PRACTICAL

ELECTRONICS

AUGUST 1976 35p

Also in this issue...

KARNAUGH MAP DISPLAY

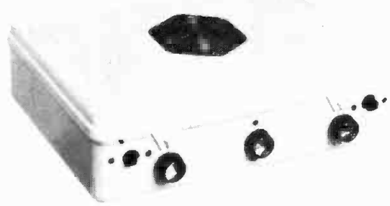
POCKET TIMER

RADIO EXCHANGE LTD.

ALL PRICES INCLUDE VAT

NEW EDU-KIT MAJOR

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



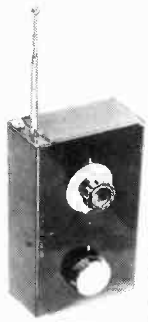
- 4 Transistor Earpiece Radio
- Signal Tracer
- Signal Injector
- Transistor Tester NPN—PNP
- 4 Transistor Push Pull Amplifier
- 5 Transistor Push Pull Amplifier
- 7 Transistor Loudspeaker Radio MW/LW.
- 5 Transistor Short Wave Radio
- Electronic Metronome
- Electronic Noise Generator
- Batteryless Crystal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

● 24 Resistors ● 21 Capacitors ● 10 Transistors ● 3½" Loudspeaker ● Earpiece ● Mica Baseboard ● 3 12-way Connectors ● 2 Volume Controls ● 2 Slider Switches ● 1 Tuning Condenser ● 3 Knobs ● Ready Wound MW/LW/SW Coils ● Ferrite Rod ● 6½ yards of wire ● 1 yard of sleeving, etc.

Complete kit of parts including construction plans

Total building costs £9·00 P.P. and Ins. 65p (Overseas Seamail P. & P. £3·50)

V.H.F. AIR CONVERTER KIT



Build this converter kit and receive the aircraft band by placing it by the side of a radio tuned to medium wave or the long wave band and operating as shown in the instructions supplied free with all parts.

Uses a retractable chrome plated telescopic aerial, gain control, V.H.F. tuning capacitor, transistor, etc.

All parts including case and plans

£3·95 P.P. & Ins. 40p

POCKET FIVE

Now with 3in Loudspeaker 3 tunable wavebands. MW, LW and trawler band. 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, attractive black and gold case. Size 5½in × 1¼in 3½ in approx.

Complete kit of parts including construction plans.

Total Building Costs: **£3·60** P.P. and Ins. 50p

NEW Everyday Series

Build this exciting new series of designs.

E.V.5. 5 Transistors and 2 diodes. MW/LW. Powered by 4½V battery. Ferrite rod aerial, tuning condenser, volume control, and now with 3in. loudspeaker. Attractive case with red speaker grille. Size 9in. × 5½in. × 2¾in. approx. All parts including Case and Plans.

Total Building costs **£4·30** P. & P + Ins. 50p

E.V.6. Case and looks as above. 6 Transistors 3 diodes. Powered by 9V battery. Ferrite rod aerial, 3in. loudspeaker, etc. MW/LW coverage. Push/Pull output.
All parts including Case and Plans.

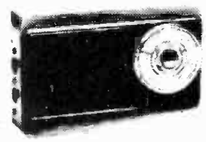
Total Building costs **£4·95** P. & P. + Ins. 55p

E.V.7. Case and looks as above, 7 Transistors and 3 diodes. Six wavebands, MW/LW, Trawler Band SW1, SW2, SW3, powered by 9V battery. Push pull output. Telescopic aerial for short waves. 3in. Loudspeaker.
All parts including Case and Plans.

Total Building Costs **£6·35** P. & P. + Ins. 55p

TRANSONA FIVE

NOW WITH 3" LOUDSPEAKER

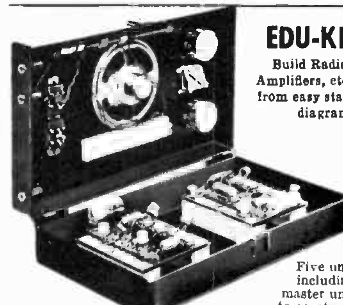


Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and Parts Price List free with parts.

Total Building Costs **£4·05** P.P. and Ins. 50p

EDU-KIT

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



Five unit including master unit to construct

Components include: Tuning condenser, 2 volume controls, 2 slider switches, fine tone 3in moving coil speaker, terminal strip, ferrite rod aerial, battery clips, 4 tag boards, 10 transistors, 4 diodes, resistors, capacitors, 3 ½in knobs. Units once constructed are detachable from master unit, enabling them to be stored for future use. Ideal for schools, educational authorities and all those interested in radio construction.

All parts including case and plans. **£6·30** P.P. and Ins. 55p

ELECTRONIC CONSTRUCTION KITS

E.C.K. 2 Self Contained Multi-Band V.H.F. Receiver Kit.

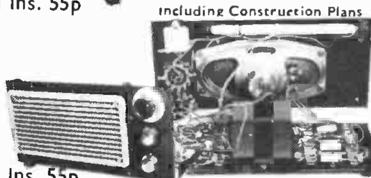
8 transistors and 3 diodes. Push pull output. 3in loudspeaker, gain control, superb 9 section swivel ratchet and retractable chrome plated telescopic aerial, V.H.F. tuning capacitor, resistors, capacitors, transistors, etc. Will receive T.V. sound, public service band, aircraft, V.H.F. local stations, etc. Operates from a 9 volt P.P. 7 battery (not supplied with kit).

Complete kit of parts **£7·15** P.P. and Ins. 55p

Including Construction Plans

E.C.K. 4

7 Transistors, 6 tuneable wavebands, MW. LW. Trawler Band, 3 Short Wave Bands. Receiver Kit.

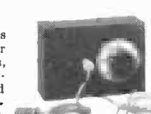


With 5in × 3in loudspeaker. Push pull output stage, gain control, and rotary switch. 7 transistors and 4 diodes. 6 section chrome-plated telescopic aerial. 8 in sensitive ready wound ferrite rod aerial, tuning capacitor, resistors, capacitors, etc. Operates from a 9 volt P.P. 7 battery (not supplied with kit).

Complete kit of parts **£6·55** P.P. and Ins. 55p

Including Construction Plans

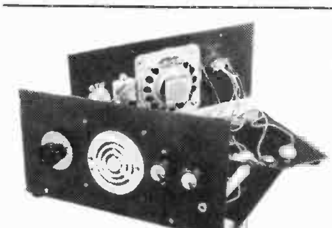
JIFFY TESTER



Easy to build and operate, fits in the pocket. A quick checker for continuity of resistors, chokes, diodes, transistors, circuit wiring (not mains) and loudspeakers. **SPECIAL APPLICATION**—Can also be used as a versatile signal injector. Complete with earpiece, jack plug and socket resistors, capacitors, components, etc.

Complete kit of parts including construction plans **£2·85** P. & P + Ins. 30p

EDU-KIT JUNIOR



Completely Solderless Electronic Construction Kit. Build these projects without Soldering Iron or Solder.

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★ One Transistor Radio
★ 2 Transistor Regenerative Radio
★ 3 Transistor Earpiece Radio Medium Wave Coverage
★ 4 Transistor Medium Wave Loudspeaker Radio
★ Electronic Noise Generator
★ Electronic Metronome
★ 4 Transistor Push/Pull Amplifier

All parts including loudspeaker, earpiece, MW ferrite rod aerial, capacitors, resistors, transistors, etc.

Complete kit of parts including construction plans **£6·55** P. & P. + Ins. 55p

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PRACTICAL ELECTRONICS

VOLUME 12 No. 8 AUGUST 1976

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our September issue will be published on Friday, August 13, 1976
(for details of contents, see page 651)

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HEAVY DUTY RELAYS, 24V d.c. operated (will work on 18V) 3 heavy duty make contacts (around 10A rating) + 4 change over contacts + 1 break contact. New, complete with mounting bracket (ideal for switching HT on Linears.) Many uses for this high quality unit. £1·50 each
Good Quality Pressure Guages, 2½in dia. flange mounting. 3 models avail. 0–60 lb sq.in, 0–100 lb sq. in, 0–200 lb/sq. in, state which £1·25 each
2N3055 type Transistors, O.K., but unmarked, 5 for £1.

ALU-SOL ALUMINIUM SOLDER (made by Multicore). Solders aluminium to itself or copper, brass, steel, nickel or tinplate. 16 s.w.g. with multicore flux, with instructions. Approx. 1 metre coil 30p pack. Large reel (approx. 12 metres) £2·75.

MIXED COMPONENT PACKS, containing resistors, capacitors, switches, pots, etc. All new (random sample bag revealed approx. 700 items). £2 per pack, while stocks last.
TUNED COILS, 2 section coils, around 1MHz, with a black smart tuning knob, which moves an internal core to vary the inductance, many uses, easily rewound, 3 for 50p.

SMALL MAINS SUPPRESSORS (small chokes, ideal for radio, HI-FI inputs, etc.) approx. ½in × 1½in, 3 for 50p.
PERSPEX TUNER PANELS (for FM Band 2 tuners) marked 88-108 MHz and Channels 0-70, clear numbers, rest blacked out, smart modern appearance, size approx. 8½in × 1½in, 2 for 35p.
Lead suppressors (10kohm) for mobile plug leads, 4 for 50p.
1mA Meters, 2 in square, plastic fronts (these have a paper scale stuck over the original marked 0–1mA which is easily peeled off and an internal 18K resistor which is easily removed). £1·75 each or 2 for £3.

MINIATURE PLIERS High quality 'Crescent', made in USA, £4·35 + VAT (35p).
SIDE CUTTERS, high quality 'Crescent', made in USA, £4·45 + VAT (44p).

HIGH QUALITY SPEAKERS, 8½in × 6in elliptical, only 2in deep, inverse magnet, 4 ohms, rated up to 10W, £1·50 each, or 2 for £2·75 (qty. discount available + 12½% VAT.

TV PLUGS AND SOCKETS
TV Plugs (metal type), 5 for 50p.
TV Sockets (metal type), 4 for 50p.
TV Line Connectors (back-to-back sockets), 4 for 50p. **Please add 12½% VAT.**

PLUGS AND SOCKETS
N-Type Plugs 50 ohm, 60p each, 3 for £1·50.
N-Type Sockets (4-hole chassis mounting, 50 ohms (a small coax lead type), 50p each
PL259 Plugs (PTFE), brand new, packed with reducers, 65p or 5 for £3.
SO239 Sockets (PTFE), brand new (4-hole fixing type), 50p each or 5 for £2·25.
25-way ISEP Plugs and Sockets, 40p set (1 plug + 1skt)
Plugs and sockets sold separately at 25p each.
Bulgin Round Free Skts, 3 pin, for mains input on test equipment, etc., 25p each

Mobile Converters, 24V DC input 13·8V at approx 3·4A DC output, fully stabilised, £3·50 each (ideal for running 12V car radio from 24V lorry battery).
R/S Midget 3 pole 4 way, rotary switches, 40p each

We now stock Spiralux Tools for the electronic enthusiast. Screwdrivers, Nut Spanners, BA and Metric sizes, pop rivet guns, etc. S.A.E. for list

I.F. Cans, ½in square, suitable for rewind, 6 for 30p. + 12½% VAT
Miniature earphones with min. jack plug, 2 for 50p + 12½% VAT

TWIN I.F. CANS, approx. 1in × ½in × 1in high, around 3·5–5MHz, 2 separate transformers in 1 can, internally screened, 5 for 50p + 12½% VAT.

Dubilier Electrolytics, 50µF, 450V, 2 for 50p.
Dubilier Electrolytics, 100µF, 275V, 2 for 50p.
Plessey Electrolytics, 470µF, 63V, 3 for 50p.
TCC Electrolytics, 1000µF, 30V, 3 for 60p.
Plessey Electrolytics, 1000µF, 180V, 40p each (3 for £1).
Dubilier Electrolytics, 5000µF, 35V, 50p each.
Dubilier Electrolytics, 5000µF, 50V, 60p each.

ITT Electrolytics, 6800µF, 25V, high grade, screw terminals, with mounting clips, 50p each
Plessey Electrolytics, 10,000µF at 63V, 75p each
Plessey Cathodray Capacitors, 0–0·4µF at 12·5kV DC. Screw terminals, £1·50 each.
PLEASE ADD 12½% VAT TO ALL CAPACITORS

A LARGE RANGE OF CAPACITORS AVAILABLE AT BARGAIN PRICES, S.A.E. FOR LIST.

SPECIAL OFFER!
MAINS TRANSFORMER, TYPE 14/4, 14V at 4A, £2·50.
TO3 transistor insulator sets, 10 for 50p.
MINIATURE 2 PIN PLUGS AND SOCKETS (fit into ¼in hole, pins enclosed, with covers for chassis mounting, or can be used for in-line connectors). Bargain pack of 3 plugs + 3 sockets + covers, 50p.
PROGRAMMERS (magnetic devices). Contain 9 microswitches (suitable for mains operation) with 9 rotating cams, all individually adjustable, ideal for switching disco lights, displays, etc., or industrial machine programming (Need slow motion motor to drive cams, not supplied) 9 switch version £1·50.
HEAVY DUTY HEATSINK BLOCKS, undrilled, base area 2½in × 2in, with 6 fins, total height 2¼in 50p each.
RUBBER MAGNETS ½in square, with mounting hole, 20 for 30p.
SPERRY 7-SEGMENT P.G.O. DISPLAYS, digit height 0·3in red, with decimal points, 150V to 200V (nominal 180V) operation. These are high-volt industrial type and therefore brighter than normal displays. All brand new, AT THE BARGAIN PRICE OF 50p PER DIGIT. TYPE 332 (two digits in one mount) £1 each, TYPE 333 (three digits on one mount) £1·50. (Sorry, no single digit available.) Data Supplied

BSX20 (VHF Osc. Mult), 3 for 50p.
BC108 (metal can), 4 for 50p.
PBC 108 (plastic BC108), 5 for 50p.
OC200 Transistors, 6 for 50p.
BFY51 Transistors, 4 for 60p.
BCY72 Transistors, 4 for 50p.
PNP audio type TO5 Transistors, 12 for 25p.
BF152 (UHF amp mixer), 3 for 50p.
BA121 Varicap Diodes, 4 for 50p.
1N914 diodes, 10 for 25p.

1¼in polythene chassis mounting fuseholders, 6 for 30p.
Mullard Tubular ceramic trimmers, 1–18pF, 6 for 50p.
I.C.s, some coded, 14 DIL type, untested, mixed, 20 for 25p.

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4·3 × 2·3 × 1·2	85p
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TCP1 TEMPERATURE CONTROLLED IRON.
Temperature controlled iron & PSU, £20 + VAT (£1·60)
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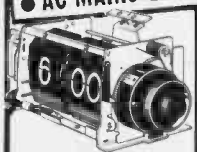

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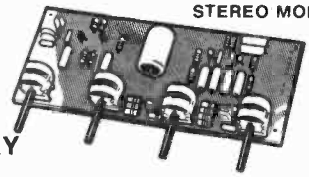

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- Operating voltage—10 to 16V

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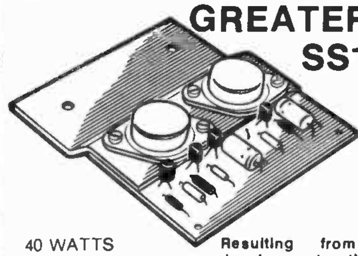

POWER AMP Built for hard work

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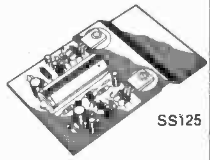

SS125

★ CONTROL

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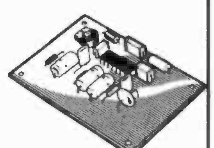

SS203

★ POWER STABILISER

SS300	Add this to your unstabilised supply to obtain a steady working voltage from 12 to 50V for your audio system, workbench etc. Money saving and very reliable	£3·25*

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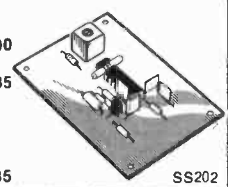
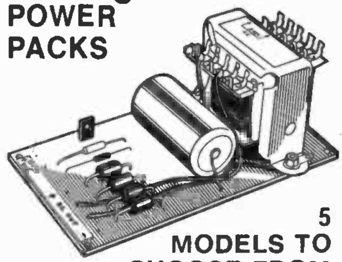
SS202	I.F. amp A meter and/or A.F.C. can be connected (size 3in × 2in)	£2·85
SS203	**Stereo decoder** For use with Stirling Sound modules, or with any other good mono F.M. tuning section. A L.E.D. beacon can be added to indicate when a stereo signal is tuned in (3in × 2in)	£3·85



SS202

Stirling Sound POWER PACKS



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Not only do these excellent power packs stand up unflinchingly to hard work, inclusion of a take off point at around 13–15V adds to their usefulness and once again price value is outstanding.

Add 50p for p/p any model.

Made to serve for years

SS312	12V/1A	£3·75*
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SS334	34V/2A	£5·20*
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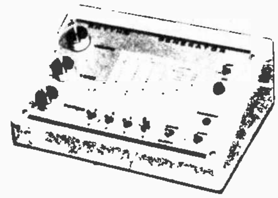

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BC168C	0·15	BD138	0·26	BU105	2·50	MPSA05	0·25	TIP41C	1·40
BC169B	0·15	BD139	0·71	BU205	2·50	MPSA06	0·31	TIP42A	0·90
BC169C	0·15	BD140	0·87	C106D	0·65	MPSA12	0·35	TIP42C	1·60
BC170A	0·15	BD529	0·80	CA3020A	1·80	MPSA55	0·25	TIP2955	0·98
BC171	0·16	BD530	0·80	CA3028A	0·79	MPSA56	0·31	TIP3055	0·50
BC172	0·12	BDY20	1·05	CA3035	1·37	MPSU05	0·65	TIS43	0·28
BC177	0·19	BF115	0·29	CA3046	0·70	MPSU06	0·58	ZTX300	0·13
BC178	0·18	BF117	0·55	CA3048	2·11	MPSU55	0·63	ZTX301	0·13
BC179	0·21	BF121	0·35	CA3052	1·62	MPSU56	0·80	ZTX302	0·20
BC182	0·12	BF123	0·35	CA3080A	1·08	NE555V	0·70	ZTX500	0·15
BY182L	0·12	BF125	0·35	CA3089E	1·96	NE556	1·30	ZTX501	0·13
BC183	0·12	BF152	0·20	CA3090Q	4·23	NE560	4·48	ZTX502	0·18
BC183L	0·12	BF153	0·25	LM301A	0·48	NE561	4·48	ZTX530	0·23
BC184	0·13	BF154	0·20	LM308	1·17	NE565A	4·48	ZTX531	0·22
BC184L	0·13	BF159	0·27	LM309K	1·88	OC28	1·48		
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CD4010	0·57	CD4025	0·20	CD4050	0·56
CD4011	0·20	CD4027	0·56	CD4510	1·54
CD4012	0·20	CD4028	0·91	CD4511	1·70
CD4013	0·59	CD4029	1·17	CD4516	1·54
CD4014	1·01	CD4030	0·57	CD4518	1·38
CD4015	1·01	CD4031	2·26	CD4520	1·38
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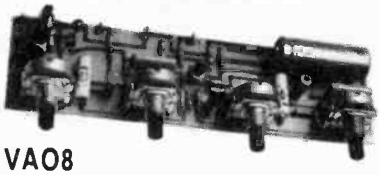
PRE AMPLIFIERS



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VA08 Vol. Treb, Mid and Bass controls. HI. IMP. FET. I/P suitable Mid. Guitar, Radio, Crystal/Ceramic P.U. Sensitivity 4mV. Treble +35dB at 16kHz. Mid +20 −15dB at 1kHz Bass +20 −10dB at 40Hz.

£8·50

VA06 Vol. Treb, and Bass controls. Sensitivity 8mV. Treb +28 −15dB at 12kHz, Bass ±18dB at 40 Hz.

£7·50

SVA08 STEREO PRE AMP Vol. Treb, Mid and Bass controls, I/P suitable, Guitar, Radio, Crystal/Ceramic P.U. Sensitivity 4mV. Treble +35dB at 16kHz. Mid +20 −15dB at 4kHz. Bass +20 −10dB at 40Hz Plus Full Balance Control. Full I/C operation supply voltage ±15VDC.

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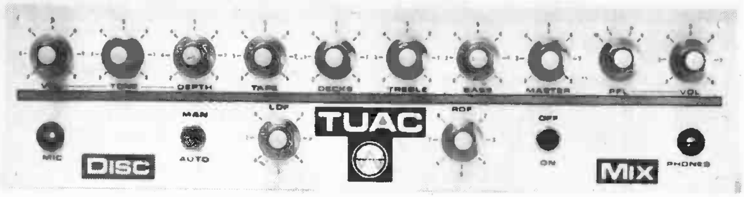


Designed for the discerning D.J. of professional standard. Offering a vast variety of functions. Controls: Mic Vol; Tone, over-ride depth, auto/manual sw; Tape Vol; L & R Deck Faders; Deck Volume; Treble and Bass; H. Phon Vol Selector; Master Vol On/Off sw. Max output 3V RMS.

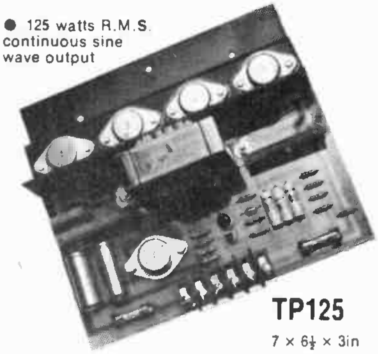
Specification: Deck Inputs—50mV into 1MΩ; Deck Tone Controls—treble total range 36dB at 15kHz—Bass total range 36dB at 50Hz. Mic input—200 ohms upwards 2mV into 22k. Mic Tone Control—Total range 40dB at 15kHz. Tape input—100mV into 200 ohms. Power requirements 20–50 volts d.c. at 50mA. R.I.A.A. comp mag inputs available 75p extra.

£39·75

PANEL SIZE
18 × 4½in
DEPTH 3in

★ TUAC AMPLIFIER MODULES ★ POWER AND QUALITY ★

- 125 watts R.M.S. continuous sine wave output



TP125

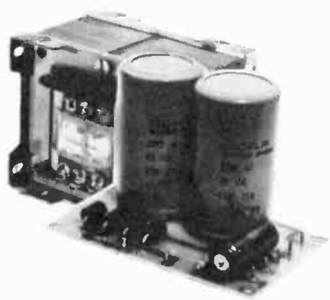
7 × 6½ × 3in

£23·25

- 4 R.C.A. 150 watt 15 amp output transistors

- Rugged layer wound driver transformer
- Short—Open—and Thermal overload protection
- Only 6 connections

Power supplies vacuum impregnated. Transformers with supply board incorporating pre-amp supply.



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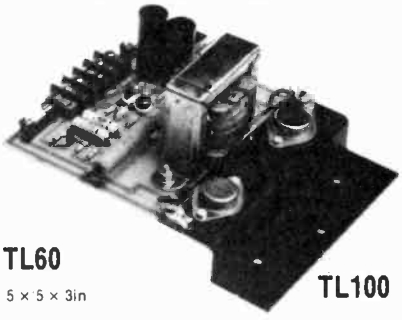

TL60

5 × 5 × 3in

- 60 watts R.M.S. continuous sine wave output
- 2 R.C.A. 110 watt 15 amp transistors

£16·75

TL100

5 × 5 × 3in

- 100 watts R.M.S. continuous sine wave output
- 2 R.C.A. 150 watt 15 amp transistors

£18·75

Specification on all power modules: All output power ratings ±0·5dB; Output impedance 8–15 ohms; THD at full power 2% typically 1%; Input sensitivity 60mV into 10kΩ; Frequency response 20Hz–20kHz ±2dB; Hum and noise better than −70dB.

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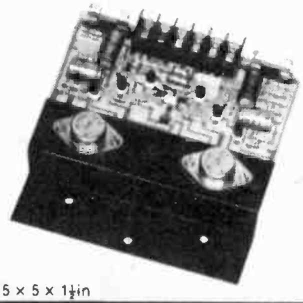

5 × 5 × 1½in

TL30

NEW FROM TUAC TL30 D.C. COUPLED POWER AMPLIFIER MODULE.

- Output power 30 watts R.M.S. continuous sine wave
- Output impedance 8–15 ohms
- T.H.D. at full power 0·5%
- Signal to noise ratio −85dB
- Input sensitivity 60mV into 50k ohms
- Frequency response 25Hz–50kHz
- 8 transistors
- 4 diodes
- Only six connections

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TECHNICAL INFORMATION TEL 01-672 3137 TRADE AND EXPORT ENQUIRIES TEL 01-672 9080

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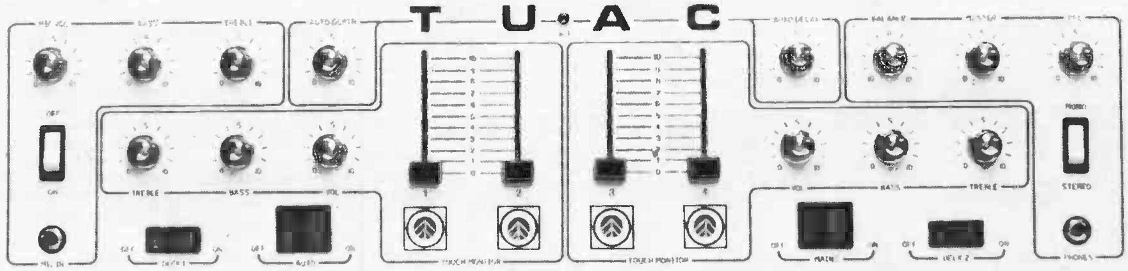
STEREO DISCO MIXER With touch sensitive switching and auto fade



INPUTS: Four identical stereo inputs available with any equalisation. Two magnetic and two flat supplied as standard. High quality slider control on each channel. Volume, treble, and bass controls for each pair of sliders. Sensitivity mag. 3mV (R.I.A.A. comp.). Flat 50mV at 1kHz. Bass controls ±18dB at 60Hz. Treble controls ±18dB at 15kHz.
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P.F.L.: Output 250mV into 8 ohms. Rotary volume control. Monitoring facility for all 4 channels. Selection via touch sensitive illuminated switches. Switched visual cue indicator.

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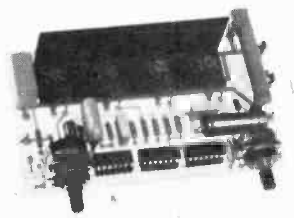
Size 25in long × 6in high × 3in deep

£115

4 CHANNEL SOUND TO LIGHT SEQUENCE CHASER—4LSMI



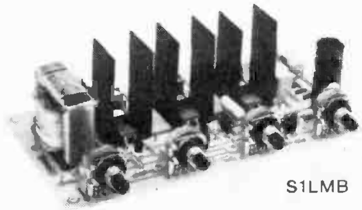
- RCA 8A Triacs
- 1000W per channel
- Fully suppressed and fused
- Switched master control for sound operation from ¼W to 125W
- Speed control for fixed rate sequence from 8 per minute to 50 per second
- Full logic integrated circuitry with optical isolation for amplifier protection
- Full wave control
- 13 easy connections

Patents applied for **£18·75**

Model 501 500W per channel as above without sound triggering £12·25

3 CHANNEL LIGHT MODULATOR

- RCA 8A Triacs
- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 100W
- Full wave control
- 12 easy connections

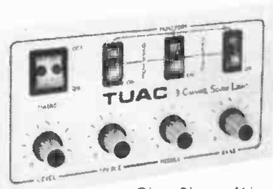


S1LMB

£18·00 (Single Channel Version 1500 Watts £9·50)

NEW FROM TUAC FRONT PANELS FOR LIGHTING EFFECT MODULES

complete with switches, neons and knobs as illustrated



Size 8in × 4½in

◀ For S1LMB **£6·50**

Size 6½ × 4½in

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Size 9in × 4½in

◀ For S1LMB combined with 3SDM1 **£7·50**

ADD SEQUENCE CHASING AND DIMMING EFFECTS TO YOUR TUAC 3 CHANNEL LIGHT MODULATOR

- Speed Control 3 per min. to 10 per sec.
- Full logic integrated circuitry
- Dimmer control to each channel
- 9 easy connections

SEQUENCE DIMMER MODULE—3SDMI **£13·00**

Suppliers to H.M. Govt. Depts. Manufactured and assembled in Gt. Britain fully tested and guaranteed.

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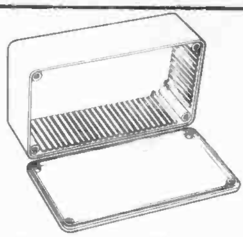

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100x50x25mm	51p	(1-9) 49p	(10+)
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190x110x60mm	£1.33	(1-9) £1.30	(10+)

Polystyrene version
Plain inside, no integral bushes

112x61x31mm	35p	(1-9) 32p	(10+)

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TYPE A NEON INDICATORS

Held in 8mm hole by plastic bezel
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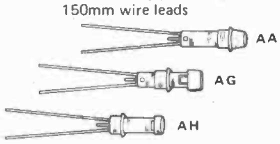
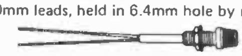


Red, Amber, Clear, Opal 19p each
Green 28p each

TYPE MP NEON INDICATOR

150mm leads, held in 6.4mm hole by nut



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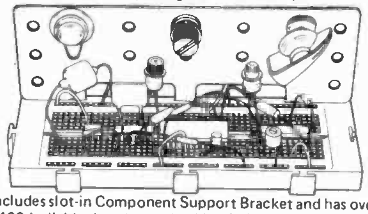

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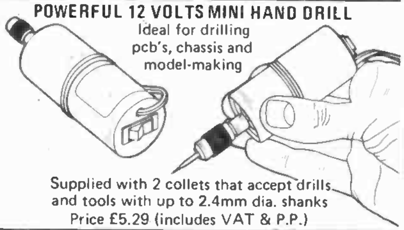
POWERFUL 12 VOLTS MINI HAND DRILL

Ideal for drilling pcb's, chassis and model-making



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L.H. decimal, Red, Green, Yellow
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Economy Quality, as above, Red only, 73p.

P.P. Note. Unless included in price add 25p post & packing for orders totalling under £10.Prices include VAT and are valid in UK only for 2 months from journal issue date.

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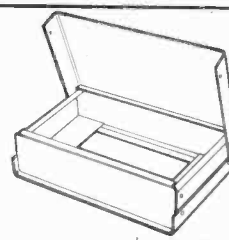

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(Adaptor provided but not lamp)
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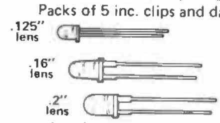

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7423	25p	7493	49p	74185	1-49p
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7443	63p	74126	57p	74199	1-89p
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74L04	21p	74L72	31p	74L95	97p
74L06	21p	74L73	44p	74L98	1-69p
74L10	18p	74L74	44p	74L164	1-69p
74L20	18p	74L78	49p	74L165	1-69p
74L30	18p	74L85	96p		
74L42	97p	74L86	44p		

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74LS00	26p	74LS32	29p	74LS95	1-38p
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74H04	18p	74H40	18p	74H74	37p
74H08	18p	74H50	18p	74H101	40p
74H10	18p	74H52	21p	74H102	40p
74H11	18p	74H53	23p	74H103	46p
74H20	18p	74H55	23p	74H106	46p
74H21	18p	74H60	24p	74H108	46p

SCHOTTKY

74S00	26p	74S08	35p	74S22	26p
74S02	35p	74S10	26p	74S32	40p
74S03	26p	74S20	26p	74S74	26p
74S04	35p				

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8092	38p	8230	1-45p	8812	65p
8095	87p	8288	89p	8822	1-49p
8121	56p	8520	75p	8830	1-49p
8123	97p	8552	1-39p	8831	1-49p
8130	1-38p	8563	32p	8836	29p
8200	1-63p	8810	45p	8880	79p
8214					

8000 (SIGNETICS)

8263	3-79	8267	1-79

9000

9002	24	9309	56	9601	62
9301	72	9312	56	9602	56

DTL

930	12	937	12	949	12
932	12	944	12	962	12
936	12	946	12	963	12

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MM5311	6 digit multiplexed BCD, 7 seg 12-24 Hr, 50-60 Hz 28 pin	£3-07
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MM5314	6 digit multiplexed 12-24 Hr, 50-60Hz 24 pin	3-07
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4000A	21	4018A	89	4066A	72
4001A	21	4020A	1-22	4068A	36
4002A	21	4021A	1-13	4069A	36
4006A	1-10	4022A	90	4071A	22
4007A	22	4023A	21	4072A	29
4008A	1-46	4024A	72	4073A	32
4009A	47	4025A	21	4075A	32
4010A	44	4027A	48	4078A	32
4011A	22	4028A	81	4082A	29
4012A	21	4030A	37	4518A	1-69
4013A	37	4035A	1-04	4528A	1-31
4014A	1-22	4040A	99	4585A	1-71
4015A	1-22	4042A	1-21	4901A	31
4016A	46	4049A	48		
4017A	98	4050A	48		

74C00	24	74C74	72	74C162	2-05
74C02	35	74C76	1-07	74C163	2-05
74C04	47	74C107	94	74C164	2-21
74C08	47	74C151	1-83	74C173	1-83
74C10	41	74C154	2-21	74C195	1-90
74C20	41	74C157	1-38	80C95	94
74C42	1-36	74C160	2-05	80C97	94
74C73	98	74C161	2-05		

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CT5002	12 digit, 4 function fixed decimal — battery operation 40 pin	£1-99
CT5005	12 digit, 4 function plus memory, fixed decimal 28 pin	2-06
MM5725	8 digit, 4 function, floating decimal 28 pin	1-37
MM5736	6 digit, 4 function, 9V battery operation 18 pin	2-78
MM5738	8 digit, 5 function plus memory and constant floating decimal, 9V battery operation 24 pin	2-78
MM5739	9 digit, 4 function, 9V battery operation 22 pin	2-78

MEMORIES

1101	256 bit RAM MOS 16 pin	£1-09
1103	1024 bit RAM MOS 18 pin	1-97
1702A	2048 bit static PROM elect. prog. - UV eras. 24 pin	10-50
2102	1024 bit static RAM	
2602	DTL/TTL comp. 1 ms 16 pin	2-00
2101-1	Same as 2101 except 500ns	2-25
5203	2048 bit static PROM elect prog. - UV eras. 24 pin	7-55
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5261	1024 bit dynamic RAM MOS 16 pin	1-35
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2.2 mfd	35V	15p	33 mfd	10V	25p
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6.8 mfd	6V	18p	56 mfd	6V	25p
6.8 mfd	50V	21p			

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MM5016	500/512 bit dyn. 8 pin	1-10
SL5-4025	Quad 25 bit	95
2504	1024 bit multiplexed dyn 8 pin	3-40

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ULN2209	FM gain block 48dB mDIP	1-03
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CA 3046	Transistor array 14 pin DIP	55

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1000-			04

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MV50	Mini LED red emitting - axial	10p
NSL100	Mini red LED - point	10p
NSL102	Mini red LED - diffused	10p
XC209-R	Mini red LED - diffused	12p
MV5020	Jumbo red - diffused	12p
MV5020	Jumbo green - diffused	15p
MV5020	Jumbo clear	12p
MV5020	Jumbo amber	12p

LED DISPLAYS

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MAN3A	Red .127" CC	-15
MAN5	Green .27" CA	2-03
MAN6	Red .6" CA	2-93
MAN7	Red .27" CA	-97
MAN8	Yellow .27" CA	2-03
MAN66	Red .6" CA spaced seg	2-03
DL10A	Red .26" CA	2-08
NSN71L	Red .27" CA	-89
FND70	Red .25" CC	-49

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HP5082-7414	4 digit .11 red LED	1-70
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300	Pos V Reg (super 723) TO-5	£ 49
301	Hi Perf Op Amp mDIP TO-5	21
302	Volt follower TO-5	49
304	Neg V Reg TO-5	56
305	Pos V Reg TO-5	60
307	Op AMP (super 741) mDIP TO-5	44
308	Micro Pwr Op Amp mDIP TO-5	69
309K	5V 1A regulator TO-3	1-25
310	V Follower Op Amp mDIP	75
311	Hi perf V Comp mDIP TO-5	67
319	Hi Speed Dual Comp DIP	82
320T	Neg Reg 5, 12, TO-220	1-12
320K	Neg Reg 5.2, 12 TO-3	1-32
322	Precision Timer DIP	69
324	Quad Op Amp DIP	1-23
339	Quad Comparator DIP	1-06
340K	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-3	1-48
340T	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-220	1-23
370	AGC/Squelch AMPL DIP	92
372	AF-IF Strip detector DIP	51
373	AM/FM/SSB Strip TO-5	35
376	Pos V Reg mDIP	38
380	2w Audio Amp DIP	93
380-8	.6w Audio Amp mDIP	1-02
381	Lo Noise Dual preamp DIP	1-13
382	Lo Noise Dual preamp DIP	1-13
531	High Slew rate Op Amp	2-07
540	Power driver TO-5	1-38
550	Prec V Reg DIP	62
555	Timer mDIP	44
556A	Dual 555 Timer DIP	1-02
560	Phase Locked Loop DIP	2-23
562	Phase Locked Loop DIP	2-23
565	Phase Locked Loop DIP TO-5	1-38
566	Function Gen mDIP TO-5	1-38
567	Tone Decoder mDIP	1-38
709	Operational AMP TO-5 or DIP	31
710	Hi Speed Volt Comp DIP	24
711	Dual Difference Compar DIP	51
723	V Reg DIP	44
733	Diff. video AMPL TO-5	63
739	Dual Hi Perf. Op Amp DIP	75
741	Comp Op Amp mDIP TO-5	29
747	741 Dual Op Amp DIP or TO-5	53
748	Freq Adj 741 mDIP	31
1304	FM Mulpx Stereo Demod DIP	75
1307	FM Mulpx Stereo Demod DIP	52
1456	Op Amp mDIP	91
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75451	Dual Perepheral Driver mDIP	24
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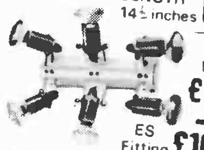

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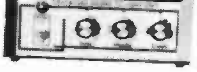

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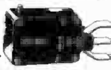
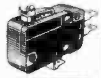
3 c/o 5 amp contacts. 120 ohm coil. **85p.** Post 15p.
6 VOLT A.C. 1 make contacts **45p.** Post 15p.
100 VOLT A.C. 2 c/o 75p. 3 c/o 85p. Post 15p.
ENCLOSED TYPE RELAYS
24 VOLT D.C. 3 c/o **85p.** Post 20p. Base **15p** extra.
24 VOLT A.C. Mfg. by ITT. 3 h.d. c/o contacts. **65p.** Post 20p. Base **15p.**
55 VOLT A.C. RELAY
3 h.d. c/o contacts. Price **65p.** Post 20p. Base **15p.**
230 VOLT RELAY
3 h.d. c/o contacts. Price **85p.** Post 20p. Octal plug in base 15p extra.
230/240 VOLT A.C. RELAY. Mfg. by Arrow 2 h.d. 15 amp c/o contacts. Amp connectors. Price **£1·10.** Post 20p.
220/240 VOLT A.C. RELAY
3 c/o 5 amp contacts. Sealed. Mfg. ISKRA. **£1·35.** Post 20p. Base 15p extra.
CLARE-ELLIOTT TYPE RP7641 G8
Miniature relay. 675 ohm coil. 24 Volt D.C. 2 c/o. **80p** post paid.

