph). When the rectifiers are mounted the panel should be attached to the transformer using 4B.A. nuts and bolts and ¼in spacers.

INTERWIRING

Interwiring details for the complete power supply are given in Fig. 5. The arrowed connections to the boards can be determined by referring to Figs. 3 and 4.

The front panel carries all the controls, the meter, fuse, indicator neon and output terminals (Fig. 5). On the prototype, the output voltage control, VR2 was a ten turn potentiometer, though somewhat expensive it is to be recommended since it enables precise setting to be achieved. Of course, an ordinary wirewound potentiometer can be substituted.

Transformer T2 is one of the clamp type of construction and is secured to the rear wall of the case. So too is a five way tag strip, to which the mains input is connected, and the heat sink for TR6 and TR7.

COMPONENTS...

Resistors

R1	680Ω	R7	0·47Ω	1W wirewound
R2	10Ω	R8	1·2Ω	2·5W wirewound
R3	10kΩ	R9	0·47Ω	1W wirewound
R4	4·7kΩ	R10	12Ω	2·5W wirewound
R5	3·9kΩ	R11	299kΩ	1% metal film (see text)
R6	390Ω	R12*	See text	

All 5%, ¼ watt carbon except where shown

Capacitors

C1	2,000μF elect. 50V	C4	1,000μF elect. 50V
C2	100μF elect. 50V	C5	100μF elect. 50V
C3	1,000μF elect. 50V	C6	2,000μF elect. 50V

Transistors
TR1–TR4 BC109 (4 off)
TR5 2N3053
TR6–TR7 2N3055 (2 off)

Diodes
D1–D4 SX632 (4 off)
D5–8 OA202 (4 off)
D9 1Z3·3T5 1W 3·3V Zener
D10 1Z11T5 1W 11V Zener

Potentiometers
VR1 1kΩ miniature horizontal preset
VR2 2·5kΩ multi-turn potentiometer (see text) (R.S. Components)
VR3–VR4 100Ω miniature horizontal presets (2 off)

Switches
S1 Double pole mains on/off switch
S2 Double pole, double throw slide switch
S3 Double pole, double throw "centre-off" toggle switch

Meter
M1 100μA Type MR26 (R.S. Components)

Transformers
T1 Mains transformer: Primary 0–240V
Secondary 26V at 1·6A
Type X6705 (Belçlere Ltd)
T2 Mains transformer:
Primary 0–240V
Secondaries 26–0–26V, 23mA
and 11–0–11V, 33mA
Type X676X (Belclere Ltd)

Miscellaneous
LP1 Mains neon indicator, FS1 500mA fuse with holder, 3¾in × 4¾in pegboard 0·1in pitch, 2½in × 3½in pegboard, 0·15in pitch, 20 s.w.g. aluminium sheet cut as required
Heat sink 4·875in × 1·05in extruded aluminium 4in long with eight pairs of fins, SK1–SK6 insulated sockets (6 off)

LABPACK INTERWIRING

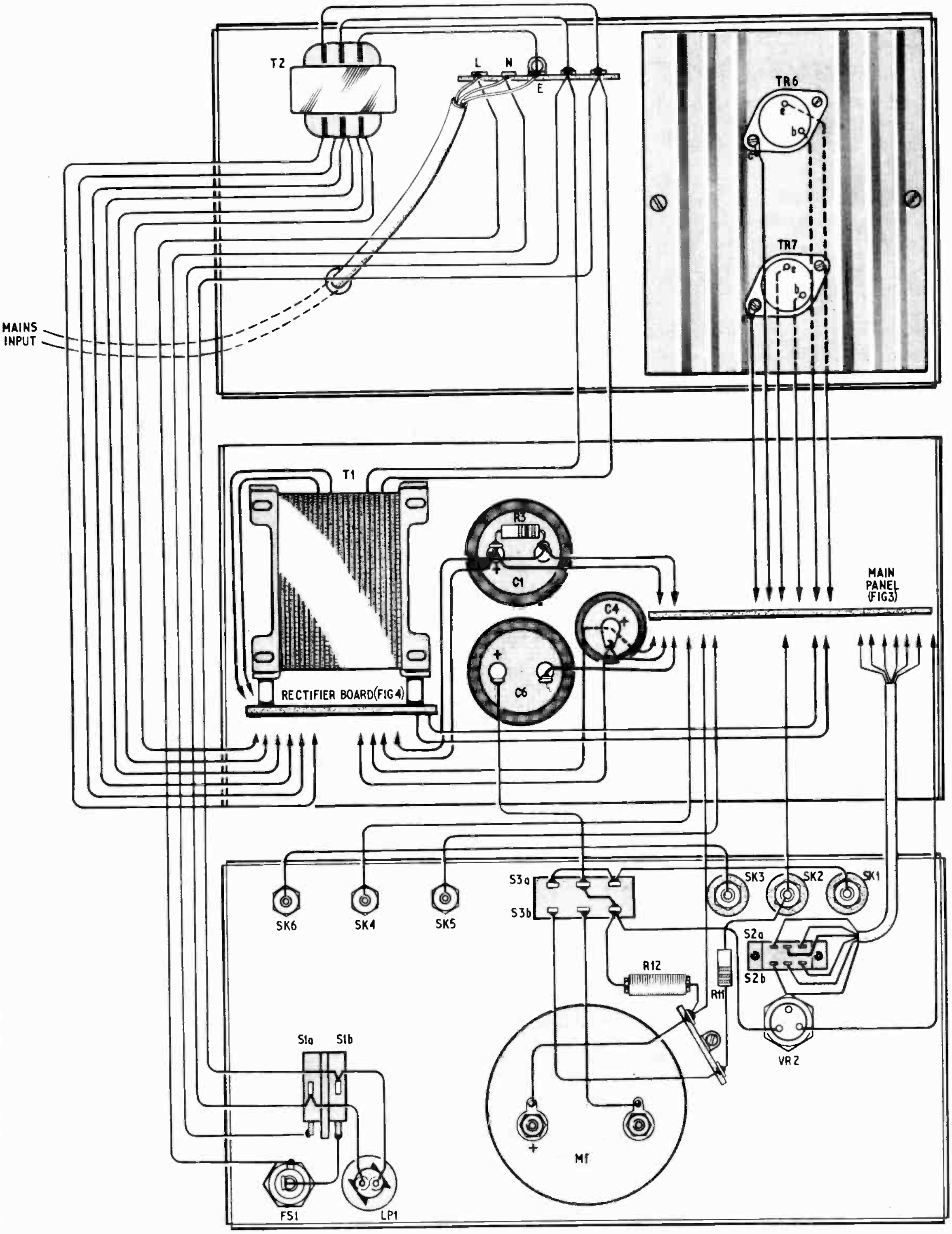


Fig. 5. Interwiring details of power supply

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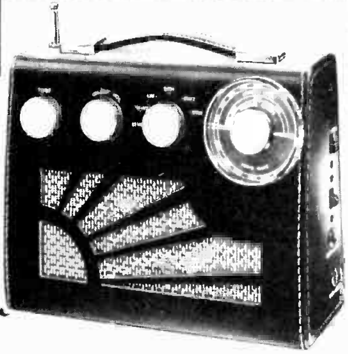

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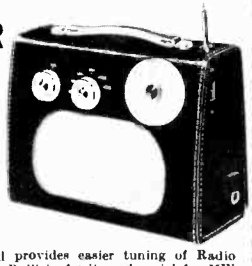

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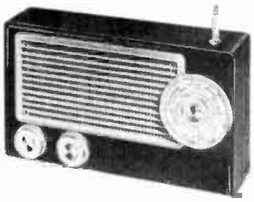

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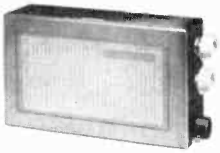

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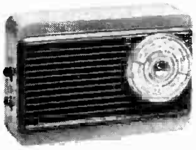

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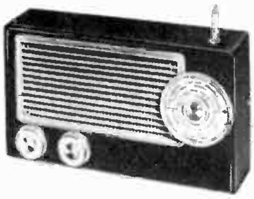

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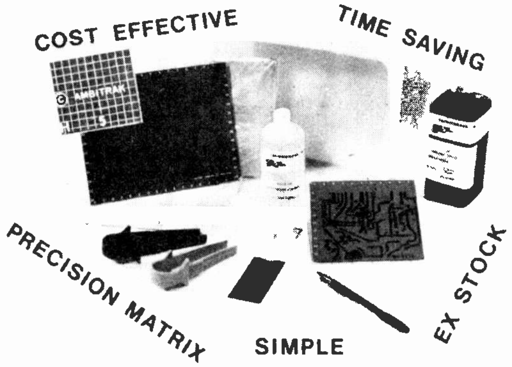

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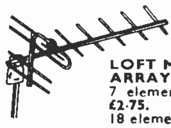

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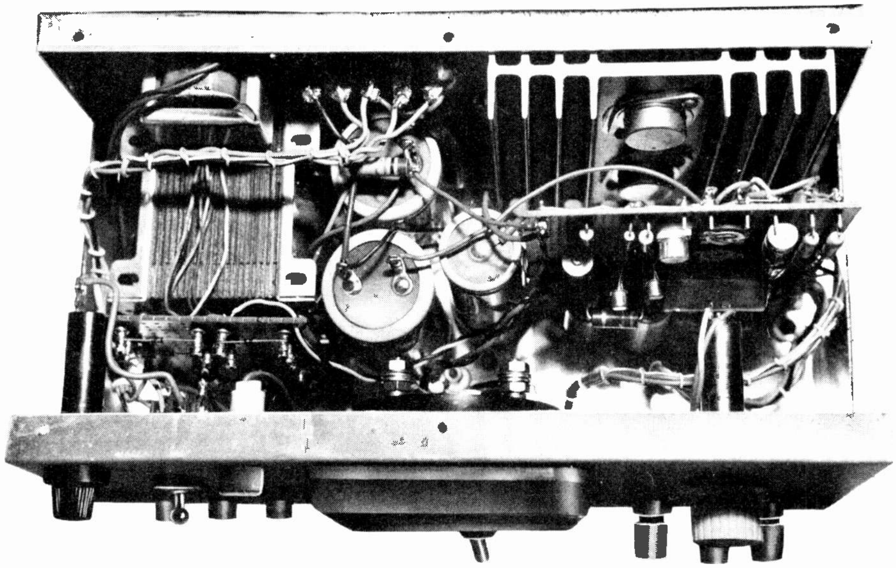


