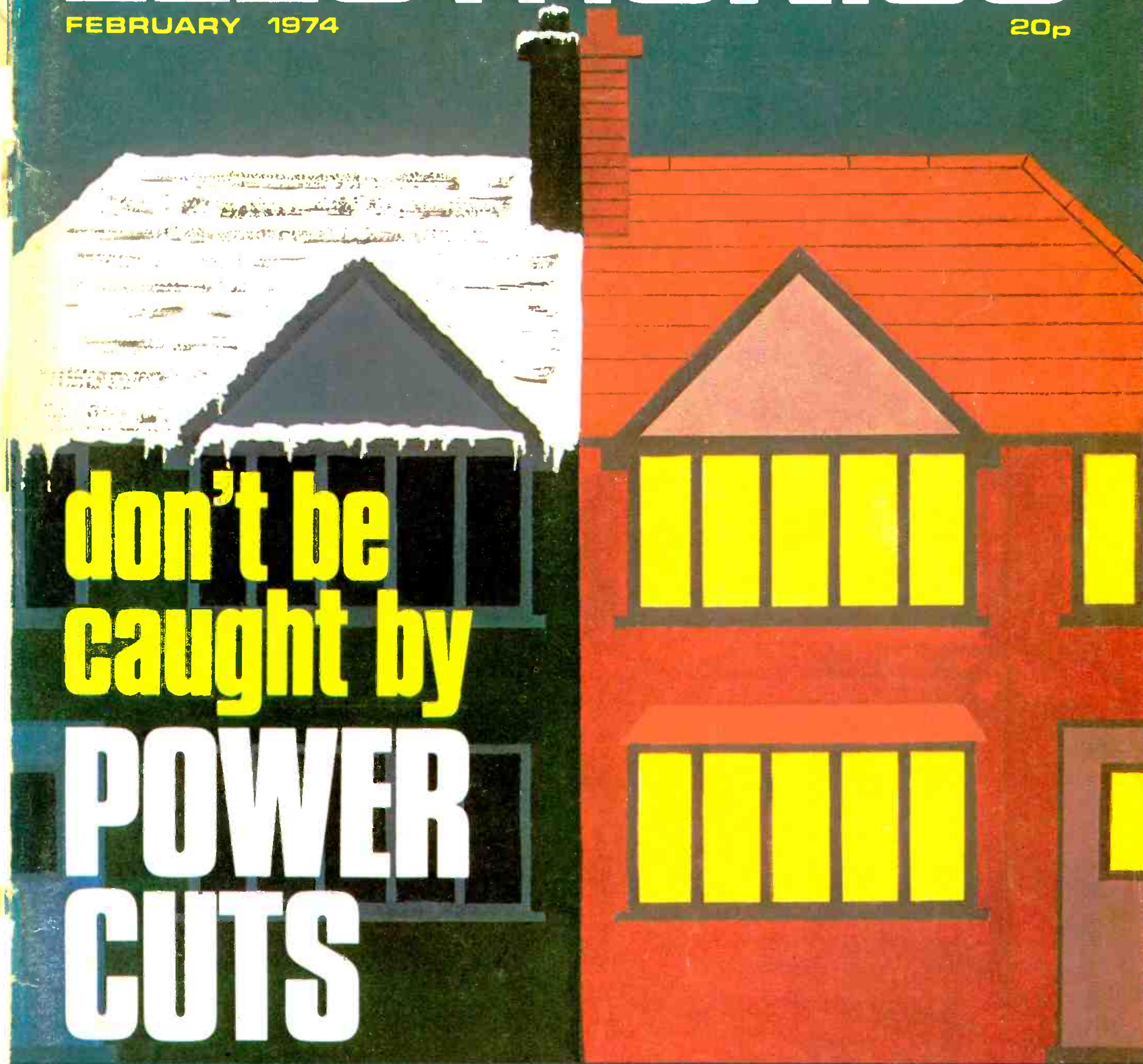
PRACTICAL

ELECTRONICS

FEBRUARY 1974

20p



don't be caught by POWER CUTS

MAINTAIN ESSENTIAL SERVICES *such as . . .*

YOUR CENTRAL HEATING PUMP-SOLENOID VALVES & A 40w LAMP

with this **100WATT INVERTER-CHARGER**

PRACTICAL
ELECTRONICS

VOLUME 10 No. 2 FEBRUARY 1974

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our March issue will be published on Friday, February 8, 1974

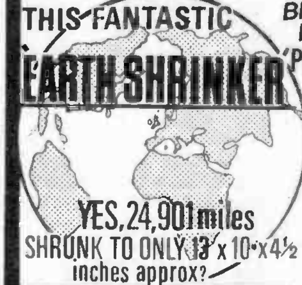
YES, "YOU'VE GOT THE WHOLE WIDE WORLD IN YOUR HANDS"! ALMOST UNBELIEVABLE! Think of the year 1984 and what might be produced then—now get the fantastic ASTRAD 17 and SEE for yourself that the incredible Russians have done it all NOW! It's the radio perfectionist's dream come true! THIS ONE SUPERSEDES 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, refund 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 spaceship and satellite communications. Yes, EVERY WAVEBAND 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 × 10in × 4½in overall approx. Magnificently designed, in 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 £££'s & £££'s!

THOUSANDS of MILES REDUCED to INCHES?

LATEST RUSSIAN RADIO TECHNOLOGY SHRINKS THE WORLD! *COMPUTERISED?

THIS FANTASTIC EARTH SHRINKER



YES, 24,901 miles SHRUNK TO ONLY 13" x 10" x 4½ inches approx?

BRAND NEW FABULOUS **ASTRAD 17** PORTABLE RADIO & COMMUNICATIONS RECEIVER

WORLD WIDE RECEPTION
THOUSANDS OF TRANSMISSIONS & STATIONS POUR IN FROM THE FOUR CORNERS OF THE EARTH

"MAGIC EYE" tuning level indicator

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.)

*MUST YOU PAY UP TO £80?

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 finger tips – 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's got EVERYTHING!

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

WITH REMOTE CONTROL MICROPHONE

RECOMMENDED RETAIL PRICE

OUR PRICE **£20·97** CARR ETC. 50p

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 RETAIL PRICE £44! WE OFFER AT UNDER HALF PRICE! Wonderful features: ★ Press-button Keyboard Control Panel or latest MASTER SWITCH CONTROL! ★ "MAGIC EYE" Visual Battery check/recording level indicator or built-in automatic Leveller! ★ Separate ON/OFF and HI-LO volume controls! ★ Heavy duty built-in speaker! ★ Earphone (for personal listening or 'monitoring") and extension speaker sockets! ★ Remote control microphone! ★ Built-in swivel telescopic extension aerial (24in approx.)! Magnificently made case with carry handle. (DESIGNS VARY SLIGHTLY.) Takes standard 30, 60, 90 or 120-minute Cassette Tapes, obtainable everywhere. AND the amazing built-in full circuit VHF, AM/FM Radio gives you superb clarity of tone, incredible station selection. Unique rotating Station Selector Dial—gets, locally, local city and regional stations in every part of the country, plus B.B.C. National, VHF. Picks up dozens of foreign stations. Fabulous in your car! You could pay £££'s more for a Car Radio or Car Cassette player ALONE! £20·97, carr. 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.

FIRST TIME EVER! *SAVE £16·02!

BRAND NEW AC/DC BATTERY/MAINS

Cassette TAPE RECORDER & PLAYER

With remote control microphone.

FIRST CLASS MAKERS

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 9½in × 5in × 2½in 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 one 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.)

Callers: ACCESS & BARCLAY CARDS ACCEPTED AT BOTH STORES

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C.W.O. only. P. & P. 10p on orders below £5
Discount: £10–10%, £20–15% (except net items)
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SPECIAL RESISTOR KITS

10E12 ¼W KIT: 10 of each E12 value. 22 ohms—1M. a total of 570 (CARBON FILM 5%). £3·10 net
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20E12 ½W KIT 20 of each E12 value. 10 ohms—1M. a total of 1220 (METAL FILM 5%). £7·50 net
15E12 1W KIT 15 of each E12 value. 10 ohms—1M. a total of 915 (METAL FILM 5%). £8·15 net
10E12 2W KIT 10 of each E12 value. 10 ohms—1M. a total of 610 (METAL FILM 5%). £12·85 net

MULLARD POLYESTER CAPACITORS C280 SERIES

250V P.C. Mounting: 0·01μF, 0 015μF, 0·022μF, 0·033μF, 0 047μF, 3½p. 0·068μF. 0·1μF, 4½p. 0·15μF, 4½p. 0·22μF. 5½p. 0·33μF, 8p. 0·47μF, 9p. 0·68μF, 11p. 1μF, 15p. 1·5μF, 22p. 2·2μF, 25p.

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160V: 0·01μF, 0·015μF, 0·022μF, 2½p. 0·047μF, 0·068μF, 3½p 0 1μF. 0 15μF, 4½p. 0·22μF, 5p. 0·33μF, 6p. 0 47μF, 7½p. 0·68μF, 11p. 1μF, 12½p.

MINIATURE CERAMIC PLATE CAPACITORS

50V: (pF) 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820, 1K, 1K5, 2K2, 3K3, 4K7, 6K8, (μF) 0·01, 0·015, 0 022, 0 033, 0 047, 2½p. each. 0·1, 30V. 4½p.; 0·1; 100V, 5½p.

POLYSTYRENE CAPACITORS 160V 5%

(pF) 10, 15, 22, 33, 47, 68, 100, 150, 220, 330, 470, 680, 1000, 1500, 2200, 3300, 4700, 4p. 6800, 10,000, 4½p.

RESISTORS

CF—High Stab Carbon Film 5% MF—High Stab Metal Film, 5%.

W.	Type	Range	1-9	10-49	50-99	100-249	250-499	500-999	1000+	Size mm
⅛	CF	22-1M	1	0·8	0·65	0·62	0·55	0·5	0·45	2·4 × 7·5
¼	CF	22-2M2	1	0·8	0·65	0·62	0·55	0·5	0·45	3·9 × 10·5
½	CF	22-1M	1	0·8	0·65	0·62	0·55	0·5	0·45	5·5 × 16
⅛	MF	10-2M7	1	0·9	0·8	0·7	0·65	0·65	0·6	3 × 7
¼	MF	10-2M2	1	0·9	0·8	0·7	0·65	0·65	0·6	4·2 × 10·8
1	MF	10-10M	1·5	1·25	1·25	1·1	1	0·95	0·8	6·6 × 18
2	MF	10-10M	3	2·5	2·5	2	1·75	1·75	1·6	8 × 17·5

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VALUES AVAILABLE—E12 Series only. Net prices above 100.

PRESET SKELETON POTENTIOMETERS

MINIATURE 0·25W Vertical or horizontal 6p each
1K, 2K2, 4K7, 10K, etc. up to 1MΩ
SUB-MIN 0·05W Vertical, 100Ω to 220KΩ 5p each

Wavechange Switches
1P, 4W; 1P, 12W, 2P, 2W
2P, 4W; 2P, 6W, 3p, 3W
4P, 2W, 3P, 4W; 4P, 3W.
28½p

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(P.E.) 61 CHEDDINGTON ROAD, PITSTONE,
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PLEASE WRITE FOR FREE CATALOGUE

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1·0μF	63V	6p	68μF	16V	6p
1·5μF	63V	6p	68μF	63V	12p
2·2μF	63V	6p	100μF	10V	6p
3·3μF	63V	6p	100μF	25V	6p
4·0μF	40V	6p	100μF	63V	14p
4·7μF	63V	6p	150μF	16V	6p
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
15μF	63V	6p	330μF	63V	25p
16μF	40V	6p	470μF	6·4V	9p
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
32μF	63V	6p	1500μF	6·4	15p
47μF	10V	6p	1500μF	16V	25p
47μF	25V	6p	2200μF	10V	25p
47μF	63V	8p	3300μF	6·4	26p

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2½ × 5"	28p	28p
2½ × 3¾"	26p	19p
3¾ × 5"	32p	33p
3¾ × 3¾"	28p	28p
2½ × 1"	7p	7p
2½ × 5" (Plain)	—	14p
2½ × 3¾" (Plain)	—	12p
5 × 3¾" (Plain)	—	22p
Insertion tool	59p	59p
Track Cutter	44p	44p
Pins, Pkt. 25	10p	10p

TRANSISTORS

AC127	16½p	BC212L	12p
AC128	22p	BC213L	12p
BC107	11p	BC214L	17p
BC108	12p	OC44	18p
BC109	13p	OC71	13p
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POTENTIOMETERS

Carbon Track 5K Ω to 2M Ω, log or lin. Single, 16½p. Dual Gang 46p. Log Single with Switch 26p. Slider Pots. 10K, 100K, 500K. 30mm, 34p. 45mm, 47p. 60mm, 55p.

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IN4001	6½p
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IN4004	9½p
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IN4006	14p
IN914	7p
IN916	7p
BA100	10p
OA5	42p
OA47	9p
OA81	11p
OA200	8p

PLUGS

DIN 2 Pin	12p
3 Pin	13p
5 Pin 180°	15p
Std. Jack	14½p
2.5mm Jack	11p
Phono	5½p

SOCKETS

DIN 2 Pin	10p
3 Pin	10p
5 Pin 180°	12p
Std. Jack	14½p
2.5mm Jack	11p
Phono	5½p

ELECTROLYTIC CAPACITORS. Tubular & Large Cans

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250V: 0·05μF, 0·1μF 4½p, 0 25μF, 5½p, 0·5μF, 6½p, 1μF, 9p.
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1000V: 0·01μF, 10p. 0·022μF, 12p. 0·047μF, 0·1μF, 16p. 0·22μF, 31p, 0·47μF. 39p.

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μA709C	50p
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Neon Bulb, 90V Wire Ended	5 for 24p
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Electronic Ignition Kit

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Kit comprises EVERYTHING
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A new development from the manufacturers of Gunton ignition Price **£9.35** inc V.A.T. and postage (12 volt only State Pos or Neg. earth). Ready built unit also available **£11.55** inc V.A.T. and postage **GUARANTEED 5 YEARS**

ORDER NOW—send P.O./Cheque direct to:
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***STILL AT £42·50**
Solartron CD 711S.2 Double Beam Oscilloscope D.C.—9 Mc/s; 3 MV/cm; trigger delay; crystal calibrator; 4in flat faced tube. In good working condition. Carr. £1·50.

NEW WIDE RANGE WOBBULATOR
5 MHz to 150 MHz up to 15 MHz sweep width. Only 3 controls, preset RF level, sweep width and frequency. Ideal for 10·7 or TV IF alignment, filters, receivers. Can be used with any general purpose scope. Full instructions supplied. Connect 6·3V A.C. and use within minutes of receiving. All this for ONLY **£5·75p.** P. & P. 25p. (Not cased, not calibrated.)

20 Hz to 200 kHz WB.

SINE and SQUARE GENERATOR. Four ranges. Independent amplitude controls, thermistor stabilised. Ready to use, 9V supply required. **£7·85** each. P. & P. 25p (Not cased, not calibrated.)

GRATICULES. 12cm × 14cm high quality plastic **15p** each. P. & P. 5p.
12" Long Persistence Crt, full spec. Price **£7·50** to include V.A.T. & carr.

£1 WORTH OF "UFS". Six brand new capacitors all between 15V and 100V. Total capacitance not less than 7,000mF. P. & P. 45p.

PHOTOMULTIPLIER type 931A **£3·25** each. P. & P. 25p.

ROTARY SWITCH PACK. Six brand new switches (1 ceramic; 1 off, 4 pole, 2 way, etc.), **50p.** P. & P. 20p.

COMPONENT PACK consisting of 5 pots, various, brand new; 250 resistors ¼ and ½ watt, many high stabs, etc. Fine value at **50p.** P. & P. 17p.

P.C.B. PACKS 5 & D. Quantity 2sqft—no tiny pieces. **50p** plus P. & P. 20p.

FIBRE GLASS as above **£1** plus P. & P. 20p. Ferric Chloride Resistance Pen FREE (whilst stock lasts) on all purchases of our £1 Fibre Glass pack.

5 CRYSTALS 70 to 90kHz. Our choice, **25p.** P. & P. 15p.

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CAPACITOR PACK—50 Brand new components only **50p.** P. & P. 17p.

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PHOTOCELL equ. OCP71, **13p** each.

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MODERN TELEPHONES type 706. Two-tone grey, **£3·75** each. Two-tone green, **£3·75** each. Black, **£2·75** each. P. & P. 25p each.
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DELIVERED TO YOUR DOOR 1 cwt of Electronic Scrap chassis, boards, etc. No Rubbish. FOR ONLY **£3·50.**

PLEASE ADD 10% V.A.T.

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Baker De Luxe 12in d cone	£9·62
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Kef T27	£4·67
Kef T15	£5·50
Kef B110	£6·16
Kef B200	£7·42
Kef B139	£10·72
Kef DN8	£1·92
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Fane Pop 100W 8 15 ohm	£21·45
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Fane Crescendo 15in 8 or 15 ohm	£27·50
Fane Crescendo 12A 100W 8 or 15 ohm	£24·20
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Fane 807T 8in d c roll s 8 or 15 ohm	£3·85
Fane 808T 8in d cone 8 or 15 ohm	£2·64
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Goodmans 8P 8 or 15 ohm	£3·80
Goodmans 10P 8 or 15 ohm	£4·49
Goodmans 12P 8 or 15 ohm	£11·55
Goodmans 15P 8 or 15 ohm	£17·05
Goodmans 18P 8 or 15 ohm	£29·70
Goodmans Twinaxiom 8	£6·79
Goodmans Twinaxiom 10	£7·61
Elac 9 × 5 59RM109 15 ohm 59RM114 8 ohm	£2·53
Elac 6½in d c roll s 8 ohm	£3·22
Elac 6½in d cone 8 ohm	£2·59
Elac 4in tweeter TW4	£1·21
Wharfedale Super 10 RS DD	£9·80
Coral 6½in d cone roll s 8 ohm	£2·42
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10in × 6in 3 8 or 15 ohm	£1·92
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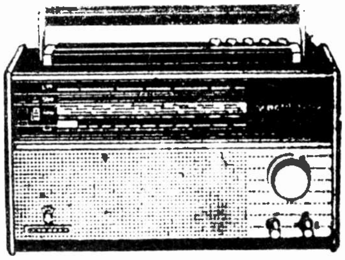

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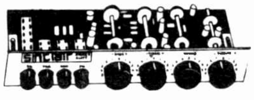

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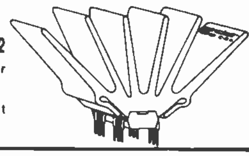

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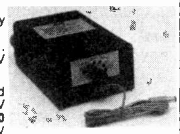

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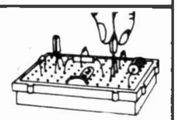

S-DECS	**£1·44** (25p)
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T3	8	D1216	OC81D
T4	8	2G381T	OC81
T5	8	2G382T	OC82
T6	8	2G344B	OC44
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T8	8	2G378	OC78
T9	8	2G399A	2N1302
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Vebo = 80V. Vceo = 50V. I.C. = 10 amps. Ptot = 30W. hfe = 30–170. Replaces the majority of Germanium power transistors in the OC, AD and NKT range.