C/O MICRO SWITCH



VERY SPECIAL OFFER. Mfg. by C.E.M. 3 amp 250 volt. 10 amp 125 volt. 50 for **£3.** Post 36p. 100 for **£5.** Post 50p. 1,000 for **£45.** Post paid. Bulk purchase means LOW! LOW! prices. DOUBLE POLE C/O or 2 make/2 break micro switch. 10 amp 250v a.c. With detachable roller assembly. 10 for **£2·50.** Post 50p (min. order 10).

MINIATURE C/O ROLLER MICRO SWITCH



OMRON Type V15 FL22/1C. 10 for **£2.** Post 50p. (Min. order 10).

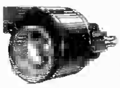
24 VOLT DC SOLENOIDS

UNIT containing 1 heavy duty solenoid approx. 25lb pull 1 inch travel. Two × approx. 1lb pull ½ inch travel. 6 × approx. 4oz. pull ½ inch travel. One 24 volt d.c., 1 heavy duty single make relay. Price **£3·00.** Post **£1.** **ABSOLUTE BARGAIN.**

600 WATT DIMMER SWITCH

Easily fitted. Fully guaranteed by makers. Will control up to 600W of lighting except fluorescent at mains voltage. Complete with simple instructions. **£2·75.** Post 25p.
1,000 watt model, **£4.** Post 25p.
2,000 watt model, **£8.** Post 40p.

CENTRIFUGAL BLOWER

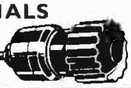


Mfg by Smiths Industries. 230/240V a.c. Miniature Model. Series SE/200. Size 95mm × 82mm × 82mm. Aperture 38mm × 31mm. 12 c.f.m., **£2·75.** Post 50p.
Mfg. by Airflow Developments Ltd. Precision made, continuously rated, smooth running. 230/240V a.c. motor. 80 c.f.m. As illustrated but with round aperture, **£6·50.** Post 75p.
Mfg. by Woods. Extremely powerful. 220/250V a.c. 0·3A 2,700 r.p.m. continuously rated. Capacitor start. Cast construction. Aperture 66mm × 50mm, O/A 200mm. **£12.** Post **£1.**
Mfg. by Parvalux Type SD38B. 220 volt A.C., 50Hz, 0·55 amp. Continuously rated 2800 r.p.m. 120 cfm. Brand New. Fraction of makers price. **£10.** Post **£1.**

BLOWER UNIT

200/240V a.c. precision German built. Dynamically balanced, quiet, con rated, reversible. Consumption 60mA. Size 120mm dia. 60mm deep. Price **£3·50.** Post 50p.

INSULATED TERMINALS



Incorporating 4mm socket. Available in black, red, white, yellow, blue and green. **18p** each. Post paid. (Min. 6)

All Mail Orders—Callers—Ample Parking
Dept. PE8, 57 BRIDGMAN ROAD CHISWICK, LONDON W4 5BB
Phone 01-995 1560
Showroom open Mon.-Fri.

VARIABLE VOLTAGE TRANSFORMERS

INPUT 230/240V a.c. 50/60 OUTPUT VARIABLE 0–260V All Types
SHROUDED TYPE
200 watt (1 amp) **£10·00**
0·5 KVA (2½ amp) (MAX) **£11·50**
1 KVA (5 amp) (MAX) **£16·50**
2 KVA (10 amp) (MAX) **£30·00**
3 KVA (15 amp) (MAX) **£33·00**
4 KVA (20 amp) (MAX) **£60·00**
37·5 amp (MAX) **£102·50**
CARRIAGE AND PACKING EXTRA

L.T. TRANSFORMERS

0, 6, 12 Volt at 10 amp.	**£6·15.**	Post 70p.
0, 10, 17, 18 Volt at 10 amp.	**£8·70.**	Post £1·00
0, 4, 6, 24, 32 Volt at 12 amp.	**£10·90.**	Post £1·00
0, 6, 12 Volt at 20 amp.	**£9·90.**	Post £1·00
0, 12, 24 Volt at 10 amp.	**£10·30.**	Post £1·00
0, 6, 12, 17, 18, 20 Volt at 20 amp.	**£11·80.**	Post £1·00

Other types to order at short notice—Phone your enquiries.

AUTO TRANSFORMERS

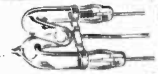
Step up, step down, 0-115/200/220/240 volts at 75 watt **£3.** Post 40p. 150 watt **£4·30.** Post 50p. 300 watt **£6·20.** Post 60p. 500 watt **£9·20.** Post 75p. 1000 watt **£13·50.** Post 90p.

STROBE! STROBE! STROBE!

HY-LIGHT STROBE MK IV

Build a Strobe Unit, using the latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/250V a.c. operation. For use in large rooms, halls and utilises a silica tube, printed circuit. Speed adjustable 0-20 f.p.s. Light output greater than many (so called 4 Joule) strobes **£15·40.** Post 75p.

XENON FLASHGUN TUBES

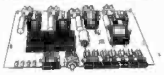


Range available from stock. S.A.E. for details.

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES

4ft 40 watt, £6·05 (callers only). **2ft 20 watt, £4·68.** Post 60p. (For use in standard bi-pin). MINI. **12in 8 watt, £1·76.** Post 25p. **9in 6 watt, £1·43.** Post 25p. Complete ballast unit and holders for 9in and 12in tube, **£1·87.** Post 30p. (9in and 12in measures approx.)

SQUAD LIGHT



A new conception in light control. Four channels each capable of handling 750 watts of spot lights, flood lights or dozens of small mains lamps. Seven programs all speed controlled plus flash modulation, effectively giving 14 different displays. Makes sound-to-light obsolete. Completely electrically and mechanically noise free. Price only **£60.** Post 75p. S.A.E. (Foolscap) for further details.

WIDE RANGE OF DISCO LIGHTING EQUIPMENT

6" graphic wheels, 3½" cassettes. S.A.E. (Foolscap) for details.

COLOUR WHEEL PROJECTOR TYPE P150 INTACHANGE

200/240V a.c. 50Hz 150W lamp, complete with oil filled colour wheel and motor plate. Takes intachange accessories and full range of lenses. **£29·95.** Post £1·35. (Total inc. VAT & Post, **£33·70.**)

BIG BLACK LIGHT

400W Mercury Vapor Ultra Violet Lamp. Powerful source of UV P.F. ballast unit is essential with this lamp. Price of bulb and matched ballast unit. **£28.** Post £2. Spare bulb only **£10.** Post 80p.

VAT

VAT AT 8% MUST BE ADDED TO ALL ORDERS FOR THE TOTAL VALUE OF GOODS INCLUDING POSTAGE UNLESS OTHERWISE STATED.

SERVICE TRADING CO.

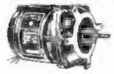
GEARED MOTORS

100 r.p.m. 115 lb. in. 110V, 50Hz, 2·8A, single phase, split capacitor motor. Immense power. Continuously rated. Totally enclosed. Fan cooled in-line gearbox. Length 250 mm. Dia. 135 mm. Spindle dia. 15·5 mm. Length 145 mm. Ex-equipment tested **£14.** Post £1·50. Suitable transformer 230/240V operation **£8.** Post 75p.

60 R.P.M. REVERSIBLE

220/240V a.c. Small, powerful, continuously rated, reversible motor. M.f.g. Berger (Germany). Size 80mm × 65mm × 65mm. Spindle dia. 6mm × 15mm long. Weight 725g. **£5·50.** Post 50p.

BODINE TYPE N.C.I.



(Type J) 71 r.p.m. torque 10 lb. in. Reversible 1/70th h.p. 50Hz. (Type 2) 28 r.p.m. torque 20 lb. in. Reversible 1/80th h.p. 50Hz. The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115V A.C. Supplied complete with transformer for **230/240V A.C. input.**
Price, either type **£6·25.** Post 75p or less transformer **£3·75.** Post 65p.
(Type 3) 71 r.p.m. 4 lb. ins. 230V a.c. Continuously rated. Non-reversible. **£6·50.** Post 75p.

15 R.P.M.

Type SD48 80 lb. in. Input 100/200 volt A.C. Length incl. gearbox 270 mm. Height 135 mm. Width 150 mm. drive shaft 16 mm. Weight 8·5 Kilos. BRAND NEW. Price **£10.** Carr. **£1.**
Suitable transformer for use on 220/240 volt A.C. **£3·85.** Post 50p.

24 R.P.M.

230V a.c. Continuously rated. Mfg. Mycalex. Ex-equip. Fully tested. **£3·85.** Post 75p.

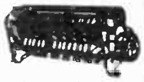
1 R.P.M. 230/240V A.C. SYNCHRONOUS!

Ex-equipment. Thoroughly tested and guaranteed. **ONLY £1·50.** Post 20p.

20 R.P.M.

230/240 volt a.c. miniature motor. Price **£1.** Post 20p.

PROGRAMME TIMERS

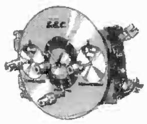


230V operation a.c. 15 or 20 r.p.m.
6 cam model **£5.** Post 60p.
9 cam model **£6·50.** Post 60p.
12 cam model **£7·50.** Post 60p.
Also available for 50V operation. Prices as above.

INSULATION TESTERS NEW!

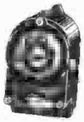
Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L.8in, W.4in, H.6in, weight 6lb. 500V, 500 megohms, **£40.** Post 80p. 1,000V, 1,000MΩ, **£46.** Post 80p.

A.C. MAINS TIMER UNIT



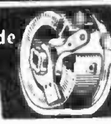
Based on an electric clock, with 25 amp. single pole switch, which can be preset for any period up to 12 hrs. ahead to switch on for any length of time, from 10 mins. to 6 hrs. then switch off. An additional 60 min. audible timer is also incorporated. Ideal for Tape Recorders, Lights, Electric Blankets, etc. Attractive satin copper finish. Size 135mm × 130mm × 60mm. Price **£2·25.** Post 40p. (Total incl. VAT and Post **£2·87**).

TIME SWITCH



'Horstmann' Type V Mk. II Time switch. 200/250 volt A.C. Two on/two off every 24 hours, at any manually pre-set time. 30 amp contacts. 36 hour spring reserve in case of power failure. Day omitting device. Fitted in heavy high impact case, with glass observation window. Built to highest Electricity Board Spec. individually tested. Price **£7·75.** Post 50p. (Total inc. VAT **£8·91**)

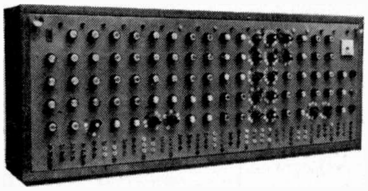
Superior Quality Precision Made NEW POWER RHEOSTATS



New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.
25 WATT 10/25/50/100/150/250/500/1k/1·5k ohm. **£1·70.** Post 20p.
50 WATT 1/5/10/25/50/100/250/500/1k ohm. **£2·10.** Post 25p.
100 WATT 1/5/10/25/50/100/250/500/1k/1·5k/2·5k/3·5k/5k ohm **£3·30.** Post 35p.
Black Silver, Skirted knob calibrated in Nos. 1–9 1½in. dia. brass bush. Ideal for above **22p** each.

Personal callers only. Open Sat.
9 LITTLE NEWPORT STREET LONDON WC2H 7JJ
Phone 01-437 0576

SYNTHESISERS, SOUND EFFECTS AND



COMPONENTS SETS include all necessary resistors, capacitors, semi-conductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, etc. are not included but most of these may be bought separately. Fuller details of kits, PCBs and parts are shown in our lists.

CIRCUIT AND LAYOUT DIAGRAMS are supplied free with all PCBs designed by Phonosonics.

PHOTOCOPIES of the P.E. texts for most of the kits are available—prices in our lists.

PHONOSONICS

MAIL ORDER SUPPLIERS OF QUALITY PRINTED CIRCUIT BOARDS, KITS AND COMPONENTS TO A WORLD-WIDE MARKET.

P.E. SYNTHESISER

(P.E. Feb. 73 to Feb. 74)
The well acclaimed and highly versatile large-scale mains-operated Sound Synthesiser complete with keyboard circuits. All function circuits may be used independently, or interconnected. The greater the number of circuits, the greater the versatility. Other circuits in our lists may be used with the Synthesiser to good advantage (notably P.E. Minisonic, Phasing Unit, Wind and Rain, Rhythm Generator, Sound Bender, Voltage Controlled Filter, Guitar Effects Pedal).

THE MAIN SYNTHESISER

Stabilised power supply	£12·05
Two Linear Voltage Controlled Oscillators and one Inverter—all 3 circuits	£16·38
PCB (2 are required) each	£1·48
Two Ramp Generators and Two Input Amplifiers all 4 circuits	£5·62
PCB (holds all 4 circuits)	£1·38
Sample-Hold and Noise Generator	£6·64
PCB (holds both circuits)	£1·70
Tone Control	£2·43
PCB	80p
Reverberation Amplifier	£6·36
Sprine Line unit for Reverb. Amp.	£4·95
Ring Modulator	£3·93
Peak Level Meter Circuit	£1·50
100µA Panel Meter	£3·75
PCB to hold Reverb, Ring Mod and Meter Circuits	£1·94
Envelope Shaper	£5·35
PCB	£1·46
Voltage Controlled Amplifier and Differential Amplifier	£6·86
PCB (holds both circuits)	£1·32

THE SYNTHESISER KEYBOARD CIRCUITS

(Can be used without the Main Synthesiser to make an independent musical instrument)

Two Logarithmic Voltage Controlled Oscillators	
Component set	£14·55
PCB (holds both circuits)	£2·60
Divider, 2 Hold Circuits, 2 Modulation Amplifiers, Mixer and 2 Envelope Shapers	£19·64
PCB (holds the first 6 circuits)	£1·80
PCB for both Envelope Shapers	£1·55
Keyboard Stabilised Power Supply	£7·30
Printed Circuit Board	94p

GUITAR EFFECTS PEDAL (P.E. July 75)

Will modify an audio signal not only from a guitar but from any audio source, producing 8 different switchable effects that can be further modified by manual controls. Possibly the most interesting of all the low-priced sound effects units in our range.

Component Set with special foot operated switches	£6·25
Alternative component set with panel mounting switches	£4·60
Printed Circuit Board	£1·30

SOUND BENDER (P.E. May 74)

A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice-operated fader, automatic fader and frequency-doubler.

Component Set for above functions (excl. SWs)	£6·58
Printed circuit board	£1·58
Optional extra—additional Audio Modulator, the use of which, in conjunction with the above component set, can produce "jungle-drum" rhythms. Component Set (incl. PCB)	£2·55

PHASING UNIT (P.E. Sept. 73)

A simple but effective manually controlled unit for introducing the "phasing" sound into live or recorded music.

Component Set (incl. PCB)	£2·50

PHASING CONTROL UNIT (P.E. Oct. 74)

For use with the above Phasing Unit to automatically control the rate of phasing.

Component Set (incl. PCB)	£3·75

WAH-WAH UNIT (P.E. Apr. 76)

The Wah-wah effect produced by this unit can be controlled manually or by the integral automatic controller.

Component Set incl. PCB	£2·99

P.E. JOANNA (P.E. May/Sept. 75)

A five-octave electronic piano that has switchable alternative voicing of Honky-Tonk piano, ordinary piano, harpsichord, or a mixture of any of the three, together with facilities including fast and slow tremolo, loud and soft pedal switching, and sustain pedal switching. The power amplifier typically delivers 24 watts into 8 ohms. The PCBs have been redesigned by ourselves making improved use of the space available.

Main Power Supply	£9·41
Tone Generator and Top C Envelope Shaper	£9·97
PCB for Main PSU, Tone Gen & Top C E.S.	£2·10
Envelope Shapers for all notes (except Top C)	£32·16
Set of PCBs for Envelope Shapers (except Top C)	£10·40
Voicing and Pre-Amp Circuits	£8·37
PCB for Voicing and Pre-amp	£2·64
Power Amplifier (incl. separate Power Supply)	£14·50
PCB for Power Amp and PSU	95p

RHYTHM GENERATOR (P.E. Mar./Apr. 74)

Programmable for 64,000 rhythm patterns from 8 effects circuits (high and low bongos, bass and snare drums, long and short brushes, blocks and soft cymbal), and with variable time signatures and rhythm rates. Really fascinating and useful.

Tempo, Timing and Logic circuits	£12·57
PCB for above circuits (double-sided)	£2·84
Component set for all 8 effects circuits	£10·49
PCB for all 8 effects	£3·60
Simple mixer (our design) incl. PCB	£3·70
Alternative mixer with external volume controls, incl. PCB	£9·93
Power Supply for T, T and L, and Effects, incl. PCB	£6·42

(See our list for Power Supplies for Mixers)

REVERBERATION UNIT (P.W. Nov./Dec. 72)

A high quality unit having microphone and line input pre-amps, and providing full control over reverberation level.

Component Set (excl. spring unit)	£7·55
Printed Circuit Board	£1·76
9 in. Spring Unit	£4·95
Panel Meter (50µA) (optional)	£3·75

WIND AND RAIN UNIT

A manually controlled unit for producing the above-named sounds.

Component set incl. PCB	£2·83

P.E. MINIMIX 6 (P.E. Nov./Dec. 75)

Each of the 6 input channels has its own gain, volume and panning controls. The volume of the twin channel outputs are fully manually controllable, as are the headphone and pre-fade monitoring facilities. Twin VU meters provide visual display of channel audio levels. Ideal for use with effects and synthesiser kits. For details see our list.

8-INPUT MIXER

A simple mixer having 8 inputs each of which has a preset level control and which are combined into one output channel having a preset over-all level control and a master output volume control. Designed for inter-coupling our various sound effects and synthesiser kits.

Component set incl. PCB	£3·70

25 WATT MONO AMPLIFIER (P.E. Sept. 75)

A good general purpose integrated circuit power amplifier typically delivering 25 watts into 8 ohms. Power bandwidth 20Hz to 20kHz, 3dB, Input impedance 20km. Distortion 0·2%. Suitable for use with any of our sound producing kits.

Component Set incl. power supply	£14·50
Printed Circuit Board	95p

For stereo use two sets and PCBs are required.

TREBLE BOOST UNIT (P.E. Apr. 76)

Gives a much shriller quality to audio signals fed through it. The depth of boost is manually adjustable.

Component Set incl. PCB	£2·15

P.E. MINISONIC MK I

(P.E. Nov. 1974 to March 1975)
A portable, battery or mains operated, miniature sound synthesiser, with keyboard circuits. Although having slightly fewer facilities than the large P.E. Synthesiser, the functions offered by this design give it great scope and versatility. Like the large Synthesiser it too may be advantageously used with other circuits in our lists.

Two Voltage Controlled Oscillators	£5·22
Voltage Controlled Filter and Voltage Reference Circuit	£3·41
Two Envelope Shapers and Two Voltage Controlled Amplifiers	£7·25
Keyboard Controller and Hold Circuits	£2·66
Keyboard Divider Resistors (select type to suit keyboard used) (all are 2% tolerance): 2 Octave £1; 3 Octave £1·48; 4 Octave £1·96; 5 Octave £2·44.	
H.F. Oscillator and Detector	£1·66
Ring Modulator, Noise Generator and Envelope Inverter	£5·45
Two Power Amplifiers and Two Mixers	£3·55
Battery Eliminator	£5·88
Temperature Stabiliser	£1·47
PCB to hold 2 VCOs, VCF and V-Ref	£2·02
PCB to hold 2 ESs, 2 VCAs, 2 Mixers, Ring Mod, Keyboard Control and Hold	£2·20
PCB to hold 2 Power Amps., Noise Gen., Envelope-Inverter, H.F. Osc and Detector	£1·45
PCB to hold Battery Eliminator and Temperature Stabiliser	£1·35

P.E. MINISONIC MK 2

Conversion kits and PCBs for updating the MK I version are now available. Details in our list.

ENVELOPE SHAPERS

Both of the kits below have manual control over their Attack, Decay, Sustain and Release functions. Both kits include PCB (VCA means Voltage Controlled Amplifier)

Envelope Shaper and VCA (P.E. Apr. 76)	£5·43
Envelope Shaper (without VCA) (P.E. Oct. 75)	£4·16

VOICE OPERATED FADER (P.E. Dec. 73)

For automatically reducing music volume during "talk-over"—particularly useful for Disco work or for home-movie shows.

Component Set incl. PCB	£3·05

VOLTAGE CONTROLLED FILTER (P.E. Oct. 74)

An independently designed VCF that can be used with the P.E. Synthesiser.

Component Set	£3·41
Printed Circuit Board	£1·25

P.E. TUNING FORK (P.E. Nov. 75)

Produces 84 switch-selected frequency-accurate tones. An LED monitor clearly displays all beat note adjustments. Ideal for tuning acoustic and electronic musical instruments alike.

Main Component Set incl. PCB	£14·22
Power Supply set incl. PCB	£6·57

P.E. SYNCHRONOME (P.E. Mar. 76)

An accented-beat electronic metronome, providing duple, triple and quadruple times with full control over the beat rate. Can also be used as a simple drum-beat rhythm generator. Includes power supply.

Component Set incl. loudspeaker	£10·20
Printed Circuit Board	£1·70

PEAK LEVEL INDICATOR (P.E. Mar. 76)

A twin-channel visual display unit for monitoring the peak level of audio signals. Well suited for use when inter-coupling our many sound producing kits to help avoid signal over-loading.

Component Set incl. PCB (as published)	£3·26

POST AND HANDLING

U.K. orders—under £15 add 25p plus VAT, over £15 add 50p plus VAT.
Optional Insurance for compensation against loss or damage in post, add 35p in addition to above post and handling.
Eire, C.I., B.F.P.O., and other countries are subject to Export postage rates.

VAT

Add 12½% (or current rate if changed) to full total of goods, post and handling. (Does not apply to export orders).

EXPORT ORDERS are welcome, though we advise that a current copy of our list should be obtained before ordering as it also shows Export postage rates. All payments must be cash-with-order, in Sterling and preferably by International Money Order or through an English Bank. To obtain list for Europe send 20p, for other countries send 40p.

PHONOSONICS • DEPT. PE47 • 22 HIGH STREET • SIDCUP • KENT DA14 6EH

**MAIL ORDER AND C.W.O. ONLY
DON'T FORGET VAT!**

OTHER PROJECTS

PHOTOGRAPHS in this advertisement show two of our units containing some of the P.E. projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, though a small selection of other cases is available.

LIST—Send Stamped Addressed Envelope with all U.K. requests for free list giving fuller details of PCBs, kits, and other components.

OVERSEAS enquiries for list: Europe—send 20p; Other Countries—send 40p.

KEYBOARDS AND CONTACTS

Kimber-Allen Keyboards as required for many published circuits, including the **P.E. Joanna, P.E. Minisonic,** and **P.E. Synthesiser.** The manufacturers claim that these are the finest moulded plastic keyboards available. All octaves are C to C. The keys are plastic, spring-loaded and mounted on a robust aluminium frame.
3 Octave (37 notes) £20·50. 4 Oct (49 notes) £23·50. 5 Oct (61 notes) £27.
Contact Assemblies for use with above keyboards: Single-pole change-over (type SP) as for P.E. Joanna and P.E. Minisonic. Two-pole normally open-make-break (type DP) as for P.E. Synthesiser. Special contact assembly (type 4PS) having 4 poles, 3 of which are normally-open make-break contacts and the fourth is a change-over contact—this special assembly enables THE SAME KEYBOARD to be used with the P.E. Synthesiser, P.E. Minisonic and the P.E. Joanna simultaneously thus avoiding the cost of more than one keyboard.

Contact	Each	3 Octave Set	4 Octave Set	5 Octave Set
SP	20p	£7·40	£9·80	21·20
2P	24p	£8·88	£11·76	£14·64
4PS	48p	£17·76	£23·52	£29·28

PRINTED CIRCUIT BOARDS for use with the above contacts and thus eliminating most of the inter-wiring required, are available. Details in our lists.

SOUND-TO-LIGHT (P.E. Apr./Aug. 71)

The ever-popular **Aurora**—4 or 8 channels each responding to a different sound frequency and controlling its own light. Can be used with most audio systems and lamp intensities. A MUST for any Disco, and a fascinating visual display for the home.

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PCB for 4 frequency channels	£3·32
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1 A 400V thyristors (1 per chan. req.) each	75p
Panel meter (1μA) (optional)	£3·75

3-CHANNEL SOUND-TO-LIGHT (P.E. Apr. 76)

A simple but effective sound-to-light controller capable of operating 3 lamps each of approximately 700 watts. Includes power supply, thyristors, and by-pass switches.
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BIOLOGICAL AMPLIFIER (P.E. Jan./Feb. 73)

Multi-function circuits that, with the use of other external equipment, can serve as lie-detector, alphaphone, cardiophone etc.

Pre-Amp Module Component Set incl. PCB	£3·71
Basic Output Circuits—combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feed-back lamp-driver circuits	£5·38
Audio Amplifier Module Type PC7	£6·75

TAPE NOISE LIMITER

Very effective circuit for reducing the hiss found in most tape recordings. All kits include PCBs.

Standard Tolerance Set of Components	£2·60
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SINE AND SQUARE WAVE GENERATOR (P.E. July 75)

Suitable for audio, digital, or general purpose. Controllable through 4 decade ranges 10Hz to 100kHz, switched attenuation through 10 ranges from 10V to 1mV peak-to-peak.

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PCB for above components	£1·60
Power Supply	£5·70
PCB for Power Supply	96p

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Practical Electronics, August, 1976

Details in list

SEMI CONDUCTOR TESTER (P.E. Oct. 73)

Essential test equipment for the enterprising home constructor. While stocks last.

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Panel meter (500μA)	£3·75

PHOTOPRINT PROCESS CONTROL (P.E. Jan./Feb. 72)

For colour and B & W, and indispensible dark-room unit for finding exposure, controlling enlarger timing, and stabilising mains voltage. While stocks last.

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Printed Circuit Board	£1·74
Panel Meter (1mA)	£3·75

TREMELO inc. P.C.B.	£2·85
FUZZ UNIT inc. P.C.B.	£1·80

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BC187	25p
BC204	14p
BC209C	14p
BC212L	15p
BC213	15p
BC478	28p
BCY71	22p
BD131	44p
BD132	54p
BFY50	22p
BFY51	22p
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BSY95A	22p
MJE2955	110p
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OC71	14p
OC72	14p
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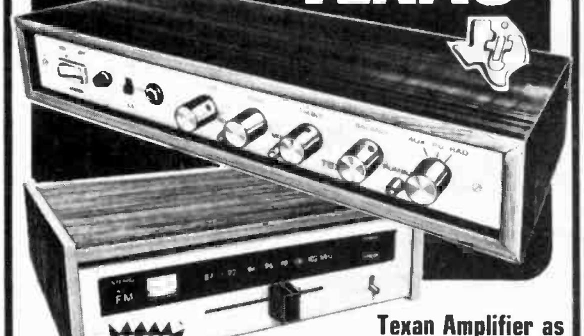

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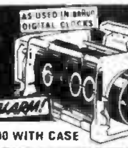

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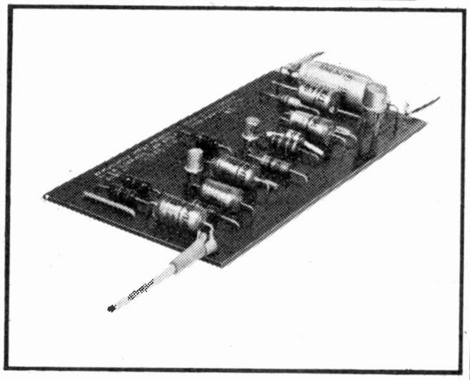

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DOWN TO THE SEA

A TIMELESS cry of the island race—it may be either a bold statement of intent or a hopeful wish—becomes more meaningful and urgent when summer comes around. Down To The Sea has no single and precise meaning we realise. To the majority of folk it means escape to some not too distant coastal watering place, with or without accompanying blandishments of civilisation, depending upon taste. To the bolder and the true nautical spirits, it means a much more intimate relationship with open space and deep waters, afloat and accepting the challenge of the natural elements in some slight craft.

Even those of us incarcerated in office, factory or other place of work have been able to get a whiff of the wide open sea these past few weeks by following the progress of those intrepid yachtsmen battling their way across the wastes of the Atlantic in the biggest single-handed long distance race ever organised. Yet, sad to say, this romantic picture of man against nature is in one respect sullied by knowledge of the practically unbridled employment of advanced electronic navigational aids, beyond simple radio communication equipment such as is more or less the rule amongst all competing craft, by one participant.

The multitude of tiny craft participating in this race have been over-shadowed in the news as well as physically on the water by the 236ft colossus *Club Mediterranée*. This French craft is officially described as a schooner. Captain Onedin would be nonplussed if he stepped aboard, but an electronics engineer would be quite at home. *Club Mediterranée* is, we gather, a veritable paradise for the technical fanatic; also, we suspect, a valuable floating showcase for certain equipment makers. This cornucopia of electronic and electrical delights contains CCTV for monitoring sail positions, satellite-aided navigation computer, radar, radio weather map machine, sea temperature and visibility measuring and warning devices; plus the more commonplace assortment of marine electronics like two-way radio, d.f. equipment and depth sounder. (Use of satellite information and the radar screen was prohibited during the race.)

Yet, despite all this sophistication, something is missing. Where is the robot to take overall command of this wonderful prototype of the electronic-age sailing ship? It's rather a let-down to discover a solitary man at the wheel. But of course, this is a bona fide single-handed sailing vessel competing in the Royal Western/Observer transatlantic race, thanks to the elaborate aids and devices provided by modern technology.

To be fair, *Club Mediterranée* is something more than an entry in a race. It is a remarkable symbol of modern technology applied for an imaginative commercial end—the rebirth of sail as an economical form of transport. Its owner and sponsors declare it is a serious attempt to demonstrate the possibility of linking the old and the new: using the abundant and free natural force of the winds with maximum efficiency through scientific control, with the minimum of human intervention. We imagine the performance of this vessel extraordinary was studied closely by marine engineers and shipping concerns no less than by sporting yachtsmen of the world. And, who knows, there may be some exhilarating careers for electronics engineers (sailing vessel) in the near future. A prospect that might be particularly alluring to some readers as they dream of far-away places during this hot dry summer.