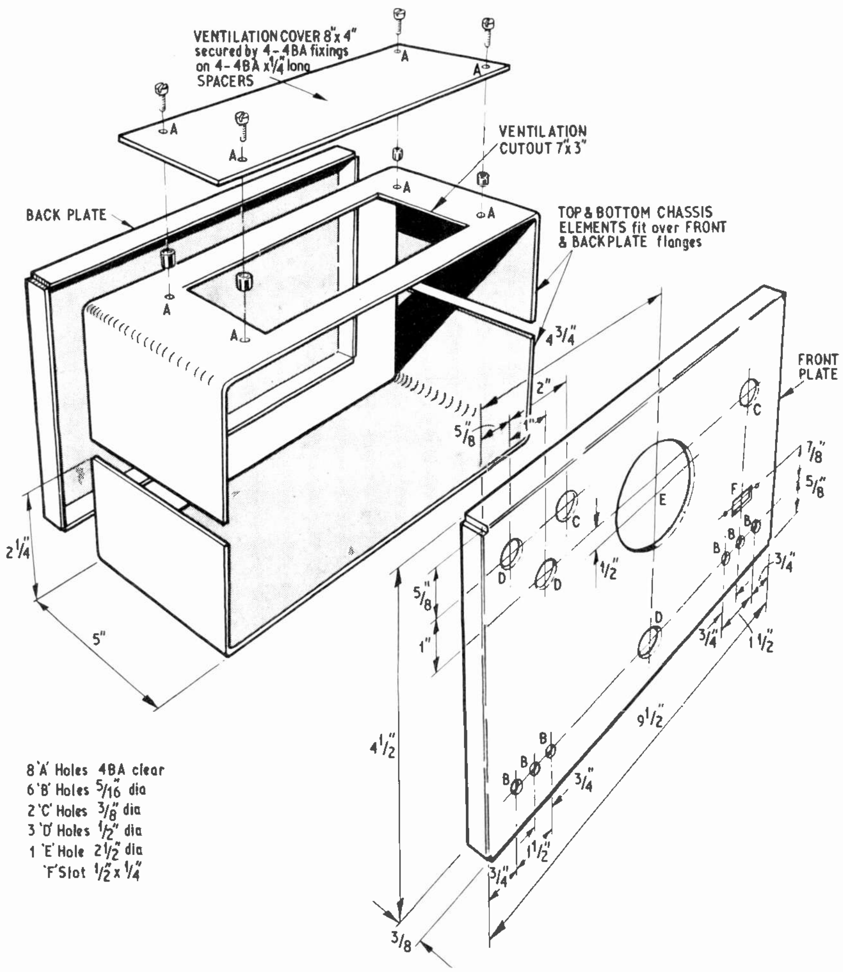
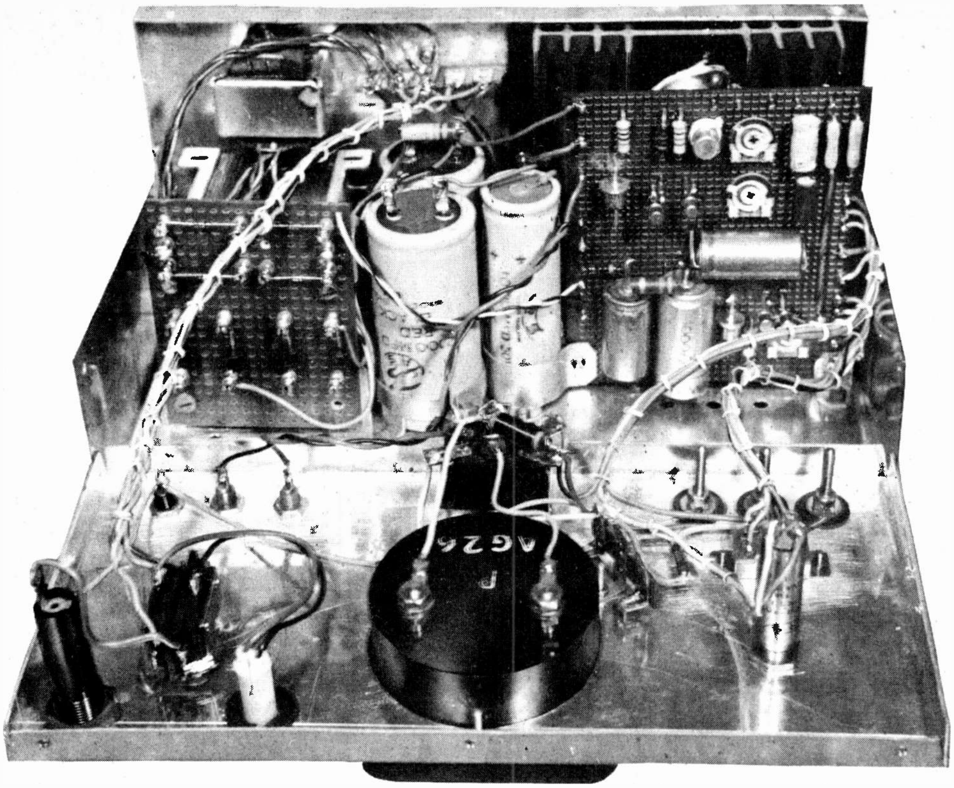


Fig. 6. Case assembly and drilling details. Self tapping screws are used for all fixings



Transformer T1 and capacitors C1, C4 and C6 are mounted on the cabinet base. The main component board is attached vertically at its two lower corners, one corner by means of a small right angled bracket, the other by the clamp of C4.

MAKING THE CASE

The cabinet used for the prototype was made from 20 s.w.g. aluminium, bent and cut as in Fig. 6. In assembling, the various panels are all secured together by small self tapping screws.

Ventilation must be adequate and is effected by means of a rectangular hole 3in × 7in cut out of the top panel. This is covered by an aluminium plate 4in × 8in separated from the top by $\frac{1}{4}$in spacers.

To maintain air flow through this port $\frac{3}{8}$in holes should be drilled below the heat sink and around T1.

TESTING

When all of the components have been assembled and connected, a careful check for wiring errors should be made. If everything appears satisfactory set VR1 and VR2 for maximum resistance, and VR3 and VR4 to mid-range. S3 should be set for a voltage reading. A load is not required.

With the unit connected to the mains and switched on, the voltmeter should indicate. VR2 should be rotated anti-clockwise, when the voltage should fall, then rise again as VR2 is returned to its original fully clockwise position.

The preset VR1 should now be set for a maximum output voltage of 24V.

METER SHUNT

The meter shunt, R12, is made up of resistance wire with a measured value of 0·125 ohms. Since the formula for calculating this includes the meter resistance the meter specified, or one with a resistance of 1,250 ohms, must be used.

To actually construct the shunt, a length of resistance wire, somewhat longer than is required, is connected in the position of R12. With S3 set to "Volts" adjust the output of the unit for 10V. Switch off and connect a 10 ohm, 10W resistor, in series with a multimeter switched to 1A d.c., across the output terminals.

If S3 is switched to "Amps" and the unit switched on, R12 can be adjusted so that 1A flows in the multimeter when meter M1 registers full scale deflection.

A high value resistor can be used as a mounting for the resistance wire, it being simply wrapped round the resistor body with the wire ends soldered to the resistor leads.

CURRENT LIMIT SETTING

Having set the output voltage, attention can now be turned to the current limiting potentiometers VR3 and VR4.

With S2 switched to the 1A range a multimeter switched to the 1A d.c. range can be connected directly across the output terminals and VR3 adjusted for a reading of 1A.

The time taken for this adjustment should be a minimum as the dissipation in the output transistors is high. Adjustment for the 100mA range is identical with suitable multimeter range switching. Here, of course, VR4 is adjusted.

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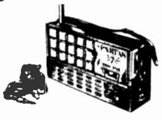

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Model 6000/79. 275-0-275V at 330mA and 6·3V at 4·6A. Price **£4·50.** 50p post.

Model 6000/71. 290-215-0-215-290 at 125mA and 2 at 6·3V 6A. Price **£4·50** + 40p post.

Model 49. 250V at 10mA. 6·3V at 3A, 5V at 0·75A. Price **£2** + 30p post.

Model 47. 620-0-620 at 9mA. 4V at 1A. Price **£4·50** + 40p post.

Parmeko Neptune C. Core Chokes. These are encased and match the transformers above.

Model 6000/73. 4H at 560mA. **£2·50** + 40p post.
Model 55. 10H at 1mA. **£2·50** + 40p post.
Model 49. 10H at 70mA. **£1·50** + 30p post.
Model 69. 10H at 110mA. Price **£2** + 40p post.

RHYTHMETRON
As featured in November issue. Electronics parts kit, less case and knobs, but including Vero panels. **£4·25p** + 20p post.

Electronic Car Ignition. In addition to the kits for 12V cars we can also supply systems for 6V cars. These are not kits but made up and ready to work. Price **£5·50** + 30p post.

Carbon Resistors. We are now stocking these in a big way and will be pleased to quote special prices to quantity buyers. Made by Erie, Morganite or Dubilier.

	Price per each			
	1-9	10-99	100-999	1,000 up
½ Watt	1p	8p	6p	5p
1 Watt	2p	18p	15p	125p
2 Watt	4p	32p	30p	275p

Special Resistor Assortment Offer (1). 100 × ½W resistors made up of 2 each of 50 different values fairly evenly spaced between 1 ohm and 10 megs. Price **50p.**

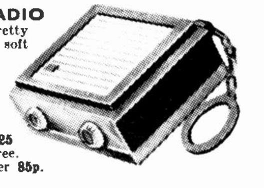
Special Resistor Assortment Offer (2). 1,000 × ½W resistors made up of 20 each of 50 different values fairly evenly spaced between 1 ohm and 20 megs. Price **£4.**

Special Resistor Assortment Offer (3). As offer 1 but 1W. Price **£1.**

Special Resistor Assortment Offer (4). As offer 2 but 1W. Price **£8.**

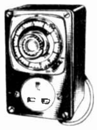
12 Way Sub-Miniature Multi-core Cable 7·0076 copper cores each core p.v.c. insulated and of different colour. P.v.c. covered overall and approx. 3/16in thick. Price **20p** per yard.

MICROSONIC KEYCHAIN RADIO



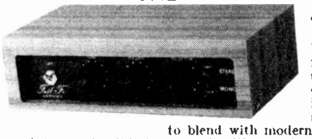
7 transistor Keychain Radio in very pretty case, size 2¾ × 2½ × 1½in—complete with soft leather zipped bag. 7 transistor, ferrite rod. Loudspeaker.
In transit from the East these sets suffered corrosion as the batteries were left in them but when this corrosion is cleared away they should work—offered without guarantee except that they are new. Price only **£1·25** less batteries plus **13p**, post 6 for **£7** post free. Pair of rechargeable batteries and charger **85p.**

24-HOUR TIME SWITCH



Made by Smiths, these are a.c. mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods per 24 hours, 5A changeover contacts will switch circuit on or off during these periods. **£2·50** post and ins. 23p. Additional time contacts **50p** pair.

THE FULL-FI STEREO SIX



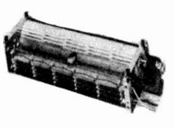
The amplifier sensation of the year You will be amazed at the fullness of reproduction and at the added qualities your records or tuner will reproduce. Built into metal cabinet elegantly styled in simulated teak finished to blend with modern furnishings, this amplifier uses an integrated solid state circuit with an output power of 6W R.M.S. split over the two channels. The amplifier is ideal for use with normal pick-ups and tuners, it has a double wound mains transformer and ganged volume and tone controls—also switching for Mono to Stereo, tuner or pick-up. Other controls include "treble lift and cut", "balance" and separate mains on/off switch. UNREPEATABLE PRICE is **£9** plus 38p post and insurance.

THIS MONTH'S SNIP

POCKET CIRCUIT TESTER

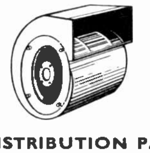
Test continuity of any low resistance circuit, house wiring, car electrics. Tests polarity of diodes and rectifiers. Also ideal size for conversion to signal injector (circuit supplied) **30p** or 2 for **50p**, post paid.

TANGENTIAL HEATER UNITS



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

CENTRIFUGAL FAN



Mains operated, turbo-blower type. Pressed steel Housing contains motor and aluminium impeller. Motor is 1/10th h.p. giving considerable air flow but virtually no noise. Approx. dimensions 10½in wide by 12in dia. Outlet into trunking 10¾in × 4¼in. **£4·95** + £1.

DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 × 13A sockets in metal box to take standard 13A fused plugs and on/off switch with neon warning light. Supplied complete with 7 feet of heavy cable. Wired up ready to work, **£2** less plug **£2·25** with fitted 13A plug; **£2·40** with fitted 15A plug, plus 23p post and ins.

CAPACITOR DISCHARGE CAR IGNITION

This system which has proved to be amazingly efficient and reliable was first described in the Wireless World about a year ago. We can supply kit of parts for improved and even more efficient version, (P.W. June), price **£4·95.** When ordering please state whether for positive or negative systems. Plus 30p post.