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Q 6	5	OC72 transistors	0·55
Q 7	4	AC128 transistors *pnp* high gain	0·55
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Q25	15	IN914 Silicon diodes 75PIV 75mA	0·55
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Q27	2	10A 600 PIV Silicon rectifiers IS425R	0·55
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Q32	3	*pnp* Silicon transistors 2 × 2N1131, 1 × 2N1132	0·55
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5A	TO66	0·39	0·52	0·54	0·59	0·75	0·88
5A	TO64	0·39	0·52	0·54	0·62	0·75	0·88
7A	TO48	0·52	0·55	0·62	0·67	0·84	0·99
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100	0·05	0·07	0·06	0·10	0·17	0·23	0·75
200	0·06	0·10	0·07	0·12	0·22	0·25	1·00
400	0·08	0·15	0·08	0·15	0·30	0·38	1·35
600	0·09	0·17	0·10	0·18	0·36	0·45	1·90
800	0·12	0·19	0·11	0·20	0·38	0·55	2·10
1000	0·14	0·30	0·12	0·25	0·48	0·65	2·50
1200	—	0·35	—	0·30	0·58	0·75	3·00

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UIC01	= 12 × 7401	0·55	UIC48	= 5 × 7448	0·55	UIC90	= 5 × 7490	0·55
UIC02	= 12 × 7402	0·55	UIC50	= 12 × 7450	0·55	UIC91	= 5 × 7491	0·55
UIC03	= 12 × 7403	0·55	UIC51	= 12 × 7451	0·55	UIC92	= 5 × 7492	0·55
UIC04	= 12 × 7404	0·55	UIC53	= 12 × 7453	0·55	UIC93	= 5 × 7493	0·55
UIC05	= 12 × 7405	0·55	UIC54	= 12 × 7454	0·55	UIC94	= 5 × 7494	0·55
UIC06	= 8 × 7406	0·55	UIC60	= 12 × 7460	0·55	UIC95	= 5 × 7495	0·55
UIC07	= 8 × 7407	0·55	UIC70	= 8 × 7470	0·55	UIC96	= 5 × 7496	0·55
UIC10	= 12 × 7410	0·55	UIC72	= 8 × 7472	0·55	UIC100	= 5 × 74100	0·55
UIC20	= 12 × 7420	0·55	UIC73	= 8 × 7473	0·55	UIC121	= 5 × 74121	0·55
UIC30	= 12 × 7430	0·55	UIC74	= 8 × 7474	0·55	UIC141	= 5 × 74141	0·55
UIC40	= 12 × 7440	0·55	UIC76	= 8 × 7476	0·55	UIC151	= 5 × 74151	0·55
UIC41	= 5 × 7441	0·55	UIC80	= 5 × 7480	0·55	UIC154	= 5 × 74154	0·55
UIC42	= 5 × 7442	0·55	UIC81	= 5 × 7481	0·55	UIC193	= 5 × 74193	0·55
UIC43	= 5 × 7443	0·55	UIC82	= 5 × 7482	0·55	UIC199	= 5 × 74199	0·55
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OUTPUT 7·5V or 9V d.c.
MAX. CURRENT 500mA

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Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	P & P £	p
07	20	1	8	7·0 × 6·0 × 6·0	2·32	30
149	60	3	12	9·9 × 7·7 × 8·6	3·45	36
150	100	5	8	9·9 × 8·9 × 8·6	3·79	52
151	200	8	0	12·1 × 9·3 × 10·2	6·45	52
152	250	13	12	12·1 × 11·8 × 10·2	8·41	67
153	350	15	0	14·0 × 10·8 × 11·8	11·20	82
154	500	19	8	14·0 × 13·4 × 11·8	16·25	*
155	750	29	0	17·2 × 14·0 × 14·0	22·10	*
156	1000	38	0	17·2 × 16·6 × 14·0	29·87	*
158	2000	60	0	21·6 × 15·3 × 18·1	49·25	*

AUTO TRANSFORMERS

Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	Auto Taps	P & P £	p
113	20	1	0	5·8 × 5·1 × 4·5	0-115-210-240	1·22	22
64	75	2	4	7·0 × 6·7 × 6·1	0-115-210-240	2·40	30
4	150	3	4	8·9 × 7·7 × 7·7	0-115-200-220-240	2·89	36
66	300	6	4	9·9 × 9·6 × 8·6	" "	5·63	52
67	500	12	8	12·1 × 11·2 × 10·2	" "	8·36	67
84	1000	19	8	14·0 × 13·4 × 14·3	" "	15·19	82
93	1500	30	4	14·0 × 15·9 × 14·3	" "	21·99	*
95	2000	32	0	17·2 × 16·6 × 14·0	" "	28·70	*
73	3000	40	0	21·6 × 13·4 × 18·1	" "	39·17	*

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115 500W enclosed transformer, with mains lead and two 115V outlet sockets, **£9·49**, P & P 67p. 20W version, **£2·02**, P & P 22p.

LOW VOLTAGE SERIES (ISOLATED)
PRIMARY 200-250 VOLTS 12 AND/OR 24 VOLT RANGE

Ref. No.	Amps. 12V	24V	Weight lb	oz	Size cm.	Secondary Windings	P & P £	p
111	0·5	0·25		8	4·8 × 2·9 × 3·5	0-12V at 0·25A × 2	1·22	22
213	1·0	0·5	1	4	6·1 × 5·8 × 4·8	0-12V at 0·5A × 2	1·44	22
71	2	1	1	12	7·0 × 6·4 × 6·1	0-12V at 1A × 2	1·90	22
18	4	2	2	12	8·3 × 7·7 × 7·0	0-12V at 2A × 2	2·68	36
70	6	3	3	8	8·9 × 8·0 × 7·7	0-12V at 3A × 2	3·20	42
108	8	4	5	8	9·9 × 8·9 × 8·6	0-12V at 4A × 2	3·60	52
72	10	5	6	4	9·9 × 9·6 × 8·6	0-12V at 5A × 2	4·25	52
116	12	6	6	12	9·9 × 10·2 × 8·6	0-12V at 5A × 2	5·10	52
17	16	8	8	12	12·1 × 9·9 × 10·2	0-12V at 8A × 2	6·56	52
115	20	10	11	8	14·0 × 9·6 × 11·8	0-12V at 10A × 2	8·36	67
187	30	15	15	8	14·0 × 12·1 × 11·8	0-12V at 15A × 2	15·40	82
226	60	30	32	0	17·2 × 15·3 × 14·0	0-12V at 30A × 2	28·44	*

30 VOLT RANGE

Ref. No.	Amps	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
112	0·5	1	4	6·1 × 5·8 × 4·8	0-12-15-20-24-30V	1·42	22
79	1·0	2	4	7·0 × 6·7 × 6·1	" "	1·92	36
3	2·0	3	4	8·9 × 7·7 × 7·7	" "	2·90	36
20	3·0	4	8	9·9 × 8·3 × 8·6	" "	3·58	42
21	4·0	6	4	9·9 × 9·6 × 8·6	" "	4·25	52
51	5·0	6	12	12·1 × 8·6 × 10·2	" "	5·30	52
117	6·0	8	0	12·1 × 9·3 × 10·2	" "	6·31	52
88	8·0	12	0	12·1 × 11·8 × 10·2	" "	8·18	67
89	10·0	13	12	14·0 × 10·2 × 11·8	" "	10·33	67

50 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
102	0·5	1	12	7·0 × 6·4 × 6·1	0-19-25-33-40-50V	1·90	30
103	1·0	2	12	8·3 × 7·4 × 7·0	" "	2·80	36
104	2·0	5	8	7·9 × 8·9 × 8·6	" "	3·87	42
105	3·0	6	12	9·9 × 10·2 × 8·6	" "	5·26	52
106	4·0	10	0	12·1 × 10·5 × 10·2	" "	6·99	52
107	6·0	12	0	14·0 × 10·2 × 11·8	" "	10·35	67
118	8·0	18	0	14·0 × 12·7 × 11·8	" "	13·51	97
119	10·0	25	0	17·2 × 12·7 × 14·0	" "	16·95	*

60 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
124	0·5	2	4	7·0 × 6·7 × 6·1	0-24-30-40-48-60V	1·93	36
126	1·0	3	4	8·9 × 7·7 × 7·7	" "	2·70	36
127	2·0	6	4	9·9 × 9·6 × 8·6	" "	4·25	42
125	3·0	8	12	12·1 × 9·9 × 10·2	" "	6·46	52
123	4·0	13	12	12·1 × 11·8 × 10·2	" "	8·36	67
40	5·0	12	00	14·0 × 10·2 × 11·8	" "	9·85	67
120	6·0	15	8	14·0 × 12·1 × 11·8	" "	12·14	82
121	8·0	25	00	14·0 × 14·7 × 11·8	" "	13·65	*
122	10·0	25	0	17·2 × 12·7 × 14·0	" "	20·09	*
189	12·0	29	00	17·2 × 14·0 × 14·0	" "	22·49	*

MINIATURE TRANSFORMERS WITH SCREENS

Ref. No.	mA	Weight lb	oz	Size cm.	Volts	P & P £	p
238	200		2	2·8 × 2·6 × 2·0	3-0-3	1·31	10
212	1A, 1A	1	4	6·1 × 5·8 × 4·8	0-6, 0-6	1·52	22
13	100		4	3·9 × 2·6 × 2·9	9-0-9	1·12	10
235	330, 330		4	4·8 × 2·9 × 3·5	0-9, 0-9	1·52	10
207	500, 500	1	00	6·1 × 5·4 × 4·8	0-8-9, 0-8-9	2·03	22
208	1A, 1A	1	12	7·0 × 6·4 × 6·1	0-8-9, 0-8-9	2·73	30
236	200,200		4	4·8 × 2·9 × 3·5	0-15, 0-15	1·52	10
214	300, 300	1	4	6·1 × 5·8 × 4·8	0-20, 0-20	1·60	22
221	700 (d.c.)	1	8	7·0 × 6·1 × 6·1	20-12-0-12-20	1·41	30
206	1A, 1A	2	12	8·3 × 7·7 × 7·0	0-15-20, 0-15-20	3·08	38
203	500,500	2	4	8·3 × 7·0 × 7·0	0-15-27, 0-15-27	2·82	38
204	1A, 1A	3	4	8·9 × 7·7 × 7·7	0-15-27, 0-15-27	2·86	38

*Carriage via B.R.S.

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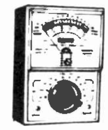
AUDIOTRONIC Model ATM1



Top value 10,000 opv pocket multimeter. Ranges:– 0/10/50/250/1,000 volt AC and DC. DC current 0-1mA/100mA. Resistance 0/150k ohms. Decibels –10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.

OUR PRICE £2.95 P&P 15p

MODEL TE200

20,000opv. Mirror scale, overload protection. 0/5/25/125/1000V DC. 0/10/50/250/1000V AC. 0/50uA/250mA. 0/60k/6 Meg ohms. –20 to +62dB.

OUR PRICE £4.95 P&P 15p

MODEL U437 MULTIMETER

10,000opv. A first class, instrument manufactured in USSR to the highest standards. Ranges: 2.5/10/50/250/500/1000V DC. 2.5/10/50/250/500/1000V AC. DC current 100uA/1/10/100mA/1A. Resistance 300 ohms/3/30/300k/3 Meg. ohms. Complete with batteries, test leads, instructions and a sturdy steel carrying case.

OUR PRICE £4.95 P&P25p

MODEL TH12

20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/50/150/1000V DC. 0/10/50/250/1000V AC. 0/50uA/25/250mA DC. 0/3k/30k/300k/3 Megohms. –20 to +50dB.

OUR PRICE £5.97 P&P 15p

HIOKI Model 720X VOM

A versatile, accurate measuring instrument. 20,000 opv. 0/5/25/100/500/1000V DC. 0/10/50/250/1000V AC. 0–50uA/250mA. 0–20k/2 Megohms.

OUR PRICE £5.97 P&P 20p

U4323 MULTIMETER

20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance 5/50/500 ohms/5/10/100k ohms/1Meg. Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.

OUR PRICE £7.00 P&P 20p

U4312 MULTIMETER

extremely sturdy instrument for general electrical use. 667opv. 0/0.3/1.5/7.5/30/60/150/300/600/900V DC & 75mV. 0/0.3/1.5/7.5/30/60/150/300/600/900V AC. 0/300uA/1.5/6/15/150/60/600mA/1/1.5/6A DC. 0/1.5/6/15/60/150/600mA/1.5/6A AC. 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.

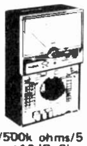
OUR PRICE £9.75 P&P 25p

MODEL TE300

30,000opv. Mirror scale. Overload protection. 0/0.6/3/15/60/300/1200V DC. 0/6/30/120/600/1200V AC. 0/30uA/6mA/60mA/300mA/600mA. 0/8k/80k/800k/8 Meg ohms. –20 to +63dB.

OUR PRICE £7.50 P&P 15p

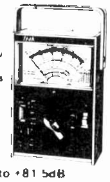
U4324 MULTIMETER



High sensitivity, overload protected. 20,000opv. Ranges: 0.6/1.2/3/12/30/60/120/600/1200V DC. 3/6/15/60/150/300/600/900V AC. Current: 0.06/0.6/6/60/600mA/3A DC. 0.3/3/30/300mA/3A AC. Resistance: 25/500 ohms/0.5/5/50/500k ohms/5 Mohms. Decibels: –10 to +12dB. Size 167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.

OUR PRICE £8.00 P&P 20p

TMK MODEL TW50K



46 ranges, mirror scale. 50k/V DC 50k/V AC. DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistance: 10k/100k/1 Meg/10 Meg ohms. –20 to +81.5dB.

OUR PRICE £8.50 P&P 17p

U435 MULTIMETER

20,000opv. Overload protected. Ranges: 75mV/2.5/10/25/100/250/500/1000V DC. 2.5/10/25/100/250/500/1000V AC. Current: 50uA/1/5/25/100mA/0.5/2.5A DC. 5/25/100mA/0.5/2.5A AC. Resistance: 0.3/3/30/300k ohms. Size: 205 x 110 x 84mm. Supplied complete with leads, crocodile clips and steel carrying case.

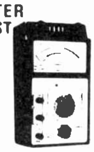
OUR PRICE £8.75 P&P 20p

U91 Clamp VOLT AMMETER

For measuring AC voltage and current without breaking circuit. Ranges 300/600V AC. Current 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 36mm. Complete with carrying case, leads and fuses.

OUR PRICE £10.50 P&P 20p

U4341 MULTIMETER TRANSISTOR TESTER



27 ranges. 16,700opv. Overload protected. Ranges: 0.3/1.5/6/30/60/150/300/900V DC. 1.5/7.5/30/150/300/750V AC. Current: 0.06/0.6/6/60/600mA DC. 0.3/3/30/300mA AC. Resistance: 0.06/0.6/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.

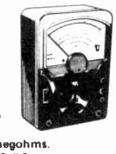
OUR PRICE £10.50 P&P 20p

Model 449A In Circuit TRANSISTOR TESTER

Checks true AC, Beta in/out. Checks ICO. Checks diodes in/out. Checks SCR etc. Beta HI 10–500 LO 2–50. ICO 0–5000uA. 220/240 V AC operation.

OUR PRICE £17.50 P&P 25p

MODEL 500



30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC. 0/50uA/5/50/500mA. 12A DC. 0/60k/6 meg/60 megohms.

OUR PRICE £10.50 Carr. paid

Leather case for above £1.75

KAMODEN HM350 TRANSISTOR TESTER

High quality instrument to test reverse leak current and DC current. Amplification factor of NPN, PNP, diodes, transistors, SCR's etc. 4" square clear scale meter. Operates from internal batteries. Complete with instructions, leads carrying handle.

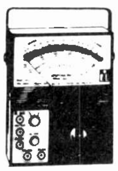
OUR PRICE £12.50 P&P 30p

MODEL C7080EN

Giant 6" mirror scale. 20,000 opv. 0/0.25/1/2.5/10/50/250/1000/5000V DC. 0/2.5/10/50/250/1000/5000V AC. 0/50uA/1/10/100/500mA/10A DC. 0/2k/200k/20 Meg. –20 to +50dB

OUR PRICE £13.95 P&P 35p

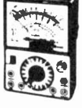
KAMODEN 360 MULTIMETER



High sensitivity. DC 100kohm/V AC 10kohm/V 5" mirror scale, overload protected. Ranges: 0.5/2.5/10/50/250/1000V DC. 5/10/50/250/1000V AC. Current: 0.01mA/0.5/5/50/500mA/10A. Resistance: 0.1/1/10/100 ohms/1/10/100k ohms/10/100M ohms. Decibels –20 to +62dB. Battery operated. Size: 180 x 140 x 80mm. Supplied complete with test leads etc.