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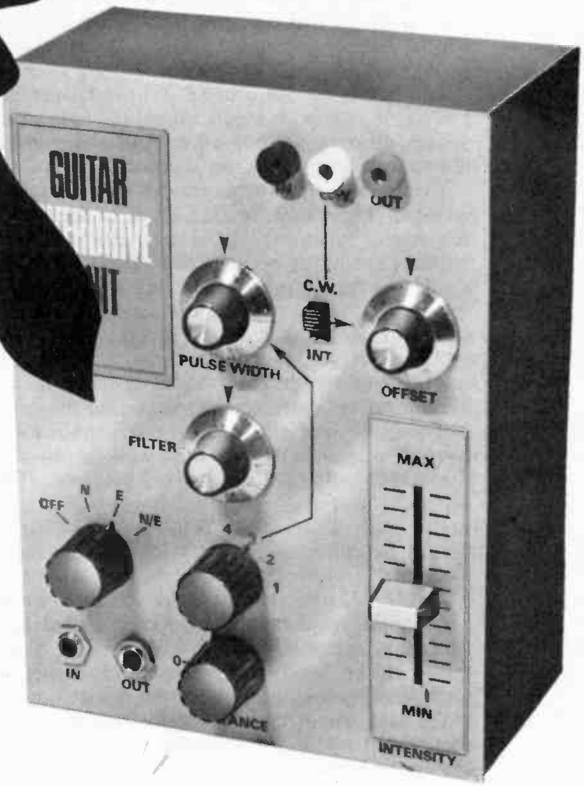
GUITAR OVERDRIVE UNIT

By J. D. ROGERS



MANY fuzz units, some of which depend on Schmitt or other forms of triggers, give a very harsh output with good sustain, but the attack and decay characteristics of the guitar notes are completely lost.

The present unit allows the user to produce many degrees of distortion, from a slightly overdriven, "dirty amplifier" sound through round "shifting" tones, to the more common hard spiky fuzz. In the first two types of distortion, the attack/decay characteristics of notes are not lost, and also the guitar volume controls are left at or near to maxi- often have no effect in fuzz units, are able to alter the sound produced.

Throughout the following it is intended that the guitar volume controls are left at or near to maximum. The treble and bass controls of the amplifier to be used are also best left at or near maximum boost.

The input impedance of 49kΩ will suit most guitars, and the relatively large input capacitors used allow for bass guitars.

CIRCUITRY

The circuit (Fig. 1) operates as follows: The maximum output voltage swing of IC3 is approx. ±8V (± 9V supply −1V) and the gain (in position 1) is set by R5 and R12 at 10,000/620 = 16. Hence an input swing to this operational amplifier of approx. ± 500mV will saturate the output at ± 8V. Any input above this amplitude will not increase the output swing but will cause symmetrical clipping.

Now if IC2 has a gain of, say, 100, it can be seen that any input above ±5mV will be sufficient to cause clipping in IC3. If the gain is increased to 250, then the clipping limits are set 2·5 times lower at ±2mV. Thus it is arranged that changes in input voltage are amplified only within a "window" between the positive and negative clipping levels, the width of this window being set by the gain of IC2, which is variable over a wide range by means of the negative feedback control VR1a.

The larger the proportion of the input waveform that falls outside the window, i.e. the higher the gain, the shorter will be the rise time of the clipped waveform, and therefore the greater will be the intensity, and also the sustain of the output.

When a single note is played, as it decays, progressively less and less of the waveform lies outside the "window", and so clipping gradually reduces finally leaving an unclipped, normal note.

At the top end of the gain range, clipping occurs in IC2 as well as IC3, giving a more fierce spiky fuzz. Clipping does not damage the i.c.s as the maximum specified input voltages are neither reached nor exceeded.

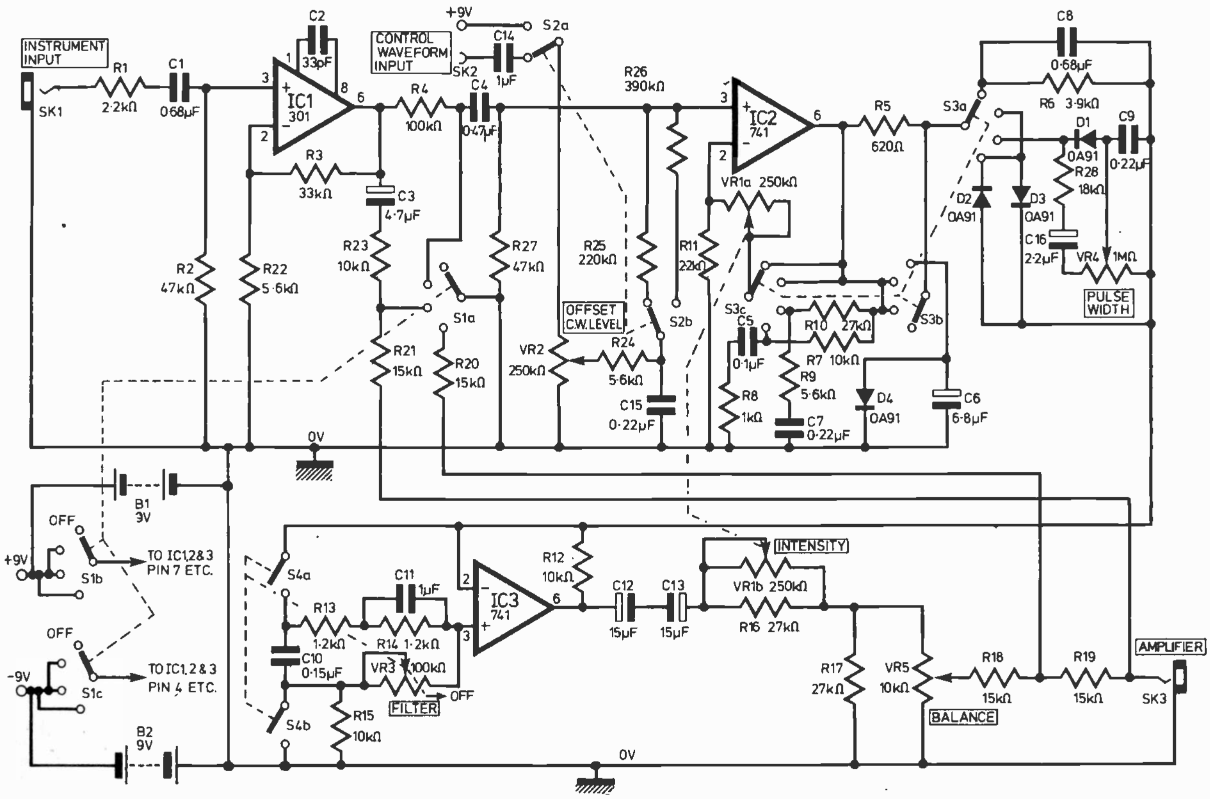


Fig. 1. Full circuit diagram of the Guitar Overdrive Unit. Note S3 is shown in position 1

OPTIMISING R12

For best effects, the feedback resistor R12 must be within the range 6·8kΩ to 15kΩ. If R12 is less than 6·8kΩ there is insufficient gain in the IC3 section, and also the current consumption rises somewhat whenever a signal is applied. The feedback properties of op. amps under clipping conditions are not as straightforward as is normal and it is found that if R12 is greater than 15kΩ, the effects produced are not as unusual; 10kΩ is therefore optimum.

By using a dual potentiometer for VR1, output volume compensation can be applied so that alteration of the gain of IC2 to control fuzz intensity, does not involve re-adjusting the balance control to keep the same approximate output volume. The compensation is designed to occur mainly at the lower end of the gain range, as a little beyond the onset of clipping, the output volume remains subjectively constant.

TONE FORMING

In between the output of IC2 and the input of IC3 are four switched networks. Position 1 gives simple straight clipping. Position 2 gives possibly the most interesting sound available on the unit. The brightness produced in this channel is partly due to the anti-parallel arrangement of diodes in the signal path. These would normally produce crossover distortion due to the diodes being non-conductive during the period when the voltage across them is less than 0·6V.

Under clipping conditions in IC3 however, these crossover regions become compressed into a shorter time, and a degree of ringing is produced due to the filter circuitry around the i.c. and the non-linearity of the diodes. At full gain these crossover regions are so small and fast as to be inaudible, although still faintly visible on a 'scope. This explains why the effect is at its optimum at mid gain settings of VR1. This setting is useful for guitar solo work, being especially effective when finger vibrato is used, when the tone shifts with the vibrato. Also in this setting, bass notes played with the thumb, rather than with a plectrum, have a distinctively sharp attack and decay.

In position 3, VR4 gives control of pulse width and towards the top of the range gives a percussive attack to notes.

In position 4, a powerful, "heavy" sound is available; the effect depending on the value of C6 which should be in the range 2µF to 15µF, 6·8µF being optimum. This capacitor integrates the output of IC2 which reduces the h.f. somewhat, hence the feedback in IC2 is altered by R7/R8/C5 to give a higher gain range and also some treble boost to counteract the treble cut effect of C6. R5 prevents putting too great a load on IC2 output.

FILTER

The addition of only a few components around IC3 converts it into a manually controlled filter, which may be switched out of circuit when not

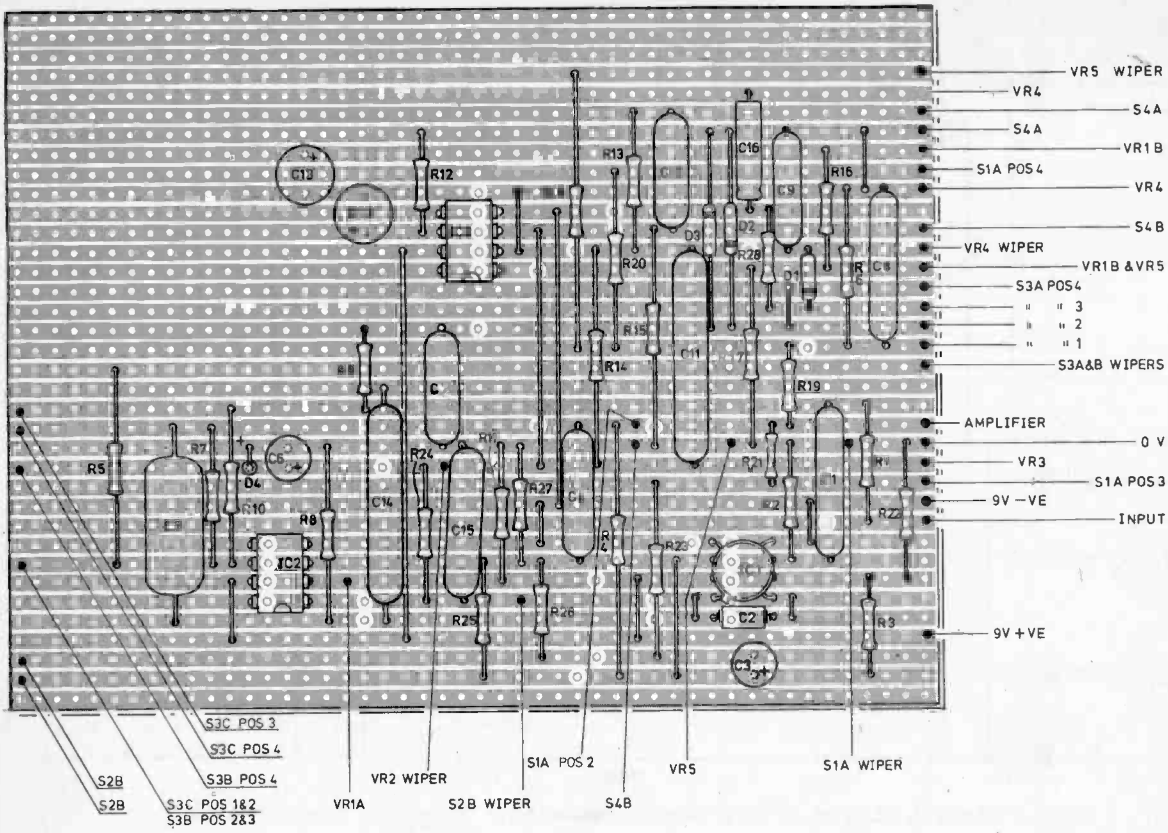


Fig. 4. Stripboard cutting details, component layout and interwiring between the component board and panel mounted components

COMPONENTS . . .

Resistors

R1	2·2k Ω	R15	10k Ω
R2	47k Ω	R16	27k Ω
R3	33k Ω	R17	27k Ω
R4	100k Ω	R18	15k Ω
R5	620 Ω	R19	15k Ω
R6	3·9k Ω	R20	15k Ω
R7	10k Ω	R21	15k Ω
R8	1k Ω	R22	5·6k Ω
R9	5·6k Ω	R23	10k Ω
R10	27k Ω	R24	5·6k Ω
R11	2·2k Ω	R25	220k Ω
R12	10k Ω	R26	390k Ω
R13	1·2k Ω	R27	47k Ω
R14	1·2k Ω	R28	18k Ω

Potentiometers

VR1	250k Ω dual log. (slider) RS Components
VR2	250k Ω log.
VR3	100k Ω log. + d.p.d.t. switch
VR4	1M Ω log.
VR5	10k Ω log.

Capacitors

C1	0·68μF polyester	C9	0·22μF polyester
C2	33pF plastic or ceramic	C10	0·15μF polyester
C3	4·7μF 10V elect.	C11	1μF polyester
C4	0·47μF polyester	C12	15μF 10V elect.
C5	0·1μF polyester	C13	15μF 10V elect.
C6	6·8μF 10V elect.	C14	1μF polyester
C7	0·22μF polyester	C15	0·22μF polyester
C8	0·68μF polyester	C16	2·2μF 10V elect.

Semiconductors

IC1	LM301C
IC2, 3	741
D1–D4	OA91 (4 off)

Miscellaneous

S1	3-pole 4-way rotary (RS Midget wafer switch)
S2	d.p.d.t. slide switch
S3	3-pole 4-way (as S1)
SK1, 3	standard jack socket
SK2	single pole socket

Case and hardware (knobs, etc.) to suit. B1, 2. PP7 9V batteries

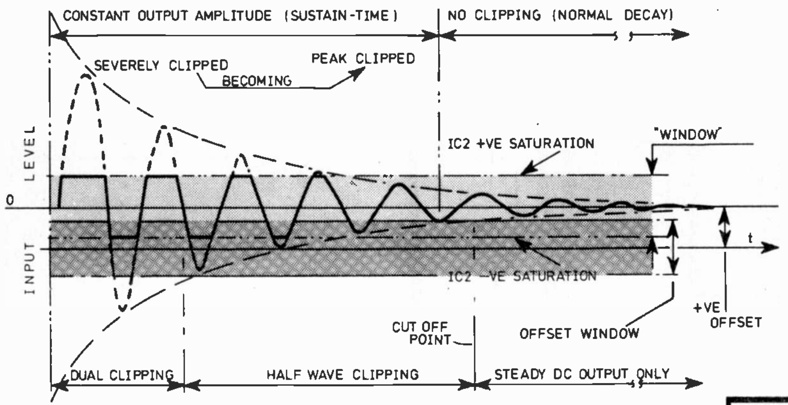


Fig. 2. The effect on the clipping characteristics of IC2 when a d.c. offset is introduced. Note how the "window" in which the op. amp operates linearly is shifted from being symmetrical about zero, and how the resultant offset causes low level signals to be "gated out".

required. When clipping in IC3 is slight, the effect of the filter is treble boost, then treble cut with a band-pass or accent type response, decreasing in frequency as VR3 is increased. When clipping occurs in IC3, it has only a treble boost/cut function, returning gradually to a band-pass response as the note decays and clipping becomes less.

If the filter is not required at all, the non-inverting input of IC3 must be earthed via a 10kΩ resistor.

NOISE GATING

A d.c. offset can be applied by VR2, which is amplified by IC2. At low gains, when all of the input waveform is within the window, this can be used to push the waveform up against the positive clipping level, producing one sided or half-wave clipping, which gives a buzz tone.

At high gains, when hum or noise may be audible, and guitar strings may become oversensitive, a small d.c. offset can be used to "gate out" low level signals, by setting a level below which an input signal will not be amplified. In this case inverted clipping occurs, and notes decay to a cut off point, not to a normal note (see Fig. 2).

Hence sustain can also be controlled by varying the d.c. offset, causing notes to cut off at various stages of decay. For longest sustain VR2 is generally at zero.

MODULATION

There are two ways in which modulation of the effects by control voltages can be achieved. The first is achieved by using a tremolo unit before the overdriver unit as shown in Fig. 3.

The second method is by applying the control voltage via C14. This allows positive or negative going control voltages to be used to give a small voltage swing about zero at the non-inverting input which in effect, sweeps the "window" up and down relative to the input waveform, giving a Stylophone-like tone.

Suitable control voltage sources are the slow-sine oscillator described for the "P.E. Sound Bender" or slow running oscillators of any type.

CONSTRUCTION

The Guitar Overdrive Unit was built on 0·1in stripboard; the component layout and cutting details are given in Fig. 4. An aluminium box of dimensions in the region of 200 × 150 × 80mm was used to house the unit. The front panel layout is not

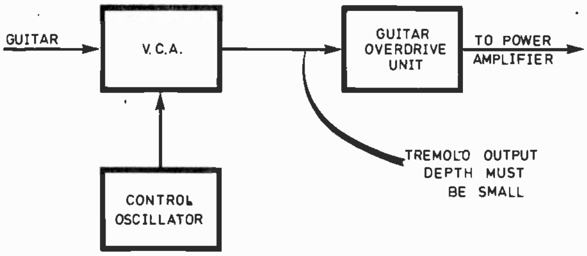


Fig. 3. The suggested method of using a tremolo (v.c.a./l.f. oscillator) with the Overdrive unit. A typical control oscillator that would be suitable for this application is that used in the "P.E. Sound Bender" (May 1974)—not available

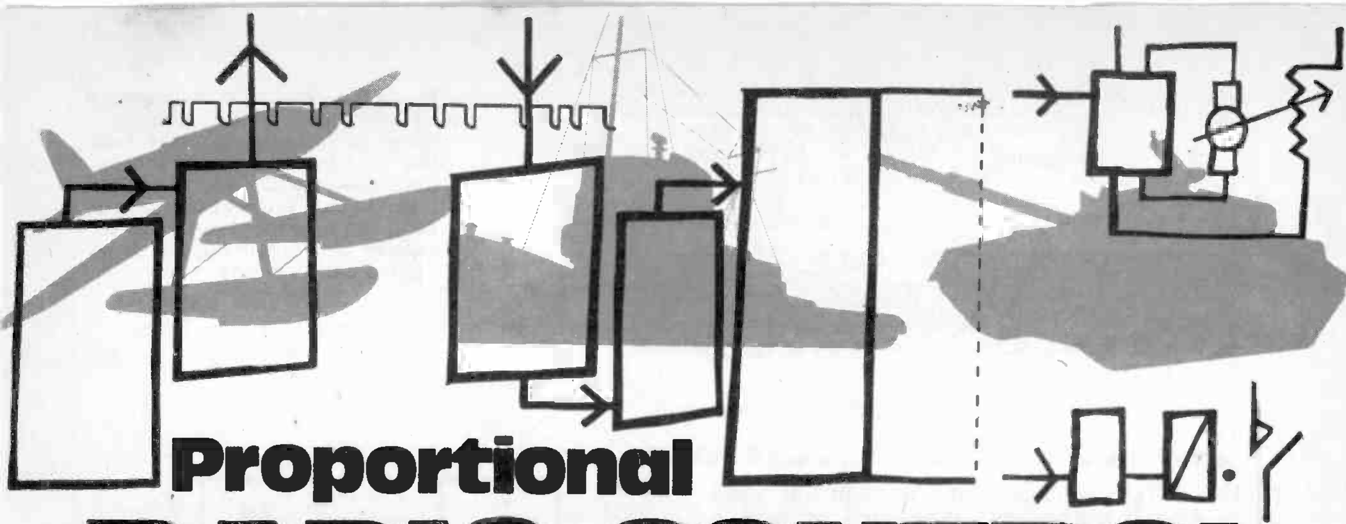
critical, that shown in the photograph may be followed, but constructors may feel they would like to alter this somewhat or have one or two of the controls situated remotely on a foot pedal.

The component board is mounted under the front panel, and held clear of the pots and switches with suitable length spacers.

USE

To set up for use, the guitar volume controls should be set at or near to maximum. With S1 in the normal position (position 2) the amplifier volume control is adjusted to the desired level. The balance control is then used to obtain a comparable volume on switching to "effect" (position 3). When S1 is in position 4, "straight through" signal can be mixed with any amount of "effect" signal. After use S1 is returned to position 1 where the batteries are disconnected.

The unit gives by far the best range of sounds when single notes are played. For chord work, the intensity should be kept low. ★



Proportional RADIO CONTROL SYSTEM

By J. D. WHITELEY

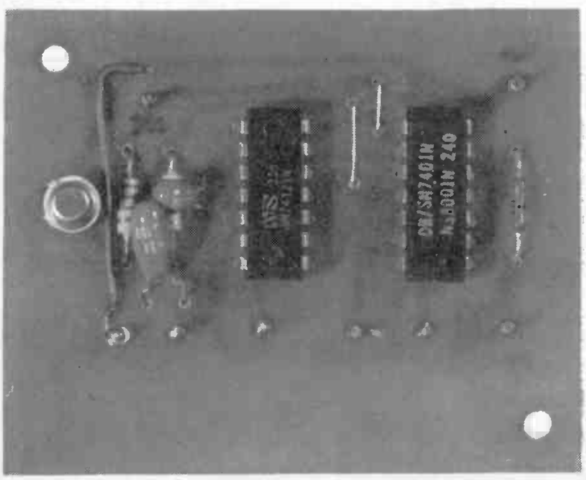
Part 3 Servo Amplifier, Servo Drive and Relay Drive

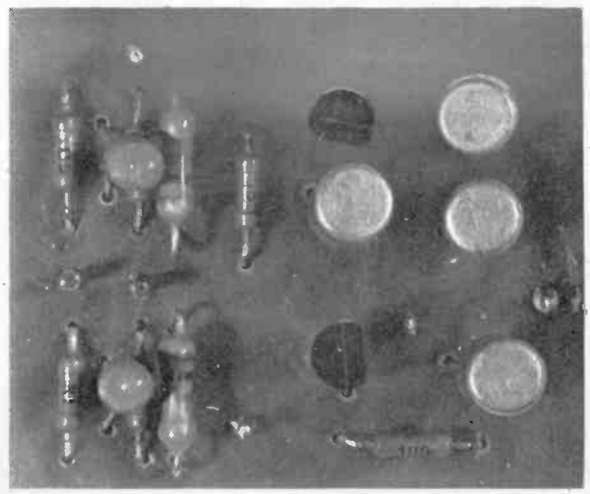
UNLIKE most servo systems which use a centre tapped battery to obtain bi-directional motor drive, this system makes use of a "bridge" connected servo-amplifier which drives the motor directly from the TTL supply rails. Such a servo system is very cheap to construct when one compares it with the price of manufactured equivalents.

OPERATION OF THE SERVO DRIVE AND AMPLIFIER CIRCUITRY

The incoming negative-going pulse from the decoder is inverted at TR6 (Fig. 15) so that the negative leading edge of the pulse can trigger the "B" Schmitt input to the monostable IC5.

The expanded pulse set by C21 and the position of the feedback potentiometer VR1 (coupled to the servo motor) appears at the $\overline{Q}$ and Q outputs. The Q output pulse is compared in width with the incoming pulse at the open collector NAND gate IC6a, and in a similar way the $\overline{Q}$ output is compared with the inverted incoming pulse from the collector of TR6 at the NAND gate IC6b. The unused inputs to IC6 are taken to the +5V rail by R22. The open collector load resistances for IC6a and IC6b are on the servo amplifier board R23 and R30 forming the outside arms of the bridge.





With an unbalance set up in the bridge by an alteration in the pulse width to the servo, an output is produced at either IC6a or IC6b thus driving the motor to a new position set by the servo feedback potentiometer VR1. The RC networks R24, C22 and R29, C24, enable the motor to sustain drive during the 20ms period until the next pulse arrives from the decoder.

SWITCH

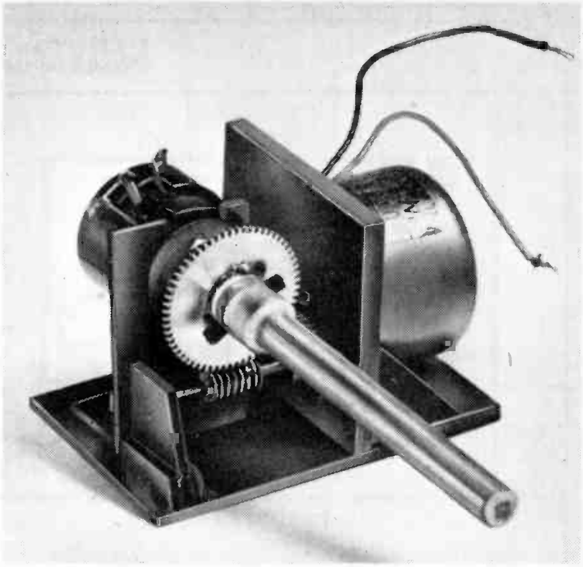
The servo amplifier (Fig. 15) is arranged as a two pole switch allowing the motor to be connected either way round to the supply rails by TR7, TR9 or TR10, TR12 being turned on by TR8, TR11. Motor suppression is achieved by C23 which under certain conditions may require to be modified in value.

MOTOR CONSIDERATIONS

With the transistors shown most small servo motors can be driven as the unit can deliver up to about 300mA. The author has found that the surplus cassette tape motors which work from 4-7V make an ideal servo. These are mostly 5 pole motors and therefore a good starting performance is obtained. An example of such a motor is illustrated mounted in the servo assembly.

CONSTRUCTION

The two printed circuit boards are made as shown in Fig. 16 and the notes on construction followed as indicated earlier in the series. It is intended that the constructor will be mounting the servo amplifier board on the servo unit he constructs.



Servo gearing to VR1 and cassette motor mounting used by the author

SERVO UNIT

The servo motor must be mechanically connected to the feedback potentiometer VR1. In the author's case this was accomplished with a gearing arrangement with the actual output of the servo unit being an extension of the pot. spindle.

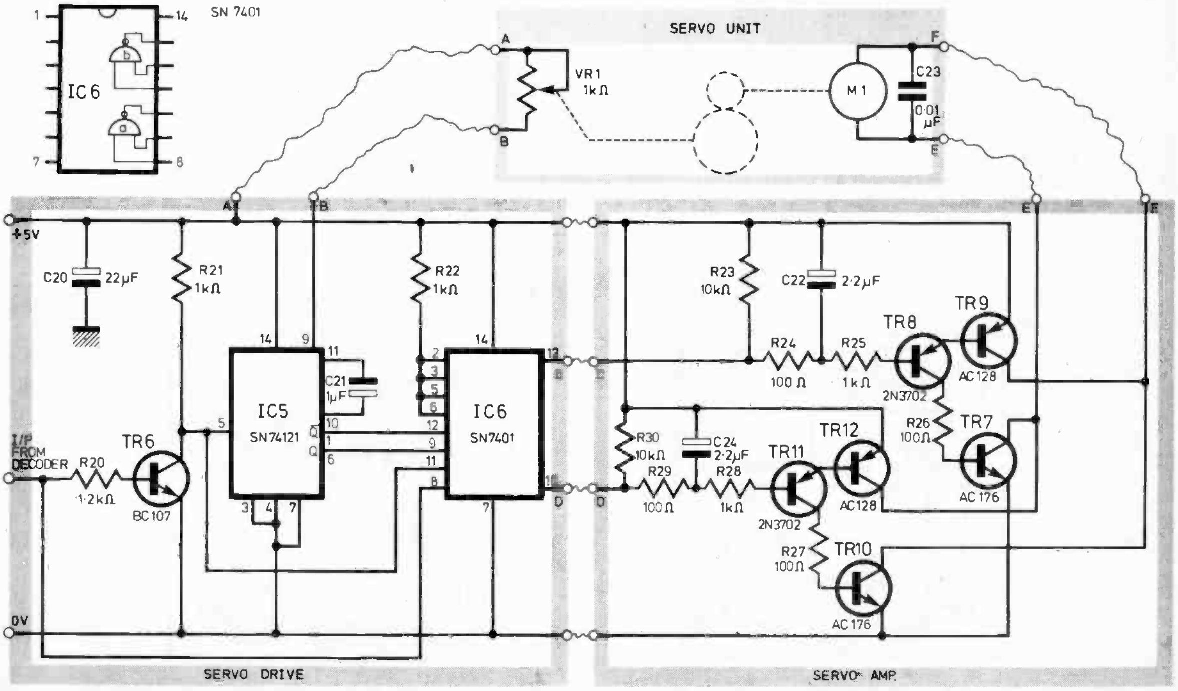
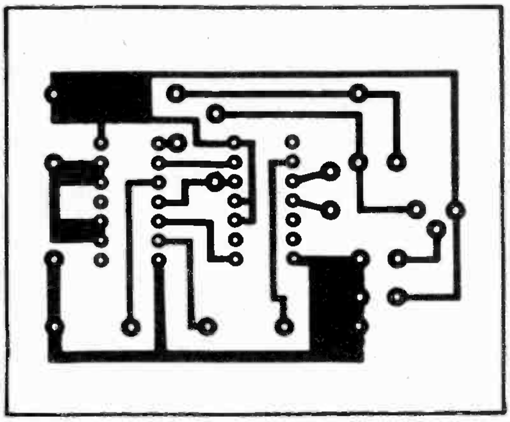
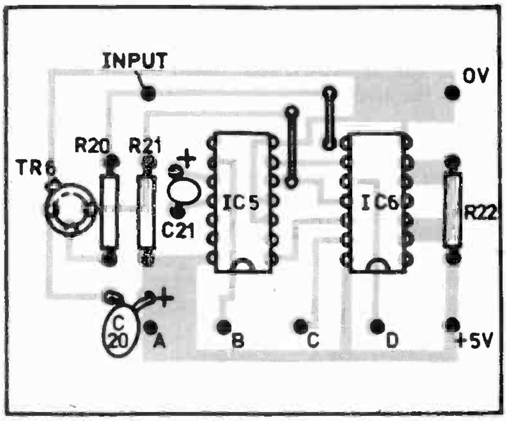


Fig. 15 Servo amplifier and servo drive circuitry, showing connections to the servo unit

SERVO DRIVE BOARD





COMPONENTS . . .

SERVO DRIVE BOARD

Resistors
R20 1·2kΩ
R21 1kΩ
R22 1kΩ
All resistors $\frac{1}{8}$W 5% carbon

Potentiometers
VR1 1kΩ wirewound, to suit drive from motor gearing

Capacitors
C20 22μF 10V tantalum
C21 1μF 10V tantalum

Semiconductors
TR6 BC107
IC5 SN74121
IC6 SN7401

Miscellaneous
Printed circuit board 66 × 54mm
P.C.B. pins

SERVO AMPLIFIER BOARD

Resistors

R23	10kΩ	R27	100Ω
R24	100Ω	R28	1kΩ
R25	1kΩ	R29	100Ω
R26	100Ω	R30	10kΩ

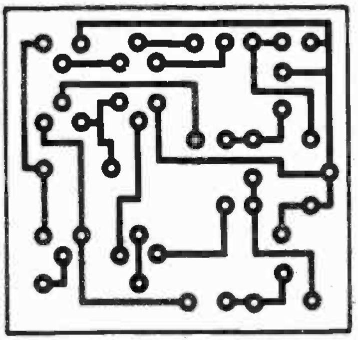
All resistors $\frac{1}{8}$W 5% carbon

Capacitors
C22 2·2μF 10V tantalum
C23 0·01μF disc ceramic (not on board)
C24 2·2μF 10V tantalum

Semiconductors
TR8, 11 2N3702
TR9, 12 AC128
TR7, 10 AC176

Miscellaneous
Printed circuit board 46 × 44mm
P.C.B. pins

SERVO AMPLIFIER BOARD



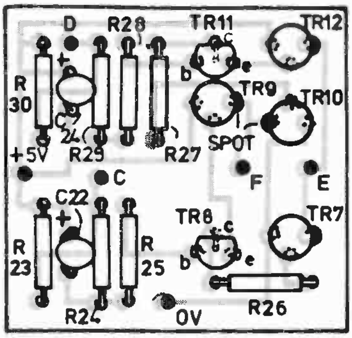


Fig. 16 P.C.B. details of the servo amplifier and servo drive boards

RELAY DRIVE

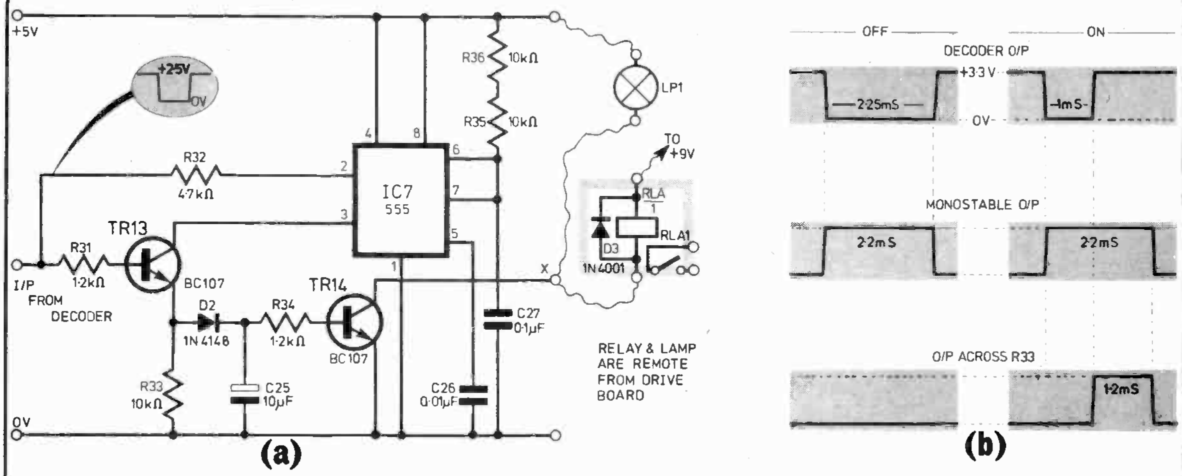


Fig. 17 (a) Circuitry for the relay drive section (b) Waveforms showing operation of the relay driver. The relay is only activated when the monostable output and the incoming pulse are high simultaneously

COMPONENTS . . .