2 OCTAVE MINI ORGAN

As featured in P.W. Kit of Electronic parts **£4·50** plus 20p post. Gold wire and other metal parts **£1·50.**

15 WATT 12in HI-FI SPEAKER

Is undoubtedly one of the finest loudspeakers that we have ever offered, produced by one of the country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi and public address. Handling 15W R.M.S.—Cone moulded fibre—Freq. response 30 10,000 c.p.s.—specify 3 or 15 ohms. Chassis dia. 12in—12¾in over mounting lugs. Overall height 5¼in. A £10 speaker offered this month for **£3·75** plus 30p. post and ins.

DIGITAL COUNTER TIMER

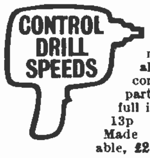
Very stable and reliable crystal controlled circuit. Capable of work in excess of 15MHz. Construction simplified by use of 15 integrated circuits. Complete kit with case **£37·50,** or construction data and price list 30p.

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

TREASURE TRACER

Complete Kit (except wooden battens) to make the metal detector as the circuit in Practical Wireless August issue. **£2·95** plus 20p post and insurance.

DRILL CONTROLLER
NEW 1KW MODEL



Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£1·50** plus 13p post and insurance. Made up model also available, **£2·25** plus 13p post & p.

Snap Action Slide Switch. Rated 5A 240V. Made by Arrow. Type fitted in the handles of electric drills, vacuums, etc. **5p** each, 10 for **45p.**

Numicator Tubes. For digital instruments, counters, timers, clocks, etc. Hi-vac XN, 3. Price **£1·45** each. 10 for **£13.**

Pressure Switch. Containing a 15A change over switch operated by a diaphragm which in turn is operated by air pressure through a small metal tube. The operating pressure is adjustable but is set to operate in approx. 10in of water. These are quite low pressure devices and can in fact be operated simply by blowing into the inlet tube. Original use was for washing machines to turn off water when tub has reached correct level but no doubt has many other applications. **50p** each. 10 for **£4·50.**

Papst Miniature Extractor Fans. Beautifully made as are all Papst motors. Intended for cooling computers but suitable for any equipment. Size 4¾in square and 1½in thick. Price **£2** each. Post and insurance 20p.

Commutator Motor, Small Size approx. 3in plus 1in of shaft, 3in high × 1½in wide, but high speed and very powerful. These motors operate from the mains. Are particularly useful as they can be speed controlled by our thyristor kit or by variable resistor. **£1** each.

Auto Light Kit. The circuit for this appeared in *Practical Wireless,* October issue. It is a simple circuit but has many uses: Parking light, porch light, etc. Uses light cell and two transistors. Complete kit, no case **95p.** Suitable case **20p.**

Charger Kit. Comprises of 3A transformer, 5A rectifier and a pair of hefty crocodile clips. With wiring diagram. **£1·40** plus 20p post and ins.

24 hr. Clock Switch. In metal case with 13A socket. Smiths movement, 2 ons and 2 offs per 24 hours. Very neatly made and finished. Original retail price **£7** each. Few only, new and perfect. **£4·00** each.

Neon Indicator Lamps. With amber lens, standard type with built in resistor for mains. **10p** each. 10 for **90p.**

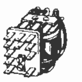
Condensers. Another addition to our range. 500μF at 50V. **15p** each. 10 for **£1·25.**

Thermistor Bead Type. For instruments, medical applications, etc. ITT No. GL23. **75p** each. 10 for **£6·75.**

3 Core Mains Leads. Special offer this month is a 6ft lead with 23/36 cores and coloured according to the new code i.e. Brown—live; Yellow/Green—earth; Blue—neutral. Price **6p** each or 10 for **50p.**

DIGITAL DICE
as featured in this issue. Send S.A.E. for parts list.

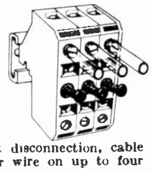
MAINS RELAY BARGAIN



Special this month are some single, double and treble pole changeover relays. Contacts rated at 15 amps. Operating coil wound for 240V A.C. Good British Make. Ex-unused equipment. Size approx. 1½in × 1in.

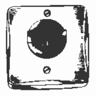
Open construction		
Single pole	25p each	10 for £2·25
Treble pole	40p each	10 for £30·6

FLEX CONNECTOR



A quick way to connect equipment to the mains safely and firmly—L., N. and E. coded to new colour scheme; disconnection by plugs prevents accidental switching on: has sockets which allow insertion of meter without disconnection, cable inlets firmly hold one hair wire on up to four 7·029 cables. **85p** each.

THYRISTOR LIGHT DIMMER



For any lamp up to 200W. Mounted on switch plate to fit in place of standard switch. Virtually no radio interferences. Price **£1·99** plus 20p post and insurance.

J. BULL (ELECTRICAL) LTD.

Dept. (P.E.) 7, Park Street, Croydon CRO 1YD

Callers 102/3 Tamworth Road, Croydon

Great new OFFER from DIOTRAN

TRANSISTORS

BRAND NEW FULLY GUARANTEED DEVICES

AC107	15p	AF115	17p	BC140	35p	BCY31	22p	BF272	80p	EC403	15p	ORP60	40p
AC113	20p	AF116	17p	BC141	35p	BCY32	25p	BF273	30p	GET880	27p	ORP61	40p
AC115	23p	AF117	17p	BC142	45p	BCY33	17p	BF274	30p	MAT100	15p	ST140	12p
AC125	17p	AF118	30p	BC143	40p	BCY34	20p	BF308	35p	MAT101	17p	ST141	17p
AC126	17p	AF124	21p	BC145	45p	BCY70	17p	BF309	37p	MAT120	15p	TIS43	40p
AC127	17p	AF125	20p	BC147	17p	BCY71	30p	BF316	75p	MAT121	17p	UT46	27p
AC128	17p	AF126	20p	BC148	12p	BCY72	15p	BFW10	55p	MPF102	43p	V405A	25p
AC141K	17p	AF127	20p	BC149	17p	BCZ11	20p	BFX29	27p	MPF105	43p	V410A	45p
AC142K	17p	AF139	33p	BC150	17p	BD121	85p	BFX84	20p	OC19	30p	2G301	19p
AC151	15p	AF178	50p	BC151	20p	BD123	85p	BFX85	27p	OC20	50p	2G302	19p
AC154	15p	AF179	50p	BC152	17p	BD124	75p	BFX86	22p	OC22	30p	2G303	19p
AC155	17p	AF180	50p	BC153	27p	BD131	80p	BFX87	25p	OC23	33p	2G304	20p
AC156	17p	AF191	50p	BC154	30p	BD132	80p	BFX88	22p	OC24	45p	2G306	35p
AC157	17p	AF186	45p	BC157	20p	BDY20	£1	BFY50	20p	OC25	25p	2G308	35p
AC165	17p	AF239	37p	BC158	17p	BF115	22p	BFY51	20p	OC26	25p	2G309	35p
AC166	17p	AFZ11	37p	BC159	20p	BF117	45p	BFY52	20p	OC28	40p	2G339	17p
AC167	20p	AFZ12	45p	BC167	13p	BF118	60p	BFY53	17p	OC29	40p	2G339A	15p
AC168	20p	AL102	85p	BC168	13p	BF119	70p	BSX19	15p	OC35	33p	2G344	15p
AC169	14p	AL103	85p	BC169	13p	BF152	35p	BSX20	15p	OC36	40p	2G345	15p
AC176	23p	ASY26	25p	BC170	12p	BF153	35p	BSY25	15p	OC41	20p	2G371	13p
AC177	20p	ASY27	30p	BC171	13p	BF154	35p	BSY26	15p	OC42	22p	2G371B	10p
AC187	30p	ASY28	25p	BC172	13p	BF157	45p	BSY27	15p	OC44	15p	2G374	17p
AC188	30p	ASY29	25p	BC173	13p	BF158	25p	BSY28	15p	OC45	12p	2G377	27p
ACY17	25p	ASY50	25p	BC174	13p	BF159	30p	BSY29	15p	OC70	15p	2G378	15p
ACY18	20p	ASY51	25p	BC175	22p	BF160	30p	BSY38	15p	OC71	9p	2G382	15p
ACY19	22p	ASY52	25p	BC177	17p	BF162	30p	BSY39	15p	OC72	12p	2G401	30p
ACY20	20p	ASY54	25p	BC178	17p	BF163	35p	BSY40	30p	OC74	12p	2G414	30p
ACY21	20p	ASY55	25p	BC179	17p	BF164	35p	BSY41	35p	OC75	15p	2G417	25p
ACY22	19p	ASY56	25p	BC180	20p	BF165	35p	B5Y95	12p	OC76	15p	2N388	30p
ACY27	18p	A5Y57	25p	BC181	22p	BF167	22p	BSY95A	12p	OC77	25p	2N388A	50p
ACY28	19p	A5Y58	25p	BC182	10p	BF173	22p	BU105	£3·90	OC81	15p	2N404	22p
ACY29	30p	ASY58	25p	BC182L	10p	BF176	35p	C111E	60p	OC81D	15p	2N404A	30p
ACY30	25p	ASZ21	40p	BC183	10p	BF177	35p	C400	30p	OC82	15p	2N524	55p
ACY31	25p	BC107	10p	BC183L	10p	BF178	45p	C407	25p	OC82D	15p	2N527	60p
ACY34	18p	BC108	10p	BC184	13p	BF179	50p	C424	17p	OC83	20p	2N696	12p
ACY35	18p	BC109	11p	BC184L	13p	BF180	30p	C425	40p	OC84	20p	2N697	15p
ACY36	30p	BC113	25p	BC186	27p	BF181	30p	C426	30p	OC139	15p	2N698	24p
ACY40	15p	BC114	30p	BC187	27p	BF182	30p	C428	20p	OC140	17p	2N699	55p
ACY41	18p	BC115	30p	BC207	11p	BF183	30p	C441	27p	OC170	15p	2N706	7p
ACY44	35p	BC116	35p	BC209	11p	BF184	25p	C442	35p	OC171	15p	2N706A	8p
AD140	40p	BC117	35p	BC209	11p	BF185	30p	C444	37p	OC200	25p	2N708	12p
AD142	40p	BC118	25p	BC212L	11p	BF188	30p	C450	17p	OC201	27p	1N709	45p
AD149	43p	BC119	45p	BC213L	11p	BF194	23p	C720	12p	OC202	27p	2N711	40p
AD161	35p	BC125	35p	BC213L	11p	BF195	24p	C722	25p	OC203	25p	2N717	42p
AD162	35p	BC126	35p	BC214L	12p	BF196	30p	C740	25p	OC204	25p	2N718	24p
AD161/		BC132	25p	BC225	25p	BF197	35p	C742	17p	OC205	35p	2N718A	50p
162(MP)	63p	BC134	30p	BC226	35p	BF200	45p	C744	17p	OC309	35p	2N726	27p
ADT140	50p	BC135	30p	BC317	12p	BF222	80p	C760	17p	P346A	17p	2N727	27p
ADZ11	£2	BC136	30p	BC318	12p	BF257	35p	C762	17p	P397	45p	2N743	17p
ADZ12	£2·10	BC137	35p	BC319	12p	BF270	25p	C764	60p	OCP71	43p	2N744	17p
AF114	17p	BC139	45p	BCY30	20p	BF271	17p	EC401	15p	ORP12	43p	2N914	17p