OUR PRICE £13.95 P&P 25p

HIOKI MODEL 700X



100,000opv. Overload protection. Mirror scale 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC. 1.5/3/6/12/30/60/150/300/600/1200V AC. 15/30uA/3/6/30/60/150/500mA/6/12A DC 2k/200k/2M/20MOhms –20 to +63dB.

OUR PRICE £14.95 P&P20p

S100TR MULTIMETER–TRANSISTOR TESTER

100,000opv. Mirror scale. Overload protection. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600V AC. 0/12/600uA/12/300mA612A DC. 0/10k/1 Meg/100 Meg. –20 to +50dB. 0.01–0.2 MFD. Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.

OUR PRICE £14.95 P&P 25p

KAMODEN HM7208 FET VOM

Input impedance 10 Megohms. Ranges 0/.25/1/2.5/10/50/1000V DC. 0/2.5/10/50/250/1000V AC. 0/25uA/2.5/25/250 mA DC. 0/5k/50k/500k/5 M 500 Megohms

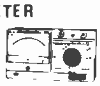
OUR PRICE £14.95 P&P 30p

MODEL TE15 GRID DIP METER

Transistorised. Operates as Grid Dip, Oscillator, Absorbtion Wave Meter and Oscillating Detector. Frequency range 440kHz–280MHz in six coils. 500uA meter. 9V battery operation. Size: 180 x 80 x 40mm.

OUR PRICE £15.00 P&P 20p

U4317 MULTIMETER



High sensitivity instrument for field and laboratory work Knife edge pointer. 86mm. mirror scale Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000 V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: –5 to +10dB Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.

OUR PRICE £15.00 P&P 20p

KAMODEN 72200 Multitester

High sensitivity tester. 200,000 opv Overload protected Mirror scale. Ranges:–0/.06/.3/3/30/120/600/1200V DC. 0/3/12/60/300/11200 V AC. 0/6uA/1.2mA/120mA/600mA/12A DC 0/12A AC. –20 to +63dB. 0/2k/200k/2 Meg/200 Megohms

OUR PRICE £16.95 P&P 30p

370WTR MULTIMETER

Features AC current ranges. 20,000opv 0/0.5/2.5/10/50/250/500/1000V DC 0/2.5/10/50/250/500/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/5 Meg/50 Meg. Decibels: –20 to +62dB

OUR PRICE £17.50 P&P 25p

TMK MODEL 117 FET ELECTRONIC VOLTMETER

Battery operated. 11 Meg input, 26 ranges. Large 4¾" mirror scale. Size: 149 x 117 x 60mm. 0.3–12000V DC. 3–300V RMS AC. 8–800V P-P. DC current 0.12–12mA. Resistence up to 2000MOhms. Decibels. –20 to +51dB. Supplied complete with leads and instructions.

OUR PRICE £17.50 P&P 20p

TE65 VALVE VOLTMETER

28 ranges. DC volts 1.5–1500V. AC volts 1.5–1500V. Resistance up to 1000 Megohms, 200/240V AC operation. Complete with probe and instructions.

OUR PRICE £17.50 P&P 30p

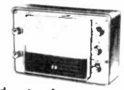
Additional probes available: RF £2.12, HV £2.50

TE40 HIGH SENSITIVITY AC VOLTMETER

10 Meg input. 10 ranges: 0.001/0.03/0.1/0.3/1/3/11/30/100/300V RMS. 5cps–1.2MHz. –40 to +50dB supplied brand new complete with leads and instructions.

OUR PRICE £17.50 P&P 25p

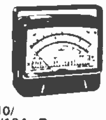
KAMODEN HMG500 insulation resistance tester



Range 0–1,000 Megohms, 500V Battery operated Wide range clear meter 4" x 4¾". Complete with deluxe carrying case, batteries and instructions

OUR PRICE £19.95 P&P 30p

TMK LAB TESTER



100,000opv. 6½" scale. Buzzer short circuit check Sensitivity 100,000 opv DC. 5k/V AC DC Volts: 0.5/2.5/10/50/250/1000V AC. 3/10/50/250/500/1000V DC. current 10/100uA/10/10/100/500mA/2.5/10A. Resistance: 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: –10 to +49dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.

OUR PRICE £19.95 P&P 25p

MODEL U4311 Sub-standard Multi-range Volt-Ammeter

Sensitivity 330 Ohms/Volt AC and DC. Accuracy 0.5% DC. 1% AC. Scale length: 165mm. 0/300/750uA/1.5/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A DC. 0/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A AC. 0/75/150/300/750mV/1.5/3/7.5/15/30/75/150/300/750V DC. 0/750mV/1.5/3 /7.5/15/30/75/150/300/750V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificates.

OUR PRICE £49.00 P&P 50p

AT201 Decade ATTENUATOR

Frequency range 0-200kHz. Attenuator 0–111dB, 0.1dB steps. Impedence 600 ohms. Input power maximum 30dBm. Size: 180 x 90 x 55mm.

OUR PRICE £12.50 P&P 37p

TE16A TRANSISTORISED SIGNAL GENERATOR

5 ranges, 400kHz to 30 MHz. An inexpensive instrument for the handy-man. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. Size: 149 x 149 x 92mm Complete with instructions and leads.

OUR PRICE £8.97 P&P 25p

TE22 SINE SQUARE WAVE AUDIO GENERATOR

Sine 20cps to 200kHz on 4 bands. Square 20 cps to 30 kHz. Output impedence 5000 Ohms. 200/250V AC operation. Supplied brand new guaranteed, with instruction manual and leads.

OUR PRICE £17.50 P&P 37p

ARF 300 AF/RF SIGNAL GENERATOR

All transistorised compact fully portable. AF sine-wave 18Hz to 220 kHz. AF square wave 18Hz to 100k Hz. Output Square/Sine wave 10V. P-P RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads.

OUR PRICE £29.95 P&P 50p

LASKYS

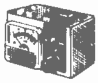
ALL PRICES EXCLUDE VAT

INCORPORATING LASKYS RADIO LTD & G W SMITH & CO (RADIO) LTD

WALKIE TALKIES

SKYFON 100mW
OUR PRICE £24.95 per pair
P302 Two Channel 300mW
OUR PRICE £52.50 per pair
P1003 Three Channel 1 Watt
OUR PRICE £71.25 per pair
P&P 50p per pair

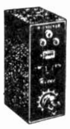
LB3 TRANSISTOR TESTER



Tests ICO and B. PNP/NPN. Operates from 9V battery. Complete with all instructions etc.

OUR PRICE £3.95 P&P 20p

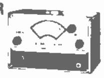
LB4 TRANSISTOR TESTER



Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.

OUR PRICE £4.50 P&P 20p

BELCO Sine Square Wave CR OSCILLATOR



Sine 18 x 200,000Hz Square 18 x 20,000 Hz. Maximum output +10dB (10k ohms) Operates from internal batteries. Attractive two tone case. Size: 196 x 127 x 50mm.

OUR PRICE £17.50 P&P 17p

POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range available ex-stock. Single hole fixing. ¼" diameter shafts. Bulk quantities available.

25 WATT 10/25/50/100/250/500/1000 Ohms. **£1.15** P&P 10p

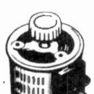
50 WATT 10/25/50/100/250/500/1000/2500/5000 Ohms. **£1.62** P&P 10p

100 WATT 1/5/10/25/50/100/250/500/1000/2500 Ohms. **£2.34** P&P 15p

YAMABISHI VARIABLE VOLTAGE TRANSFORMERS

Excellent quality at low cost.
All models—Input 230V 50/60Hz.
Variable output 0–260V
MODEL S260 GENERAL PURPOSE BENCH MOUNTING

		P&P
1A	£8.75	30p
2.5A	£10.00	35p
5A	£14.70	37p
8A	£25.50	50p
10A	£28.10	75p
12A	£29.50	100p
20A	£72.50	125p
25A	£72.50	130p
40A	£103.10	150p



MODEL S260B

2.5A	£8.75	30p
1A	£10.00	35p

AUTO TRANSFORMERS

0/115/250V. Step up or step down. Fully shrouded.

80W	£2.75	P&P 18p
150W	£3.50	P&P 18p
300W	£4.50	P&P 23p
500W	£6.95	P&P 33p
1000W	£9.50	P&P 38p
1500W	£12.50	P&P 43p
2250W	£20.95	P&P 50p
5000W	£44.95	P&P £1

SWR METER Model SWR3

Handy SWR meter for transmitter antenna alignment, with built-in field strength meter. Accuracy 5%. Impedence 52' Indicator 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.

OUR PRICE £4.25 P&P 25p

240° Wide Angle 1mA METERS

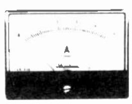
MW 1–6 60x60mm
£3.97 P&P 15p
MW 1–8 80x80mm
£4.97 P&P 15p

SEW

CLEAR PLASTIC PANEL METERS

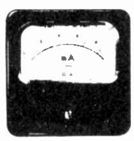
USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS AND EDUCATIONAL AUTHORITIES.

Over 2,000 ranges in stock—other ranges to order. Quantity discounts available. Send for fully illustrated brochure.



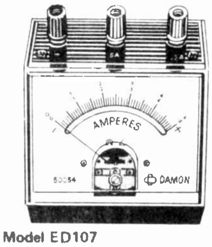
Clear Plastic Model SD830

Enlarged Window Model S80



Bakelite Model 65

Clear Plastic Model 45P



Model ED107

RANGE	MR 38P	MR 45P	MR 52P	MR 65P	MR 85P	MR 65	S 80	SW 100	SD 460	SD 640	SD 830	PE 70	ED 107
25uA	–	–	–	–	–	£4.60	–	–	–	–	–	–	–
50uA	£2.55	£2.70	£3.50	£3.70	£4.40	£3.55	£3.50	£4.15	£2.80	£3.05	£3.40	£3.75	£6.90
100uA	£2.45	£2.60	£3.00	£3.15	£4.25	£3.00	£3.40	£3.95	£2.75	£3.00	£3.35	£3.60	£6.40
200uA	£2.40	£2.50	–	£3.05	£4.05	–	–	–	£2.70	£3.00	£3.30	£3.40	–
500uA	£2.25	£2.45	£2.65	£2.75	£3.90	£2.70	£3.05	£3.70	£2.55	£2.95	£3.15	£3.20	–
50-0-50uA	£2.50	£2.65	£3.05	£3.15	£4.25	£3.05	£3.40	£3.95	£2.80	£3.05	£3.40	£3.60	£6.40
100-0-100uA	£2.40	£2.50	£2.95	£3.10	£4.05	£3.00	£3.30	£3.90	£2.75	£3.00	£3.35	£3.50	–
500-0-500uA	£2.25	£2.40	–	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
1mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	£3.20	–
1-0-1mA	£2.25	–	–	–	£3.90	£2.60	–	–	–	–	–	–	–
2mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
5mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	£2.90	£3.10	–	–
10mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	£2.90	£3.10	–	–
20mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
50mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	£2.90	£3.10	–	–
100mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	£2.90	£3.10	–	–
150mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
200mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
300mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
500mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	£2.90	£3.10	–	–
750mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
1A DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	–	£5.95
2A DC	£2.25	–	–	–	–	£2.60	–	–	–	–	–	–	–
5A DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	–	£5.95
10A DC	£2.25	–	–	£2.60	–	–	–	–	£2.60	£2.90	£3.10	–	–
15A DC	£2.25	–	–	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
20A DC	£2.25	–	–	£2.60	–	–	–	–	–	–	–	–	–
30A DC	–	–	–	£2.80	£3.95	£2.60	–	–	–	–	–	–	–
50A DC	–	–	–	£2.90	–	£2.60	–	–	–	–	–	–	–
3V DC	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
5V DC	–	–	–	£2.60	–	£2.60	–	–	£2.60	£2.90	£3.10	–	£5.95
10V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	–	£3.10	–	£5.95
15V DC	£2.25	–	–	–	–	–	–	–	–	–	–	–	£5.95
20V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	–	£2.90	£3.10	–	£5.95
50V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	–	£5.95
100V DC	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
150V DC	£2.25	–	–	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
300V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	–	£5.95
500V DC	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
750V DC	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
15V AC	£2.30	£2.45	£2.60	£2.80	£3.95	–	–	–	£2.70	£3.00	£3.30	–	–
30V AC	–	–	–	–	–	£2.65	–	–	–	–	–	–	–
50V AC	£2.30	–	–	£2.80	–	£2.65	–	–	–	–	–	–	–
150V AC	£2.30	–	–	£2.80	–	£2.65	–	–	–	–	–	–	–
300V AC	£2.30	£2.45	£2.60	£2.80	£3.95	£2.65	£3.00	£3.70	£2.70	£3.00	£3.30	£3.25	–
500V AC	£2.30	–	–	£2.80	–	£2.65	–	–	–	–	–	–	–
S Meter 1mA	£2.30	£2.50	£2.60	£2.85	£3.90	–	–	–	–	–	–	–	–
VU Meter	£2.65	£2.70	£3.60	£3.70	£4.55	£3.65	£3.70	£4.30	£2.90	£3.15	£3.50	£3.85	–
1A AC	–	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
5A AC	–	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
10A AC	–	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
20A AC	–	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
30A AC	–	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
50A AC	–	–	–	–	–	£2.60	–	–	–	–	–	–	–
50mA AC	–	–	–	£2.60	–	–	–	–	–	–	–	–	–
100mA AC	–	–	–	£2.60	–	–	–	–	–	–	–	–	–
200mA AC	–	–	–	£2.60	–	–	–	–	–	–	–	–	–
500mA AC	–	–	–	£2.60	–	£2.60	–	–	–	–	–	–	–
50mV DC	–	–	–	–	–	£2.90	–	–	–	–	–	–	–
100mV DC	–	–	–	–	–	£2.90	–	–	–	–	–	–	–
500mA/5A DC	–	–	–	–	–	–	–	–	–	–	–	–	£7.00
1/15A DC	–	–	–	–	–	–	–	–	–	–	–	–	£7.00
5/15V DC	–	–	–	–	–	–	–	–	–	–	–	–	£7.00
5/50V DC	–	–	–	–	–	–	–	–	–	–	–	–	£7.00

SEW PANEL METERS—SIZES AND FIXING INFORMATION

	Front	Panel Hole	Fixing
Model 38P	42 x 42mm	32mm dia.	4 studs
Model 45P	50 x 50mm	38mm dia.	4 studs
Model 52P	60 x 60mm	48mm dia.	4 studs
Model 65P	86 x 78mm	57mm dia.	4 studs
Model 85P	120 x 110mm	98mm dia.	4 studs
Model 65	80 x 80mm	64mm dia	4 studs
Model S80	80 x 80mm	65mm dia.	4 studs

	Front	Panel Hole	Fixing
Model SW100	100 x 80mm	65mm dia.	4 studs
Model SD460	59 x 46mm	38mm dia.	4 studs
Model SD640	85 x 64mm	45mm dia.	4 studs
Model SD830	110 x 83mm	58mm dia.	4 studs
Model PE70	90 x 34mm	70 x 31mm	2 holes

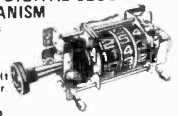
Model ED107 Size. 100 x 90 x 150mm high including terminals.

LASKYS

INCORPORATING LASKYS RADIO LTD & G W SMITH & CO (RADIO) LTD

ALL PRICES EXCLUDE VAT

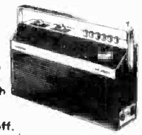
OT55B DIGITAL CLOCK MECHANISM



Features 24 hour alarm setting with built in buzzer. On/off and auto alarm 'sleep' switch. Illuminated rotary dial with hours, minutes and seconds. Automatically turns off radio, TV, light etc. and with auto-switching will turn on again when required. 240V AC operation. Switch rating 250V, 3 Amp.

OUR PRICE £5.95 P&P 30p

AUDIOTRONIC AR3000
AM/FM Portable Radio



4 wave-bands covering FM: 87–108MHz. MW: 510–1605kHz. LW: 145–285 kHz. SW: 5.8–12.5MHz. Push button wave change plus AFC and on/off. Thumbwheel tuning. Slider volume and tone controls. Earphone socket. Built-in and telescopic aerials. Car aerial socket. Battery and mains operation.

OUR PRICE £14.95 P&P 50p

AUDIOTRONIC DOLBY B
Noise Reduction Units

Reduce tape hiss by 3dB at 600Hz, 6dB at 1200Hz and 10dB for all frequencies above 3000Hz. Size: 460 x 203 x 79mm. AC 220/240V

PROCESS 4

For use with semi-professional tape recorders. Frequency response 30Hz–20kHz ± 2dB. S/N better than 70dB. Full source/tape monitoring. Switchable multiplex filter. Supplied with test tape.

OUR PRICE £50.00 P&P 50p

PROCESS 2

For use with cassette and tape recorders. Frequency response 30Hz–20kHz Switchable multiplex filter. 2 Dolby calibration meters. Off tape monitoring. S/N better than 70dB. Supplied complete with test tape or cassette.

OUR PRICE £34.50 P&P 50p

CT5050 Cassette Recorder

Instant recording and playing. Piano key controls. Automatic level control. Built-in speaker. Complete with remote control microphone, carrying case and shoulder strap.

OUR PRICE £8.50 P&P 50p

AUDIOTRONIC AHP8–D
8 Track Stereo Tape Deck

Can be used with most hi-fi amplifiers. Push button track selector & illuminated track indicators. Attractive cabinet with black and silver trim. Output level 750mV. 220/240VA C.

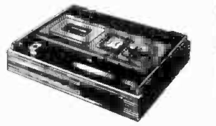
OUR PRICE £11.95 P&P 50p

SPECIAL BARGAIN !!
STEREOSOUND SPEAKERS

Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 368 x 229 x 190mm. 8 ohms. 8 watts RMS, 16 watts peak. Complete with Din lead.