RELAY DRIVE BOARD

Resistors
R31 1·2kΩ R34 1·2kΩ
R32 4·7kΩ R35 10kΩ
R33 10kΩ R36 10kΩ
All resistors ⅛W 5% carbon

Capacitors
C25 10μF 10V tantalum
C26 0·01μF C280 type
C27 0·1μF C280 type

Semiconductors
TR13, 14 BC107
IC7 NE555
D2 1N4148
D3 1N4001

Miscellaneous
Printed circuit board 57 × 46mm
P.C.B. pins
Relay (RLA) see text

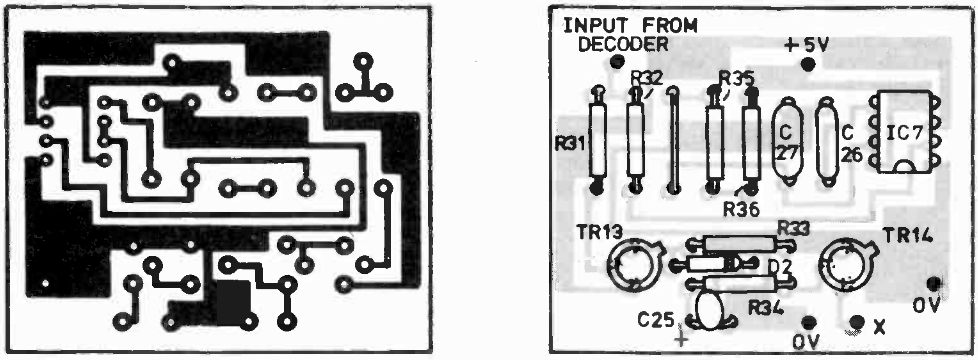


Fig. 18 Component layout and p.c.b. master for the relay drive board

RADIO CONTROL SYSTEM INTERWIRING

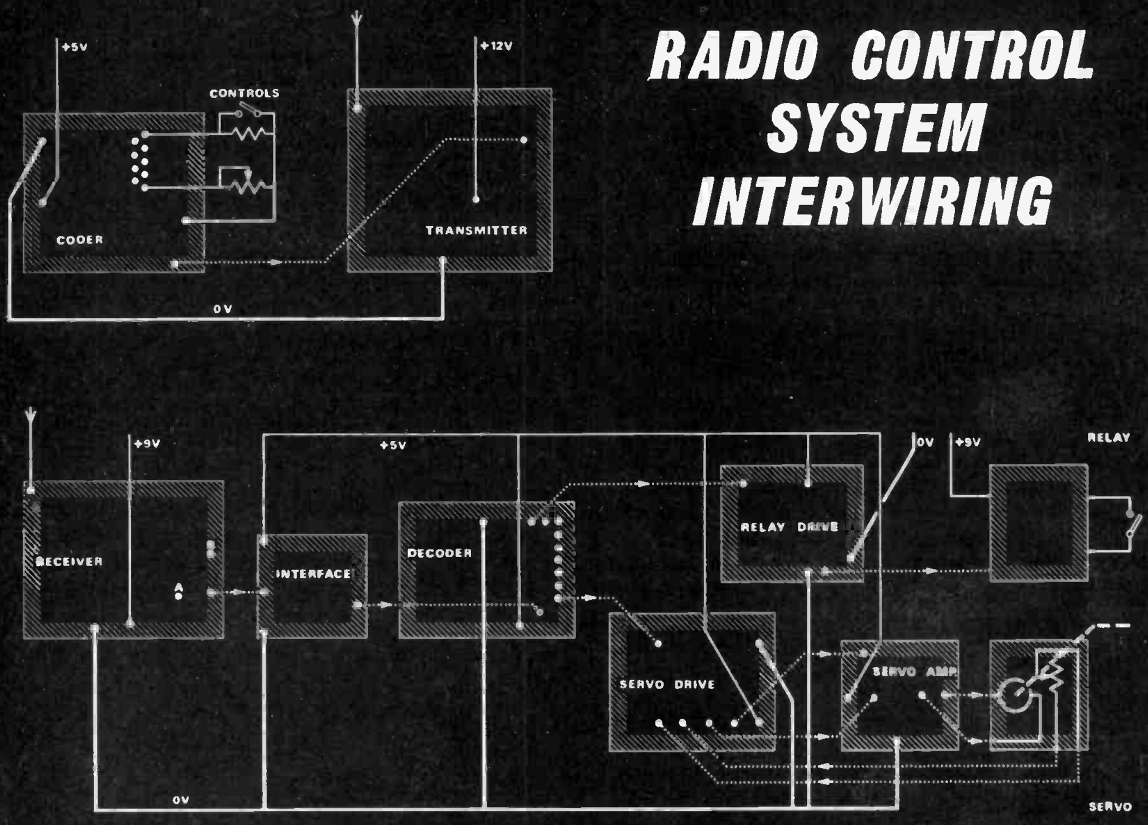


Fig. 19 Interconnection diagram for all the cards involved in the radio control system. The connection points marked on the diagram correspond in position to the p.c.b. pins on the boards themselves

The extension consists of a rod of brass bored out at one end to fit onto the shaft of the pot. Affixed to it is a gear wheel which meshes with a worm drive which is in turn driven from the servo motor via further reduction gearing.

It is obvious that the application of the control system will ultimately determine the design of the servo drive unit, whether it be used to control ailerons, rudders or a steering system as in model cars or tanks.

LICENCE

We would like to warn constructors that a licence is required to operate any Radio Control system. This licence may be obtained from: The Home Office, Radio Regulatory Department, Waterloo Bridge House, Waterloo Road, London SE1 8UA. (A licence for 5 years costs £2.40)

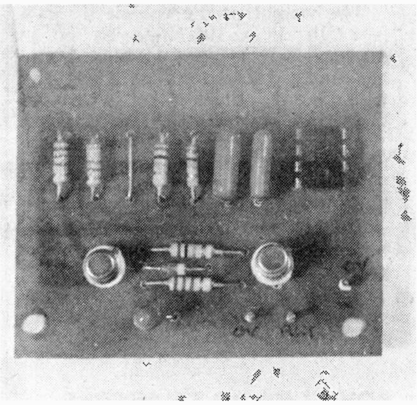
RELAY DRIVE CIRCUITRY

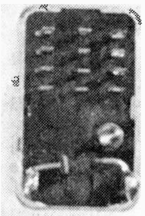
The relay drive board enables on/off functions to be detected when connected to a decoder output. It is effectively a pulse width comparator which uses the popular 555 timer integrated circuit.

Only one circuit is shown as the constructor may wish to group several circuits on the one board using the layout shown in Fig. 17. The relay is shown connected to a +9V rail; this may be a rail run from a small PP3 battery for relays of 120 ohms, but the +5V rail could be used if a relay in a TTL package is used providing the circuit to be controlled is within the rating of the relay contacts (about 200mA). A small tungsten lamp can also be driven directly from the +5V rail provided the current rating of TR14 (100mA) is not exceeded.

CIRCUIT DESCRIPTION

The 555 is connected as a monostable with the pulse length set by R36, R35, C27 using the formulae $t = 1{\cdot}1RC$ a time of 2·2ms pulse length is obtained. The monostable is triggered at pin 2 by the negative going pulse from the decoder channel output via





R32 and it is also fed to the base of TR13 via R31. The collector of TR13 is taken to the 555 output at pin 3 whereas the emitter is taken to ground as an emitter follower configuration. It will be seen from Fig. 17(b) that when the input pulse is equal to the inverted expanded monostable pulse then there will be no output across R33 since the base of TR13 is at ground when the collector is at approx +3·3V.

However, when the command pulse is reduced by the operation of the switch on the coder channel then an output across R33 will be detected. Diode D2 and C25 form a storage network so as to allow chatter-free operation of the relay, since an output will only occur across R33 every 20ms or so. Diode protection is included across RLA with D3 to prevent the back e.m.f. from the relay coil damaging TR14.

CONSTRUCTION

The relay drive components are mounted on the printed circuit board and the board etched as shown in Fig. 18. The size of the p.c.b. is 57 × 47mm. As with the other boards, printed circuit pins are used for lead connections. It is again important to observe the correct location of IC7.

Clean the board of flux when all the soldering is complete using the method described earlier.

BOARD INTERWIRING

Details of the interconnection of the various boards of the control system are given in Fig. 19. This needs little comment. Suffice it to say that excessive lead lengths should be avoided and that good decoupling of the supplies to each of the cards will help achieve proper operation of the system. Perhaps most important from this point of view is the decoupling of the supplies to the servo amplifier since this section supplies the drive to the motor and therefore handles the most current.

NOTE

Under the heading "Setting Up the Transmitter" (June issue) reference is made to adjustment of C8, this should read C9. However, if adjustment is found to be outside the range of C9 the value of capacitor C8 should be altered accordingly (increased or decreased).

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JUPITER'S TAIL

On its way out of the solar system *Pioneer 10* encountered the influence of the magnetic tail of Jupiter. The magnetosphere of the planet forced out of shape by the pressure of the solar wind streams outwards from Jupiter as far as the orbit of Saturn.

After the encounter with Jupiter *Pioneer 10* passed on at a speed of 3 astronomical units a year. During a 24 hour period nearly two and a half years later the solar wind recorder indicated zero. Since it is not possible for the solar wind to suddenly cease and the instrument was not faulty only one explanation was possible. The spacecraft was within the envelope of the tail. At the time the position of *Pioneer 10* was beyond the orbit of Saturn.

It had been thought that owing to the rapid rotation of Jupiter on its axis, less than ten hours, the tail would be short. The Jupiter tail is very much greater in extent than that of the Earth. It stretches for more than 680 million kilometres from the planet. The strength of the solar wind falls off as it gets to Saturn's orbit by more than four times. This may be the reason why the tail is greater in volume.

Saturn itself will pass through the tail in about five years' time and this should cause a period of significant magnetic phenomena. The passage of Saturn through the tail is expected to occur every 20 years. The next mission, that of *Mariner* Jupiter-Saturn flypast should bring a spacecraft to an encounter at this time.

LASER SATELLITE

Early in May a satellite was launched to help in the study of the movements of the Earth's crust. The satellite *Lageos* (Laser Geodynamic Satellite) was put into a circular polar orbit at 5,800 metre level. The surface of the satellite is covered with laser reflectors.

This satellite described in its planning stage in "Spacewatch" some time ago is like a large golf ball. It weighs 903lb but is only 24in diameter and because of its high density and its small size offering low drag, stability for long periods is assured. In consequence precise location by ground stations will be possible and the short term movements of the crust of the Earth will be apparent in a number of master earth based stations.

Over a period of several years the plots of changes will indicate the movements in direction and magnitude. By this method it will be possible to form ideas of the large scale movement of land masses and assess the behaviour of the tectonic plates. Particularly the forecasting of earthquakes will be made easier when the crustal movements are detected in earthquake areas.

The technique is to measure the time taken for the pulses of a laser beam to travel from the earth station to the satellite and return. Because of the stability of the satellite and the narrowness of the laser beam, it is expected that the degree of measurement difference of any movement will be as accurate as one inch.

NON-COMMERCIAL SATELLITE

The US Navy and the US Airforce have embarked on a joint services project for a special programme with a communications satellite called *Fltsatcom*. This is to provide the most advanced system of global communication.

The satellite will weigh some 1,854lb in orbit, have three axis stabilisation and large panels of solar cells to take care of the high power needed for its operation. It is designed to provide 30 u.h.f. voice channels and 12 teletype channels for simultaneous use.

Fleet communications are to be at super high frequency for satellite-ground links. It is expected that the Navy will use 75 per cent of the facilities and the Air Force the remainder with provision for Army participation.

Though there have been a number of technical difficulties mainly with the communications equipment and rising costs, it is now expected to be launched in November 1977.

NATO LAUNCH

The first of three satellites, *Nato 3*, designed to take over from the smaller *Nato 2* type was launched into its stationary orbit in two stages to its final position at 15·5 degrees W.

The weight of the vehicle in orbit is 825lb. It is 10ft high by 7ft in diameter. It is spin stabilised and has much greater power levels and wider bands of coverage. Two spot beams are transmitted, one to cover NATO countries in the northern hemisphere and the other western Europe. The channels frequency bands are 7GHz to 8GHz.

Two more of these satellites will be launched and the dates for these at the moment are 1977 and 1979. These satellites are in a sense comparable with *Skynet II* in stationary orbit over the Indian Ocean.

SOVIET RADIO TELESCOPE

The new Soviet radio telescope set up in the form of a square with sides 600 metres long is progressing well at the special astrophysical observatory in the Caucasus. It is one of the largest radio telescopes in the world. Two of the sides, the north and the south have become operational and the east and west sides are expected to commence observations shortly.

The radio telescope consists of 895 aluminium reflectors so arranged that they can be oriented in three axes. The whole array is controlled by a computer. The effective area is 10,000 square metres. It is intended primarily for the band of wavelengths between 8 millimetres and 30 centimetres.

SOLAR ENERGY

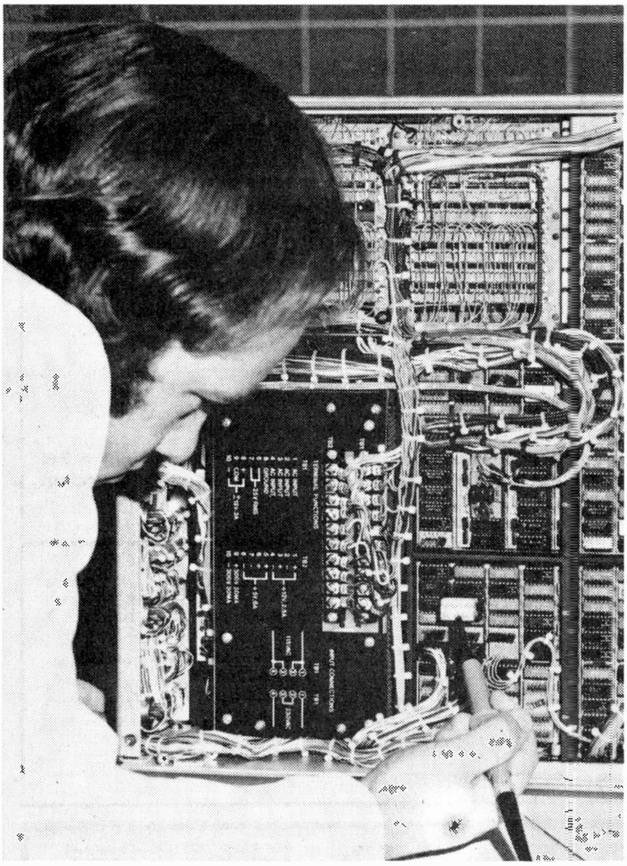
A test power tower is being built by Sandia Laboratories at Alberquerque in the United States.

It consists of a boiler mounted on the top of a 200ft tower and surrounded by over 300 mirror modules in the form of heliostats. These will follow the sun by motor control so that the boiler is irradiated during the available sunlit part of the day.

Each heliostat will consist of 25 mirrors 4ft by 4ft. These are in 78 strategic positions and focus 1MW of solar power on the boiler. A further 240 heliostats will be required to provide for the 5MW target contemplated. High pressure steam will be produced at the boiler at 1,000 degrees Fahrenheit.

This facility will not produce electricity though the 5MW unit could produce about 1·5MW if the steam were applied to this purpose. The purpose of this complex is to act as a test bed for equipment designed as part of the proposed 10MW electrical solar power station.

A site for this larger plant is not yet decided but will be later in the year. It is planned to be in an operational state in 1980. The 10MW pilot plant will provide enough electricity for a town of 10,000 people.



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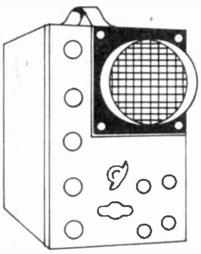

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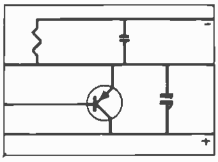

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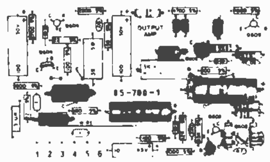

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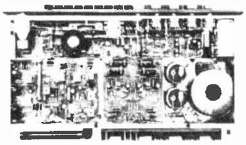

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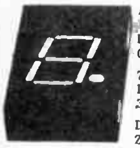

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IEA ELECTREX SHOW

A look at two major exhibitions combined under the one roof of Birmingham's National Exhibition Centre

By G. GODBOLD

The International Electrical, Electronic and Instrument Exhibition IEN/ELECTREX (3–7 May), combined for the first time, two major London exhibitions under the one vast roof of the world's most modern exhibition centre—NEC Birmingham.

To house what was the Instruments Electronics and Automation Exhibition and the International Electrical Exhibition, four of the largest halls of the National Exhibition Centre were needed.

But everything about the Centre is big. It is set in a landscaped park of 310 acres with a 16 acre lake and an enormous fountain. The seven exhibition halls cover a total of 90,000 square metres. The whole concept is really remarkable and worth a visit just to see it.

INSTRUMENTS

The oscilloscope market is an intensely competitive one with an enormous number of instruments to choose from. Advancing technology has brought the high bandwidth instrument within the purchasing orbit of many constructors.

New from Scopex, which really does represent value for money is the 4S6-LS selling at £105. Based on the successful 4S6 this single beam instrument has a 6MHz bandwidth and a timebase speed down to one second/cm.

The trend in general purpose scopes now is extreme portability, large displays for easy readability and simple to use controls. Reflection from c.r.t. faces has been a common problem for many years in affecting readability and to combat this, Scopex are treating graticules with a non-reflective acrylic coat.

With an avowed intention of concentrating on scopes from 50MHz and down Gould Advance have upgraded and restyled their successful OS250. The OS250A is a 10MHz dual trace unit with a maximum sensitivity of 2mV/cm—a general purpose workhorse; but there is a version available incorporating an active TV sync. separator capable of maintaining a stable trigger lock for the examination of television waveforms.

Other new instruments from Gould Advance are the J3A and J4A a.f. oscillators with a 10Hz–100kHz range in both sine and square modes. The J4A can provide 7W into 15 ohms.

The widespread use of l.e.d. displays and microcircuits have added an almost artistic elegance to many measuring and test instruments.. A fine example is the low profile Gould Advance DMM7A digital multimeter with a total of 28 current, voltage and resistance ranges.

Marconi Instruments, determined to have their cut of the cake in the digital counter market, have introduced three new equipments bracketing the frequency range from 10Hz to 560MHz. The TF2430, TF2431 and TF2432 are relatively low cost, for example, the TF2430 with a measurement capability of 10Hz–80MHz costs £165. A custom designed microcircuit makes this possible as it contains much of the circuitry, including the entire low frequency element.

The commonest measuring instrument is the multimeter. Unfortunately, the pocket variety are usually the most likely to succumb to damage. With the cheaper varieties servicing is a "throw-away" exercise and for the better types, repair and calibration can be costly. Alcon Instruments have come up with a solution in their multimeters from Miselco. Modular assembly of the instruments means that any one module may be replaced by the user using only a screwdriver. Factory matching of modules means that there is no need for recalibration.

Multimeters from Miselco appear in two styles—the pocket Tester range and Master range which is designed to meet more stringent applications. Both ranges include an optional signal injector. The "do-it-yourself" feature applies only to the Tester range.

Avo had their range on display. These include the Model 8 Mk 5, Model 73 and the high impedance models EM272 and EA113.

The digital Avometer DA114 maintains the tradition of rugged reliability with a choice of d.c., a.c., and resistance ranges. High input impedance and comprehensive built in calibration check facilities also feature.

Two versions are available—one for mains operation and the other with built-in rechargeable battery.

ENERGY SAVING

With the recent five-fold increase in oil, it's obvious that the era of cheap energy from this source is over. Coal, gas and electricity follow this spiral so it's obvious that any energy saving investment must be money well spent.

Something for nothing is always desirable and in the long run solar panels provide this. Redpoint claim that two of their S175 panels will save about 1,850kWh in an average year and give 40 gallons of hot water on a sunny day, all without running cost.

On the subject of conservation, did you know that there are more battery electric vehicles in Britain than in any other country?

These are ideally suited to fixed route journeys such as general urban delivery. A number of electrical road vehicles on show demonstrated their potential. These included a taxi with a range of 100 miles/charge and a top speed of 55 m.p.h., a saloon car, range 55 miles and top speed 40 m.p.h., and a number of vans and a tractor.

The hybrid petrol-electric vehicle is another exciting concept. Here the petrol engine has just sufficient power to drive the vehicle on the level. Extra power for acceleration and hill climbing is provided by the electrics. Power drawn from the battery is regenerated during the journey, this means very high m.p.g. returns.

WIRING AIDS

Today's complex equipments usually require many terminal connections. With advanced technology and dense component assemblies, there has been a re-think on methods of making fast, more reliable and inexpensive connections. An idea born in the Bell Telephone Laboratories was the technology of wire wrapping. Here a connection is made by coiling a wire, under tension, around the sharp corners of a terminal. In doing so the oxide layer on both wire and terminal is crushed and a clean contact obtained. An advantage of this method is that wires may be easily removed without damage to the terminal.

To implement a wrap, special tools are required ranging from power to manually operated. Vero displayed a complete range of these.

Included on the Vero stand was a new kind of wiring system—Verowire—which enables prototype circuits to be rapidly and reliably constructed. It could be of particular use to a designer as it enables maximum packing density to be achieved using i.c.s and/or discrete components.

The two main parts of the system consist of a wire dispenser in the form of a pen which is used to route pre-assembled wire from one point to another and plastic moulded wiring combs which are designed to retain the wire in a neat fashion.

Unlike the wire wrapping technique the Vero wire system requires a soldering iron to complete a joint.

It appears that the applications range of the microprocessor has barely been tapped. We've heard of automatic car safety devices which warn of dangerous driving conditions or mechanical fault. For the home, programmable sewing machines, dishwashers, washing machines and central heating systems are already under development.

To aid the potential user, Vero have introduced a range of boards suitable for the evaluation and production of microprocessor based systems. This consists basically of a Central Processor Board, Memory Board and Interface Board.

The design of the boards allows the user to construct his system using any of the currently available microprocessor chip sets.

CASES

Much of the attractiveness of instrumentation lies in the casing. The variety in both shapes and colours available was very much in evidence. Foxall introduced their new range of Tring small instrument cases in nine standard sizes and a choice of colours. Vero have extended their range of plastic boxes with three additional sizes which clip together for ease of assembly. These follow the pattern of those with metal front and rear panels for mounting meters, switches, sockets, etc. An additional size of sloping front box has also been added.

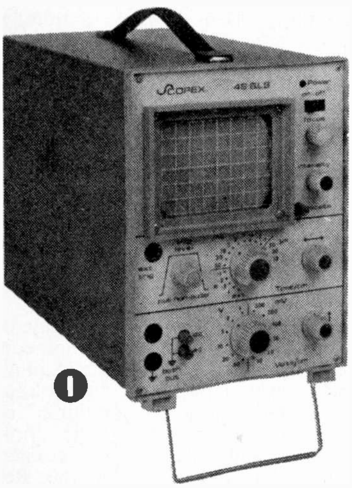
West Hyde Developments who boast a holding of more than 250 different case models, showed their new Contil Elan anodised case. This is black with blue p.v.c. top and bottom panels, incorporating built-in board supports and a special rear section that includes heat sinking for transistors.

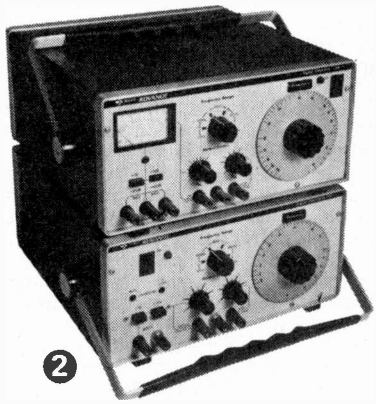
NEW CONNECTORS

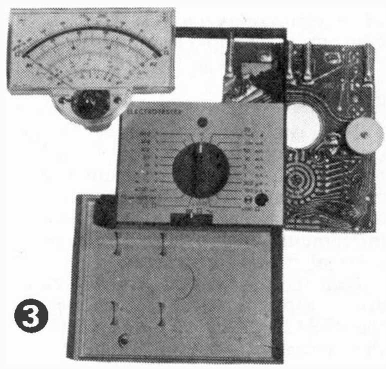
The manufacturers of the highly successful EZ hooks have added two new connectors to their present range of instrument test probes. Currently available are two basic sizes of EZ-hook, one designed for standard use (adequate for attaching to most p.c.b. mounted components) and one miniature version which allows direct clipping to i.c.s.

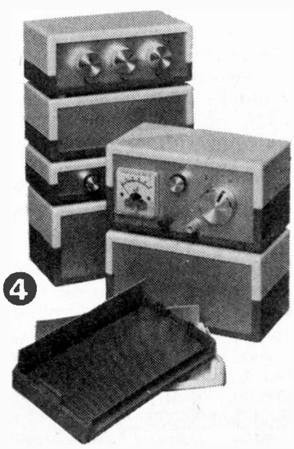
These particular probes are so small that it becomes an easy task to have one on each leg of an i.c. without overcrowding. The standard and miniature versions are fine for small components, but they cannot be attached to larger components due to their physical size. The new range therefore is a magnified version of the standard type and has been designed with heavy-duty work in mind. Spring-loaded and heavily insulated to a single contact point to ensure true readings, the hooks are of heat and chemical resistant nylon and come in ten different colours.

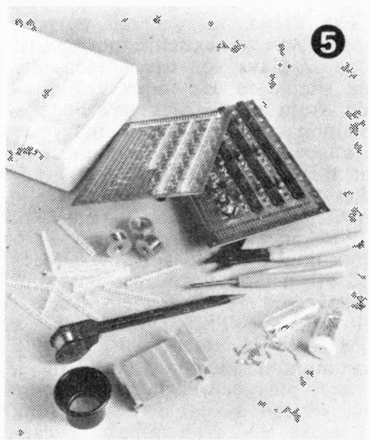
Also from EZ Hook comes a new concept in probe thinking, the "Pistol-Grip Probe". As well as having the unique EZ hypodermic action, the Pistol-Grip Probe also has an epoxy glass board for built-in circuitry which is incorporated in the handle. This will enable one to easily construct a ×10, or an r.f. probe to suit one's own requirements. The hooks are designed to attach to component leads up to 1mm in diameter.











1. **The new Scopex model 4S6–LS oscilloscope**
2. **From Gould Advance, the J3A and J4A high performance, low cost test oscillators**
3. **The Miselco Tester range from Alcon Instruments**
4. **Examples of Verobox plastic range**
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*BC212L	10p	*2N3703	8p
*BC213	10p	*2N3704	9p
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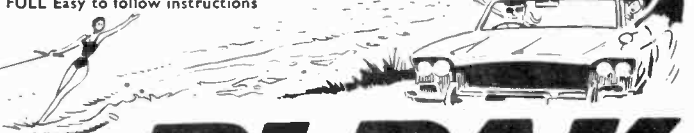

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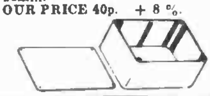

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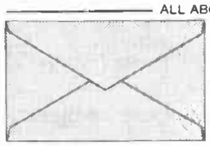

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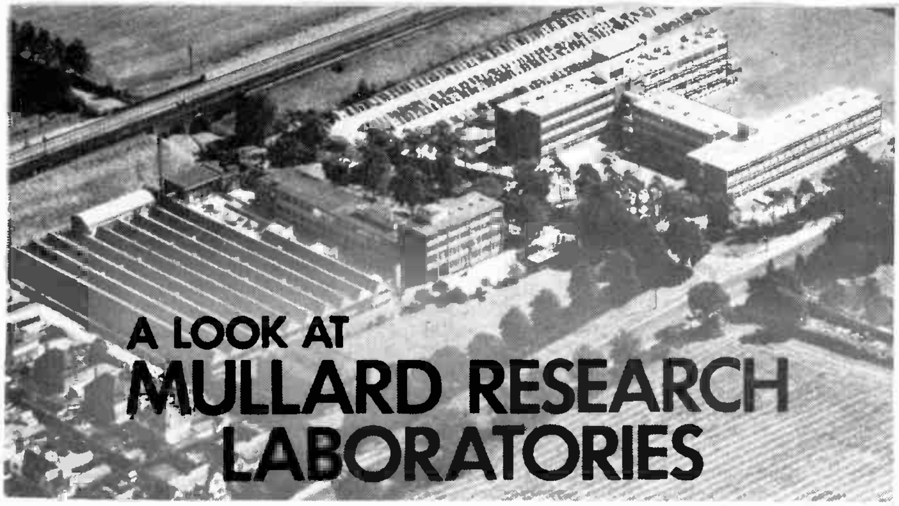


A LOOK AT MULLARD RESEARCH LABORATORIES

INDUSTRIAL research is performed on a day-to-day basis, and is generally afforded scant attention except when a significant and perhaps exciting development is revealed to the public gaze. The continual investigation into new electronic techniques is an essential activity pursued by large electronic organisations in self-interest, though the whole industry and the ultimate users of its products are joint beneficiaries of the successful developments that emerge from such backroom work.

A notable example of such vital backroom activity is provided by The Mullard Research Laboratories, Redhill, Surrey, part of the multinational Philips concern. These laboratories (MRL) contribute to the total research effort of Philips, and in particular undertake work on behalf of the companies within the U.K. group. These include the MEL Equipment Co., Mullard Ltd., Philips Electrical Ltd., and the Pye of Cambridge Group.

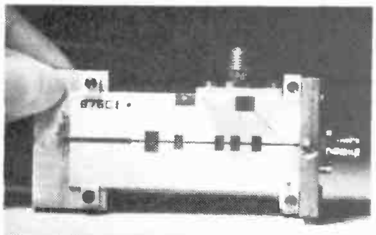
Some of the work currently in progress at MRL was demonstrated during a recent "open day" at Redhill. As the Director of MRL, Professor K. Hoselitz pointed out, work had to be selected for viewing on the basis of its demonstrability, and this did not necessarily imply that the work shown was the most significant in the total programme at present being undertaken at MRL.

PULSED TRAPATT OSCILLATORS

In microwave equipments, solid state devices have partially superseded vacuum tubes, magnetrons etc., but for certain applications they cannot provide the required peak power. Avalanching silicon devices operated in the TRAPATT mode offer considerable peak power potential and are likely to replace triodes and travelling wave tubes in low and medium power pulsed radars.

TRAPATT is derived from Trapped Plasma Avalanche Triggered Transistor. MRL is one of the leaders in the international state of the art "league table" relating to power output for avalanche diodes. This laboratory has recently achieved peak power levels of up to 120W at 2·3GHz (S-band) from a single device in a coaxial oscillator with an efficiency of greater than 45 per cent. Both planar and mesa device structures have been used.

Probable uses for this kind of oscillator include airborne radar, aircraft altimetry, M.L.S., pulsed doppler radar and aircraft/marine radar. See photo below.



MAGNETO-OPTIC BUBBLE DISPLAY

A new portable display concept for mobile radio systems is being developed at MRL. It uses a thin film of a special magnetic material which supports magnetic bubbles and has a very large Faraday effect in the visible region of the spectrum. Magnetic bubbles can be easily moved over the surface of the film, and can be made visible by means of the Faraday effect. They can therefore be made to act like mobile light spots. In the display, a sequence of magnetic bubbles is propagated serially along a folded shift register fabricated on the display chip, and is used to form a dot matrix picture. Since the display is magnetic, it has a non-volatile memory and requires low drive voltages.

At the moment, chips have been made with 10 × 10 bubble positions. Various alpha - numeric characters were written into these registers using 10μm diameter bubbles. These characters could be clearly seen using a simple × 10 eyepiece. Bubble chips with capacities of 10^4, for magnetic memory applications, have been fabricated in many laboratories. MRL intend to make 100 × 100 folded shift registers for the display application. For a 10,000 bubble position display operated at a rate of 10kHz, it would take 1 second to build up the picture. If alpha-numeric characters of the 7 × 5 format were used then over 100 characters could be written into the display.

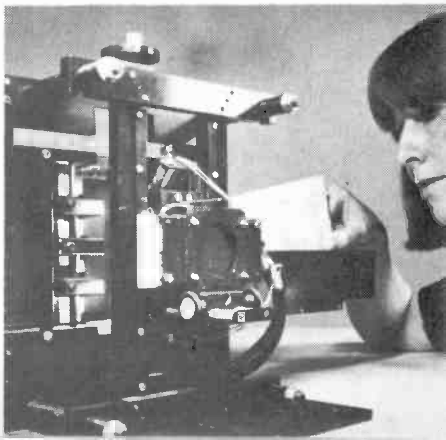
TELEPHONE/TV INFORMATION SYSTEM

The new field of electronic home information services is being investigated at MRL. A home terminal for requesting, storing and displaying data was demonstrated. The information may be derived either from a computer organised data bank or from a local data source, and connection is made via the public telephone network. An alphanumeric keyboard is used to request pages of information for display as text on a standard TV receiver. In addition to information retrieved, certain interactive facilities, such as games, classified advertisements and a diary facility have been included. The use of an unmodified domestic cassette recorder for local storage was described.

OPTICAL CHARACTER RECOGNITION

A prototype optical character recognition (OCR) reader intended for eventual high volume production at very low unit cost has been designed and built. The reader uses a simple hand-fed paper transport and recognises machine printed numerals at 50 per second. Extensive use is made of standard LSI circuits, including a microprocessor.

This OCR is aimed at the new and growing market, wherever documents are presented; for example, airline ticket offices, banks, electricity board offices—where there is a steady trickle of documents, each containing perhaps only a single line of numerals which need to be entered into the data system.



A selection of readers suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. Any idea published will be awarded payment according to its merits. Why not submit YOUR IDEA?

Please Note
Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

PULSE GENERATOR FOR BATTERY OPERATED CLOCKS

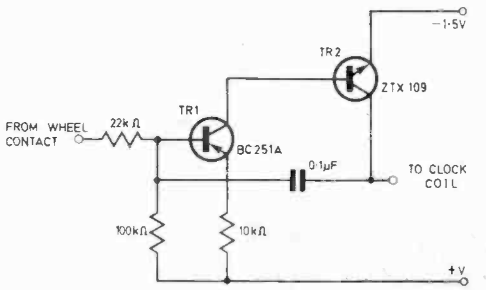


Fig. 1

This simple circuit has proved very satisfactory in a 1·5V battery clock (alarm). The clock has two balance wheels on a common spindle and each has a small magnet attached. Between these magnets there is a fixed coil connected to the battery via contacts. The clock was never satisfactory and while cleaning and adjusting contacts and fitting a new battery helped, the improvement was only temporary. The monostable device takes no current until the clock contacts make, then TR1 switches on TR2 which passes a constant current pulse to the coil (see Fig. 1).

The six components are mounted on a piece of Veroboard which should be fastened to the clock. The existing connection from the balance wheel to the coil should be broken. It may then be necessary to move the diode already fitted so that it is again connected across the coil. If the contacts require adjustment move the fixed spring contact until it just touches the wheel contact when the wheel is at rest. Check that no steel washers etc. have attached themselves to the magnet.

Using this circuit the clock has kept perfect time for over six months without once stopping and is still going. Whether this is the complete answer only time will tell.

J. Hassitt,
Bootle,
Lancs.

F.E.T. VOLTMETER

Circuits for high-impedance voltmeters have been widely featured, invariably using an integrated circuit or a f.e.t. However the i.c. versions usually require a balanced supply of a rather "high" voltage (usually ±9V) and a rather substantial current of about 5–7mA. The f.e.t. version uses a high source resistor but the linearity is critical.

The circuit given here (Fig. 1) is simple and linearity obtained is very good. A high degree of negative feed-back is used and voltage gain is one. A potential divider may be used in place of R1 to provide the ranges of voltage required. As the linearity is very good, the voltmeter used should be a quality one with good linearity as well.

This circuit can be easily modified into a linear ohmmeter as shown in Fig. 2. Here another f.e.t. is used as a constant-current source with S1 to provide different constant currents. The source resistance for a particular constant current depends on the characteristic of the f.e.t. and can be easily obtained by adjusting R whilst measuring the current between S1 and the negative line. The resistance range can go up to 10MΩ without difficulty and voltmeter reading is R_x multiplied by the constant current (Ohm's Law).

Pek Yaw Kee,
Sarawak, E. Malaysia.