2N918	30p	2N2714	25p	2N3704	15p
2N929	22p	2N2904	25p	2N3705	12p
2N930	25p	2N2904A	30p	2N3706	12p
2N1131	20p	2N2905	25p	2N3707	13p
2N1132	22p	2N2905A	30p	2N3708	8p
2N1302	17p	2N2906	25p	2N3709	8p
2N1303	17p	2N2906A	27p	2N3710	10p
2N1304	20p	2N2907	25p	2N3711	10p
2N1305	20p	2N2907A	30p	2N3819	40p
2N1306	22p	2N2923	13p	2N3820	£1
2N1307	22p	2N2924	13p	2N3903	25p
2N1308	27p	2N2925	13p	2N3904	27p
2N1309	27p	2N2926		2N3905	25p
2N1613	17p	(G)	12p	2N3906	27p
2N1711	20p	2N2926(Y)	11p	2N4058	15p
2N1889	35p	2N2926		2N4059	10p
2N1890	45p	(O)	10p	2N4060	12p
2N1893	37p	2N3010	80p	2N4061	12p
2N2160	60p	2N3011	20p	2N4062	12p
2N2147	75p	2N3053	20p	2N5172	12p
2N2148	60p	2N3054	50p	2N5459	43p
2N2192	30p	2N3055	63p	2S034	75p
2N2193	30p	2N3391	17p	2S301	50p
2N2194	27p	2N3391A	20p	2S302A	45p
2N2217	20p	2N3392	17p	2S302	45p
2N2218	25p	2N3393	15p	2S303	60p
2N2219	27p	2N3394	15p	2S304	£1·10
2N2220	22p	2N3395	20p	2S305	£1
2N2221	22p	2N3402	22p	2S306	£1·10
2N2222	27p	2N3403	22p	2S307	£1·10
2N2368	17p	2N3404	32p	2S321	60p
2N2369	15p	2N3405	45p	2S322	50p
2N2369A	15p	2N3414	20p	2S322A	45p
2N2411	50p	2N3415	20p	2S323	60p
2N2412	50p	2N3417	37p	2S324	£1·20
2N2646	55p	2N3525	74p	2S325	£1·20
2N2711	22p	2N3702	12p	2S326	£1·20
2N2712	22p	2N3703	12p	2S327	£1·20

DIODES & RECTIFIERS

AA119	8p	BYZ11	32p	OA81	7p
AA120	8p	BYZ12	30p	OA85	7p
BA116	22p	BYZ13	25p	OA90	6p
BA126	22p	BYZ16	35p	OA91	7p
BY100	15p	BYZ17	35p	OA95	7p
BY101	12p	BYZ18	30p	OA200	6p
BY105	15p	BYZ19	25p	OA202	7p
BY114	12p	OA5	17p	SO10	4p
BY126	15p	OA10	22p	SO19	4p
BY127	17p	OA47	7p	IN914	6p
BY130	15p	OA70	7p	IN916	6p
BYZ10	35p	OA79	8p	IN4148	6p

1,000,000 SILICON PLANAR TRANSISTORS

NPN-PNP PLASTIC AND METAL CAN TYPES

Clearance of manufacturers' seconds, selected in types and guaranteed no open or short circuit units. Ideal cheap transistors for radio enthusiasts, manufacturers, schools and colleges.

TYPE STN18. Silicon Planar Transistors npn TO-18 Metal Can. Types similar to: 2N706, 2N2220, BSY27-95A, BSX44-76-77.
Price: 500 £9, 1,000 £15

TYPE STP18. Silicon Planar Transistors pnp TO-18 Metal Can. Types similar to: BCY70-72, 2N2906-7, 2N2411 and BC186-7. Also used as complementary to the above npn type device type STN18.
Price: 500 £9, 1,000 £15

TYPE STNL. Silicon Plastic Epitaxial Planar Transistors TO-92 case. I.C. 200mA, 300mW medium to high gain, available in npn or pnp and types similar to: *NPN*2N2926—2N2711—2N3391—2N3707 — 2N3711 — BC167-8-9.
Price: 500 £7·50; 1,000 £13

TYPE STPL. As above but in pnp and similar to types 2N5354-56, 2N4058-2N4061 and 2N3702-3. Also used as complimentary to the above npn devices type STNL.
Price: 500 £7·50; 1,000 £13

TYPE STNK. Silicon Planar Plastic Transistor npn with TO-18 pin circular lead configuration, I.C. 200mA, 300mW and similar to BC107-8-9, BC170, BC173, BC182-184, BC237-8-9 and BC337-8.
Price: 500 £9·50; 1,000 £16

When ordering, please state type required, i.e., STNK or STN18, etc.

1,000,000 SILICON TRANSISTORS FOR SALE

Clearance of *pnp* Silicon Transistors from the 2S300 (TO-5) and 2S320 (SO-2) range and similar to the GC200-205 and BCY30-34 series. Ideal for *Amateur Electronics, Radio Hams and for experimental use in Schools, Colleges and Industry.*

Approximate count by weight:
100 off—**75p** (plus p. & p. 10p)
300 off—**£1·75** (plus p. & p. 15p)
500 off—**£2·50** (plus p. & p. 17½p)
1,000 off—**£4** (plus p. & p. 25p)
10,000 off—**£35** (plus p. & p. 55p)

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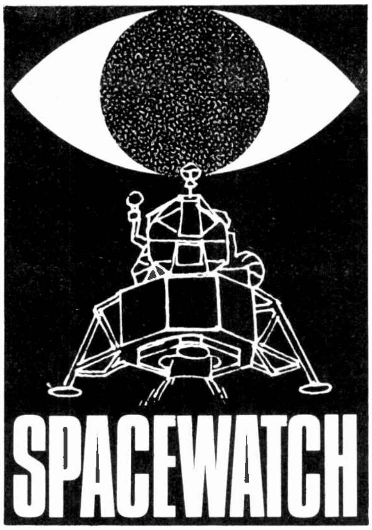


BY FRANK W. HYDE

RADIO FREQUENCIES USED IN SPACECRAFT

A large number of enquiries are received about the communication frequencies used by the *Apollo* missions and other spacecraft.

The frequencies that are used on spacecraft depend on the matter to be transmitted and also on the propagation conditions. There are normally three bands in use. These are the h.f., v.h.f. and u.h.f. bands. The latter includes the S-band which is of considerable importance since it is less susceptible to propagation anomalies and has perhaps the best noise level characteristic. Noise is at a minimum on this band.

Taking the *Apollo* spacecraft as an example, there are three units involved. These are the command module, the service module and the lunar module. Communication between ground and the spacecraft from the count down through launch and into earth orbit is maintained by v.h.f. on frequencies of 259MHz and 296MHz (exact values for *Apollo 15* were 259·7MHz and 296·8MHz). The command and lunar modules also operate on these frequencies. Within the spacecraft the u.h.f. frequencies are used as well as sound frequencies.

After leaving earth orbit and heading toward the target, communications change to the S-Band. These frequencies are 2273·5MHz for the television channel and 2106·4MHz for speech and exchange of data between the spacecraft and earth. Another channel on 2287·5MHz gives a link between the command module and the ground for speech, directly given data on the course position and other real time information..

The lunar module has two transceivers one of which is used for speech and data and operates on a frequency of 2101·8MHz. The other channel uses a frequency of 2282·5MHz and can be used for data, speech or television. In addition to these systems the craft operates another transceiver which uses a frequency of 10,006MHz. The powers that are used are quite low being 2·8 watts and 11·2 watts on the S-band.

PARACHUTE TESTING

NASA is to carry out free-flight tests on the *Viking* landers to test the parachute system to be used in the *Viking* spacecraft when they are launched in 1975. This is a new departure in technique for no parachute landing of spacecraft has been attempted before.

The *Viking* system is operated by a mortar which is fired automatically and deploys a 50ft diameter parachute. During tests units will be dropped from 50,000ft and drogue parachutes will slow a ten foot container to the speed at which the mortar will fire.

PROJECT EOLE

The new French *Eole* world wide system of weather watch reported previously ran into difficulties.

One hundred and forty-one balloons had been launched in the southern hemisphere and when the satellite was instructed to interrogate it sent instead a destruct signal to 72 balloons which were lost with all their sensors. This occurred on the 364th orbit.

The origin of the wrong signal was traced to one of the control centres at Bretignay. The French space organisation, CNES, consider that the programme will still be valuable since up to 500 balloons will be released during the 180 day period of observation.

SEARCH FOR EXTRA-TERRESTRIAL LIFE

At the final session of a Conference on Communication there was a discussion for a programme to organise a search for intelligent beings in the space of the galaxy. The conference was attended by many countries and the delegates were from many disciplines: astrophysicists, theoretical astronomers, radio astronomers, sociologists, archaeologists and anthropologists.

LUNOKHOD

The Russian roving vehicle Lunokhod was shut down after its eleventh day. The last test period resulted in a movement of only 100 metres. It has been shut down because Russian scientists are unwilling to risk the possible misalignment of the on-board laser reflector.

LAST LUNAR MISSION

The *Apollo 17* is, at the moment, the last lunar mission of the series for manned landing on the Moon. The planning of its landing site is therefore of considerable importance. Last June the target decided upon was the area near the crater Alphonsus. It still is the prime candidate.

There are important reasons for the examination of this area. It was from here that the Russian astronomers noted the emmission of gases and changes in the spectrum which suggested vulcanism. Since then, this area has been the subject of close study by professionals and amateurs. Many instances of transient changes in the crater have been noted, some of them detected by spacecraft photographs.

However, after examination of the *Apollo 15* data, recovered with much new information, it may be that another site would be of greater scientific value. This sets a problem because the time for crew training is affected particularly as this is the last mission.

SPACECRAFT COMPUTER

A low power spacecraft computer has been developed by Honeywell. It is suitable for a wide range of unmanned spacecraft missions and its power requirements are only 26·9 watts. It provides a one microsecond memory cycle time.

NASA's satellites for application technology will use two of these computers in parallel. The package weighs 23lb and is known as *HDC 401*.

SATELLITE GANYMEDE

Ganymede is one of the four satellites originally discovered by Galileo to revolve round Jupiter. It has virtually no atmosphere and it was thought, till recently, that the surface would be like that of the Moon. Recent observations, however, have shown that the atmosphere is below one millibar and the surface may be rock powder or ammonia snow.

These observations were carried out at a wavelength of 25 micrometres at the University of Hawaii. Led by Dr. D. Morrison the team at the University and the Los Alamos Scientific Laboratory observed the satellite before, during and after the eclipse by Jupiter, revealing that except for the presence in the spectrum of features which suggest ammonia frost, the surface is indeed moonlike in character.

The presence in the spectrum of features which suggest ammonia frost still leaves some puzzling questions.

Substitutes for ZENERS

By J. N. WATT

THE regulation of fairly low voltages using Zener substitutes is fairly straightforward, if a little unconventional, as was illustrated last month. In this final part we shall look at the application of these substitutes in power supply circuits and give some examples of their applications.

SHUNT REGULATOR

Fig. 9 shows a typical shunt regulator, where the extra transistor handles the additional power.

The Zener substitute and the power transistor's base-emitter voltage hold the output voltage at $V_0 = V_Z + V_{BE}$.

The resistor R2 ensures that sufficient current flows through the Zener substitute to give stability.

The current through the shunt transistor is about h_{FE} times that through the Zener substitute (ignoring the current in R2). It is this that gives the greater power handling capability, which is that of the shunt transistor. This latter could well be one of the unmarked *npn* devices mentioned earlier as being suitable for use as a Zener substitute.

Calculation of the value of R1 follows the same procedure as in the simple shunt regulator in Fig. 2.

In common with all shunt regulators there are two disadvantages: firstly, stability of output voltage is not as good as can be obtained by other methods, and secondly, the circuit is very inefficient, since full current is taken from the supply whatever the actual load current. With a shunt regulator, the total of load and shunt element currents is a constant.

There is one compensating advantage though—a shunt regulator is inherently short-circuit proof.

SERIES REGULATOR

For most purposes, series regulators are used when simple low power Zener shunt regulators are not capable of handling the power level required.

Fig. 10 shows the circuit of a typical simple series regulator. The Zener substitute holds the base of the series transistor at a constant voltage and, by emitter follower action in TR1, the output voltage remains constant also, at $V_0 = V_Z - V_{BE}$.

Sufficient base current must be supplied to the series transistor TR1 to permit it to pass the required load current. The maximum base current is $I_B = I_{max}/h_{FE}$, which must be made available by the Zener substitute.

