

PRACTICAL

ELECTRONICS

JANUARY 1974

20p

**IGNITION
TIMING
LIGHT**

**PE
BORDO**

**LOUDSPEAKER
ENCLOSURE**

*in this
issue...*



HERE'S A NEW YEAR WISH

...that you bring your soldering equipment up to date with Antex!

MODEL CCN

220 volts or 240 volts. The 15 watt miniature model CCN also has negligible leakage. Test voltage 4000v. A.C. Totally enclosed element in ceramic shaft. Fitted long-life iron-coated bit 3/32". 4 other bits available 1/8", 3/16", 1/4" and 3/64" including Heat Shield.

PRICE £2.48 (rec. retail) P & P 8p

MODEL X25

Soldering Iron
220 240 or
100-120 Volts.

The leakage current of the NEW X25 is only a few microamps and cannot harm the most delicate equipment even when soldered "live". Tested at 1500v. A.C. This 25 watt iron with its truly remarkable heat-capacity will easily "out-solder" any conventionally made

MODEL C

Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 3/64" to 3/16". Voltages 240, 220, 110, 50 or 24. PRICE £2.05 (rec. retail) P & P 8p.

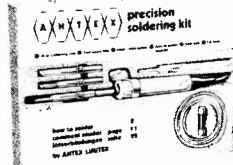
PRICE £2.05 (rec. retail) P & P 8p. Suitable for production work and as a general purpose iron.

40 and 60 watt soldering irons, due to its unique construction advantages. Fitted long life iron-coated bit 1/8". 2 other bits available 3/32" and 3/16". Totally enclosed element ceramic and steel shaft. Bits do not "freeze" and can easily be removed.

MODEL G 18 watt miniature iron, fitted with long-life iron-coated bit 3/32". Voltage 240, 220 or 110. PRICE £2.26 (rec. retail) P & P 8p

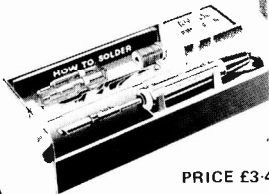
MODEL SK. 2 KIT

Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32" heat sink, solder, stand and "How to Solder" booklet. PRICE £3.25 (rec. retail) P & P 10p



MODEL SK.1 KIT

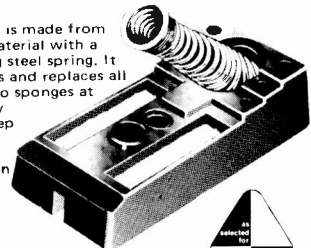
Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet. PRICE £3.48 (rec. retail) P & P 12p.



MODEL MLX KIT

Battery operated 12v. 25 watt iron fitted with 15" lead and 2 heavy clips for connection to car battery. Packed in strong plastic wallet and with booklet "How to Solder". PRICE £2.54 (rec. retail) P & P 12p.

ST3 Stand - This stand is made from high grade insulation material with a chromium plated strong steel spring. It is suitable for all models and replaces all previous stands. The two sponges at the side which are easily replaceable, serve to keep the soldering bits clean. Spare bits can be accommodated as shown on the illustration. PRICE: £1.00 (rec. retail) P & P 10p



PRICE £3.48 (rec. retail) P & P 12p.

ALL PRICES include VAT at 10%



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P. E. 1



PRACTICAL ELECTRONICS

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25/25V 10p	8 + 10/400V 25p	10 + 10 + 10/275V 45p
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100/25V 10p	32 + 32/350V 40p	

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With flared tweeter cone and ceramic magnet, 10 watt. Bass res. 45-60 c/s. Flat 10,000 gauss. State 3 or 8 or 15 ohm. **£2.75** Post 25p

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8 ohm. 10W. Large ceramic magnet. Special Cambria cone surround. Frequency response 30-12,000 c/s. Ideal P.A. £4
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The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 c/s to 18,000 c/s. Size 8 1/2 x 3 1/2in deep. Rating: 10W, 3 ohm. Crossover 95p **£1.90** Post 20p.



GOODMANS 8in. WOOFER

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1-6V d.c. operation over 100 hours continuous on SP2 battery, fully adjustable swing and speed. Ideal displays, teaching electro magnetism or for metronome. **95p** Post 20p

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2 stage triode pentode valve. 3 watts output. Volume on/off and tone controls. Printed circuit A.C. **£4.50** Post 25p

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JACK PLUGS Std. Chrome 20p; 3-5mm Chrome 12p. DIN
SOCKETS Chassis 3-pin 10p; 6-pin 10p. DIN SOCKETS
Lead 3-pin 18p; 5-pin 15p. DIN PLUGS 3-pin 18p; 5-pin 25p.
VALVE HOLDERS 5p; CERAMIC 8p; CANS 5p.

ALL OUR PRICES INCLUDE V.A.T.

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

Comprising a fine example of a Woofer 10 1/2 x 8 1/2 in with a massive Ceramic Magnet, 440z Gauss 13,000 lines. Aluminium Cone centre to improve middle and top response. Also the E.M.I. Tweeter 3 1/2 in square has a special lightweight paper cone and magnet flux 10,000 lines. Crossover condenser and full instructions supplied.

Impedance Standard 8 ohms
Maximum power 12 watts
Useful Response 35 to 18,000 cps
Bass Resonance 45 cps
SUITABLE ENCLOSURE 20 x 13 x 9 in.
MODERN DESIGN. TEAK WOOD FINISH.



£9-90
Post 25p



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

Dual cone plasticised roll surround. Large ceramic magnet. 50-16,000 cps. Bass resonance 55 cps. 8 ohm impedance. 8in. 10 watts, 10in. 12 watts.

£3-75

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Fluted Wood Fronts

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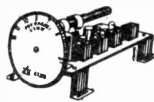
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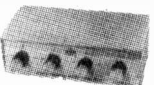
LOUDSPEAKER CABINET
WADDING 18in wide, 15p ft.



BARGAIN AM TUNER.
Medium Wave.
Transistor Superhet **£4-95**
Ferrite aerial, 9 volt.



BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt battery operated. **£3-95**



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As above less cabinet.

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OFFERING 1001 USES for every type of heating and drying applications in the home, garage, greenhouse, factory (available in manufacturing quantities). Approx. size 10 1/2 x 8 1/2 x 1/4 in. Operating voltage 200/250V. a.c. 250 watts approx. Printed circuit element enclosed in asbestos fitted with connecting wires. Completely flexible providing safe Black heat. British-made for use in photocopyers and print drying equipment.

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

ONLY 40p EACH (FOUR FOR £1-50)

ALL POST PAID—Discounts for quantity.

BAKER MAJOR 12" £9-90



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

Module kit, 30-17,000 c/s with tweeter, crossover, baffle and instructions. **£12-50**
Post Free
Please state 3 or 8 or 15 ohms. Post free

BAKER "BIG SOUND" SPEAKERS

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

GROUP "25" **£8-80**
12in 25 watt
3, 8 or 15 ohms. Post Free

GROUP "35" **£9-90**
12in 35 watt
3, 8 or 15 ohms. Post Free

GROUP "50" **£22-00**
15in. 50 watt
8 or 15 ohms.

NEW 12in VERSION £17-60



MAJOR 100 WATT ALL PURPOSE TRANSISTOR AMPLIFIER

All purpose transistorised. Ideal for Groups, Disco and P.A. 4 inputs speech and music. 4 way mixing. Output 8/15 ohm a.c. Mains. Separate treble and bass controls. Guaranteed. Details S.A.E.



£49 Carr. £1-00

CALLERS ONLY! DE-LUXE 100 WATT AMPLIFIER CHASSIS. 7 Valve version, 4 inputs, 10 wide range controls. For Mikes, Discos, Organs, Guitars, etc. 4, 8 and 15 ohm Loudspeaker matching. **£59**

Q MAX CHASSIS CUTTERS

A die, punch and Allen Screw	
Sizes 3/4"	74p
" 1"	83p
Key "T" for above 6p	
" 2"	90p
" 2 1/2"	92p
" 3"	99p
Key "A" for above 6p	
" 1", 1 1/4", 1 1/2" £1-00	
" 1 7/8", 1 3/4" £1-15	
1 1/2", 1 3/4" £1-20	
1 1/2" £1-35	
1 3/4" £1-55	
Sizes 1 1/2"	£1-70
Key "B" for above	10p
" 2"	£2-25
" 2 3/8"	£2-50
" 2 1/2"	£3-30
Key "C" for above 13p	
" 2 1/2"	£4-50
" 3"	£5-75
Key "E" for above	£9-00
" 1" Square, with key	20p
" 1 1/2" Square, with key	£2-10

SPECIAL OFFER

100 ohm Rheostat 2 1/2 in dia. Ceramic former screw terminals 1/2 in dia. spindle. 95p. Post 25p.

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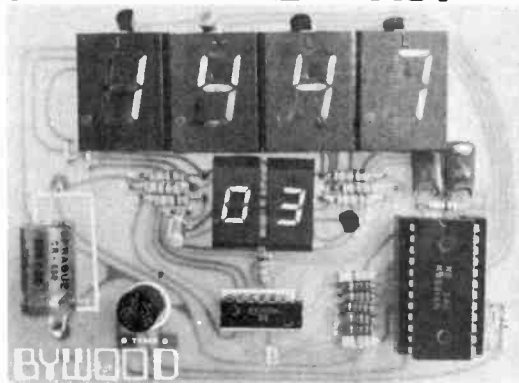
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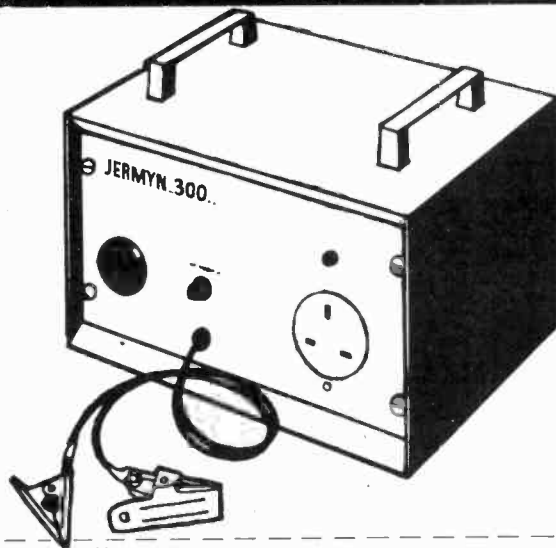
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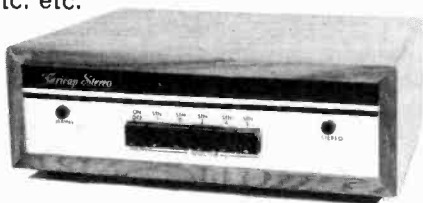
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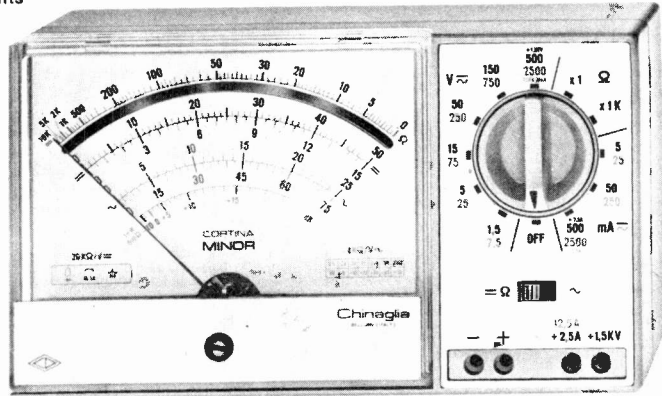


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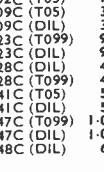
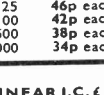
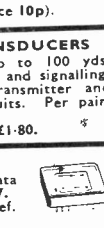
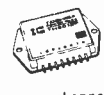
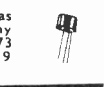
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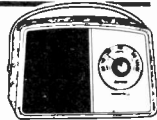


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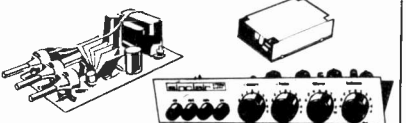
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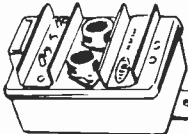
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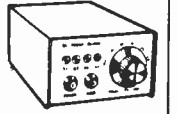
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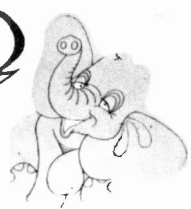


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1N253	0-50	ASV28	0-35	BYZ13	0-35	OAZ222	0-45	ZT43	0-25
1N256	0-50	ASV29	0-30	BYZ15	1-25	OAZ2223	0-45	ZTX107	0-12
1N645	0-25	ASV36	0-35	BYZ16	0-60	OAZ2224	0-45	ZTX108	0-10
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1N914	0-05	ASV61	0-40			OAZ2242	0-35	ZTX304	0-24
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1B119	0-13	ASV65	0-20			OAZ2246	0-25	ZTX603	0-18
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2N697	0-15	AC108	0-12	DD006	0-18	OC24	1-10	7403	0-20
2N698	0-30	BC109	0-12	DD007	0-40	OC25	0-40	7404	0-20
2N706	0-10	BC113	0-18	DD008	0-33	OC26	0-35	7405	0-20
2N708A	0-12	BC115	0-20	GD3	0-33	OC28	0-65	7406	0-40
2N708	0-15	BC116	0-20	GD4	0-10	OC29	0-35	7407	0-40
2N709	0-40	BC116A	0-23	GD5	0-33	OC30	0-40	7408	0-25
2N1091	0-55	BC118	0-15	GD8	0-25	OC35	0-55	7409	0-33
2N1131	0-25	BC121	0-20	GD12	0-10	OC36	0-65	7410	0-20
2N1132	0-25	BC122	0-20	GET102	0-50	OC41	0-35	7411	0-20
2N1302	0-18	BC125	0-35	GET103	0-40	OC42	0-40	7412	0-28
2N1303	0-18	BC126	0-35	GET113	0-35	OC43	0-70	7413	0-30
2N1304	0-22	BC130	0-35	GET114	0-30	OC44	0-18	7414	0-20
2N1305	0-22	BC147	0-12	GET115	0-75	OC44M	0-17	7416	0-30
2N1306	0-22	BC148	0-10	GET116	0-35	OC45	0-18	7417	0-30
2N1307	0-22	BC149	0-12	GET120	0-50	OC45M	0-18	7420	0-20
2N1308	0-22	BC157	0-14	GET872	0-30	OC46	0-27	7422	0-25
2N2147	0-75	BC158	0-12	GET875	0-40	OC57	0-60	7423	0-40
2N148	0-40	BC160	0-33	GET880	0-55	OC58	0-60	7425	0-37
2N2160	0-61	BC169	0-13	GET881	0-25	OC59	0-60	7427	0-37
2N2218	0-22	BCY31	0-45	GET882	0-35	OC68	0-50	7428	0-43
2N2219	0-25	BCY32	0-35	GET883	0-35	OC70	0-18	7430	0-20
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2N2904	0-20	BCY40	0-50	GJ4M	0-38	OC75	0-30	7440	0-20
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2N2905	0-22	BCY70	0-15	GJ7M	0-50	OC77	0-55	7442	0-85
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2B301	0-59	BF196	0-15	NKT218	1-13	OC140	0-80	7486	0-50
2B304	1-15	BF197	0-15	NKT219	0-33	OC141	0-80	7490	0-75
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2B703	1-00	BF891	0-25	NKT224	0-25	OC170	0-25	7492	0-75
AA129	0-20	BFX12	0-20	NKT224	0-25	OC171	0-25	7493	0-75
AAZ12	0-75	BFX13	0-25	NKT271	0-20	OC200	0-55	7494	0-85
AAZ13	0-10	BFX29	0-28	NKT272	0-20	OC201	0-80	7495	0-85
AC107	0-35	BFX30	0-28	NKT273	0-20	OC202	0-90	7496	1-00
AC126	0-25	BFX33	0-98	NKT274	0-20	OC203	0-55	7497	4-82
AC127	0-25	BFX63	0-50	NKT275	0-25	OC204	0-65	74100	0-20
AC128	0-20	BFX63	0-50	NKT275	0-25	OC205	1-00	74107	0-51
AC137	0-20	BFX85	0-28	NKT277	0-20	OC206	1-10	74110	0-57
AC188	0-20	BFX86	0-25	NKT301	0-55	OC207	1-00	74111	0-66
ACY17	0-35	BFX87	0-25	NKT304	0-75	OC460	0-20	74118	1-00
ACY18	0-27	BFX88	0-22	NKT403	0-70	OC470	0-80	74119	1-92
ACY19	0-27	BFY10	1-00	NKT404	0-80	OC771	1-00	74121	0-57
ACY20	0-22	BFY11	1-25	NKT678	0-30	ORP12	0-55	74122	0-80
ACY21	0-22	BFY17	0-25	NKT713	0-30	ORP60	0-45	74123	1-44
ACY22	0-16	BFY18	0-45	NKT773	0-25	ORP61	0-45	74141	1-00
ACY27	0-25	BFY19	0-55	NKT777	0-38	ORP71	0-30	74145	1-44
ACY28	0-25	BFY24	0-45	078B	0-38	SAC40	0-25	74150	2-30
ACY39	0-65	BFY44	1-00	OA6	0-12	SFT308	0-88	74151	1-15
ACY40	0-22	BFY50	0-20	OA7	0-08	ST722	0-38	74152	2-30
ACY41	0-22	BFY51	0-20	OA70	0-10	ST723	0-38	74155	1-15
ACY44	0-32	BFY52	0-20	OA71	0-10	ST7231	0-38	74156	1-15
AD140	0-60	BFY53	0-17	OA73	0-10	SX68	0-20	74157	1-08
AD149	0-50	BFY64	0-45	OA74	0-15	SX631	0-45	74170	2-88
AD161	0-39	BFY90	0-75	OA79	0-10	SX640	0-75	74174	1-80
AD162	0-39	B8X27	0-50	OA81	0-10	SX641	0-75	74175	1-29
AF106	0-30	B8X60	0-93	OA85	0-15	SX642	0-80	74176	1-44
AF114	0-25	B8X76	0-18	OA86	0-15	SX644	0-85	74190	2-30
AF115	0-25	B8Y26	0-18	OA90	0-07	SX645	0-85	74191	2-30
AF116	0-25	BSY27	0-18	OA91	0-07	V15/30P	0-75	74192	2-30
AF118	0-50	BSY51	0-40	OA95	0-07	V15/30P	0-75	74193	2-30
AF118	0-50	BSY95A	0-12	OA200	0-08	V60/201P	0-75	74193	2-30
AF119	0-20	BSY95	0-12	OA202	0-10	XA101	0-10	74194	1-72
AF124	0-30	BT102/500R		OA210	0-25	XA102	0-18	74195	1-44
AF125	0-30	BTY42	0-75	OA211	0-30	XA151	0-15	74196	1-58
AF126	0-30	BTY42	0-92	OA2200	0-50	XA152	0-15	74197	1-58
AF127	0-30	BTY79/100R		OA2201	0-45	XA161	0-25	74198	3-16
AF139	0-30	BTY79/400R	0-75	OA2202	0-45	XA162	0-25	74199	2-88
AF178	0-55			OA2203	0-45	XB101	0-43		
AF179	0-65			OA2204	0-45	XB102	0-30		
AF180	0-55	BY100	0-15	OA2205	0-45	XB103	0-35		
AF181	0-50	BY126	0-14	OA2206	0-45	XB113	0-30		
AF186	0-40	BY127	0-15	OA2207	0-45	XB121	0-30		
AFY19	1-13	BY182	0-85	OA2208	0-45				
AFZ11	1-15	BY213	0-25	OAZ208	0-40	ZR24	0-68		

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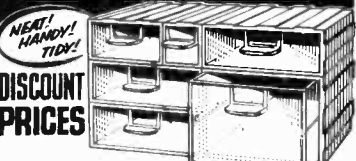


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- 4 Transistor Earpiece Radio
- 7 Transistor Loudspeaker Radio MW/LW
- 2 Transistor Regenerative Radio
- Signal Tracer
- 5 Transistor Short Wave Radio
- 3 Transistor Regenerative Radio
- Transistor Injector
- Electronic Metronome
- Audible Continuity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

TOTAL BUILDING COSTS

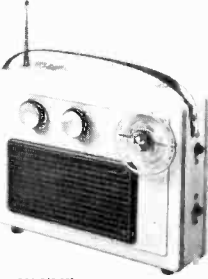
£7-23 P.P. & INS. 44p
(Overseas P.P. £1-85p)
(+10% VAT 72p)

Components include:

- 24 Resistors
- 21 Capacitors
- 10 Transistors
- 31" Loudspeaker
- 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
- 6 1/2 yards of wire
- 1 yard of sleeving, etc.
- Parts price list and plans 60p (free with parts)

NEW ROAMER NINE

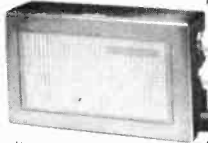
WITH V.H.F. INCLUDING AIRCRAFT



Nine Transistors, 9 Tunable wavebands, a Roamer Ten. Built with ferrite rod aerial for MW/LW. Retractable chrome plated telescopic aerial for VHF and SW. Push Pull output using 600mW transistors. 9 Transistors and 3 diodes. Tuning condenser with VHF section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange. Attractive all white case with red grille and carrying strap. Size 9 1/2in x 7in x 2 1/2in approx. Parts price list and plans 30p (FREE with parts).

TOTAL BUILDING COSTS **£6-95** P.P. & INS. 44p
(+10% VAT 80p) (OVERSEAS P. & P. £1-85)

POCKET FIVE



3 Tunable wavebands. MW/LW and Trawler Band. 7 stages, 5 transistors and 2 diodes. Super-sensitive ferrite rod aerial, moving coil loudspeaker, attractive Black and Gold Case. Size 5 1/2in x 1 1/2in x 3 1/2in approx. Plans and parts price list 15p (FREE with parts).

Total Building Costs **£2-28**
(+10% VAT 22p) P.P. & Ins. 26p (Overseas P. P. £1-25)



TRANSONA FIVE

Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and parts price list 15p (FREE with parts).

Total Building Costs **£2-50** P.P. & Ins. 26p
(+10% VAT 25p) (Overseas P. & P. £1-25)

TRANS EIGHT 8 TRANSISTORS AND 3 DIODES

6 TUNABLE WAVEBANDS, MW, LW, SW1, SW2, SW3 AND TRAWLER BAND. Sensitive ferrite rod aerial for MW and LW. Telescopic aerial for short waves. 3in speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9in x 5 1/2in x 2 1/2in approx. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 25p (FREE with parts).

TOTAL BUILDING COSTS **£4-48** P.P. & INS. 33p
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ROAMER SIX CASE AND LOOKS AS TRANS EIGHT 6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, TRAWLER BAND PLUS AN EXTRA MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. Sensitive ferrite rod aerial and telescopic aerial for short waves. 3in speaker. 8 stages - 6 transistors and 2 diodes, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9in x 5 1/2in x 2 1/2in approx. Plans and parts price list 25p (FREE with parts).

TOTAL BUILDING COSTS **£3-98** P.P. & IN. 31p
(+10% VAT 39p) (OVERSEAS P. & P. £1-85)

NEW EVERYDAY SERIES



Build this exciting New series of designs

EV5 5 Transistors and 2 diodes. MW/LW. Powered by 4 1/2 volt Battery. Ferrite rod aerial, tuning condenser, volume control, and loudspeaker. Attractive case with red speaker grille. Size 9in x 5 1/2in x 2 1/2in approx. Parts price list and plans 15p (FREE with parts).

TOTAL BUILDING COSTS **£2-73** P.P. & INS. 30p
(+10% VAT 27p) (OVERSEAS P. & P. £1-25)

EV6 Case and looks as above. 4 Transistors and 3 diodes. Powered by 9 volt Battery. Ferrite rod aerial, 3" loudspeaker, etc. MW/LW coverage. Push Pull Output. Parts price list and plans 15p (FREE with parts).

TOTAL BUILDING COSTS **£3-60** P.P. & INS. 30p
(+10% VAT 36p) (OVERSEAS P. & P. £1-25)

EV7 Case and looks as above. 7 transistors and 3 diodes. Six wavebands. MW/LW, Trawler Band, SW1, SW2, SW3, powered by 9 volt Battery Push Pull Output. Telescopic Aerial for Short Waves. 3" Loudspeaker. Parts price list and easy build plans 20p. Free with parts.

TOTAL BUILDING COSTS **£4-08** P.P. & INS. 31p
(+10% VAT 40p) (OVERSEAS P. & P. £1-85p)

ROAMER EIGHT Mk. I

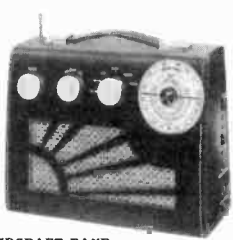
NOW WITH VARIABLE TONE CONTROL



7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND. Built-in ferrite rod aerial for MW and LW. Retractable chrome plated telescopic aerial for short waves. Push-pull output using 600mW transistors. Car aerial and tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Latest 4" 2 watt Ferrite Magnet loudspeaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9in x 7in x 4in approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).

TOTAL BUILDING COSTS **£6-98** P.P. & INS. 47p
(+10% VAT 69p) (OVERSEAS P. & P. £1-85)

ROAMER TEN WITH VHF INCLUDING AIRCRAFT



10 TRANSISTORS. 9 TUNABLE WAVE BANDS, MW1, MW2, LW, SW1, SW2, SW3, TRAWLER BAND, VHF AND LOCAL STATIONS. ALSO AIRCRAFT BAND. Latest 4" 2 watt Ferrite Magnet Loudspeaker. Built-in ferrite rod aerial for MW/LW. Retractable, chrome plated 7 section telescopic aerial, can be angled and rotated for peak short wave and VHF listening. Push-pull output using 600mW transistors. Car Aerial and tape record sockets etc. 10 transistors plus 3 diodes. Ganged tuning condenser with VHF section. Separate coil for Aircraft Band. Volume/on/off, wave change and tone controls. Attractive case in black with silver hickory. Size 9in x 7in x 4in. Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts).

TOTAL BUILDING COSTS **£8-50** P.P. & INS. 52p
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Build Radios, Amplifiers, etc., from easy stage diagrams.

Five units including master unit to construct.

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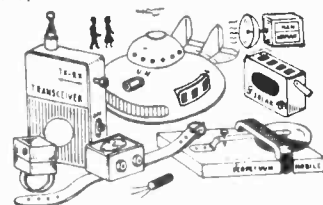


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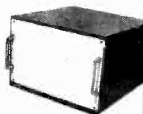


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220	8	6	3	£2-85
221	8	6	6	£2-80
320	12	8	12	£5-00

Chassis for model 320 £1.75 extra. Please send s.a.e. for free illustrated leaflet.

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13 Master Frequencies on ONE tiny circuit board. LOOK AT THESE AMAZING ADVANTAGES

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★ EXTREMELY ECONOMICAL PRICE. ★ Ready built, tested and fully guaranteed. DMO2T (with tremulant) ONLY £14.25.

★ S.a.e. please for full technical details.

Trade enquiries welcome.

DMO2 (without tremulant) £12.25. 8AJ110 7-stage frequency divider in one 14 pin DIL package. Sine or square wave input allows operation from almost any type of master oscillator including the DMO2 (where 97 notes are available). Square wave outputs may be modified to saw-tooth by the addition of a few components. 8AJ110: £2.63 each OR special price for pack of 12: £25.00. S.a.e. please for data sheet.



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741C 8-pin DIL	36p
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SG 3402N Ring Modulator	£1-69
CA 3046	69p

CAPACITORS

Sub-miniature Axial lead electrolytic

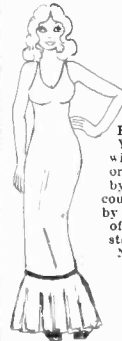
Mfd	V	Price	Mfd	V	Price
1	63	6p	68	6-3	6p
1-5	63	6p	68	16	6p
2-2	63	6p	68	63	10p
3-8	63	6p	100	4	6p
4-7	63	6p	100	10	6p
6-8	40	6p	100	25	6p
6-8	63	6p	100	40	6p
10	25	6p	100	63	12p
10	63	6p	150	6-3	6p
15	16	6p	150	16	6p
15	40	6p	150	25	6p
15	63	6p	150	40	10p
22	10	6p	150	63	12p
22	25	6p	220	4	6p
22	63	6p	220	10	6p
33	6-3	6p	220	16	6p
33	16	6p	220	25	10p
33	16	6p	220	10	15p
33	40	6p	220	40	12p
47	10	6p	330	4	6p
47	25	6p	330	10	6p
47	40	6p	330	16	10p
47	63	6p	330	63	22p
47	63	6p	330	63	22p
47	63	6p	330	63	22p
47	63	6p	330	63	22p
47	63	6p	330	63	22p
47	63	6p	330	63	22p

PLUGS AND SOCKETS



DIN PLUGS	MAINS	R88 8 way chassis socket	Std. 1" stereo plug
2 pin (1 flat) 8p	P360 3 pin 1.5A chassis plug with line's socket. Per pair 24p	52p	Plastic 15p
3 pin 9p	SA 2190 3 pin 5A chassis plug 17p	SA 1862 Line socket for above 19p	Screened 25p
4 pin, 5 pin A (180°), 5 pin B (240°), 6 pin 10p			Open mono socket 1" 10p; Moulded mono socket 1" with 2 break contacts 18p; Moulded stereo socket 1" with 3 break contacts 18p; 3.5mm. plug plastic 8p; screened 11p; screened 8p.
DIN Sockets	McMURDO	JACK	PHONO
2 pin 6p	R18 8 way chassis plug 7p	Std. 1" mono plug Plastic 12p	Plug plastic 5p
3 pin, 4 pin, 5 pin A (180°), 5 pin B (240°), 6 pin 7p		Screened 17p	Plug screened 9p
			Chassis socket 4p

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PP3, 6 etc. battery clip dual nin. 8p.
PP1, 9 etc. battery clip separate per pair 6p.
Pair crocodile clips 1 red, 1 black insulated sleeve 7p.
Solder Multicore 22 s.w.g. 10 metres 20p.
Silicone grease in special dispenser 20ml 48p.
Red neon 240V panel mounting 25p.
Lacing Cord Strong rayon core PVC 25m 48p.
Panel fuse holders 20mm 20p; 14in 30p.

Transformers

LT700 min. output transformer Pri. 1-2kΩ Sec. 5-0 200mW 35p.

Sub-min. Mains Transformer

6-0-6V 100mA 85p. 12-0-12V 50mA 95p. Size: Both approx. 30 x 27 x 25mm.

Min. Mains Transformer

Size: 46 x 31 x 38mm. 0-12V 250mA, 0-12V 250mA £1-86.

Hook-up wire, 7 strand 0.2mm PVC covered tinned copper wire for light general connections up to 1-4A. 11 colours: black, blue, brown, green, grey, orange, pink, red, violet, yellow. 10 metres of any one colour 15p. Pack of 11 (1 of each colour) 10m. coils £1-50.

Single core screened 6p per metre.
Twin individually screened 8p per metre.
High quality single screened 50Ω 100pF per metre. ideal for high grade audio connections 11p per metre.

Mains 3-core sub-miniature 1A black PVC covered 19 strand 0.1mm per conductor. 61p per metre

POTENTIOMETERS

Rotary miniature carbon track 1" spindle

Single gang Lin or Log 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M, 2M (and 1k Lin) 12p



Dual gang (Stereo) without switch Log or Lin 5k to 2M as above 38p.

PRESETS

Sub-miniature 0-1W Vert or Horiz 100, 250, 500, 1k, 2.5k, 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M 6p

Wirewound 10% 1W 1/4" spindle 10.5, 100R 34p; 250, 500, 1k, 5k 33p; 10k, 37p; 25k 40p; 50k 44p.

RESISTORS

Carbon Film 1/4W 5% 1Ω to 1M; 10% 1.2M to 10M E12	1p
Carbon Film 1/4W 5% 1Ω to 10Ω; 10% 1.2M to 10M E12	1p
Carbon Film 1/4W 5% 1Ω to 910k E12 & E24	1p
Carbon Film 1W 5% 10Ω to 10M E12	3p
Metal Oxide 1/4W 2% 10Ω to 1M E12 & E24	4p
Wirewound 1/4W 10% 0.2Ωohms to 0.47ohms E12	10p
Wirewound 1/4W 5% 1ohm to 27ohms E12	10p
E12 values 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and decades	
E24 values 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and decades	

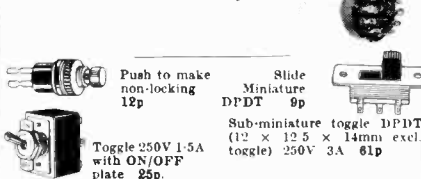
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AD181/2 69p	OC44 20p	0A80 7p
BC107 10p	OC71 20p	0A91 6p
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BC109 10p	2N706 10p	1N4148 4p
BC147 10p	2N1304 30p	1N4001 6p
BC148 10p	2N1711 24p	1N4002 61p
BC149 12p	2N2219 25p	1N4003 7p
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BC169C 12p	2N2905 33p	1N4005 8p
BC182L 12p	2N2907 25p	1N4006 8p
BC204 14p	2N2926 10p	1N4007 9p
BC209C 14p	2N2926Y 10p	W005 30p
BD131 45p	2N2926Z 10p	W04 34p
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BFY94 15p	DIL Sockets 8-pin 25p	
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BA5	4"	2 1/2"	2"	41p
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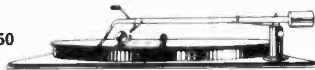
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 1021 For model G240 1" }
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C8 10	Reed Switches	0.55
C9 3	Micro Switches	0.55
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PS 26	Jack 3.5mm Plastic	0.12
PS 27	Jack 1" Plastic	0.24
PS 28	Jack 1" Screened	0.28
PS 29	Jack Stereo Plastic	0.22
PS 30	Jack Stereo Screened	0.32
PS 31	Phono Screened	0.14
PS 32	Car Aerial	0.15
PS 33	Co-Axial	0.17

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PS 1	D.I.N. 2 Pin (Speaker)	0.11
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PS 3	D.I.N. 4 Pin	0.15
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PS 15	Car Aerial	0.15
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CP 9	Speaker Cable	0.04
CP 10	Low Loss Co-Axial	0.10

CARBON POTENTIOMETERS

Log and Lin	Types	Price
47K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M		
VC 1	Single Less Switch	0.14
VC 2	Single D.P. Switch	0.26
VC 3	Tandem Less Switch	0.44
VC 4	1K Lin Less Switch	0.14
VC 5	100K Log anti-Log	0.44

HORIZONTAL CARBON PRESETS

0.1 watt 0.08 each
 100, 220, 470, 1K, 2.2K, 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M, 4.7M

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TTC J-2005	Crystal/Hi Output	95p
TTC J-20 10C	Crystal/Hi Output Compatible	£1.10
TTC J-200 CS	Stereo/Hi Output	£1.60
TTC J-2105	Ceramic/Med. Output	£1.64

CARBON FILM RESISTORS

The E12 Range of Carbon Film Resistors, 1/4 watt available in PAKS of 50 pieces, assorted into the following groups—

R1	50 Mixed 100 ohms-820 ohms	40p
R2	50 Mixed 1K ohms-8.2K ohms	40p
R3	50 Mixed 10K ohms-82K ohms	40p
R4	50 Mixed 100K ohms-1 Meg. ohms	40p

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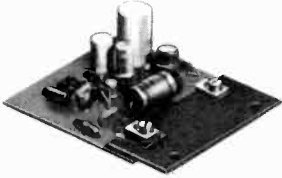
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AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.