Fig. 1

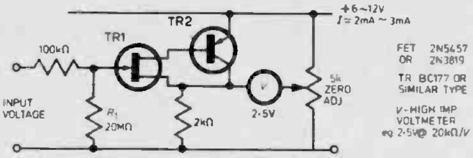
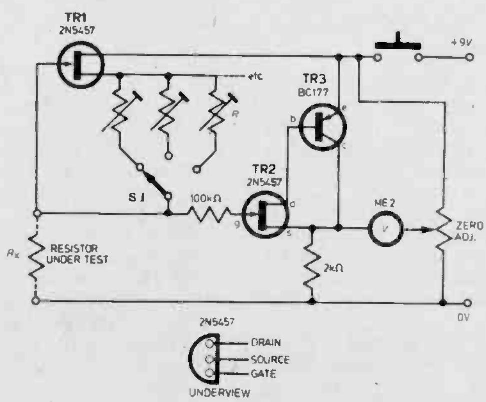


Fig. 2



RISE TIME SPEED-UP

I THOUGHT your readers may be interested in a circuit I recently devised to improve the rise time of the astable multivibrator. The problem is simply that in the conventional circuit the leading edge of the output pulse is generated by an RC network. (Fig. 1).

It is not practical to use low values of load resistor, since, although this would improve the rise time, it would also lead to high collector currents. However, if a complementary transistor, with its base driven from the opposite stage is included, this problem can be overcome (Fig. 2). Operation should be self explanatory.

Care should be taken with large values of C to ensure that the high charging current does not damage the base emitter junctions of TR1 and TR2. The pulse repetition frequency remains unchanged at

$$\text{p.r.f.} = \frac{1}{2CR \operatorname{Log}_e 2}$$

If both outputs are not required TR4 may be removed and a resistor put in its place.

M. J. Nicholas,
Ashburton.

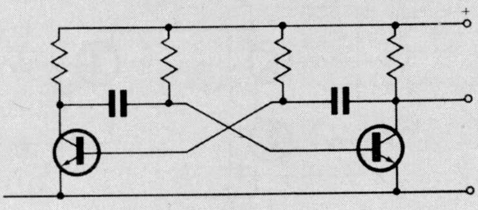


Fig. 1

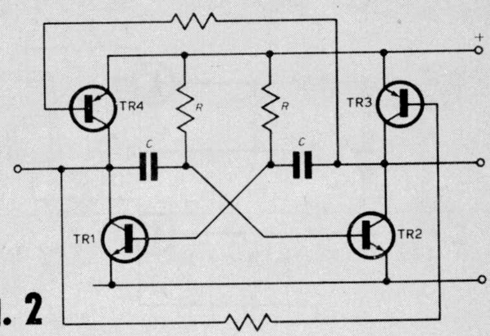


Fig. 2

MULTI-WAY TOUCH SWITCH

THE circuit shown in Fig. 1 was developed as a multi-way touch switch. Transistors TR1 and TR2 form a Darlington pair, and when a finger bridges the touch plates TR2 goes into saturation. This provides a Logic 1 pulse at G1 and at the same time l.e.d. D1 lights. G1 and G2 act as a simple memory by means of positive feedback, so that when the finger is removed point 1 remains at Logic 1. The ouput goes from Logic 1 to Logic 0. The l.e.d. is wired so that it will stay on when the finger is removed. The output remains at Logic 0.

To enable the touch-switch to be multi-way, some form of cancelling is needed when one of the other stages is turned on. This is achieved by taking the output at point 1 and applying it via an inverter to the equivalent point in the other stages. This will result in the memory circuit being reset in these stages, and their outputs will go from Logic 0 to Logic 1 (if they were not already at Logic 1); also, any lit l.e.d.s will go out.

The circuit can be extended from two to nine stages, it is cheap and easy to build, each section using one half of a 7404 TTL i.c. An attractive layout can be achieved using a p.c.b. with the l.e.d.s showing through holes in the board.

Transistors TR1 and TR2 may be replaced with a single Darlington transistor. The l.e.d.s may be dispensed with, but NOT their associated resistor. The transistors in one of the stages may be replaced by a light-sensitive Darlington, in which case the unit could be used as a burglar alarm or remote control.

The original unit was designed for direct interface with TTL, but if heavier loads are required the outputs could be used to drive a relay.

T. J. Hill,
Reading,
Berks.

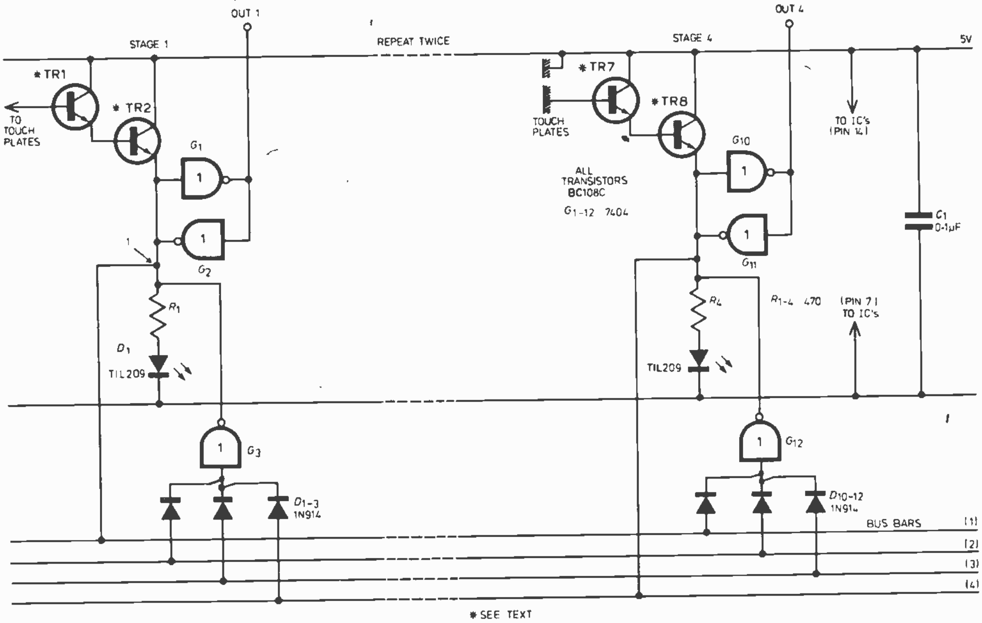


Fig. 1

BETTER DISPLAY

WITH reference to the Digital Clock presented by Mr A. J. Sutton as featured in the August, 1975 issue of Practical Electronics, the respective "A" and "D" segments of the 6 and 9 digits were unable to display. I wish to suggest two simple additional circuits which I hope will be interesting to other readers. These additional circuits (shown in dotted lines in Fig. 1 and Fig. 2) will enable the clock to display better figures.

To get the "A" segment to light simply add a diode across the "A" and "D" outputs of IC1 (pins 3 and 6 respectively) as shown in Fig. 1.

For the "D" segment, a NAND gate is connected as shown in Fig. 2.

Cheong Yip Tham,
Singapore.

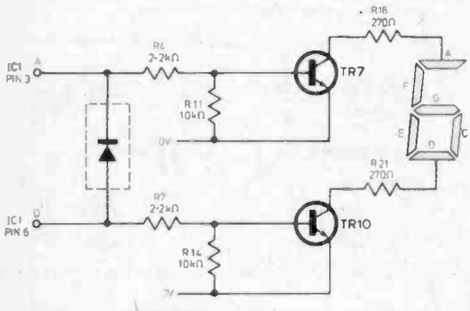


Fig. 1

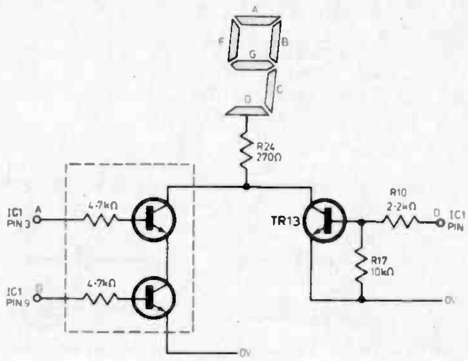


Fig. 2

TOUCH TUNER

SOME readers may be interested in my solution to a touch tuner for the LP1186 tuner. It has the advantages over Mr. Bonfield's design (see P.E. May, 1975) of much lower power consumption, and simple extension to any number of presets. The component cost is also less.

The current source R5/6, D3, TR4 supplies 15mA. The "thyristor" TR1/2 passes this through resistors R4, VR1 to produce a constant voltage, part of which is picked off by VR1 to provide the tuning voltage.

Assume pre-set VR1a is conducting, C2 is then charged to about 11V and C2b is discharged. Touching the touch terminals on TR3b switches on TR1b and TR2b so bringing the common supply to all units down to a few volts which reverse biases TR1a/2a, switching them off.

Components R1/2/3, and C1 are to eliminate pulse triggering of other units by the surges with the switching. The 680 ohm resistor R4 gives a maximum of about 9·5V for tuning. This can be increased, if necessary, by raising the value of R4 and the supply voltage.

R. E. Thomas,
Cambridge.

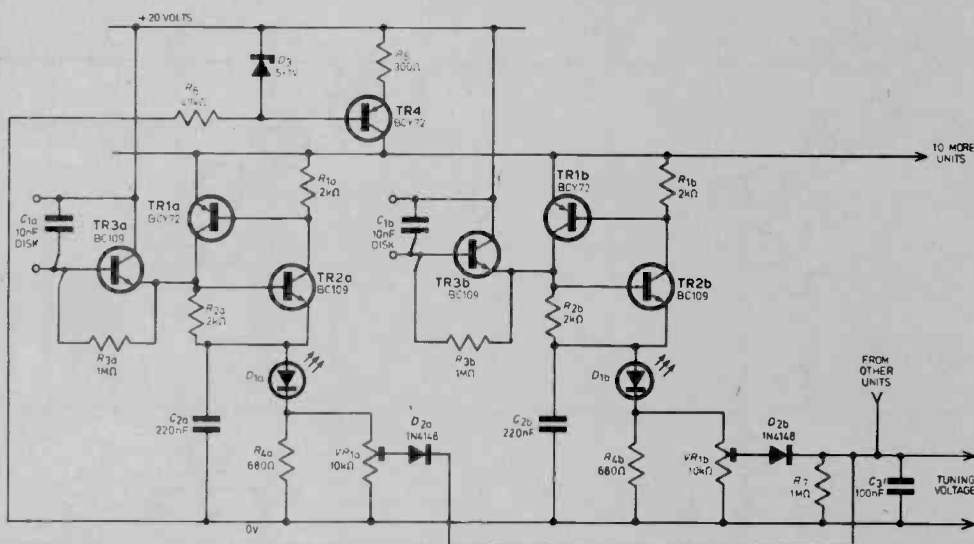


Fig. 1

3 STATE TTL LOGIC PROBE

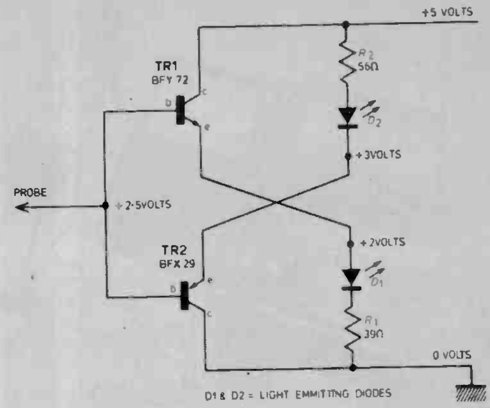


Fig. 1

THE circuit shown is for a very simple logic probe capable of indicating "HI" (+5 volts) when D1 is lit, "LO" (0 volts) when D2 is lit and also a floating probe condition when both l.e.d.s are dimly lit. Thus the circuit can distinguish between +5 volts, earth and open circuit.

The circuit may be miniaturised and enclosed in a hand-held container such as a 35mm film can. The supply leads may be connected to the +5 volts and earth supply of the circuit under test by means of crocodile clips.

Basically the logic probe consists of two complementary emitter followers with both bases connected to the probe.

Both lamps are normally lit due to base current flowing via R2, D2, TR2 base emitter junction. TR1 base emitter junction, D1 and R1.

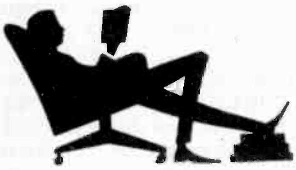
With the probe testing for a logic 1 level, TR1 is forward biased, thus D1 lights fully and D2 is extinguished due to insufficient voltage across it. With the probe at logic 0 volts the reverse occurs, i.e. TR2 is forward biased, hence D2 lights fully and D1 is extinguished.

With the resistance values shown the circuit was found to work effectively but since the brightness of different l.e.d.s supplied with the same current may vary and also the H_{FE}s of the transistors may vary, it may be found necessary to adjust the resistance values to achieve the same l.e.d. brightness in the floating probe condition. The brightness of the l.e.d.s for the "HI" and "LO" conditions may also differ slightly due to the collector load resistance of the logic circuit under test.

The Fig. 1 shows the approximate voltage levels in the floating probe condition when both lamps are dimly lit.

Any miniature l.e.d. with a plastic diffusing dome will be suitable.

V. Brett,
Luton



BOOK REVIEWS

THE ELECTRONIC MUSICAL INSTRUMENT MANUAL (6th Edition)
By Alan Douglas
Published by Pitman
205 pages, 254mm × 190mm. Price £7.50

ELECTRONIC organs have come a long way since the first edition of this manual in 1948. Then, it seemed, manufacturers were trying to reconcile a prejudiced pipe organ-aware buying public to the electronic "plug-in" by maintaining classical stop nomenclature.

We all know that today the "plug-in" is accepted in its own right. It makes beautiful and exciting sounds with its own unique voices—although most would have it that excellence in tonality is synonymous with pedigree names such as Hammond, Lowry, Baldwin, etc.

In recent years, with the proliferation of solid state devices, many of them customised for the organ, we have seen an equal spate of new instruments, mostly small, and bristling with ingenious features, which makes many of them surprisingly easy to play. Inevitably there will be many new owners and prospective buyers who will be naturally curious about what is under the lid.

This manual contributes a great deal to an understanding of organ workings, although it will never educate the technically blind. An "O" level awareness of physics and electronics is necessary to glean anything of value.

It commences with a chapter on the physics of sound, music and noise. Organ electronics follows with oscillator and divider systems. Further chapters cover tone forming, keying and vibrato circuits, amplifiers, loudspeakers and p.s.u.s.

Part circuits of many well-known commercial instruments makes up a large chapter. Many more aspects of circuitry are contained in a chapter on experimental methods.

The manual is completed with nine useful appendices.

G.G.

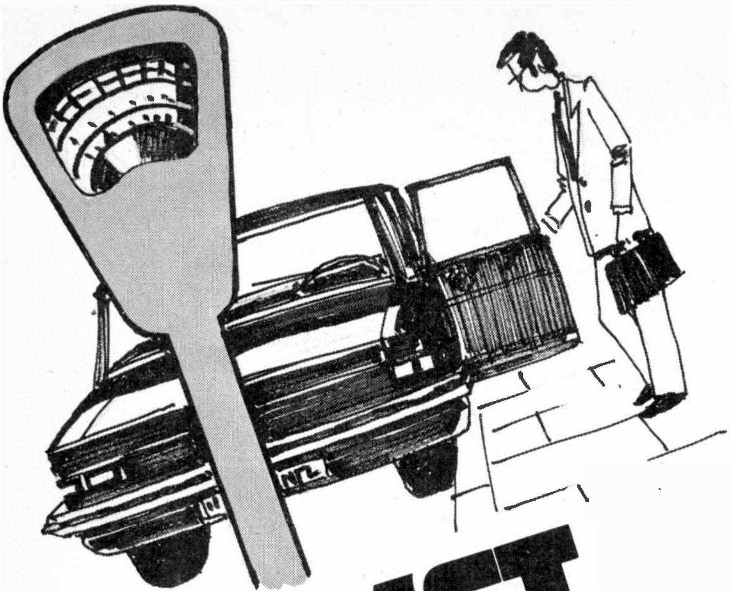
A GUIDE TO AMATEUR RADIO (16th Edition)
By Pat Hawker
Published by Newnes-Butterworth
124 pages, 254mm × 190mm. Price £3.95

THIS edition first appeared last year in limp cover form published by the Radio Society of Great Britain. The Newnes-Butterworth hardback is identical in content with the addition of another six pages consisting of three chapters on International Amateur Radio Organisations, learning the morse code and the international allocation of call-signs.

The hard cover and attractive dust jacket do nothing to disguise the crying need for a revision of the contents, the photos seem archaic and many of the circuit examples, lean towards this description and this seems sad in light of the developments in radio communications, particularly with integrated circuits.

However, apart from this, the Guide is probably the best introduction for the newcomer to Amateur Radio, providing as it does answers to questions on Licence Examinations, operating a station, receivers and transmitters and morse code basics.

G.G.



POCKET TIMER

By M. PLANT

A pocket timer with audio/visual alarms covering six set intervals from 10 seconds to 1 hour. Applications include the timing of competitive events, games, car parking periods, etc.

THIS timer provides an audio-visual alarm after the elapse of a preset period of time. Time delays of 10s (for test and initiating the timing periods), 1 minute, 4 minutes, 15 minutes, 30 minutes and 1 hour with a repeatability of better than 2 per cent can be obtained. Accuracy is largely determined by the care taken in selecting resistor values and the constructor can easily design his timer to provide other timing periods as desired, although 60 minutes appears to be the maximum reliable delay which can be achieved.

The 4 minute delay is suitable for boiling eggs, and the longer delays have been of particular value in reminding the author to return to his car parked in a limited time zone.

The timer is provided with a push-button so that the preset times can be readily recycled. Games and other competitive events are possible uses for the timer.

CIRCUIT

Fig. 1 shows the complete circuit of the pocket timer making use of monostable and astable circuits with the 555 and 556. Note that the output pin of IC1, the single 555 timer chip, is connected to the positive power rails of IC2, the dual timer, via the transistor. Thus a low voltage at pin 3 of IC1 turns on this transistor which allows current to flow into the positive voltage supply pins of IC2 to start the astable oscillators.

Suppose PL1 makes connection to one of the timing resistors (R10–R15). Initially, assume that the output voltage at pin 3 is high so that the transistor is off and no drive current is supplied to the dual astable based on IC2. When the voltage across capacitor C4 rises to 2/3 of the supply voltage, the internal flip-flop of IC1 sets the voltage at pin 3 low hence switching on TR1 and starting the astables working. The approximately 1kHz astable is formed by one internal timer chip of IC2 and components R7, R8 and C3, and the low frequency 1Hz oscillator by the other timer and components R5, R6 and C2.

These two astables are d.c.-coupled by R9 so that the changing voltage at pin 5 regularly alters the time constant of the 1kHz astable to produce a two-tone alarm in the earpiece. The visual signal is produced by the 1Hz astable switching on D1 and D2 which flash in time with the audio alarm tone change.

ALARM RESET

Note that once the alarm sounds, it can be stopped by pressing S1 which resets the internal flip-flop of IC1 to put the voltage at pin 3 high so turning off TR1 and the alarm. Capacitor C4 then immediately begins to charge on a new timing cycle. If during a timing cycle S1 is accidentally pressed, the timing period will not be affected. This is clearly fortunate since, after a timing period has been initiated, subsequent accidental pressing of the push switch is quite likely to occur as the timer is carried around.

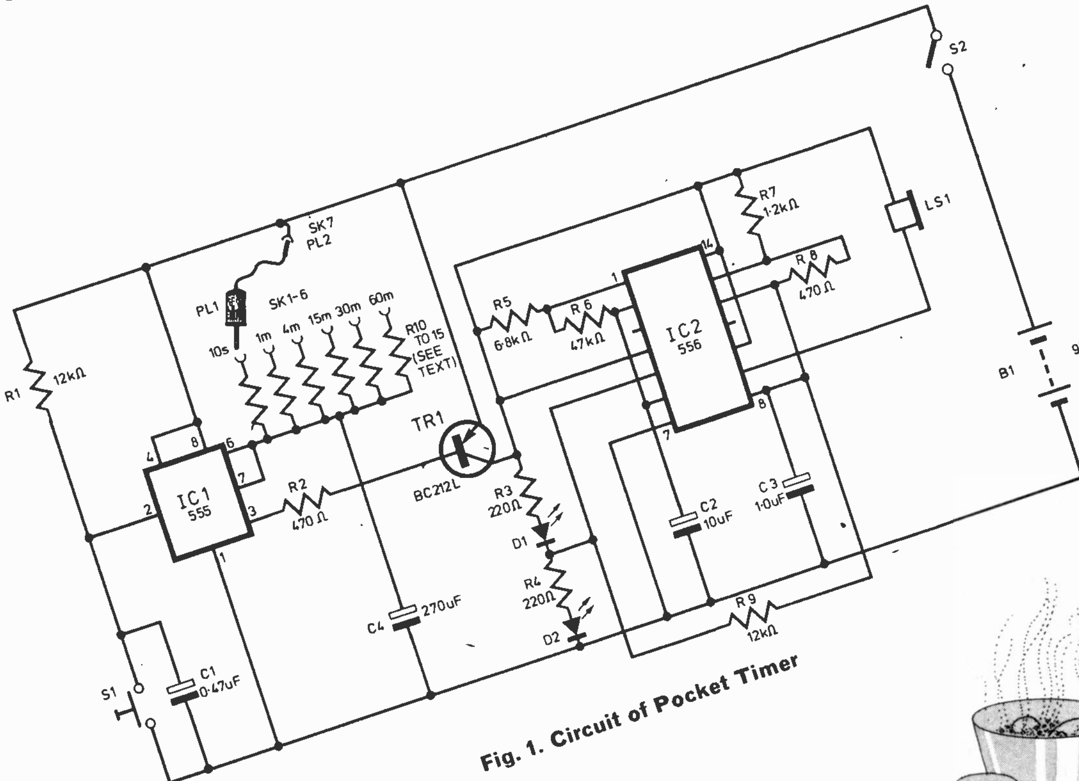
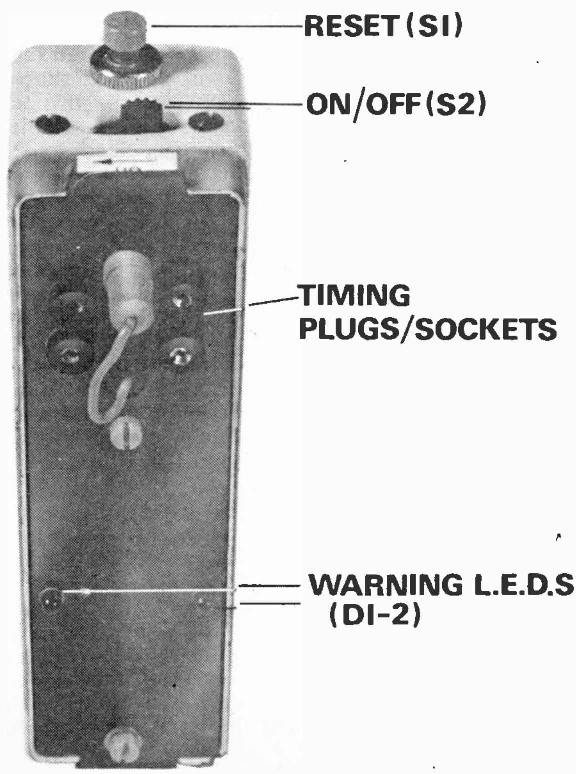


Fig. 1. Circuit of Pocket Timer



COMPONENTS . . .

Resistors

R1	12kΩ
R2	470Ω
R3, R4	220Ω
R5	6·8kΩ
R6	47kΩ
R7	1·2kΩ
R8	470Ω
R9	12kΩ
R10–R15	see text

All ¼W 5% metal film

Capacitors

C1	0·47μF tantalum 15V
C2	10μF 15V
C3	1μF 15V
C4	270μF 6V

Semiconductors

TR1	BC212L or ZTX500, BC477
IC1	555
IC2	556
D1, D2	miniature red l.e.d.s

Miscellaneous

7 miniature sockets (1mm), 2 miniature 1mm plugs, S1 press-to-make switch, S2 on/off toggle or slide switch, LS1 miniature earpiece (35Ω)

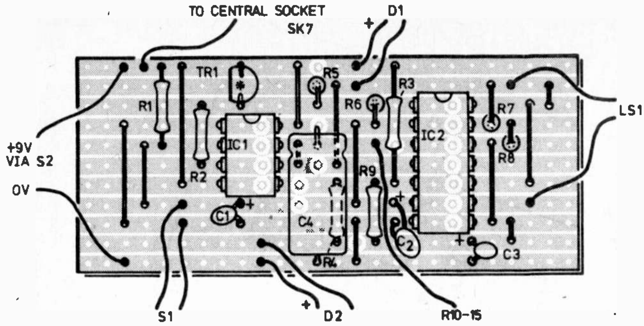


Fig. 2. Veroboard component assembly details

CURRENT DRAIN

The current drain from B1 is about 3mA during the timing period and is not excessive for this low capacity battery. However, the current drain rises to about 20mA when the alarms operate so that the user should switch off the circuit with S2, or press the timing button S1, without delay to ensure economical use of the timer. As a guide to the state of discharge of the battery, it will be found that the rate of flashing of the l.e.d.s and the pitch of the audio alarm will increase slightly with continued use of the timer. However, provided the monostable delay circuit is operated by a voltage greater than 4·5V, the delays obtained will be substantially independent of the supply voltage.

CONSTRUCTION

The timer was housed in a modified transparency box intended to hold 36, 35mm slides. A PP3 battery fits neatly into this. The lid was discarded and a purpose-made lid cut from a piece of Paxolin (any other rigid insulating material will do) and shaped so as to snap fit into recesses cut into the two top ends of the box. The components were assembled on a piece of Veroboard which was fixed to the underside of the lid, and from this lid wires were taken to the battery, earpiece, push switch, on-off switch and l.e.d.s.

The component layout on a piece of 26 × 11 hole 0·1 matrix Veroboard is shown in Fig. 2. In order for it to be the same width as the lid of the box, the Veroboard needs to be filed slightly, so that its long edges lie flush with the 1st and 11th tracks. The l.e.d.s should be soldered into place so as to come out on the copper track side of the Veroboard. Their leads should be sleeved and adjusted in length so as to lie directly opposite each other for they are to be pushed through two holes drilled into the lid.

Nylon nuts and bolts fix the Veroboard to the lid. Ensure that the tantalum timing capacitor, which is mounted over the top of R4, is not in contact with any components.

A ring of six miniature sockets, and a central one, are required for selecting the timing resistors. The central socket is connected to the positive rail on the Veroboard and into this socket a plug is permanently inserted. This plug carries a wander plug on a short lead for selecting the timing resistors via the other sockets.

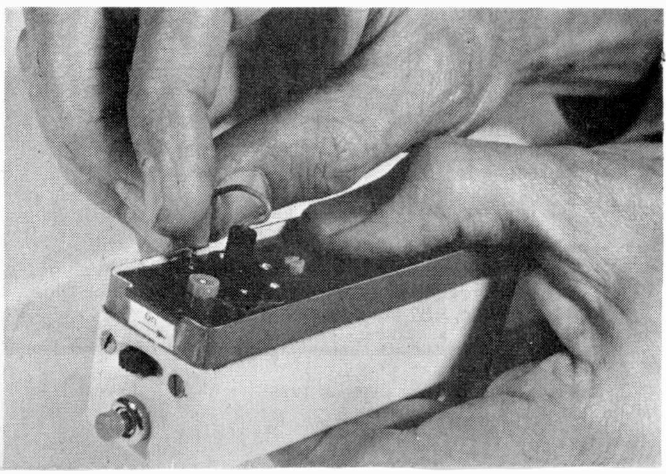
TESTING AND CALIBRATION

Once the circuit board has been fitted to the Paxolin lid, the l.e.d.s are positioned, and the various wires are connected to S1, S2, B1 and the earpiece. Upon switching on the unit the alarm should not sound since there is no charging path for the timing capacitor. However, if a short is made between the central socket and the junction of R2 and pin 3 of IC1, the alarm should sound and the l.e.d.s flash. Once the short is removed, the alarm will continue to sound. Press the push button switch and the alarm will stop.

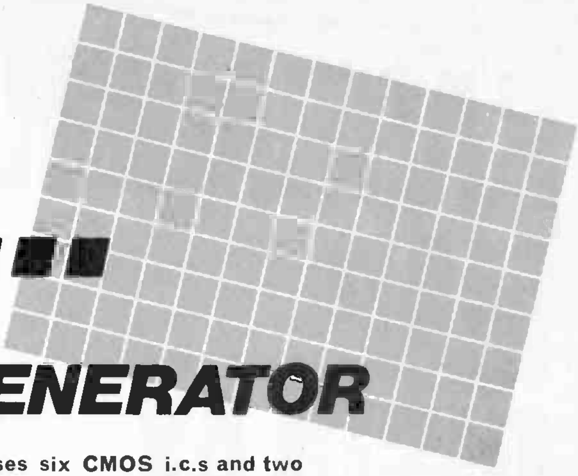
It may be necessary to tailor the timing resistor values according to individual capacitor spreads. Any alterations should be based on the following: 1 minute, 180kΩ; 4 minutes, 680kΩ; 15 minutes, 2·5MΩ; 30 minutes, 4·7MΩ in series with the 180kΩ used for the 1 minute resistor; 60 minutes, 10MΩ. All resistors were 5 per cent metal oxide types. Note that the resistor values required for the longer delays fall increasingly short of the calculated value. For instance, for a 30 minute delay, the calculated value is 6MΩ. Ensure that the resistors are rigidly soldered into place and not touching each other. The wander plug is then used to select the appropriate resistor for a particular delay.

USING THE TIMER

Put the plug into the 10s socket and switch on the timer. Once the alarm sounds, remove the plug (which does not stop the alarm) and insert it into the appropriate socket. Press the push switch briefly and the alarms will cease and begin again after the preset delay. A momentary press of the push switch will then reset the delay. The unit is now ready for use. ★

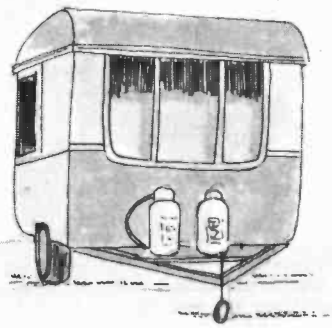


Next Month...



CROSS-HATCH GENERATOR

This completely self-contained unit uses six CMOS i.c.s and two transistors to generate a cross-hatch signal at u.h.f. for servicing and adjustment of 625-line television receivers. No external sync pick-up is required—simply connect to the aerial socket.



GAS/SMOKE DETECTOR

Smoke/gas detectors are always extremely popular, especially with those involved with boats or caravans. This unit features small size, fast response time and warm-up time, high sensitivity to smoke and gases, and at the same time retaining low sensitivity to steam or dust.

LIGHT-UP ALARM

Driving in poor light conditions can be hazardous. This alarm senses ambient light level outside the car and lets you know when to "light-up".

An exciting follow-up to the RADIO CONTROL SERIES

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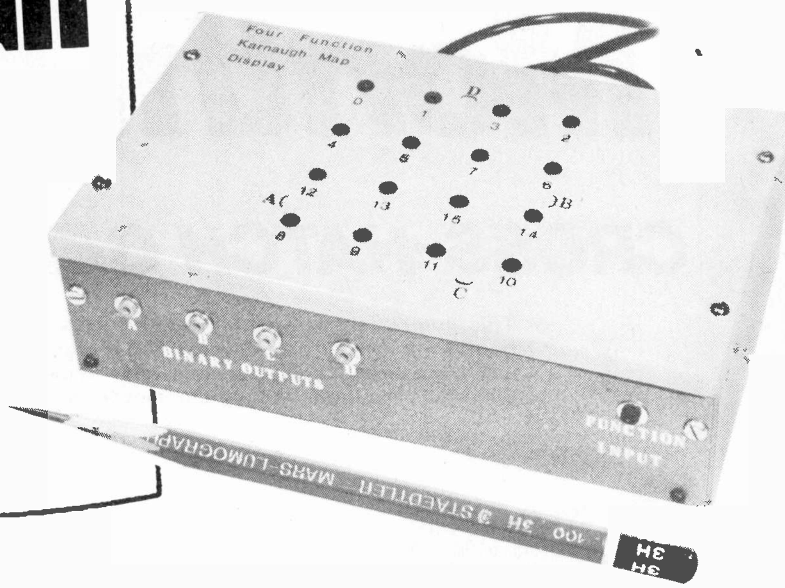
KARNAUGH MAP DISPLAY

By C. CARTLIDGE



A KARNAUGH map is a simple visual representation of a two state function, and may be used to obtain a simplified Boolean expression from a truth table. The mapping is usually done with a pencil and paper, and four functions are about a comfortable limit, giving sixteen possible mappings of the four variables.

It was after using this technique with a group of computer degree students that the idea of constructing a "real time" Karnaugh map display developed; thus bringing initial theory and practice together hopefully in a successful conclusion. The students could prepare their maps on paper for a given logic problem, patch up the hardware in the department's logic laboratories, and then display the results on the Karnaugh map display unit. For those readers not too familiar with logic and mapping techniques, a brief explanation is included at the end of this article.

This unit is fairly compact and not too expensive to build, and should be of particular interest to those who have their own "logic labs" and to many schools and colleges who have science or electronics laboratories.

OPERATION

The general system of the unit is shown in Fig. 1. Integrated circuits are used throughout; the display

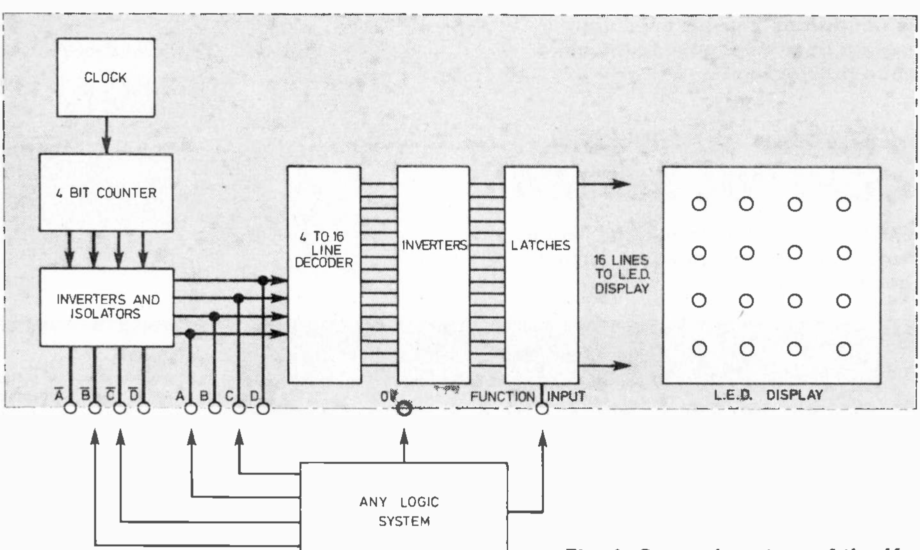


Fig. 1. General system of the Karnaugh map display

COMPONENTS . . .