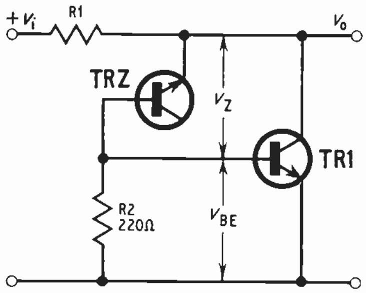
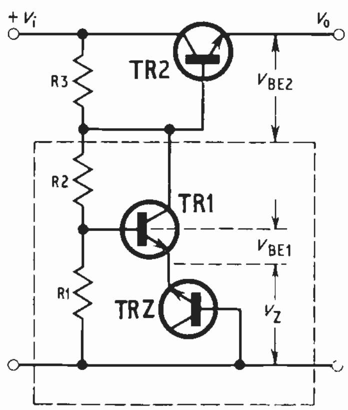
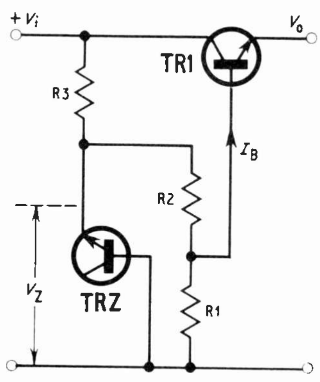


Fig. 9. Transistor shunt regulator





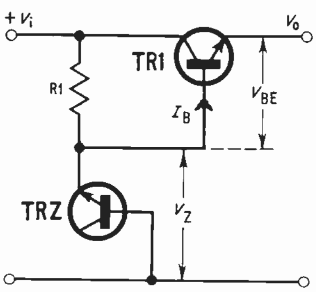
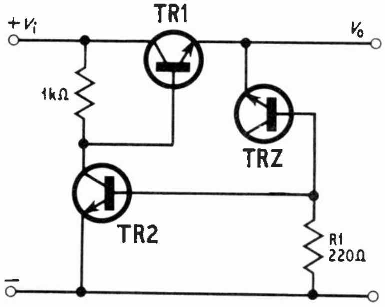


Fig. 10 (left). Simple series regulator

Fig. 11 (above). Series regulator using an "amplified Zener"

Fig. 12 (above right). Division of Zener voltage

Fig. 13 (right). Shunt regulator with improved performance



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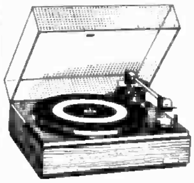

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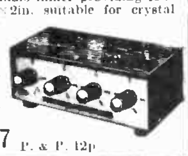

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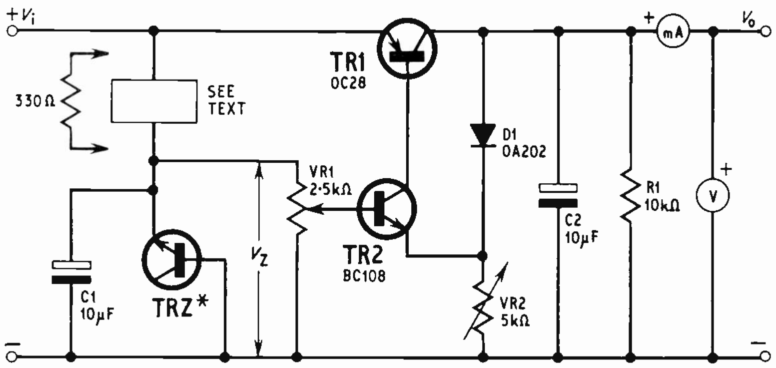


* TRZ is a silicon planar npn transistor, e.g. BSY95A, BC107, BC108, 2N2926

Fig. 14. Stabiliser with variable output voltage and short circuit protection

It is as well, therefore, by suitable choice of R1 to arrange for the current through the latter to be, say, 50% greater than this value of I_B.

With no load current, the current taken from the supply is only that through the Zener substitute. However, as it stands the arrangement is unprotected against short circuit of its output, an event which would be most likely to destroy the series transistor, unless protective measures are taken.

SHUNT TO SERIES CONVERSION

To provide an output voltage greater than V_Z, the circuit in Fig. 6 can be adapted to series operation, as shown in Fig. 11.

$$V_0 = \frac{R_1 + R_2}{R_1}(V_Z + V_{BE_1}) - V_{BE_2}$$

An output voltage less than the Zener voltage is easy to arrange by simple division of V_Z.

$$V_0 = \frac{R_1}{R_1 + R_2} V_Z - V_{BE}$$

This is shown in Fig. 12.

With these last two circuits sufficient base current must be supplied to permit the series transistor to pass the required full load current.

Thus in Fig. 12, R1 and R2 should be chosen to allow a standing current of, say, five times I_B to flow through them. This current can be looked upon as the load of the simple circuit comprising the Zener substitute and its series resistor R3.

With R1 and R2 so chosen, R3 can be selected as before.

VOLTAGE AMPLIFER

Regulation of the output voltage can be improved by incorporating a further transistor, used as a voltage amplifier, shown in Fig. 13.

If V_0 tries to rise in level, then so does the voltage at the base of TR2, since the Zener substitute has a constant voltage developed across it. Transistor TR2 amplifies this change, with reversal of sign, so that a larger fall in voltage appears at TR1 base. Emitter follower action in TR1 thus tends to reduce V_0, so correcting the original rise. TR1 can be a member of the OC28 to OC36 family, while TR2 can be almost any of the popular silicon *npn* devices so readily available.

Besides the better regulation given by the gain of TR2, it is noteworthy that the Zener substitute is driven by the regulated output voltage, V_0. Since this is constant, better stability of Zener voltage is obtained. In those circuits where the Zener is fed from the unregulated supply, some change of Zener voltage can occur with variation in that supply, due to change of current through the Zener.

An alternative method of obtaining better Zener voltage stability will be mentioned later.

STABILISED POWER SUPPLY

Having thus briefly described many of the circuits in which Zener substitutes can be employed, we can now turn to the design of a stabilised power supply, using a circuit configuration not previously mentioned, see Fig. 14. It has the following advantages:

1. Being a series regulated supply, it can efficiently handle moderately large currents—up to 1A or even greater, depending on the transistor and heat sink employed.

2. It gives a variable stabilised output.

3. Despite the series regulator configuration, short circuit protection is provided.

4. Constant current output, in place of constant voltage output, is possible, the level of such constant current being easily adjustable.

SERIES RESISTANCE FOR ZENER

Initially, consider the "black box" (between V_i and TRZ) feeding the Zener substitute to consist of a resistor of an appropriate value, say 330 ohms. Alternative components for the "black box" will be considered later.

Let us assume that an output current of 1A is required. Then the base current of TR1 will be $I_{B_1} = 1/h_{FE_1}$. Since this current is provided by TR2, its base current will be $I_{B_2} = 1/(h_{FE_1}h_{FE_2})$.

Assuming $h_{FE_1} = 25$ (OC28 family) and $h_{FE_2} = 100$ (BC108), then the base current of TR2 is 400μA.

We should allow, say, 10 times this current to flow through VR1 as a standing current, i.e. 4mA. If V_Z is made 8 volts (a reasonable value for a Zener substitute), then the value of VR1 is equal $V_Z/4 = 2\text{k}\Omega$.

A 2·5kΩ potentiometer will be suitable; it does of course give us the means of providing a variable stabilised output.

Capacitor C1 ensures that the Zener voltage is held smoothly, despite any rapid, large changes in supply voltage (V_i) which could occur if the mains were used

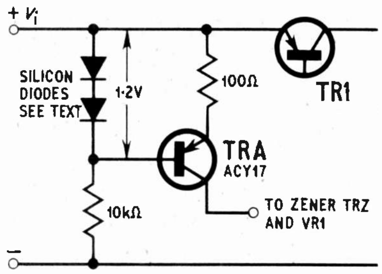


Fig. 15. Constant current drive for Zener substitute

as a primary supply, while C2 reduces any similar changes at the output due to rapid variations in load current. Resistor R1 is necessary to turn on TR1, thereby providing control, by drawing a small load current when no, or only a very small, load current would otherwise be taken. Without R1, V_0 could rise above the stabilised voltage, due to leakage in TR1.

SHORT CIRCUIT PROTECTION

Turning now to D1 and VR2, it is these components that provide the short circuit protection and constant current output facility.

In normal running, D1 is forward biased. Should a short circuit be applied to the output of the power supply, it will no longer be so biased, since its anode will then be at negative rail potential (via the short circuit). This results in TR1 passing a current determined by its then existing base current; this will be set largely by the value of VR2, since the lower end of VR2 is now connected directly to the collector of TR1 (via the short circuit).

Thus by choice of an appropriate setting of VR2, limiting of the current to any desired value is obtained.

The constant current mode is brought into play by ensuring that the output voltage setting is such as to attempt to deliver more current than the setting of VR2 allows. Output current is then constant despite supply voltage changes and load changes, provided of course the necessary output voltage can in fact be reached by the supply.

The short circuit protection and constant current output facility are possible in this way because of the method of connection of TR1. It is not, as in previous examples of series stabilised supplies, connected so that emitter follower action takes place. With the output taken from the collector as shown, the output impedance is still low, however, because of the heavy negative feedback present.

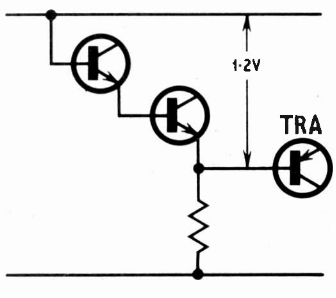


Fig. 16. Use of npn transistors in place of the silicon diodes shown in Fig. 15

CONSTANT SERIES CURRENT FOR ZENER

There is, of course, a disadvantage in this method of connection.

It has been noted above, in connection with the circuit in Fig. 13, that better output voltage stability is obtained if the Zener substitute is driven from the stabilised supply, V_0. Because of the circuit arrangement, in Fig. 14, of the series transistor being used with its collector as the output, it is not possible to drive the Zener substitute from the stabilised side. Consequently, other means of providing a more constant voltage need to be investigated.

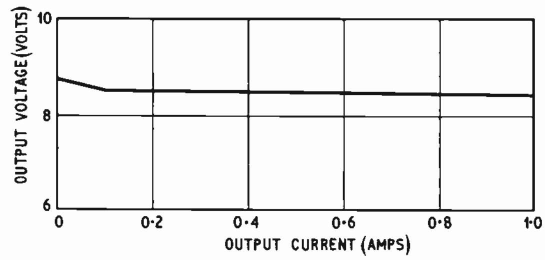


Fig. 17a. Graph of output voltage versus output current for the circuit in Fig. 15

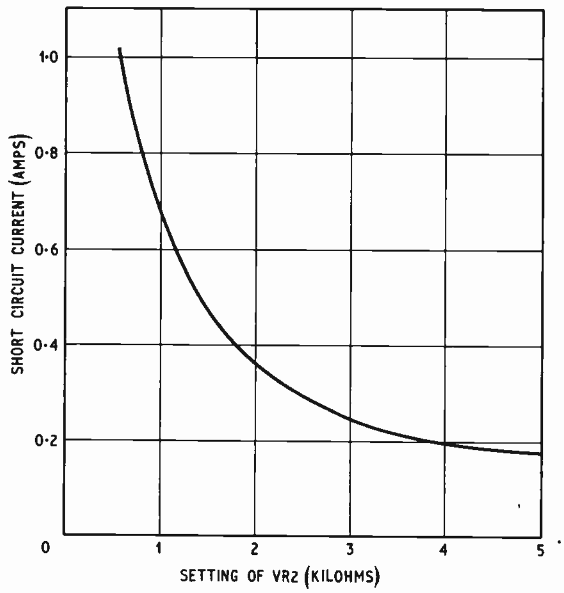


Fig. 17b. Output short circuit current versus setting of VR2

That adopted here concerns the replacement of the "black box" with a constant current circuit similar to that in Fig. 7. The arrangement of this is given in Fig. 15, where a current of 7mA is given by TR1, 4mA through VR1, and 3mA through the Zener substitute.