The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f = 1KHz	0.25%
LOAD IMPEDANCE	—	8-16 Ω
INPUT IMPEDANCE	f = 1KHz	100 kΩ
FREQUENCY RESPONSE -3dB	Po = 2 WATTS	50 Hz-25KHz
SENSITIVITY for RATED O/P	Vs = 25V. R1 = 8Ω f = 1KHz	75mV. RMS
DIMENSIONS	—	3" x 2 1/4" = 1"

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power out for 2% T.H.D. (RL = 8Ω f = 1KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

AUDIO AMPLIFIER MODULES

AL 10. 3 watts	£2-19
AL 20. 5 watts	£2-59
AL 30. 10 watts	£3-01

POWER SUPPLIES

PS 12. (Use with AL10 & AL20)	88p
SPM 80. (Use with also AL30 & AL50)	£3-25

FRONT PANELS PA 12 with Knobs	£1-00
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PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20)	£4-85
PA 100. (Use with AL30 & AL50)	£13-15

TRANSFORMERS

T461 (Use with AL10)	£1-38 P & P 15p
T538 (Use with AL20)	£1-93 P & P 15p
BMT80 (Use with AL30 & AL50)	£2-15 P & P 25p

PA12 PRE-AMPLIFIER SPECIFICATION

The PA12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with ceramic cartridges while the auxiliary input will suit most magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 132mm x 84mm x 35mm.

Frequency response—	20Hz-50KHz (-3dB)
Bass control—	± 12dB at 60Hz
Treble control—	± 14dB at 14KHz
*Input 1. Impedance	1 Meg. ohm
Sensitivity 300mV	
†Input 2. Impedance	30 k ohms
Sensitivity 4mV	

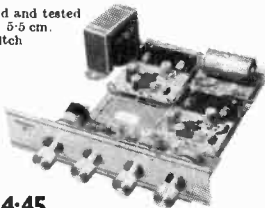
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The STEREO 20

The "Stereo 20" amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 5.5 cm. This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls. Transformer, Power supply and Power amp. Attractively printed front panel and matching control knobs. The "Stereo 20" has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ± 12dB at 60Hz typically 0.25% at 1 watt. Treble con. ± 14dB at 14kHz.

£14-45



50W pk 25w (RMS)

0.1% DISTORTION!
HI-FI AUDIO AMPLIFIER

THE AL50

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

★ Load—3, 4, 8 or 16 ohms.

★ Distortion—better than 0.1% at 1KHz.

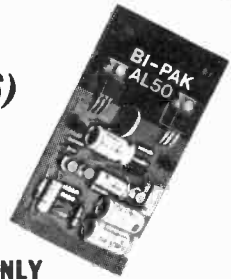
★ Signal to noise ratio 80dB.

ONLY
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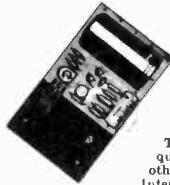
★ Supply voltage 10-35 Volts.

★ Overall size 63mm 105mm x 13mm.

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AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1.6 amps at 35 volts. Size: 63mm x 105mm x 30mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available 10p **PRICE £3-25**

TRANSFORMER BMT80 £2-15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

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

SPECIFICATION

Frequency Response	20Hz—20KHz ± 1dB
Harmonic Distortion	better than 0.1%
Inputs: 1. Tape Head	1.25 mV into 50K Ω
2. Radio, Tuner	35 mV into 50K Ω
3. Magnetic P.U.	1.5 mV into 50K Ω
All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.	
Bass Control	± 16dB at 20Hz
Treble Control	± 16dB at 20KHz
Filters: Rumble (High Pass)	100Hz
Scratch (Low Pass)	8KHz
Signal/Noise Ratio	better than -65dB
Input overload	+ 26dB
Supply	+ 35 volts at 20mA
Dimensions	292mm x 82mm x 35mm

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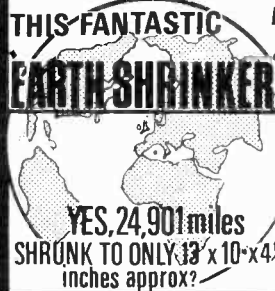
Please send details of: Kit O Kit M
Please send me: Kit O Kit M
I enclose PO/Cheque to the value of £ _____

NAME _____

ADDRESS _____

YES, "YOU'VE GOT THE WHOLE WIDE WORLD IN YOUR HANDS"! ALMOST UNBELIEVABLE! Think of the year 1984 and what might be produced then—now get the fantastic **ASTRAD 17** and SEE for yourself that the incredible Russians have done it all NOW! It's the radio perfectionist's dream come true! **THIS ONE SUPERSEDES ALL EARLIER MODELS!** It will probably make your present radio seem like a "crystal set"! Complete with optional battery eliminator for both battery and mains use! We're almost giving them away at only £18.50—a mere fraction of even today's Russian miracle price! We challenge you to compare performance and value with £80 radios! Send quickly, test on mail order 7 day approval from receipt of goods if not delighted. Or call. Volume controlled from a whisper to a roar that would fill a hall! Much wider band spread for absolute "pinpoint" station selection! Plus "MAGIC EYE" tuning level indicator for ultra perfect tuning sensitivity! Yes, the Russians have surpassed themselves, proving again their fantastic ability in the field of electronics and brilliantly reflecting their advanced micro-circuitry techniques in the field of spacehip and satellite communications. Yes, **EVERY WAVE-BAND** instantly at your fingertips including Standard Long, Medium, Short and Ultra Short Waves to cover the four corners of the earth during 24 hours a day including all normal transmissions. VHF: FM/USW, AM: LW, MW, SW, gets, locally, local & new stations not yet operational, and messages from all over the world! Expensive **TURRET TUNER** side control waveband selection unit (as used on expensive T.V.'s!). Every waveband clicks into position giving incredible ease of station tuning! Genuine push-pull output ON/OFF volume and separate Treble and Bass tone controls for utter perfection of reproduction and tone! Press-button dial illumination! Take it anywhere—runs economically on standard batteries (obtainable everywhere) or direct through battery eliminator from 220/240V AC mains supply. Internal ferrite rod aerial plus built-in "rotatable" telescopic aerial extending to 39 in approx. It's also a fabulous **CAR RADIO**. Can also be used through extension amplifier, tape recorder or public address system. **SIZE** 13in x 10in x 4 1/2in overall approx. Magnificently designed, highly polished cases. Made to give years of perfect service. Purer & sweeter tone than ever. (U.K. service facilities & spares available for years & years to come, if ever necessary!). With **WRITTEN GUARANTEE**, manual with simple operating instructions & circuit diagram. **PLUS** ultra sensitive earphone for personal listening. **ONLY £18.50** (with mains/battery eliminator £2.25 extra) **BOX, POST, ETC. 45p. NO MORE TO PAY! BUT WAIT!** For only 75p extra you get the sensational "COMPUTERISED" **WORLD TUNING GUIDE** (it enables you to zone and time in a flash for transmissions the whole world over—even a child can do it in a flash—it even lets you know when to tune into the U.K. when abroad. **NO GUESSING! NO MESSING!**) **PLUS** Standard 'longlife' batteries and Converter Plug. (Sorry—We cannot change these new radios for any earlier model already purchased.) Send quickly to Uxbridge Road address, or call at either Store. **BUT HURRY!** **SHOPERTUNITIES SAVE YOU £££.**

THOUSANDS OF MILES REDUCED TO INCHES?
LATEST RUSSIAN RADIO TECHNOLOGY
SHRINKS THE WORLD! *COMPUTERISED?



BRAND NEW FABULOUS ASTRAD 17
PORTABLE RADIO & COMMUNICATIONS RECEIVER



28 TRANSISTORS AND DIODES!
WAVEBANDS:
 STANDARD LONG and MEDIUM
Plus 5 SHORT WAVEBANDS
Plus ULTRA SHORT WAVES
 (V.H.F. AM, FM, MW, LW, USW.)

BATTERY MODEL £18.50 **BOX POST ETC. 45p**
MAINS/BATTERY ELIMINATOR £2.25 extra

FIRST TIME EVER!
 *NOW AVAILABLE WITH fabulous **COMPUTERISED** **WORLD TUNING GUIDE!**
NO MORE GUESSWORK!
INSTANT DATA at your fingertips — enables you to **ZONE & TIME IN A FLASH** for transmissions the world over!

THIS OFFER ONLY FROM US!

BUY ONE FROM US! **SAVE £23.03 NOW!**

fabulous BRAND NEW SOLID STATE This equipment got EVERYTHING!

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

WITH REMOTE CONTROL MICROPHONE

OUR PRICE £20.97 **CARR. ETC. 50p** **RECOMMENDED RETAIL PRICE**

Shopertunities "thunder" ahead with an offer that's **FANTASTIC** (even by our standards). We've snapped up 500 magnificent machines. Latest sensation in the world of sound! First-class makers! Fabulous **VHF, AM/FM Radio AND Cassette Tape Recorder & Player** combined & it also runs off standard batteries or mains. (Simply plug in the 220/240V AC line cord). Record and play back anything, anywhere! **IMPORTERS RECOMMENDED WHOLESALE PRICE £44!** **WE OFFER AT UNBEATABLE HALF PRICE!** Wonderful features: ★ Press-button Keyboard Control Panel or latest **MASTER SWITCH CONTROL!** ★ "MAGIC EYE" Visual Battery check/recording level indicator or built-in automatic Leveller! ★ Separate ON/OFF and HI-LO volume controls! ★ Heavy duty built-in speaker! ★ Earphone (for personal listening or "monitoring") and extension speaker sockets! ★ Remote control microphone! ★ Built-in swivel telescopic extension aerial approx. 11" Magnificently made case with carry handle. (DESIGNS VARY SLIGHTLY.) Takes standard 30, 60, 90 or 120-minute Cassette Tapes, obtainable everywhere. **AND** the amazing built-in full circuit **VHF, AM/FM Radio** gives you superb clarity of tone, incredible station selection. Unique rotating Station Selector Dial—gets, locally, locality and regional stations in every part of the country, plus B.B.C. National, VHF. Picks up dozens of foreign stations. **Fabulous in your car!** You could pay £45 more for a Car Radio or Car Cassette player **ALONE!** **£10.95, post, etc. 50p. NO MORE TO PAY!** Complete with simple instructions, remote control microphone with on/off switch and microphone stand. **WITH WRITTEN GUARANTEE.** Send quickly, test on mail order 7 day approval from receipt of goods, refund if not delighted. Or call. **BONUS OFFER:** Batteries and Cassette Tape 28p extra if required. **Callers: ACCESS & BARCLAY CARDS ACCEPTED AT BOTH STORES**

FIRST TIME EVER! *SAVE £16.02!

BRAND NEW AC/DC BATTERY/MAINS

Cassette TAPE RECORDER & PLAYER

FIRST CLASS MAKERS

With remote control microphone.

WE COULD CHARGE UP TO £26.97!

OUR PRICE £10.95 **POST ETC. 50p**

THE ONE STEP FORWARD EVERYONE HAS WAITED FOR! **NOW** a superb de-luxe portable **BATTERY/MAINS** tape recorder and player—and incredible Shopertunities bring it to you for **ONLY £10.95**. Due to our cut price we cannot name first-class makers—but rest assured you're getting one of the **BEST!** Expensive "PIANO KEYBOARD" CONTROL PANEL (or latest **MASTER SWITCH** control) **AND** **AUTOMATIC LEVEL CONTROL**. No fiddling with awkward tape and reels, just "slap-in" a cassette and off you go! (Takes 30, 60, or 90 minute standard cassette tapes obtainable everywhere.) Amazing performance ensures perfect tapings and superb reproduction! Remote control microphone. Rapid Rewind! Fast forward! Beautiful tone from a whisper to a roar! Complete—record anywhere, indoors or out! Runs on standard batteries **AND 220/240V AC** mains. Separate jacks for remote control microphone, etc. Size 9 1/2in x 5 1/2in x 2 1/2in approx. Design can vary slightly. With carry handle. **WRITTEN GUARANTEE** and full instructions. (Importers recommended selling price £26.97!) **OUR PRICE ONLY £10.95, post, etc. 50p. NO MORE TO PAY!** Send and Test, on mail order 7 day approval from receipt of goods—refund if not delighted. Or call at either of our stores. **BONUS OFFER** (Rationed 1 per customer)—Cassette tape, Standard batteries AND microphone stand 55p extra if required.

Order by post to Uxbridge Road address or call at either store.
 Bargains galore at both stores.—(COMMERCIAL TRAVELLERS PLEASE
 NOTE: Merchandising office at Holborn Store.)

SHOPERTUNITIES LTD.

Dept. PN/NC/34, 164 UXBIDGE RD. (facing Shepherds Bush Green), LONDON W12 8AQ. (Thurs. 1, Fri. 7). Also at 37/39 HIGH HOLBORN (opposite Chancery Lane), LONDON, W.C.1. (Thurs. 7 p.m.) BOTH OPEN MON. TO SAT. 9 A.M. TILL 6 P.M.

Now! A FAST EASY WAY TO LEARN BASIC RADIO & ELECTRONICS



Build as you learn with the exciting new **TECHNATRON** Outfit! No mathematics. No soldering—you learn the *practical way*.

Learn basic Radio and Electronics at home—the fast, modern way. Give yourself essential technical “know-how”—like reading circuits, assembling standard components, experimenting, building—quickly and without effort, and enjoy every moment. B.I.E.T.’s simplified study method and the remarkable **TECHNATRON** Self-Built Outfit take the mystery out of the subject, making learning easy and interesting.

Even if you don't know the first thing about Radio now, you'll build your own Radio set within a month or so!

... and what's more, you will understand exactly what you are doing. The **TECHNATRON** Outfit contains everything you need, from tools to transistors—even a versatile Multimeter which we teach you to use. All you need give is a little of your spare time and the surprisingly low fee, payable monthly if you wish. And the equipment remains yours, so you can use it again and again.

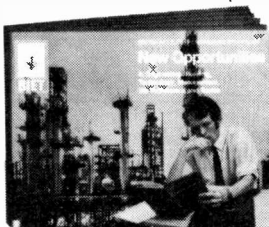
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Among many other interesting experiments, the Radio set you build—and it's a good one—is really a bonus. This is first and last a teaching course, but the training is as fascinating as any hobby and it could be the springboard for a career in Radio and Electronics.

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If you wish to make a career in Electronics, send for your **FREE** copy of “**NEW OPPORTUNITIES**”. This brand new booklet—just out—tells you all about **TECHNATRON** and B.I.E.T.’s full range of courses.



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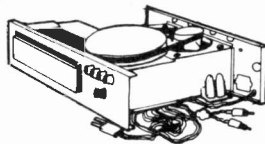
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BI-PRE-PAK AUDIO BARGAINS



8 TRACK ONLY £11

The latest B.S.R. 8 Track cartridge Replay Deck. Ready to install in your Hi-Fi Stereo System. This unit comes complete with Hi Gain Stereo Pre-Amplifier, 4-Programme Indicator Lamps. Track Selector Switch, all leads and plugs, etc. for 230V a.c. mains operation.

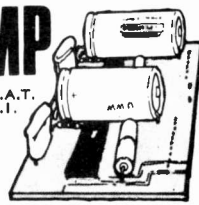
3 W.R.M.S. I.C. AMP

only **£1.65**

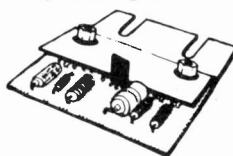
incl. P. & P. and V.A.T. Order Code I.C.A.1.

On P.C. Board with all components or 2 on one board for £2.86. Order Code I.C.A.1/5.

These amps. are supplied with a free booklet on connecting up, specifications and easy-to-build projects using the I.C.A.I.



5W & 10W AMPS



5W ONLY £1.98
10W ONLY £2.49

incl. P. & P. and V.A.T.

These matchbox size amplifiers have an exceptionally good tone and quality for the price. They are only 2 1/2 in x 1 1/2 in. The 5W Amp will run from a 12V car battery making it very suitable for portable voice reinforcement such as public functions. Two amplifiers are ideal for stereo. Complete connection details and treble, bass, volume and balance control circuit diagrams are supplied with each unit. Discounts are available for quantity orders. More details on request. Cheapest in the U.K. Built and tested.

Now available for 5 & 10W AMPS

Pre-assembled printed circuit boards 2 in x 3 in available in stereo only, will fit 0-15 edge connector.

Stereo Pre-Amp 1 (Pre 1). This unit is for use with low gain or ceramic pick-up cartridges. **£1-21**

Stereo Pre-Amp 2 (Pre 2). This unit is for use with magnetic pick-up cartridges. **£1-69**

Stereo Tone Control (STC). This unit is an active tone control board and when used with the right potentiometers will give bass and treble boost and cut. **£1-21**

Instruction leaflet supplied with all units. Post and packing and V.A.T. included in prices.

I enclose £.....for
.....8 Tracks/.....3W Amps/.....5W Amps
.....10W Amps/.....Stereo Pre-Amps 1
.....Stereo Pre-Amps 2.....Stereo Tone Controls
(Please insert quantities and delete those not applicable).

Name

Address

BI-PRE-PAK

Dept. A, 222/224 West Road, Westcliff-on-Sea, Essex SS0 9DF. Telephone: Southend (0702) 46344.

Co. Regn. No. 820919

YATES ELECTRONICS

(FLITWICK) LTD.

DEPT. PE, ELSTOW STORAGE DEPOT
KEMPSTON HARDWICK
BEDFORD

C.V.O. PLEASE. POST AND PACKING
PLEASE ADD 10p TO ORDERS UNDER £2.

Catalogue which contains data sheets for most of the
components listed will be sent free on request.
10p stamp appreciated.

CALLERS WELCOME Mon.-Sat. 9 a.m.-5 p.m.
PLEASE ADD 10% VAT

RESISTORS

1W Iokra high stability carbon film—very low noise—capless construction
1W Mullard CR25 carbon film—very small body size 7.5 x 2.5mm.
1W 2% ELECTROSIL TR5

Power watts	Tolerance	Range	Values available	Price
1	5%	4.7Ω-22MΩ	E24	1p
	10%	3.3MΩ-10MΩ	E12	1p
1/2	5%	10Ω-1MΩ	E24	3.5p
	10%	1Ω-3.9Ω	E12	1p
1/4	5%	4.7Ω-1MΩ	E12	1p
	10%	1Ω-10Ω	E12	6p

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

DEVELOPMENT PACK

0.5 watt 5% Iokra resistors 5 of each value 4.7Ω to 1MΩ.
E12 pack 325 resistors £2.40. E24 pack 650 resistors £4.70.

POTENTIOMETERS

Carbon track 5kΩ to 2MΩ, log or linear (log 1/2W, lin 1/2W).
Single, 12p. Dual gang (stereo), 40p. Single D.P. switch 24p.

SKELTON PRESET POTENTIOMETERS

Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C.
mounting (0.1 matrix).
Sub-miniature 0.1W, 5p each. Miniature 0.25W, 7p each.

TRANSISTORS

AC107	15p	AF139	32p	BF177	28p	OC45	12p	2N3710	11p
AC126	12p	AF178	32p	BF178	32p	OC70	12p	2N3711	11p
AC127	15p	AF180	40p	BF179	32p	OC71	12p	2N3819	32p
AC128	15p	AF181	40p	BF180	32p	OC72	12p	2N4062	12p
AC131	12p	BC107	12p	BF181	32p	OC81	12p	2N4286	20p
AC132	12p	BC108	12p	BF194	14p	OC82D	12p	2N4289	20p
AC176	15p	BC109	12p	BF195	14p	2N2646	60p	40360	35p
AC187	22p	BC147	12p	BF197	15p	2N2904	20p	40361	35p
AC188	22p	BC148	12p	BF200	32p	2N2926	10p	40362	40p
AD140	50p	BC149	12p	BFY50	20p	2N3054	50p	40408	40p
AD149	45p	BC157	14p	BFY51	20p	2N3055	60p	ZTX108	15p
AD161	33p	BC158	14p	BFY52	20p	2N3702	13p	ZTX300	15p
AD162	36p	BC159	14p	BUY105		2N3703	12p	ZTX302	20p
AF114	20p	BC187	22p		£2.25	2N3704	13p	ZTX500	15p
AF115	20p	BD131	75p	OC26	45p	2N3705	12p		
AF116	20p	BD132	75p	OC28	50p	2N3706	11p		
AF117	20p	BD133	75p	OC35	50p	2N3707	12p		
AF118	38p	BF115	25p	OC42	12p	2N3708	10p		
AF126	20p	BF173	20p	OC44	12p	2N3709	11p		

ZENER DIODES

400mW 5% 3.3V to 30V, 12p. | WIRE WOUND POTS, 3W, 10, 25,
50Ω and decades to 100kΩ, 35p.

DIODES

RECTIFIER	1250V	1A	12p	SIGNAL	7p
BY127	1250V	1A	12p	OA85	7p
IN4001	50V	1A	7p	OA90	5p
IN4002	100V	1A	8p	OA91	5p
IN4004	400V	1A	8p	OA202	7p
IN4006	800V	1A	10p	IN4148	5p
IN4007	1000V	1A	10p	BA114	8p

BRUSHED ALUMINIUM PANELS

12in x 6in = 25p; 12in x 2 1/2in = 10p; 9in x 2in = 7p

SLIDER POTENTIOMETERS

86mm x 9mm x 16mm, length of track 59mm.

SINGLE 10K, 25K, 100K log. or lin. 40p.

DUAL GANG, 10K + 10K etc. log. or lin. 60p.

KNOB FOR ABOVE 12p.

FRONT PANEL 65p.

18 Gauge panel 12in x 4in with slots cut for use
with slider pots. Grey or matt black finish complete
with fixings for 4 pots.

THYRISTORS

2N5060 50V 0 BA 30p,

2N5064 200V 0 BA 47p,

CRS1/40 400V 1A 25p,

106F 50V 4A 40p, 106D

400V 4A 65p.

ALUMINIUM BOXES

AB7	2 1/2 x 5 1/2 x 1 1/2in	50p	AB14	7 x 5 x 2 1/2in	84p
AB8	4 x 4 x 1 1/2in	50p	AB15	8 x 6 x 3in	£1.08
AB9	4 x 2 1/2 x 1 1/2in	50p	AB16	10 x 7 x 3in	£1.22
AB10	4 x 5 1/2 x 1 1/2in	50p	AB17	10 x 4 1/2 x 3in	£1.08
AB11	4 x 2 1/2 x 2in	60p	AB18	12 x 5 x 3in	£1.20
AB12	3 x 2 x 1in	44p	AB19	17 x 8 x 3in	£1.60

HEATSINKS

2W 24p	4W 45p	TO5 clip 5p	TO1 single 5p
3W 36p	6W 60p	TO18 clip 5p	TO1 double 8p

TRANSFORMERS

All have 240V primary			
MT30/2	0-12-15-20-24-30V	2A	£2.85
MT50/1 1/2	0-19-25-33-40-50V	1A	£1.90
MT50/1	0-19-25-33-40-50V	1A	£2.55
MT50/2	0-19-25-33-40-50V	2A	£3.50
MT60/1 1/2	0-24-30-40-48-60V	1A	£2.10
MT60/1	0-24-30-40-48-60V	1A	£2.80
MT60/2	0-24-30-40-48-60V	2A	£3.80

MULLARD POLYESTER CAPACITORS C296 SERIES

400V: 0.001μF, 0.0015μF, 0.0022μF, 0.0033μF, 0.0047μF, 21p. 0.0068μF, 0.01μF, 0.015μF, 0.022μF, 0.033μF, 3p. 0.047μF, 0.068μF, 0.1μF, 4p. 0.15μF, 6p. 0.22μF, 7 1/2p. 0.33μF, 11p. 0.47μF, 13p.
160V: 0.01μF, 0.015μF, 0.022μF, 0.033μF, 0.047μF, 0.068μF, 3p. 0.1μF 3 1/2p. 0.15μF 4 1/2p. 0.22μF, 5p. 0.33μF, 6p. 0.47μF, 7 1/2p. 0.68μF, 11p. 1.0μF, 13p.

MULLARD POLYESTER CAPACITORS C280 SERIES

250V P.C. mounting: 0.01μF, 0.015μF, 0.022μF, 3p. 0.033μF, 0.047μF, 0.068μF, 3 1/2p. 0.1μF, 4p. 0.15μF, 0.22μF, 5p. 0.33μF, 6 1/2p. 0.47μF, 8 1/2p. 0.68μF, 11p. 1.0μF, 13p. 1.5μF, 20p. 2.2μF, 24p.

MYLAR FILM CAPACITORS 100V

0.001μF, 0.002μF, 0.005μF, 0.01μF, 0.02μF, 21p. 0.04μF, 0.05μF, 0.068μF, 0.1μF, 31p.

CERAMIC DISC CAPACITORS

100pF to 10,000pF, 2p each.

ELECTROLYTIC CAPACITORS—MULLARD O15/6/7

(μF/V) 1/63, 1/5/63, 2/2/63, 3/3/63, 4/7/63, 6/8/40, 6/8/63, 10/25, 10/63, 15/16, 15/40, 15/63, 22/10, 22/25, 22/63, 33/6/3, 33/16, 33/40, 47/4, 47/10, 47/25, 47/40, 68/6/3, 68/16, 100/4, 100/10, 100/25, 150/6/3, 150/16, 220/4, 220/6/3, 220/16, 330/4, 6p. 47/63, 100/40, 150/25, 220/25, 330/10, 470/6/3, 7p. 68/63, 150/6, 220/40, 330/16, 1,000/4, 10p. 470/10, 680/6/3, 11p. 100/63, 150/63, 220/63, 1,000/10, 12p. 470/25, 680/16, 1,500/6/3, 13p. 470/40, 680/25, 1,000/16, 1,500/10, 2,200/6/3, 18p. 330/63, 680/40, 1,000/25, 1,500/16, 2,200/10, 3,300/6/3, 4,700/4, 21p.

SOLID TANTALUM BEAD CAPACITORS

0.1μF	35V	2.2μF	35V	22μF	16V	12p
0.22μF	35V	4.7μF	35V	33μF	10V	
0.47μF	35V	6.8μF	25V	47μF	6.3V	
1.0μF	35V	10μF	25V	100μF	3V	

VEROBOARD

0-1	0-15
2 1/2 x 3	22p
2 1/2 x 5	16p
3 1/2 x 3	24p
3 1/2 x 5	24p
17 x 2 1/2	27p
17 x 3 1/2	75p
17 x 5	100p
17 x 5 (plain)	82p
17 x 3 1/2 (plain)	60p
17 x 2 1/2 (plain)	42p
2 1/2 x 5 (plain)	12p
2 1/2 x 3 1/2 (plain)	11p
Pin insertion tool	53p
Spot face cutter	42p
Pkt. 50 pins	20p

JACK PLUGS AND SOCKETS

Standard screened	18p	2.5mm insulated	8p
Standard insulated	12p	3.5mm insulated	8p
Stereo screened	35p	3.5mm screened	13p
Standard socket	15p	2.5mm socket	8p
Stereo socket	18p	3.5mm socket	8p

D.I.N. PLUGS AND SOCKETS

2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin
Plug 12p. Socket 8p.
4 way screened cable, 15p/metre.
6 way screened cable 22p/metre.

BATTERY ELIMINATOR

£1.50
9V mains power supply. Same size as PP9 battery.

LARGE (CAN) ELECTROLYTICS

1600μF	64V	74p	2500μF	64V	80p	4500μF	16V	50p
2500μF	40V	74p	2800μF	100V	£2.60	4500μF	25V	£1.68
2500μF	50V	58p	3200μF	16V	50p	5000μF	50V	£1.10

HIGH VOLTAGE TUBULAR CAPACITORS—1,000 VOLT

0.01μF	10p	0.047μF	13p	0.22μF	20p
0.022μF	12p	0.1μF	13p	0.47μF	22p

POLYSTYRENE CAPACITORS 160V 2 1/2%

10pF to 1,000pF E12 Series Values 4p each.

SMOKE AND COMBUSTIBLE GAS DETECTOR—GDI

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

Detector GDI, £2. Kit of parts for detectors including GDI and P.C. board but excluding case. Mains operated detector £5.20. 12 or 24V battery operated audible alarm £7.30. As above for PP9 battery, £6.40.

PRINTED BOARD MARKER

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

METERS

£1.90
1 1/2in scale 500mA, 1mA, 10mA, 100mA.

BULGIN MAINS CONNECTORS

3 pin 1 1/2A chassis plug	13p	3 pin 1 1/2A chassis socket	18p
line socket	13p	line plug	13p
3 pin 3A chassis plug	10p	3 pin 3A chassis socket	21p
line socket	10p	line plug	23p
3 pin 5A chassis plug	16p	line plug	20p
line socket	18p	2 pin 5A line plug	20p

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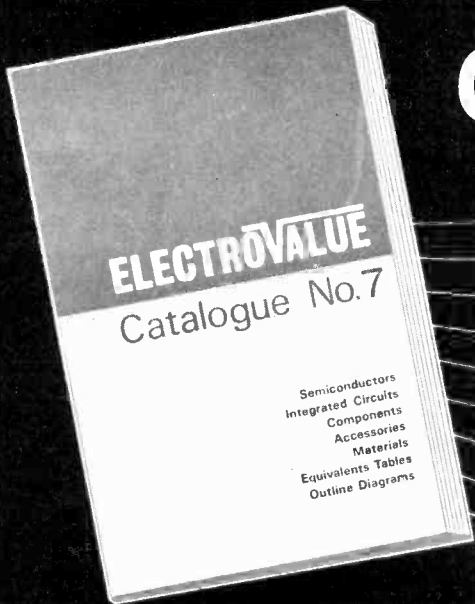
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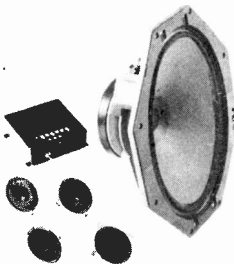
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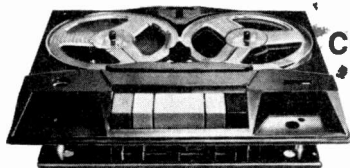
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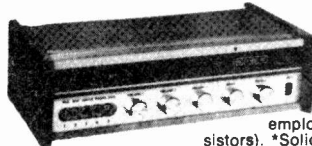
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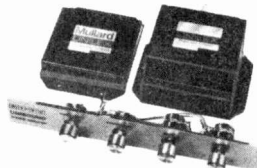
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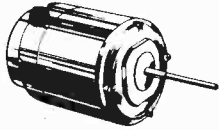


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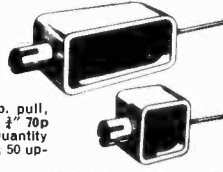
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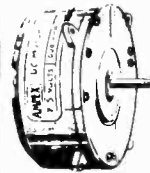
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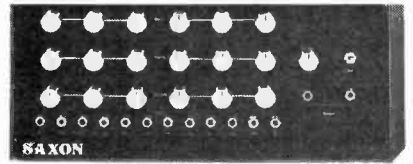
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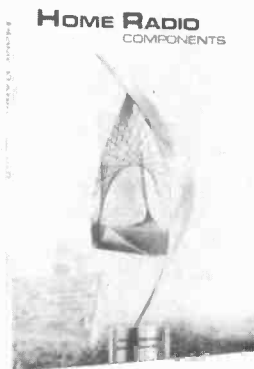
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FUEL AND POWER

OUR almost total dependence upon the fossil fuels, coal and oil, has been brought home to everyone these last few weeks. Nothing concentrates the mind on such basic facts of life as a threatened fuel and power shortage.

But need it be so? Remember nuclear power, and how it was to solve all our energy problems in a few decades? Well, its present contribution to the national grid is very small. This is a great disappointment after the tremendous pioneering work performed by British scientists and engineers in the post 1946 years. The high hopes of generating electricity cheaply by nuclear fission have not been fulfilled, though the failure stems mainly from political decisions, rather than from any technical shortcomings.

The relationship between nucleonics and electronics is close and real. Present day electronic circuitry owes quite a lot to development work carried out expressly to meet the special instrumentation requirements of the first nuclear power stations.

When looking for future alternative sources of power, the possibility of harnessing solar energy on a large scale seems more conjectural. However, like nuclear power, any practical scheme for using radiation from the sun must involve electronic devices and techniques, so again there is a special relationship between these technologies.

Perhaps, arising out of our winter of discontent will come a renewal of interest in these exotic sources of energy. They evoke concepts different in the extreme, from the microscopic dimension of the nucleus, to the macrocosmic distance from earth to the sun. Here are the two most probable sources of energy that will ultimately succeed the fossil fuels we are recklessly consuming without thought for the hundreds of millions of years it has taken for the oil, gas and coal to be formed beneath the earth's crust. Yet, alas, the probability is that once the present fuel crisis is over complacency will take over again and the prodigious research effort required will not be made.

Aside from such thoughts on power generation necessitating a major national programme, the present difficult position will undoubtedly encourage further development work in certain areas by individuals and companies. One example is electroluminescent materials, since lighting panels with negligible power consumption obviously have a great future. And what of the long-awaited electric car? Work in this area will receive a new impetus, for sure.

And now, more to the point so far as our readers are concerned, there are the various ways in which electronics can help *immediately* to alleviate some of today's power and fuel problems—at home and on the road. PRACTICAL ELECTRONICS will be publishing some useful designs to help out. As a start there is this month an Ignition Timing Light. This simple device will help towards improved engine running, with attendant saving in fuel consumption. Those readers concerned with maintaining essential services in the home should note the announcement relating to next month's issue of this magazine.