Resistors
R1 680Ω ¼W 5% carbon

Capacitors
C1, C2 1μF polyester (2 off)
C3 10,000μF 40V elect
C4 0·22μF polyester
C5 0·47μF polyester

Diodes
D1–D16 TIL209 l.e.d.s (16 off)
D17–D20 2A 200V$_{RRM}$ silicon bridge

Integrated Circuits
IC1, IC2 74121 (2 off)
IC3 7493
IC4–IC8 7404 (5 off)
IC9 74154
IC10–IC17 7475 (8 off)
IC18 7440
IC19 LM309K 5V, 1·2A regulator

Miscellaneous
T1 Mains primary, 9V 1A (minimum) secondary, e.g. R.S. Components (access through Doram) 207–122
S1 D.p.s.t. mains toggle
FS1 500mA fuse and holder
LP1 Neon indicator 240V
Output and input sockets (9 off); perforated board (0·1in matrix) or i.c. stripboard; case.

being on light-emitting diodes. Fig. 2 shows the layout of the l.e.d.s and their map interpretation, and the photographs give an impression of the overall packaging.

A clock signal is fed to a four bit binary counter. This counts from zero through to fifteen as in Table 1. Each of the output lines from the counter is taken to the four-to-sixteen line decoder, this giving sixteen mutually exclusive pulses at its output lines. The counter output lines are also fed via the double inverters, which act as isolators, and the single inverters to provide A, B, C, D and $\bar{A}$, $\bar{B}$, $\bar{C}$, $\bar{D}$ on the front panel. These signals are used as input functions to the logic circuit to be mapped.

As the four-to-sixteen line decoder outputs go to logic 0 when addressed by the appropriate inputs, inverters are required in each of the sixteen lines. From the inverters the lines are taken to the clock inputs on the latch circuits. It is these latches that store each bit and display it finally on the light-emitting diodes. All of the data inputs on the latches are connected together and fed from the function input socket on the front panel of the unit, this signal being derived from the external logic under examination.

As the functions A, B, C, D are clocked into each of their sixteen possible states an input will be available on the data lines of the display latches for each condition in which the external logic system is asserted. Thus after sixteen clock pulses a complete mapping of the external logic function can be read on the light-emitting diode display. The counter is then back at the beginning of its cycle, and the

Table 1

Clock	A	B	C	D	Lamp
16(0)	0	0	0	0	D1
1	1	0	0	0	D2
2	0	1	0	0	D3
3	1	1	0	0	D4
4	0	0	1	0	D5
5	1	0	1	0	D6
6	0	1	1	0	D7
7	1	1	1	0	D8
8	0	0	0	1	D9
9	1	0	0	1	D10
10	0	1	0	1	D11
11	1	1	0	1	D12
12	0	0	1	1	D13
13	1	0	1	1	D14
14	0	1	1	1	D15
15	1	1	1	1	D16

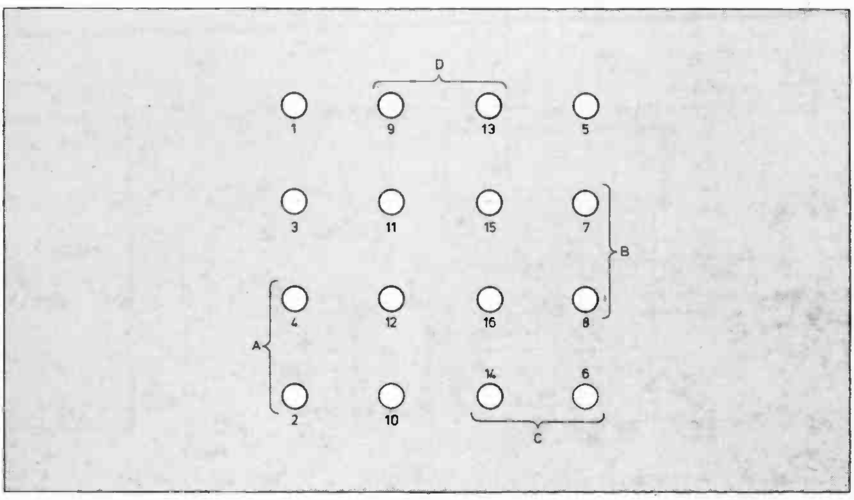


Fig. 2. Top panel layout, showing l.e.d. identification and map interpretation

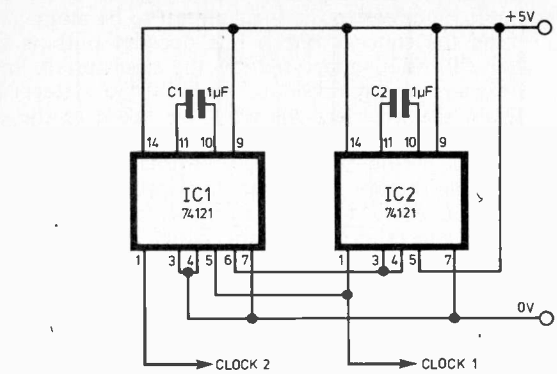
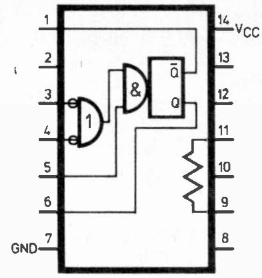


Fig. 3. Clock generator, which produces two antiphase outputs



74121

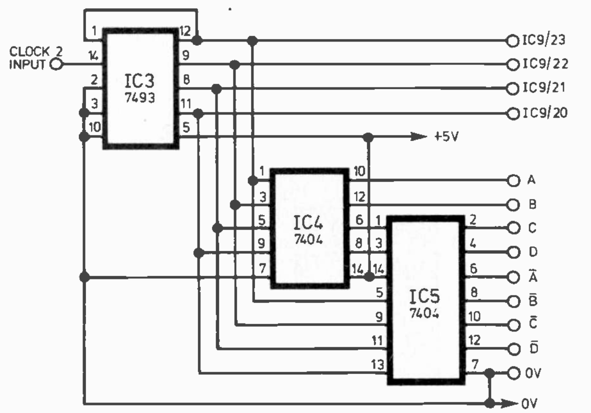
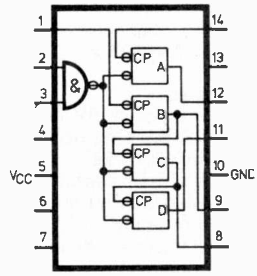
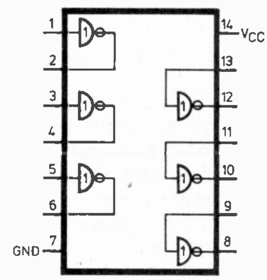


Fig. 4. Binary counter circuit with output inverters and isolators. On IC4, links should be added from pin 2 to pin 11, and from pin 4 to pin 13



7493



7404

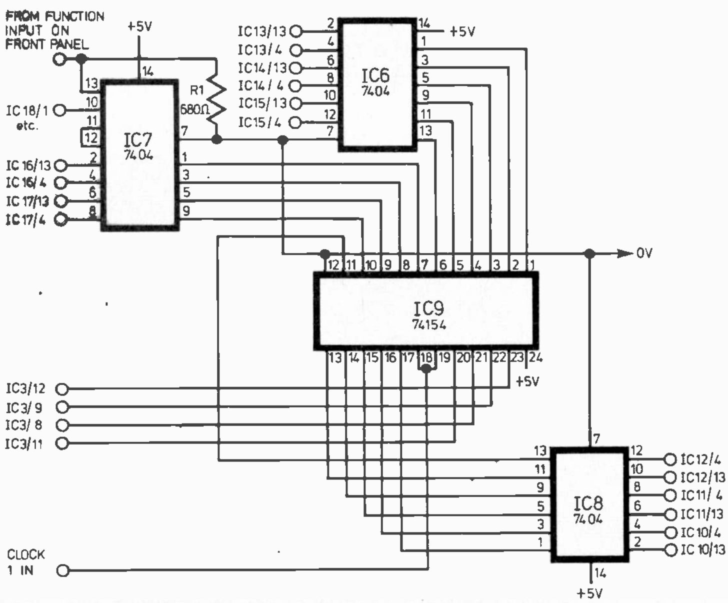
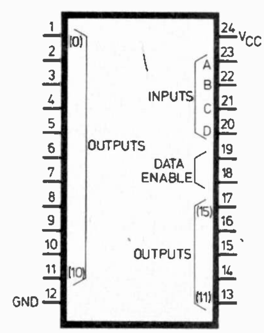


Fig. 5. Four-to-sixteen line decoder with output inverters



74154

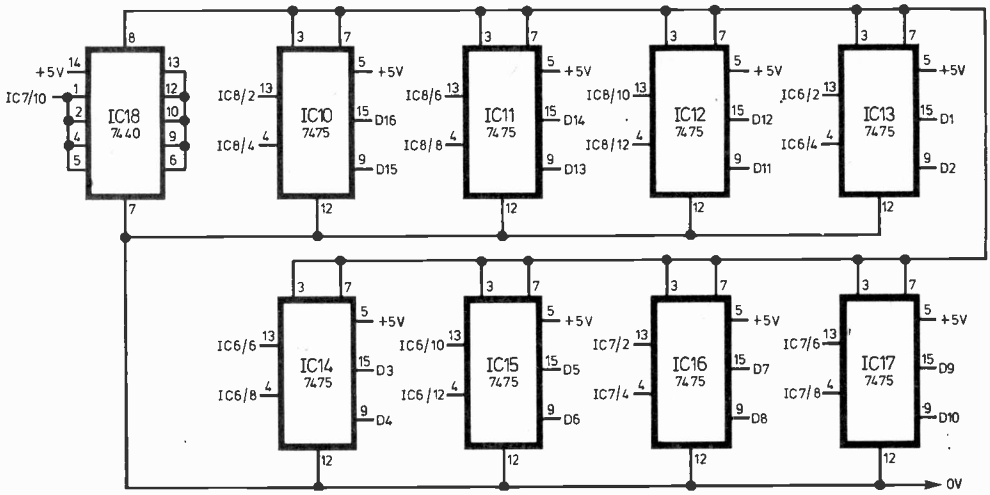
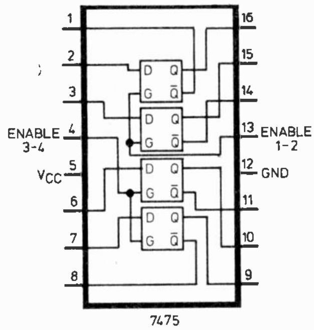
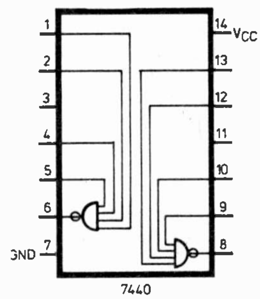


Fig. 6. Output latches. The Function Input signal is buffered in IC18 before application to the latch data inputs. Connections labelled D1–D16 go to the display l.e.d.s, see Fig. 2





process repeats itself. It is only necessary to keep the clock speed above the persistence of vision in order to obtain a bright flicker free display, and thus a Karnaugh map of the logic function under examination.

CLOCK CIRCUIT

The clock circuit is shown in Fig. 3. It uses two SN74121 monostable multivibrators and operates as follows. The basic monostable will "one shot" when either its A1 or A2 inputs go to logic 0 with its B input at logic 1. Alternatively the B input will trigger the "one shot" when it goes to logic 1 with either A1 or A2 or both at logic 0. By cross coupling two such "one shot" circuits as in Fig. 3 a continuous clock pulse train may be generated.

BINARY COUNTER AND OUTPUT INVERTER-ISOLATORS

The circuitry of these stages is shown in Fig. 4. The binary counter is a SN7493 four-bit counter wired as in the diagram, while the inverter-isolator stages use two SN7404 hex inverters. The inversion provides $\overline{A}$, $\overline{B}$, $\overline{C}$ and $\overline{D}$ outputs from the counter's A B, C, D lines, while the double inversion provides the A, B, C, D outputs, but isolates the external circuitry from the counter, thus minimising any loading which may take place.

FOUR-TO-SIXTEEN LINE DECODER

This ominous function can be achieved in one integrated circuit. It is the 74154, and is shown in Fig. 5. Unfortunately, the output of any line addressed is asserted to ground and so the inverters also shown in this diagram are required to provide assertion to logic 1 level.

OUTPUT LATCHES AND L.E.D. DISPLAY

The output latches are used to store each bit of information one or zero, and feed it to the light-emitting diode display panel. SN7475 quad bi-stable latches are used here, their data inputs being commoned and fed from the external logic while each latch is individually clocked from the sixteen line decoder.

LIGHT-EMITTING DIODE DISPLAY

The light-emitting diodes should be mounted on the top panel, and labelled as in Fig. 2. This clearly shows the A lights, B, C and D lights as two rows of four. All the possible combinations of the outputs are given in Table 1. The cathodes of the diodes should be commoned together and wired to the 0V rail and each anode should be wired from the latch output lines as shown in Fig. 6. In the prototype unit l.e.d.s type TIL209 were used, although any general purpose l.e.d. should suffice. Also the prototype, shown in the photographs, was wired somewhat differently to this design making the numbering of the l.e.d.s on the top panel differ from the D1–D16 numbering given with these circuits. In this context, the photographs should be ignored, and the top panel laid out and marked as in Fig. 2.

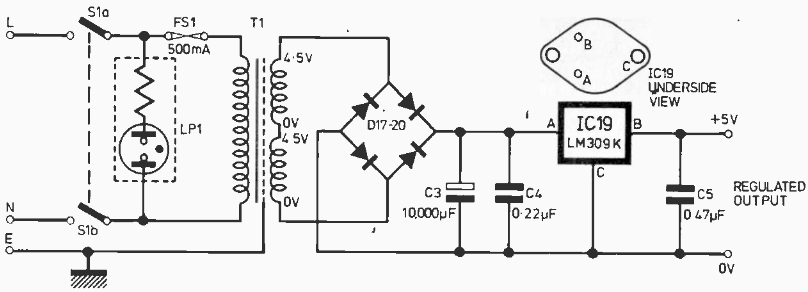
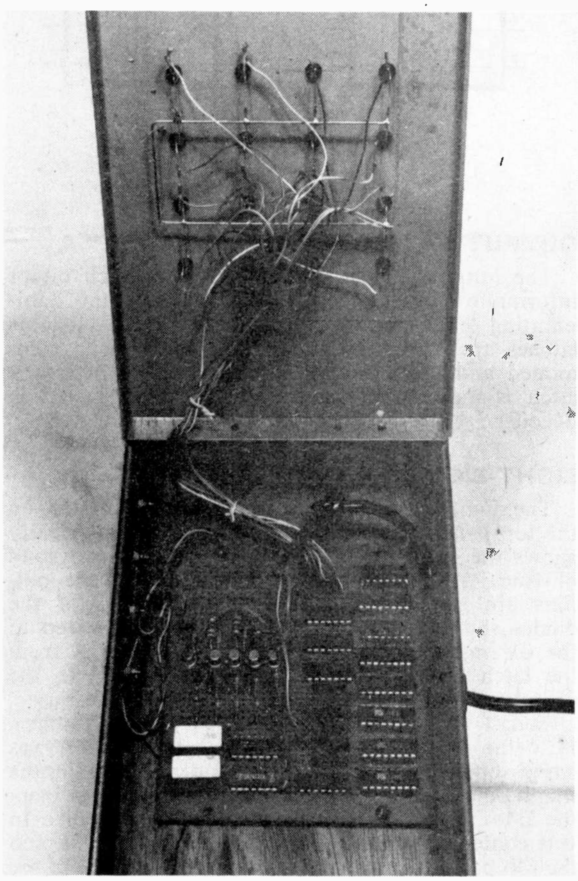


Fig. 7. Circuit of a suitable power supply, providing a 5V regulated output. Note that the 0V line is not connected to chassis anywhere within the unit, since an earth may well be present somewhere on the logic circuitry under test

POWER SUPPLY

The unit requires +5V regulated supply at about 600mA, and the circuit to provide this is shown in Fig. 7. It is a straightforward bridge rectifier circuit followed by a monolithic voltage regulator.

Interior view of a prototype version of the map display, which also incorporated a number of transistors. Most of the circuitry is mounted on a plain perforated board, the wiring being point-to-point between the i.c. pins



The unit was built on a single "Lektrokit" panel and enclosed in a "Lektrokit" housing as shown on the photographs. Although the photographs are of a prototype unit involving transistors, a general impression of the layout can be seen.

TESTING THE UNIT

On completion of the display, plug in and switch on. No light-emitting diodes should be lit. Connect a jumper lead from the function input socket on the front panel, to the A output socket; both rows of l.e.d.s bracketed and labelled A should now light up. Repeat this for the B, C and D outputs when the corresponding two rows of l.e.d.s for each case should light up. Now proceed to the NOT A output. In this case all the l.e.d.s except those two rows bracketed and labelled A should light up. Repeat this test for the NOT B, NOT C and NOT D outputs; in each case all l.e.d.s other than those labelled B, C, and D should light up for the appropriate input function. If all the above tests work satisfactorily, the unit is performing correctly and ready for use.

INTERPRETATION OF THE DISPLAY

The above test routine gives some idea of how the map is interpreted; each of the four functions A, B, C, D is bracketed and labelled as two rows of four l.e.d.s. Each function has its own side of the map, and by intersecting on the map any combination of the four functions from A, B, C, D to $\overline{A}$, $\overline{B}$, $\overline{C}$, $\overline{D}$ can be displayed.

For example, let us assume that we have fed the appropriate input functions to a "black box" on the bench, and from its output we have jumpered a lead to the input of the map. Further assume that l.e.d. D1 is the only one to light. By reading across from the bracketed labels we see that D1 is on neither of the rows labelled A, nor the rows labelled B. By reading down from our bracketed labels we find that D1 is not on rows C or D either. The function in the "black box" is therefore NOT A, NOT B, NOT C and NOT D ($\overline{A}.\overline{B}.\overline{C}.\overline{D}$.).

Let us take another example. The "black box" is wired as before, but this time l.e.d.s D9, D13 and D5 are lit. Starting at the rows bracketed and labelled A we see that no l.e.d.s on these rows are lit. Neither are any l.e.d.s lit on the two rows bracketed and labelled B; but on rows C, D13 and D5, and on rows D, D13 and D9 are lit. Thus the function in the "black box" must be NOT A, NOT B, AND C OR D ($\overline{A}.\overline{B}.(C + D)$). ★

Strictly Instrumental

by K. Lenton-Smith

THE human ear is both selective and critical where vibrato is concerned. The fact that most French singers use a faster vibrato is easily perceived, for instance. This organ is even more choosy when listening to the organ electronic! It will not require an oscilloscope to prove when vibrato is non-linear, but we should whisper into it that good electronic vibrato is not easy to arrange. In short, what satisfies the electronic engineer and even looks good on a 'scope may not please a discerning musician.

New integrated circuits are always being introduced to carry out a complex task with savings in cost and the space hitherto taken up by discrete circuitry. However, so far, no manufacturer seems to have produced an in-line vibrato i.c. (i.e. to be placed in the signal path) which will modulate *symmetrically* in sine fashion. Having said this, I am hoping to be proved wrong before this article goes to press as such an i.c. would be most welcome to manufacturer and amateur constructor alike!

SHAKY

The majority of lower-priced commercial instruments have vibrato applied to the master oscillators, but this has several disadvantages. Long term tuning stability is essential, yet the master oscillator cannot be made so stable that it will refuse to react to the vibrato signal, therefore, design of the oscillator has to be a compromise. In fact, a high "Q" in the tank circuit of an oscillator becomes a distinct disadvantage in this respect and extra components are often added to lower its value.

From the musical standpoint, injection at the oscillator stage means that the choice is between vibrato on everything (perhaps the pedal included) or on none. Ideally, pedal notes should always be unaffected and the player should be able to select vibrato on one or both manuals as appropriate.

Amplitude modulation (tremulant) has always been simple enough and, with the advent of the l.d.r. (Light Dependent Resistor), was made easier still.

Good sine-wave frequency modulation is quite another matter, so that historic methods of producing vibrato are legion. Stators of the electrostatic generator (Compton) were "wobbled" at low frequency, the oscillator's inductor could be varied by causing part of the core to move by electro-mechanical means and an extra winding on an oscillator coil was used to superimpose a vibrato signal.

At the loudspeaker end, rotating speakers or baffles carrying several speakers have been used, calling for accurate slip-ring contacts or mercury connection. The surviving mechanical system employs a stationary speaker and rotor.

MOTORPHASER

In the early days of the Hammond, the precise sound of the generators was modulated by a large "butterfly valve" inserted in the column of a speaker cabinet. This was superseded by the line-scanner and fitted to most of the rotary-generator models of the time.

The exception was the Hammond L100, where the company turned to electronic vibrato. In this case, a phase-shift oscillator was arranged to feed a buffer amplifier driving three series-connected saturable-reactor transformers. The audio signal was applied to three cascaded phase-shift stages modulated by secondary windings of the transformers. In this way continuous phase-shift and thus frequency modulation was achieved.

Exactly the same principle (with one difference in effect) has been employed recently by JEM Elettronica in their "Motorphaser", using three i.c.s and discrete components. Each i.c. is a double op. amp., one of these being used as a VCO and the others as a cascaded phase-shift chain.

The oscillator modulates the chain, as in the Hammond design of two decades ago, but the VCO provides "chorale" or "fast" according to its voltage. When the speed (voltage) is switched the change is arranged to be gradual, thus the electronic "rotor" appears to slow down or speed up. This must be taken as a compliment to makers of the Leslie speaker!

A small p.c. board carrying a few i.c.s, f.e.t.s and other components is an improvement on 12AX7s, 12AU7s and their associated "heavy" engineering, but surely some enterprising i.c. manufacturer can condense this into a single 14-pin device?

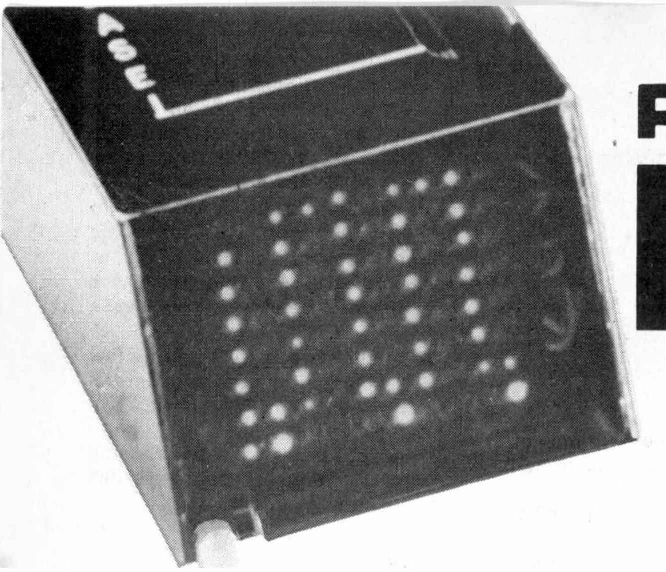
FUNKY

Literature describing the Rocky Mount Instruments Keyboard Computer tells the reader that he can alter the voice from "funky organ . . . to kicking in the sliding sound of a fuzz guitar with compressor/expander down center stage". The technical description of this new instrument all sounds vaguely familiar, permanent storage waveforms, card reader etc. So it is no surprise to learn that the RMI Keyboard Computer has been sired by the Allen Organ Company.

This single manual instrument would appear to be the ultimate keyboard for a pop group. Fully polyphonic, it has an inbuilt digital computer to plot and read out waveforms at many different frequencies simultaneously. For the C Major expert, a transposing control allows total freedom of key signature and by varying the Transposer whilst holding the keys, chromatic chord glissandos may be obtained. Bass tones may be taken down to 32' and pitch bending used.

Twenty-nine waveforms are permanently stored between solo and ensemble divisions, whilst the card reader gives access to hundreds of additional voices. Controlled by a pedal, there are three output channels for: standard pitch and pure tones; ensemble chorus and percussion; and brass accents. Increasing the readout frequency by about 2Hz on one channel produces a celeste or chorus generator effect.

The Allen Computer Organ is a brilliant piece of electronics but has met with a mixed reception by serious musicians; lack of proper scaling has been a frequent criticism. This should not deter the performer who plays this mini-skirted version as he should be able to throw in everything—including the kitchen sink!



PE DIGISCOPE

By R. W. Coles and B. Cullen

PART 2

THE physical construction of Digiscope is based on a "double decker" circuit board arrangement and this month the remaining electronic circuits of the top deck are described along with the necessary constructional details. Last month the Y Amplifier was covered in detail, and this leaves the Timebase Oscillator, the Timebase Dividers and the Trigger Amplifier to be described this month.

TIME BASE OSCILLATOR

Since the circuitry of Digiscope is digital rather than analogue in nature, the Timebase Oscillator is not a sawtooth generator as would be expected in a conventional oscilloscope, but a square wave clock oscillator of the type found in most digital logic systems. Despite this inherent operating difference, however, the purpose of the Timebase Oscillator remains what it has always been, an accurately timed, gated oscillator to produce a linear sweep of the trace across the display. As with any other oscilloscope, Digiscope requires a variety of timebase sweep speeds to facilitate the examination of waveforms with periods of between 1 microsecond and several seconds.

DIVIDERS

To achieve a wide variety of sweep speeds by switching resistors and capacitors would be rather cumbersome and difficult to calibrate, so in Digiscope only four basic oscillator frequencies are used, with the other sweep rates being produced by division in the ratios 1:2 1:5 1:10 1:20 1:50 1:100. This 1-2-5 sequence has been used in test equipment for many years because of its good practical coverage between decades with the minimum of switching, and in Digiscope division is readily achieved with programmable decade counters.

DUAL MONO

The Timebase Oscillator itself utilises a 74123 dual monostable connected as a gated astable. This connection of the 74123 is very convenient because it provides good pulse stability, simple range switching and straightforward gating, together of course with a high fanout TTL drive capability. Because the fastest sweep speed required is 100ns per division, the Timebase Oscillator is required to run at 10MHz maximum. This repetition frequency is near the upper limit of operation for a 74123 astable, and may require the use of values of R Ext lower than the data-sheet minimum of 5 kilohms, this was true of the prototype but will vary from device to device.

No problems have been encountered due to the use of low values of R Ext, but if anyone is dubious about breaking the rules in this way, it is of course possible to scale all timebase oscillator frequencies down by a factor of 2, to give a fastest sweep speed of 200ns per division which is readily obtainable with approved R Ext values!

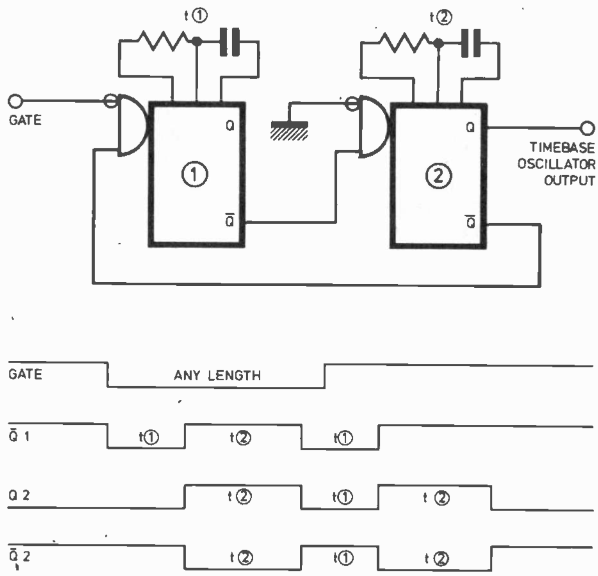
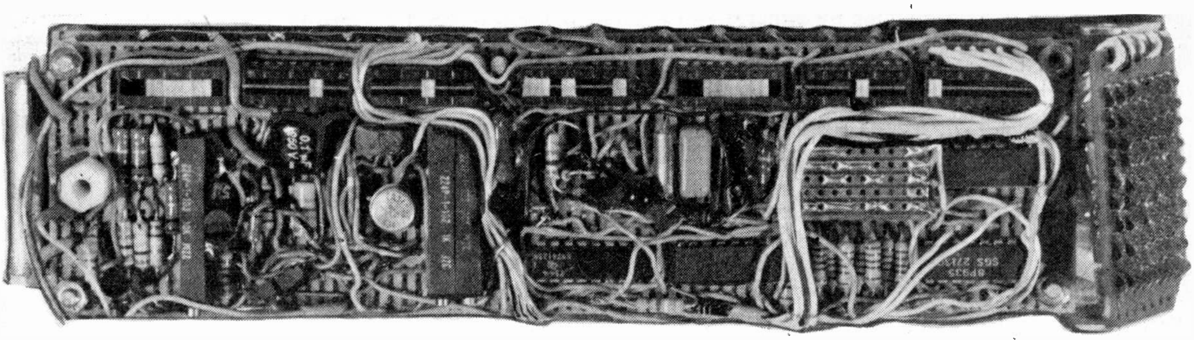


Fig. 2.1. The basic astable circuit. The CR network with each monostable is referred to as C Ext, R Ext in the text



A view of the upper deck of Digiscope

OPERATION

A monostable produces a single output pulse with a duration determined by the CR network C Ext and R Ext, in response to a triggering pulse edge. The 74123 monostables have complementary outputs and both positive and negative edge trigger inputs.

To form an astable it is necessary to use two monostables arranged so that the output of one provides the trigger input to the other and vice versa. With the versatile 74123 the astable connection can be configured in several different ways, the connection used in Digiscope being chosen for its superior high speed performance.

Referring to Fig. 2.1, when a negative going gate signal is applied to the active low gate input of monostable (1) this mono is triggered, causing the $\overline{Q}$ output to go low for a time set by C Ext. When this mono times-out, its $\overline{Q}$ output goes back to a logic 1 and in doing so, triggers the active high input of monostable (2). The Q output of mono (2) goes to a 1 and the $\overline{Q}$ goes to a 0 for a time (not necessarily the same as that of mono (1)) set by C Ext, R Ext. At the end of the mono (2) pulse, $\overline{Q}$ (2) goes back to a logic 1 and thus triggers mono (1) again, and so on, until the gate signal goes high, inhibiting the trigger to mono (1) and breaking the cycle.

Notice that this astable always completes a full cycle, even when the gate signal is removed early in the cycle.

PULSE LENGTHS

The basic astable circuit of Fig. 2.1 operates at a single fixed-frequency determined by the sum of the two monostable pulse periods. The relationship linking monostable pulse length and the values of C Ext R Ext is the straightforward formula pulse length (seconds) = 0·28 C Ext R Ext, making it a simple matter to change the frequency by varying the values of C Ext or R Ext, or both. Luckily it is not necessary to alter these values for *both* monos, a better plan is to set the pulse length of one of them to some fixed, minimum value, and then vary the frequency by varying the C Ext R Ext values of the other.

A moment's thought should show that this is certainly possible, but you may be worried about the resulting assymetry of the output waveform, especially at the slower timebase speeds. This assymetry is really of no consequence, and makes choosing the values of C Ext R Ext for the switched ranges very simple since for all but the fastest timebase range, the narrow, fixed, pulse length can be ignored and the total period assumed to be 0·28 C Ext R Ext (switched).

The shortest pulse which can be achieved with a 74123 monostable even without any external C Ext component is about 50ns, governed by the stray capacitance around the package, and other circuit constants. Since this is a useful minimum for our purposes, no external capacitor is used on the fixed duration mono.

RANGE SWITCHING

The variable pulse length monostable has C Ext and R Ext values selected by S5 (Fig. 2.2), a two pole four way d.i.l. switch. Both timing components are switched to facilitate the calibration required, and to make possible the two orders of magnitude change in pulse length between adjacent ranges. The 100ms, 1ms and 10μs ranges are provided by a switched resistor and capacitor combination, but the 100ns range, being at the limit of device capability, uses no capacitor apart from the unavoidable strays associated with the switching layout.

The resistor network for the three slower ranges uses a common, fixed, 10 kilohm resistor in series with individually selected trimming resistors which are chosen to give the required oscillator period during calibration. The 100ns range uses a single resistor which again is selected during calibration, although as mentioned earlier, the value of this resistor may have to be lower than the data sheet minimum to achieve a 100ns period. In the prototype a 2·2 kilohm resistor was used in this position.

PROGRAMMABLE DIVIDERS

The required final timebase frequencies are obtained from the basic Timebase Oscillator by division in two cascaded b.c.d. counters which are switch programmed. The counters used must be capable of operating at a maximum frequency of 10MHz with easily altered division ratio, and this led to the choice of the very versatile 74160 synchronous counters which have the advantage of a parallel load facility.

To achieve the desired 1:1 1:2 1:5 1:10 1:20 1:50 division ratios the first counter divides by either 1 or 10, and the second counter by either 1, 2 or 5 under the control of a single switch. A six way switch is all that is really needed, but the nearest available type in the d.i.l. switch format is a single pole eight way, and it was decided to utilise the extra two ways to provide a divide by 100 range. This extra division ratio is not strictly necessary but it does provide an overlap between Timebase Oscillator ranges, and also provides one extra timebase range at the slow end, making a total of 25 in all.

PARALLEL LOAD

Perhaps the most obvious way to change the divition ratio of a counter is to let it count up to some selected count and then reset it to zero to shorten the unmodified full count. This method is not the most satisfactory in many cases, and in Digiscope a better system is employed made possible by the parallel load facility of the 74160.

To achieve, say, a division ratio of 6, the counter is preset to 4, and then allowed to count normally to its full count of 9 which is detected as a terminal count and used to preset the counter on the next clock pulse. Using this method the count of zero never appears unless a division requiring a full count of 10 is selected. The 74160 has a ready decoded "Terminal Count" output and this can be used to prime the "Preset Enable" input via an inverter so that on the next low to high clock transition, the data present at the "Preset" inputs are entered into the counter in parallel.

COMPONENTS . . .