A modification of the original constant current circuit is employed, due to the need for it to function correctly with a varying supply voltage, V_i. The two silicon diodes (these can be of any low power type, or alternatively two *npn* silicon transistor base-emitter junctions, forward biased as shown in Fig. 16) provide a constant voltage at the base of TRA—constant, that is, with respect to the positive supply line. With the base and hence emitter so held constant, the 100 ohm resistor passes a constant 7mA current through TRA and hence to the TRZ and VR1 in parallel.

It was from this configuration that the graphs in Fig. 17 were obtained, to show how output voltage varies with output current, and how the level of short circuit current varies with the setting of VR2.

In passing, note that the driving of the TRZ from the input voltage allows the output voltage to be made variable down to zero volts. If TRZ is driven from the output side, output voltages of less than Zener voltage would cease to give regulation.

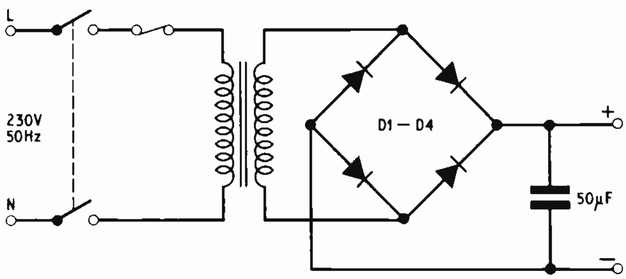


Fig. 18. Suggested mains supply unit for the stabiliser shown in Fig. 14

VOLTAGE FEEDER

Practical construction of such a stabilised power supply can follow usual techniques. After maximum output current and maximum output voltage have been decided upon, a decision is made on the method of driving the regulator. A simple mains unit is shown in Fig. 18, and the voltage rating of the transformer secondary is chosen to give, at full load current, a value of V_i, about 4 volts more than the maximum regulated output voltage. Alternatively, a battery or accumulator could provide power.

HEAT SINK FOR TR1

As for the size of the heat sink required for TR1, calculate first the maximum power dissipated in that transistor. This will be:

$$V_i - \text{(minimum output voltage used)]} \times \text{maximum load current}$$

It is at minimum output voltage and maximum load current that maximum power will be dissipated in TR1, and a suitable heat-sink should be chosen.

Generally speaking, for an OC28 or similar transistor, bolted to a heat-sink with an insulating mica washer, a rise in heat-sink temperature of about 40°C above ambient room temperature can be permitted.

Heat-sinks of various °C/watt ratings are readily available from components stockists.

As an example, for a 1A 9 volts output, driven from a 13 volts supply, with operation down to 3 volts expected, maximum power dissipated in TR1 is $(13 - 3) \times 1 = 10$ watts, so a heat-sink of 4°C/watt is needed for an OC28. About 20 sq in of 16 s.w.g. aluminium sheet will suffice.

Having thus decided on transformer and heat-sink requirements, the size of the final unit can be settled. VR1, and possibly VR2, are front panel controls, but otherwise layout is unimportant, and can be adapted to suit individual requirements.

TRICKLE CHARGER FOR SMALL BATTERIES

Mention was made earlier of deriving the supply from an accumulator and this is a useful way of obtaining a good general purpose stabilised voltage for powering many circuits. Recharging of the accumulator can be carried out overnight or a trickle charger can be used while the power supply is in use.

It is worth noting that many 12 volt car batteries can still provide a handy 1A even after their useful life in a car is over.

Constant current output can prove useful in the charging of some types of small batteries.

Batteries such as nickel–cadmium have a low internal resistance; hence, when in a discharged state, they would draw very large currents if the usual constant (or almost constant) voltage charging system is employed. This large current could give rise to overheating, tending to reduce the internal resistance still further and hence allowing thermal runaway to take place, and so leading to destruction of the battery.

However, for battery charging applications, adjust VR2 to give the required current, ensuring that VR1 is set to give a high enough voltage to charge the battery in question when it reaches its full final voltage. The battery manufacturer's instructions should be followed if in doubt.

Otherwise, the constant current circuitry is used as an overload limiter. With VR2 at maximum resistance, short circuit the output terminals; then bring down VR2 until the output current is a little greater than the maximum expected to flow in the unit being powered, under normal conditions.

Thereafter, should excessive current attempt to flow due to a fault, such current will be safely limited to that previously set by VR2.

Although the uses of Zener substitutes so far described have been in power supplies, this does not exhaust their usefulness.

OTHER USES

Clipping and limiting of waveforms to specific amplitudes can easily be accomplished. In the design of d.c. amplifiers, shifts of voltage by the constant voltage of the Zener substitute enable large gains to be achieved without limiting due to saturation of later stages.

With the ready availability of *npn* silicon transistors for use as substitute Zeners, it is hoped that experimenters will be encouraged to make greater use of them in stabilised power supplies, on the lines suggested, with corresponding improvement in equipment performance. ★

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.

PHOTOCONDUCTIVE CELL DESIGNERS' KIT

Designed primarily for educational establishments as well as industrial organisations interested in developing light activated controls, **Photain Controls** have produced a Photoconductive Cell Designers' Kit which readers may like to experiment with.

The kit consists of five different photoconductive cells together with 13 circuit diagrams each complete with a brief explanation of the circuit. Each diagram enables the student to build devices embracing light intensity measurement; feedback gain controllers; photo switches; signal modulating and musical instrument volume controller.

The kit is available from Photain Controls Ltd., Randalls Road, Leatherhead, Surrey, price £2.

SOLDERING ACCESSORIES

Leaving one hand free to hold the work piece, the Anextra Solder Feed fits the majority of soldering irons and carries up to 4oz reels of flux cored solder.

Solder from 22 to 18 s.w.g. can be used and is fed to the joint by operating the solder feed trigger.

Supplied with an initial 1oz reel of 60/40 cored 22 s.w.g. solder, the recommended retail price is £4·25. Further details of the Solder Feed is obtainable from **Anextra Ltd.**, Chiltern Works, 77–78 Chiltern View Road, Uxbridge, Middlesex.

Standard package integrated circuits, despite their numerous advantages, suffer from one major drawback as far as the amateur is concerned. The removal of these units from printed circuit boards, since it is necessary either to remove all traces of solder from all the connecting pin joints or melt all the joints simultaneously.

A range of desoldering heads for the Solderstat HMS miniature irons is an accessory which, using the method of simultaneous desoldering, removes the standard dual-in-line packages within a few seconds is claimed by **Solderstat Ltd.**

The desolder head is placed on the iron in place of the copper bit and aligned with the i.c. connecting pins on the printed circuit board. Both 14-way and 16-way dual-in-line heads are available.

Readers can, of course, use standard i.c. holders available from advertisers when they construct prototype circuits.

LOW VOLTAGE TOOLS

A range of battery-operated miniature tools capable of operating drills, cleaning brushes, abrasive stones, cutting burrs, polishing mops and other tools for precision work has been introduced by **Expo (Drills) Ltd.**

Two basic models are available. The "Reliant" designed for lighter work such as model making, and has a full load current of 1·5A, and the "Titan Super". Rated torque of the "Reliant" is 1·38oz in (100gm cm.).

For jobs requiring a more powerful tool and for professional applications the "Titan Super", rated at 3·5A on full load, should be used. It has a rated torque of 350 c.m.p. operating at 4,000–9,000 r.p.m.

Accessories include a diamond bonded drill, for gem stones up to 7MOHS, various types of abrasives, cutters and saws. Different collets and accessories are supplied according to model.

Prices range from £3 to £5·50 and full details are obtainable from Expo (Drills) Ltd., 62 Neal Street, London, W.C.2.

INSTANT LETTERING

To help finish-off equipment **Instant Plastic Ltd.** have introduced a range of p.v.c. self-adhesive plastic lettering kits.

Designated type K, the kits consist of 40 different sets in five colours, sizes from 10mm (⅜in) high upwards, in capitals and lower case letters and numerals.

The smallest set contains 578 letters and numerals and the number in each set reduces as the letter size increases.

The K sets cost approximately £1 per set, and details of their other ranges can be obtained from Instant Plastic Ltd., 101 Bramley Road, London, W.10.

PRINTED CIRCUIT BOARDS

A new price list of printed circuit boards for previously published P.E. projects has just been issued by **P.H. Electronics.**

Copies of the price list can be obtained from P.H. Electronics, Industrial Estate, Sandwich, Kent.

SWITCH KIT

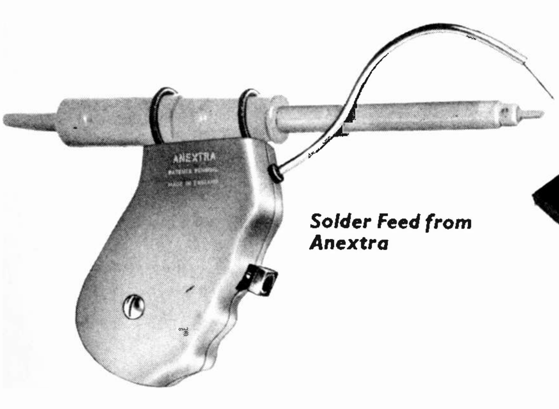
The mention of the versatile switch kit in the September issue should have included the following firms who are all part of the buying group set up by Home Radio (Components Ltd.).

Crescent Radio, 40 Mayes Road, London, N.22.

Garland Bros., Chesham House, Deptford Broadway, London, S.E.8.

Radioparts, 5 Market Way, Plymouth, Devon.

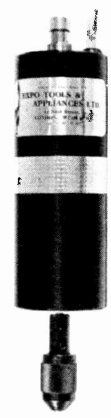
Servio Radio, 156–158 Merton Road, Wimbledon, London, S.W.19.



Solder Feed from Anextra

Solderstat I.C. Desolder Heads

Miniature electric tool made by Expo (Drills) Ltd

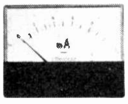


SEW PANEL METERS

USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES, ETC.
● LOW COST ● QUICK DELIVERY ● OVER 200 RANGES IN STOCK ● OTHER RANGES TO ORDER

NEW "SEW" DESIGNS!

CLEAR PLASTIC METERS

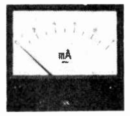


TYPE SW. 100
100 x 80 mm

50µA	£3·60	500µA	£3·35
50-0-50µA	£3·45	1mA	£3·10
100µA	£3·20	20V d.c.	£3·10
100-0-100µA	£3·45	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

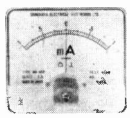
TYPE S-80
80 mm square fronts



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

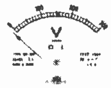
"SEW" CLEAR PLASTIC METERS

Type MR.85P. 4¼in 4¼in fronts.



		50mA	£2·80
		100mA	£2·80
		500mA	£2·80
		1A	£2·80
		5A	£2·80
		15A	£2·80
		30A	£2·90
		20V d.c.	£2·80
		50V d.c.	£2·80
		150V d.c.	£2·80
50µA	£3·60	300V d.c.	£2·80
50-0-50µA	£3·10	15V a.c.	£2·80
100µA	£3·10	300V a.c.	£2·80
100-0-100µA	£3·00	S Meter	
200µA	£3·00	1mA	£2·87
500µA	£2·90	VU Meter	£3·60
500-0-500µA	£2·80	1A a.c.*	£2·80
1mA	£2·80	5A a.c.*	£2·80
1-0-1mA	£2·80	10A a.c.*	£2·80
5mA	£2·80	20A a.c.*	£2·80
10mA	£2·80	30A a.c.*	£2·80

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



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

Type MR.52P. 2¼in 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	
5mA	£2·00	1mA	£2·10
10mA	£2·00	VU Meter	£3·20
50mA	£2·00	1A a.c.*	£2·00
100mA	£2·00	5A a.c.*	£2·00
500mA	£2·00	10A a.c.*	£2·00
1A	£2·00	20A a.c.*	£2·00
5A	£2·00	30A a.c.*	£2·00
10V d.c.	£2·00		

Type MR.45P. 2in square fronts.