OUR PRICE £12.95 P&P 50p

AUDIOTRONIC ACD660
Stereo Cassette Deck



A beautifully styled four track stereo deck with an outstanding specification offered at a remarkably low price. Incorporates a host of features including switchable noise filter, normal/chrome tape selector, twin VU meter slider record/playback level controls, front panel headphone socket, recording indicator lamp, phono/Din line input sockets, 3.5mm microphone input sockets etc, etc. Frequency response: 40–12kHz (40–16kHz CrO2). S/N: –45dB. Crosstalk 45dB. Separation: –35dB. Noise limiter –6dB at 10kHz. Complete with connecting leads.

OUR PRICE £39.50 P&P 50p

AUDIOTRONIC AMR900
Global AM/FM Portable Radio

10 wave-bands covering AM: 535–1605kHz. LW: 150–380 kHz. MB 1.6–4MHz. SW1: 4–8MHz. SW2: 8–1.6 MHz. SW3: 16–24MHz. PSB1: 30–50 MHz. PSB2: 148–174MHz. FM 88–108MHz. Air: 108–136MHz. Feature time zone map and timing dial. Large clear scale. Telescopic aerial and built in aerial. AFC on FM. 6"x4" speaker and personal earpiece. Battery/mains operation. Size: 345 x 133 x 305mm.

OUR PRICE £36.00 P&P 50p

AUDIOTRONIC STEREO HEADPHONES

LSH20 Individual volume controls. Stereo/mono switch. 8 ohms. 40–19,000Hz.

£3.75 P&P 30p

LSH30 Open back type. Individual tone and volume controls. 8 ohms. 30–20,000Hz

OUR PRICE £5.95 P&P 30p

LSH40 Two way speaker system Individual volume controls. 8 ohms. 20–20,000Hz

OUR PRICE £7.50 P&P 30p

LSH60 3" speaker units. 8 ohms. Complete with zipped carrying case. 20–20,000Hz.

OUR PRICE £8.95 P&P 30p

LSH50 Electrostatic with self powered energiser, and control unit, with headphone speaker selector. 4–32 ohms 20–24,000Hz.

OUR PRICE £16.95 P&P 30p

LQH400 4 channel dynamic headphones. Each earpeice has four drive units. 4–32 ohms 20–20,000Hz

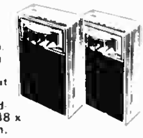
OUR PRICE £9.95 P&P 30p

BINATONE DS100 Digital Clock

240V mains operation. Ivory case with large clear numbers for hours, minutes and seconds. Size 159 x 76 x 82mm.

OUR PRICE £4.50 P&P 30p

SPECIAL BARGAIN!!
PHONIC 10 Two Way Speakers



Matched pair of compact book-shelf speakers of unique design. Incorporating a 2" high frequency unit & 6" woofer. 8 ohms impedence. Size: 348 x 228 x 110mm.

OUR PRICE £8.85 Pair P&P 50p

AUDIOTRONIC LOW NOISE CASSETTES

Top Hi-Fi quality in library cases

TYPE	5	10	25
C60	£1.37	£2.61	£6.16
C90	£1.95	£3.70	£8.71
C120	£2.38	£4.50	£10.65

Postage and Packing 15p

RECORD DECKS P&P 50p

BSR McDONALD	
C114 Mini	£3.95
C129 Mono	£5.50
C137	£7.00
510/TPD1	£12.55
610	£10.55
610/TPD1	£13.90
710	£21.15
810	£26.30
MP60	£8.25
MP60/ADC K8	£10.90
MP60/TPD1	£13.20
HT70	£11.60
HT70/ADC K7E	£14.25
HT70/TPD1	£16.55
CONNOISSEUR	
BD1 Kit	£10.20
BD1 Chassis	£12.50
BD2/SAU2/Chassis	£25.50
BD2/SAU2/Plinth/Cover	£32.25
GARRARD	
1025T Stereo	£4.95
2025TC Less Cartridge	£6.35
2025TC/KS40A	£6.95
SP25 Mk3	£9.25
SP25 Mk3/G800	£10.95
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CONSERVATION

SUDDENLY, we are all conservationists. Not by any means as voluntary converts, but rather because we are victims of our own materialistic expansion. Circumstances now force us all to look twice at any proposed expenditure: the cost factor, if not an actual shortage of particular commodities, being a very effective brake to indiscriminate spending.

The old question, how to escape from the rat race must be in many minds. Complete self-sufficiency is an idle dream for members of modern industrialised and over-organised societies. But the man who is capable of applying his own skills to satisfy part—even a minor part—of his needs is obviously at an advantage compared with his less endowed fellows. Make-do-and-mend is a good, sensible philosophy, and never was more pertinent than at this present time of economic crisis.

The individual craftsman—in all senses of the word—is a true asset to the community. Most of us will have had cause at one time or another to regret the demise of certain professional craftsmen—in various trades—when we have required some special service to be performed. In place of that vanishing breed, the amateur "do-it-yourselfer" looks like becoming the torch bearer for traditional craftsmanship.

Social and cultural considerations apart, there is now a greater economic incentive for private individuals to acquire new skills, or to re-exercise dormant skills, through practical activities in their spare time. Those who have adopted electronics as a hobby are particularly fortunate, in that electronic circuits can be applied to help overcome many of the problems associated with fuel and power shortages.

Unlike many other industries, electronics cannot be accused of squandering vast amounts of raw materials. Yet it would be true and honest to admit that this rapidly expanding technology has been rapacious in its consumption of ideas and especially of circuit devices. Too often an interesting device has hardly seen the light of day before being made obsolescent by a "new generation". Progress is fine, but perhaps quite a lot has been lost on the way.

Shortages in certain types of resistors, capacitors and solid state devices have already been experienced throughout the industry. This reflects the continuing healthy expansion of electronics, and is not primarily attributable to shortages in raw materials. If shortages in certain components do become really acute—and this is a possibility that must always be kept in mind—some of these neglected "obsolete" devices may be given proper attention and a new lease of life.

So as good conservationists we should on occasion take a look inside the Junk Box; check up on alternatives and substitutes, and if necessary devise modified circuits to permit the resuscitation of these victims of rapid technological advancement.

F.E.B.

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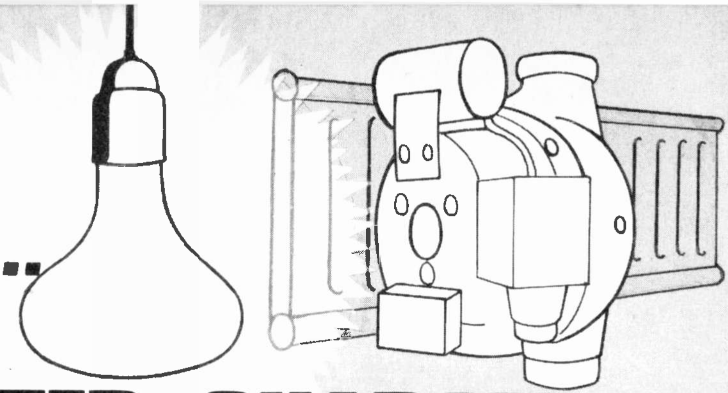
MAINTAIN THE ESSENTIALS... WITH THIS 100W INVERTER-CHARGER



By R.VERRILL B.Sc.

THE present unit was developed by the author during the coal miners' strike of 1971. A home-made car battery charger was modified to work in reverse thus producing a 240V 50Hz supply.

During the four-hour power cuts the mains supply to the house was isolated at the main switch and the output of the inverter was plugged into a wall socket. It was then possible to operate such combinations as a 100W lamp, two 40W lamps and the stereo hi-fi system, or one 40W lamp and the central heating pump and solenoid valves of the gas-fired central heating system.

A 50 ampere-hour battery supplied adequate power for the duration of the four-hour cuts and a switch on the unit converted it back to the battery charger function, where up to about 10A could be obtained. This was sufficient to recharge the battery between cuts.

Such a unit can of course be used anywhere where a small portable supply is required for normally mains operated equipment.

CIRCUIT DESCRIPTION

The basic circuit diagram of the inverter/charger is shown in Fig. 2. The two-pole switch S1 is shown in the inverter position.

The output of a 100Hz multivibrator TR1, TR2 is fed to a flip-flop TR3, TR4 where the frequency is divided by two. The output from transistors TR3 and TR4 are two 50Hz square waves in antiphase with exactly one-to-one mark space ratio, although the multivibrator mark space ratio may differ widely from one to one as only one of its two timed periods is adjusted to obtain the required frequency.

The TR3/TR4 outputs are fed to power transistors TR5 and TR8 via drivers TR6 and TR7, so that a square wave of current flows alternately through the two halves of the transformer winding.

TUNED CIRCUIT

The capacitor C7 forms a tuned circuit with the transformer secondary inductance. C7 is selected to tune to 50Hz. The circuit is efficient since the transistors TR5 and TR8 operate in the saturated mode, i.e. only their low saturation voltage appears

COMPONENTS . . .

Resistors

R1	10k Ω	R10	10k Ω
R2	150k Ω	R11	220 Ω
R3	100k Ω	R12	560 Ω
R4	10k Ω	R13	47k Ω
R5	100k Ω	R14	100k Ω
R6	47k Ω	R15	10 Ω 7W wirewound
R7	220 Ω	R16	150 Ω
R8	560 Ω	R17	10 Ω 7W wirewound
R9	10k Ω	R18	150 Ω

All 5% tolerance, ¼W except where noted
NOTE: R15 and R17 should be mounted ⅜in from board.

Capacitors

C1 0·05μF
C2 0·05μF
C3 250μF 16V
C4 0·01μF
C5 0·01μF
C6 1μF 45V RMS (63V d.c.)
C7 Select in test. Must be capable of withstanding mains a.c. conditions. 2 μF, 600 V.W. available from Home Radio.

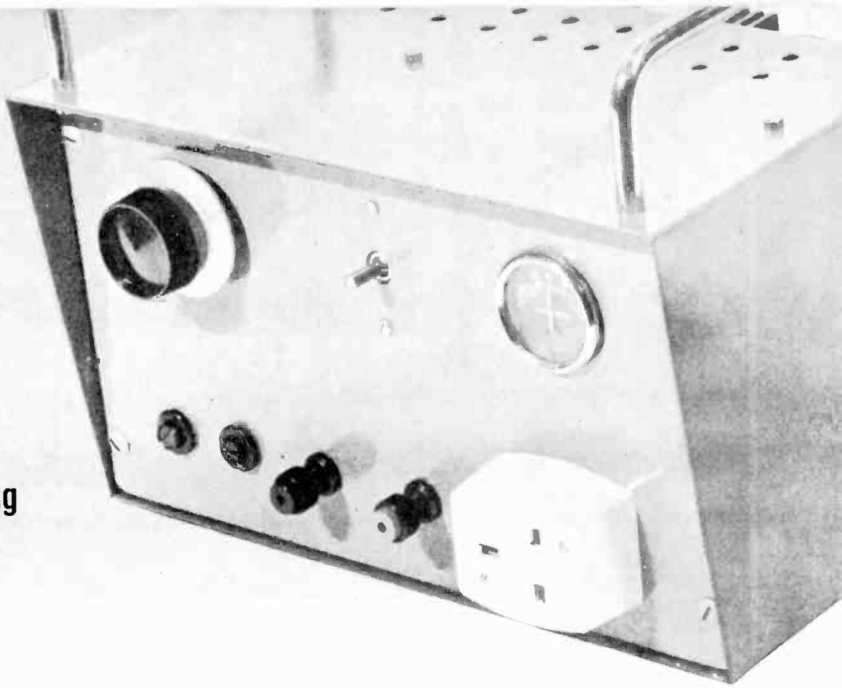
Potentiometers

VR1 100k Ω ¼W preset Plessey MPD
VR2 3 Ω 10A Rheostat.

Transistors

TR1 to TR4	ZTX502 or BC212 (4 off) (see text)
TR5	2N3055
TR6 and TR7	BFS59 (2 off) or BFS60 or 61 (see text)
TR8	2N3055

- Capable of providing 80 to 100W output
- Battery charger up to 10A 12V d.c.
- Drive your central heating pump/solenoids
- Run 80W of filament lighting

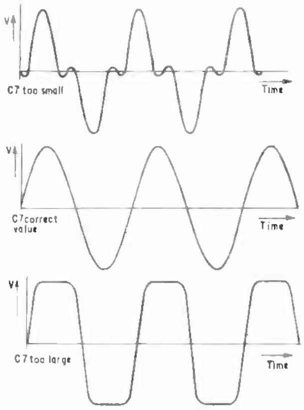


Diodes
D1 to D4 IN914 or IN4148 or ZS120, etc. (4 off)
D5 to D8 50V 5A silicon rectifier (4 off) or one potted 10A bridge rectifier Bi-Pak, AEI, Motorola, etc.

Miscellaneous
Switch S1 Double pole change-over toggle switch with at least one pole rated for 10A d.c.
Transformer T1 Primary, 240V 50Hz
Secondary 12-0-12V, 10A*
Inductor L1 8mH 10A*
Fuses FS1 10A
FS2 1A
Glass fibre printed circuit board or Veroboard
Tagstrip for mounting capacitors C6 and C78.
Suitable chassis, terminals for battery, battery terminal clips, mains lead, centre zero 10A meter

* A variety of suitable transformers are available from several sources. The first prototype used an unidentified item with extra windings added to provide the required voltages. The second utilised a shrouded Douglas MT 89 EC. PCB, LI, TI—Veritronics, 23 Roper Close, Rugby.
The inductor L1 is available from Zeta Windings, 26 All Saints Road, London, W.11, as No. 1028 at £5·20 incl. VAT to callers and £6·30 including P. & P. and VAT.

Fig. 1. Inverter output voltage waveforms showing the effect of tuning the transformer T1 by adjusting C7



between collector and emitter during the time the transistor is conducting.

The waveforms shown in Fig. 1 should help to clarify the above description.

An earlier version of the unit which did not include the inductor L1 and the capacitor C7 gave a square wave output. This circuit was rejected however because it proved unable to power the writer's central heating pump or electric clocks which just made a rather disturbing rattling noise, nor a 40W fluorescent tube which caused the inverter to fail altogether. When the circuit was modified by including L1 to give a sine wave output these devices all operated although the sine wave shape showed some distortion at full output.

The capacitor C6 was included to suppress high voltage spikes which occurred at the collectors of TR5 and TR8 just after switching off and before the current was established in the other transistor. The effect was probably due to transformer leakage inductance limiting the rate of rise and fall of current in the two halves of the winding. The value of C6 is not critical; about 1μF was found to be sufficient to reduce the amplitude well below the breakdown voltage of the transistors used.

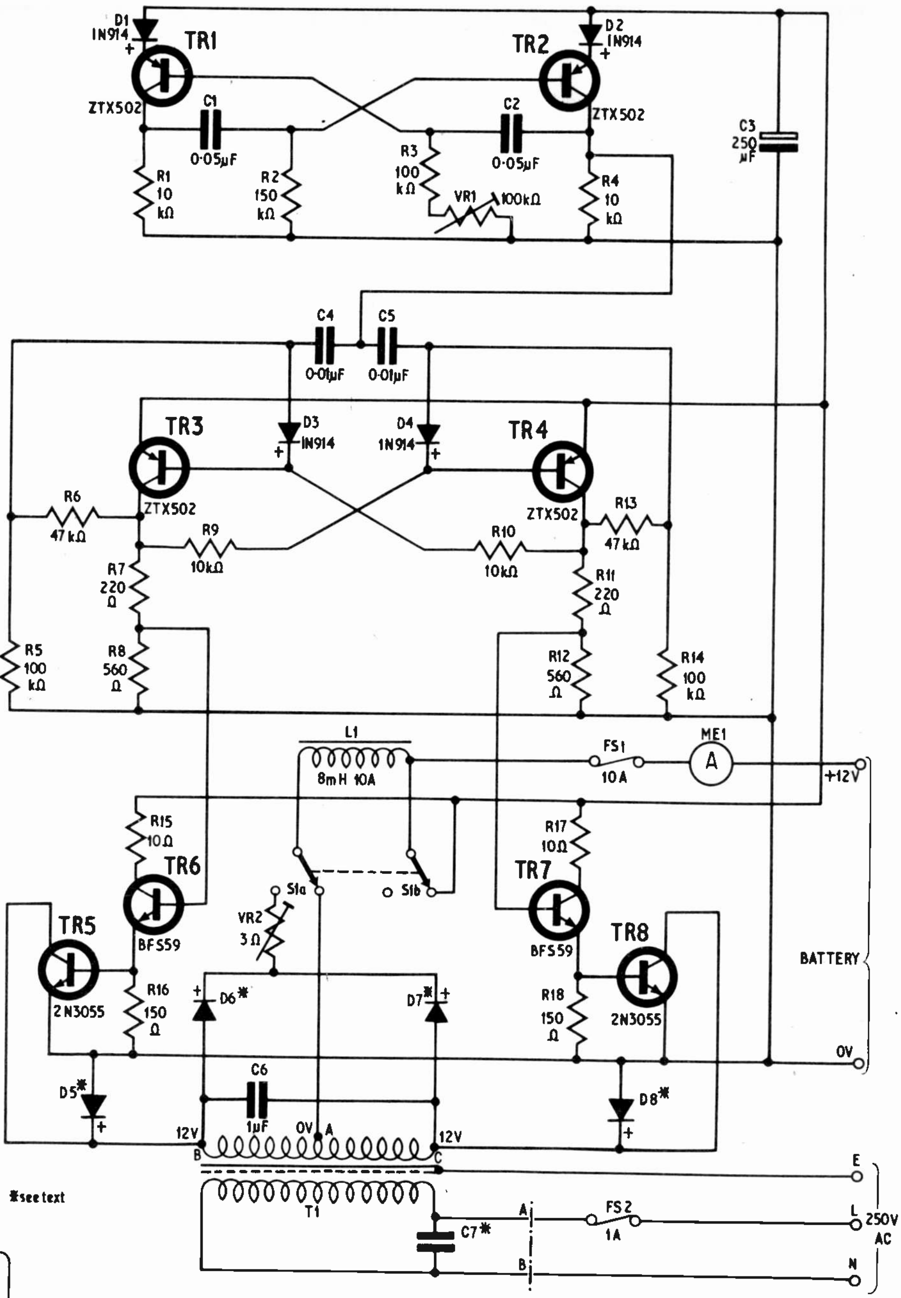
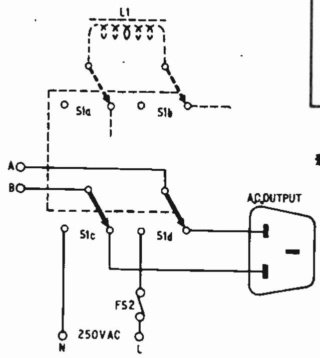


Fig. 2. General circuit diagram of the inverter. Note the modification (below) to S1 allowing switching of both battery and a.c. circuits. This alternative obviates the danger of mixing mains and inverted output voltages but requires a 4-pole 10A centre-off switch or two strapped 2-pole switches



FREQUENCY CONTROL

The multivibrator frequency is determined by two separately timed periods during which TR1 is on while TR2 is off, or TR2 is on and TR1 is off. During the time transistor TR1 is off its base is held positive by the capacitor C2. This capacitor is being discharged via the resistors R3 and VR1. When the voltage on the base of TR1 has fallen sufficiently to make it conduct, its collector voltage starts to rise. Because an instantaneous voltage charge cannot occur across a capacitor the voltage on the base of TR2 must also rise. TR2 starts to turn off and its collector voltage falls.