TIMEBASE OSCILLATOR AND TIMEBASE DIVIDER

Resistors

R26–R29*	(see text)
R30	10k Ω
R31	3·9k Ω
R32–R40	1·2k Ω (9 off)

All ¼W 5% metal oxide miniature

Capacitors

C8	22μF elect. 15V
C9	0·22μF
C10	0·002μF
C11–C13	0·01μF ceramic (3 off)

Semiconductors

IC2	SN74123
IC3	SN74160
IC4	935
IC5	SN74160
D3–D17	Any silicon switching type (15 off)

Switches

S5	DS16A	2-pole 4-way (Erg Components)
S6	DS16A	1-pole 8-way (Erg Components)

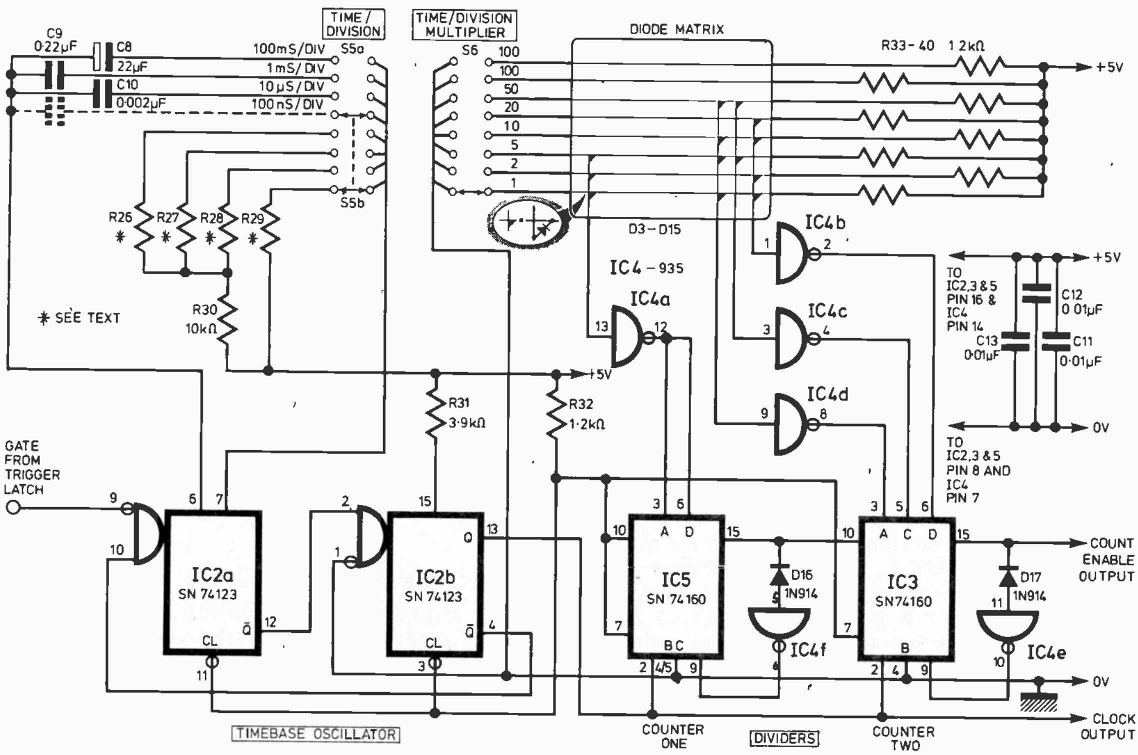


Fig. 2.2. Circuit of Timebase Oscillator and Timebase Dividers

Table 2.1

74160 PROGRAMMING CODES					
Division Ratio	Decimal Input	Binary Equivalent			
		A	B	C	D
1	9	1	0	0	1
2	8	0	0	0	1
3	7	1	1	1	0
4	6	0	1	1	0
5	5	1	0	1	0
6	4	0	0	1	0
7	3	1	1	0	0
8	2	0	1	0	0
9	1	1	0	0	0
10	0	0	0	0	0

COUNTER ONE					
Division Ratio	Decimal Input	Binary Equivalent			
		A	B	C	D
1	9	1	0	0	1
10	0	0	0	0	0

COUNTER TWO					
Division Ratio	Decimal Input	Binary Equivalent			
		A	B	C	D
1	9	1	0	0	1
2	8	0	0	0	1
5	5	1	0	1	0

DIVISION RATIOS		
Overall	Counter One	Counter Two
1	1	1
2	1	2
5	1	5
10	10	1
20	10	2
50	10	5
100	10	10

Note: No change required on those inputs shown shaded

DIODE R.O.M.

For each different division ratio, a unique binary word must be present at the "Preset" inputs to each counter, and these are summarised in Table 2.1. One way of generating the required binary programming code for the counter inputs would be to use a ready coded thumbwheel switch, but these are expensive and bulky and may have redundant positions. A much simpler and more flexible solution is to generate the necessary binary codes in a diode matrix arranged as a read-only-memory. A diode r.o.m. suitable for use with the specified divider circuits is shown in Fig. 2.2.

The r.o.m. in this case has eight inputs connected to a one pole eight way earthing switch, so that only one of the inputs is at a logic zero at any one time, the others being pulled up to +5V by 1·2 kilohm pull-up resistors.

You may think that eight outputs are also required, since the counters have a total of eight preset inputs, but examination of Table 1 shows that three of these eight inputs never change and so can be hard-wired. In addition the two programmed inputs (A and D), on "Counter One" change in the same way (both "ones" or both "zeros") and so can share a single output from the r.o.m., leaving a need for only four outputs in all, one for "Counter One", and three for "Counter Two".

DTL INVERTERS

Unfortunately, diode logic cannot be connected directly to TTL inputs because of the diode V_f of about 800mV which cancels any noise immunity the TTL circuit has, making false operation a distinct possibility. Luckily in the DTL family there can be found the 935 device which is a hex-inverter without internal input diodes, which is made specifically for this sort of situation. In effect, the DTL inverter, when connected to a particular diode r.o.m. line, becomes a multi-input DTL gate, with the number of inputs depending on the number of diodes connected to its particular r.o.m. output.

The inverters invert the logic levels out of the r.o.m., so that where a diode is present and selected, the signal presented to the preset inputs of the counter is a logic one. To programme the r.o.m., then, one simply goes through the "Binary equivalent" columns of Table 2.1, inserting a diode into the matrix wherever a one is found, and doing nothing wherever a zero is found.

DIVIDING BY ONE

Some readers might be a little puzzled by the prospect of division by one. Table 1 shows that to divide by one it is necessary to load the counter with binary 9 (1001) and then clock as usual. This seems a little strange since 1001 is the terminal count for the 74160 decade counter, and so another parallel load is initiated immediately. The end result is, of course, that the 74160 outputs remain in the 1001 state indefinitely, but, and this is the important point, the "Terminal Count" output also remains in the one state, and thus continuously enables the following counter which can count normally. A division by one then, means "do nothing" which is just as it should be!

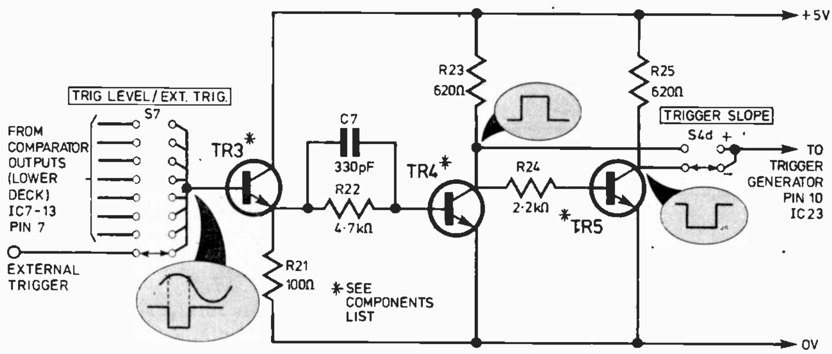


Fig. 2.3. Circuit of Trigger Amplifier

TRIGGER AMPLIFIER

As mentioned in part one, Digiscope has a ready-available source of trigger pulses in the form of the Comparator outputs which are TTL level signals each undergoing a level transition at a different point on the input signal waveform. There are nine Comparator outputs and any one out of this nine can be used as a trigger signal.

A switch used to select one of these signals provides a simple "Trigger Level" control (Fig. 2.3) which enables the start of the timebase-sweep to be synchronised to a particular amplitude level of the input signal waveform. In fact an eight way switch is used but only seven of the eight positions available are connected to the Comparator outputs. These seven possible trigger levels seem perfectly adequate in practice, and the eighth switch-way is put to good use to give the option of an "External Trigger" source, which can be fed in via a front panel socket.

EMITTER FOLLOWER

The Comparator outputs are fully loaded by the Row Decoder inputs, and so it is important that the Trigger Amplifier does not significantly add to this loading. To achieve a relatively high input impedance an emitter follower stage is used as a buffer before the Trigger Amplifier proper. The other two transistors in this stage are operated as saturated switches and are required simply to give a sufficient TTL fan-out to satisfy the drive requirements of the Trigger Latch circuit which follows, and to provide trigger pulse inversion when necessary for triggering the sweep from negative edges.

The selection of positive or negative slope triggering is made possible by S4d which is connected so as to pass either the collector output of TR4 or the collector output of TR5 on to the Trigger Latch which always triggers on the positive edge of the Trigger Amplifier output. The output from TR4 is inverted once with respect to the selected Comparator output, and causes the sweep to be triggered by a positive transition of the signal under examination, but the output of TR5 is inverted twice and so causes triggering on negative transitions.

In the first case, the Trigger Latch circuits ignore the first (negative going) transition at the output of TR4, but respond to the positive transition as the input signal itself swings negative. On very low frequency, or slowly changing input waveforms, it is possible for the output of the selected Comparator to oscillate as the input passes slowly through its sensitive threshold region, this of course will cause

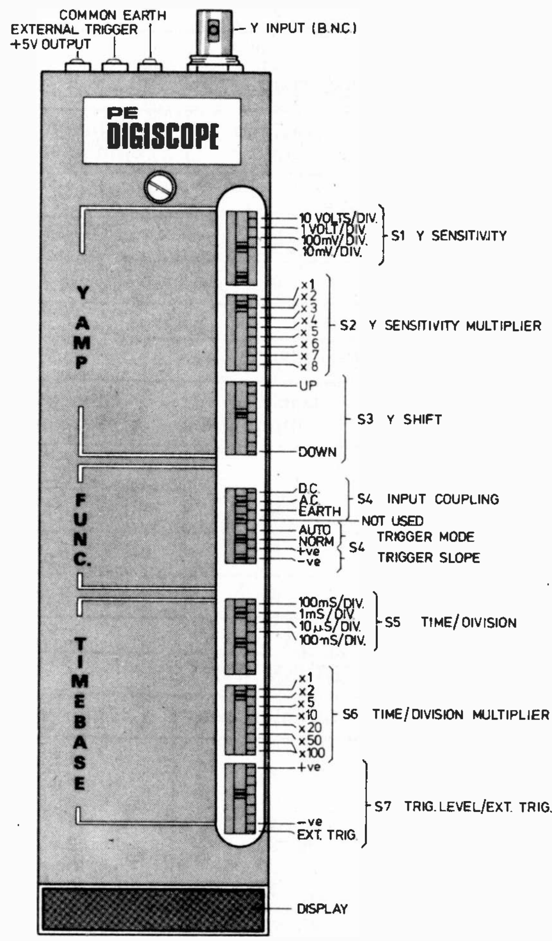


Fig. 2.4. Control panel details

COMPONENTS . . .

TRIGGER AMPLIFIER

Resistors

R21	100 Ω
R22	4·7k Ω
R23	620 Ω
R24	2·2k Ω
R25	620 Ω

All $\frac{1}{8}$W 5% metal oxide miniature

Capacitor

C7 330pF

Semiconductors

TR3–TR5 Any silicon npn transistor

Switches

S7 DS16A single-pole 8-way (ERG)

a miss-trigger to the extent that if negative slope is selected, triggering may be indicated by a positive transition of the input.

In general, the Digiscope triggering circuits all perform very well indeed, and the conventionally commonplace phenomena of a free-running or unlocked timebase, cannot occur.

CIRCUIT BOARDS

Because of the "long and thin" format necessary for a probe type shape, standard Veroboard is not suitable for the construction of Digiscope. A type of stripboard is employed, however, and it is of a layout which lends itself perfectly to the probe shape. The two 7½in × 2in stripboard decks are both cut from an Imhof-Bedco plug-in d.i.p. board type MCV/5CX/100 which is available from the manufacturers and has also been available in the past, at very low cost, from West-Hyde Developments in the form of "manufacturer's rejects". The sort of slight imperfections found in these rejects do not render them unsuitable for use in Digiscope, and if available, they are a very good buy.

The two decks can be easily cut from the larger card with the aid of a hacksaw or nibbling tool, following the layout shown in the diagrams. The pad layout is very convenient for this application, and requires only a minimum of spot-face cuts, those required for the top deck being shown in the diagrams. Six holes are necessary in the top and bottom decks for the assembly bolts, and since these must match, it is necessary to drill them with the two boards clamped tightly together. The top deck also needs an additional hole to accept the Sorrel pillar which is used as an attachment anchorage for the case-cladding.

COMPONENTS

It cannot be emphasised too strongly that subminiature components must be used in the construction of Digiscope for success to be guaranteed. It is admitted that in constructing the prototype a number of larger components were used and this caused several problems. Electrosil TR4 resistors are ideal, although cheaper $\frac{1}{8}$ watt carbon film types could be substituted as an economy if necessary.

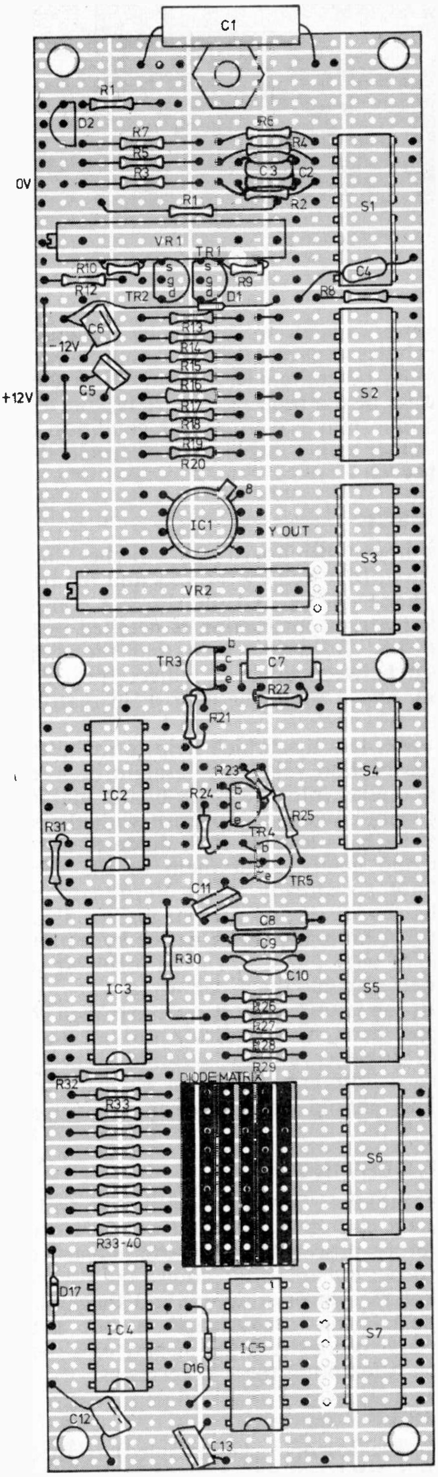
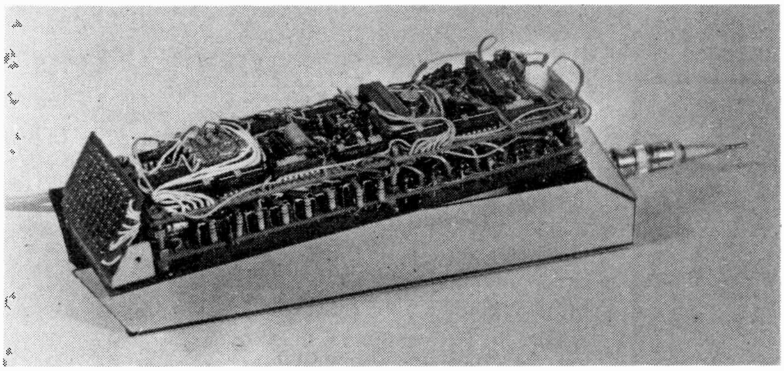


Fig. 2.5. Component layout of top deck. For interwiring details reference should be made to the appropriate circuits. The diode ROM is made up of 13 diodes sandwiched between a piece of Veroboard and the main deck



Showing sandwich construction of Digiscope

Decoupling capacitors should be ceramic discs, and electrolytics are resin dipped tantalum-beads. The two trimming potentiometers mounted on the upper deck must be of the multi-turn variety, but the exact type is unimportant providing this condition is satisfied. All other components are as specified in the components list.

UPPER DECK

On the upper stripboard the switches should be mounted first, followed by the i.c.s and the trimmers, then the diode matrix and the discrete components. The diode matrix construction is detailed in the diagram Fig. 2.5. It can be seen that the diodes are sandwiched between an X-Y matrix framed by the upper deck and a small piece of 0·1in matrix Veroboard.

There are a few tips which help to make this part of the construction relatively straightforward. First solder the diodes into the main-board making sure that their glass envelopes are flush with the surface, then crop the bare lead of each diode to about $\frac{3}{16}$in in length and gently bend them to the vertical if they are not so already. The Veroboard may fit easily over the diodes at this stage, but this tricky operation can be made much easier by countersinking the holes with the aid of a $\frac{1}{4}$in drill bit so as to form funnels to guide the diode wires.

When all the main components have been soldered to the upper-deck board, wiring up can be started using fine, single core p.v.c. covered tinned copper wire, using a different colour for each main circuit section. This should be done using the circuits as reference.

CIRCUIT TESTING

The Y-Amplifier, Timebase-Oscillator and Timebase Dividers can all be checked out in isolation if desired, before proceeding with the construction of the lower deck, but this will require the use of +12, −12, and +5V power supplies, and the loan of an oscilloscope. If an oscilloscope is not available, it is necessary to construct the display and the lower deck before attempting these procedures.

Y-AMPLIFIER

With an oscilloscope (d.c. coupled) connected to pin 6 of IC1 VR1 can be adjusted to set the output d.c. level to 0V. A square wave oscillator can be used to examine the dynamic performance of the amplifier and check the gain settings etc, exact gain setting being achieved with VR2. The attenuator h.f. compensation can be checked by observing the "overshoot" on the output edges. Too much overshoot means that C2 or C3 are too large, "rounding" means that they are too small.

TIMEBASE

To set up the timebase frequencies a 10 kilohm pot should be substituted for R26, R27, R28 and R29 in turn, and adjusted until the required accuracy is achieved. The resistance of the pot should be measured (out of circuit) with a multimeter set to the "Ohms" range so that an appropriate fixed resistor can be substituted.

Timebase Divider operation can be checked by monitoring the output on pin 15 of IC3 with an oscilloscope or counter and then operating S6 to change the division ratios, remembering that for a division ratio of one the output on pin 15 should be a steady logic "one", not a frequency. There is no real need to check out the Trigger Amplifier at this stage since it is such a simple circuit and needs no calibration.

Next month: Lower deck circuitry and constructional details

PE

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SEMICONDUCTOR UPDATE... By R.W. COLES

BCX38
G5001
G5002
G5003
LF155
LF156
LF157

LITTLE DARLING(TON)

From Ferranti comes a new transistor, coded **BCX38**, which could be a really useful addition to any enthusiast's semiconductor "stock-pile". The BCX38 is a "Darlington" device which means that really it's two transistors in one, connected as a super-alpha-pair to obtain high current gain and high input impedance. The resultant compound device appears to the outside world very much like an ordinary transistor, except that the V_{be} is double the usual 700mV and, more useful, the H_{fe} is the product of the individual transistor H_{fe}'s, or between 1,000 and 10,000!

Of course you may be saying "so what's new?" because power Darlingtons have been around for some time, and are often used in audio power amplifiers, etc. The thing which makes the BCX38 different is the fact that it comes in a teeny-weeny plastic E line package and so can be sprinkled around in your everyday circuits, wherever you need its particular advantages. A particular application could be when driving lamps or relays from CMOS logic where the CMOS source current is measured in 100's of microamps and the load requires 100's of milliamps. You don't have to be a genius to see that you need a drive transistor with a gain of about 1,000, and that would normally mean you would have to use a two transistor drive circuit. The BCX38 makes the whole thing simple, and you needn't stop at a 1k gain either; this little darling is available in three gain selections (suffix A, B, C) up to a whopping 10k H_{fe}!

With a V_{CBO} rating of 80V and an 800mA collector current rating this device is sure to be a winner.

BIG TURN OFF

Conventional thyristors provide an extremely efficient means of power switching and this fact has made them the natural choice for most a.c. power control applications where their superior performance can be used to advantage. Despite the inherent efficiency of thyristor devices, they have essentially been limited to a.c. only circuits because they are difficult to turn off once triggered. In a.c. circuits this does not pose a problem since turn-off is achieved by reducing the current through the device to zero, and this happens quite naturally twice in every cycle of an a.c. supply, as the voltage passes through zero.

In d.c. circuits the thyristor is still an efficient switch, but one which can only be turned on, never off, via the control, or gate input, restricting its usefulness to latching applications where it can occasionally be used to replace bistable flip-flops. The power-control engineer's dream is a thyristor which can be both turned on and off at the gate, and to some extent this dream has been fulfilled in a new range of devices from RCA called GTO (gate turn off) silicon controlled rectifiers, the **G5001**, **G5002** and **G5003** series.

The GTO devices employ the same basic four-layer regenerative semiconductor structure and can be turned on in the normal way by means of a positive current pulse applied to the gate. Turn off is achieved by applying a negative voltage pulse to the gate, but the rub is that a voltage of between 30 and 70V is necessary.

These new devices will undoubtedly be in direct competition with power transistors and will probably be the better choice when currents of more than a few amps have to be switched or where high off state voltages are encountered. As an example, the G5001M will switch 15A and block 600V, a combination of features which cannot be found in any power transistor currently available.

The new devices are housed in TO3 power transistor cans and are available from RCA distributors.

FET FRONT END

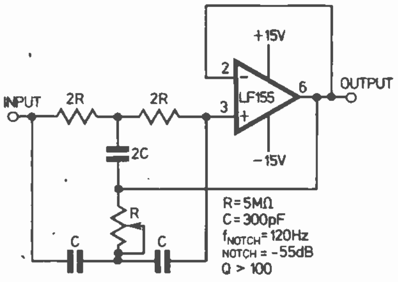
The high input impedance of junction f.e.t. devices makes them ideal for use in the "front-end" of operational amplifiers, but if you leaf through any semiconductor catalogue you'll find very few j.f.e.t. op amp integrated circuits, and those which you do find will have a high price tag.

The reasons for this apparent oversight on the part of semiconductor manufacturers are not hard to find, because until recently it was possible to make j.f.e.t.s, and it was possible to make bipolar amplifiers, but it was not possible to make both on the same chip! To make an integrated j.f.e.t. input amplifier it was necessary to put two interconnected chips in the same can (a hybrid) which meant double-trouble for the manufacturers and double prices for the long suffering users. Most users have found it cheaper and better to use a discrete j.f.e.t. pair and a cheap op amp such as the 741 to achieve the desired results, but from now on they won't have to bother because National have got it together, and produced a new technology called BI-FET which makes possible cheap monolithic j.f.e.t. amplifiers.

To start the ball rolling they have introduced three new devices, the **LF155, LF156** and **LF157** which together form an integrated family of cheap, robust, j.f.e.t. input, op amps with characteristics to suit every electronic occasion. All three have extremely high input impedance and low offset voltage coupled with high gain and low noise.

The LF155 is optimised for low supply drain applications, drawing only 2mA (typical) from plus and minus 15V supplies (see Fig. 1) while the LF157 is optimised for high frequency, wideband applications where it exhibits a 50V per microsecond slew rate and offers about 20dB gain at 1MHz.

The LF156 is a middle of the road version with internal compensation and a reasonable slew rate for general purpose applications.



The LF155 as a High Q notch filter

MARKET PLACE

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

NEW MULTI-FAMILY LOGIC PROBE

Designed to simplify and speed logic circuit testing, this new Model 545A Logic Probe from **Hewlett-Packard** indicates digital states and pulses in both high level (CMOS) logic and low level (TTL) logic.

An unambiguous single lamp indicator displays high or low level or detects bad level and open circuit conditions. CMOS and TTL operation is selected with a slide switch. CMOS logic threshold levels are variable and set automatically. Now, nearly all positive logic up to +18 volts d.c. can be sensed using one probe.

Another feature is a built-in pulse memory which, along with the display, will catch intermittent pulses. When a logic change occurs, the indicator lamp turns on and remains lighted until the memory is reset. Pulse stretching is provided so the operator can see fast pulses as short as 10 nanoseconds with the blinking display. Pulse trains to a frequency of 80MHz are detected in TTL logic, and to 40MHz in CMOS logic.

This hand-held model is fully protected against voltage overload. Power required for TTL operation is 4·5 to 15 volts d.c., and for CMOS operation is 3 to 18 volts d.c.

To use, the operator connects the probe to the circuit's highest level power supply, sets the slide switch to the appropriate logic family, then probes. Open, pulsing, or stuck nodes and gates are quickly detected.

Further information can be obtained from **Hewlett-Packard Ltd., King Street Lane, Winnersh, Wokingham, Berkshire.**

ENCLOSURE

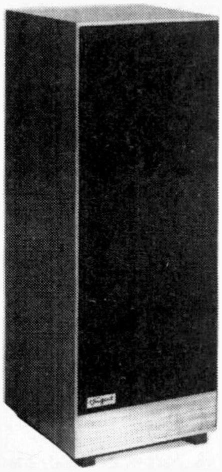
The RS6 is a floor standing fully integrated moving coil loudspeaker system having performance characteristics akin to the very best electrostatic speakers. All hint of "boxiness" and other cabinet colouration has been eliminated is the claim for this enclosure from **Tangent Acoustics.**

It is claimed that by a unique application of "acoustic negative feedback" it has resulted in the virtual elimination of room effects at upper bass frequencies, and the lower bass down to well below 35Hz. Precise control of the phase charactreistics through elaborate crossover circuits provides a very high standard when used in pairs for stereo reproduction.

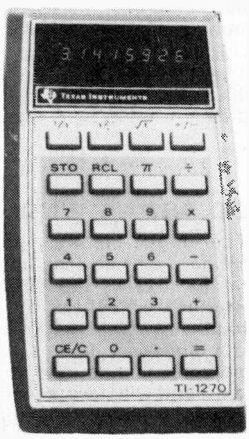
A special feature of the RS6 is a guarantee for 5 years when used with amplifiers rated at 25 to 100W per channel into 8 ohms. Each enclosure contains three drive units: a 19mm wide-dispersion dome tweeter; a 900mm Bextrene cone midrange unit in sealed enclosure and a 140mm Bextrene cone low-resonance unit in ported reflex enclosure.

The RS6 is finished in teak veneer with brown Vynair grille and the frequency response is ±3dB 30Hz to 30kHz. The impedance of the system is 8 ohms nominal and 6 ohms minimum.

The complete range of Tangent enclosures available and prices can be obtained from **Tangent Acoustics Ltd., Dept P.E., 3 Kesters Close, Hardwick, Cambs, CB3 7QV.** A stamped addressed envelope is requested.



The RS6 loudspeaker enclosure from Tangent Acoustics



The Texas TI-1270 calculator

RIGHT ANSWER

It has often been said of equipment, "if only manufacturers would consult us before designing their equipment, we could tell them that we don't need that facility, but why the hell didn't they include that facility." Well now, with the introduction of the TI-1270 calculator from **Texas Instruments,** any shortcomings should be levelled at our educators.

Designed specifically for secondary school students, the calculator keyboard and functions were evolved after recommendations from mathematics teachers on the basic problems encountered by pupils. It does not include, for instance, a percent key, as it was felt that this function should be worked through by students.

The four function machine features a store and recall "scratch pad" memory and four specially recommended keys: reciprocal $\left(\frac{1}{x}\right)$ square (x^2); square root ($\sqrt{x}$); and π (pi).

The recommended retail price for the TI-1270 is £12.95 including VAT and further details of local stockists can be obtained from **Texas Instruments Ltd., European Calculator Division, 165 Bath Road, Slough SL1 4AD.**

RADIO CONTROL

The current series on "Radio Control" has aroused such a great deal of interest that we understand several of our advertisers are now supplying complete kits, component packs and printed circuit boards.

We would suggest that any readers, who are about to start or having difficulty in obtaining any parts for this project, should first check through the advertisements appearing in this and future issues of P.E.

The comments above are valid for all the more popular projects published, i.e. see the ABC Electronics (Oldham) advertisement for the "Digital Frequency Meter" project.

NOTICE

We have been asked to point out that some of our readers may be experiencing delays in completion of orders from **RST Valve Mail Order Co.**

This is due to the fact that one of their warehouses was severely damaged by fire and their move to new premises added to the delays.

All correspondence should be addressed to **RST Valve Mail Order Co., Climax House, Fallabrook Road, SW16 6ED.**

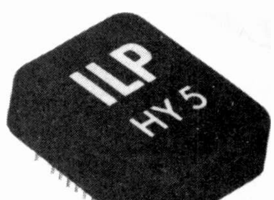
15-240 WATTS!

HY5
Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.) are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropiate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: complete pre-amplifier in single pack; multi-function equalisation; low noise; low distortion; high overload; two simply combined for stereo.
APPLICATIONS: hi-fi; mixers; disco; guitar and organ; public address.
SPECIFICATION: Inputs–magnetic pick-up 3mV; ceramic pick-up 30mV; tuner 100mV; microphone 10mV; auxiliary 3–100mV; input impedance 47kΩ at 1kHz. Outputs—tape 100mV; main output 500mV R.M.S. Active Tone Controls—treble ±12dB at 10kHz; bass ±12dB at 100Hz. Distortion—0·1% at 1kHz; signal/noise ratio 68dB. Overload—38dB on magnetic pick-up. Supply Voltage—±16–50V.

Price £4·75 + 59p VAT. P. & P. free
HY5 mounting board B.1. 48p + 6p VAT. P. & P. free



HY30
15W into 8Ω

The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of: I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up to date technology available.

FEATURES: complete kit; low distortion; short, open and thermal protection; easy to build.
APPLICATIONS: updating audio equipment; guitar practice amplifier; test amplifier; audio oscillator.
SPECIFICATION: Output Power—15W R.M.S. into 8Ω. Distortion—0·1% at 15W. Input Sensitivity—500mV. Frequency Response—10Hz–16kHz –3dB.

Price £4·75 + 59p VAT. P. & P. free

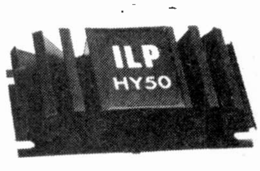
AVAILABLE JUNE 1976

HY50
25W into 8Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: low distortion; integral heatsink; only five connections; 7 amp output transistors; no external components.
APPLICATIONS: medium power hi-fi systems; low power disco; guitar amplifier.
SPECIFICATION: Input Sensitivity—500mV. Output Power—25W R.M.S. into 8Ω. Load Impedance—4–16Ω. Distortion—0·04% at 25W at 1kHz. Signal/Noise Ratio—75dB. Frequency Response—10Hz–45kHz –3dB. Supply Voltage—±25V. Size—105 × 50 × 25mm.

Price £6·20 + 77p VAT. P. & P. free



HY120
60W into 8Ω

The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

FEATURES: very low distortion; integral heatsink; load line protection; thermal protection, five connections; no external components.
APPLICATIONS: hi-fi; high quality disco; public address; monitor amplifier; guitar and organ.
SPECIFICATION: Input Sensitivity—500mV. Output Power—60W R.M.S. into 8Ω. Load Impedance—4–16Ω. Distortion—0·04% at 60W at 1kHz. Signal/Noise Ratio—90dB. Frequency Response—10Hz–45kHz –3dB. Supply Voltage—±35V. Size—114 × 50 × 85mm.

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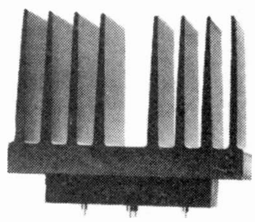

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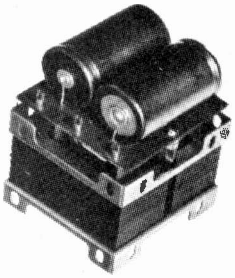

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AC141	0·18	BC142	0·23	BC337	0·17*	BF179	0·30	BU126	1·60*	MJ481	1·05	IN2070	0·16	2N3570	0·80
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AC176	0·16	BC148	0·09*	BCY32	0·60	BF197	0·12*	BY207	0·20*	MJE371	0·60	IN4004	0·07*	2N3705	0·10*
AC176K	0·25	BC149	0·09*	BCY33	0·55	BF224J	0·18*	BYX36–		MJE520	0·45	IN4005	0·08*	2N3706	0·10*
AC187	0·18	BC152	0·25*	BCY34	0·55	BF244	0·17*	300	0·12*	MJE521	0·55	IN4006	0·09*	2N3707	0·10*
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AC188	0·18	BC157	0·09*	BCY39	1·15	BF258	0·35	900	0·18*	OA90	0·08	2N696	0·14	2N3715	1·15
AC188K	0·25	BC158	0·09*	BCY70	0·12	BF337	0·32	1200	0·21*	OA91	0·08	2N697	0·12	2N3716	1·25
AD140	0·50	BC159	0·09*	BCY71	0·18	BFW60	0·17*	BYX38–		OC41	0·15	2N706	0·10	2N3771	1·60
AD142	0·50	BC160	0·32	BCY72	0·12	BFX29	0·26	300	0·50	OC42	0·15	2N929	0·14	2N3772	1·60
AO143	0·46	BC161	0·38	BO115	0·55	BFX30	0·30	600	0·55	OC44	0·12	2N930	0·14	2N3773	2·10
AO149	0·45	BC168B	0·09*	BO131	0·36	BFX84	0·23	900	0·60	OC45	0·10	2N1131	0·15	2N3819	0·28*
AD161	0·35	BC182	0·11*	BD132	0·40	BFX85	0·25	1200	0·65	OC70	0·10	2N1132	0·16	2N3904	0·16*
AD162	0·35	BC182L	0·11*	BO135	0·36	BFX88	0·20	BZX61	Series	OC71	0·10	2N1304	0·20	2N3906	0·11*
AL102	0·95	BC183	0·10*	BD136	0·39	BFY50	0·20	Zeners	0·20	OC72	0·22	2N1305	0·20	2N4124	0·14
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AF118	0·50	BC212L	0·11*	BD183	0·97	BFY39	0·40	C106D	0·50	SC41A	0·65	2N2646	0·50	2N4920	0·50*
AF139	0·35	BC213	0·12*	BD232	0·60*	BSX19	0·16	C106F	0·35	SC41B	0·70	2N2905	0·18	2N4922	0·58*
AF239	0·37	BC213L	0·12*	BD233	0·48*	BSX20	0·18	CRS1/05	0·25	SC41D	0·85	2N2905A	0·22	2N4923	0·46*
BC107	0·09	BC214	0·14*	BD237	0·55*	BSX21	0·20	CRS1/10	0·25	SC41F	0·60	2N2926R	0·10*	2N5060	0·20*
BC107B	0·09	BC214L	0·14*	BD238	0·60*	BSY95A	0·12	CRS1/20	0·35	ST2	0·20	2N29260	0·09*	2N5061	0·25*
BC108	0·09	BC237	0·16*	BD184	1·20	BT106	1·00	CRS1/40	0·40	TIP29A	0·44	2N2926Y	0·09*	2N5062	0·27*
BC109	0·09	BC238	0·16*	BDY20	0·80	BT107	1·60	CRS1/60	0·65	TIP30A	0·52	2N2926G	0·10*	2N5064	0·30*
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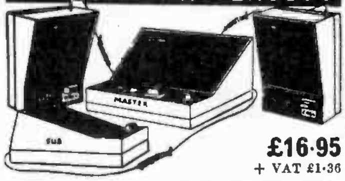

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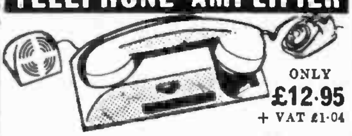

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Relaxation Oscillator Circuits

By P. YAP

WHEN faced with a choice of an audio oscillator design for a circuit, the first type that comes up in the constructor's mind is the astable multi-vibrator. This circuit is not, however, without its disadvantages, among which are: the mark-space ratio of the simple circuit cannot be more than about 10:1; the necessity for two timing capacitors; the emitter-base junctions must be protected by two silicon diodes if the supply voltage exceeds the emitter-base reverse breakdown voltage, which is about 7–8V in modern silicon planar transistors; and finally, high current loads require the use of low-value base resistors and correspondingly large capacitors for given frequency.