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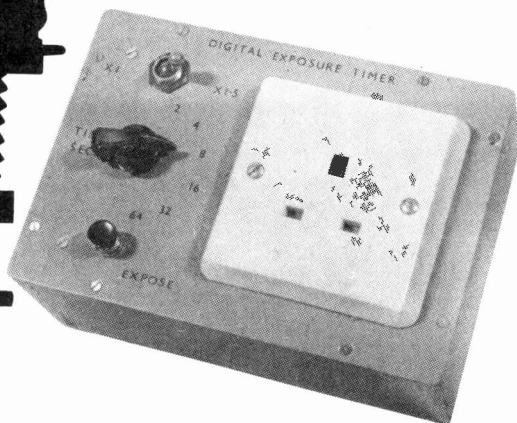
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DIGITAL EXPOSURE TIMER

By S.A. MONEY

ACCURATE EXPOSURE TIMES AND NO SETTING UP REQUIRED



MANY amateur photographers today make use of 35mm or Instamatic 126 cameras. Because of the small size of the negatives produced by these cameras the amateur who wants to make his own prints will need to use an enlarger in order to get prints of a reasonable size.

If a number of prints are to be produced in this way then a very useful addition to the normal dark-room equipment is some form of automatic timer unit to control the length of the exposure in the enlarger.

This device is normally used to switch on the enlarger lamp for some pre-determined period of time to give an accurately reproducible exposure with the minimum of effort on the part of the operator.

DIGITAL TIMING

In the timer to be described, timing is carried out by the use of digital techniques with the frequency of the supply mains acting as a basic clock. No calibration is required and the timing will remain accurate to within about one fiftieth of a second.

A switch provides a series of fixed exposure times which should cover most of the requirements for both black and white and colour printing.

EXPOSURE REQUIREMENTS

One of the standard methods for finding the optimum exposure time for printing from a particular negative is to produce a test strip print in which a series of steps of exposure are made across the strip. Usually the exposure for one step is twice that of the previous step.

A typical series of steps might be 2, 4, 8, 16 and 32 seconds. The resultant print usually shows a series of strips where the density of the image increases by roughly the same amount at each step. This is due to the logarithmic sensitivity characteristic of the average photographic emulsion.

For black and white work a satisfactory print will generally be obtained by selecting one of the steps of exposure on the test strip. Colour printing tends to be rather more critical and may require the use of intermediate values of exposure between two of the adjacent steps on the test strip. Provision has been made for this requirement in the design of the digital timer.

SELECTOR SWITCH

A selector switch on the timer enables the operator to select the basic exposure times of 2, 4, 8, 16, 32 and 64 seconds. A second switch has been provided by means of which the basic times may be increased by 50 per cent to give the intermediate exposures of 3, 6, 12, 24, 48 and 96 seconds.

Finer adjustment of exposure between these 12 fixed exposure times can usually be catered for by using the aperture control on the enlarger lens. If desired it is possible, by giving multiple exposures, to achieve any exposure time equal to a whole number of seconds.

The circuit diagram of the digital timer unit is given in Fig. 1. It will be seen that the unit comprises a frequency divider using integrated logic circuits, a control logic circuit, a triac switch for the enlarger lamp and a low voltage power supply for the logic elements.

FREQUENCY DIVIDER SECTION

Frequency variations in the 50Hz mains supply are normally held to less than plus and minus one per cent by the Electricity Generating Board. By deriving the basic clock for the timer from the supply frequency the resultant timing accuracy will be more than adequate for all normal photographic requirements.

A small voltage at mains frequency is extracted from the low voltage power supply in the unit and applied via C2 and R1 to the base of transistor

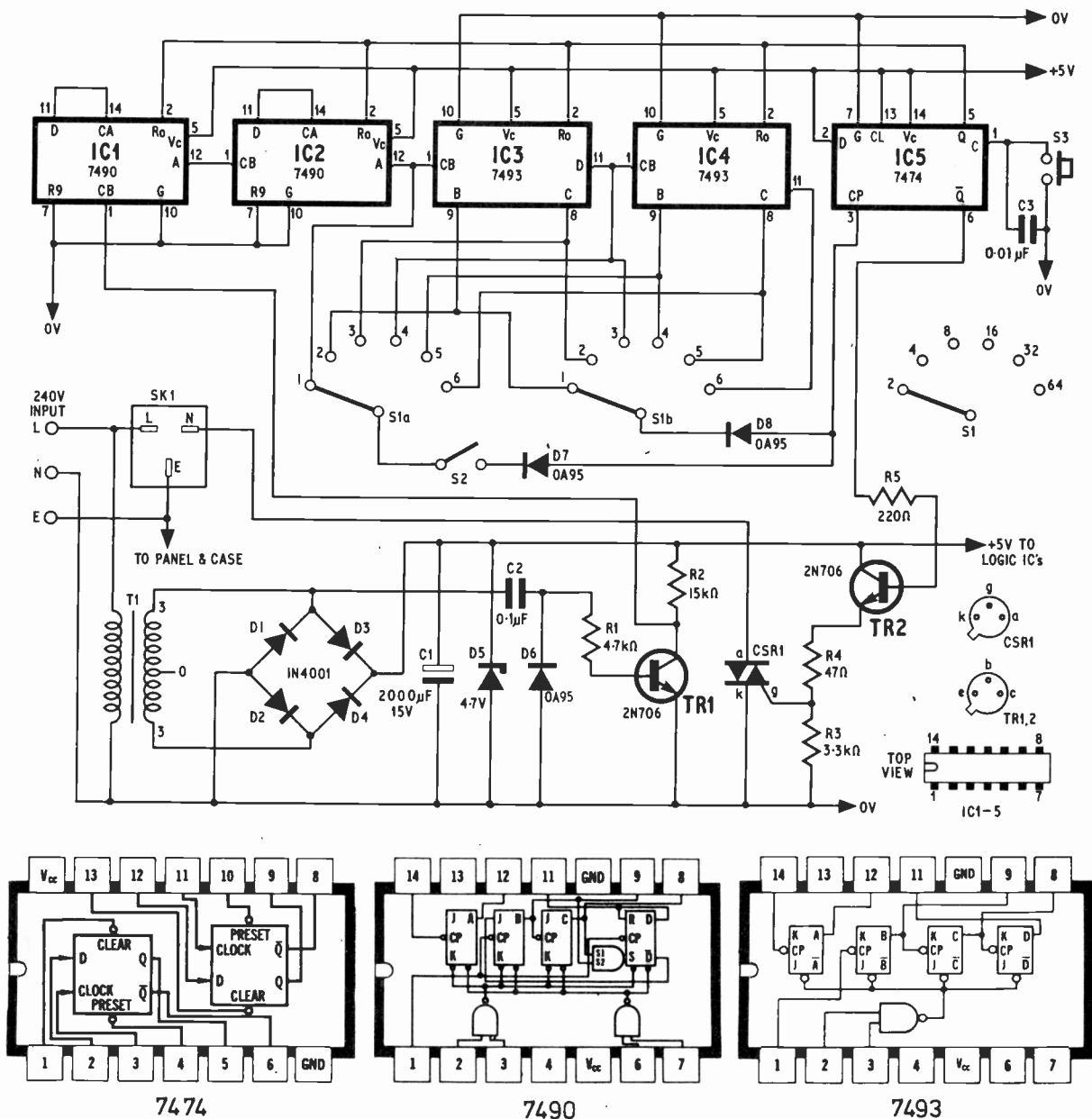


Fig. 1. Complete circuit diagram of the Digital Exposure Timer. S1 sets the exposure time, S2 is closed to increase the exposure time by 1.5 times and S3 is the expose switch

TR1. This transistor acts as a pulse shaper and produces at its collector a 50Hz square wave of about four volts amplitude. Diode D6 is used to provide d.c. restoration to maintain optimum bias for TR1.

The collector output from TR1 provides a clock drive signal for IC1 which is a 7490 decade counter. The 7490 consists of four flip-flops arranged to give a divide-by-five counter and a divide-by-two counter. By connecting the two sections in cascade a division by ten is obtained.

A second 7490 counter module (IC2) has its clock driven by the output of IC1 and provides a further divide-by-ten count. The resultant output signal from

the final stage of IC2 is a square wave having a frequency of one cycle every two seconds.

The two second clock output from IC2 is now divided down further in frequency by IC3 and IC4.

In the 7493, which is similar to the 7490, the four flip-flops are arranged as four separate divide-by-two counter stages. Only three of the four stages in each 7493 module are used and these are connected in cascade to form a six stage binary counter chain.

The output frequency from the final stage of this counter chain will be one cycle every 128 seconds. It is this counter chain which controls the basic exposure times.

CONTROL LOGIC

One half of a 7474 dual D-type flip-flop module (IC5) is used to provide the control logic for the unit. This particular type of flip-flop was chosen for the purpose because it is edge triggered by the positive going edge of the clock pulse input.

Between exposures this flip-flop is in a dormant state with its Q output set at the logic 1 level (+4 volts). This Q output is joined to the reset (R0) inputs of the four counter modules (IC1 to 4).

When the reset line is held at the logic 1 level the counters are held in their reset state with all outputs at logic 0 (0 volts). On the 7490 counters only the (R0) input is connected to the reset line, the (R9) inputs being joined to the zero volt supply rail.

TIMING CYCLE

To start a new exposure cycle the push-button switch S3 is made momentarily. This action sets the "clear" input of flip-flop IC5 at logic 0 which, in turn, causes its Q output to change to logic 0.

After S3 is released IC5 will remain in this "clear" state. It is arranged that when Q is at logic 0 the enlarger lamp is turned on to make the exposure. At the same time the reset line to the counters will also go to logic 0 and allow them to start counting the 50Hz input clock pulses.

Switch S1 is used to select the basic exposure time periods. One bank of this switch (S1b) is used to select one of the six outputs of the 7493 counters (IC3 and IC4) and route it via diode D8 to the clock input of flip-flop IC5.

When this selected signal goes from logic 0 to logic 1 level it will clock the flip-flop IC5. This flip-flop is connected so that when clocked it will return to its initial condition with Q at logic 1 thus turning off the enlarger lamp and terminating the exposure.

Let us assume that the switch S1 is set so that the output from stage B of IC3 is selected via S1b. At the start of the exposure period the output from B will be at logic 0. In the 7493 type counter the output will change on the falling edge of the clock input when it goes from logic 1 to 0.

The clock for stage B is obtained from the output of IC2. The total frequency division in IC1 and IC2 is 100 so the output frequency from IC2 will be one cycle every two seconds.

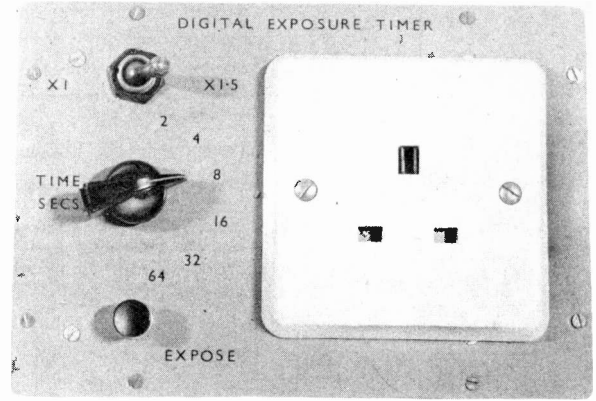
Since the counters start off from zero the output of IC2 will go to logic 1 after one second of counting and will return to logic 0 after two seconds. Stage B of IC3 will therefore be clocked to logic 1 two seconds after the start of the exposure cycle. When stage B goes to logic 1 it clocks IC5 and ends the exposure.

Thus with switch S1 in this position the exposure period will be two seconds. In the same way the exposure times produced by the other positions of S1 will be 4, 8, 16, 32 and 64 seconds as the selected output position is moved along the counter chain.

INTERMEDIATE EXPOSURES

To obtain intermediate exposure times the switch S2 and a second bank of switch S1 are brought into play. The switch bank S1a is also used to select one of the outputs from the counter chain but it is wired so that it selects its output from the stage before the one selected by S1b.

When switch S2 is closed the output from S1a is routed to the clock input of IC5 via diode D7. The



Photograph of the completed Digital Exposure Timer

two diodes D7 and D8 form an AND gate so that the outputs from S1a and S1b must both be at the logic 1 level before the flip-flop IC5 will be clocked.

Once again let us assume that switch S1 is set at its two second position but in this case S2 is closed. At one second after the start of the exposure cycle the output of IC2 will go to logic 1 and therefore S1a output will go to logic 1. The output of S1b will still be at logic 0 so no clock pulse will be applied to IC5 and the exposure goes on.

After two seconds the S1a output will go to logic 0 and S1b will go to logic 1 so that there will still be no clock pulse applied to IC5. After three seconds output S1a will go to logic 1 again but this time S1b will still be at logic 1 so a clock pulse is applied to IC5 and the exposure ends.

Closing switch S2 will thus increase the normal two second exposure period to three seconds. In the same way the other positions of S1 will give exposure periods of 6, 12, 24, 48 and 96 seconds when S2 is closed.

It was found that the flip-flop IC5 tended to be triggered by mains transients picked up on the push-button switch input. This problem was overcome by connecting the capacitor C3 across the "clear" input of IC5.

LAMP CONTROL SWITCH

Instead of using a relay contact to switch the supply to the enlarger lamp, this unit makes use of a triac as a solid-state switch. The triac acts in a similar fashion to a thyristor but conducts on both half cycles of the supply.

The triac CSR1 is connected in series with the enlarger lamp and the mains supply. When the gate to cathode voltage of the triac is held below 0.5 volt the triac does not conduct and the enlarger lamp will be off.

If the gate to cathode voltage is increased so that about 15 to 20mA gate current flows the triac will conduct between anode and cathode on both half cycles of the supply. Since the voltage drop across a conducting triac is of the order 1 volt, virtually the whole of the mains supply will now be applied to the lamp and it will operate at normal brilliance. When the gate voltage is again reduced below 0.5 volt the triac ceases to conduct and the lamp will be turned off.

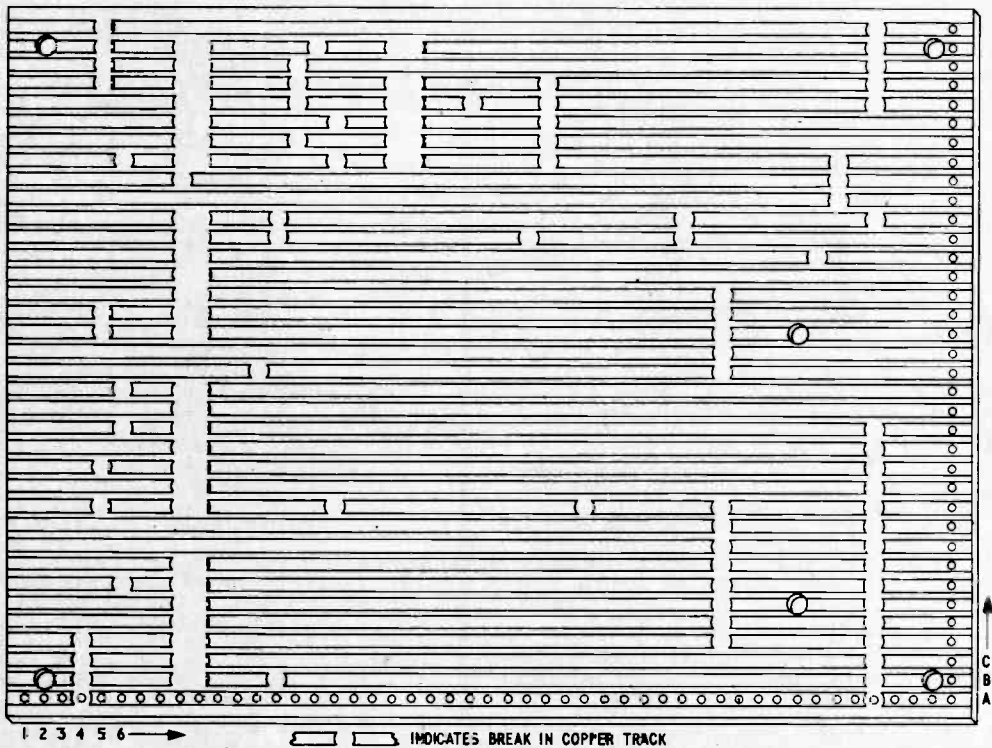
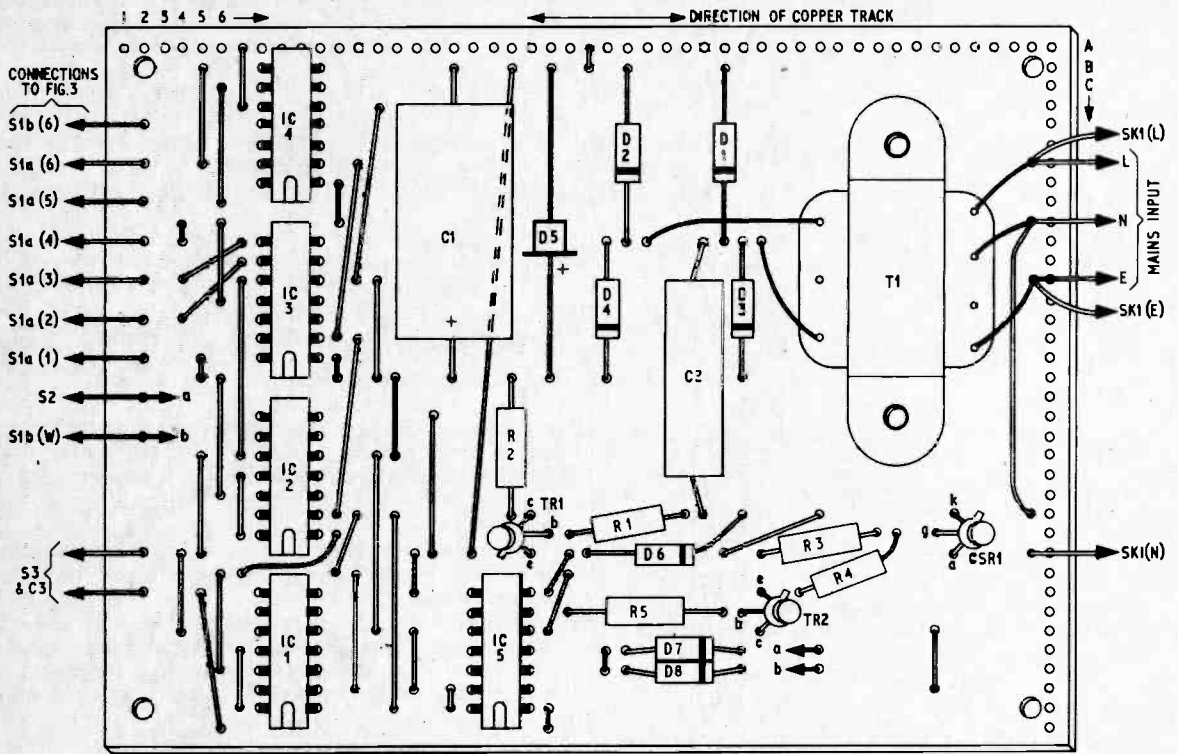


Fig. 2. Layout of the components on the Veroboard with breaks in the copper strips

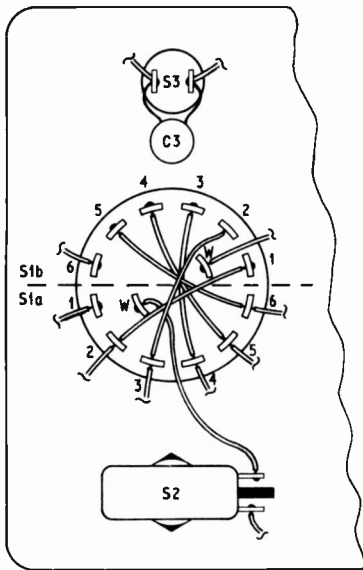


Fig. 3. Interwiring of the Digital Exposure Timer switches. Refer to Fig. 2 for connections to Veroboard

TRIAC TRIGGERING

A gate control signal for the triac is obtained from the inverted (\bar{Q}) output of the flip-flop IC5. Before an exposure cycle the Q output will be at logic 1 and therefore the \bar{Q} output will be at zero.

The gate-cathode voltage on the triac will be low and the triac is not conducting.

When an exposure cycle occurs the \bar{Q} output will rise to the logic 1 level thus increasing the gate voltage to make the triac conduct and turn on the lamp. The output from IC5 itself is not capable of delivering the current required to operate the triac gate directly. An emitter follower buffer stage TR2 is therefore included to drive the triac gate.

Triac CSR1 is a TO5-can type rated at 400 volts and 2 amps. This device should be capable of handling all of the normal mains voltage enlarger lamps up to about 200 watts without the need for a heat sink.

LOW VOLTAGE LAMPS

If the enlarger is fitted with a low voltage lamp it is not advisable to use this triac to switch the supply to the lamp directly. Low voltage lamps require much higher currents and would demand the use of a larger triac. The voltage drop produced by the triac will no longer be an insignificant part of the lamp supply and will result in the lamp being under-run with a corresponding loss in light output.

It is usual for low voltage lamps to be fed from the mains supply via a transformer. It is practicable to use the triac to switch the supply to the primary of the lamp transformer. Since the transformer can present an inductive load it will be necessary to wire a $0.1\mu\text{F}$ capacitor and a 100 ohm resistor in series across the triac to protect it from switching transients. The capacitor used should have a working voltage of at least 500 volts.

POWER SUPPLY

An internal power unit provides the 5V supply for the counters and the control logic. This employs a small transformer giving an output of 6V at about 150mA.

Four 1N4001 silicon diodes (D1 to D4) are used as a bridge rectifier with a $2,000\mu\text{F}$ capacitor C1 acting as a reservoir and providing ripple filtering. The 4.7V Zener diode D5 operates as a shunt stabiliser to produce a d.c. output voltage of approximately five volts.

A signal taken from one of the a.c. inputs to the bridge, at the junction of D1 and D3, provides the clock frequency input to the base of transistor TR1.

CONSTRUCTION

All circuit components, with the exception of the switches, are mounted on one circuit card. This is made up using 0.1in matrix Veroboard which fits in conveniently with the pin spacing on the integrated circuits. The midget transformer used is small enough to be mounted directly onto the circuit card.

A compact assembly can be produced by mounting the circuit board behind the front panel on a set of spacing pillars.

The layout of components and wiring of the circuit board is shown in Fig. 2. To make the required breaks in the copper tracks either a Vero cutter or the tip of a $\frac{1}{16}$ in twist drill may be used. Care must

COMPONENTS . . .

Resistors

R1 4.7k Ω R4 47 Ω
 R2 15k Ω R5 220 Ω
 R3 3.3k Ω
 All $\frac{1}{4}$ W $\pm 10\%$ carbon

Capacitors

C1 2,000 μF 15V elect. C3 0.01 μF
 C2 0.1 μF

Transistors

TR1, TR2 2N706 or similar npn general purpose
 (2 off)

Diodes

D1-D4 1N4001 (4 off)
 D5 4.7V 1.5W Zener
 D6-D8 OA95 or similar (3 off)

Triac

CSR1 400V 2A triac (TO5 can)

Integrated Circuits

IC1 SN7490N decade counter
 IC2 SN7490N decade counter
 IC3 SN7493N 4 bit binary counter
 IC4 SN7493N 4 bit binary counter
 IC5 SN7474N flip-flop

Switches

S1 2-pole 6-way break before make rotary
 S2 s.p.s.t. toggle
 S3 push-to-make release-to-break push-button

Transformer

T1 Mains primary, 3V-0-3V 200mA secondary
 (R.S. Components)

Miscellaneous

SK1 13A mains socket
 Veroboard 0.1in matrix 5in \times 3 $\frac{1}{2}$ in
 Case, approx. 7in \times 5in \times 3in

be taken in this operation so that the minimum amount of material is removed from board under the copper track.

Flexible stranded wire is preferable for the wire links across the circuit card. Solid core wire tends to cut through its p.v.c. insulation when the links are soldered to the card.

For the spacing pillars 6BA brass hexagon bar was used. The pillars are made 1¼in in length and they are drilled and tapped at each end to take 6BA fixing screws. An alternative would be to use wood dowels for the pillars and to fix the card and the front panel using small wood screws.

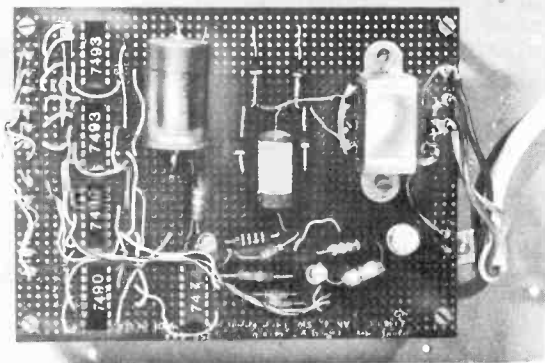
FRONT PANEL

The front panel is made from 16 s.w.g. aluminium. Component layout is shown in the photograph and interwiring between the Veroboard and the front panel is shown in Figs. 2 and 3.

For safety it is essential that the front panel should be solidly connected to the earth pin of the socket and to the earth wire of the mains lead. The mains cable itself should be anchored to the front panel by means of a cable clip.

A case for the unit can be readily made up from ¾in plywood. The four sides and bottom may be glued or screwed together to form a box which should be at least 2¼in deep on the inside.

For neatness the fixing holes in the front panel should be countersunk. Instrument head or countersunk screws should then be used for fixing the panel to the spacing pillars and to the case.



Photograph showing the layout of the components on the Veroboard

OPERATION

The enlarger mains lead is simply plugged into the socket on the unit. The timer itself may then be plugged into a suitable mains supply. When the unit is switched on at first there may be a brief flash from the enlarger lamp as the logic resets itself.

Whilst focusing and setting up the enlarger it is convenient to have the timer set to the 96 seconds time period, and to retrigger it as required. Once the enlarger has been set up the desired exposure is selected on the timer using S1 and S2. With the paper set up in the enlarger the exposure is initiated by pressing switch S3. ★

NEWS BRIEFS

THE NEW REVOLUTION

THE Royal Albert Hall, London — Victorian monument to the Industrial Revolution with friezes depicting arts and industry decorating the outside walls — was the scene of the Imperial College of Science and Technology Commemoration Day Ceremony on October 25. To the impressive setting provided by the Hall, splendid colour was added by the gowns of the college dignitaries, professors, and associates assembled for this important occasion in the academic year.

Amongst the new Honorary Fellows introduced was Robert W. Sarnoff, Chairman of RCA. In his Special Visitor's Address, Mr. Sarnoff discussed the new electronic revolution which has "... begun amplifying the power of the mind just as the Industrial Revolution amplified the power of muscle." He spoke of the likely impact of electronics during the next decade or so, and remarked upon the modest requirements of electronics in terms of materials and energy, and on the absence of environmental pollution or urban blight arising from expansion in this field of technology. Wider dissemination of knowledge and information for private and business use through compact communication and computing systems was one of the great contributions the whole world would enjoy as the Electronic Revolution really gets under way.

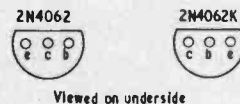
POINTS ARISING

PARTY STROBE LIGHT (December 1973)

In Fig. 1 and the components list diodes D1 and D2 should have been identified as 1N4004.

SEMICONDUCTOR TESTER (November 1973)

The transistors shown in the Veroboard layout (Fig. 7) are 2N4062K, an equivalent for the 2N4062 but with differing pin connections as shown:



In addition, the emitter and collector connections of TR3 are reversed and should be transposed.

VOICE OPERATED FADER (December 1973)

The printers apologise for omitting the title and the author's name.

IGNITION TIMING LIGHT

BY F.T. KLER

Can improve engine performance and contribute to a more economical use of fuel

CORRECT ignition timing is essential to the efficient and economic running of a car engine. Incorrect timing may produce poor acceleration and performance, overheating, loss of power and possibly reduced engine life.

Ignition timing is essentially stroboscopic. A powered timing light is triggered by the voltage from the spark plug to which it is connected, usually the No. 1 cylinder.

Using the light enables the operator to see how the actual timing compares with the specified timing while the engine is running. Any advancement or retardation is achieved by adjustment of the distributor.

TWO TYPES

Two types of timing light are available using either the neon or xenon tube. With a neon, this can be operated directly by the spark plug voltage to which it is connected. However, the light output compared to the xenon tube is a lot less.

The flash requirements for the xenon tube are a high d.c. voltage and a trigger pulse which will ionise the gas within the tube. A transistor inverter provides the d.c. in the unit to be described with triggering from No. 1 spark plug as in Fig. 1.

OPERATION

Upon application of 12V to the circuit, both transistors will commence to turn on, due to the bias network R1 and R2. Because of normal manufacturing spreads in gain and base/emitter voltage drop, one transistor will begin to draw more collector current through its half of the primary winding than the other.

This difference in primary currents produces a small net flux in the transformer core, and the appearance of this flux in turn induces a potential difference across each of the other windings. The feedback windings between the bias network and the transistor bases are connected in such a way as to reinforce the original imbalance, that is, the base of whichever transistor has the higher collector current is driven slightly positive, turning it on harder, while the other transistor is turned off by the fall in potential on its base. This is a positive

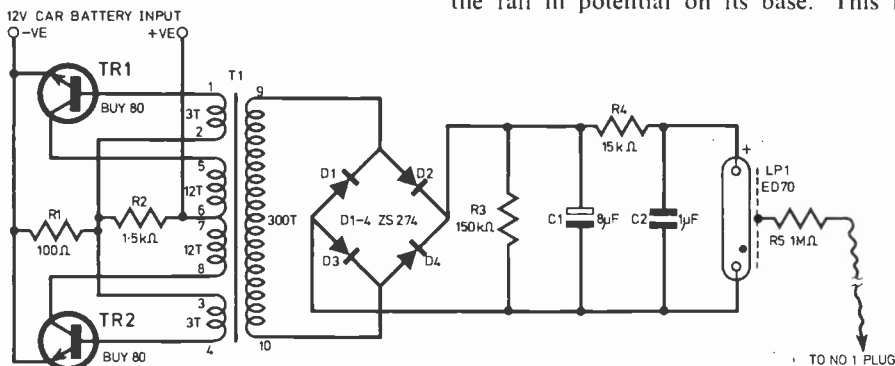
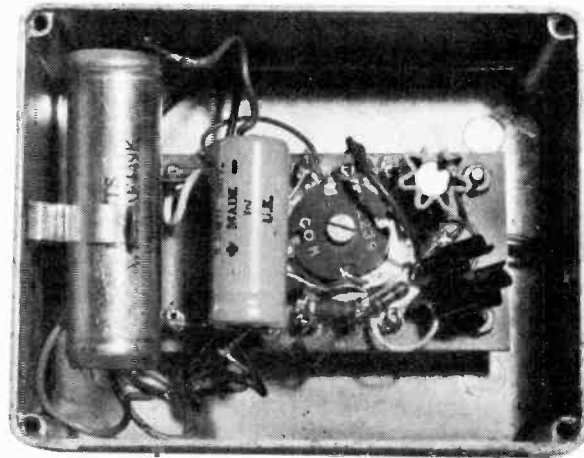


Fig. 1. Circuit diagram of Ignition Timing Light

feedback condition, as the original imbalance is now being reinforced by the differential drive to the transistors.

As the current in the primary winding increases, it causes an increase in magnetic flux in the core, which, however, has an upper limit set by the material used. When this limit is reached, the flux no longer increases and the core is said to be saturated. Since it is the rate at which the flux is changing which produces the e.m.f. in a winding, and the flux has now stopped increasing, it follows that the voltages on the feedback windings must fall to zero. Under these circumstances, the transistor which had been held off by the reduced bias applied to it now has a chance to conduct once more. The collector current through this transistor and its associated primary winding acts to produce a flux in opposition to the original direction. Thus there will now be an overall reduction in the magnetic flux in the core, and this reduction brings the transformer out of saturation and at the same time gives rise to e.m.f.s across the feedback windings of opposite polarity to the original e.m.f.s.

This time, the transistor which took the core up to saturation is turned off, while the other is turned on. Again, positive feedback holds one transistor off and the other transistor on until the core saturates with the flux in the other direction. When saturation takes place, the positive feedback disappears, and the transistors change state. Thus the process is continuous, and each flux reversal induces a high voltage across the output winding.



The encased electronic assembly

D.C. OUTPUT

The secondary winding is connected to a conventional bridge rectifier and reservoir capacitor C1. This feeds the discharge capacitor via a charging resistor R4 which eliminates any possibility of a continuous arc in the xenon tube. R3 is connected across the reservoir capacitor to discharge it after use. The voltage across this is about 350V.

COMPONENTS . . .

Resistors

- R1 100Ω ½ watt 10%
- R2 1.5kΩ ½ watt 10%
- R3 150kΩ 1 watt 10%
- R4 15kΩ 1 watt 10%
- R5 1MΩ ½ watt 10%

Capacitors

- C1 8μF elect. 500V
- C2 1μF 600V

Transistors

- TR1-TR2 BUY 80 Ferranti (2 off)

Transformer

- T1 FX2239 pot cores (2 off) (Mullard) complete with bobbin, clips and tagboard (see text) (Gurneys Radio, 91 The Broadway, Southall, Middlesex)

Diodes

- D1-D4 ZS274 (Ferranti) (4 off)

Miscellaneous

- Eddystone box 4 1/8 in × 3 1/8 in × 2 1/8 in, crocodile clips (3 off), transistor heat sinks (2 off), 30 and 40 s.w.g. wire as required (see text) LP1—ED70 xenon tube

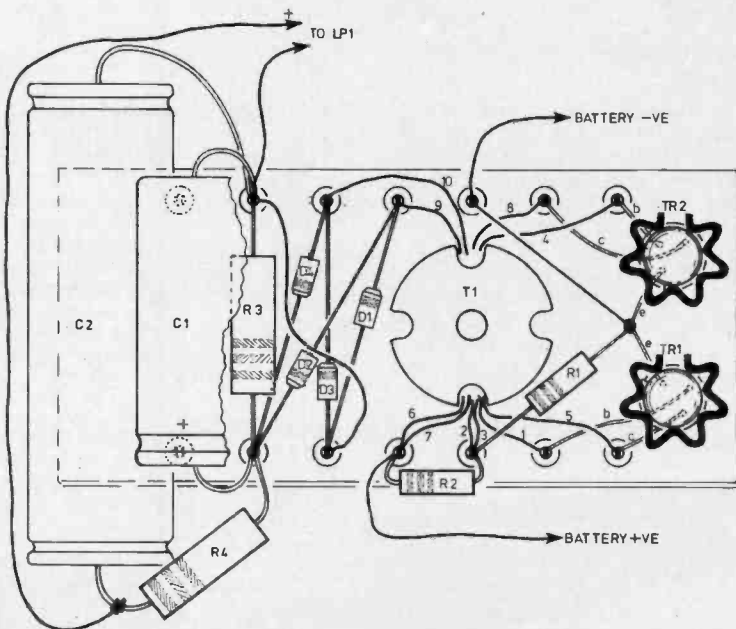


Fig. 2. Component and wiring details

NEWS BRIEFS

AUTOMATIC RADIO DIRECTION FINDER

RADIO direction is an important aid to sailors since it allows radio beacons to be used as accurate reference points so that position can be accurately determined.