The current in R5 which was flowing through TR2 now flows through C2 from the base of TR1, charging C3 and turning TR1 harder on. Regeneration occurs finishing with TR1 fully on and TR2 fully off with its base held positive. This cycle is repeated with the two transistors changing roles. The diodes D1 and D2 are included to prevent the base emitter junctions of transistors TR1, TR2 from breaking down when the other transistor turns on.

STEERING CIRCUIT

The flip-flop has two stable states in which either TR3 is on and TR4 is off, or TR4 is on and TR3 is off. If TR3 is off current will flow from the base of TR4, through resistors R7, R8 and R9 holding TR4 on. Since TR4 is on, no base current can flow in TR3 through resistor R10. Without any input from the multivibrator, the flip-flop would remain in this condition indefinitely.

The components C4, R6, R5, and D3 and components C5, R14, R13 and D4 form two halves of what is known as a steering circuit. The function of this circuit is to direct the positive-going edges of the multivibrator waveform at TR2 to the base of either TR3 or TR4 depending on which of these two transistors is conducting.

The circuit is best understood if resistors R5 and R14 are assumed to be removed. If TR3 is on, the anode of D3 will be at a voltage close to the 12V power rail since R6 will have charged C4 up to the same voltage as the collector of TR3. The voltage across D3 will be very nearly equal to the base-emitter voltage of TR3 so D3 will be on the point of conducting. The voltage on the anode of D4, however, will be nearly zero because TR4 is off. Thus D4 will have a reverse voltage nearly equal to the supply. If a positive-going pulse now occurs at the junction of C4 and C5, D3 will conduct immediately causing TR3 to turn off and driving the flip-flop into its other state.

Since D4 had a large reverse voltage before the pulse occurred this reverse voltage will only be reduced towards zero so that TR4 is free to turn on as soon as TR3 goes off. The resistors R5 and R14 merely give the circuit some noise immunity by giving a small reverse bias across the two diodes so that an input pulse of finite magnitude is required to trigger the change of state. Without this the circuit would be likely to switch erratically due to any small amount of noise fed back from the power output stage.

DESIGN CALCULATIONS

The two timed periods of the multivibrator are approximately

$t_1 = 0{\cdot}7\ C1.R2$ and
$t_2 = 0{\cdot}7\ C2(R3 + VR1)$

Where time is measured in seconds, capacitance in farads, and resistance in ohms. The frequency required is 100Hz, so $t_1 + t_2 = 10$ms and we can make $t_1 = t_2 = 5$mS.

R2 is chosen as 150kΩ since this will ensure adequate current to saturate TR2. R1 and R4 are chosen as 10kΩ. Adjustment of VR1 will vary t_2 by ±33 per cent giving a variation of about ± 13 per cent in the multivibrator frequency. This should be sufficient to obtain exactly 100Hz if 10 per cent tolerance capacitors and 5 per cent tolerance resistors are used.

The required values for C1 and C2 are:—

$$C = \frac{t}{0{\cdot}7R} = \frac{5\times10^{-3}}{0{\cdot}7\times1{\cdot}5\times10^{5}} = 4{\cdot}76\times10^{-8}$$

The nearest available values are 0·047μF or 0·5μF.

The resistors R1 and R4 are chosen as 10kΩ which is sufficiently low to allow C1 and C2 to be completely recharged between half cycles.

The value of C4 and C5 is not critical except that they must be small enough to be recharged in the 5ms half cycle of the multivibrator. This will be achieved if the time constant C4 (R6/R5) is less than 1ms. This time constant must also be longer than the rise time of the multivibrator. With R5 and R6 equal to 100kΩ and 47kΩ respectively and C4 at 0·01μF this time constant is about 30μs. The rise time of the multivibrator is less than 1μs, so both conditions are satisfied.

The flip-flop has a low output impedance so that adequate power is delivered to the output stage. R15 and R17 are 10Ω resistors giving approximately 1A of base drive to the output transistors which are required to switch approximately 10A into the transformer for full load.

TRANSFORMER CALCULATIONS

The waveform at the centre tap of the 12-0-12V winding is 12V because of the equal number of the d.c. voltage dropped across L1 is small, the average d.c. level at this point is approximately equal to the 12V power supply. The average d.c. level of a rectified sine wave of peak value Vm is:

$$\frac{Vm}{\pi}\int_0^{\pi} \sin \omega t \; d(\omega t) = \frac{2Vm}{\pi}$$

$$\therefore Vm = \frac{\pi}{2}\cdot \text{V supply}$$

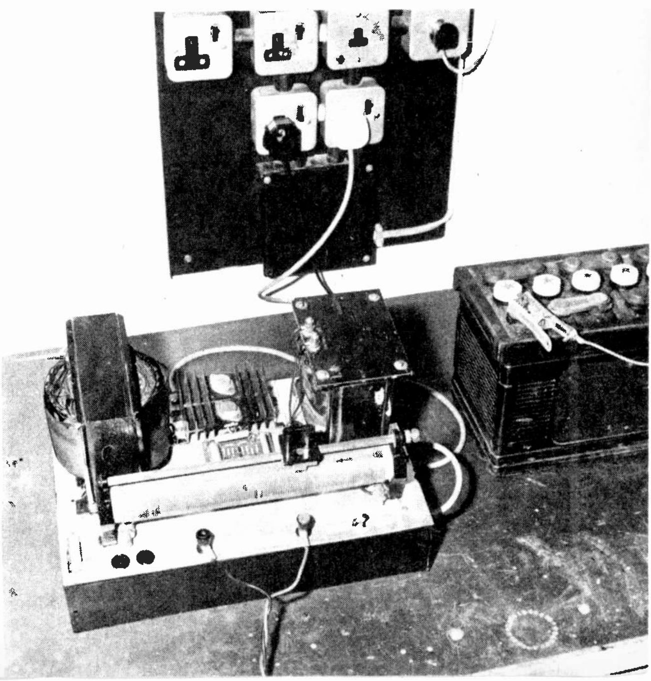
The maximum voltage at the ends of the tapped winding is 12V because of the equal number of turns on the two halves of the winding. The maximum collector voltage of TR5 and TR8 is therefore $12\pi \simeq 37{\cdot}7$V.

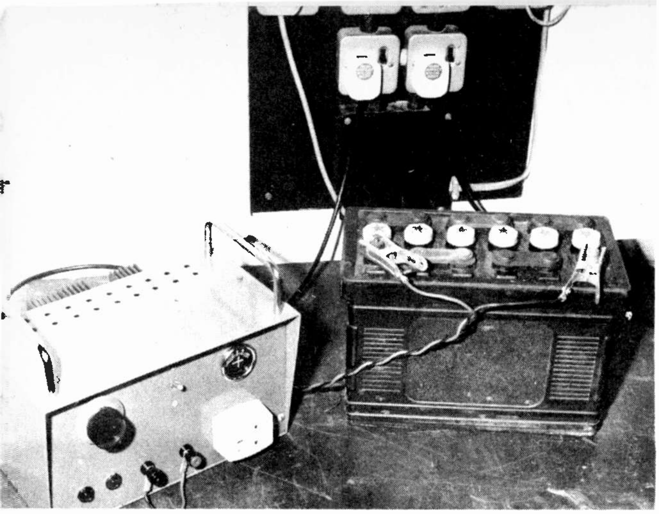
So transistors capable of withstanding at least this voltage must be used here. The total voltage swing across the primary of the transformer is 37·7V peak-to-peak assuming negligible resistance in L1 and negligible saturation voltage for the power transistors. The r.m.s. value is

$$\frac{37{\cdot}7}{\sqrt{2}} = 26{\cdot}6\text{V}$$

Thus if a mains transformer with a 12V-0-12V winding is used this will give some allowance for voltage drop in L1 and the power transistors.

Prototype of the inverter/charger acting as a charger





The second prototype equipment boxed in a case and using a circular potentiometer and centre-off control switch

To give a reasonably constant excitation current at full load the inductor L1 should have an impedance of about four or more times the load impedance reflected back to the transformer primary. Since this current is effectively fed into a 12V winding on a 240V output transformer the turns ratio is 20:1. If the load is 100W at 240V, then the load resistance is

$$\frac{240^2}{100} = 576 \text{ ohms}$$

This appears on the 12V primary as a resistance of

$$\frac{576}{20^2} = 1{\cdot}44 \text{ ohms}$$

Thus the required impedance of the inductor L1 is $4 \times 1{\cdot}44 = 5{\cdot}76$ ohms.

Since the voltage waveform which appears across L1 is a full wave rectified sine wave, its fundamental frequency is twice the output frequency, i.e. 100Hz and thus the value of reactance is given by

$$X_L = L \times 2\pi \times 100 = 5{\cdot}76\Omega$$

$$\therefore L = \frac{5{\cdot}76}{100 \times 2\pi} = 9{\cdot}2\text{mH}$$

The value of L1 used in the prototype was 8mH. With this condition satisfied the excitation current will be a good square wave and will contain the maximum possible content of the 50Hz fundamental.

In order to get a reasonable sine wave at the transformer output it is also necessary to have reasonable value of Q for the tuned circuit. If this is not so no amount of increase in the inductance L1 will give any improvement. However, experience has shown that for most applications it is sufficient if the corners of a square wave are merely rounded off but, if necessary, extra inductance and capacitance can be added in parallel with the transformer output in order to give a higher Q and hence a better sine wave.

The value of the capacitor C7 required in the prototype to tune the transformer inductance to 50Hz was 2μF. The impedance of a 2μF capacitor at 50Hz is:

$$\frac{1}{2\pi \times 50 \times 2 \times 10^{-6}} = 1{,}600 \text{ ohms}$$

With a load reistance of 576 ohms this gives a Q of only:

$$\frac{576}{1600} = 0{\cdot}36$$

This was found to be quite adequate to drive the equipment mentioned at the beginning of this article. As an experiment an extra 4μF capacitor was added to C7 and sufficient inductance in parallel to retune to 50Hz. This made a marked improvement to the output sine wave at full load.

TRANSISTORS USED

The transistors used for the two low power stages were Ferranti ZTX502. The requirements are a V_{ce} rating of greater than 24V and an h_{fe} gain of greater than 50 over a range of collector currents from 1mA to 60mA. Another cheap alternative is the BC212 series of transistors.

Driver transistors TR6 and TR7 must be capable of switching 1A and the current is limited to this value by the 10 ohm collector resistors R15 and R17. The type used in the prototype was the Ferranti BFS61 but either the BFS59 or BFS60 would be equally suitable or equivalents such as BFY50, BFY51, BFX84 or BFX85.

The two resistors R15 and R17 dissipate a total of about 12W. This limitation to the efficiency of the inverter could be reduced if these resistors were omitted and the collectors of TR6 and TR7 taken to the collectors of TR5 and TR8 respectively.

It would then also be necessary to use larger transistors for the drivers TR6 and TR7 because under excess load conditions TR5 and TR8 would not bottom properly thus increasing the dissipation in all four transistors. Even under normal operating conditions the improvement to efficiency would be only marginal since TR5 and TR8 would never be able to saturate below their base emitter voltage of 0·7V plus the saturation voltage of TR6 and TR7.

The 2N3055 transistors used for TR5 and TR8 may be chassis mounted using TO3 mica washer insulators. These transistors will only dissipate a few watts if the circuit is operating correctly since they operate in the saturated switching mode.

THE BATTERY CHARGER

In order to obtain a good charging characteristic a voltage well in excess of the 12V battery voltage is needed so the full 24V winding is used to drive a bridge rectifier. This winding now becomes the secondary of the transformer with the 240V primary connected across the normal mains supply. It is essential to use a full wave rectifier if currents approaching the full rating of the transformer are required.

This is because a half-wave rectifier causes a net d.c. current to flow thus magnetising the core into saturation and causing a larger a.c. magnetising current to maintain the required rate of change of magnetic flux, with consequent overheating of the transformer.

The diodes D5, D6, D7 and D8 form the bridge rectifier. If separate rectifiers are used these should be rated for at least 50V 5A or half the required charging current and they should be mounted on separately insulated heat sinks of approximately 2in square 16 s.w.g. aluminium.

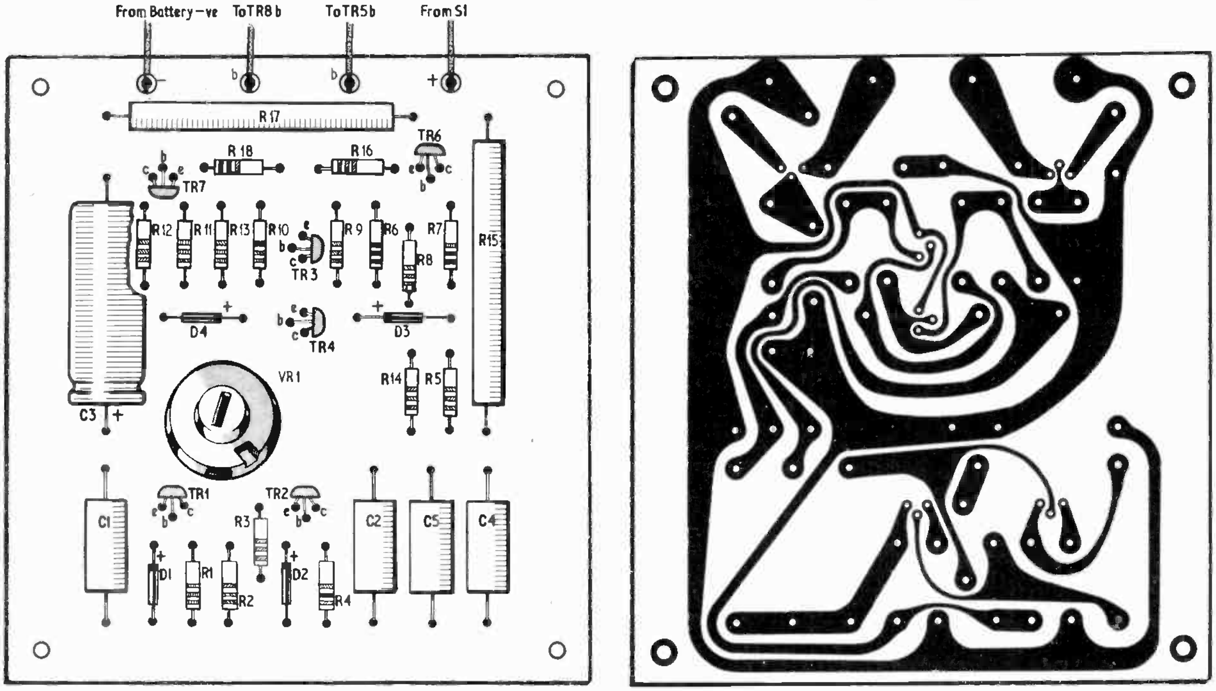


Fig. 3. Component layout and printed circuit master (full size) for the inverter

VARIABLE RESISTORS

The 3 ohm 10A variable resistor VR2 used in the prototype was of the heavy duty sliding type of rheostat. Rotary types suitable for panel mounting are also available but if desired a fixed resistor of from 1 to 3 ohms rated at 100W may be used, preferably with tapping band so that the required current can be preset.

When operating as a battery charger the inductor L1 is left in circuit. This has the advantage that a nearly constant current is obtained with very little ripple instead of the high peaks of current which are obtained with most conventional battery chargers.

AMMETER

The ammeter used in the first prototype was an edgewise 1mA meter which was adjusted and re-scaled to produce a centre reading 500μA-0-500μA. A 10A shunt was made from a few inches of 16 s.w.g. tinned copper wire. If this method is used it is important to make up a four terminal shunt by tapping two points along the wire to give the leads to the meter. In this way any danger of overloading the meter due to contact resistance is avoided. Alternatively, a conventional car dashboard type of centre reading ammeter can be used as in the second model.

PRINTED CIRCUIT

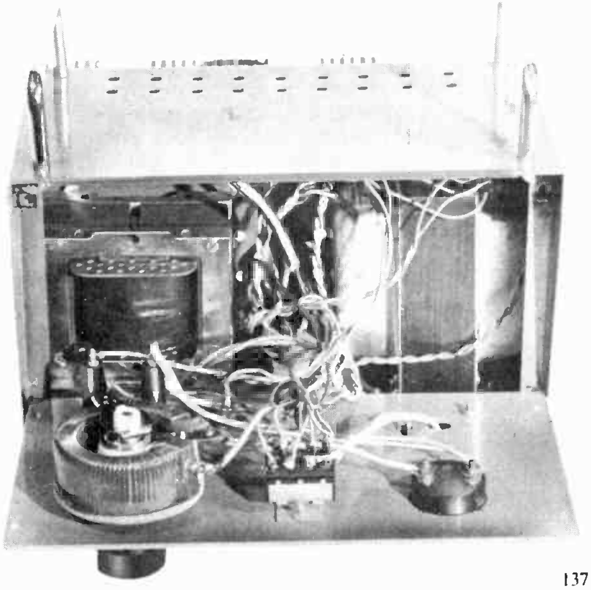
All the smaller components are mounted on a printed circuit board, see Fig. 3. The terminals marked "b" should be wired to the bases of the power transistors + to S1b and − to the battery negative (Fig. 2).