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

Type MR.65P. 3¼in × 3¼in 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	
50mA	£2·20	1mA	£2·37
100mA	£2·20	VU meter	£3·37
500mA	£2·20	50mA a.c.*	£2·20
1A	£2·20	100mA a.c.*	£2·20
5A	£2·20	200mA a.c.*	£2·20
10A	£2·20	500mA a.c.*	£2·20
15A	£2·20	1A a.c.*	£2·20
20A	£2·20	5A a.c.*	£2·20
30A	£2·30	10A a.c.*	£2·20
50A	£2·50	20A a.c.*	£2·20
5V d.c.	£2·20	30A a.c.*	£2·20
10V d.c.	£2·20		

"SEW" BAKELITE PANEL METERS

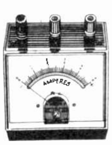
Type MR.65 3¼in square fronts.

		500mA	£1·90
		1A	£1·90
		5A	£1·90
		15A	£1·90
		30A	£1·90
		50A	£1·90
		5V d.c.	£1·90
		10V d.c.	£1·90
		20V d.c.	£1·90
		50V d.c.	£1·90
		150V d.c.	£1·90
		300V d.c.	£1·90
25µA	£3·50	30V a.c.*	£1·95
50µA	£2·37	50V a.c.*	£1·95
50-0-50µA	£2·35	150V a.c.*	£1·95
100µA	£2·35	300V a.c.*	£1·95
100-0-100µA	£2·25	500mA a.c.*	£1·95
500µA	£2·20	1A a.c.*	£1·95
1mA	£1·90	5A a.c.*	£1·95
1-0-1mA	£1·90	10A a.c.*	£1·95
5mA	£1·90	20A a.c.*	£1·95
10mA	£1·90	30A a.c.*	£1·95
50mA	£1·90	50A a.c.*	£1·95
100mA	£1·90	VU meter	£3·10

* MOVING IRON — ALL OTHERS MOVING COIL

Please add postage

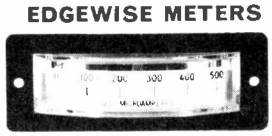
"SEW" EDUCATIONAL METERS



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 n 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		

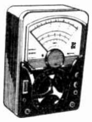
MULTIMETERS *for EVERY purpose!*

MODEL TE-200. 20,000 O.P.V. Mirror scale, overload protection. 0/5/25/125/1,000V d.c. 0/10/50/250/1,000V a.c. 0/50µA/250MA. 0/60K/6 meg. −20 to +62dB. **£3·75.** P. & P. 15p.

MODEL TE-300. 30,000 O.P.V. Mirror scale, overload protection 0/0·6/3/15/60/300/1,200V d.c. 0/6/30/120/600/1,200V a.c. 0/30µA / 6mA / 60mA / 300mA/600mA. 0/8K/80K/800K/8 meg. −20 to +63dB. **£5·97½.** P. & P. 15p.

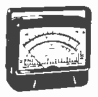
TMK MODEL MD.120. Mirror scale. 20kΩ/volt d.c., 10kΩ/volt a.c. 30/60/300/600/3,000V d.c. 6/120/1,200V a.c. Current 0–60µA/0–12/0–300mA. 0–60kΩ/0–6MΩ −20 to +63dB. **£4·62½.** P. & P. 15p.

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



MODEL 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.

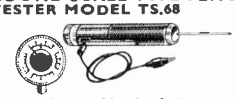
MODEL 5025. 57 ranges, giant 5¼in meter, polarity reverse switch. Sensitivity: 50K/Volt d.c. 5K/Volt a.c. D.c. Volts: ·0·125, 0·25, 1·25, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.c. Volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.c. current: 25, 50µA, 2·5, 5, 25, 50, 250, 500mA. 5, 10A. Resistance: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



TMK LAB TESTER. 100,000 O.P.V. 6½in scale buzzer short circuit check. Sensitivity: 100,000 OPV d.c. 5/Volt a.c. D.c. volts: 0·5, 2·5, 10, 50, 250, 1,000V. A.c. volts: 3, 10, 50, 250, 500, 1,000V. D.c. current: 10, 100µA, 10, 100, 500mA, 2·5, 10A. Resistance: 1K, 10K, 100K, 10 meg, 100 meg. Decibels: −10 to +49dB. Plastic case with carrying handle, size 7¼in × 6¾in × 3¼in. **£18·90.** P. & P. 25p.

TMK MODEL TW-20CB. Features Resettable Overload Button. Sensitivity: 20KΩ/Volt d.c. 5KΩ/Volt a.c. D.c. volts: 0–0·5, 2·5, 10, 50, 250, 1,000V. A.c. volts: 0–2 5, 10, 50, 250, 1,000V. D.c. currents: 0–0 05, 0·5, 5, 50, 500mA. Resistance: 0–5K, 50K, 0–500K, 5 meg. Decibels: −20 to +52dB. **£11·50.** P. & P. 17½p.

ROUND SCALE TYPE PENCIL TESTER MODEL TS.68



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

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

TMK MODEL 117 F.E.T. ELECTRONIC VOLTMETER

Battery operated, 11 meg input. 26 ranges. Large 4½in mirror scale. Size 5¾in × 4¼in × 2¾in. D.c. volts 0·3–1,200V. A.c. volts 3–300V R.M.S. 8·0–800V P-P. D.c. current 0·12–12MA. Resistance up to 2,000M ohm. Decibels −20 to +51dB. Complete with leads/instructions. **£17·50.** P. & P. 20p.

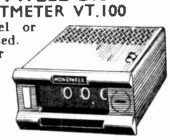
TO-2 PORTABLE OSCILLOSCOPE

A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 CPS-1 MHZ. Input imp. 2 megΩ 25 P.F. Illuminated scale. 2in. tube. 115 × 180 × 230mm. Weight 8lb. 220/240V a.c. Supplied brand new with handbook. **£22·50.** Carr. 50p.

T.E.40 HIGH SENSITIVITY A.C. VOLTMETER

10 meg. input 10 ranges: ·01 / ·003 / ·1 / ·3 / 1 / 3 / 10 / 30 / 100 / 300V. R.M.S. 4c/s.-1·2Mc/s. Decibels −40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V a.c. **£17·50.** 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 AT APPROX. HALF PRICE
£49·97½ Carr. 50p

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. **£16·50.** Carr. 37½p.

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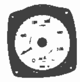

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7403	Quadruple 2-input NAND gate with open collector output	291	20p	16p	14p
7404	Hex inverter	211	25p	21p	18p
7405	Hex inverter with open collector output	271	25p	21p	18p
7408	Quad 2-input positive AND gate Totem pole output	381	25p	21p	18p
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7410	Triple 3-input NAND gate	111	20p	16p	14p
7413	Schmitt Trigger	351	35p	29p	25p
7420	Dual 4-input NAND gate	121	20p	16p	14p
7430	8-input NAND gate	131	20p	16p	14p
7440	Dual 4-input NAND buffer	141	24p	20p	17p
7442	BCD to decimal decoder TTL output	281	£1·16	94p	81p
7443	Excess 3 to decimal decoder	361	£1·45	£1·20	£1·08
7444	Excess 3 gray to decimal decoder	371	£1·45	£1·20	£1·08
7450	Expandable dual 2-wide 2-input AND-OR-INVERT gate	151	20p	16p	14p
7451	Dual 2-wide 2-input AND-OR-INVERT gate	161	20p	16p	14p
7453	Expandable 4-wide 2-input AND-OR-INVERT gate	171	20p	16p	14p
7454	4-wide 2-input AND-OR-INVERT gate	181	20p	16p	14p
7460	Dual 4-input expander	FLY 101	20p	16p	14p
7470	J-K flip flop	FLJ 101	45p	37p	32p
7472	J-K master-slave flip-flop	111	32p	27p	23p
7473	Dual J-K master-slave flip-flop	121	45p	40p	35p
7474	Dual D-type edge triggered flip-flop	141	46p	38p	33p
7475	Quad bistable latch	151	45p	40p	37p
7476	Dual J-K master-slave flip-flop with preset and clear	131	45p	40p	36p
7480	Gated full adder	FLH 221	67p	56p	48p
7482	2-bit binary full-adder	231	87p	73p	62p
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7491A	8-bit shift register	221	£1·28	£1·07	92p
7492	Divide-by-12 counter	171	85p	71p	61p
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7494	4-bit shift register	231	£1·13	94p	81p
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74100	Dual quadruple bistable latch	301	£1·64	£1·37	£1·17
74107	Dual J-K master-slave flip-flop with preset and clear	271	52p	43p	36p
74121	Monostable multi-vibrator	FLK 101	48p	40p	34p
74141	BCD to decimal decoder and nixie driver	FLL 101	£1·22	£1·02	87p
74190	Synchronous up down 4-bit decade counter with one line mode control	201	£1·80	£1·48	£1·27
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IN4005	600	·120	·100	·090
IN4006	800	·140	·130	·110
IN4007	1000	·190	·150	·120

	p.i.v	500+	1000+
IN4001	50	·045	·040
IN4002	100	·055	·045
IN4003	200	·060	·050
IN4004	400	·070	·060
IN4005	600	·075	·070
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Mfd.	
0·01	3p
0·015	3p
0·022	3p
0·033	3p
0·047	4p
0·068	4p
0·1	4p
0·15	5p
0·22	5p
0·33	7p
0·47	8p
0·68	11p
1·0	14p
1·5	20p
2·2	24p

Mullard Electrolytic C437 series

Mfd.	Volt. Wkg.	
250	16	9p
400	16	12p
640	16	15p
1,000	16	18p
160	25	9p
250	25	12p
400	25	15p
640	25	18p
100	40	9p
160	40	12p
250	40	15p
400	40	18p

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63 volt working. Range 1·8pf to 220pf (usual pref. values). Packs of 6 (any values) .. 15p

CAPACITORS—Mullard Miniature Electrolytic C426 series

Mfd.	Volt Wkg.	
2·5	16	8p
10	16	6p
20	16	6p
40	16	6p
80	16	6p
1·6	25	8p
6·4	25	6p
12·5	25	6p
25	25	6p
50	25	6p
80	25	6p
1	40	8p
4	40	6p
8	40	6p
16	40	6p
32	40	6p
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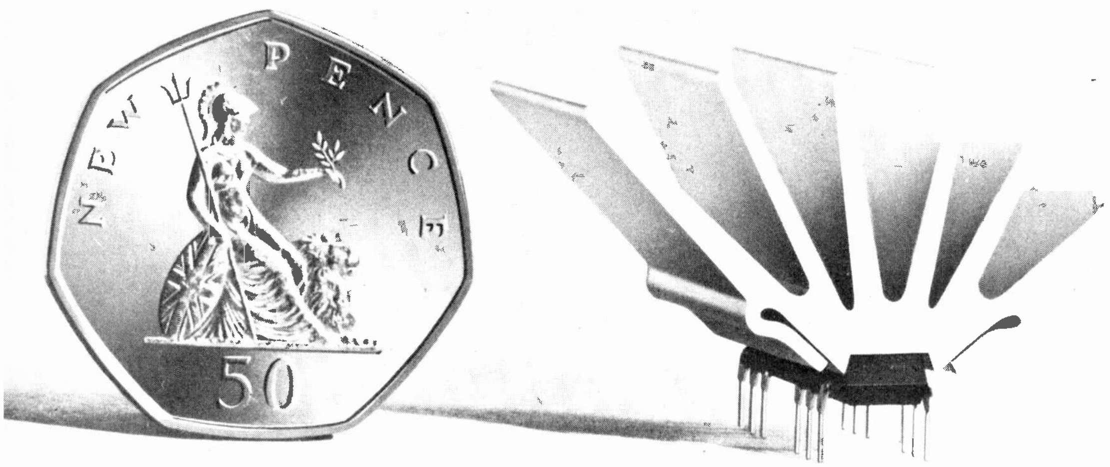
Super IC-12



High fidelity Monolithic Integrated Circuit Amplifier

Two years ago Sinclair Radionics announced the World's first monolithic integrated circuit Hi-Fi amplifier, the IC.10. Now we are delighted to be able to introduce its successor, the Super IC.12. This 22 transistor unit has all the virtues of the original IC.10 plus the following advantages:

1. Higher power.
2. Fewer external components.
3. Lower quiescent consumption.
4. Compatible with Project 60 modules.
5. Specially designed built-in heat sink. No other heat sink needed.
6. Full output into 3, 4, 5 or 8 ohms.
7. Works on any voltage from 6 to 28 volts without adjustment.
8. NEW 22 transistor circuit.