A new automatic direction finder from EMI is intended for use mainly in fishing and larger commercial pleasure craft. Beacon selection is simple: individual crystals are inserted, each crystal covering a specified beacon group; a five-position switch on the front panel is used to spot select the group required.

The bearings obtained are displayed on a back-lit circular dial and can be either relative to the ship's heading or direct magnetic bearing according to the compass course set on the outer scale.

The rotating ferrite rods of the directional aerial are contained in a small weatherproof dome and are controlled by a servo from the main unit.

COMMUNICATIONS FOR NORTH SEA PLATFORMS

A FIVE million pound project to provide a communications system for the North Sea gas and oil rigs has been announced by the Post Office. Scheduled to come into service in early 1975, the heart of the system will be two new radio stations equipped with 40ft dish aerials able to provide reliable communications to platforms more than 200 miles from the coast.

Because many of the rigs are out of sight of the land the Post Office is using a new technique known as "trans-horizon radio". In this system powerful microwave signals are beamed into the troposphere and are scattered by atmospheric turbulence so that a small but usable signal reaches the receiver. Some production platforms will act as relay stations, passing on the signal to the other platforms by ordinary line-of-sight microwave link.

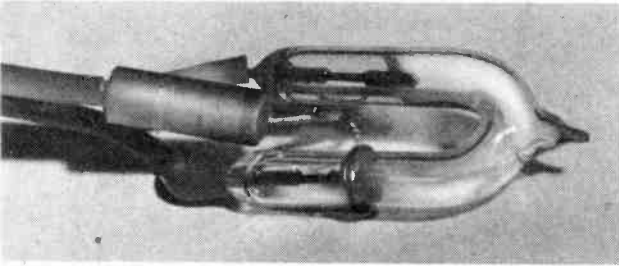
WEATHER SATELLITE WILL BEAM DATA TO ALL NATIONS

A SPACECRAFT launched by NASA on November 8th is now the primary weather watcher in the world-wide system. Known as NOAA-3, the new satellite is in a 942 mile high sun-synchronous orbit and observes every portion of the earth twice a day.

A new feature of this satellite is that data will be beamed directly to nations around the world so that any nation equipped to receive the signals will be able to make use of the information.

The satellite, built by RCA under the direction of NASA's Goddard Space Flight Centre, will monitor the temperature of the atmosphere up to 20 miles above the earth. There is also a scanning radiometer which will transmit cloud cover pictures to 550 simple, inexpensive stations located in 80 countries around the world.

**NEXT MONTH
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CONSTRUCTION

The majority of components are mounted on a 14 pin tag board as in Fig. 2. The most difficult item for construction is the transformer. To make this, first wind on the bobbin 24 turns of 30 s.w.g. enamelled wire. Centre tap this winding and identify the lead-out with coloured sleeves.

On top of this primary winding, wind 300 turns of 40 s.w.g. enamelled wire keeping the ends bare.

Insulate these windings with p.v.c. tape, now wind on three turns of 30 s.w.g., then take off a centre and wind another three turns ensuring that the ends are colour coded to facilitate tag connections. The cores can now be assembled around the bobbin using the clips to fix it on the tag board.

After fixing the components according to Fig. 2, the board is attached to the base of a $4\frac{1}{16}$ in \times $3\frac{1}{16}$ in \times $2\frac{1}{16}$ in Eddystone box using nuts, bolts and insulating spacers.

The handle housing the ED70 tube and R5 must be made of some insulating material such as p.v.c. or Tufnol capable of withstanding the spark plug e.h.t. In the prototype a turned Tufnol bar of $\frac{3}{4}$ in inside diameter and $1\frac{1}{2}$ in outside was used. The overall length was $5\frac{1}{2}$ in. The tube can be fixed using Araldite or silicon rubber compound within the barrel.

Home Radio supply $\frac{3}{4}$ in p.v.c. tube which can be used for this. They also supply push-on end caps.

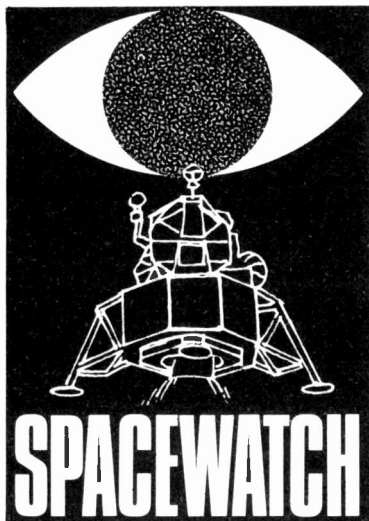
SET UP

The timing light requires the two input leads to be connected across the car's 12 volt battery. The other lead is then connected to No. 1 cylinder h.t. lead at the sparking plug. Then engine may now be started, but the revs should be kept at tickover (i.e. 500-600 r.p.m.).

By flashing the light on the crank pulley markings and the crank case markings, the state of the timing will be seen. Adjustment of the timing is achieved by the distributor micrometer vacuum screw, which can advance or retard the ignition to the manufacturers' figures. ★

The probe assembly with the xenon tube and R5 removed





BY FRANK W. HYDE
RESEARCH ROCKETS

In October 1973 the largest UK space rocket research project involving *Skylark* and *Petrel* rockets was launched from the rocket range at Andøya in Norway. This was the first project in which the objectives were dependent on the co-ordinated firing of the *Petrel* and *Skylark*.

Financed by the Science Research Council, under the control of the Radio and Space Research Station for the University space groups, the main objectives are the study of the auroral sub-storm phenomena at various stages of development and at different altitudes.

The whole project was made possible because of the facilities made available to the United Kingdom space scientists by the Royal Norwegian Council for Scientific and Industrial Research. The range on Andøya Island off the north coast of Norway at a latitude of 69°N was particularly suitable for the project.

The auroral sub-storms occur at high latitudes and at these times energetic particles are precipitated. At the same time there is increased ionisation of the atmosphere caused by the particles and the ionisation causes increased absorption of radio waves.

The particles themselves are believed to originate from the low energy plasma within the solar wind. These particles are precipitated at high energies before they are precipitated into the atmosphere.

The five main experiments examined the well defined phases of typical sub-storms. The experiments were devised so that a comprehensive study of the physical processes could be made.

The five main experiments were carried on the *Skylark* rockets, one to each. The supporting experiments were flown on the *Petrel*

vehicles. The nature of the investigations is complex and is reflected in the construction of the payloads. The procedure to launch was also complex and the timing of each rocket launch required considerable accuracy. Special design of payloads was required because of limited space available and also the need to avoid interaction between experiments on the same rocket.

The main experiments were arranged to investigate:

1. Particle acceleration which occurs at the onset of the negative phase of a sub-storm.
2. Particle storage and the onset of particle precipitation during the initial phase of a sub-storm.
3. The fine structure of the particle precipitation within the auroral area.
4. The ionospheric density of the electrons and their temperature, ionospheric electric fields and thermospheric winds.
5. Wave-particle interactions during a sub-storm, and the effects on the propagation of v.l.f. emissions in the ionosphere.

Onboard instruments operated at different levels, those in the *Skylark* at between 200 and 300km altitude and those in the *Petrel* at about 150km. Thus the coverage of the two levels should add very much to the understanding of these mechanisms.

An additional feature used in the experiments was the tuned laser. This is being used to track sodium "dumping" from a rocket. For the first time also pulse coded modulated (PCM) telemetry was used.

The groups directing experiments were the Radio Space Research Station, and Universities from Birmingham, Sussex, Southampton, Sheffield, University College. A group from the Royal Institute of Technology, Stockholm, also collaborated with the Radio and Space Research Station.

The *Skylark* rockets are made by BAC and the *Petrel* rockets by Bristol Aerojet Ltd.

NEWS FROM JUPITER

The satellite of Jupiter, Io, that has an effect on the radio radiations from the planet has an atmosphere of its own. This is thought to be mostly methane and ammonia like its parent. There is, however, a peculiar thing about this atmosphere. It has been noted on a number of occasions that after being eclipsed by another body, Io on reappearance seems to be considerably brighter in the ultraviolet region. This brightness is seen to be enhanced for about 20 minutes after eclipse.

The phenomena was puzzling and unpredictable, but now it would seem that there is yet another possible solution. It was noted that the brightening took place when Jupiter

is at perihelion, and eclipses the satellite. It has been suggested by Cruikshank and Murphy at the Hawaii University, that the heavy gas of Io's atmosphere becomes frozen when the satellite passes behind Jupiter into an extremely low temperature region. There is good evidence that the time of twenty minutes agrees with such a mechanism. It would take about twenty minutes for the solid gas to evaporate and the very bright appearance is consistent with freezing as the explanation.

As *Pioneer 10* will have been occulted by Io on December 3, data will have been acquired about the atmosphere of the satellite by using radio signals from the spacecraft to measure its properties.

Hitherto, it had been thought that Io had no atmosphere since the disappearance and the emergence of a star occulted by the satellite seemed to be instantaneous. This discovery comes at a time when the large satellite Ganymede has shown that it has a significant though not very hospitable atmosphere. The final acceptance of the fact that the atmosphere is a reality has come after a long period of observation started by Dr. G. E. Taylor of the Royal Greenwich Observatory.

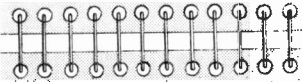
Well known for his work on the prediction of occultations Dr. Taylor predicted that an occultation of Ganymede was due. The difficulty of making an exact time of the event arises from the fact that the precise position of the star involved is often not known.

SPECIAL OBSERVATIONS

To put this matter right special observations were made from Perth and the Cape of Good Hope in order to fix the relative position of Ganymede and the star SA0 186800. The fix was accurate to 0.3 arc/secs. This enabled the occultation observers in India, Java and Australia to monitor the event.

Australia were not able to carry out their task successfully since it turned out that they were 50km south of the actual track across the Earth. However, the other two observers were successful and their observations clearly showed that the atmosphere existed by reason of the slow disappearance of the star and its subsequent emergence equally slow. Though the fall in light value was only 5 per cent (not very surprising when it is realised that the star is only of magnitude 8) nevertheless the indication was positive.

The received data has now made it possible to decide a more accurate estimate of the diameter of Ganymede, which turns out to be 250km less than was thought. Again it is a fortunate period for this discovery since *Pioneer 10* will be able to obtain more data.



INDUSTRY NOTEBOOK

By Nexus



CRYSTAL BALL

The National Economic Development Office report "Industrial Review to 1977 — Electronics" (Neddy Books, Millbank Tower, London, SW1P 4QX, price 50p) is so full of ifs and buts and windy generalisations that its value is limited. Of course, the authors are handicapped from the start by lack of reliable statistics, thus it is hard enough to interpret the immediate past, let alone attempt an intelligent forecast of the future. The chosen base year is 1971 and the report attempts to analyse the growth of the industry, sector by sector, for national economic growth rates of 3.5 per cent and 5 per cent per annum through to 1977.

Quite realistic assumptions with all the economic indicators pointing in the right direction when the words were written. How unfortunate, then, that the assumptions were overtaken at the very moment of publication by new factors such as the world energy crisis, political turmoil in the United States, industrial strife at home. And, of course, the as yet unmeasured consequences of Britain's entry into the EEC.

Electronics is a dynamic industry operating internationally in a dynamic political and economic framework. What the industry really needs is an annual report based on really up-to-date figures with short-term forecasting of trends. In fact if the trade associations would only standardise on the presentation of industry statistics in their annual reports I would settle for these alone, bound up into one handy volume.

Let us turn from people trying to analyse the industry to people

out and about actually working towards that magic 15 per cent growth, characteristic of the industry in its better years.

PRODUCTIVITY

The crafters of the industry—those who churn out the "nuts and bolts" which keep the rest going—are all too often overlooked amid the glare of publicity afforded to glamour technology and super systems.

I take, as an example, the Mullard plant at Blackburn where production is measured by the million pieces and productivity is unashamedly the goal. It is a huge plant covering 46 acres and was established in a small way in 1938. Famous for its high volume valve production it is now busy on additional products following a slow run-down in valve production as solid state devices have become more widely used. But Mullard Blackburn still produces 27 million valves a year so don't imagine the valve is already dead.

Electrolytic capacitors is one of the many other lines produced at Blackburn, brought into production in 1969 with an output for the year of 10 million. Production has now risen to an annual level in excess of 80 million, with a forecast expansion of well over 100 million per year by 1975. Much the same story applies to foil capacitor production where production is approaching 200 million a year.

A new product is glass delay lines for PAL TV receivers. By refining production processes, including automatic testing and adjustment of delay characteristics, production is approaching 2 million a year.

There has also been a big upsurge in production of electronic modules. Speed control modules for washing machines, voltage multipliers for TV sets, radio and audio modules such as tuners, pre-amps, i.f. strips, stereo decoders and a.f. power modules.

It is heartening to see such dedication to productivity which is the name of the game if prices are to be held down.

PIONEERS

It was equally heartening to spend a week at the Japan Electronics Show at Osaka and see at first hand how British products measured up to the Japanese market. BSR record players and autochangers are selling in the areas of Japan, Taiwan and South Korea at the rate of 600,000 a

year, a remarkable achievement based entirely on BSR's enormous productivity which lands the product in Japan at a quality/price ratio which leaves the local competition gasping for breath.

More interesting, however, was the group of 17 British companies which exhibited at the Show under the auspices of the British Overseas Trade Board in a group exhibit organised by the Electronic Engineering Association.

For most companies it was their first experience in penetrating the Japanese market and there was, naturally enough, some prior doubt on the value of the investment in time and money spent. They needn't have worried. The market is by no means wide open but there are plenty of business opportunities now that trade liberalisation is becoming a reality in Japan and this, coupled with a current exchange rate which gives British products a keen price-edge, augers well for a substantial trade build-up.

The Osaka show coincided in time with the opening of the British Marketing Centre in Tokyo at which regular exhibitions of British goods are to be held and which can be used by visiting executives for business meetings with agents and customers. Decca Radar was the first electronics company off the mark exhibiting at the opening show of marine equipment sponsored by the British Marine Equipment Council. But electronics will not be at the Centre in force until mid-74 when Avionics will be the theme.

Meantime, a contingent of 35 British companies will be exhibiting at the Internepcon Tokyo Show in January 1974 and a big increase in British participation is already being forecast for the 1974 Japan Electronics Show.

AWARD

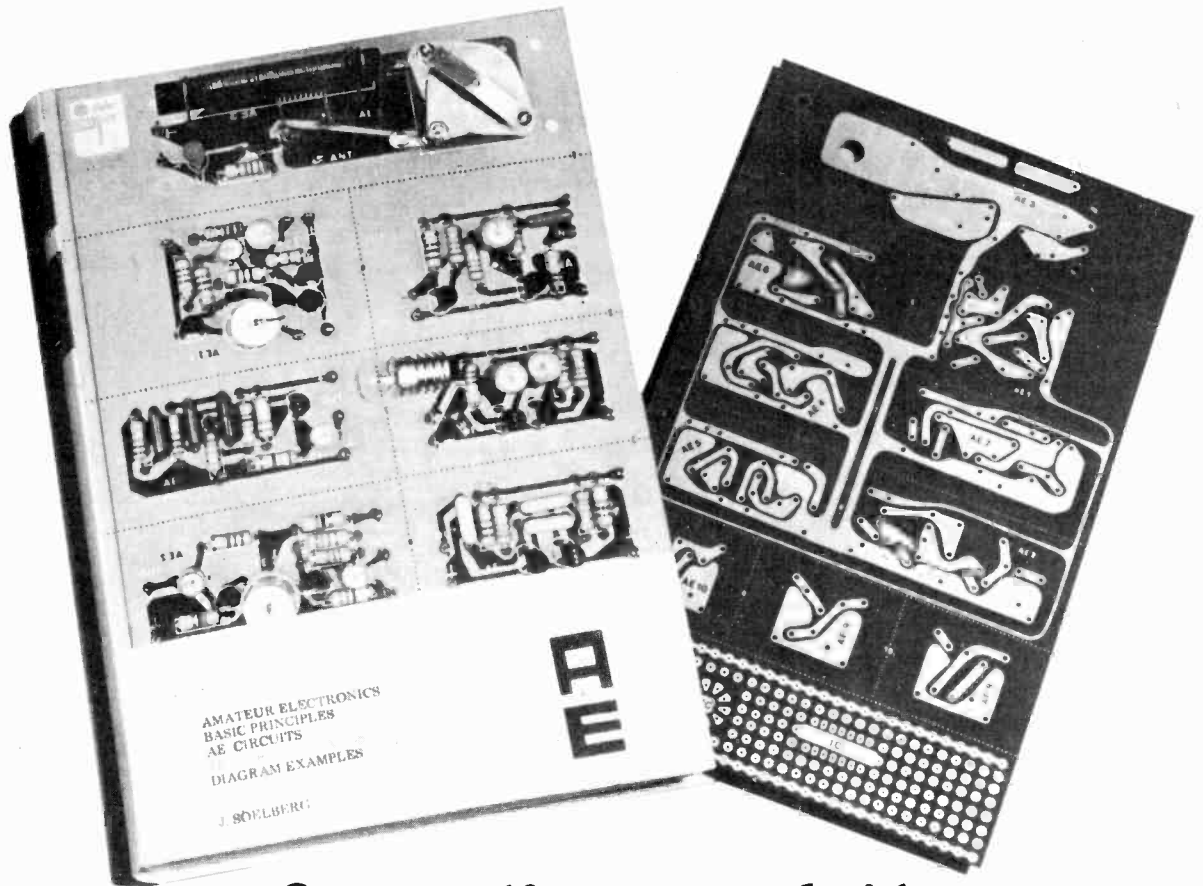
Congratulations to Pye TMC whose "Spherical" automatic telephone dialler won the "best international product" award at the big Canadian Electronics exhibition at Toronto. Spherical has already won a Council of Industrial Design award and I can vouch personally for the interest it aroused when shown in Osaka, Japan.

Basically it is a simple attachment to an ordinary dial telephone but it has push-buttons and a 10-number store in which the user can programme his ten most used numbers. To call any of these you just press two buttons and Spherical does the rest, including "try again". It uses an Emihus-designed MOS-LSI chip.

Sales could be enormous once the big PTT boys, including our own Post Office, grant approval for connecting it to domestic lines.

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'Amateur Electronics', by Jan Soelberg, is available in the U.K. only from your local Josty Kit stockists. Price £3.30 (including free circuit board). Or mail order from G. W. Smith & Co. (Radio) Ltd., Unit 4, The Hyde Industrial Estate, The Hyde, London NW96JJ. Newmark Electronics, Althem House, Belmont Street, Landsdown Road, Monton, Eccles, Manchester M309PA.

INGENUITY UNLIMITED

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

RIAA PRE-AMPLIFIER

THE pre-amplifier described here employs the MFC8040 low-noise integrated circuit. The basic internal circuitry of the device is given in Fig. 1.

Fig. 2 shows the external components necessary to produce a pre-amplifier equalised in accordance with the RIAA playback characteristic.

The circuit provides a gain of 34dB at 1kHz with a typical input of 15mV. Input impedance is 75k Ω . A curve, given in Fig. 3, plots the response up to 20kHz with the 0dB reference point set at 770mV output (15mV input). An output filter is incorporated which rapidly attenuates the output above 80kHz.

From the total harmonic distortion point of view the circuit performs very well, the figures being 0.1 per cent at 60 and 1,000Hz rising to 0.2 per cent at 10kHz with an output of 300mV r.m.s.

However, one of the main features of the design is the low-noise which is typically only 1mV and is predominantly low-frequency.

J. Francoz,
Geneva.

555 CIRCUIT MARK/SPACE RATIO

IN "Points Arising" in the October issue a reader has pointed out that a constructor attempting to use the 555 timer chip to construct a 1 : 1 mark-space ratio monostable may run the risk of damaging TR1 because of the reduction of RA below a suggested value of 1k Ω . Presumably the word "astable" should have been used instead of "monostable" in this sentence.

It should be pointed out that the current passed by the discharge transistor of the 555 is typically limited to 25mA. Thus it appears impossible to damage the 555 device in this way.

The type of astable circuit shown in Fig. 1 can be used to provide a mark-space ratio of unity or any other reasonable value. The capacitor charging current flows through RA and D1, whilst the discharging current flows through RB and D2. The charging and discharging paths are therefore quite separate and the resistors in those paths can be selected quite independently of one another. The values of RA and RB should be equal for a 1 : 1 mark/space ratio.

J. B. Dance,
Warwickshire.

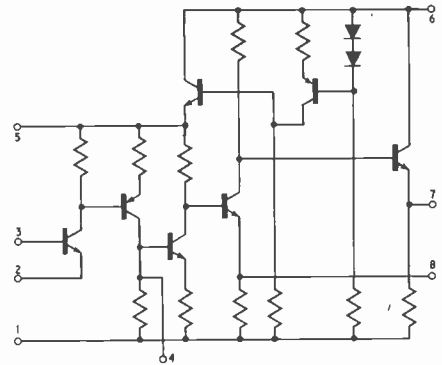


Fig. 1. Internal circuit diagram of IC1

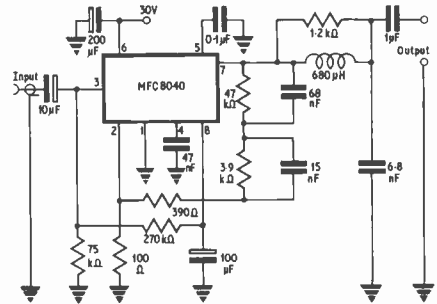


Fig. 2. Circuit diagram of the RIAA pre-amplifier

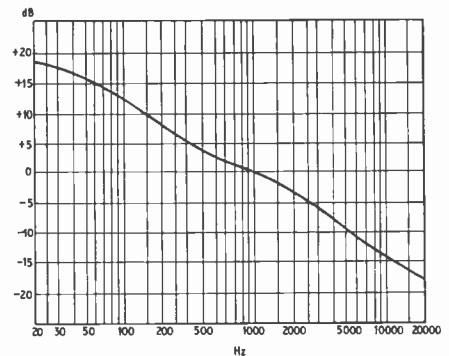


Fig. 3. Response curve of the pre-amplifier

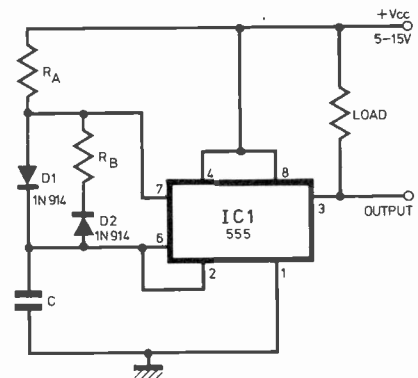
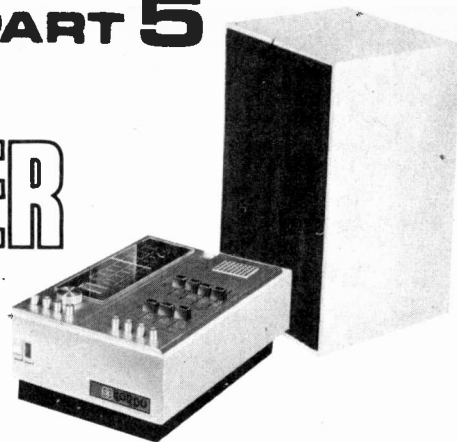


Fig. 1. The 555 Timer astable ratio circuit

PERODO PART 5

LOUDSPEAKER ENCLOSURE

BY R.A. COLE



THE loudspeaker enclosures for the Rondo system have been designed specifically to overcome many of the problems that beset the constructor attempting to produce loudspeakers equal in performance and finish to a shop bought product.

Each Rondo enclosure utilises the infinite baffle principle and can be considered to be in the medium size book-shelf category. It is however generally considered that although compact, the infinite baffle loudspeaker is lacking in bass response. The Rondo system is designed to overcome this deficiency.

BASICS

In order to explain the basic principles of the Rondo enclosure, it is necessary to briefly deal with speaker drive units and their loading. A loudspeaker drive unit used in "free air" (not mounted in any way) has a very poor bass response. In fact its response falls off below 2kHz (see Fig. 5.1). If it is mounted on a small baffle its response improves drastically. This improvement is caused by the reduction in interaction between the waveforms emitted from the front and back of the cone.

The larger the baffle, the lower the frequency at which this interaction takes effect. The interaction is caused by the waveforms from the back and front of the cone being out of phase and cancelling each other. The lowest frequency produced by a

baffle-mounted speaker has a wavelength equal to twice the distance from the cone to the edge of the baffle.

To produce 40Hz without interaction, a baffle of 14ft x 14ft is needed although in practice the walls and floor in proximity reduce this dimension somewhat. In order that there should be no air coupling between the front and rear of the cone, the baffle should theoretically be of infinite size. If a smaller baffle is "folded" back on itself to produce an air tight box round the speaker unit, there is also no interaction between the front and rear of the cone.

This box is called an infinite baffle enclosure.

THE SEALED BOX

It is obvious, however, that movements of the cone will produce compressions and rarefactions of the air within this sealed box and, due to the elasticity of air, the loudspeaker cone will not accurately follow the electrical signals fed to its voice coil.

Sound waves from the rear of the cone will also be reflected from the back of this cabinet. These waves will then pass forward through the thin speaker cone, producing the undesirable effect known as "honking".

Standing waves within the cabinet will also produce serious colouration to the sound emitted by the system.

To reduce these effects the cabinet is filled with a loose packing of fibrous material. BAF wadding, cotton wool, fibre glass and wool fibre have all been used for this purpose.

The filling, damping the effect of the elasticity of the air, reduces distortion due to non-linear movement of the voice coil. It also reduces reflections from the interior walls and damps standing waves.

THE CONE

The cone of a loudspeaker acts as a piston which pumps air. It is designed to follow, as accurately as possible, the electrical signal fed to its voice coil. In order to keep the voice coil centred within the poles of the magnet, a spider or diaphragm is needed. Peripheral suspensions provides a restoring force for cone movements.

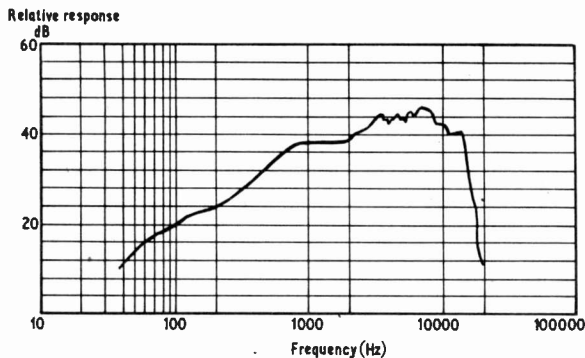


Fig. 5.1. The response characteristic of a driver unit in free air and unmounted

Both these devices reduce the ability of the cone to follow the electrical signal applied to the voice coil. This non-linearity gives rise to distortion which only careful design can reduce. In a small enclosure the cone is of small diameter and, in order to pump a useful volume of air comparable to its bigger brothers in other systems, it has to travel back and forth with greater amplitude.

This is also a cause of non-linear distortion and its effect is reduced by using special soft Neoprene or rubber roll cone suspensions and very flexible spiders or diaphragms.

The pole pieces of the magnet also have to be longer to maintain the magnetic flux acting upon the voice coil during its long incursions. To maintain this flux over the longer poles, more powerful magnets are required. Ceramic magnets, with their higher flux-to-weight ratio, are commonly used.

These speakers are called "long throw" drive units.

To summarise, a sealed enclosure or infinite baffle loudspeaker needs specially designed long throw drive units. The cabinet also has to be lagged adequately to reduce reflections, standing waves and to damp the effects of the elasticity of the air sealed in the enclosure.

A long throw loudspeaker is designed to suit a cabinet of given volume. Provided the cabinet is of that volume, its general shape is of little importance. Ideally the front/back dimension is kept around $1\frac{1}{2}$ times the diameter of the bass drive unit.

DESIGN

It is possible to design single speaker drive units to cover the entire audio spectrum but due to the compromises made in such units to give a response that is well maintained throughout, it is more common to use specialised speakers for various parts of the sound spectrum. The simplest form is to use a bass drive unit together with a high frequency speaker.

A network is used to divide the spectrum electrically to feed each speaker with its particular frequency range as shown in Fig. 5.2. The spectrum is sometimes split into three parts with a bass unit, a mid-range unit, a high frequency unit and a suitable network to feed them (Fig. 5.3). Even more complex methods can be used to provide specialised speakers for various parts of the audible spectrum. Crossover networks for such systems become very complex. The bass, mid-range and high frequency speakers are called woofers, squawkers and tweeters respectively.

Fig. 5.4 shows the relative acoustic power plotted against frequency in speech and music. Most of the power is in the range 10Hz to 300Hz with a smaller proportion in the range 300Hz to 5kHz and an even smaller proportion in the range above 5kHz.

The human ear is at its most sensitive in the mid-range from 300Hz to 5kHz and good midrange quality is thus essential together with a smooth crossover from bass to midrange.

The Rondo enclosure utilises two identical bass drive units, each capable of good response up to 5kHz. Both are used in the range up to 300Hz whilst only one continues up to 5kHz.

This provides extra power in the lower range by the use of two units to overcome the bass response deficiency of the infinite baffle enclosure.

Additionally, a smooth crossover to the mid-range is achieved by using speakers of the same tonal

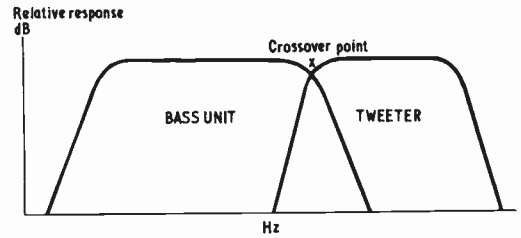


Fig. 5.2. Simplified illustration of the division of the frequency spectrum to the two speakers in a double-driver system

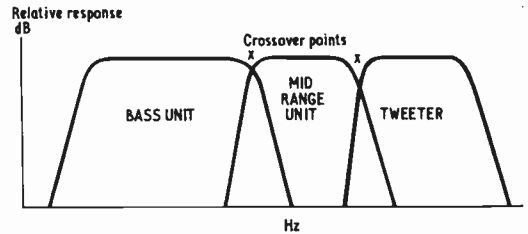


Fig. 5.3. The spectrum division used to feed a three-driver system.

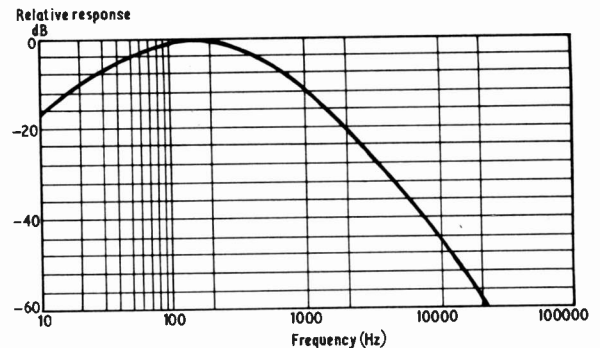


Fig. 5.4. The relative acoustic power present in average speech and music, plotted against frequency.

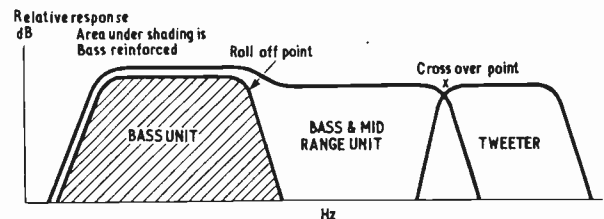


Fig. 5.5. The theoretical response curve of the driver units

character. The upper range is covered by two tweeters in parallel. The crossover network shown in Fig. 5.7 provides the correct range to each unit.

The bass and mid-range units are in fact HIF 13J's with an impedance of 8Ω , a flux density of 44,000 Maxwells, fundamental resonance of 35Hz, 10W sine wave power capacity and a frequency range of from 30Hz to 5kHz at the 3dB points. The tweeters are TW6Bi units with an impedance of 15Ω to 16Ω , flux density of 13,200 Maxwells, fundamental resonance at 2kHz, 2W sine wave power capacity and a frequency range from 3kHz to 20kHz at the 4dB points.

Fig. 5.5 shows the theoretical overall response curves for the drivers.

THE PRACTICAL DESIGN

The cabinets should be as solidly built as possible. Rigidity of the cabinet wall is essential to avoid coloration caused by sounds emitted by the walls. High density chipboard, plywood or hard timber is advisable for a cabinet of the volume of the Rondo system. The thicker the material the better but 15mm is a good minimum value from the constructional point of view.

The author does not recommend veneered chipboard offered under various trade names. Many of these makes of board are of low density and are difficult to work due to the fibrous nature of the chipboard core. If chipboard is used it is essential to ensure that the board is of high density material.

The front baffle must be cut or formed so that the speakers can be mounted from the front. This precaution is important for both the mid-range unit and the tweeters as mounting from the back reduces the upper frequency response of the drive units by an effect known as "tunnel effect." In the case of the tweeter it also reduces the polar response. The polar response of the two tweeters properly mounted is wide but if mounted wrongly it will be limited to a narrow beam.

Fig. 5.6 and Table 5.1 shows the overall dimensions and directions for making the speaker enclosure.

Provided that a strong, reasonably air-tight and rigid cabinet is made, the constructor may fabricate it from raw materials and can use an assembly method suited to his particular tool kit, materials and skills. The two methods shown here exemplify the simpler forms of a fairly wide range available.

COVERING

The choice of material for covering the front of the speaker is rather important. Only materials specifically manufactured for use in covering loudspeaker fronts should be used. Tygan and Vynair are two commonly available. Expanded aluminium mesh is also good, although perhaps a little dated in style. It is most important to back expanded aluminium with soft foam or cloth, with the appropriate apertures for the drive units cut out. This reduces vibration of the metal.

In recent months a new material called Declon has been introduced. It has all the best features for speaker fronts. It is an open pore foam that virtually passes all sounds in the audio spectrum without attenuation. It is black, but can be lightly sprayed with an aerosol paint to suit the constructor's taste. It is washable and seems the perfect solution to speaker fronts. A number of major

ENCLOSURE MATERIALS

13mm or thicker high density chipboard, block-board or hard timber.

3mm hardboard (If front baffle not routed from one part)

Outer coating material if used (PVC, Rexine, wood veneer, etc.)