This article introduces two other types of relaxation oscillators that may be more suitable for certain applications.

COMPLEMENTARY ASTABLE

The complementary astable circuit requires only one timing capacitor and the working frequency can be selected from 5kHz to 0·1Hz by the choice of an appropriate capacitor. There is no reason why it should not work beyond these frequencies, though the author has not tested this. It has also been found to work with a supply voltage as low at two volts.

Referring to Fig. 1, when power is applied to the circuit, both transistors are off. The capacitor C commences to charge through R1, R3 and R4 and when the voltage across C reaches 0·6V, transistors TR1 and TR2 turn on, pulling the potential of point *A* to 0V. The capacitor then charges very rapidly through R3 and the emitter-base junction of TR1 with the polarity shown.

The charging current keeps the transistors hard on, and when the sum of this current and that through R1 drops to a level sufficient to take TR1 out of saturation, the voltage at *A* rises. This change is communicated through C and causes rapid switch-off. R1 then discharges C, the voltage at the base of TR1 falling from approximately $2V_S$ to $V_S - 0{\cdot}6V$, to repeat the cycle.

Since R1 does not have to (in fact, must not) saturate TR1, as in the case of the astable multivibrator, high values can be used. Values of up to 10 megohms have been used by the author. Thus long periodic times can be obtained with small Cs.

The on-time is governed by C, R3 and the off-time by C, R1. Since R1 is up to 1,000 times greater than R3 typically, the frequency of operation is wholly determined by R1. A simplified analysis yields frequency, $f = 1{\cdot}4/R1C$.

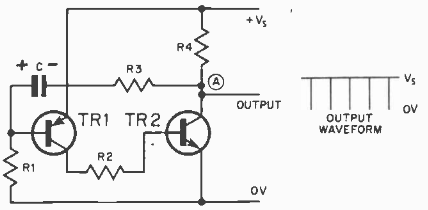

Fig. 1. A basic complementary astable circuit. The transistors should be silicon types

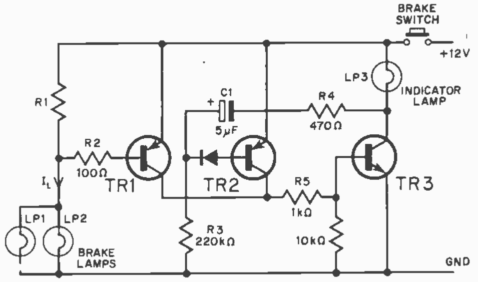

Fig. 2. A car brake-lamp failure indicator. All transistors are silicon types—TR3 must be capable of carrying the indicator lamp current

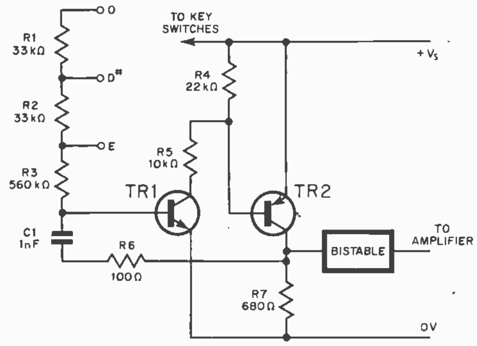

Fig. 3. A simple organ circuit based on the complementary astable. The range of notes can be extended by adding further resistors above R1

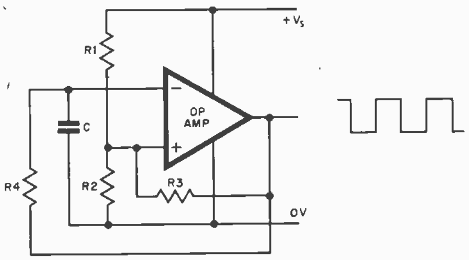

Fig. 4. An operational amplifier square wave generator

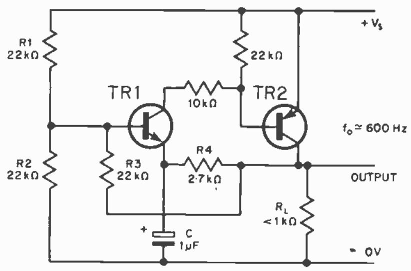

Fig. 5. A complementary astable square wave generator derived from the circuit of Fig. 4

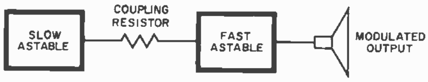

Fig. 6. A "warbling" modulated output can be obtained by interconnecting two astable square wave generators as shown here. The input connection to the second astable is made at the base of TR1 (Fig. 5 above)

In the event that the supply voltage exceeds the e-b breakdown voltage of TR1 a diode may be inserted in series with the base of TR1 for protection.

Pulses of opposite polarity may be obtained by reversing the polarity of all transistors, diodes and capacitors (if polarised), as well as the supply.

SOME TYPICAL APPLICATIONS

As the circuit gives a short duty cycle, it is suitable as a lamp flasher. Fig. 2 shows a brake lamp failure indicator. If the lamps are functional, the voltage across R1 turns on the lamp via TR1 and TR3. If there is a failure, TR1 remains off and TR2 functions as an oscillator in conjunction with TR3.

As we have shown, the frequency is determined by one resistor and one capacitor. This makes it suitable for the simple organ circuit in Fig. 3. As the waveform is not pleasant to listen to, it is squared by a bistable. The values of the resistors required in the chain can be calculated from the fact that to decrease the frequency by one semitone, the total resistance in the circuit must be multiplied by the twelfth root of 2.

SQUARE WAVE OSCILLATOR

The square wave oscillator is best understood by first considering the op amp version in Fig. 4. At switch-on the capacitor is discharged Since the non-inverting input is more positive than the inverting input, the output is at V_S and the voltage at the non-inverting input $2/3V_S$. Capacitor C charges to this voltage whereupon the output drops to 0V and the voltage at the non-inverting input to $1/3V_S$. The capacitor then discharges to this voltage to repeat the cycle.

A square wave is available at the output, the frequency of which is determined mainly by R4 and C. The hysteresis is fixed by R3. For a 1:1 mark-space ratio R1 = R2. A triangular waveform is available from the top end of C but it must be buffered to avoid loading C unduly, especially at high values of R4.

If the load is of low resistance, we can dispense with the active pull-down at the output. Also if the current through R4 is much greater, then we can dispense with the differential pair if the comparator current is small.

Thus we arrive at the circuit in Fig. 5. Some typical component values are given. R_L can be a high impedance speaker or a speaker transformer. The only point to watch is that TR2 has sufficient base drive to saturate on the positive half-cycles.

The oscillator can be modulated by another waveform injected at the base of TR1. Thus in conjunction with a slower oscillator of similar design, a warbling circuit as in Fig. 6 can be built.

This circuit can be used for electronic doorbells, warning alarms, tone generators and any other application the ingenuity of the experimenter can devise. ★

NEWS BRIEFS

British Amateur Television Club

THE B.A.T.C. is holding its next Amateur Television Convention on Saturday, September 18 in Parkinson Court at the University of Leeds, from 10 a.m. until 5.30 p.m.

Admission will be free, and everyone with an interest in amateur television will be most welcome. There will be displays and demonstrations of members' equipment. including slow scan as well as 625 line systems. In addition, there will be some trade stands and a bring-and-buy stall.

Further details are available from A. R. Watson, Somerby View, Bigby, Barnetby, South Humberside.

Museum Piece

THE National Wireless Museum has now opened in the Isle of Wight, and is situated at Arreton Manor, home of Count and Countess Slade de Pomeroy.

One of the more interesting exhibits is a genuine 30-line Televisor made by J. Logie Baird in the late twenties, but also on show are antique crystal sets with cat's whiskers; one in the form of Felix the Cat who kept on walking!

The National Wireless Museum is under the auspices of the Wireless Preservation Society, a non-profit making organisation exclusively devoted to the collection, restoration and preservation of old wireless, television and sound-reproduction equipment for purely cultural, historical and educational purposes.

On Show

THE British Amateur Electronics Club's summer Exhibition will take place on July 17 to 24. Held at the Shelter at the centre of the Esplanade, Penarth, South Glamorgan, the show will be open every night from 7 p.m. and the afternoons of July 17, 18 and 24.

A wide range of projects from members in all parts of the country will be on show, including projects built from articles appearing in Practical Electronics and Everyday Electronics.

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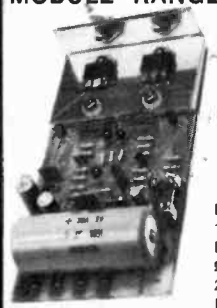

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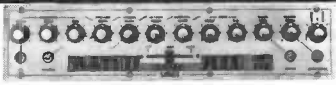

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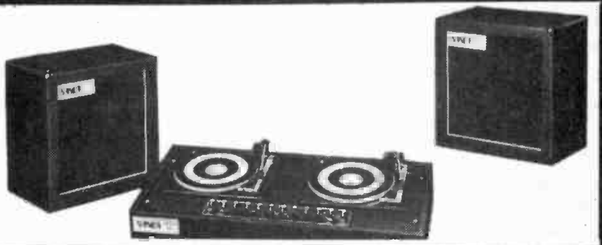

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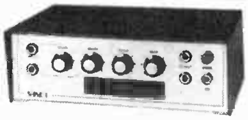

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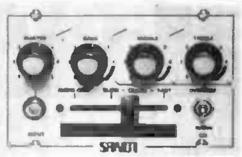

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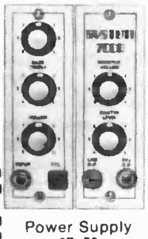

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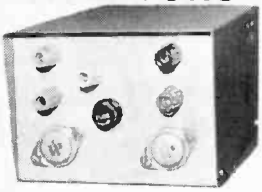

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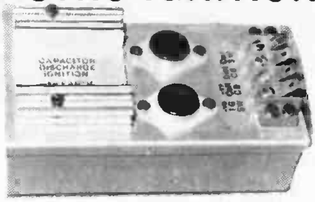

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INDUSTRY NOTEBOOK

By Nexus

IT'S ACTION YEAR

Half way through 1976 we can already see that this is "Action Year" in electronics. The hard-pressed consumer sector has had some relief from reduction in VAT but, alas, not until severe and, in some cases, irreversible damage had been done.

The All-Electronic Show in April and the IEA-Electrex Show in May both demonstrated present buoyancy and optimism for the future. The latter, in the new National Exhibition Centre at Birmingham, spurted into life after the slackest opening day ever experienced.

At first it looked as if the critics would be right and that the move from London to Birmingham would be the monumental flop they had been predicting. Day two saw the first big rush and then it was all go until the close.

The smaller "intimate" and often specialist exhibitions which have grown greatly in popularity in recent years have posed a big threat to the "spectacular" event. Now it seems that the large exhibition is fighting back, assisted by a setting worthy of such occasions.

One wonders, of course, how many of the 70,000 visitors were there for the novelty of a new venue. Not too many, I suspect, because so many of the exhibitors came away smiling. The crunch comes when the thousands of enquiries are followed up and the cost of exhibiting is analysed in terms of cost per enquiry and the conversion rate of enquiries into orders.

Even exhibiting very modestly at a big exhibition can cost as much as a salesman on the road for a whole year. On the other hand, a single order from an unexpected visitor may more than pay all the exhibition costs. It's a gamble which most companies are willing to accept.

The next IEA show will again be at Birmingham in 1978. After that it is expected to switch to a three-year cycle with Germany's Interkama and France's Mesucora.

EEA REPORT

Action Year was again confirmed by the annual report of the Electronic Engineering Association. During the past 18 gloomy months I have often commented that the capital goods sector has been holding up exceptionally well. Total output in 1974 was up 20 per cent over 1973 and last year with output at £1,090 million represented a further gain of 23 per cent. Direct exports were 40 per cent for both years. Best of all, the capital goods sector increased its positive trade balance (i.e. excess of exports over imports) from £6 million in 1974 to £96 million in 1975.

The lead time in capital goods between obtaining an order and its delivery completion is frequently two years or more and so it can be argued that to some extent the capital goods sector has been living on past orders. One factor, for example, which pushed the ground radio communications figures up substantially was the start of delivery in quantity of Clansman radios for the British Army and for export.

Inflation has had a serious effect on total production costs while selling prices have not risen comparably because of market pressures and the necessity in many cases of having to contract at fixed prices. This, together with high taxation, has depressed profits.

Last year was difficult for capital goods as, indeed, for everyone, but there were many bright spots, the brightest of all being in medical electronics and X-ray equipment due almost entirely to the rush of overseas orders for the EMI-Scanner equipment.

The Ministry of Defence remains the biggest single customer for the capital goods sector and despite the pressures for defence cuts it is likely that the requirements for all three services for electronic equipment will rise rather than fall during the next five years.

Overall, the capital goods sector is well poised for further expansion, provided the Government takes a realistic view and lets industry get on with the job. This was, in fact, the view of retiring EEA president, Commander D. W. Malim, in his speech at the Association's annual dinner.

Unhappily, the guest of honour Mr. Eric Varley, Secretary of State for Industry, in replying said little to dispel the fears of industry leaders that Government tinkering, if not outright interference, would continue. But Mr Varley, in praising and welcoming the "historic agreement" with the TUC on wage restraint did hold out the hope of economic stability through to 1978 and this was the only crumb of comfort. Glowing talk of the merits of the National Enterprise Board and tripartite agreements failed to impress his listeners.

Now, Peter Bates, divisional manager of Plessey Radar, takes up the reins of presidency of the EEA.

MARINE SALES

Three British companies have had notable recent success in marine electronics.

Decca Radar, still retaining world leadership in civil marine radar, recently took its 70,000th order. It came through the Belgian agent and the radar is scheduled for fitment in a 15,000dwt cargo ship. Recent orders included one for 15 radars for the Peoples' Republic of China.

Marconi Communications Systems has won its largest single export order ever for naval communications equipment for the Royal Netherlands Navy. The contract, worth £8 million, is for equipment for the new "S" Class frigates, the first of which starts sea trials in 1978. This is a particularly important breakthrough for Marconi as it is customary for countries in NATO to source equipment, where possible, from their own manufacturing industry and the Netherlands has plenty of indigenous capability.

Described as based on the ICS-3 system developed by Marconi for the Royal Navy, the equipment for the Royal Netherlands Navy will provide all external communications with land, sea and air. Philips equipment will, however, be used for internal communications, both video and audio, and for message switching.

Our third good-news marine story concerns the £300 million 700ft high oil production platform which Burmah Oil will place in position in the North Sea later this year. The huge structure will be towed out on its side and up-ended in position and settled on the sea bed by controlled flooding of the ballast tanks in the main legs.

The whole operation will be by remote control using nearly £1 million of electronic equipment supplied by EMI Electronics. This might seem a lot of money until one realises that 150 functions of the structure will be controlled, monitored and recorded. The digital data system will transmit 200 platform status indications, 60 analogue indications and 150 control signals. Let's hope it all works!

PATENTS REVIEW...

LIE DETECTOR BP 943 012

L. Ron Hubbard, inventor of Scientology, holds a patent on an electric gadget for members' use as a lie detector. The patent is dated 1960 (BP 943 012), and if a current attempt by Hubbard to have its normal life extended fails, the patented circuit will fall into the public domain in July, 1976.

The basic theory is shown in Fig. 1. A bridge has, as one side, resistors R1, R2, forming a potential divider of ratio 4 : 1 and, as its other side, a 1·5 volt battery B1 and a 6 volt battery B2.

Electrode terminals are provided at AB for grasping by a human subject. Terminal A is connected via a 5kΩ pre-set potentiometer VR1 to junction *X* of R1, R2 and terminal B is connected via VR2 slider, a 20 kΩ linear potentiometer, across battery B2. The junction *Y* of B1, B2 is connected to electrode A by the d.c. amplifier shown in Fig. 2 and comprising *pnp* transistors TR1, TR2 and TR3. Full circuit details and values are given in the patent specification.

A meter ME1 is switchable between a shunt position for transit and connection to TR3 collector for use. In use, the subject grasps electrodes A, B, and control VR2 is adjusted for a null on the meter. Any slight subsequent change in the resistance between A and B will affect the base current of transistors TR1 and TR2 to alter the collector current at TR3 and cause a substantial deflection of the meter. Such a change of resistance between the electrodes A, B, will be caused by any variation in the grasp of the subject, any tendency to perspire or any change in the characteristic resistance of the body cells.

Although the meter is intended for use by Scientologists to help them attain the so-called state of "clear", informed opinion is that it can, when used with a carefully graded set of questions, serve as a highly accurate lie detector.

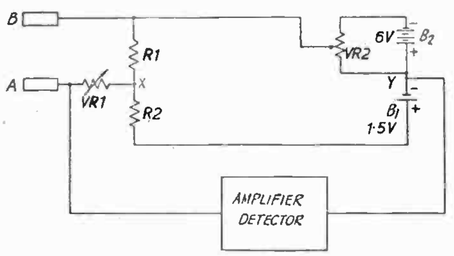

Fig. 1

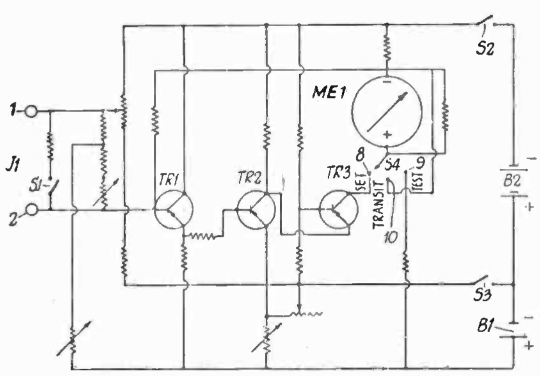

Fig. 2

IN BRIEF

BP 1 426 242—Industrie Pirelli: *Device for Detecting Variations in a Physical Characteristic of a Wheel.* Devices exist to signal abnormal tyre pressure to a driver and sound an alarm. The difficulty is always communicating between the air pressure sensor on the moving wheel and the fixed axle.

Pirelli have patented an ultrasonic excitor and detector system to combat this problem. An air pressure sensitive switch brings a pair of signal transfer coils into circuit as soon as abnormal conditions arise.

BP 1 427 238 — Shalako International Inc.: *Providing Electronic Restoration of Speech Discrimination in Aurally Handicapped Persons.* A hearing aid system that splits the audio frequency band into a number of sub-bands and boosts individual bands independently and to the necessary extent. Enables hearing defects at various frequencies to be separately corrected and so produce an overall flat hearing response.

BP 1 426 492—Matsushita Electric Industrial Co. Ltd.: *Electric Remote Control Apparatus.* Existing ultrasonic remote controls for television and the like may suffer interference from domestic noise sources (e.g. one commercially available ultrasonic switch can be triggered by the overtones in the sound of a vacuum cleaner). Radio remote controls are similarly prone.

To overcome these problems the Matsushita device uses a combination of both radio and ultrasonic signals, reception of an ultrasonic command opening a gate to allow reception of a radio command, or *vice versa.* In practice it is unlikely that the system can be legally used in the U.K., except possibly on the already cluttered model control band, owing to the Home Office regulations on radio transmission.

Copies of Patents can be obtained from the Patent Office Sales, St. Mary Cray, Orpington, Kent Price 75p each

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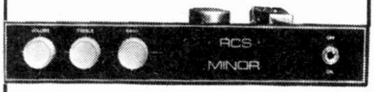

This kit is suitable for record players, tape play back, guitars, electronic instruments or small P.A. systems. Two versions are available. A mono kit or a stereo kit. The mono kit uses 13 semiconductors. The stereo kit uses 22 semiconductors with printed front panel and volume, bass and treble controls. Spec. 10W output into 8 ohms, 7W into 15 ohms. Response 20c/s to 30kc/s, input 100M.V. high imp. Size 9½in × 3in × 2in.

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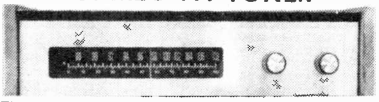

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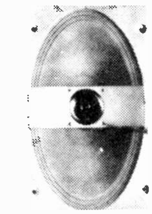

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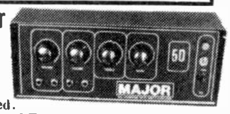

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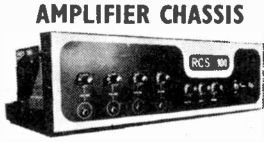

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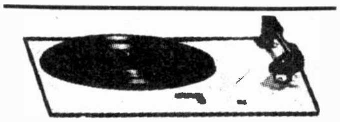

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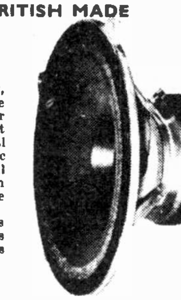

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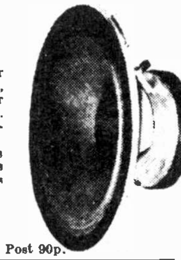

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7400	0·16
7401	0·16
7402	0·16
7403	0·16
7404	0·26
7405	0·22
7406	0·42
7407	0·42
7408	0·28
7409	0·28
7410	0·16
7411	0·25
7412	0·30
7413	0·36
7416	0·36
7417	0·36
7420	0·16
7422	0·25
7423	0·37
7425	0·87
7427	0·37
7428	0·40
7430	0·16
7432	0·37
7433	0·87
7437	0·37
7438	0·87
7440	0·22
7441AN	0·92
7442	0·79
7450	0·16
7451	0·16
7453	0·16
7454	0·16
7460	0·16
7470	0·36
7472	0·38
7473	0·41
7474	0·42
7475	0·59
7476	0·45
7480	0·60
7482	0·87
7483	1·10
7484	1·00
7486	0·47
7490	0·55
7491AN	1·00
7492	0·70
7493	0·70
7494	0·80
7495	0·80
7496	0·95
7497	3·87
74100	1·89
74107	0·45
74110	0·58
74111	0·86
74118	0·90
74119	1·68
74121	0·50
74122	0·70
74123	1·00
74141	0·90
74145	1·26
74150	1·75
74151	1·00
74154	2·00
74155	1·00
74156	1·00
74157	0·95
74170	2·52
74174	1·57
74175	1·10
74176	1·26
74190	2·00
74191	2·00
74192	2·00
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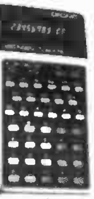

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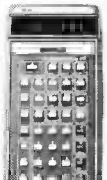

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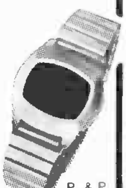

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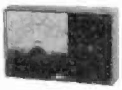

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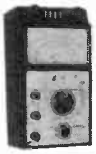

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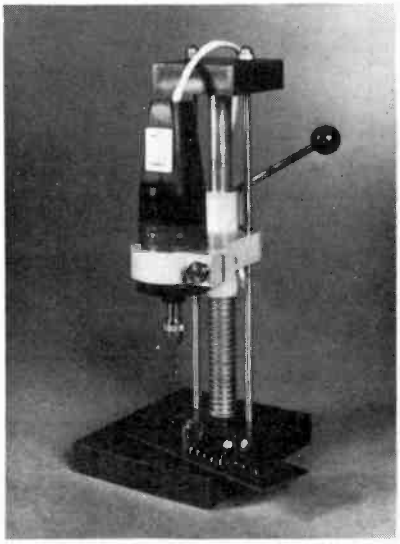

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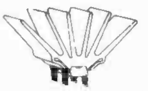

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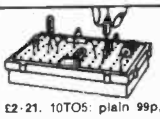

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107	6·0	15·21
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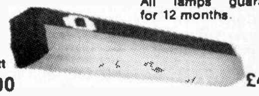

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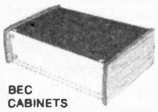

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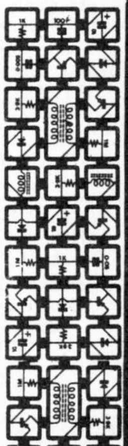

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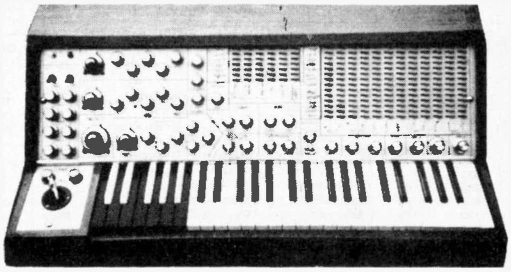

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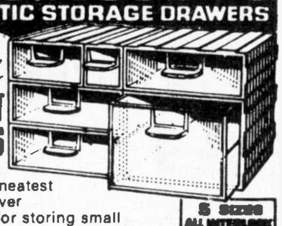

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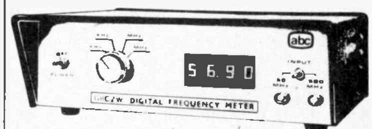

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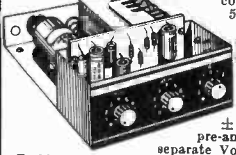
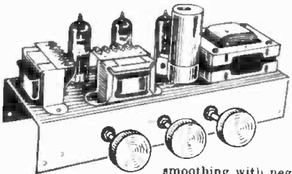
SUPERSOUND 13 HI-FI MONO AMPLIFIER



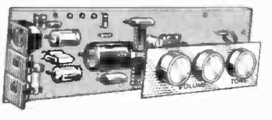
A superb solid state audio amplifier. Brand new components throughout. 5 Silicon transistors plus 2 power out-put transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz. 30KHz ±3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high × 6" wide × 7½" deep. AC 200/250V. PRICE £13·75. P. & P. £1·00.

DE LUXE STEREO AMPLIFIER



A.C. mains 200-240 v. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line-up:-2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11"w × 4"d. Overall height including valves 5". Ready built and tested to a high standard. £12·40. P. & P. £1·30.

HARVERSONIC STEREO 44



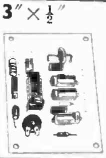
A solid state stereo amplifier chassis, with an output of 3·4 watts per channel into 8 ohm speakers. Using the latest high technology integrated circuit amplifiers with built in short term thermal overload protection. All components including rectifier smoothing capacitor, fuse, tone control, volume controls, 2 pin din speaker sockets and 5 pin din tape rec./play socket are mounted on the printed circuit panel, size approx. 9½" × 2¾" × 1" max. depth. Supplied brand new and tested, with knobs, brushed anodised aluminium 2 way escutcheon (to allow the amplifier to be mounted horizontally or vertically), at only £7·50 plus 50p P. & P. Mains transformer with an output of 17V a/c at 500 m/a can be supplied at £1·50 plus 40p P. & P. if required. Full connection details supplied.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0–210–240v. Secondary combinations 0–5–10–15–20–25–30–35–40–60v. half wave at 1 amp. or 10–0–10, 20–0–20, 30–0–30v. at 2 amps full wave. Size 3in. long × 3½in. wide × 3in. deep. Price £2·90. P. & P. 90p.

MAINS TRANSFORMER. For power supplies.
Pri. 200/240v. Sec. 9–0–9 at 500 mA. £1·50. P. & P. 60p.
Pri. 200/240v. Sec. 12–0–12 at 1 amp. £1·65. P. & P. 60p.
Pri. 200/240v. Sec. 10–0–10 at 2 amp. £2·35. P. & P. 90p.
Pri. 200/240v. Sec. 23v. at 1·5 amp, 6v. at ·6 amp, 8v. at 50 mA. £2·00 + 65p P. & P.

GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER
For P.U. Tape, Mike, Guitar, etc. and suitable for use with valve or transistor equipment. 9-18v. battery or from H.T line 200/300v. Frequency response 15Hz—25KHz. Gain 26dB. Solid encapsulation size 1¾" × 1¼" × ¾". Brand new complete with instructions. Price £1·60 P. & P. 15p.

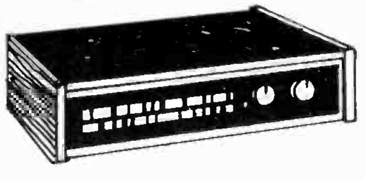
STEREO-DECODER SIZE 2" × 3" × ½"



Ready built. Pre-aligned and tested. Sens. 20-560mV for 9-16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. £5·62 plus 20p P. & P. Stereo beacon light if required 40p extra.

QUALITY RECORD PLAYER AMPLIFIER MK. II
A top quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in wide × 3in deep × 6in high. Ready built and tested. PRICE £6·20. P. & P. 90p.
ALSO AVAILABLE mounted on board with output transformer and speaker. PRICE £7·30. P. & P. £1·00.

HARVERSONIC MAINS OPERATED SOLID STATE STEREO FM TUNER



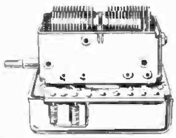
Designed and styled to match our 10 + 10 amplifier but will suit any other standard stereo amplifier. The design incorporates the very latest circuitry techniques with high-grain, low noise IF stages. Automatic frequency control to "lock on" station and prevent drift. IC stereo decoder for maximum stereo separation. L.E.D. for stereo beacon indicator. Nominal output of tuner 100mV. Approximate size 12¼in wide × 8in deep by 2¾in high. Supplied ready built, fully tested and fully guaranteed. AC mains 200/240V (not available in kit form).

Special Offer £22·50 + £1·40 P. & P.

LATEST ACOS GP91/1SC mono compatible cartridge with t/o stylus for LP/EP/78. Universal mounting bracket. £1·60. P. & P. 18p.
CERAMIC STEREO CARTRIDGE. Universal mounting brackets and turnover stylus. 70mV per channel output. ONLY £1·90. P. & P. 18p.
SONOTONE 9TAHC COMPATIBLE STEREO CARTRIDGE T/O stylus Diamond Stereo LP and Sapphire 78. ONLY £2·36. P. & P. 10p. Also available fitted with twin Diamond T/O stylus for Stereo LP. £2·86. P. & P. 18p.
LATEST CRYSTAL T/O STEREO/COMPATIBLE CARTRIDGE for EP/LP/Stereo 78. £1·80. P. & P. 18p.
LATEST T/O MONO COMPATIBLE CARTRIDGE for playing EP/LP/78 mono or stereo records on mono equipment. Only £1·58. P. & P. 18p.

SPECIAL OFFERS

Mullard LP1159 RF-IF Double Tuned Amplifier Module for nominal 470kHz. Size approx. 2¼" × 1¼" × ¾" 7·6V + earth. Brand new pre-aligned. Full specification and connection details supplied. £2·25 + P. & P. 12p.



Pye VHF/FM Tuner Head covering 88-108M/Hz. 10·7M/Hz IF output 7·8V + earth. Supplied pre-aligned, with full circuit diagram. Connection details supplied. Beautifully made with precision-geared FM and 323 Pf + 323 Pf AM Tuning Gang only £3·15 + P. & P. 35p.

PRECISION MADE
Push Button Switch bank. 8 Buttons giving 16 S/P C/O interlocked switches plus 1 Cancel Button Plus 3 d/p c/o. Overall size 5" × 2¼" × 1". Supplied complete with chrome finished switch buttons 2 for £1·50 + 20p. P. & P.

HI-FI LOUDSPEAKER SYSTEM MkII

Beautifully made simulated teak finish enclosure now with most attractive slatted front. Size 16½" high × 10¼" wide × 9" deep (approx.). Fitted with E.M.I. Ceramic Magnet 13" × 8" bass unit, H.F. tweeter unit and crossover. AVAILABLE IN NOMINAL 4 ohm, 8 ohm or 16 ohm impedance (state which).

OUR PRICE £12·00 each. Carr. £1·90

Cabinet Available Separately £7·25. Carr. £1·40.
Also available in 8 ohms with EMI 13" × 8" base speaker with parasitic tweeter £10·25. Carr. £1·90

LOUDSPEAKER BARGAINS
5in. 3 ohm £1·45, P. & P. 35p. 7 × 4in. 3 ohm £1·69, P. & P. 48p. 10 × 6in. 3 or 15 ohm £2·50, P. & P. 75p. E.M.I. 8 × 5in. 3 ohm with high flux magnet £2·06, P. & P. 50p. E.M.I. tweeter. Approx. 3½". Available 3 or 8 or 15 ohms, £2·00 + 25p, P. & P.

VYNAIR & REXINE SPEAKERS & CABINET FABRICS app. 54 in. wide. Our price £1·50 yd. length. P. & P. 35p per yd. (min. 1 yd.). S.A.E. for samples.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER
Size 11¾" × 14$\frac{11}{16}$" × 1$\frac{3}{16}$" deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz–20kHz. Can be mounted on ceilings, walls. Send S.A.E. for details. Only £7·25 each. P. & P. 75p for one, 90p for two.

OUR PRICES INCLUDE VAT AT CURRENT RATES

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT

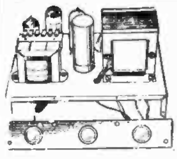
A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board with component identification clearly marked, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specifications: Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ±3dB 12–30,000 Hz Sensitivity: better than 80mV into 1MΩ. Full power bandwidth: ±3dB 12–15,000 Hz. Bass, boost approx. to ±12dB. Treble cut approx. to —16dB. Negative feedback 18dB over main amp. Power requirements 35v. at 1·0 amp. Overall Size 12"w. × 8"d. × 2¾"h.
Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

AMPLIFIER KIT	£13·50	P. & P. 65p
(Magnetic input components 33p extra)		
POWER PACK KIT	£4·85	P. & P. 85p
CABINET	£4·85	P. & P. 85p

Special offer—only £22·50 if all 3 units ordered at one time plus £1·00 P. & P.

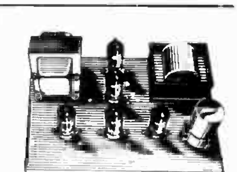
Full after sales service
Also available ready built and tested £29·25. P. & P. £1·00.
Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

3-VALVE AUDIO AMPLIFIER HA34 MK II.



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½"w. × 4"d. × 4¾"h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback 18db. 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 £7·80. P. & P. £1·00.
HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. £7·00. P. & P. £1·00.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15 Ω speaker and 2 independent volume controls, and separate base and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 25p × SAE (Free with parts). All parts sold separately. ONLY £11·25. P. & P. £1·35. Also available ready built and tested £15·20. P. & P. £1·35.

SPECIAL OFFER

Limited number of the latest BSR C141R1 Auto/Manual changer de-luxe. Lightweight tubular arm cue-ing lever bias compensator £12·60 + £1·40 P. & P.
Also similar but without cue-ing lever or bias compensator only £11·00 + £1.40 P. & P.
Now also available 8"-8 ohm. 10 watts r.m.s. 20 watt peak 40 Hz-20,000 Hz. Overall depth 1". Ideal for Hi-Fi or for use in cars. £4·90 + P. & P. (one 35p, two 65p).

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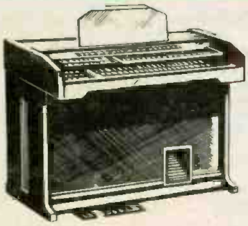

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Get started with a 49 note instrument — features tremulant and reverberation. Ideal to learn on. Leaflet MES 51. Price 15p gives full details to build this complete instrument.

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