Output power 6 watts RMS continuous (12 watts peak).

Frequency Response 5 Hz to 100KHz ± 1 dB.

Total Harmonic Distortion Less than 1%. (Typical 0.1%) at all output powers and all frequencies in the audio band.

Load Impedance 3 to 15 ohms.

Power Gain 90dB (1,000,000,000 times) after feedback.

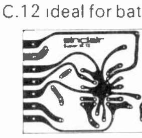
Supply Voltage 6 to 28 volts (Sinclair PZ-5 or PZ-6 power supplies ideal).

Size 22 x 45 x 28 mm including pins and heat sink.

Input Impedance 250 Kohms nominal.

Quiescent current 8mA at 28 volts.

With the addition of only a very few external resistors and capacitors the Super IC.12 makes a complete high fidelity audio amplifier suitable for use with pick-up, F.M. tuner etc. Alternatively, for more elaborate systems, modules in the Project-60 range such as the Stereo 60 and A.F.U. may be added. The comprehensive manual supplied with each unit gives full circuit and wiring diagrams for a large number of applications in addition to high fidelity. These include car radios, oscillators etc. The very low quiescent consumption makes the Super IC.12 ideal for battery operation.



Price, inc. **FREE** printed circuit board for mounting.

£2.98 Post free

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Should you not be completely satisfield with your purchase when you receive it from us, return the goods without delay and your money will be refunded in full, including cost of return postage, at once and without question. Full service facilities are available to all Sinclair customers.

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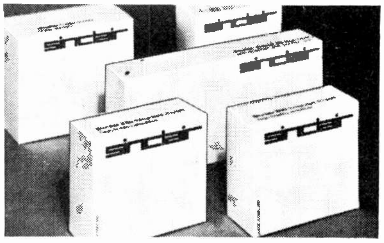
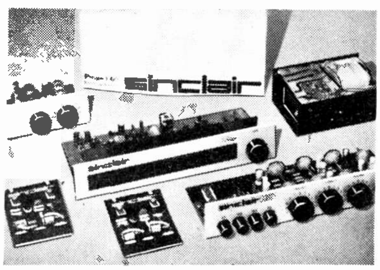
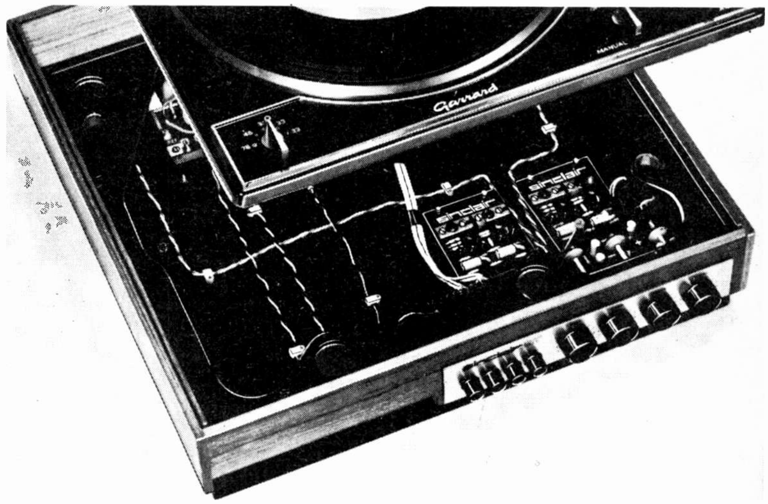
Sinclair Project 60

The World's leading range of high fidelity modules







New!

Project 605

The easy way to buy and build Project 60

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

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

All you need for a superb 30 watt high fidelity stereo amplifier.

Project 60 offers more advantage to the constructor and user of high fidelity equipment than any other system in the world.
Performance characteristics are so good they hold their own with any other available system irrespective of price or size.
Project 60 modules are more versatile – using them you can have anything from a simple record player or car radio amplifier to a sophisticated and powerful stereo tuner-amplifier. Either power amplifier can be used in a wide variety of applications as well as high fidelity. The Stereo 60 pre-amplifier control unit may also be used with any other power amplifier system, as can the AFU filter unit. The stereo FM tuner operates on the unique phase lock loop principle to provide the best ever standards of sensitivity and audio quality. Project 60 modules are very easily connected together by following the 48 page manual supplied free with all Project 60 equipment. The modules are great space savers too and are sold individually boxed in distinctive white and black cartons. With all these wonderful advantages, there remains the most attractive of all – price. When you choose Project 60 you know you are going to get the best high fidelity in the world, yet thanks to Sinclair's vast manufacturing resources (the largest in Europe) prices are fantastically low and everything you buy is covered by the famous Sinclair guarantee of reliability and satisfaction.

Typical Project 60 applications

System	The Units to use	together with	Cost of Units
Simple battery record player	**Z.30**	Crystal P.U., 12V battery volume control	**£4.48**
Mains powered record player	**Z.30, PZ.5**	Crystal or ceramic P.U. volume control etc.	**£9.45**
20 + 20 W. stereo amplifier for most needs	**2 x Z.30s, Stereo 60, PZ.5**	Crystal, ceramic or mag. P.U., F.M. Tuner, etc.	**£23.90**
20 + 20 W. stereo amplifier with high performance spkrs.	**2 x Z.30s, Stereo 60, PZ.6**	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	**£26.90**
40 + 40 W. R.M.S. de-luxe stereo amplifier	**2 x Z.50s, Stereo 60 PZ.8, mains trsfrmr**	As above	**£34.88**
Indoor P.A.	**Z.50, PZ.8, mains transformer**	Mic., guitar, speakers, etc., controls	**£19.43**

F.M. Stereo Tuner **(£25)** & A.F.U. Filter Unit **(£5.98)** may be added as required.

Sinclair Radionics Limited, London Road, St. Ives, Huntingdonshire PE17 4HJ.
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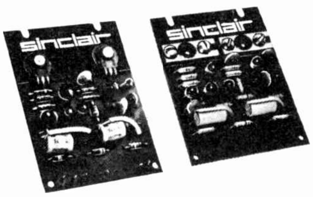
from a simple amplifier to a complete stereo tuner amplifier with Project 60 modules

Z.30 & Z.50 power amplifiers



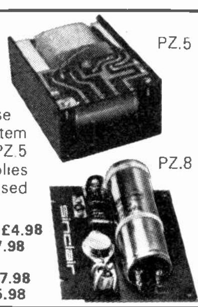
The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to achieve unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at full output and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and may be used with other units in the Project 60 range equally well.

SPECIFICATIONS ***(Z.50 units are interchangeable with Z.30s in all applications).***
Power Outputs
Z.30 15 watts R.M.S. into 8 ohms using 35 volts: 20 watts R.M.S. into 3 ohms using 30 volts.
Z.50 40 watts R.M.S. into 3 ohms using 40 volts: 30 watts R.M.S. into 8 ohms using 50 volts.
Frequency response: 30 to 300,000Hz ± 1dB.
Distortion: 0.02% into 8 ohms.
Signal to noise ratio: better than 70dB unweighted.
Input sensitivity: 250mV into 100 Kohms.
For speakers from 3 to 15 ohms impedance.
Size: 14 x 80 x 57 mm.

Z.30
Built, tested and guaranteed with circuits and instructions manual. **£4.48**

Z.50
Built, tested and guaranteed with circuits and instructions manual. **£5.48**

Power Supply Units



PZ.5

PZ.8

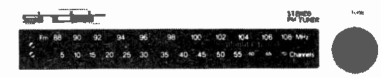
Designed special for use with the Project 60 system of your choice. Use PZ.5 for normal Z.30 assemblies and PZ.6 where a stabilised supply is essential.

PZ.5 *30 volts unstabilised* **£4.98**
PZ.6 *35 volts stabilised* **£7.98**
PZ.8 *45 volts stabilised (less mains transformer)* **£7.98**
PZ.8 *mains transformer* **£5.98**

The Sinclair Guarantee

If within 3 months of purchasing Project 60 modules directly from us, you are dissatisfied with them, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter. No charge for postage by surface mail. Air-mail charged at cost.

Project 60 Stereo F.M. Tuner



First in the world to use the phase lock loop principle

The phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio. Now, Sinclair have applied the principle to an F.M. tuner with fantastically good results. Other original features include varicap diode tuning, printed circuit coils, an I.C. in the specially designed stereo decoder and squelch circuit for silent tuning between stations. Good reception is possible in difficult areas, and often a few inches of wire are enough for an aerial. In terms of a high fidelity this tuner has a lower level of distortion than any other tuner we know. Stereo broadcasts are received automatically as the tuning control is rotated, a panel indicator lighting up as the stereo signal is tuned in. This tuner can also be used to advantage with any other high fidelity system.

SPECIFICATIONS—Number of transistors: 16 plus 20 in I.C. **Tuning range:** 87.5 to 108 MHz. **Capture ratio:** 1.5dB. **Sensitivity:** 2µV for 30dB quieting: 7µV for lock-in over full deviation. **Squelch level:** 20µV. **A.F.C. range:** ±200 KHz. **Signal to noise ratio:** > 65dB. **Audio frequency response:** 10 Hz – 15 KHz (±1dB). **Total harmonic distortion:** 0.15% for 30% modulation. **Stereo decoder operating level:** 2µV. **Cross talk:** 40dB. **Output voltage:** 2 x 150mV R.M.S. **Operating voltage:** 25-30 VDC. **Indicators:** Power on/tuning/stereo.
Size: 93 x 40 x 207 mm.

Built and tested. Post free. **£25**

Stereo 60 Pre-amp/control unit

Designed for Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout, achieving a really high signal-to-noise ratio and excellent tracking between channels. Input selection is by means of push buttons and accurate equalisation is provided for all the usual inputs.

SPECIFICATIONS—Input sensitivities: Radio – up to 3mV. Mag. p.u. 3mV: correct to R.I.A.A curve ±1dB:20 to 25,000 Hz. Ceramic p.u. – up to 3mV: Aux – up to 3mV. **Output:** 250mV. **Signal to noise ratio:** better than 70dB. **Channel matching:** within 1dB. **Tone controls:** TREBLE + 15 to —15dB at 10 KHz: BASS + 15 to —15dB at 100Hz. **Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm.
Built tested and guaranteed. **£9.98**

A.F.U. High & Low Pass Filter Unit

For use between Stereo 60 unit and two Z.30s or Z.50s, and is easily mounted. It is unique in that the cut-off frequencies are continuously variable, and as attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is suitable for use with any other amplifier system. Two filter stages – rumble (high pass) and scratch (low pass). Supply voltage – 15 to 35V. Current – 3mA. H.F. cut-off (–3dB) variable from 28KHz to 5KHz. L.F. cut-off (–3dB) variable from 25Hz to 100Hz. Distortion at 1KHz (35V. supply (0.02% at rated output. **Size:** 66 x 40 x 90 mm. *Built tested and guaranteed.* **£5.98**

To: SINCLAIR RADIONICS LTD LONDON ROAD ST. IVES HUNTINGDONSHIRE PE17 4HJ

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