Internal lagging material (see text), 6 lengths 2in thick and area of front baffle

Front cover material, Delcron or like to suit, same area as front baffle. Velcro strip to fit if required.

2 Bass and Mid-range speakers, HIF 13J, 8 ohm, 10W, $5\frac{1}{2}$ in nominal dia.

2 Tweeters, TW6Bi, 15-16 ohm, 2W, $2\frac{1}{8}$ in nominal dia.

Independent parts or complete kits of parts are available from various advertisers.

speaker manufacturers are now using Declon, in high quality and expensive units. In addition, it can easily be held in place using one of the modern hooked plastic retainers such as Velcro strip.

FILLING

Undoubtedly the best material for lagging is long hair wool followed by best quality cotton wool. It has been found that bonded acetate fibres (BAF) and materials such as Dacron and Terylene in similar form, give satisfactory results. They are easier to handle and can be contained within the cabinet without restraining bags (to stop loose hairs and fibres encroaching on the drive units). Six pieces cut to the size of the front baffle, 2 inches thick, are

Table 5.1: ASSEMBLY SEQUENCE

1. Bond front baffle and facia together firmly
2. Mount speakers securely from front using 13mm x No. 6 gauge Rd.Hd. screws applying Sealastic prior to assembly if needed
3. Mount crossover network board to terminal board on rear baffle and set aside for final assembly
4. Apply adhesive to top and bottom edges of sides and to corresponding areas of top and bottom panels
5. Offer the parts up together making certain they are square and finalise the joints using 13mm panel pins
6. Allow adhesive to set then offer up front baffle to the assembly using adhesive and pins as before
7. Connect the crossover network outputs to their respective speakers using fairly long flying leads to allow for insertion of the filling material
8. Insert filling material in rolls as shown
9. Caulk the rear enclosure opening using Sealastic type material and offer up the rear baffle. Screw into place using 38mm, No. 6 gauge C.S. woodscrews
10. Apply speaker covering or grille and finish enclosure to taste

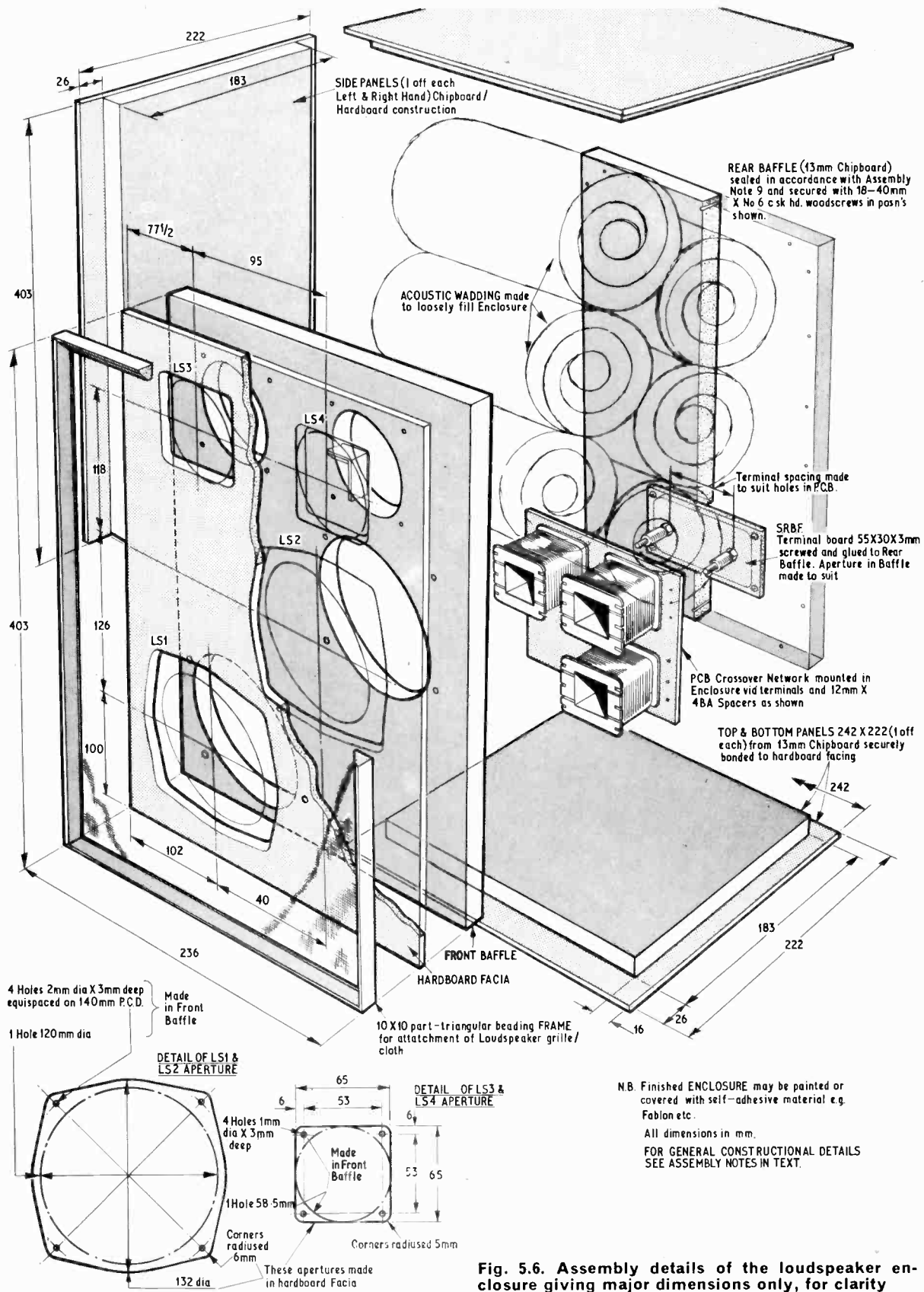


Fig. 5.6. Assembly details of the loudspeaker enclosure giving major dimensions only, for clarity

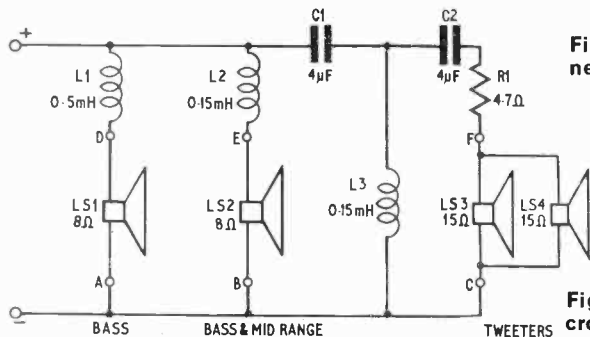


Fig. 5.7. The Rondo crossover network circuit diagram

Fig. 5.8. Printed circuit master for the crossover network and board assembly

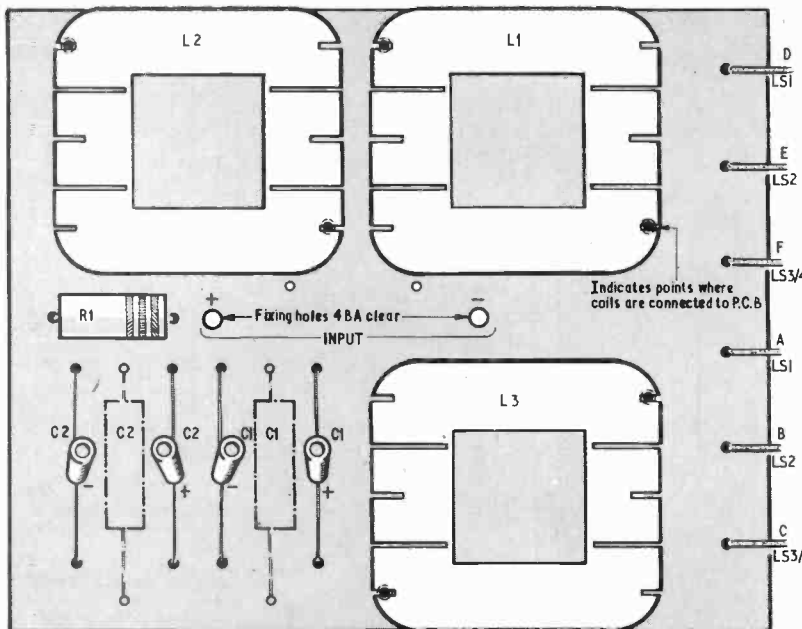


Table 5.2:

L1	155 Turns	0.9mm wire
		$\frac{3}{8}$ in former 0.5mH
L2 & L3	85 Turns	1.0mm wire
		$\frac{3}{8}$ in former 0.15mH

COMPONENTS . . .

CROSSOVER NETWORK

Capacitors

C1 & 2 4 μ F paper, polyester or non-polarised electrolytics, or 10 μ F, 16V (or above) electrolytics connected back-to-back to give required value

Inductors

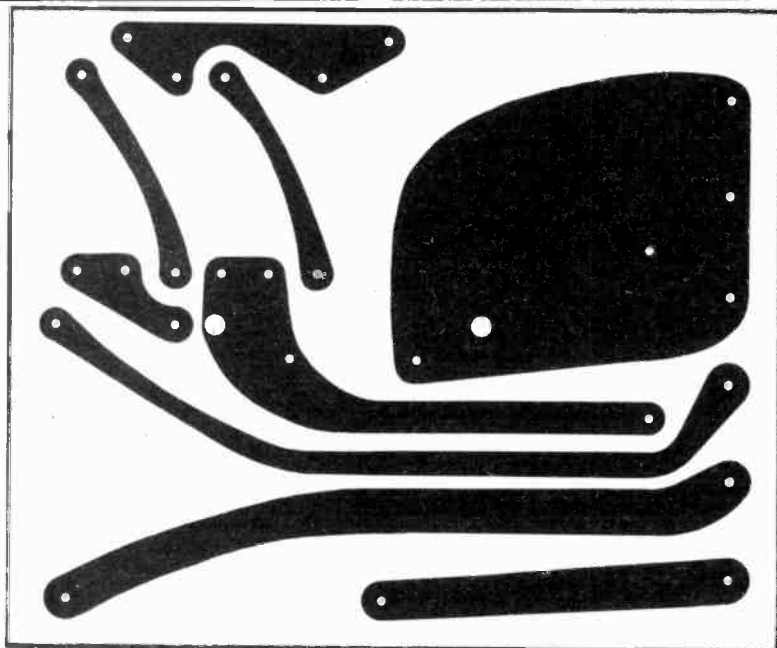
L1 0.5mH (see Table 5.2)
L2 & 3 0.15mH (see Table 5.2)

Resistors

R1 4.7 Ω 2W carbon non-inductive

Miscellaneous

3 Coilformers $\frac{3}{8}$ in square (GKN Type BA35-12 suit)
8m of 1mm enam. copper wire
28m of 0.9mm enam. copper wire
Copper clad laminate etched to suit



PE RORDO

KIT CONSTRUCTION

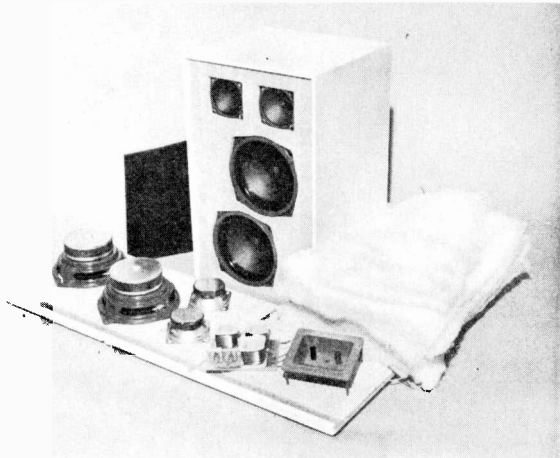


Fig. 5.9. Alternative method of assembly using carefully mitred joints and the backing material as an assembly support element.

ideal. They are rolled loosely and set in the cabinet in two layers of three.

THE CROSSOVER

The crossover network circuit diagram is shown in Fig. 5.7 and its printed circuit and layout in Fig. 5.8. The coil winding data is shown in Table 5.2. The bobbins can readily be wound by hand. If the coils are neat and tight then anchoring to the PC board using the slots in the bobbins as guides will hold them in place. If the windings are rather loose or sloppy then masking tape can be used to bind them firmly in position.

The PC board layout used provides space for either two non-polarised polyester, paper or similar good quality capacitors, or two reversible electrolytic capacitors, or two pairs of polarised electrolytic capacitors back to back as shown in the layout.

The crossover network is placed in the back of the cabinet, firmly secured to the walls or back. It may be supported by the terminals used to connect the crossover electrically to the signal supply lines and indeed the PCB is suited to drilling for just this purpose as shown in Fig. 5.8.

The inputs may also be wired to a DIN socket and the outputs are connected to the appropriate speaker drive units.

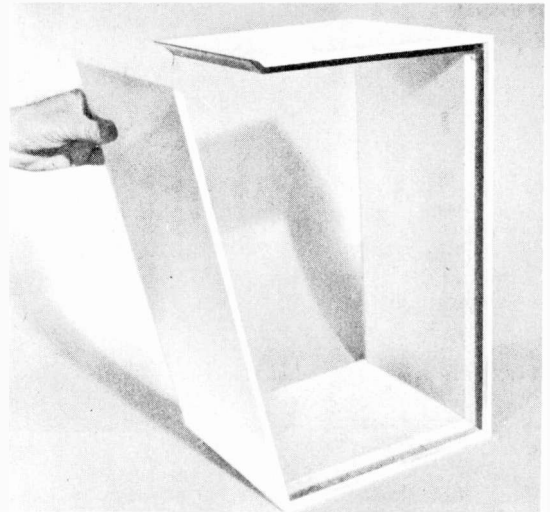
DECODER TESTING

Constructors who have the necessary test equipment may wish to carry out the performance verification test detailed below.

EQUIPMENT REQUIRED

- An audio oscillator capable of 1.5V r.m.s. output at 2.2kHz.
- An a.c. millivoltmeter with $1M\Omega$ input impedance minimum.
- A 600Ω , $\frac{1}{2}W$, 5% resistor (two $1.2k\Omega$ in parallel may be easier to obtain).

With the decoder totally disconnected from any equipment other than the test equipment and a +20V well-smoothed d.c. supply connect the audio oscillator to L_T and the a.c. millivoltmeter to L_F .



If one uses the method of construction shown in Fig. 5.9, where the corner joints are mitred and in fact the assembly is facilitated using a "skin" of plastic or veneer material this will require machines capable of producing perfect mitred joints in the main chipboard core leaving only the veneered surface uncut. The veneered surface is finished and polished with a flexible polisher, or cabinets may be finished with flexible coloured vinyl surfaces or the like.

Grooves for the front and back, together with the mitre grooves, are coated with PVA glue and the skin is then simply "wrapped" round the front and back baffles. The whole comes together precisely, giving mitre and front-back seals. The operation is descriptively called "wrapping" and the product a "wrap-round".

Such an assembly will require fairly sophisticated woodworking equipment.

As it is important to ensure an airtight assembly it is quite easy to seal any small holes or gaps with a modern bath caulking material such as Sealastic.

Note: The mounting socket for suitable pick-up input/s was not shown in Fig. 3.4. Thus one or two holes are required for a Philips stereo socket or two Phono sockets with associated wiring internally of the trough to the pre-amplifier inputs.

Next month: Pick-ups and Turntables for Quadraphonics

Connect R_T to earth through the 600Ω resistor and set the audio oscillator to 2.2kHz and adjust its output, as measured by the a.c. millivoltmeter, to 1.0V r.m.s.

Disconnect the millivoltmeter from L_F and with it measure the other outputs, L_B , R_B , R_F , which should be:
 L_B , $630mV \pm 80mV$; R_B , $630mV \pm 80mV$; R_F , between 50mV and 100mV.

Repeat the above steps with oscillator connected to R_T and L_T connected to earth through the 600Ω resistor. Outputs should now be, with R_F set 1.0V r.m.s.: R_B , $630mV \pm 80mV$; L_B , $630mV \pm 80mV$; L_F , between 50mV and 100mV.

If the results noted are not attainable careful re-examination of the board layout will most probably show wrong component insertion.

PE Sound Synthesiser 12

KEYBOARD

By G.D. SHAW



LAST month circuits for the keyboard unit divider network, hold circuits, modulation amplifiers and mixer were included. In Fig. 12.1 assembly details are given for these. The envelope shapers are mounted on a separate board shown in Fig. 12.2 which is, in turn, mounted on a small sub-chassis below the control panel. Constructional details of the control panel and envelope shaper sub-chassis are given in Figs. 12.4/3 respectively, while Fig. 12.5 shows the component and wiring arrangement of the control panel.

ADJUSTING THE MAIN CIRCUIT BOARD

Power supply links are fitted only to IC1 and IC2 of the divider circuit then this procedure should be followed.

Temporarily connect VR1 (Tune) and VR2 (Span) potentiometers and S1. With power on the board set S1 to bring VR2 into circuit and, monitoring the output of IC1, check that full rotation of VR1 gives an output voltage swing of about 8 volts. Note that the position of VR2 will affect the actual value of the maximum and minimum voltages monitored but will have no effect on the range of VR1.

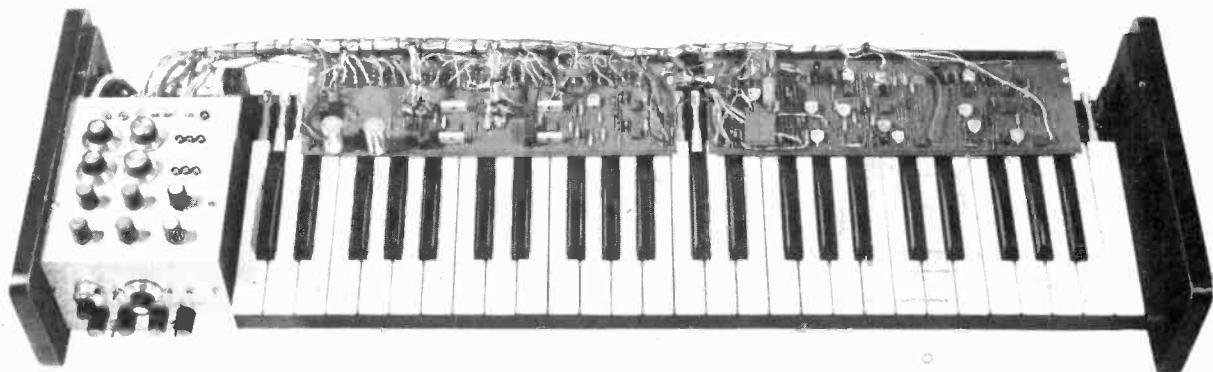
Next, monitor the output of IC2 whilst swinging VR2 through its full range. Here again the output voltage swing should be of the order of 8 volts. Set

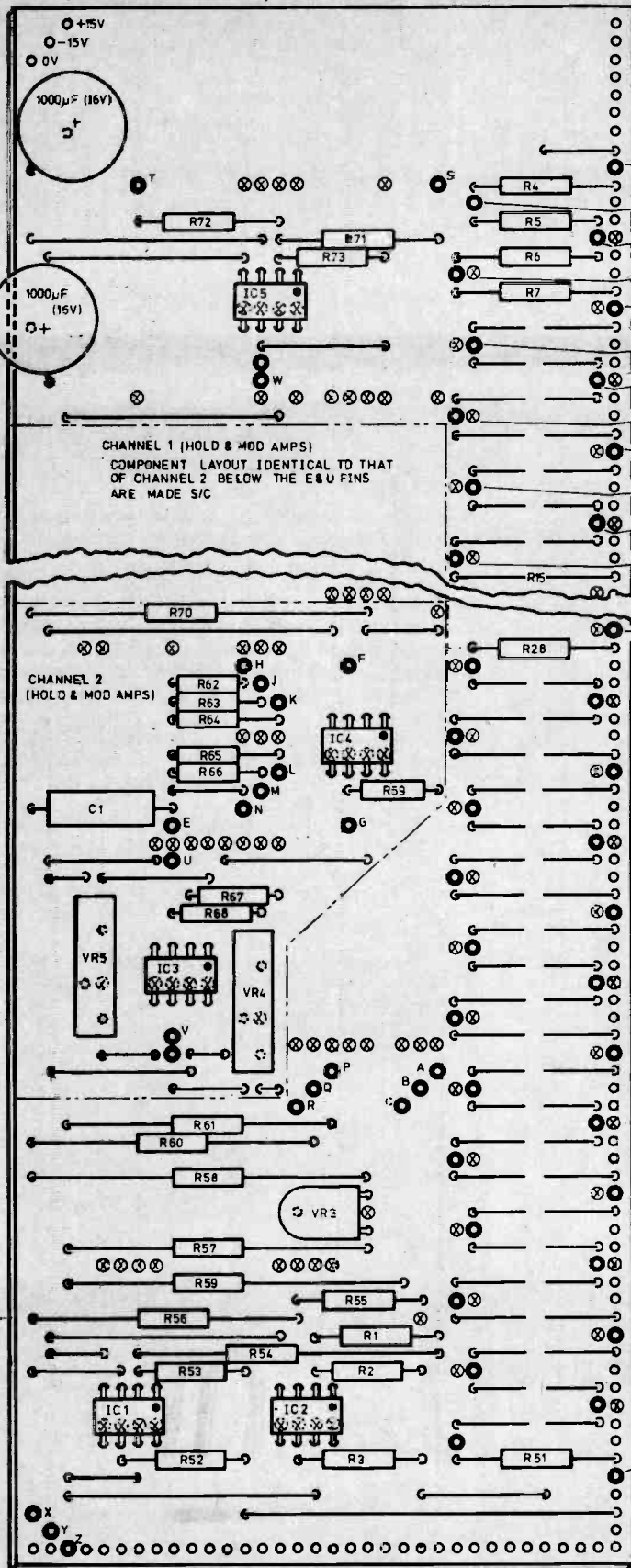
S1 to the fixed span position and adjust VR1 so that the voltage at the junction of R51-R52 is 6 volts. Transfer the voltmeter leads so that they are now measuring the potential between the junctions of R3-R4 and R51-R52 and adjust VR3 so that a reading of 4 volts is obtained. Adjustment of VR1 should have no effect on this latter reading. The final tuning of the divider network will be described later in this article.

Setting up the hold circuits should follow the pattern described in Part 11 of the series after first connecting the power supply links to the i.c.s concerned. The relative simplicity of the modulation amplifiers and mixer is such that no particular setting up is required.

Note that VR1 is specified as being a semi-precision wirewound potentiometer. For the majority of purposes this type of control will be found to be quite adequate but when the keyboard is to be matched with other musical instruments of the acoustic type it will be found that the ease of matching is greatly facilitated by the substitution of a ten-turn potentiometer for the specified type.

Prototype keyboard unit with cover removed. The circuit board to the left is that detailed in Fig. 12.1, and to the right the v.c.o. assembly





CHANNEL 1 (HOLD & MOD AMPS)
 COMPONENT LAYOUT TO THAT
 OF CHANNEL 2 BELOW THE E & U PINS
 ARE MADE S/C

CHANNEL 2
 (HOLD & MOD AMPS)

C
 C*
 D
 Eb
 E
 F
 F#
 G
 G*
 A
 Bb
 B
 R15

MIDDLE C

WIRING SEQUENCE
 FOR SUBSEQUENT
 OCTAVES IS
 IDENTICAL
 TO ABOVE

- A—VR1w
 - B—S1
 - C—VR2
 - E—S5(a)
 - F—S7 (1)
 - G—VR7 (1)
 - H: J: K: L: M: N—S4 (1)
 - P—VR1
 - Q—VR1
 - R—S1
 - W—Env. shaper 1
 - S—Env. shaper 2
 - T—SK6 and kbd junction block
 - X—0V
 - Y—-15V
 - Z—+15V
 - V—To R10 input (V.C.O. 2) and SK1 (2)
- } All to V.C.O. board

Fig. 12.1. Circuit board layout for divider; hold; modulation amplifiers and mixer

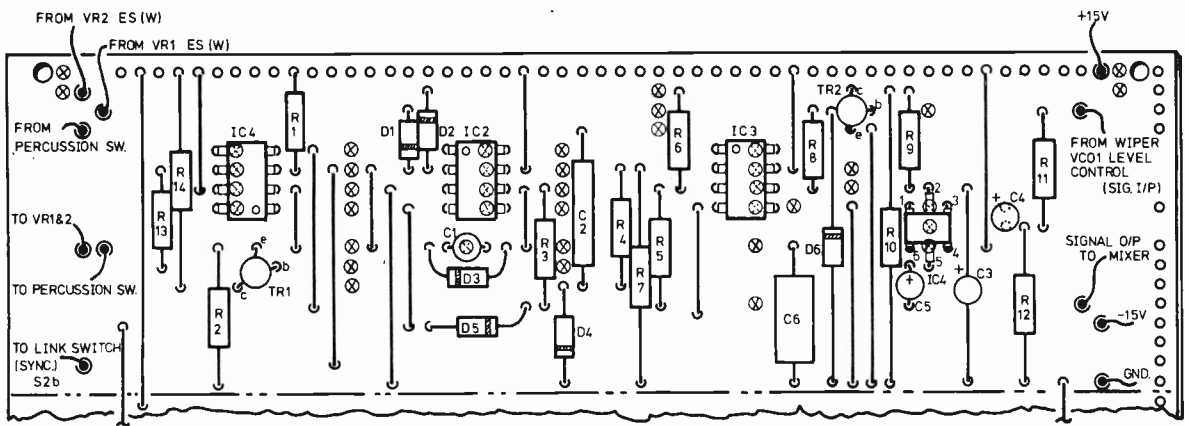


Fig. 12.2. Circuit board layout for keyboard envelope shaper and v.c.a. Only one channel is shown. The second channel is identical

ENVELOPE SHAPER ADJUSTMENT

On completion of assembly of the envelope shaper components make temporary connections to VR1, VR2 and S1, and, with power applied, measure the voltage at pin 2 of the MFC6040. This should be +6V under quiescent conditions, and, with S1 off and -15V applied to the non-inverting input of IC4, will fall to about 4.3V. Monitor pin 2 of the MFC 6040 on the oscilloscope, set VR2, the attack control, to maximum and close S1.

The transient application of -15V to the non-inverting input of IC4 will now result in a negative going pulse at IC4 control input. The pulse width should be about 37.5mS and depth about 2.3V.

With both envelope shapers operating satisfactorily the circuit board may be assembled into its sub-chassis and permanent wire links made with the attack and decay controls.

CONTROL PANEL AND MAIN WIRING HARNESS

Position the control panel components as shown in Fig. 12.5 and complete the component inter-wiring.

Making up and connecting the main harness requires the manipulation of a considerable number of wires and it is perhaps best to try and complete the operation at one sitting. Failing this it will be necessary to make a meticulous record of connections/colour codings in order to avoid the possibility of error.

The wiring operation is simplified if the main harness is broken down into a number of sub-harnesses. It was found expedient to have all the wires one metre in length and then to trim them as and when final connections were made. Connect all the wiring to the control panel first of all and bind

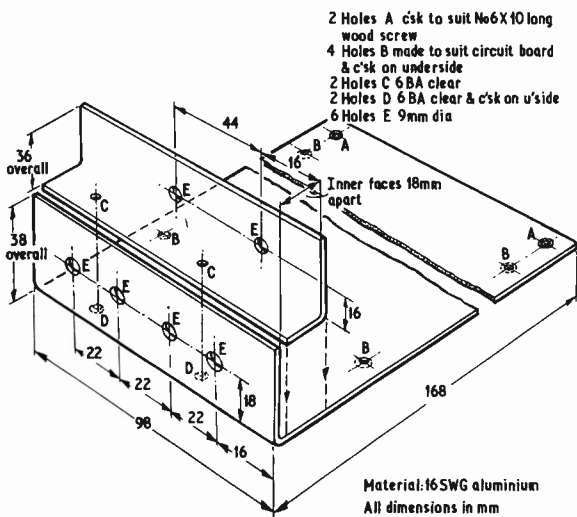
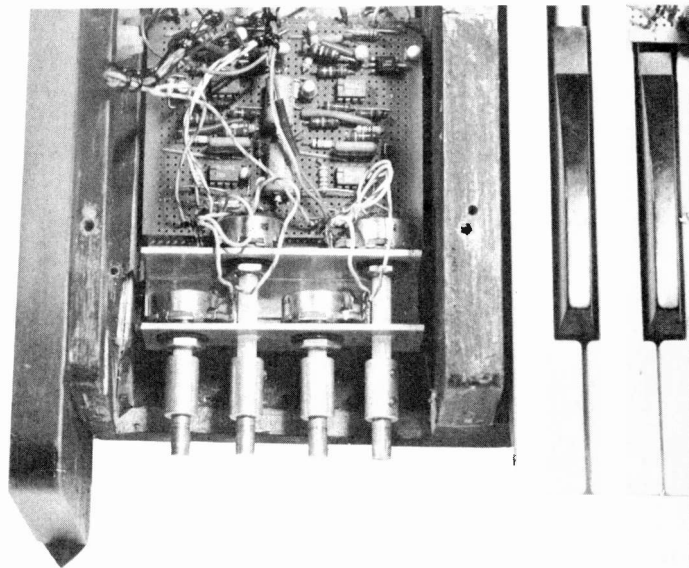


Fig. 12.3. Drilling details of envelope shaper sub-chassis



Showing how the potentiometers are arranged on envelope shaper sub-chassis

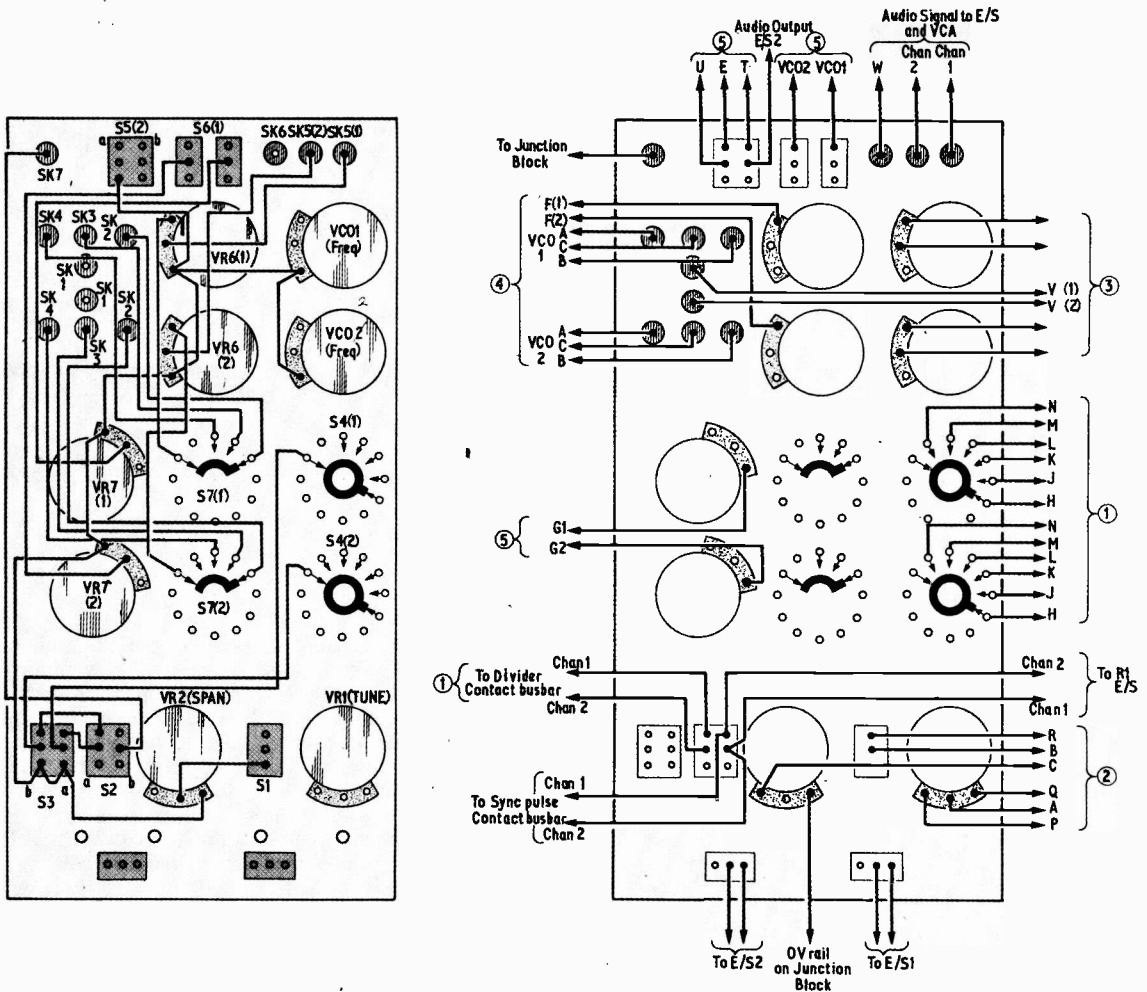


Fig. 12.5. Component layout and wiring of keyboard control panel

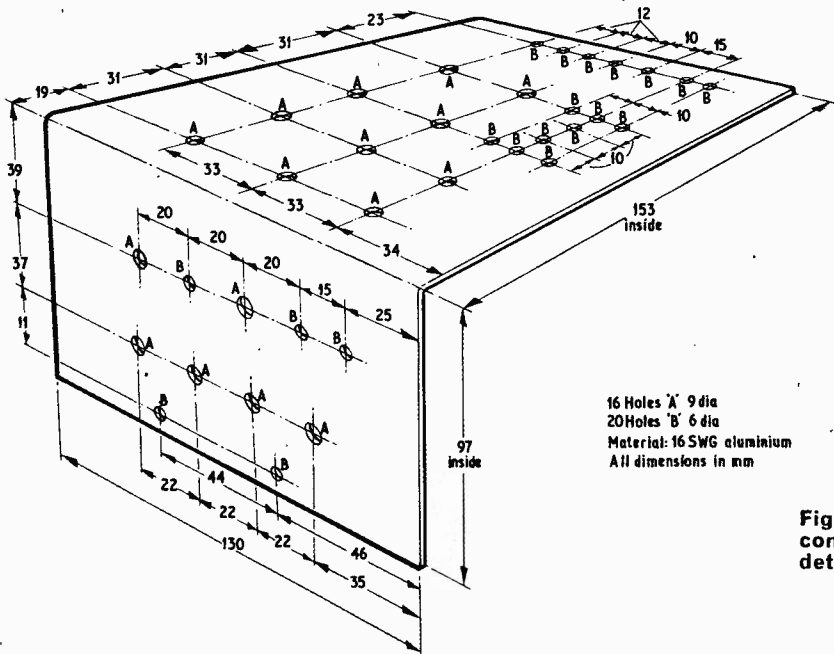


Fig. 12.4. Keyboard control panel drilling details

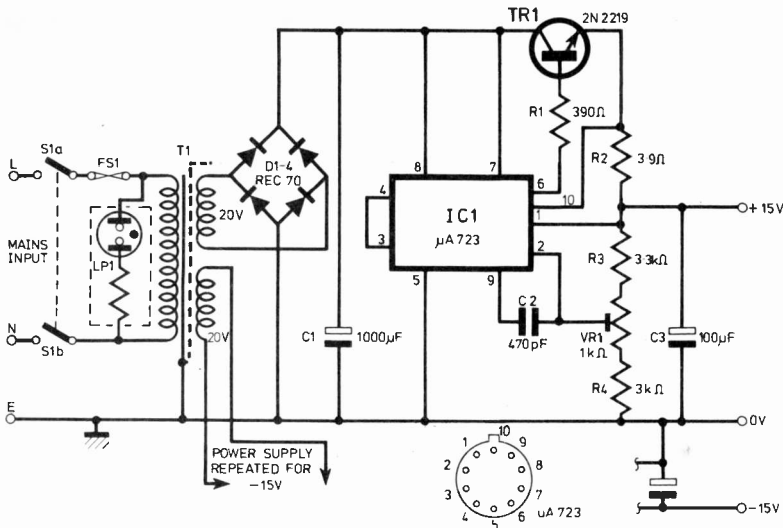
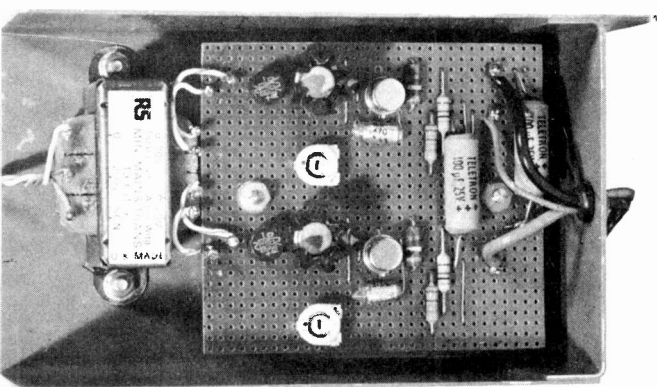


Fig. 12.6. Circuit diagram of one half of keyboard p.s.u. The negative rail half is identical. T1 is a miniature mains transformer with two separate 20V secondaries each rated at 3VA. Resistors are $\frac{1}{4}$ W 5% carbon film and the electrolytics at 50V



The completed power supply unit. The metal surround should be grounded to obviate hum pick-up

POWER SUPPLY UNIT

Where it is decided to operate the keyboard as a unit independent of or separate to the modular unit a small power supply unit may be installed within the keyboard housing. In this latter case the output signal from the keyboard may be taken from SK6.