OPERATION AND SETTING UP

It is important when operating the device as a charger to ensure that the switch S1 is in the charge position before plugging into the mains, as otherwise the fuses will blow and there will be danger of damage to the output transistors. When operating as an inverter it is important to ensure that the normal mains supply has been isolated and that not more than 100W of load is connected.

The only setting up requirements are the adjustment of the frequency to 50Hz and the selection of the capacitor C7. If an oscilloscope is available the procedure is simplified though this is not essential.

The second equipment opened to show the somewhat cramped interior arrangement which requires careful ventilating



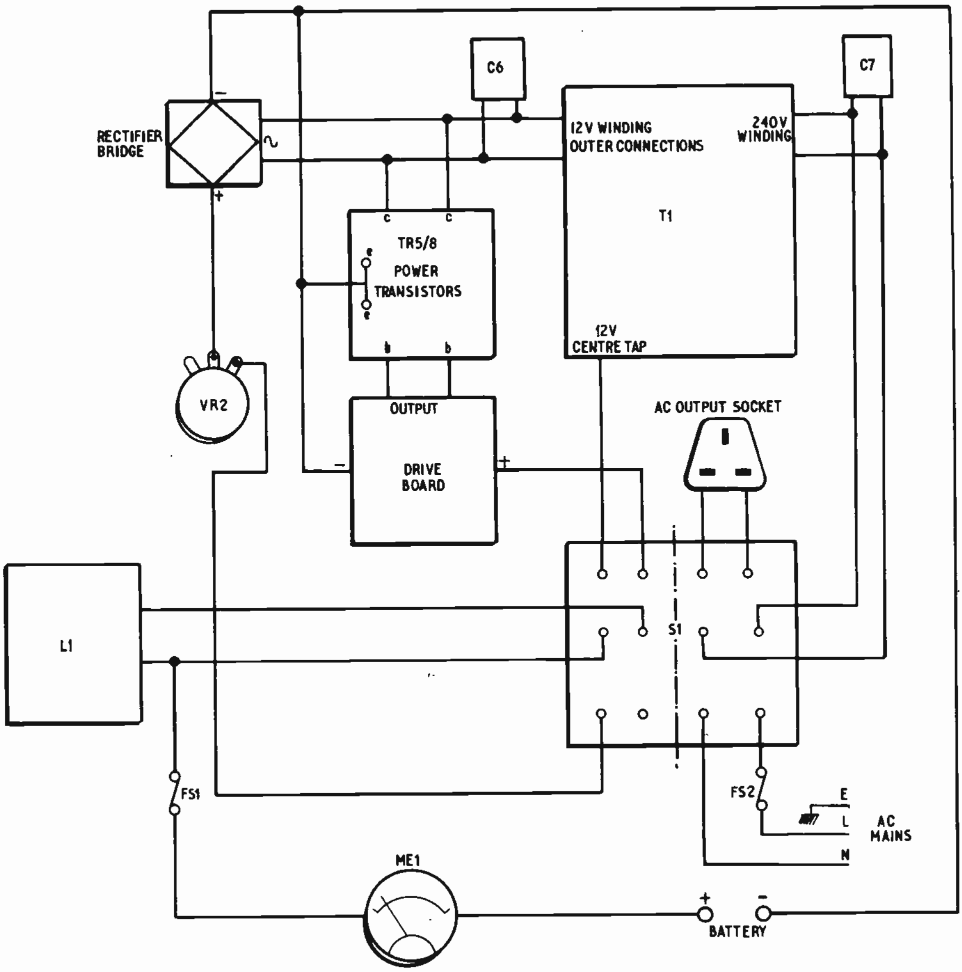


Fig. 4. Block wiring diagram of the inverter with a 4-pole changeover switch as in the second prototype

TUNING PROCEDURE

First switch S1 to 'Invert'. Connect up the 12V car battery taking care of polarity. Do not connect an output load yet. Monitor the waveform at the collector of TR4. This will be a square wave of 12V amplitude. Adjust the frequency by means of VR1 to obtain 50Hz, i.e. square pulses of 10mS width and total period 20mS. If this frequency is required *accurately* so that clocks will keep time, this is best done by triggering the oscilloscope with 50Hz mains and adjusting VR1 for minimum horizontal drift of the trace.

Obtain several capacitors in the range of 0·5μF to about 4μF rated at 240V r.m.s. If the values 0·5, 1, 2 and 4μF are obtained it will be possible to obtain by parallel combination any value between 0·5 and 7·5μF.

Monitor the 240V output waveform on an oscilloscope with no load connected and select the value of capacitance which gives the best sine wave.

A 100W lamp may now be connected as a load. The waveform will probably now show some distortion towards a square wave shape. If desired extra capacitance and inductance may be added as already described and the system retuned with the load disconnected. Do *not* attempt circuit alterations with the unit switched on.

WITHOUT OSCILLOSCOPE

If no oscilloscope is available the following procedure should be carried out. Set VR1 approximately to the mid point. Switch S1 to 'Invert' and connect up the 12V car battery. With no load connected listen to the transformer hum. Connect values of capacitance to the transformer output as above and adjust VR1.

If reducing VR1 causes the hum level to diminish, this indicates that more capacitance should be added. When a value of capacitance is obtained such that the hum disappears with VR1 in its central position, the frequency can be finally adjusted, using VR1, such that an electric clock driven by the invertor keeps accurate time.

CAUTION

The same precaution as with any live equipment must be taken with this device as the output of the inverter is just as lethal as the 240V mains supply.

Do not attempt any circuit adjustment, other than the trimming of VR1 with an insulated screwdriver, while the battery is connected.

IMPORTANT APPLICATION NOTES

As will be seen from the parts list, both the transformer and the choke are fairly heavy in terms of current and in fact it is possible to use a somewhat lower capacity transformer than 10 amp if it is to be used only as an inverter since each half winding carries current alternately. However, as the reduction is only marginal, say, a couple of amps drop in rating, it hardly seems worth while in the face of the availability of the full rating item.

As to the choke, there are in fact many applications where both this and C7 are just not needed. For example, if it is only required to drive incandescent lamps or some forms of induction motor then this can usually be achieved without the choke and C7 and thus with quite a saving in component costs.

It should be remembered that some synchronous motors just will not work on a square wave and thus care should be taken in deciding on the presence or absence of the choke. For example, the normal electric clock only buzzes and jerks when a square wave is applied. In addition, some central heating systems use an electric clock mechanism to effect switching control and it is possible that not only will these not work with a square wave but they might also be damaged by continued application.

If the unit is to be used to drive an audio system including a deck then sine wave operation is a must for the deck motor. In the same area, this equipment is not sufficiently powerful or suitable to drive a T.V. but will probably cope with most radios.

NATURE OF THE LOAD

In fact, the ability of the inverter to cope with various loads depends to a great degree on the nature of the load. A fluorescent fitting containing as it does both a large capacitance and a choke, can prove difficult to handle even with a load as low as 40W. Also, whilst one might wish to drive a motor which has a running rating of say 60W, the starting current demanded might well be considerably above this figure and could prove to be too much for the unit.

In this latter application there is risk of damage to both motor and inverter if such a load is simply left on since it could draw starting current with the result that it burns out and damages the inverter in the process.

Finally, it must always be remembered that whilst in fact the initial rating of the equipment is 120VA (12V at 10A), losses in the system, the individual characteristics of each inductor and the state of both load and, most important, the battery, all contribute to give a greater or lesser output. In any event, overall efficiency will not normally be greater than about 80 per cent.

The original prototype has been used to drive a variety of loads including those mentioned at the beginning of this article.

It has also proved possible to drive such items as a Cadet "S" Circulator central heating pump, a synchronous motor fan and a wide variety of filament bulb loads. ★

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.

TOUCH VOLUME CONTROL

I HAVE recently been experimenting with a circuit which may be of interest to other readers. It is a touch volume control, a solid state substitute for the common-or-garden type potentiometer volume control.

The circuit diagram is shown in Fig. 1. The channel of a field effect transistor TR2 may be regarded as a pure resistance, provided that the drain-source voltage is fairly low (less than 3V). The value of this resistance is controlled by the gate-source voltage, and hence by the charge on C3, see Fig. 1.

Capacitor C2 and the resistance of the f.e.t. decouple the resistance in the emitter line of TR1. Thus, the gain of the stage is varied by the charge on C3. The stage gain can be increased by touching plates B and C, or decreased by touching plates A and B simultaneously.

The volume can be varied over a fairly wide range and little drift of volume was experienced. Capacitor C3 should be a polycarbonate or a tantalum type, for low leakage. Almost any *n*-channel f.e.t. will do for TR2.

If it is desired to use a positive supply line, the polarities of the transistors and the electrolytic capacitors should be reversed.

Provided that the input signal level is kept within reasonable limits, harmonic distortion should be low enough for most applications.

C. Budd,
Petersfield,
Hants.

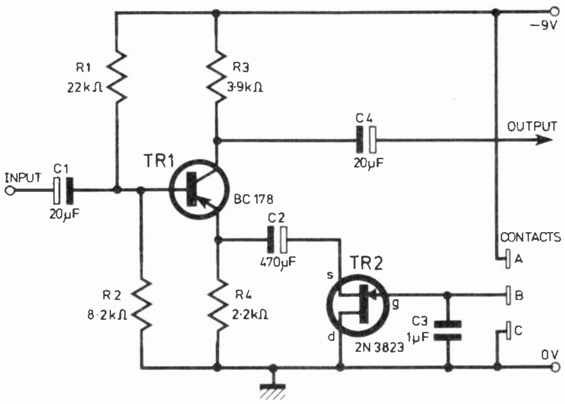


Fig. 1. Touch volume control circuit diagram

STAGE LIGHTING DIMMER

Our author R. Liffen replies to some of the points raised from the article published in our November 1973 issue

TRIAC RATING

Many readers have expressed concern that the surge current through incandescent lamps is greater than the surge current rating of the SC50D.

The peak surge current of the SC50D is 100 amp and the dimmers have been functioning for three years with no triac failures. In any case, the normal mode of operation is to fade the lamps to full brightness and not to simply switch them on with the fader up.

NEON MIMIC LAMPS

The use of mimic lamps with filament lamps and voltage dropper resistors consumes a great deal of power. Cannot neon lamps be used?

Neon tubes were rejected as mimics because they are not analogue devices at low voltage levels.

SUPPRESSION

It is normal to include inductive electromagnetic or radio frequency interference suppression as high power dimmers tend to produce enough interference to affect other people's equipment. Why was this omitted?

I would have preferred to include inductive as well as capacitive interference suppression. My enquiries indicated, however, that 13A chokes of suitable inductance were unobtainable "off the shelf" and would cost £10 to £15 each if specially made. This would have doubled or even trebled the cost of the unit. The capacitive suppression has proved adequate during tests, one of these being the effect (nil) on a nearby digital computer.

WIRING

Is there not a danger that if the electronics are wired using a wire size of, say, 14/0076 that this wire will "blow" before the supply fuse?

Certainly there would be an element of danger if an inexperienced constructor used 1A cable throughout, but he would then have ignored the last sentence of the explanation attached to Fig. 4 in the article.

For the sake of completeness may I suggest the following cables be used? (Modern metric standard)
Cables carrying lighting load to be 50/0·25mm T.C.W. Nominal C.S.A. 2·5sq mm 15A/Triac gate control electronics 16/0·2mm T.C.W. Nominal C.S.A. 0·50sq mm 3A.

SAFETY

In order to connect to an existing supply should not a connection box be used, for instance a GEC Henley 43802, and, since a connection has to be made into a live cable, assistance from the electricity board be sought?

If adaptors are used then more than one 13A fuse would be connected to the output exceeding the rating of the triacs and decreasing the safety factor. Would it not be better to put a 15A fuse inside the unit, thus allowing adaptors to be used whilst maintaining safety?

Should not the equipment be tested before being put into service, not only for insulation, etc. but for earth loop impedance as well. Since this requires equipment not normally used by the amateur would it not be wise for the assistance of a competent electrical engineer to be sought?

Is the heat sink of sufficient size to dissipate the heat generated by the triacs?

The unit was originally fitted with a Henley connector but this was removed by an electrical supervisor from the Department of the Environment and the input cables were plumbed straight into the MEM switched fuse.

"No adaptors" is, of course, the rule. It is assumed that in the case of multiple lamps (e.g. footlights) that the lighting electrician will calculate the loading for each dimmer and keep it within the safety limit.

The Stage Lighting Dimmer was designed to be used with existing lamp installations which should have been fully electrically checked. If a brand new hall or theatre is being built then the local bylaws and electricity supply regulations will normally ensure the full electrical safety of the installation.

To answer the point about the heatsink: no triac failure has occurred from surge currents or overheating. It would do no harm, however, if constructors chose to limit the current capacity of their own dimmer units to, say, 10A per channel. They should then only use lamps up to a value of 2½kW. Alternatively there is now available an even larger triac, the SC60D, which has a steady current rating of 25A and will stand peak surge currents of 250A.

The unit was checked after installation by an electrical supervisor from the Department of the Environment.

FUSING

As short circuits are quite common in stage lighting work, should not a fuse be connected in series with each lamp circuit?

Some readers seem to have overlooked the fact that since 13A sockets are fitted to each dimmer channel, then the corresponding plug will have a 13A fuse fitted and this will protect against lamp failure.

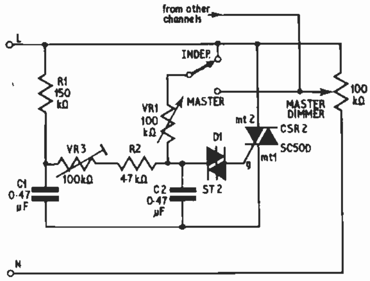


Fig. 1. A modification to the master dimmer control.

MODIFICATIONS

It is a pity that Mr Liffen has adopted the American system of master dimming rather than the British, which is superior.

The American system works as follows. Suppose that Lamp 1 is at 100 per cent brilliance, lamp 2 is at 50 per cent and lamp 3 is at 30 per cent. As the master dimmer is brought from 100 per cent down to zero, the relative brilliances of the lamps vary enormously.

With the master at 100 per cent, the relative intensities are 100 : 50 : 30, with the master at 50, the relative intensities have changed to 50 : 0 : 0. This completely upsets the balance.

Fortunately, a simple modification to Mr Liffen's design will convert the circuit to the British method. The correct balance is maintained for all master dimmer settings. The circuit to achieve this is shown in Fig. 1. Notice that only one (single-gang) master control is needed.

A. J. Fisher,
Hereford.

The master control circuit suggested by Mr Fisher may perhaps give a better balance between lamps at intermediate master fader settings, but the presence of a 100k Ω fader directly across the mains with no fuse protection seems dangerous.

RECORD PLAYBACK HEADS (TRUVOX)

Individual prices of these are:
2 track record playback heads **50p** each.
4 track record playback heads **72p** each.
Erase heads are also available separately—2 track **33p**—4 track **55p**.
MV metal mounting shields **39p** each.
2 track heads already fixed on heavy mounting plate with shield **£1·22**.

DRILL CONTROLLER

NEW 1KW MODEL

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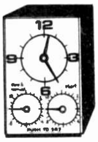

TIME SWITCH

Smith's mains driven clock with 15 amp switch, also notes showing how you can wake up with music playing, kettle boiling or come home to a warm house, warn off burglars, keep pets warm, halve your heating bills, etc. **£1·95.**

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KIT No. 4. Permeability tuner with fast and slow motion drive and LW loading coils, **50p.**

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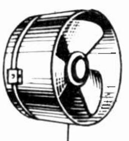
with dashboard control switch—fully extendable to 40in or fully retractable. Suitable for 12V positive or negative earth. Supplied complete when fitting instructions and ready wired dashboard switch. **£6·35** plus 25p post and insurance.

TELESCOPIC AERIAL

for portable, car radio or transmitter. Chrome plated—six sections, extends from 7½ to 47in. Hole in bottom for 6BA screw. **42p.** KNUCKLED MODEL FOR F.M. **55p.**



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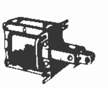
MAINS OPERATED SOLENOIDS



Model 772 — small but powerful 1in pull—approx. size 1½ × 1¼ × 1½in **68p.**
Model 4001/—½in. pull. Size 2¼ × 2 × 1¾in. **83p.**
Model TT1—1½in pull. Size 3 × 2½ × 2in **£1·98**
plus 20p post and insurance.

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Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor condensers and instructions. Real snip at only **£1·10.** Plus 20p postage.

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ULTRA-SONIC REMOTE CONTROLLER

As featured in this issue! Our 1974 catalogue lists hundreds of bargains and probably many of the parts needed for this project. **66p** brings the catalogue and the next 6 monthly supplements.

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Standard size 1¼in wafer—silver-plated 5 amp contact, standard ¼in spindle 2in long—with locking washer and nut.