The circuit of the power supply unit is shown in Fig. 12.6. Because there is nothing critical about layout board wiring details are omitted.

The power supply unit, in its casing, should be mounted to the rear of the envelope shaper sub-chassis so that its associated mains plug will be shielded by the casing and thus reduce the possibility of inducing hum into the keyboard circuitry.

Next month: Keyboard housing and final tuning

them loosely into the groups shown. Try to ensure that there are no two wires of the same colour in any one group.

The wiring groups should be brought out of the control panel on the long axis and passing over S6 (1) and (2). With the control panel upside down and with the front face away from the constructor, bend the wire groups at the near edge of the control panel so that they run to the right, and place the assembly to the rear of the keyboard housing with the control panel edge against the baseboard and directly in line with its normal position. In other words the control panel should present the appearance of having been hinged back from its normal, fixed position, and laid on the table. Starting with sub-group 1 the wiring may now be trimmed and soldered individually to its respective pins.

When all groups have been dealt with carefully check each connection and when satisfied of the correctness of each, bind them tightly together into a common harness. Wiring to the envelope shapers should be grouped with the signal input and output leads separate from those carrying the sync pulse and percussive attack signal.

EVERYDAY ELECTRONICS

This month EE details the following projects:

- V.C.O. Effects Unit**
- Fetset M.W. Receiver**
- Sewing Machine Speed Control**

Plus a new series that may help to jog your memory on some technical points:

Semiconductor Primer

THE GOOD COMPANIONS



Two magazines designed to complement each other in every way—together satisfying the needs of everyone involved in electronics.



**EVERYDAY ELECTRONICS
JANUARY ISSUE ON SALE
WEDNESDAY, DECEMBER 19**

MARKET PLACE

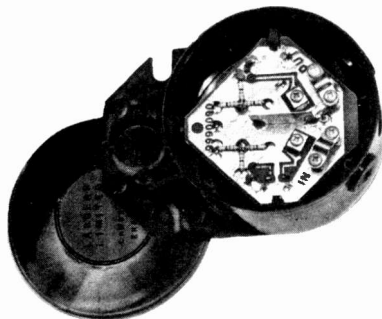
Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned.

TV AND UHF SIGNAL BOOSTER

Ideally suited for readers in poor signal areas, **Labgear Ltd.** have just introduced a new high gain u.h.f. booster covering all TV and f.m. radio transmissions on bands 1 to V.

This masthead pre-amplifier has a gain of 22dB and a typical noise level of 3.5dB. Suitable for most standard u.h.f. Vagi aerials of 75 ohm impedance the maximum output for 1 per cent cross modulation is claimed to be 189mV.

Further technical details of the CM6030 signal booster (price £11) and list of nearest stockists can be obtained from Labgear Ltd., Abbey Walk, Cambridge.



F.M. and TV Signal Booster from Labgear

PRINTED WIRING BOARD

A quick and easy method of transferring circuits to practical layouts is claimed by **Ringboard** for their new Ringboard printed circuit.

Made from glass fibre material, the copper backing has areas of circular copper "islands" or rings which take the components that form junction points in the circuit diagram. The two remaining large copper areas on the board can be used as the supply lines.

The method of layout is as follows: where two or more components intersect on the circuit diagram a pencil mark should be made. Where these pencil circles appear it represents a copper ring. When the circuit diagram has been completely marked the components are joined from ring to ring or supply line.

In practice it was found ideal for simple circuits and add-on boards can be used for mounting integrated circuits.

Full particulars can be obtained from Ringboard, 259 Chesterfield Road, Sheffield S8 0RT.

MULTIMETER

Just released onto the U.K. market is a range of high quality test instruments from **Chinaglia Elettrocostruzioni**, one of Italy's leading test gear manufacturers.

Amongst their new products is the Cortina Minor multimeter which should interest readers. Priced at £13, including VAT, this meter has a sensitivity of 20k Ω /V d.c. and 4k Ω /V a.c. and covers 39 ranges. The d.c. voltages covered range from 0-100mV to 0-1500V in eight switched ranges. The a.c. voltages are 0-7.5V to 0-1500V in six switched ranges. The d.c. current measurement available is 0-50 μ A to 0-2.5A, in five switched ranges, and a.c. current range is 0-25mA to 12.5A, in four switched ranges.

The ohmmeter coverage is in two switched ranges from 0.5 Ω up to 10M Ω . The power reading facility ranges from -10dB up to +69dB. A further facility of the meter is a capacitance range from 100 to 100,000 μ F.

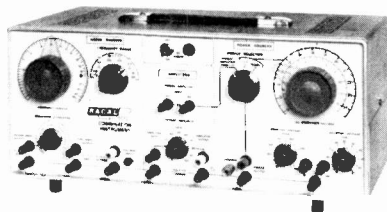
Supplied with each instrument is a shockproof carrying case, two test leads and a detailed instruction booklet. Also available as an extra (£7.80) is a 30kV high voltage probe. This increases the range of the meter and makes it suitable for television work and other high voltage work.

A catalogue covering the full range of test gear and any further information can be obtained from Chinaglia (UK) Ltd., 19, Mulberry Walk, London.

TEST GEAR

Test equipment can, at times, seem, almost by virtue of its nature, to be both expensive and repetitious. Thus any efforts by manufacturers to reduce one or both of these factors is to be applauded.

In this context **Racal Instruments** have developed a laboratory test



Racal BWD 602 Test Set

piece capable of providing one signal generator, two amplifiers and three power sources all in the one case. Identified as the BWD Model 602, this unit is claimed to be capable of replacing more expensive and sophisticated equipment in both laboratory and workshop.

The 602 includes a sine/square wave generator covering 0.5Hz to 500kHz; an amplifier with variable gain from 5 to 100, over a bandwidth from 1Hz to 50kHz; an 8 watt d.c. to 20kHz amplifier; a high voltage d.c. stabilised power supply giving +300V at 35mA and -50V at 1mA; a low voltage d.c. supply for 1 to 12V at 2A or 12 to 24V at 1A and finally an a.c. supply giving 55V, 15V and 6.3V all at 1A.

Inputs and outputs of the various items are available both at the front panel and, via an octal plug, at the rear for convenience in wiring in for semi-permanent set-ups.

The various sections can be linked up to form, for example, a 0.5Hz to 20kHz oscillator and an 8W square wave generator.

The Model 602 is available at £150, not unreasonable for precision instrumentation of this multiplicity, and full details can be obtained from Racal Instruments Ltd., Duke Street, Windsor, Berks, SL4 1SB.

QUADRAPHONIC HEADPHONES

Readers may be interested to note that among the many new products from **Eagle International** is a new four-channel headphone.



Quadraphonic Headphones from Eagle

Designated type FF.29 the four transducers in the head sets are, it is claimed, carefully angled in such a way that the effect achieved is similar to strategically placed loudspeakers.

Compatible with practically all quadraphonic systems the 'phones have a frequency range of 20Hz to 20kHz. The impedance of the FF.29 is 8 ohms per channel and the matching impedance is 8 to 16 ohms.

The price of the Eagle FF.29 headphones is £16.80 excluding VAT and they are available from most audio shops.

AUDIO

FESTIVAL AND FAIR

A look at the 1973 International Audio Fair held at Olympia, London

THIS year's Audio Fair has managed to present the public with a surprising number of new developments spread over the arts of both sound production and aesthetic appeal despite a rather slow start to the week. Indeed, the initial Trade and Press opening at Olympia was delayed by a matter of hours on the opening day whilst various labour problems were sorted out, and even then very few of the stands and displays were completed before the following day. In fact, it is understood that stand painting was still being completed as late as the Thursday, quite a tribute to the exhibitors who still managed to present a cheerful face and working exhibits despite such problems.

The show was the largest so far held, with a floor area of over 17,000 square metres, some 11,000 of which were taken up with stands. Not really surprising with the market turnover topping the £100 million in 1973. In fact audio is one of the big growth areas of the electronics industry at present.

In conjunction with the exhibition there was a series of lectures and demonstrations covering a wide range of interests, including the P.E. Sound Synthesiser by Douglas Shaw. Other subjects included quadraphonics, recent developments in sound reproduction, the current (and indeed fast growing) broadcast scene and demonstrations of pop music as well as the classics.

LARGE VARIETY

The visitor could be forgiven if he were to have limited his stay to only a few stands in the exhibition hall, not because the displays were poor but for quite the reverse reason. In fact there was all too much to see, extending from cassette equipments to a multiplicity of new tuners and power amplifiers.

All tastes were catered for both in audio quality terms and styling. For example, provided only a sufficiency of cash one could examine and possibly purchase a set of headphones and associated amplifier for £104 obtaining, for this outlay, one of the best sounding headsets ever sampled. However, £104 is rather a lot. The unit in question was the Stax SR-X Mk II Superphone.

In the same sort of price range but as a total system rather than a part, there was the Dynatron 'Gunchest' HFC 65 tuner/amplifier and separate speakers, all housed in units resembling the duelling pistol cases of an earlier age. However, to achieve this sort of elegance one has to set aside £198 and attractive as such equipment is that does seem rather a lot.

However, in the same range from Dynatron there is even more opulence in the form of the "Dorchester" complete home entertainment centre. A tuner/amplifier and Lenco GL 78 transcription deck with a cassette stereo recorder/player unit, all housed in a Queen Anne style cabinet and with associated similarly styled speaker enclosures. All that for a mere £387.

It is always difficult to imagine a large market for such equipments but no doubt quite a few must be sold to justify their manufacture.

KITS IN EVIDENCE

It was very interesting to note the upswing in the general electronic constructor kit market which is clearly gaining momentum. Josty were there in strength with a very wide range of kits extending from industrial control, through instrumentation to the audio, hi-fi and broadcast reception areas and the household gadget market. To support their effort they were introducing a book on electronics

covering the areas occupied by their kits.

Similarly equipped with an equally wide range of kits and some interesting cases and associated bits of hardware for the home constructor were Amtron. Indeed there are over 200 kits in the Amtron range, extending from a simple single transistor amplifier up to a digital clock.

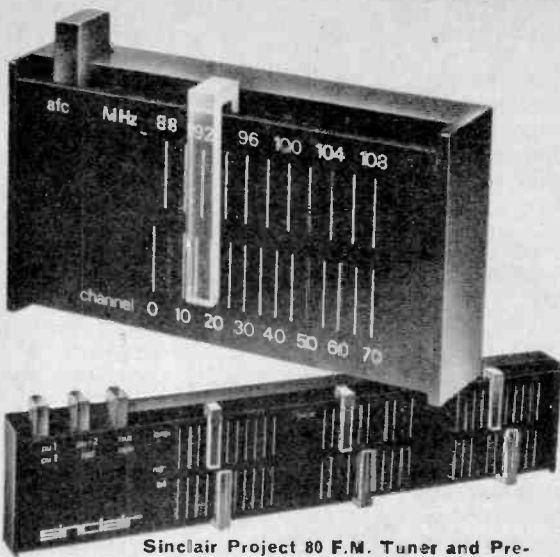
Perhaps not quite considered as kit suppliers are Connoisseur (A. R. Sugden) who were showing both kit and pre-built units including the ever popular BD1 assembly and the latest SAU2 pick-up arm which has a rather attractive lowering mechanism and is, interestingly enough, suited to use with the BD1 and the P.E. Rondo quadraphonic system.

Both KEF and Wharfedale were displaying their ranges of loud-speaker kits including the Glendale 3 and Kingsdale 3 equipments from Wharfedale capable of handling 40 and 60 W respectively.

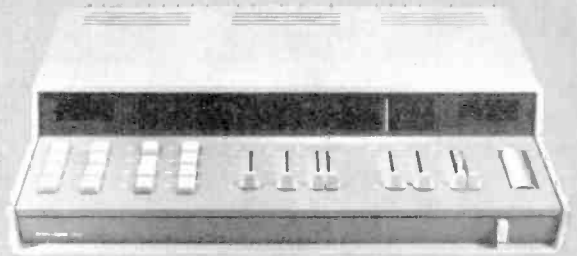
NEW MODULE RANGE

Turning to amplification equipment, Sinclair used the exhibition as an opportunity to publicise their new Project 80 modules, intended to replace the well-known Project 60 range. The new Project 80 is a series of modules of very attractive form and style which may be used singly or together to form a complete system. They include a pre-amplifier and control unit, an active filter unit, two power amplifiers, three power supply units and the Project 80 f.m. tuner and stereo decoder.

Also new from the same stable is the System 4000 amplifier and a tuner. Both are designed as rugged equipments with attractive modern styling. The amplifier is capable of giving up to 60 W per channel stereo of music power



Sinclair Project 80 F.M. Tuner and Pre-amplifier modules



The Scan-Dyna Tuner/Amplifier system and 1400 Deck



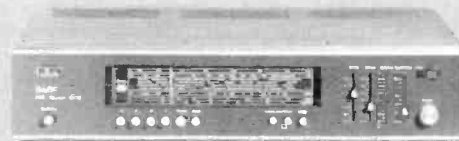
This JVC Cassette equipment caters for Quadratics



The Stax SR-X earphone system is something to hear even at £104



QAS market this glass-bowl 30W speaker



A Saba £035 stereo Tuner/Amplifier system



The Ferrograph 20-20 Stereo Amplifier



One of the Italian A.P. See-thru "see-thru" speakers

into 4 ohms. A constant power balance control gives improved volume control without the need for adjustment of balance.

We understand that Sinclair are setting up a new distribution organisation which will involve using major distributors supplying up to 250 official retail stockists and supporting this with an increased field sales team and service back up.

FOUR CHANNEL EQUIPMENT

It goes almost without saying that quadrasonics was of interest to many visitors and exhibitors. There were several interesting (though often not too impressive) demonstrations and it seems clear that this is a section of the market which has yet to settle down with established techniques and equipments.

Of interest in this area was an 8-track, 4-channel cassette deck from JVC using standard 0.15 inch tape. This equipment is indicative of the direction technology is taking—sound reproduction in terms of size and capability. The specification includes crosstalk figures of 25dB at 1kHz which is quite something in the circumstances. To do this it uses a special circuit using phase shift and cancellation techniques.

In addition the tape hiss and noise which must arise from using such small tracks is catered for using automatic noise reduction to give a signal-to-noise of 48dB in the 4-channel mode.

Clearly cassettes are the area of the future in many minds. One of the latest developments is a so-called transcription cassette recorder (NEAL model 102) from North East Audio which uses a 3M Wollensak deck and Dolby B to achieve wow and flutter figures of less than 0.15 per cent r.m.s. DIN weighted. Record and replay amplifiers are claimed to have less than 0.1 per cent distortion and crosstalk is said to be better than 45dB. With bandwidth figures of 35Hz to 12kHz, +1 to -3dB for ferric oxide tape and extended to 15kHz for chromium dioxide this is quite a specification to live up to.

NEW TREND

One factor stands out quite strongly from the exhibits, the inclusion of tuners in the basic amplifier equipment. With the advent of the varicap tuner system, phase locked loops, and integrated circuit decoders, it is now more the rule to find equipments, and indeed kits, offered as including the tuner.

Japanese exhibitions figured

strongly in new four-channel tuner/amplifiers with all systems facilities (QS, SQ and CD-4). As we have come to expect from this sector styling and control handling were, in the main, impeccable.

PERSPECTIVE STEREO

Stereo and quad are not to be left to battle it out alone! A three-speaker system demonstrated on the Brahms Manufacturing and Development Co. stand may well appeal to many audiophiles as a sensible compromise.

Described as a new concept in sound the Orthoperspecta system has been developed by Finland's largest audio manufacturers, Salora. A full range speaker placed centrally facing the listeners is reinforced by the outputs from two smaller "directional" speakers positioned either side of the listeners. The side units operate over a restricted range 300Hz to 3,000Hz and the strong reflection at these frequencies enhances the sound pattern and creates an impression of diffused sound, reminiscent of the concert hall.

The model 3000 Orthoperspecta tuner-amplifier employs a matrix system to obtain the necessary signal phasing for diffused sound from normal stereo programme sources. ★



BOOK REVIEWS

SEMICONDUCTORS FROM A TO Z

By Phillip Dahlen

Published by Foulsham-Tab Ltd.

265 pages, 5½ × 8½ in. Price £1.50

THIS book is for the man who wants to have everything he needs to know about the semiconductor "family" from the simplest diode to the most complex integrated circuit.

The author begins by defining semiconductors and adds a helpful chapter determining their various characteristics—current gain, voltage drops etc.

Succeeding chapters describe in detail the characteristics and then the applications of field-effect devices such as MOS f.e.t.s; tunnel diodes; varicaps; light-sensitive devices; unijunction transistors; Zener diodes, thyristors; diacs and triacs.

Modern developments are covered very well and even include a chapter on fibre optics!

It is important to note that this book was originally written in America which could cause one or two misunderstandings to the British reader because the mains input voltages towards the end of the book

are shown in accordance with American rather than British standard supplies.

Also confusing is the fact that *current* flow is shown as negative to positive in circuit diagrams instead of vice-versa as is usual in this country. However, there is a special chapter at the beginning of the book directed at the British reader clearing up any points which may arise.

At £1.50 this book is good value for money and a useful addition to the constructor's library.

I.L.

RAPID SERVICING OF TRANSISTOR EQUIPMENT (2nd Ed)

By Gordon J. King

Published by Newnes-Butterworths

171 pages, 8½ in × 5½ in. Price £1.90

FIRST published in 1966 this handbook has now been updated to take into account modern developments. A section on integrated circuits has been included and all reference to valves has been removed.


This book concentrates mainly on the servicing of domestic equipment with numerous hints on rapid fault diagnosis. Some fundamental theory of electronics is included in the earlier part of the book so that some understanding of the circuits can be attained.

Though biased towards fault-finding this book provides a simple introduction to electronics and some useful practical advice.

S.R.L.

BEAT POWER CUTS !!

With this...
100w INVERTER-CHARGER



Maintain essential services in the home with an inverter/charger capable of delivering 80-100 Watts, sufficient to drive such combinations as a central heating pump, solenoids (gas fired system) and a 40 Watt lamp, or perhaps, two 40 Watt lamps or an audio system.

The circuit is designed so as to provide both inverter and charging facilities. The operation of a switch changing operation over from one to the other so as to maintain optimum charge in the associated accumulators

Audio Millivoltmeter

An audio frequency millivoltmeter, with a basic sensitivity of 1mV, a response from 30Hz to above 50kHz, with an input impedance, on all ranges, of 1M Ω . It features a separate probe to preserve high frequency accuracy. An amplified signal output is also provided.

Charger/Regulator

Convert your vehicle to solid state charging control and improve efficiency, overcome electro-mechanical problems like contact wear and lengthen the life of your dynamo and battery.

Electronic Thermometer

An easy-to-build thermometer with sensitive thermistor sensor. Has audio and visual indicators for preset temperature levels. Ideal for use as a frost alarm.

All this in next month's issue of ...

**PRACTICAL
ELECTRONICS**

FEBRUARY ISSUE ON SALE JANUARY 11, 1974

The Sinclair Cambridge... no other calculator is so powerful and so compact.

Complete kit-£24.95! (PLUS VAT)

The Cambridge – new from Sinclair

The Cambridge is a new electronic calculator from Sinclair, Europe's largest calculator manufacturer. It offers the power to handle the most complex calculations, in a compact, reliable package. No other calculator can approach the specification below at anything like the price – and by building it yourself you can save a further £5.50!

Truly pocket-sized

With all its calculating capability, the Cambridge still measures just $4\frac{1}{2}'' \times 2'' \times \frac{11}{16}''$. That means you can carry the Cambridge wherever you go without inconvenience – it fits in your pocket with barely a bulge. It runs on ordinary U16-type batteries which give weeks of life before replacement.

Easy to assemble

All parts are supplied – all you need provide is a soldering iron and a pair of cutters. Complete step-by-step instructions are provided, and our service department will back you throughout if you've any queries or problems.

The cost? Just £27.45!

The Sinclair Cambridge kit is supplied to you direct from the manufacturer. Ready assembled, it costs £32.95 – so you're saving £5.50! Of course we'll be happy to supply you with one ready-assembled if you prefer – it's still far and away the best calculator value on the market.

Features of the Sinclair Cambridge

- * Uniquely handy package. $4\frac{1}{2}'' \times 2'' \times \frac{11}{16}''$, weight $3\frac{1}{2}$ oz.
- * Standard keyboard. All you need for complex calculations.
- * Clear-last-entry feature.
- * Fully-floating decimal point.
- * Algebraic logic.
- * Four operators (+, -, ×, ÷), with constant on all four.
- * Constant acts as last entry in a calculation.
- * Constant and algebraic logic combine to act as a limited memory, allowing complex calculations on a calculator costing less than £30.
- * Calculates to 8 significant digits, with exponent range from 10^{-20} to 10^{79} .
- * Clear, bright 8-digit display.
- * Operates for weeks on four U16-type batteries. (MN 2400 recommended.)



A complete kit!

The kit comes to you packaged in a heavy-duty polystyrene container. It contains all you need to assemble your Sinclair Cambridge. Assembly time is about 3 hours.

Contents:

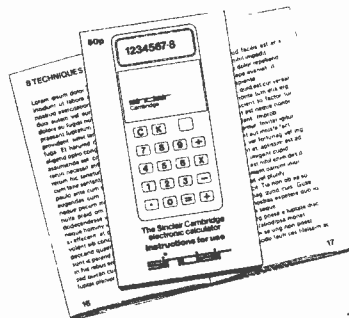
1. Coil.
2. Large-scale integrated circuit.
3. Interface chip.
4. Thick-film resistor pack.
5. Case mouldings, with buttons, window and light-up display in position.
6. Printed circuit board.
7. Keyboard panel.
8. Electronic components pack (diodes, resistors, capacitors, transistor).
9. Battery clips and on/off switch.
10. Soft wallet.



This valuable book – free!

If you just use your Sinclair Cambridge for routine arithmetic – for shopping, conversions, percentages, accounting, tallying, and so on – then you'll get more than your money's worth.

But if you want to get even more out of it, you can go one step further and learn how to unlock the full potential of this piece of electronic technology.



How? It's all explained in this unique booklet, written by a leading calculator design consultant. In its fact-packed 32 pages it explains, step by step, how you can use the Sinclair Cambridge to carry out complex calculations like:

Logs Sines Cosines
Tangents Reciprocals nth roots
Currency Compound
conversion interest
and many others...

sinclair

Sinclair Radionics Ltd, London Road,
St Ives, Huntingdonshire
Reg. no: 699483 England
VAT Reg. no: 213 8170 88

Why only Sinclair can make you this offer

The reason's simple: only Sinclair – Europe's largest electronic calculator manufacturer – have the necessary combination of skills and scale.

Sinclair Radionics are the makers of the Executive – the smallest electronic calculator in the world. In spite of being one of the more expensive of the small calculators, it was a runaway best-seller. The experience gained on the Executive has enabled us to design and produce the Cambridge at this remarkably low price. But that in itself wouldn't be enough. Sinclair also have a very long experience of producing and marketing electronic kits. You may have used one, and you've almost certainly heard of them – the Sinclair Project 60 stereo modules.

It seemed only logical to combine the knowledge of do-it-yourself kits with the knowledge of small calculator technology. And you benefit!

Take advantage of this money-back, no-risks offer today

The Sinclair Cambridge is fully guaranteed. Return your kit within 10 days, and we'll refund your money without question. All parts are tested and checked before despatch – and we guarantee a correctly-assembled calculator for one year.

Simply fill in the preferential order form below and slip it in the post today.

Price in kit form: £24.95 + £2.50 VAT. (Total: £27.45)

Price fully built: £29.95 + £3.00 VAT. (Total: £32.95)

To: Sinclair Radionics Ltd, London Road,
St Ives, Huntingdonshire, PE17 4HJ

PE/174

Please send me

a Sinclair Cambridge calculator kit at
£24.95 + £2.50 VAT (Total: £27.45)

a Sinclair Cambridge calculator ready
built at £29.95 + £3.00 VAT
(Total: £32.95)

*I enclose cheque for £ _____, made
out to Sinclair Radionics Ltd, and
crossed.

*Please debit my *Barclaycard/Access
account. Account number _____

*Delete as required.

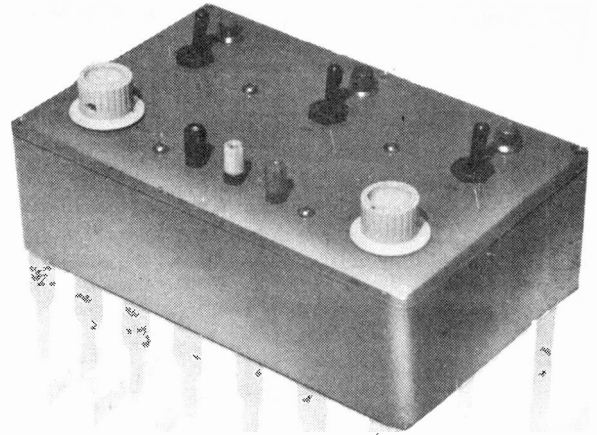
Name _____

Address _____

PLEASE PRINT

POWER SUPPLY for I.C.'s

By J. LEWIS B.Sc.



Now that the cost of integrated circuits is so low many constructors are using them in projects and general experimentation.

The main difficulty which most people encounter is supplying power to the integrated circuits (i.c.s), as most of the linear types require a dual supply rail whose values can range from ± 6 to ± 18 volts with various combinations of these voltages (for instance the 702 requires +12 and -6 volts).

Dry batteries are expensive and can destroy an i.c. as they have no inherent current limitation. To overcome these disadvantages it was decided to build a small unit capable of providing the necessary voltages in the dual range of 5 to 18 volts with a built-in current limiting device.

Required voltages are selected by a switch, ensuring greater accuracy than a potentiometer control. The current limit trips at a preset level (nominally 100mA) turning off the supply rail and lighting an indicator lamp.

TRIP CIRCUIT

The circuit of the complete power supply is shown in Fig. 1. The circuit is duplicated for positive and negative rails and so only the positive side is drawn.

Transistors TR1 to TR4 form the current trip circuit and indicator, and TR5 and IC1 form the voltage regulator.

To follow the operation of the circuit let us first consider the trip circuit. As the current through R4 increases, the voltage drop across this resistor increases. The potentiometer VR1 is used to tap off a preset fraction of this voltage and apply it to the base of TR2, the emitter of which is connected to the more positive side of VR1.

As the voltage drop increases a point will be reached where there is about 0.6 volts across the base-emitter junction of TR2 causing it to go from a non-conducting to a conducting state, which causes TR1, TR3 and TR4 to conduct also. TR1 has the indicator lamp as its collector load. TR3 keeps the circuit latched in the tripped condition by

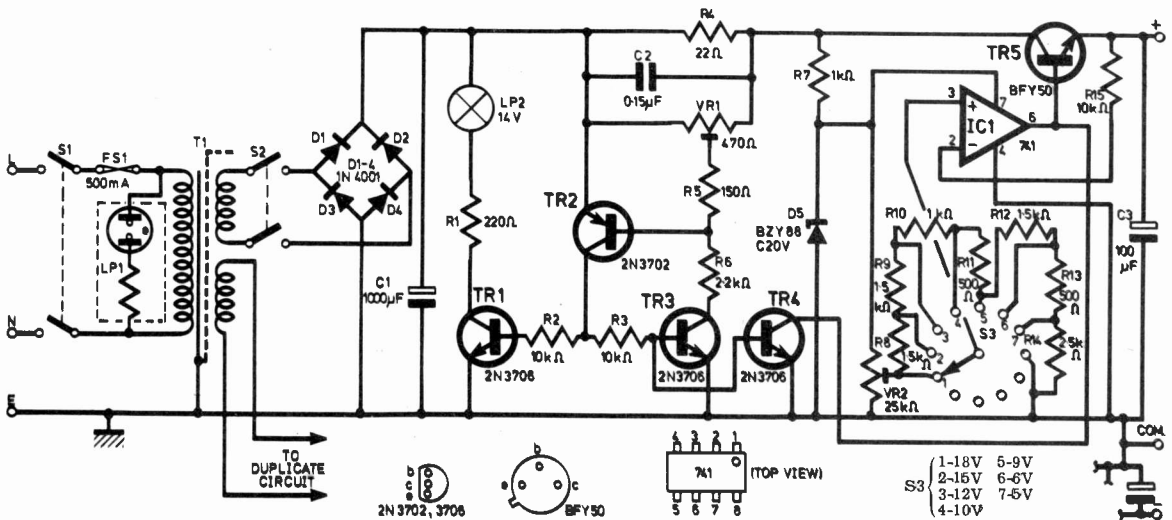


Fig. 1. Circuit diagram of the Power Supply for i.c.s. Note that the circuit to the right of the transformer should be duplicated if a dual power supply is required. Position 8 of S3 is only used to anchor R14, the switch should be stopped at 7 positions

supplying base current to TR2 as it switches on, maintaining this state by regenerative action.

TR4 is also switched on by TR2 and this causes the base of the main regulator transistor (TR5) to be taken to near ground potential, thus reducing the output to near zero volts.

REGULATOR CIRCUIT ACTION

The regulation circuit is of the common series type. IC1 acts as an error detector and its output is used to control the power transistor TR5.

It will be seen that the inverting (-) input of the i.c. is directly coupled to the output *via* R15, whilst the non-inverting (+) input is connected to a reference voltage produced by the resistor chain R8 to R14.

Any difference between these two inputs is amplified by IC1 and fed to the base of TR5 which acts

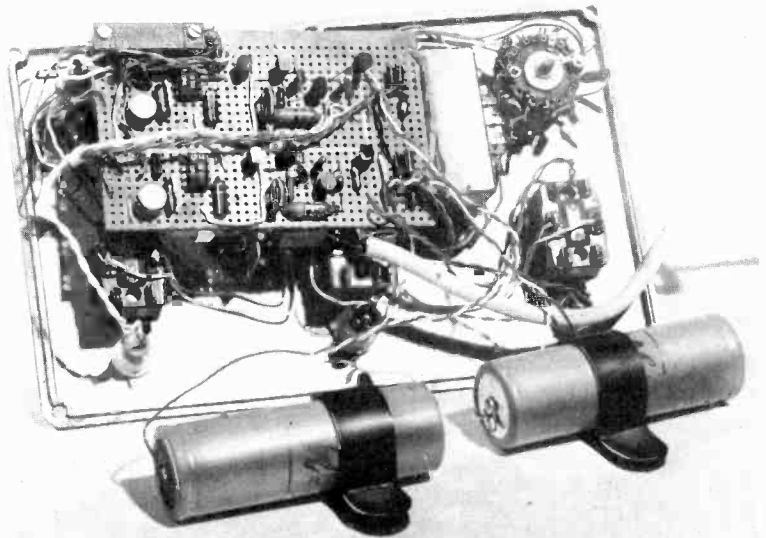
as an emitter follower, maintaining the output voltage at a level near the reference voltage (minus the base-emitter voltage of TR5).

The reference voltage is derived from Zener diode D5 which also supplies current to IC1. Because this diode only has a nominal rating of 20V its actual value may lie between 18.9 and 21.2 volts. Potentiometer VR2 was thus included to bring the voltage at the top of the resistor chain to 18V.

The resistors in the chain should be 1 per cent types, though if you have a large selection of, say, 5 per cent types and an ohmmeter, you may find some of the required values.

Regulation is better than 1 per cent. This means that the output voltage only changes by 1 per cent as the output current is varied from zero to maximum.

Photograph showing the completed power supply viewed from the rear. The rotary switches support the resistor chain and the output terminals support the C3s



COMPONENTS . . .