No. of Poles	2way	3way	4way	5way	6way	8way	9way	10way	12way
1 pole	44p	44p	44p	44p	44p	44p	44p	44p	44p
2 poles	44p	44p	44p	44p	44p	44p	44p	77p	77p
3 poles	44p	44p	44p	44p	77p	77p	77p	£1·04	£1·04
4 poles	44p	44p	44p	77p	77p	77p	77p	£1·32	£1·32
5 poles	44p	44p	77p	77p	£1·04	£1·04	£1·04	£1·60	£1·60
6 poles	44p	77p	77p	77p	£1·04	£1·04	£1·04	£1·87	£1·87
7 poles	77p	77p	77p	£1·04	£1·32	£1·32	£1·32	£2·15	£2·15
8 poles	77p	77p	77p	£1·04	£1·32	£1·32	£1·32	£2·42	£2·42
9 poles	77p	77p	£1·04	£1·04	£1·60	£1·60	£1·60	£2·70	£2·70
10 poles	77p	77p	£1·04	£1·32	£1·60	£1·60	£1·60	£3·00	£3·00
11 poles	77p	£1·04	£1·04	£1·32	£1·87	£1·87	£1·87	£3·25	£3·25
12 poles	77p	£1·04	£1·04	£1·32	£1·87	£1·87	£1·87	£3·52	£3·52

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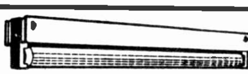

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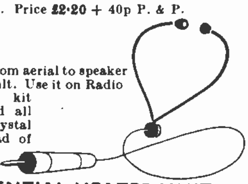

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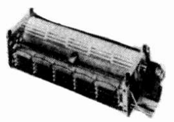

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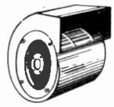

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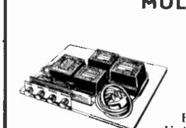

There is no doubt that it is a good system, we believe that for the money it is without comparison. We demonstrate gladly at our Tamworth Road depot. Prices of the individual items for this: – 1 Unilex Amplifier Ref. EP.9000 **£1·60.** 1 Unilex Amplifier Ref. EP.9000 **£1·60.** 1 Unilex Pre-Amp. Ref. EP.9001 **£1·98.** 1 Unilex Power Unit Ref. EP.9002 **£2·53.** 1 Control panel kit with spun aluminium faced knobs **£3·30.** Or the complete outfit—**£11·30** post paid. Pair of 15 ohm speakers made by E.M.I. are also available if required. Price **£3·30** the pair. No extra postage if ordered with the above, otherwise add 25p.

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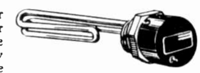

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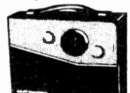

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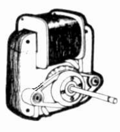

MAINS MOTOR

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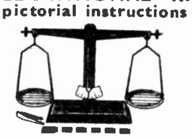

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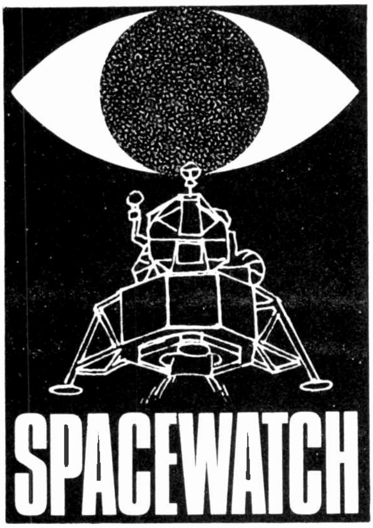


BY FRANK W. HYDE

THE FRENCH APPROACH

Inner space is emphasised as part of the French space programme of research in a number of projects.

The development of using high level balloons tethered and free and what they call space platforms, extends into many scientific fields and offers this rather intermediate technique as a supplement and in some cases an alternative to satellites. Education in emerging countries by using high captive balloons for television distribution is another specific area under intensive study.

All this emerged in a colloquium organised by the AERALL. This stands for Association d'Etude et de Recherche sur les Aeronefs Alleges.

The colloquium which was attended by many delegates from Europe, was held in Paris. Among the more ambitious of the projects was one for a gigantic flying saucer. This experiment, known as the *Pagase* platform, is some 420 metres in diameter and 66 metres in height. It takes the form of a double convex shape or lenticular as it is described in the paper given by J. Roux of "Aeroconsult France" who operate from Lyon.

The device which is intended to fly at great height, will be maintained geostationary by a proposed ion motor. The special fabric which will be used as the outer skin was developed in France and is the same material which was used for large captive balloons from which the recent French atomic test device was dropped.

The operating height that is expected to be chosen for the flying saucer is some 21,000 metres and each operational period of the order of one year. It is to be expected that the advent of this enormous object would set up a new wave of UFO sightings.

As the immediate propulsion systems are likely to be propellers driven by electric motors powered by batteries or fuel cells with a turbo system using liquid hydrogen, the amount of gas required to fill the hull would be of the order of 700,000 cubic metres.

It is claimed that such a device would in the long run be cheaper than satellites for educational television. This claim was also put forward for smaller balloons and dirigibles both captive and free.

The French scientific programme involving these devices has ranged from meteorological studies to infra-red and detailed studies of the Sun. So great is the interest in these matters that the various authorised research departments of the government and the various independent centres have been funded to a level of 90 billion francs.

One thing particularly noticeable about the French attitude is that meticulous attention to detail is the primary requirement and every project is one in which nothing in the way of testing is left to chance. Indeed this is carried so far that nothing is allowed to operate in full scale until every aspect of possible failure has been examined.

There is a definite end product commercially in spite of the emphasis on the pure research for research sake. It is planned that when the projects are proved they will be offered to emerging countries as a means to improve education, communication and transport. The French Ministry of the Environment keeps a very close watch on all the projects and were in attendance at the colloquium.

In a strictly down to earth way the British contribution was for the design of an airship to carry heavy individual loads. This airship was some 1,300 feet long and capable of carrying loads of the order of 400 tons. It was also suited to use as a scientific platform for meteorology, geodesy, oceanography to mention a few of the inner space uses. The detailed design was given in a paper by Dr. E. Mowforth of Airfloat Transport Ltd.

THE JAPANESE APPROACH

The Japanese decided to take an independent approach to space matters. Clearly, they wished to be able to control their own launchings and not to depend upon other countries. This is perhaps the reason behind their decision not to use Woomera but to develop their own sites for launchings.

All the proposed projects are peaceful ones and one of the requirements for the consent of the people as a whole to the building of launching sites was that these bases would never be used for military purposes. The World Weather Watch which is to be undertaken is in accordance with the peaceful policy line.

The preparation of launch vehicles was undertaken in the country even though they could have been purchased more cheaply from abroad. There has been a slight departure from the original rather austere attitude to the extent that some foreign components have been used. Some still important projects such as the *ISS*, Ionospheric Sounding Satellite, are almost wholly Japanese. However, there has been some discussion as to whether Japan should purchase some of the elements of the Geostationary Meteorological satellite to be launched in 1976.

Already Japan's tracking stations have been used in the past spaceflights of the *Apollo* series. This is in accordance with the Japanese declared intent of world cooperation. It is not likely that they will take part in the space shuttle programme because decisions for this were made final before Japan was ready. There is, however, a distinct air of national prestige in the general attitude to space projects.

FUTURE PROGRAMMES

The Japanese space programme for the future include a geostationary communications satellite which is regarded as vital to TV coverage in a country where mountains present a problem for surface transmission ranges and where the educational requirement demands coverage of rural areas. Also a navigational satellite for the benefit of the maritime activities of the country and for the fishery industry vital to food supplies. The third important project is the geodesic survey satellite. This will take the form of a balloon with a circular orbit of about 620 miles. It will carry laser reflectors.

The launchers to be used for the applications satellites will be by a three stage vehicle. This employs liquid fuel for the first and second stages and solid fuel for the injection motor. These cannot be regarded as strictly Japanese for they are built under licence by Mitsubishi from McDonnell Astronautics and Rockwell International.

There are a number of government establishments engaged in supporting activities. One of the larger facilities is the National Aerospace Laboratory founded in 1965. The Science and Technology Agency now operate it. Much of its efforts are directed to system studies of launch vehicles and engine research. Guidance and control and instrumentation is also undertaken together with work on the structural dynamics of rocket launchers.

PERONDO PART 6

PICK-UPS & TURNTABLES FOR QUADRAPHONICS

BY R. A. COLE

THE weakest links in a sound reproducing system are always the first and last, the pick-up and the loudspeaker. The "state of the art" in amplifier design is so advanced that distortion figures of less than 0·1 per cent are obtainable from all but the most modest amplifiers.

It is surprising to hear of the elaborate designs currently appearing for amplifiers of even better performance, when the pick-up cartridge, turntable, tape mechanism or tuner feeding signals to the amplifier themselves have distortion figures that can only be described as mediocre.

At the other end of the reproducing chain, the loudspeaker is even worse in its ability to reproduce sounds accurately. This article deals with the problems of quadraphonic reproduction.

BASIC REQUIREMENT

To play a gramophone record, one needs a mechanism to rotate the record at a constant and accurate speed. This basic requirement would appear to be a simple engineering problem and yet good turntables have far from good performance, when compared with the amplifier. Any production of mechanical noise or variation in speed will distort the accurate transfer of the original waveform from the record to the amplifier.

There are of course similar distortions of the original recorded sound up to the record itself, which we have to ignore and live with. These distortions are of a lower magnitude than in disc reproduction, due to the fine engineering quality of recording equipment.

MECHANICAL NOISE

The principal sources of mechanical noise in turntables are in the bearing on which the turntable rotates and the mechanical drive link between the motor and turntable. These give rise to a phenomenon called "rumble".

In addition to mechanical noise there are substantial fluctuations in speed. The first fluctuation is called "wow" and is a low speed variation caused by inaccuracies in the drive mechanism and turntable itself. The second source of speed fluctuation, caused primarily by inaccurate drive linkages, is of a higher frequency and is aptly called "flutter".

All of these deficiencies are reduced to lower proportions if great care is taken in design and manufacturing. This inevitably leads to higher costs. Turntable mechanisms vary in cost from a few pounds to a hundred or more pounds, and the listener should choose the best he can afford.

DRIVE SYSTEMS

There are three principal methods of driving a turntable. The first and most common, uses a horizontal intermediate rubber idler wheel between the motor and the turntable.

The rubber idler wheel is driven by the motor capstan and in turn drives the turntable. It is held in contact with both capstan and turntable by a spring. The idler wheel is disengaged when the turntable is switched off mechanically. If it does not disengage, a depression or flat will occur on the periphery of the idler wheel which causes a "bumping" noise. The more these flats occur, the more frequent the "bumping" noise. In extreme cases where numerous flats occur, the bumping noise becomes a form of rumble.

To guard against this, never turn the turntable off *electrically*. Always use the mechanical system which switches the motor off electrically *and* disengages the idler wheel.

The second method works on a similar principle to the horizontal idler wheel method, but uses a vertical idler wheel running off a horizontal tapered or stepped capstan. In this case rumble is imparted to the turntable in a vertical sense and gives slightly better performance.

The same precautions regarding idler disengagement are needed. One advantage of this system is the ability to vary the speed over a wide range with the elongated tapered capstan and the subsequent wide range of drive ratios available.

The third and most effective method is the "belt drive" method which transfers the rotation of the capstan to the turntable by means of a "rubber" belt drive. The flexibility of the thin rubber belt provides effective decoupling between the motor and turntable.

Various types of material are used for manufacturing the belt drive. Different cross-sections are used by various manufacturers. The main disadvantage is the relatively low degree of energy transfer obtainable when compared with the previous methods. The belt must be scrupulously clean and free from oil or grease or belt slip may occur.

MOTORS

Some cheap turntables use motors with two poles which tend to have high hum fields. Four-pole motors are most common in medium price units. The better turntables, including belt drive turntables, tend to use multi-pole motors, sixteen-pole principally. These motors are small and have virtually no hum field.

TURNTABLE BEARINGS

There are a number of views regarding turntables and their bearings. The cheaper turntables tend to use a thrust plate and ball race bearing. These bearings are to be avoided like the plague as they can impart serious rumble. There is no better bearing than the shaft and bush bearing. These appear in various forms, sometimes with a tapered shaft and sometimes with a single ball bearing in the bottom of the bush.

The more expensive turntables use precision machined heavy diecast non-ferrous turntables with the weight distributed mainly around the periphery. However, since the use of multi-pole motor has become common, much lighter turntables tend to be used because of the accuracy and speed constancy of these motors.

Rumble figures of 50dB to 65dB (weighted) are now common in belt drive turntables. The cheaper turntables tend to have such poor rumble figures and vary from one sample to another to such a degree that the buyer can never be sure how reliable his particular sample will be.

There are new types of turntable appearing recently; the "linear motor" turntable to mention one. These overcome many of the shortcomings mentioned above, but they are all at this time in the very high price bracket.

PICK-UP ARMS

Most turntables use a pick-up arm which carries the cartridge across the record attempting, ideally, to present the cartridge axis at a tangent to the groove. However, the errors introduced can be quite staggering. The better arms have tangential errors as little as a half degree, but needless to say they are very expensive. True parallel tracking arms which move across the record in a straight line are available, but their prices are high.

The Goldring G101, typical of equipments suited to Quadrophony

Other factors which are significant in pick-up arm design, are the bearings, which have to be virtually frictionless; arm resonance, damping, and general design geometry. All these factors are dealt with by various manufacturers to a degree which is usually related to price.

The minimum requirement for hi-fi reproduction should include an adjustable counter weight, removable head shell and a reliable arm lifting mechanism. Additionally a device to overcome the natural tendency for the arm to move into the centre of a rotating record is desirable. This is called a bias compensator or anti-skating device. As the degree of bias depends upon the weight of the pick-up upon the record, this compensator should be adjustable as well.

A word about pick-up lifts. Although a precise lift can be made using a simple type mechanism, it is useful if the lowering action is damped. Some of the viscous damped, or hydraulic mechanisms permit a precise and gentle lowering action.

PICK-UP CARTRIDGES

There are two main types of pick-up cartridge. One uses the piezo-electric effect in which certain types of crystal when flexed generate small voltages across an axis of the crystal.

The cheapest of these cartridges are made from Rochelle salt. The more modern cartridge has a man-made crystal which gives a more uniform response and is less temperature and humidity sensitive. A good ceramic cartridge can give adequate hi-fi performance and falls in the medium price bracket. The output is around 25mV to 100mV and must be fed into a high impedance, usually around 2 megohms.

Perfectly adequate reproduction of SQ and QS Quadraphonic records can be obtained using a normal stereo ceramic cartridge.

Magnetic cartridges cover the widest spectrum of price and quality in hi-fi reproduction. At the lower price end of the spectrum there appear to be some "shockers" and better performance can often be obtained from a ceramic cartridge in the same price range. However, there are a number of quite low price magntic cartridges which can be used for SQ and QS recordings to great advantage.

Do not be tempted to buy a cartridge which does not have stylus replacements available on a nation-wide basis.

MAGNETIC TYPES

Magnetic cartridges fall into three main types. The most common is the moving magnet cartridge which generates its output by movement of a small magnet within a coil of wire.

The second method, which has fallen somewhat into disfavour in recent years, is the moving iron method in which a soft iron strip moves within a coil of wire, the iron being magnetised by an external fixed magnet.

The third method utilises a coil which moves within a magnetic field. The dimensions and mass of the coil are amazingly minute and moving coil cartridges are usually in the higher priced bracket.

All the movements in each of these cases are damped.

There are other methods used in cartridge manufacturing: photo-electric, condenser and ribbon types for example. As these cartridges are rather rare and expensive, they wil lnot be described.

PLAYING WEIGHTS

In all the cases mentioned above, the stereo or quadraphonic waveform on the record is traced by a stylus which is attached to a cantilever arm. This arm is coupled to a "bridge" which has two limbs at right angles to each other and at 45 degrees with respect to the record plane. This bridge transfers the energy along each axis to one of two transducers.

The lower price cartridges tend to require higher playing weights and the stylus suspension or compliance is rather stiff. Such cartridges are more suited to simple low quality arms. More expensive cartridges are used at considerably lower playing weights and due to their more delicate compliances require better quality arms to avoid mistracking.

Never play records at a higher or lower playing weight than recommended, as distortion and record wear will occur.

PICK-UP STYLI

The use of a diamond or a diamond-tipped stylus is a "must" for hi-fi due to the long life of diamond. The use of a sapphire stylus is to be avoided.

A diamond stylus should be inspected under a stylus microscope every 1,500 to 2,000 playings. One can expect 2,000 to 3,000 playings before a "flat" becomes noticeable on the tip. In the case of sapphire a life of 20 to 30 playings is probably the maximum safe life. No stylus should be used after a flat is visible under a stylus microscope, otherwise serious record wear may occur.

A simple comparison of the cost of a new stylus against the value of the records played, should leave no doubts on this matter. Styli are usually ground and polished to a cone with the tip radiused. This radius can vary from around 0·0003in to 0·0007in for L.P. records.

ELLIPTICAL STYLI

In order to improve the tracking of the stylus and to improve the upper frequency response elliptical styli are now quite common. The diamond is ground and polished to give a tip of elliptical cross-section usually 0·0003 × 0·0007in.

THE CONNOISSEUR BD1 TURNTABLE KIT AND SAU2 PICK-UP ARM

The kits for these two items are available off the shelf from A. R. Sugden & Co. (Engineers) Ltd., of Brighouse, Yorkshire at prices of £13·31 and £14·52 respectively. In combination and used with a suitable pick-up cartridge they form a unit suited for incorporation in the PE Rondo Quadraphonic system.

The two items are sent out to customers securely packaged, the first in a folded corrugated cardboard packing with individual kit parts or sets of parts carried in plastic bags. The pick-up arm is packaged in a suitably moulded expanded polystyrene box form suitably secured with a cardboard sleeve.

Taking the turntable unit first, this is supplied with three basic items of literature, the assembly instructions themselves, a layout sheet or template for cutting the mounting board, and some fairly comprehensive descriptive material which gives specification, installation and service details.

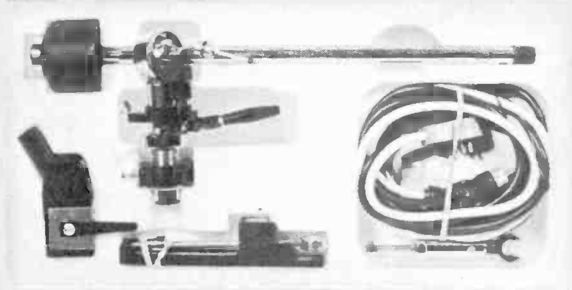
As with any kitting exercise, it is always advisable to first read through the instructions before starting on the mechanical assembly. This is no exception as there is always the risk that the supplier might call an item by one name whereas the builder might know the same item by a totally different name.