Resistors

R1	220Ω	R8	1.5kΩ	} 1%
R2	10kΩ	R9	1.5kΩ	
R3	10kΩ	R10	1kΩ	
R4	22Ω	R11	500Ω	
R5	150Ω	R12	1.5kΩ	
R6	2.2kΩ	R13	500Ω	
R7	1kΩ	R14	2.5kΩ	
		R15	10kΩ	

All 10% ¼W unless otherwise stated

Potentiometers

- VR1 470Ω vertical skeleton preset
- VR2 25kΩ (multiturn type, if available)

Capacitors

- C1 1,000μF 50V elect
- C2 0.15μF
- C3 100μF 20V elect

Semiconductors

- TR1, TR3, TR4 2N3706 (3 off)
- TR2 2N3702
- TR5 BFY50
- D1-D4 1N4001 (4 off)

D5 BZY88 C20V

IC1 741 (8 pin dual in line type)

The components above are for one half of the dual power supply. Twice the number of components above are needed for the other unit

Transformer

- T1 Mains primary, 0-20 0-20V r.m.s. 6VA secondary (R.S. miniature mains type)

Switches

- S1 Double pole mains on/off toggle
- S2 Double pole double throw toggle (2 off)
- S3 1-pole 7-way rotary (Use R.S. miniature Makaswitch components with 1-pole 12-way wafer) (2 off)

Miscellaneous

- LP1 Mains indicator neon with integral resistor
- LP2 14V 0.75W filament l.e.s. with holder (R.S.) (2 off)
- FS1 500mA fuse with holder
- 4½in × 7¼in diecast box
- Terminals (3 off)
- Veroboard 0.1in matrix 2½in × 3½in
- Capacitor clips to fit C1
- 4BA and 6BA nuts and bolts, grommets, knobs

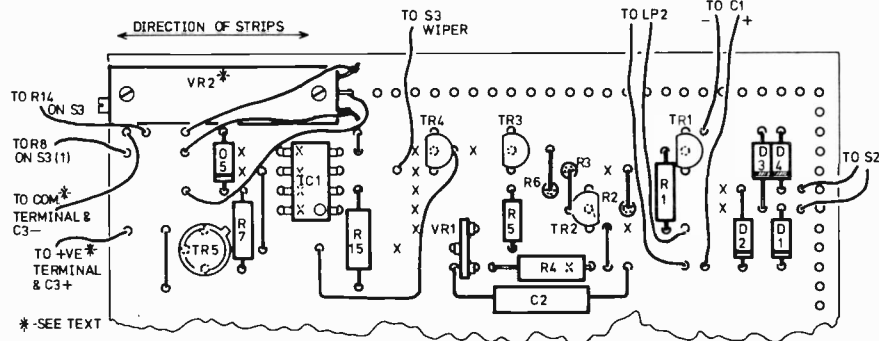


Fig. 2. Construction of the Power Supply for i.c.s. As with the circuit diagram only half of the complete circuit has been shown, the other half being identical to this. The heading photo shows a suggested front panel layout with the S2s mounted either side of S1 and their associated lamps above

CONSTRUCTION

The prototype was built into a diecast box, the majority of the components being mounted on a piece of 0.1in matrix Veroboard as shown in Fig. 2. Note that only one of the two circuits needed is shown, the other being identical.

The prototype used multi-turn pots for VR2 as these enable the 18V to be set with accuracy. In Fig. 2 both VR2s are bolted together at the top edge of the board. Skeleton pots may be used for economy but more care is needed in setting up.

Components can be mounted on the front panel as suggested in the photographs of the prototype, and the Veroboard mounted on a small aluminium bracket using nylon bolts or insulating washers to make sure that the board does not come into contact with the metal box which should be earthed.

Capacitor C3 is mounted directly on the output terminals. Note that in Fig. 2 C3 of the unseen half of the board has its positive terminal to common and negative to the negative terminal. The resistors of the reference voltage chain, R8 to R14, are mounted on the switches which are seven-way types using R.S. Makaswitch components.

Take particular care when setting up as there are mains voltages present within the case.

SETTING UP

Setting up is best done with the circuit not fixed in its case. Using a voltmeter, adjust VR2 until the voltage across the resistor chain is as near as possible to 18V. At the same time check that the voltages at points along the chain are those required. Repeat this operation for both supplies.

Connect an ammeter in series with a 3W wire-wound potentiometer and connect these across one supply. Switch the supply on and decrease the pot from maximum until the light comes on.

Adjust VR1 until the circuit just trips at 100mA (or as required). Some time may be needed on this stage as the setting of VR1 is quite critical. Repeat for the other supply.

Disconnect the dummy load and place the voltmeter across the outputs in turn and see that the voltages are those required. If not a slight adjustment of VR2 may be needed.

If a fault is suspected the voltages given in Table 1 may be helpful in locating it. The voltages shown are those which would be expected with the output set to 15V, both before and after the circuit has been tripped.

The 741 has output short circuit protection and is unlikely to be the cause of trouble. Suspect other components first.

APPLICATIONS

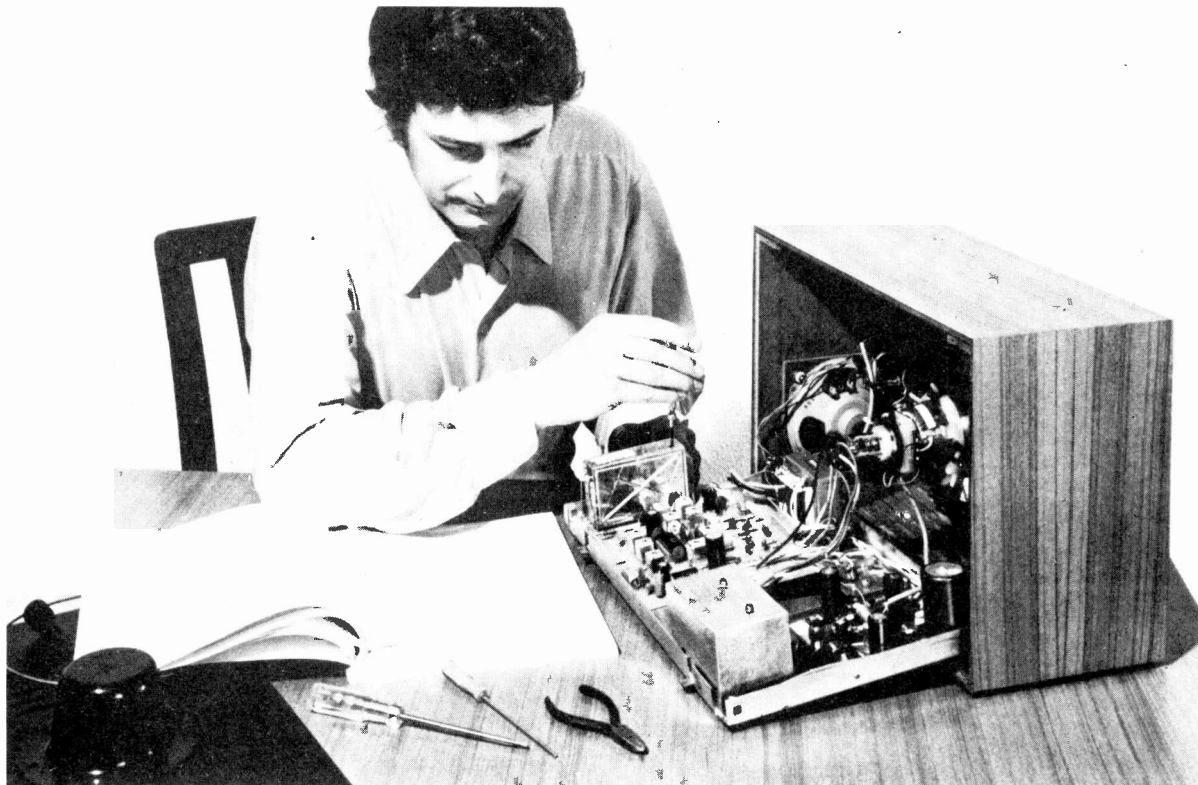
The resulting power unit is very compact and versatile. It can be used for powering both linear and logic, i.c.s or, indeed, normal transistor circuits, as there is no need to switch both sides of the supply.

At 80mA the ripple on the output was measured as being 5mV peak to peak.

One point to note is that the circuit will trip if a mains borne transient occurs. It may also trip when the voltage setting is being changed. The best procedure to adopt when switching back on is mains off, rails on then mains on.

Table 1: APPROXIMATE VOLTAGES IN THE CIRCUIT

Location	Voltage (S3 set to 15V)		
	Untripped	Tripped	
TR1	e	35	29
	b	35	28.1
	c	0	29
TR2	e	0	0
	b	0	0.75
	c	35	23.3
TR3	e	0	0
	b	0	0.75
	c	35	23.3
TR4	e	0	0
	b	0	0.75
	c	11.4	0.15
TR5	e	15	0
	b	11.4	0.15
	c	35	28.5
IC1	pin 1	0	0
	2	15	0
	3	15	7
	4	0	0
	5	0	0
	6	11.4	0.15
	7	20.4	9.2
	8	0	0



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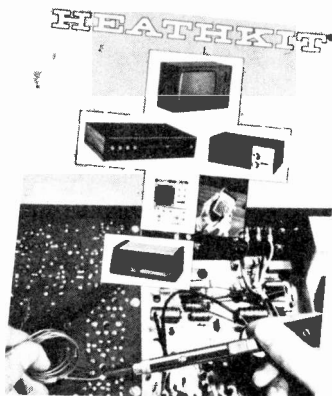
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PHASE LOCKED LOOPS

**PART 4:
MORE INTEGRATED
CIRCUIT APPLI-
CATIONS INCLUDING
STEREO DECODING**

BY J.B. DANCE M.Sc.

LAST month we looked at some applications of phase locked loop integrated circuits concentrating on devices manufactured by Signetics. In this final part devices from other manufacturers will be described with more applications, in particular the use of phase locked loops in stereo decoders.

HARRIS SEMICONDUCTORS

The Harris Semiconductor Company manufacture a range of phase locked loop integrated circuits. They produce two high frequency phase locked loops, types HA-2800 and HA-2805. These devices are essentially similar to one another, but the more expensive HA-2800 can be used over a much wider temperature range and has closer tolerances on some of its parameters.

Both devices are supplied in a 16 pin dual-in-line encapsulation with the connections shown in Fig. 4.1.

The maximum operating frequency of a typical device is 30MHz, but all HA-2800 devices are guaranteed to operate up to at least 25MHz and all HA-2805 devices up to at least 20MHz. These upper frequency limits are set by internal and external stray capacitance.

The manufacturers quote the low frequency limit as about 1kHz, since extremely stable, low leakage capacitors cannot normally be obtained with a value exceeding about 10 μ F. The variation of the centre frequency with the timing capacitor value is shown in Fig. 4.2.

A special feature of these loops is the high impedance phase detector output which acts as a current source. This is connected externally to the current controlled oscillator (in contrast to the voltage controlled oscillator employed by most other manufacturers).

POWER SUPPLIES

The HA-2800 and HA-2805 are operated from a dual power supply of between ± 5 V and the absolute maximum rating of ± 15 V. The devices should not be operated with either power supply absent and each supply should be decoupled close to the device with a capacitor of not less than 0.1 μ F. The current taken from each of the power supplies is typically 8mA. The absolute maximum permissible power dissipation is 500mW.

INPUT

The input impedance to the phase detector is about 2k Ω . The maximum input voltage is 2V r.m.s.

These phase locked loops are claimed to have a particularly low frequency drift with changes of supply voltage and with temperature.

LOW FREQUENCY PLLs

Harris Semiconductor produce two low frequency phase locked loops, the HA-2825 and an equivalent type, the HA-2820, which can be used over a much wider temperature range.

These devices are produced in a 14 pin dual-in-line encapsulation for the frequency range of 0.01Hz to greater than 3MHz (up to 5MHz for a typical device). The normal power supplies are in the range ± 6 V to ± 12 V, the absolute maximum permissible total voltage across the device being 27V.

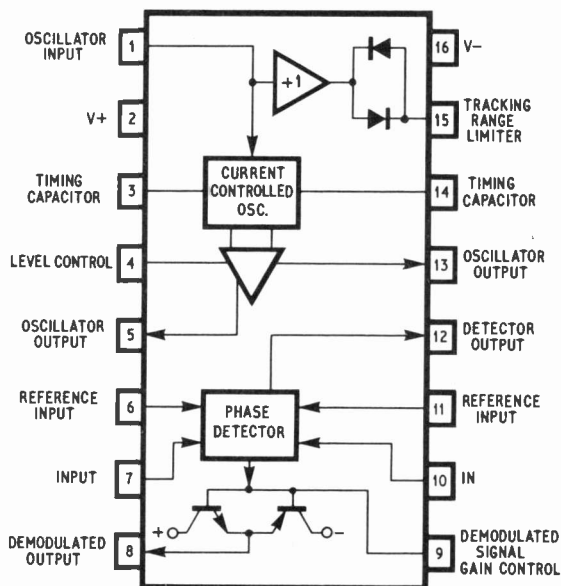
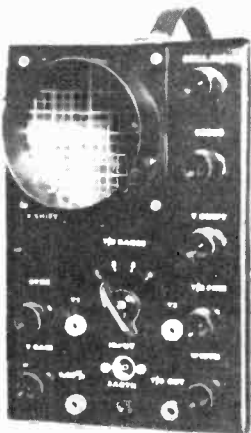
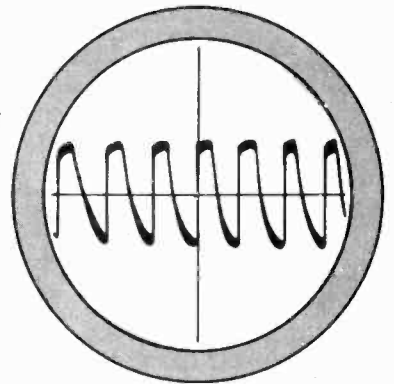


Fig. 4.1. Internal block diagram of Harris Semiconductors phase locked loops type HA-2800 and HA-2805

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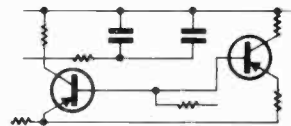
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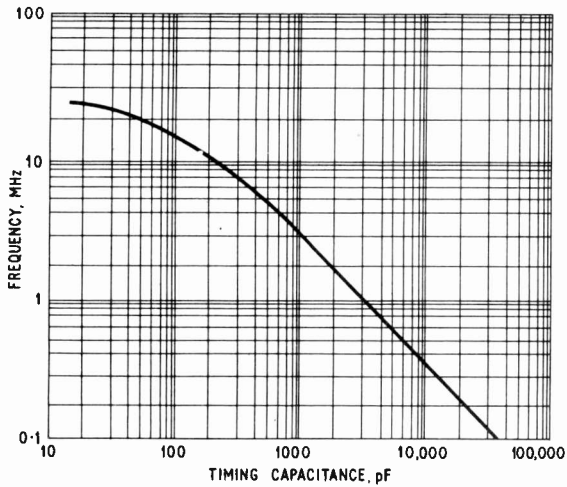


Fig. 4.2. Variation of centre frequency with timing capacitor in the Harris phase locked loop i.c.s

A 1 μ F capacitor will produce a frequency of about 300Hz when using a 540 ohm timing resistor. The frequency can be altered over a 10:1 range by changing the value of the timing resistor.

The phase detector employed in these devices has a high output impedance for connecting to the oscillator control input through a suitable low-pass filter. The two phase detector outputs are isolated from one another, so different filters can be employed in each output circuit without any interaction.

These devices can be employed in f.m. modulators and demodulators, frequency shift keying (f.s.k.) applications, frequency multiplication, industrial speed control, etc.

AVAILABILITY

The HA-2800 is available at £23.83, the HA-2805 at £10.34, and the HA-2825 at £6.66 from G.D.S. (Marketing) Ltd., Bath Road, Salt Hill, Slough, Buckinghamshire, together with some application reports.

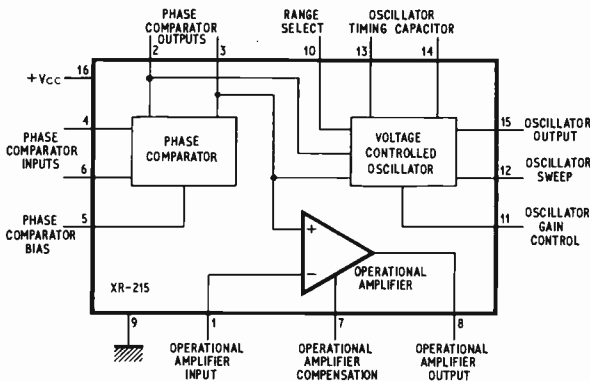


Fig. 4.3. Internal block diagram of the Exar XR-215 phase locked loop integrated circuit

THE XR-215

Another type of high frequency phase locked loop, the XR-215, is manufactured by EXAR Integrated Systems Incorporated. The maximum typical operating frequency is 35MHz (minimum value 20MHz for any device of this type). The minimum practical operating frequency is quoted as 0.5Hz, when the timing capacitor is about 500 μ F.

The XR-215 device is supplied as a 16 pin dual-in-line integrated circuit, as in Fig. 4.3.

The XR-215 can be made into a complete loop by capacitively coupling the output of the voltage controlled oscillator to either of the phase comparator inputs and adding a low-pass filter across the phase comparator output terminals.

A special feature of the XR-215 is the internal operational amplifier it contains. This can be used as an audio pre-amplifier when the device is used as an f.m. demodulator or as a high speed comparator in frequency shift keying demodulators.

The voltage controlled oscillator has frequency sweep, on/off keying, synchronisation and digital programming facilities. Its frequency is very stable and is determined by a single external capacitor.

POWER SUPPLY

The XR-215 has an absolute maximum power supply voltage rating of 26V, but it can operate from a supply as low as 5V. The current consumption is 8 to 15mA at 12V.

The absolute maximum power dissipation is 750mW at 25°C.

FREQUENCY

The variation of the free-running frequency of the voltage controlled oscillator with the value of the capacitor connected between pins 13 and 14 is shown in Fig. 4.4 for two circuit conditions. The frequency is given by the approximate equation:

$$f = \frac{200}{C} \left(1 + \frac{0.6}{R_x} \right)$$

where C is the value of the capacitor connected between pins 13 and 14 in microfarads and R_x is the value of the resistor connected between pins 9 and 10.

The tracking range is adjustable from ± 1 per cent to ± 15 per cent of the centre frequency.

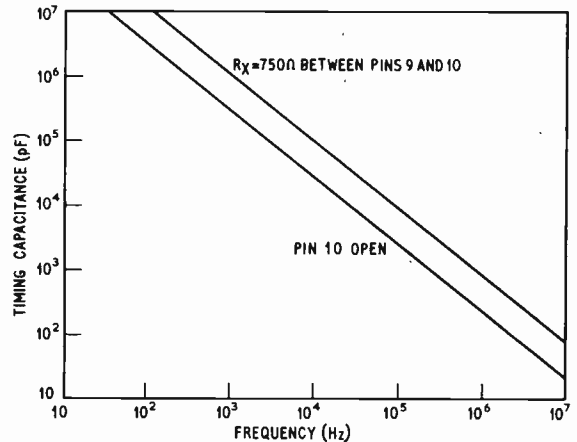


Fig. 4.4. Variation of centre frequency with timing capacitor in the XR-215

PHASE COMPARATOR INPUTS

The input signal is fed to one input of the phase comparator and the other input should be connected to the output of the voltage controlled oscillator to close the loop. Both phase comparator inputs should be returned to a potential mid-way between the supply line voltages.

FREQUENCY SWEEP

The voltage controlled oscillator frequency can be swept over a wide range by applying a varying voltage to pin 12 of the device. The impedance looking into this pin is 50 ohm and a current limiting resistor should therefore be connected in series with this terminal when the facility is used. The maximum current which can safely be drawn from pin 12 is 5mA.

If pin 10 is open circuited, the voltage controlled oscillator can be switched off by applying a positive pulse to pin 12.

FREQUENCY SYNTHESISIS

The circuit of Fig. 4.5 shows how the XR-215 can be employed in a frequency synthesiser. A SN7493 (or an equivalent type) 4-bit binary counter is used to divide the output from the voltage controlled oscillator by a certain chosen factor; the output from this frequency divider is fed to the phase comparator. The loop locks when the input frequency is less than the oscillator frequently by this factor.

The low-pass filter capacitors, C3 and C5, are normally chosen to provide a cut-off frequency equal to 0.1 to 2 per cent of the signal frequency. The digital or analogue tuning characteristics of the voltage controlled oscillator can be used to extend the available range of frequencies of the system for any one value of the capacitor C4.

AVAILABILITY

The XR-215 is manufactured in the U.S.A., but is available (together with a detailed data sheet) from Rastra Electronics Ltd., 275-281 King Street, Hammersmith, London, W6 9NF at about £15.20 each in small quantities.

THE XR-210

The XR-210 is another type of phase locked loop available from the same source at £5.25 in small quantities. It has been designed especially for use as a frequency shift keying modulator/demodulator in the frequency range 0.5Hz to 20MHz, but can also be used for f.m. demodulation, frequency synthesis, etc. It is produced as a 16 pin dual-in-line device and has many features similar to the XR-215.

COS/MOS LOOP

A special feature of the RCA phase locked loop type CD4046A is its very low power consumption. The operating voltage range is 5 to 15V, but the current required is only about 100µA from a 6V supply when the operating frequency is 10kHz. This is of the order of one hundred times less than the current required by most other monolithic loops. At 100kHz the power supply current is 350µA from a 6V supply and 630µA from a 10V supply. This device is ideal for use with battery powered equipment.

The low power consumption is achieved by the use of COS/MOS (complementary symmetry metal

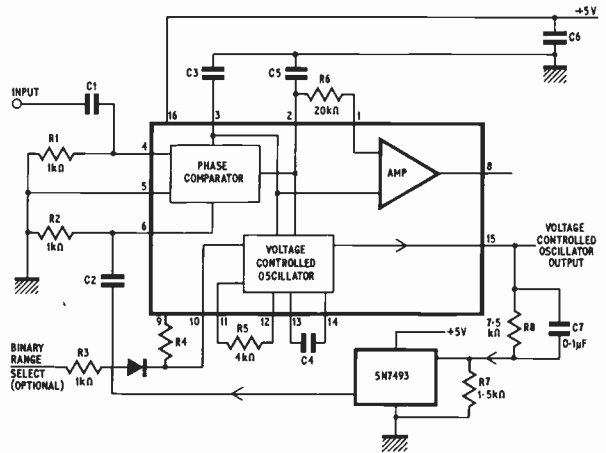


Fig. 4.5. Diagram of the XR-215 used with a TTL divider to form a frequency synthesiser

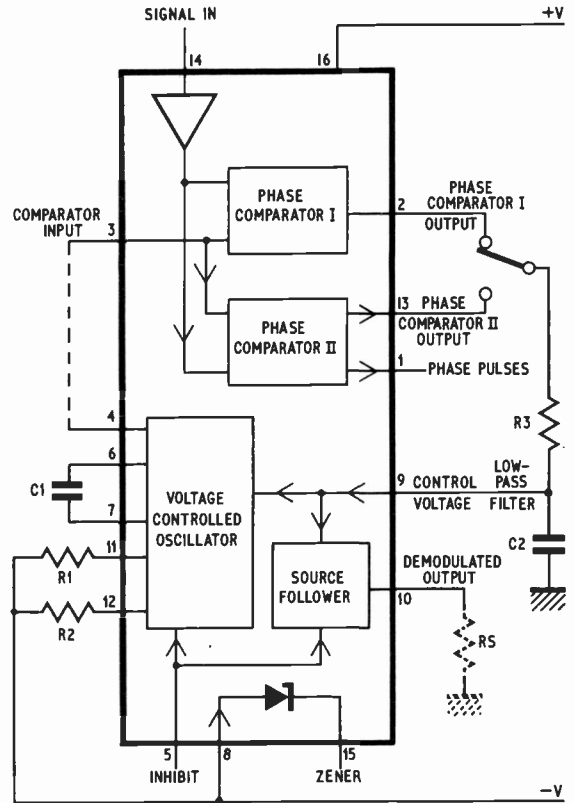


Fig. 4.6. Internal block diagram of the R.C.A. CD4046A phase locked loop with the necessary external components to complete circuit

oxide semiconductor) circuits. This type of circuitry has many other applications where low power and small size are necessary—such as in quartz controlled wrist-watches.

The CD4046A contains a linear voltage controlled oscillator, two different types of phase comparator, a source follower and a 5.4V Zener diode for power supply regulation.

The CD4046AE is encapsulated in a 16 pin dual-in-line plastic package and is priced at about £3.46. Electrically equivalent devices are available in a dual-in-line ceramic package (CD4046AD) and as a flat pack (CD4046AK).

BASIC CIRCUIT

The basic circuit of the CD4046A is shown in Fig. 4.6. An external timing capacitor, C1, and one or two external resistors (R1 or R1 and R2) are connected in the oscillator circuit. R1 and C1 determine the oscillator frequency range, whilst R2 enables the frequency to be offset if this is required. The typical maximum frequency is 500kHz.

The input impedance of the voltage controlled oscillator is extremely high (one million megohms) and this simplifies the low-pass filter design. The output of the oscillator (pin 4) may be connected directly to the phase comparator input (pin 3) or through a COS/MOS frequency divider such as the RCA type CD4018AE presettable divide-by-"N" circuit. A very low power frequency synthesiser can thus be made.

THE PHASE COMPARATORS

Most phase comparators used in phase locked loops employ analogue amplifiers, but it is not easy to make such amplifiers with well-controlled gain characteristics when using COS/MOS technology. Digital phase comparators are therefore employed in the CD4046A.

Phase comparator I is an exclusive-OR network. When no noise or signal is present at the input, the mean output voltage from this comparator is the average of the supply line potentials. Thus under no signal conditions the oscillator operates at its centre frequency.

When phase comparator II is used under no signal conditions, however, the output of this comparator feeds a control signal to the low-pass filter which causes the oscillator to operate at the minimum frequency of the band.

STEREO DECODERS

Many of the modern types of stereo decoder circuits employ a phase locked loop. In order to understand the operation of such circuits, we must first consider the nature of the stereo multiplex signal which must be decoded.

The demodulated f.m. stereo signal comprises the following parts, as depicted in Fig. 4.7:

- An audio signal containing the sum of the left and right-hand audio channel signals; the maximum frequency contained in these signals is 15kHz. If monaural reception is required, this signal is used as the audio output.
- A "left minus right" signal which is modulated onto a 38kHz sub-carrier. The sub-carrier itself is suppressed to an amplitude of less than one per cent.
- A low level 19kHz "pilot tone" which is synchronised with the 38kHz suppressed sub-carrier.

This pilot tone is used to indicate that a stereo signal is being transmitted, but it is also employed as a reference signal by means of which the 38kHz sub-carrier can be generated in the receiver. This sub-carrier signal is required for use in the stereo signal decoder.

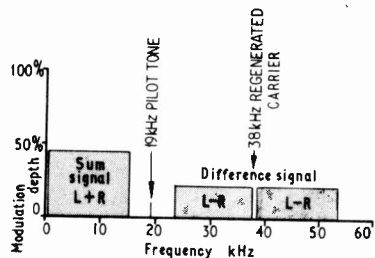


Fig. 4.7. Frequency spectrum of an f.m. stereo signal

The pilot tone is not present when a monaural signal is being transmitted.

Various forms of stereo decoding circuits have been designed which provide "left" and "right" audio signals from the demodulated f.m. signal. In the "switching" type of decoder, the 19kHz pilot tone is extracted by means of a tuned circuit, doubled in frequency to 38kHz and the resulting signal is used to switch the multiplexed input signal.

Such systems suffer from the disadvantage that optimum channel separation cannot be achieved and the inductors required are inconvenient circuit components.

The use of a phase locked loop decoder eliminates problems in setting up the circuit. Any reasonable changes of the component values with time or temperature will not matter, since the loop frequency will be locked to the input frequency.

MONOLITHIC DECODERS

During the past two years, a number of manufacturers have introduced monolithic phase locked loops which have been especially designed for stereo decoding. They offer excellent channel separation (typically better than 40dB) and many of them require no inductors in the external circuit.

THE CA3090

The RCA phase locked loop stereo decoder type CA3090 was introduced in 1971. It is available as the 16 pin CA3090Q quad-in-line device and also as the 16 pin dual-in-line device type CA3090E at about £4.20. Devices of this type can be used in a simple decoding circuit consuming about 22mA, but one adjustable 2mH inductor must be employed.

The internal circuit of the CA3090 (which contains 128 transistors) is shown in block form in Fig. 4.8 together with the external components required to form a complete stereo decoder circuit.

The demodulated multiplexed signal is applied to pin 1 of the CA3090 where the input impedance is about 50 kilohm. The signal is amplified before being fed to both the 19kHz and the 38kHz synchronous detectors.

The phase locked loop itself consists of a voltage controlled oscillator, two "divide-by-two" stages and a 19kHz phase-lock detector (or phase comparator). The free-running frequency of the voltage controlled oscillator is set to 76kHz by the circuit connected to pins 15 and 16.

CIRCUIT OPERATION

The 76kHz signal is divided in frequency to produce a 38kHz signal and two 19kHz signals in phase quadrature with one another. The 19kHz signal present at the input is compared with one of

the internally generated 19kHz signals by the phase-lock detector and the phase difference signal is used to lock the oscillator to the pilot tone frequency in the normal way. The loop is thus employed to generate the 38kHz suppressed sub-carrier.

A 19kHz synchronous detector senses the presence of the pilot tone; it switches the Schmitt trigger when the level of this tone exceeds a certain amplitude determined by the resistor connected between pins 7 and 8. The Schmitt trigger circuit causes the lamp in the pin 12 circuit to be illuminated showing that a stereo signal is being received. In addition, the Schmitt trigger activates the 38kHz synchronous "L-R" detector and switches the whole circuit to stereo operation.

A light emitting diode is used as the stereo indicator in the pin 12 circuit of Fig. 4.8. The maximum current which can be passed by the pin 12 circuit is about 14mA, but a transistor amplifier can be used if it is desired to drive a lamp requiring more current. The circuit switches to stereo operation when the pilot tone level at the input is at least 4mV with the values shown, but greater sensitivity can be obtained if necessary. However, at low signal levels monaural operation is to be preferred, since a better signal to noise ratio can be obtained.

OUTPUTS

The output signal from the 38kHz detector and the multiplex input signal are applied to a matrix circuit which provides the required left and right channel outputs. The internal amplifier in each channel provides enough gain for the output to be able to drive most types of amplifier directly. The channel separation is typically 40dB and the total harmonic distortion 0.45 per cent.

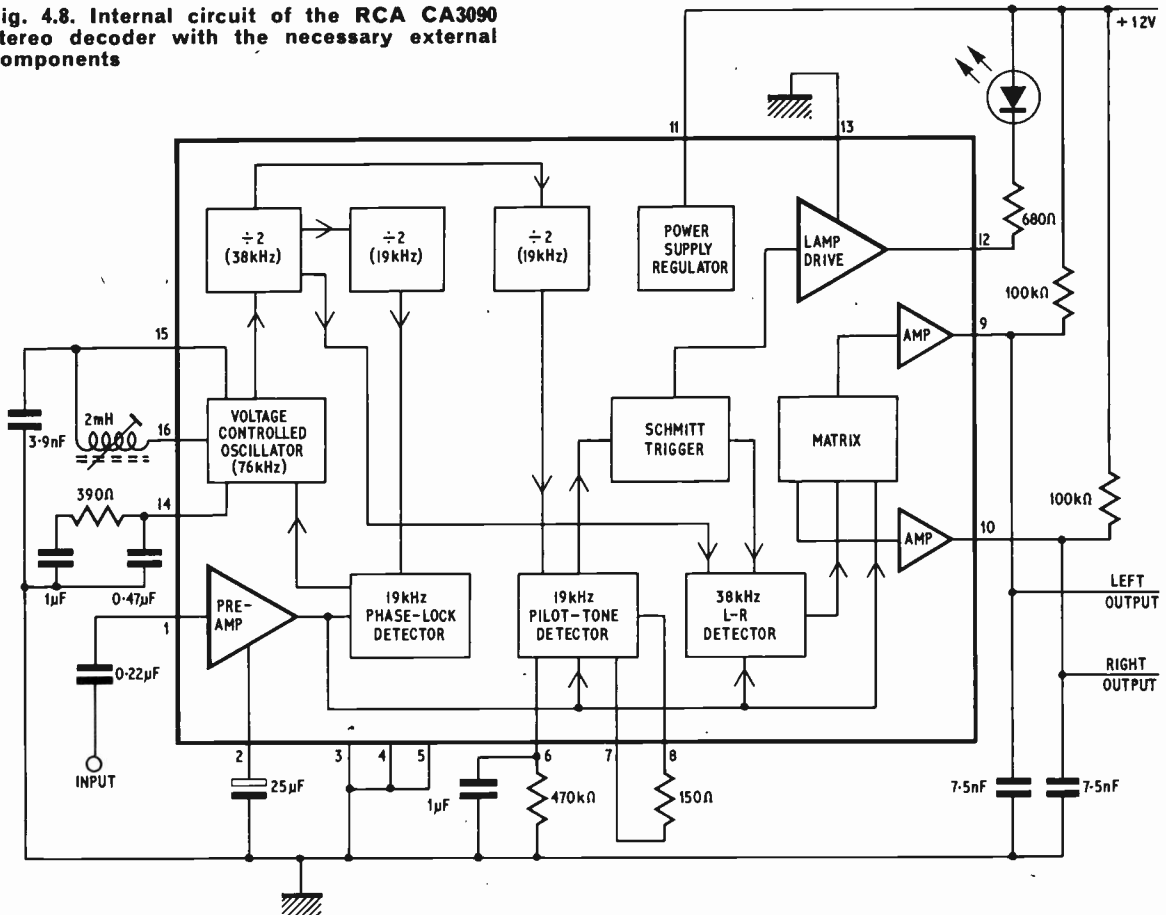
The core of the 2mH inductance is set half way between the points at which the indicator lamp becomes illuminated as the core adjustment is varied. The centre frequency of the voltage controlled oscillator is then very close to 76kHz. The capture range of the loop is typically ± 10 per cent of the centre frequency.

MC1310P/SN76115N/LM1310

The Motorola MC1310P is a phase locked loop stereo decoder first introduced in 1972. It is available as a 14 pin dual-in-line plastic device at approximately £3. Equivalent devices are the Texas Instruments' SN76115N and the National Semiconductor type LM1310.

These devices have the advantage that no inductors are required in the external circuit with which

Fig. 4.8. Internal circuit of the RCA CA3090 stereo decoder with the necessary external components



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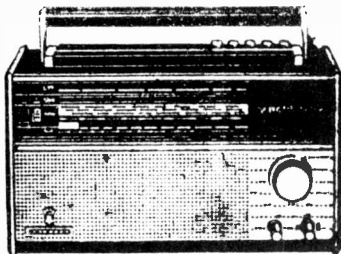
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they are used. This removes the possibility of unwanted coupling and the inconvenience of coil design. The only components required other than the integrated circuit itself are eight capacitors, four resistors, a variable resistor and an indicator lamp.

The functioning of these devices is essentially similar to that of the CA3090 and therefore it will not be described in detail. The voltage controlled oscillator operates at 76kHz. Its frequency is determined by the values of a capacitor and a variable resistor in the pin 14 circuit (see Fig. 4.9). The oscillator signal is frequency divided to produce two 19kHz signals in phase quadrature to each other and the 38kHz signal required for the decoding.

CIRCUIT ADJUSTMENTS

When the circuit is first used, the potentiometer VR1 of Fig. 4.9 must be adjusted so that the oscillator free running frequency is close to 76kHz. (This operation is comparable with the adjustment of the core of the inductance of Fig. 4.8.)

The frequency adjustment may be carried out by connecting pin 10 to a frequency counter and altering the value of VR1 until the frequency at this pin (3V peak) is 19kHz. If a frequency counter is not available, VR1 should be adjusted to the point at which the indicator lamp remains illuminated at the lowest possible signal amplitude.

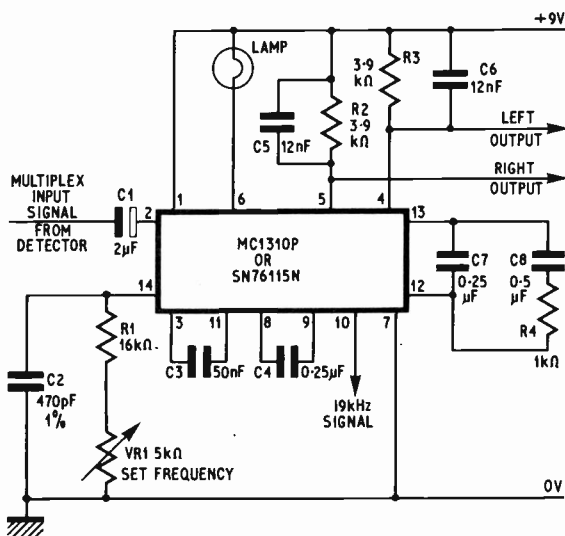


Fig. 4.9. Diagram showing the MC1310P (or an equivalent) used as a stereo decoder

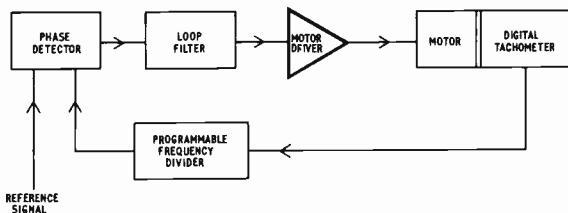


Fig. 4.10. Block diagram showing how the phase locked loop can be used in motor speed control

The capture range is typically ± 3 per cent. It may be increased by reducing C2 and increasing R1 and VR1 in proportion, but this will result in increased beat note distortion at high signal levels due to oscillator phase jitter. Ideally the temperature coefficient of the time constant of C1, R1 and VR1 should be minus 200 parts per million.

The capacitor C4 controls the stereo/monaural switching delay. The switching time constant is equal to C4 multiplied by about 53 kilohm. If pin 8 is earthed, the circuit will operate in the monaural mode only.

INDICATOR LAMP

The MC1310P circuit can drive an indicator lamp in the pin 6 circuit which requires up to 75mA. (A surge limiting circuit is incorporated in the device which restricts the lamp current to about 250mA when the lamp is cold.) The circuit switches to stereo operation when the amplitude of the pilot tone exceeds 16mV at the input.

If a simpler circuit is required at the expense of performance, C7 may be omitted if R4 is reduced to 100 ohm and C8 to 0.25µF.

The audio outputs are 485mV r.m.s. when the input is 560mV. The total harmonic distortion is typically 0.3 per cent and the channel separation 40dB at 1kHz. The input impedance of the device is 50 kilohm.

The minimum value of the load resistors R2 and R3 is determined by the power supply voltage. It is 2.7kΩ, 4.5kΩ and 6.2kΩ for supplies of 8, 10 and 12V respectively. C5 and C6 are the de-emphasis capacitors; their values should be chosen so that they give the desired time constant with R2 and R3 (50µs in the U.K.). If R2 = R3 = 2.7kΩ, C5 = C6 = 18nF, whilst if R2 = R3 = 6.2kΩ, C5 = C6 = 8nF.

MOTOR SPEED CONTROL

A basic circuit suitable for motor speed control is shown in block form in Fig. 4.10. The speed of rotation of the motor is "sensed" by a digital tachometer; the latter produces an output pulse frequency related to the motor speed. The phase detector compares a signal derived from the tachometer output with a very stable reference frequency (such as that from a crystal oscillator). The motor speed can thus be made as stable as the frequency of the reference source.

CONCLUSIONS

Readers who have followed the whole of this series will begin to appreciate the vast number of applications for which phase locked loops can be employed. Indeed, the number of applications is limited only by the ingenuity of the user. Thus the relatively new devices which are coming onto the market offer a real challenge to the amateur experimenter as well as to the professional engineer.

It is difficult to forecast future progress in a field such as electronics, but the writer feels that phase locked loops will form part of many types of radio receivers in the future, including high fidelity systems, car radio receivers and communications receivers. From the point of view of the amateur enthusiast, applications in radio receivers are probably the most significant ones, but the professional circuit designer will find many other fields for phase locked loops also.



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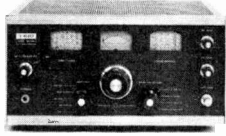


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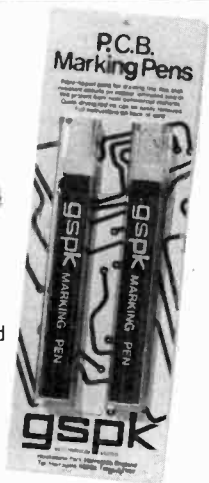
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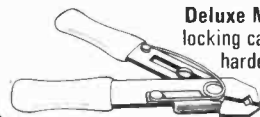
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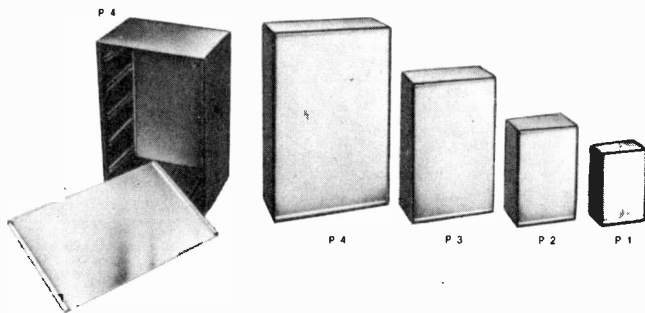
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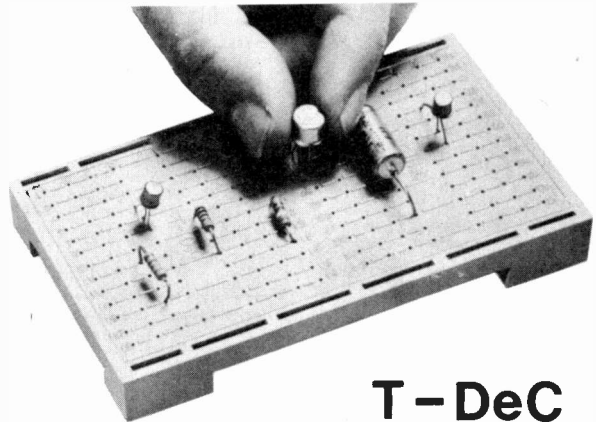
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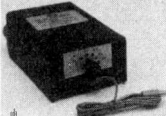
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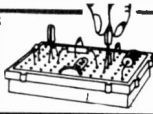


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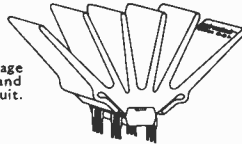
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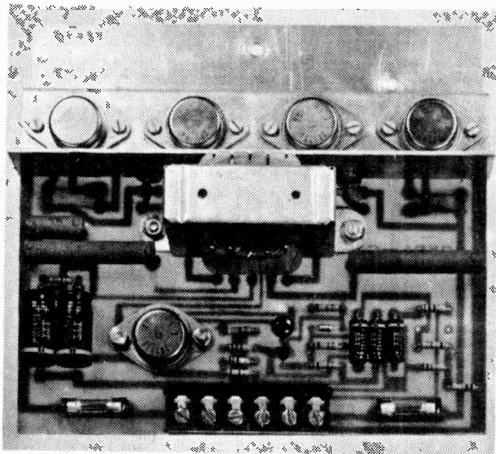
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6.8µF 63V	6p	150µF	63V 15p
8.0µF 40V	6p	220µF	6.4V 6p
10µF 16V	6p	220µF	10V 6p
10µF 25V	6p	220µF	16V 8p
10µF 63V	6p	220µF	63V 21p
15µF 16V	6p	330µF	16V 12p
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22µF 25V	6p	470µF	40V 20p
22µF 63V	6p	680µF	16V 15p
32µF 10V	6p	680µF	40V 25p
33µF 16V	6p	1000µF	16V 20p
33µF 40V	6p	1000µF	25V 25p
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POTENTIOMETERS

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PLUGS

DIN 2 Pin	12p
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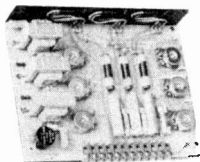
(µF/V): 2.2/25, 2.2/63, 4.7/10, 4.7/25, 4.7/63, 22/10, 22/25, 22/63, 5p, 27/10, 10/10, 50/10, 100/10, 10/25, 50/25, 10/50, 5½p, 200/10, 100/25, 50/50, 64p, 500/10, 200/25, 100/50, 9p, 1000/10, 500/25, 200/50, 11p, 2000/10, 1000/25, 500/50, 16p, 1000/50, 39p, 1000/100, 66p, 2000/25, 27p, 2500/12, 17p, 2500/25, 33p, 2500/50, 62p, 3000/50, 72p, 5000/25, 66p, 5000/50, 94p, 7000/50, 60p, 25,000/25, 74p. HI-VOLT: 8/350, 14p, 16/350, 19p, 32/350, 25p, 50/250, 18p, 100/500, 33p.

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Mk III Sound to Light Unit Chassis Version



The audio drive voltage is derived directly from the amplifier output or across the speaker load. The unit converts the audio-frequency signals into a three-coloured light display when used with coloured flood lamps or similar; the colour depending on the frequency of the signal and the intensity on the loudness of the audio source. Max. power 1.5kW per channel at 240V a.c. Complete assembly built and tested. Size: 9in x 7in x 3in. Price £27.50.

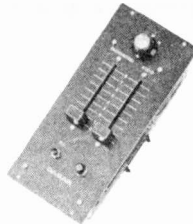
MN3 3 Channel I.C. Mixer Kit



Three channel I.C. audio mixer kit MN3 is specially designed for the home constructor or educational project. Suitable for use in domestic audio, discotheque and simple p.a. applications. The MN3 mixer kit has the following features: Advanced design using 5 ICs; Slider fader level controls mounted directly to p.c. board; Full range Bass and Treble controls; Uses top grade components with fibreglass ready-drilled and tinned printed circuit board and the unit may be operated from twin 9V batteries (PP3) if required.

As optional extras, an attractive ready-punched fascia panel and control knobs are available. The unit is available as a ready built mixer with fascia. Size: 9.5in x 4.8in x 1.5in (with fascia). Construction manual available separately at 25p. Kit Price £11.

STL/I Single Channel Sound to Light Unit



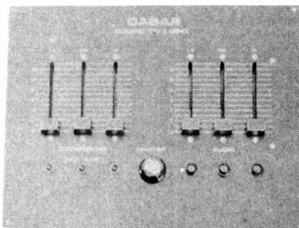
Single channel "Sound to Light" unit with 60mm slider fader controls for audio trigger level and background load dimmer. This unit is switchable for response to High, Mid. and Low frequency audio signals, selected by fascia control. A D.J. "pulse-flash" push button is fitted for manual flashing of the lamp load together with neon load indicator. Maximum Load: 1kW at 240V a.c. Size: 8in x 3.6in x 3in. Price £14.30.

Practical Electronics "Scorpio" Electronic Ignition System Kit



This Capacitor-Discharge Electronic Ignition system was described in the November and December issues of Practical Electronics. It is suitable for incorporating in any 12V ignition system in cars, boats, go-karts, etc. Case size: 7.25in x 4.5in x 2in approx. Complete assembly and wiring manual 25p. Price £12.10.

STL/3 Sound to Light Unit



The performance of this unit is similar to the Mk III chassis version above, but is provided with an attractive black anodised fascia panel and designed to mount directly into equipment desks or cabinets. High, Mid. and Low frequency channel sensitivity controls employ 60mm slider faders for present-day attractive appearance and ease of use. Size: 11in x 8.5in x 4in. Price £42.35.

AUDIO EFFECTS

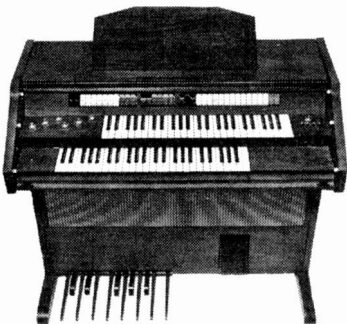
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AC188K 24p	BC115 20p	BC460 68p	BF197 15p	
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8p and 9p each. See Cat. for values.

POTENTIOMETERS—CARBON TRACK

5K, 10K, 25K, 50K, 100K, 250K, 500K, 1M.
Log or lin less switch 11p
Log or lin with switch 23p
Dual log less switch 250K, 500K, 1M, 2M, only 39p
Dual lin less switch 5K, 10K, 25K, 50K, 100K, only 39p
Dual log with switch 10K, 100K, 250K, 500K, 1M only 55p

JACK PLUGS AND SOCKETS

Standard insulated 11p; Standard screened 18p;
Stereo insulated 22p; Stereo screened 30p;
3.5mm insulated 8p; 3.5mm screened 12p;
Standard socket switched 17p; Stereo socket switched 21p; 3.5mm socket switched 6p;
Standard line socket 15p; Stereo line socket 22p;
3.5mm line socket 10p.

PHONO-D.I.N. PLUGS AND SOCKETS

Phono plug insulated 7p; Phono plug screened 11p; Phono line socket screened 12p; Metal coax plug 8p; 2, 3, 5 pin 180°, 240°, D.I.N. plugs 12p; 4, 6, 7 pin plugs 15p; 2, 3, 5 pin 180° line sockets 13p; 2, 3, 5 pin 180° chassis sockets 7p.

CABLES AND SCREENED WIRES

Min. mike cable single 7p/metre; Min. twin mike cable 11p/metre; Pick up wire single 7p/metre; Pick up wire twin 11p/metre; Stereo screened twin 10p/metre; 4 core individually screened 14p/metre; Speaker wire twin coded 6p/metre.

E. A. HALL (ELECTRONICS)

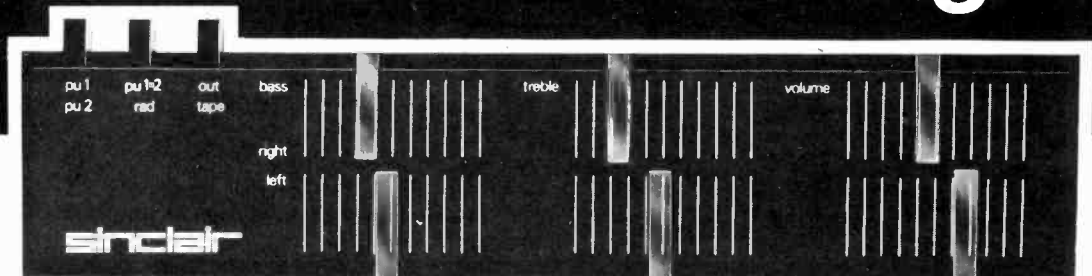
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Mail Order Only. C.W.O. Postage and packing 10p per order. Detailed Catalogue 6p. Please add V.A.T. on total order incl. postage and packing. Many other items in our catalogue.

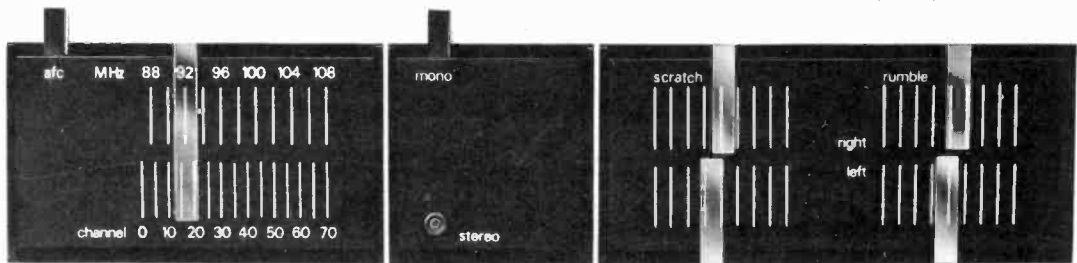
now...

Project 80

... exciting new thinking
in modular hi-fi design



Stereo 80 pre-amplifier/control unit



Project 80 tuner

Stereo decoder

Project 80 Active Filter Unit (AFU)

the slimmest, most elegant hi-fi modules ever made



Living with hi-fi takes on new meaning now that Project 80 is here. These amazing new modules mark a brilliant technical advance all round; their size and presentation bring exciting new opportunities to install systems in ways hitherto only dreamed about but never before made practical. You can build a Project 80 system virtually anywhere and it is unbelievably simple to install and connect up. Everything that could possibly be wanted in a top quality do-it-yourself domestic hi-fi system will be found in Project 80 – compactness, elegantly ultra-modern styling, ease of fixing and operation, new control methods, and above all superb performance. New as well as popular established ideas on installation are featured on page four of this announcement to provide just a few examples of the system's fantastic versatility.

sinclair

Project 80 new modules

Stereo 80 pre-amplifier and control unit

As with other Project 80 units, the Stereo 80 is mounted by means of two bolts fixed at the rear which pass through holes drilled in the wood or plastic on which modules are to be mounted. All the electronics are contained within the $\frac{3}{4}$ " deep front panel! Connecting leads are taken away similarly out of sight. Each channel in the Stereo 80 has its own independent tone and volume controls operated by sliders. This enables exceptionally good environmental matching to be obtained. Provision is made for magnetic and ceramic pick-ups, radio and tape in and out. A virtual earth input stage forms part of the up-dated circuitry of the Stereo 80 to ensure the finest possible quality from all signal sources. Generous overload margins are allowed on all inputs. Clear instructions with template are supplied.

TECHNICAL SPECIFICATIONS

Size - 260 x 50 x 20mm ($10\frac{1}{4}$ x 2 x $\frac{3}{16}$ ins)
 Finish - Black, with white markings
 Inputs - Mag P U 3mV RIAA corrected, Ceramic P U, 300 mV
 Radio 300 mV, Tape 30 mV
 S/N ratio - 60db
 Frequency range - 20Hz to 15KHz \pm 1dB 10Hz to 25KHz \pm 3dB
 Power requirements - 20 to 35 volts
 Outputs - 100mV \pm AB monitoring for tape
 Controls - Press button for tape, radio and P U selection Volume, Bass - 12dB to -14dB at 100Hz, Treble +11dB to -12dB at 10KHz

Project 80 FM tuner smaller, more efficient

A truly remarkable tuner in every way - its unbelievably compact size - its original circuitry - its dependable performance - all this in a boldly designed modern case measuring 85 x 50 x 20mm ($3\frac{3}{8}$ x 2 x $\frac{3}{16}$ ins). Greater adaptability (and possibly financial convenience) results from the tuner and stereo decoder section being made available separately.

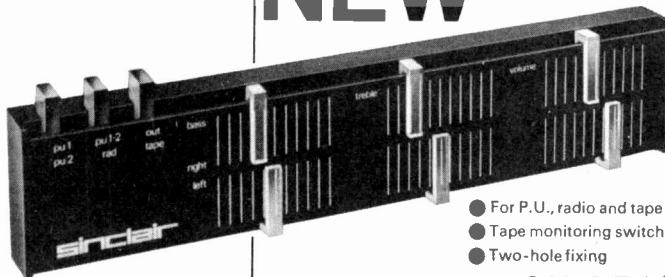
TECHNICAL SPECIFICATIONS

Size - 85 x 50 x 20mm (approx $3\frac{3}{8}$ x 2 x $\frac{3}{16}$ ins)
 Tuning range - 87 to 108 MHz
 Detector - I C balanced coincidence, for good A M rejection
 AFC - Switchable, with thermistor control to prevent from drift
 One 26 transistor I.C.
 Twin dual varicap tuning
 Distortion - 0.3% at 1KHz for 75KHz deviation
 Ceramic filter in I.F. section
 Aerial impedance - 75 Ω or 240-300 Ω
 Sensitivity - 4 microvolts for 30dB quieting
 Power requirements - 12 to 45 volts

Project 80 stereo decoder

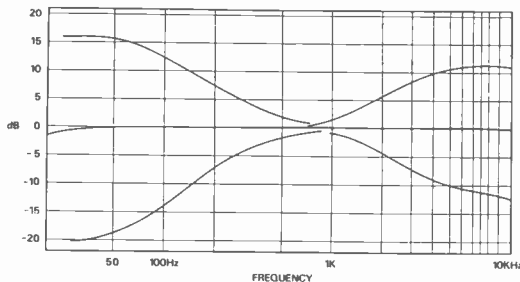
Making the Project 80 decoder separate from the F M. tuner gives the constructor a wider choice of systems as well as saving money in cases where stereo reception may not be required. This unit gives a 40dB channel separation with an output of 150mV per channel. The gallium arsenide light emitting beacon automatically lights up to show when a stereo transmission is tuned in. Designed essentially as an integral part of Project 80 systems, this multiplex stereo demodulator may be used in many cases with existing single channel frequency modulated tuners to provide stereo reception.
 Size - 47 x 50 x 20mm ($1\frac{7}{8}$ x 2 x $\frac{3}{16}$ ins)
 One 19 transistor I.C.

NEW

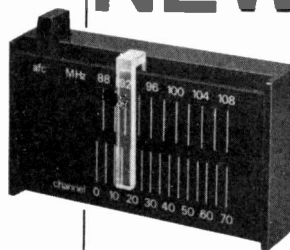


- For P.U., radio and tape
- Tape monitoring switch
- Two-hole fixing

R.R.P. £11.95 + £1.19 V.A.T.



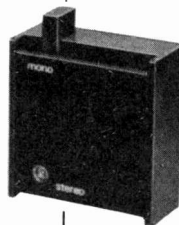
NEW



- AFC switch
- Twin dual varicap tuning
- 4-hole ceramic filter
- Slider tuning

R.R.P. £11.95 + £1.19 V.A.T.

NEW



- Solid-state stereo indicating beacon
- Readily adaptable for use with other tuners

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new constructional techniques

...and again Sinclair leads the world

- 1962 Micro-miniature power amp small enough to stand on a 10p. piece. Slimline pocket receiver smaller than a 20 cigarette pack
- 1963 Micro-6 receiver, smaller than a matchbox
- 1964 Pocket F.M. receiver; PWM amp.
- 1965 Z.12 power amplifier module; PZ.3 power supply
- 1966 Stereo 25 pre-amp/control unit
- 1967 Micromatic; Q.14 loudspeaker; the first Neoteric
- 1968 IC.10, the first ever integrated circuit for constructors' use

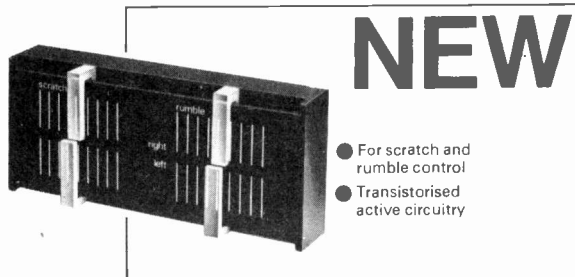
- 1969 Q.16 - improved version of Q.14 Systems 2000 and 3000: Project 60 launched
- 1970 IC.12: Project 60s
- 1971 Project 60 stereo FM tuner: Z.50: PZ.8
- 1972 Improvements to Project 60 with Z.50 MK.2 and PZ.8 Mk.3 The Executive Calculator: Digital multi-meter: Q.30 speaker
- 1973 Cambridge Calculator
PROJECT 80 LAUNCHED
... and next ?

Project 80 active filter unit

This efficiently designed unit makes a highly desirable part of any worthwhile system where inputs may be from record, radio or tape. As with Stereo 80, separate controls are applied to each channel thereby making it easier to obtain ideal stereo balance in any kind of indoor environment.

TECHNICAL SPECIFICATIONS

Size - 108 x 50 x 20mm (4 1/4 x 2 x 3/8 ins)
Voltage gain - minus 0.2dB
Frequency response - 36Hz to 22KHz, controls minimum
Distortion - at 1KHz - 0.03% using 30V supply
HF cut off (scratch) - 22KHz to 5.5KHz, 12dB/oct. slope
L.F. cut off (rumble) - 28dB at 20Hz, 9dB/oct. slope



NEW

- For scratch and rumble control
- Transistorised active circuitry

Z.40 & Z.60 power amplifiers totally short-circuit proof

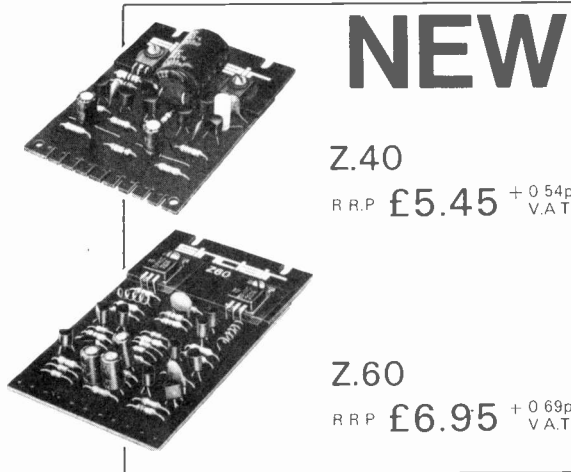
Either of these entirely new power amplifiers is intended for use in Project 80 installations although, of course, they are readily adaptable to an even wider range of applications. Both Z.40 and Z.60 incorporate built-in protection against shortcircuiting and risk of damage arising from mis-use is greatly reduced. Comprehensive instructions are supplied with each of the modules.

Z.40 Technical Specifications

Size - 55 x 80 x 20mm (2 1/8 x 3 1/8 x 3/8 ins) 9 transistors
Input sensitivity - 100mV
Output - 15 watts RMS continuous into 8 Ω (35V), 30 watts music power into 4 Ω (30V)
Frequency response - 10Hz - 100KHz ± 1dB
Signal to noise ratio - 64dB
Distortion - at 10 watts into 8 Ω less than 0.1%
Power requirements - 12-35 volts

Z.60 Technical Specifications

Size - 55 x 98 x 20mm (2 1/8 x 3 7/8 x 3/8 ins) 12 transistors
Input sensitivity - 100-250mV
Output - 25 watts RMS into 8 Ω (45V), 50 watts music power into 4 Ω (50V)
Distortion - typically 0.03%
Frequency response - 10Hz to more than 200KHz ± 1dB
Signal to noise ratio - better than 70dB
Built-in protection against transient overload and short circuit
Load impedance - 4Ω min; max. safe on open circuit



NEW

Z.40
R.R.P. £5.45 + 0.54p V.A.T.

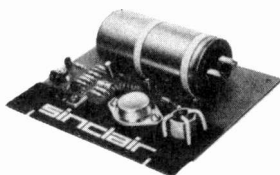
Z.60
R.R.P. £6.95 + 0.69p V.A.T.

Sinclair power supply units PZ.8

the worlds most advanced unit in its class

Stabilised power supply unit. Re-entrant current limiting makes damage from overload or even direct shorting impossible, a principle never before incorporated in a commercially available constructor module. Normal working voltage (adjustable) 45V.

R.R.P. £7.98 + 0.79p V.A.T.
Without mains transformer
PZ.5 30V un stabilised
R.R.P. £4.98 + 0.49p V.A.T.
PZ.6 35V, stabilised
R.R.P. £7.98 + 0.79p V.A.T.



Recommended Project 80 applications

System	The Units to use	Units cost
Simple battery record player	Z.40	£5.45 + £0.54 V.A.T.
Mains powered record player	Z.40, PZ.5	£10.43 + £1.04 V.A.T.
30W. RMS continuous sine wave stereo amp.	2 x Z.40s, Stereo 80; PZ.6	£30.83 + £3.08 V.A.T.
50W (8 Ω) RMS continuous sine wave de luxe stereo	2 x Z.60s, Stereo 80; PZ.8	£33.83 + £3.38 V.A.T.
amplifier Indoor P.A.	Z.60, PZ.8	£14.93 + £1.49 V.A.T.
Car Radio	F.M. tuner, Z.40	£16.40 + £1.64 V.A.T.

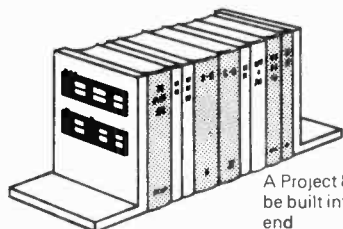
sinclair

R.O. London Rd., St. Ives, Huntingdon PE17 4HS Reg. England 699483

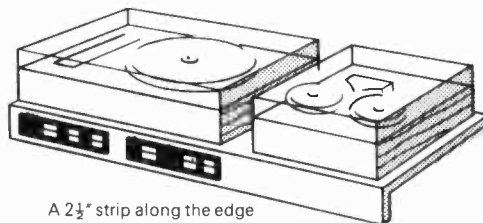
Practical Electronics January 1974

From Sinclair the worlds most advanced hi-fi modules

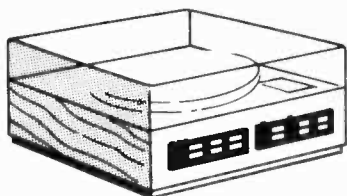
Sinclair Project 80 the ultra-modern non-obtrusive hi-fi



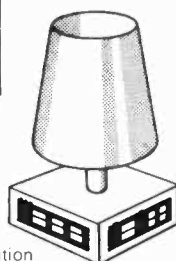
A Project 80 system could be built into a book-shelf end



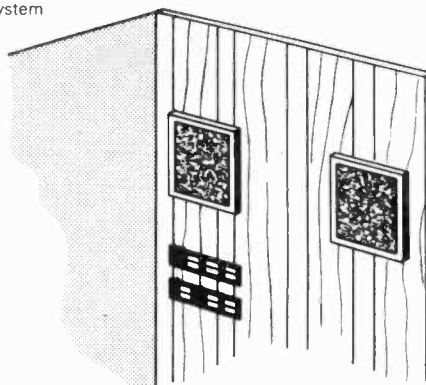
A 2 1/2" strip along the edge a shelf could be sufficient to contain a complete system



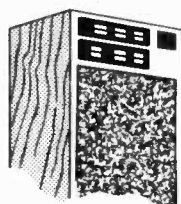
The modules mount very easily onto a playing plinth



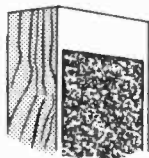
A novel application would be to build around the base of a lampshade



Two Sinclair Q.16 loudspeakers suitably positioned together with Project 80 could be mounted on to a false wall.



Project 80 could be easily mounted onto a loudspeaker cabinet



When you have seen for yourself how fantastically slim and cleverly designed these modules are, further ways will suggest themselves in which they can become a pleasing part of your particular domestic environment.

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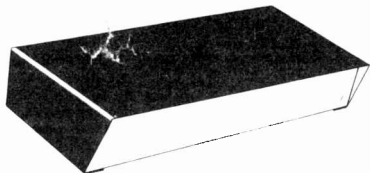
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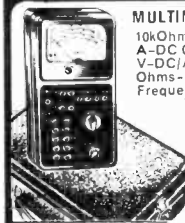
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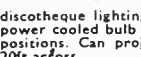
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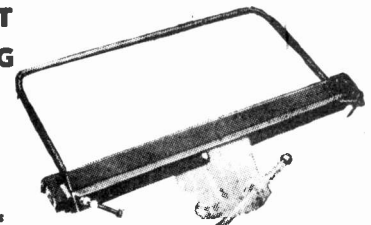
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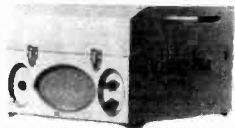
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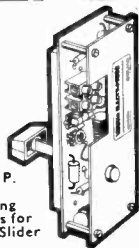
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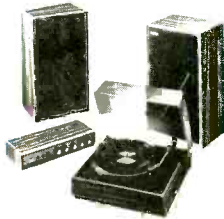
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The Texan Stereo Systems include the high quality Texan Stereo amplifier assembled and ready to use. A pair of Type 200 20 watt Speaker-Tweeter systems, size 12 x 12 x 10in and a choice of Garrard players built into a plinth with cover with Goldring G800 magnetic cartridge. System 25 uses Garrard SP25 Mk III and system 76 the Garrard AP76 de luxe turntable. All necessary leads are supplied.

SYSTEM 25 (list approx. £109) £79.50
SYSTEM 76 (list approx. £117) £89.50
(plus 10% VAT and plus £1.45 carr/packing).

BARCLAYCARD/ACCESS

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EASY TERMS FOR CALLERS

- Stereo Preamplifier £11.95
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Z60 25 watt Amplifier £6.95
PZ6 Mod. for 1 on 2 Z40 £4.98
PZ Mod. (S Tab) 1 on 2 Z40 £7.98
PZ8 Mod. (S Tab) 1 on 2 Z60 £7.98
TRANSFORMER FOR PZ8 £2.95
NEW FM TUNER £11.95
STEREO DECODER £7.45
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Kit Price £21.00 (+ VAT)
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EMI 13in x 8in—full range speakers (post 20p each or 30p pair); *150TC—8 ohms Twin Cone 10 watt, £2.20 each or £4 pair; *450 10 watt c/o Twin Tweeters 3, 8 or 15 ohms, £3.50 each or £6.90 pair; EW 15 watt 8 ohms c/o Tweeter, £4.30 each or £7.90 pair; 350 20 watt c/o Tweeters 8 or 15 ohms, £7.50 each or £14.20 pair.
* Polished wood cabinet £4.60, post 35p.

8 ohms full range (post 20p)
FR4 4in 5 watt, £4; FR65 6in 10 watt, £5.50;
FR8 8in 15 watt, £7.60; FR23 9 x 6in 15 watt, £6.00.

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