In the present case all appeared in order from the beginning and construction was commenced.

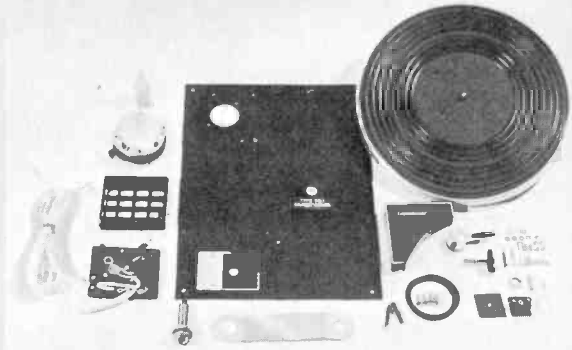
Each step is detailed in the instructions in fairly simple terminology and in an easy-to-follow order. Indeed if anything the instructions are perhaps more detailed than necessary for the greater majority of readers.

The only error discovered, if error it can be called as it is more one of omission than fact, concerns the fixing of a small but strong spring to the on/off switch. It would probably be of considerable help to the uninitiated in springs to know that one can attach the offending item quite easily with the switch mechanism in an apparently wrong position and then apply the tension by rotating the mechanism to the correct position.

This process is fairly simple for those used to dealing with reluctant springs but will probably give some trouble to the newcomer to the effects of a suddenly released tension spring which invariably flies to the darkest corner of the room.



The Connoisseur SAU2 pick-up arm kit



The Connoisseur BD1 turntable kit

Such a stylus presents its smaller dimension to the modulations on the groove walls, but will still be prevented from "bottoming" by is major dimension. The process of elliptical grinding and polishing is expensive and elliptical versions of cartridges normally fitted with a spherical stylus are more expensive.

The foregoing forms are used for a stereo and SQ-QS quadraphonic reproduction. The CD-4 system however requires a cartridge with a much higher frequency response.

For good CD-4 reproduction an uppper frequency response of 45kHz to 50kHz is required and it is also necessary to utilise styli of special form, such as the Shibata stylus. This has four times the groove contact area of the conventional styli and a cross-section which is small enough to trace the high frequency modulations on the CD-4 disc.

RECORD AND STYLUS CLEANING

In order to preserve a record collection it is imperative that all records should be kept clean. It is only too easy to allow dust, finger marks and abrasions to accumulate and once they have accumulated the whole standard of reproduction of records falls.

Equally so, the gramophile can be persuaded to use patent cleaners and fluids that tend to leave traces of fluff and oily deposits. The combination of fluff, greasy deposits and dust become gathered by the stylus into congealed lumps, that harden and are finally pushed round by the stylus, scoring the groove walls.

A series of cleaning aids, pioneered by Cecil Watts and now copied by numerous others, provide a safe, efficient and inexpensive means of preserving records. These consist of the Dust Bug, the Disc Preener and the stylus brush.

The only fluid that can be safely used on records is pure absolute ethyl alcohol or a mixture of the same with distilled water (not demineralised).

The expedient of using alcohol or alcohol diluted should only be used to clean excessively dirty records. Any claims for the use of fluids should be treated with reserve until the user is sure that *no* deposits are left.

The stylus brush may be used in conjunction with a little stylus cleaning fluid. The brush is used so that the bristles move backwards and forwards along the axis of the cantilever; never side to side. In the case of CD-4 records, it is advisable to clean the disc with a disc preener before and after playing.

In fact, assembly took only about 30 minutes and proved to be easy. One warning, do not be too liberal with the oil on the main spindle or you will only have to remove most of it afterwards since the fit between the shaft and the bearing is, of necessity, close and as the bearing is closed at the lower end air becomes trapped in the space below the spindle. Whilst it is very nice to run on an effective air bearing this is not the object of the exercise and in any case it makes the turntable ride far too high.

Newcomers to the type of drive used in the Connoisseur BD1 will probably note with some surprise that the on/off or start switch includes a small button which engages with the turntable as the switch is operated. This is intended to overcome the basic inertia of the mass of the turntable by giving it a small push in the direction of rotation.

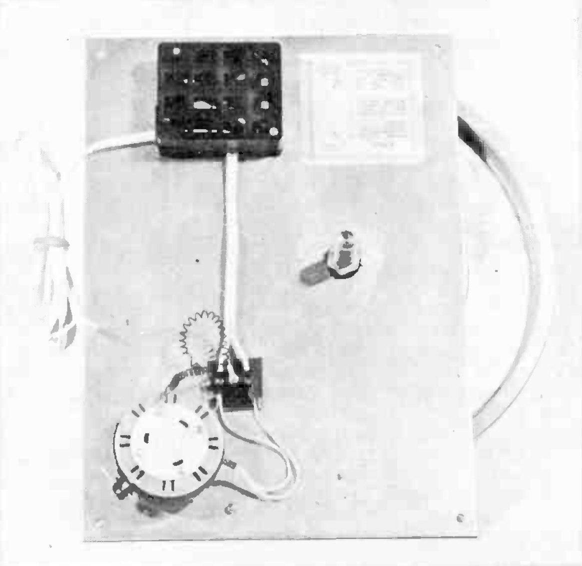
This is done for two reasons. In the first place the belt used is light and fairly elastic. Secondly, the turntable is fairly heavy in order to give the mass needed to provide the very good rumble and flutter figures.

Thus the small hand-operated push. It allows the motor, belt and flywheel all to take up the drive without jerks, jumps or other unnecessary problems.

The SAU2 pick-up arm proved to be an even simpler job to assemble, taking only a matter of moments to work out which part goes where.

Whilst the whole assembly was not mounted on a plinth the procedure was rehearsed and is simple, particularly as it is assisted by the presence of a cutting template for drilling the arm mounting hole and an alignment protractor for adjusting the pick-up in the head.

Underside view of the assembled BD1 turntable



Assembled BD1 and SAU2

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.

ORGAN KIT

For an American company (one of the largest) that is spending over £3 million on launching its UK operations, it seems ironical that the construction kit our Editor brought back from **Tandy Corporation's** official opening ceremony in Birmingham should be minus a component. (From a £3·95 kit!)

Dealing mainly in hi fi equipment, Tandy's Science Fair P-Box construction kits range from a "Goofy Lite" to an "Analogue Computer" and may interest some readers. The kit we constructed was the 28-101 Electronic Organ.

A feature of these kits is the use of the bottom of the boxes as a mounting base for components. A matrix of holes drilled in the base, annotated with a number for holes and a letter for rows, takes the components.

Included with each kit is a set of instructions and a booklet on construction hints. For readers who have not tackled much constructional work it is recommended that these hints be read first, particularly the hints on soldering.

The organ kit consists of 27 components plus P-box and took approximately two hours to construct following their instructions. But if one was to just follow their excellent wiring diagram it would probably only take one hour.

Science Fair Electronic Organ Kit from Tandy

Apart from the practice of inserting two component leads in one hole and the difficulty in soldering a strapping lead, without burning the case, across the key switches the kit is very well designed. However, for a unit that is called an "electronic organ" the sound reproduced from our kit is certainly not anything like an organ sound, in fact, it's more like that produced by a cat that's got its tail caught in a mouse trap.

All Tandy products are available from franchise shops which have been or are being set up throughout the Midlands. Eventually Tandy franchise shops will be nation-wide.

If you want to obtain a franchise it will cost you £2,000 and an additional outlay of approximately £12,000 for a shop and stock.

A catalogue of Tandy products is available from any dealer or direct from their head office at Bilton Road, Holyhead Road, Wednesbury, Staffordshire WS10 7JN.

CASSETTE LIBRARY KIT

After the success of their Record Library kit, **Bib** are now marketing a Tape Indexa system catering for tape cassettes, cartridges or reels.

Bib Cassette library system

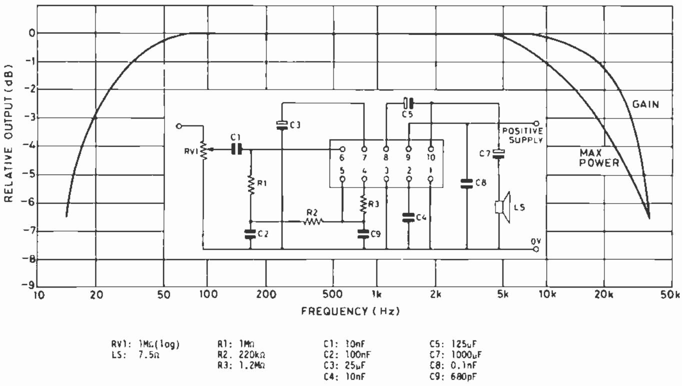
The system enables 1 to 100 cassettes, cartridges or reels to be referenced and with additional units it can be expanded to accommodate up to 999 cassettes. The kit comprises a cassette library case to hold 20 index cards and two summary cards, which are clipped together and swivelled to read entries. There are 300 self-adhesive labels, three of each numbers from 1 to 100, and 10 spare Indexa Cards.

One label of each number is stuck on each side of a cassette and the appropriate library case. Entries are made on the cards detailing any particular points the collector wants to record.

Full details of using the Bib Cassette Tape Indexa are included with the kit and the system is claimed to be completely flexible. The recommended retail price is 66p, excluding vat.

NEW AUDIO I.C.

Over the last few years we have published several audio circuits which have used the excellent Plessey SL402/3 integrated circuit because of its dependability. Now Plessey's announce the replacement of the 402/3 with two new audio amplifiers with the reference of SL414 and the SL415.



Typical external components required for the Plessey SL414 and SL415 audio amplifier integrated circuit

The amplifiers have an output of 3 and 5 watts r.m.s. respectively into a 7·5 ohms load. Designed for operation from a 20V (SL414) and 25V (SL415) supply, distortion is quoted as being 0·1 per cent r.m.s. and 0·3 per cent with a power output of 1W at a frequency of 400Hz.

The high input impedance of the new devices is obtained by using a built-in pre-amplifier consisting of a triple Darlington stage.

The SL414 and the SL415 should be available from most advertisers or can be obtained direct from **SDS Components Ltd., Hilsea** Trading Esate, Portsmouth, **Hants** PO3 5JW.

PE Sound Synthesiser 13

KEYBOARD

By G.D.SHAW

IN this last part keyboard construction will be completed and final tuning described.

KEYBOARD HOUSING CONSTRUCTION

The design of the keyboard housing is based on the use of the four octave Kimber-Allen keyboard. Constructors using keyboards other than the one specified will have to modify some of the dimensional details accordingly. Fig. 13.1, is a composite illustration giving details of the various timber components required to construct the main housing. Since no interlocking joints are used it is recommended that all joints be secured with a powerful adhesive such as Araldite together with pins or woodscrews as necessary.

Firstly the end frames, cheek plates complete with battens and baseboard were made according to the figures and lightly tacked together dry, as a check on dimensional accuracy. The housing was then stripped and, with the exception of the faces to be glued and the underside of the baseboard, all parts were finished with two coats of dark grey undercoat and four sprayed coats of matt black paint.

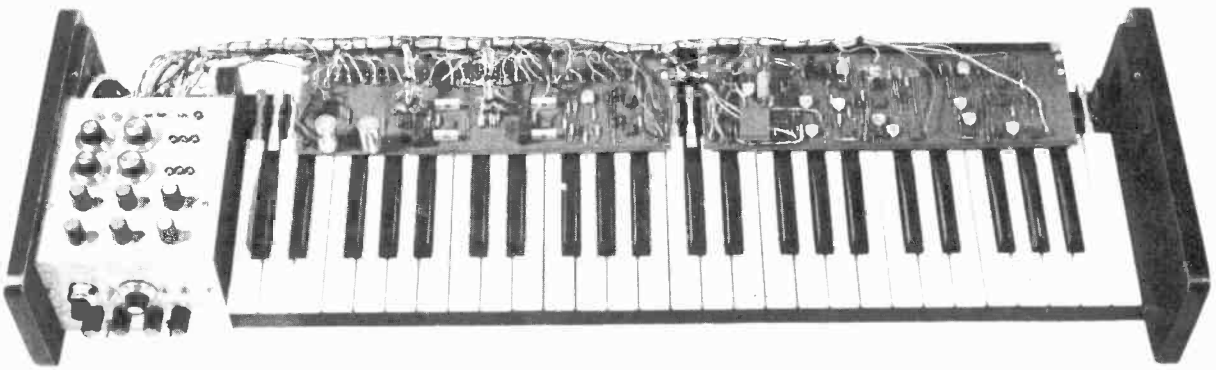
A piece of upholsterer's heavy quality black figured vinyl was then cut to cover the underside and front lip of the baseboard. In cutting the vinyl an allowance of about 38mm should be made for overlapping each of the long edges of the baseboard and, similarly, allow about 50mm on the overall width. Do not attempt to cut out the rectangular opening at this stage.

With the vinyl spread out on a flat surface coat the underside with a thin layer of suitable adhesive leaving about 25mm clear all round. Dunlop "Thixofix" was used in the prototype. The underside of the baseboard should be similarly prepared.

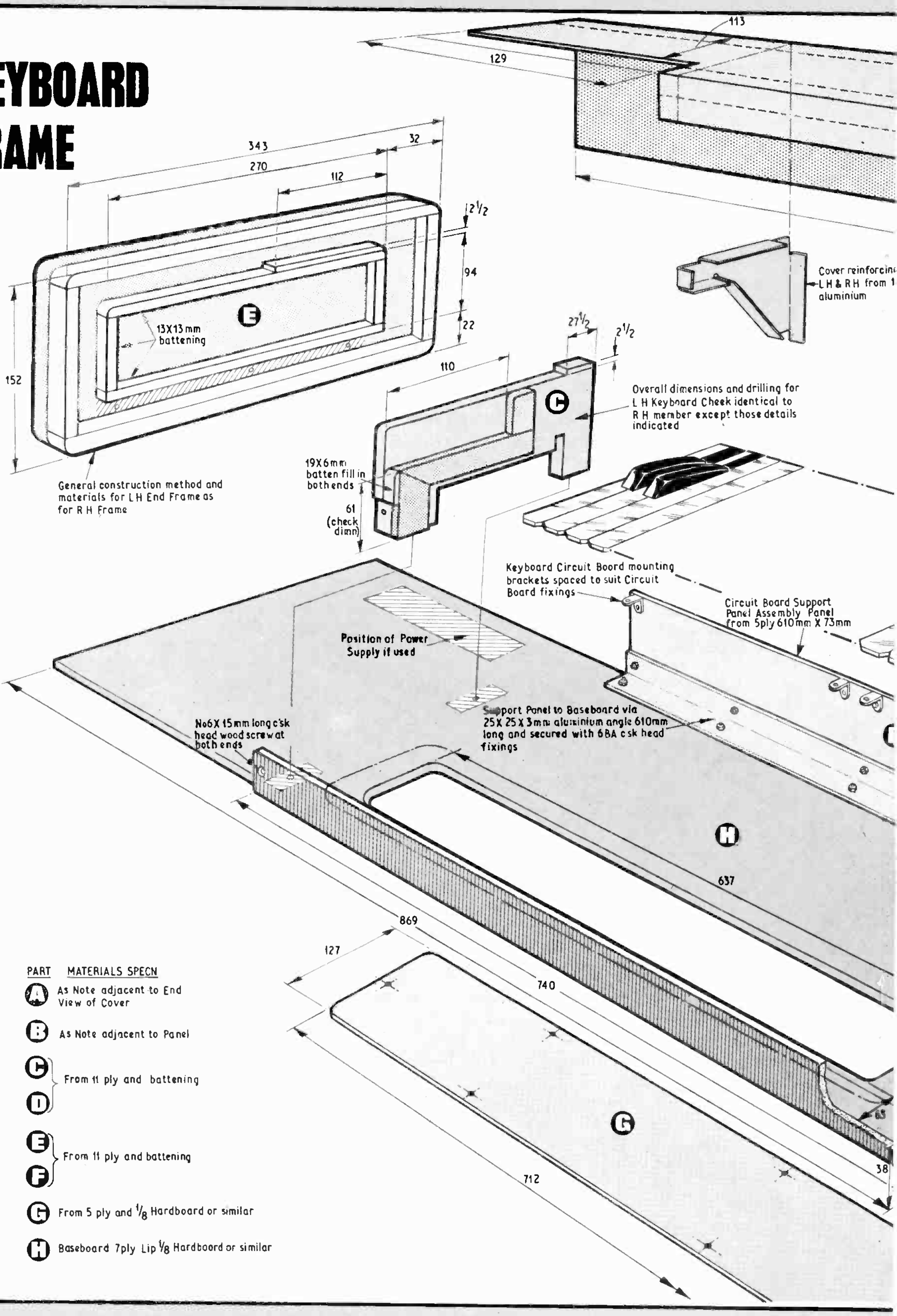
When the adhesive appears dry to the touch place the baseboard, glued side up, on a table and cover lightly with a sheet of greaseproof paper or similar. Place the vinyl over the baseboard, glued side down, and adjust its position to allow for the overlaps. When correctly positioned gradually slip the paper from between the two glued surfaces and roll the vinyl onto the baseboard. A wallpaper joint roller would be suitable for this purpose.

Ensure that the vinyl goes on without wrinkling but do not attempt to apply any degree of stretching otherwise shrinkage will occur at a later date. The vinyl may, however, be pulled tight over the batten on the front lip of the baseboard. When this stage has been reached reverse the position of the baseboard and apply a layer of adhesive to both long edges of the vinyl, baseboard, rear face of the batten and in a 38mm strip around the rectangular opening.

With a sharp knife, and following the contour of the opening, cut out a rectangle leaving an overlap of about 38mm all round. Make three or four cuts into the radiused corners of the opening as shown but leave a gap between each cut and the timber edge. Roll down each of the overlaps in turn pulling the vinyl tightly over the edges of the baseboard. In the case of the opening set down the corners first of all before attempting the long edges.

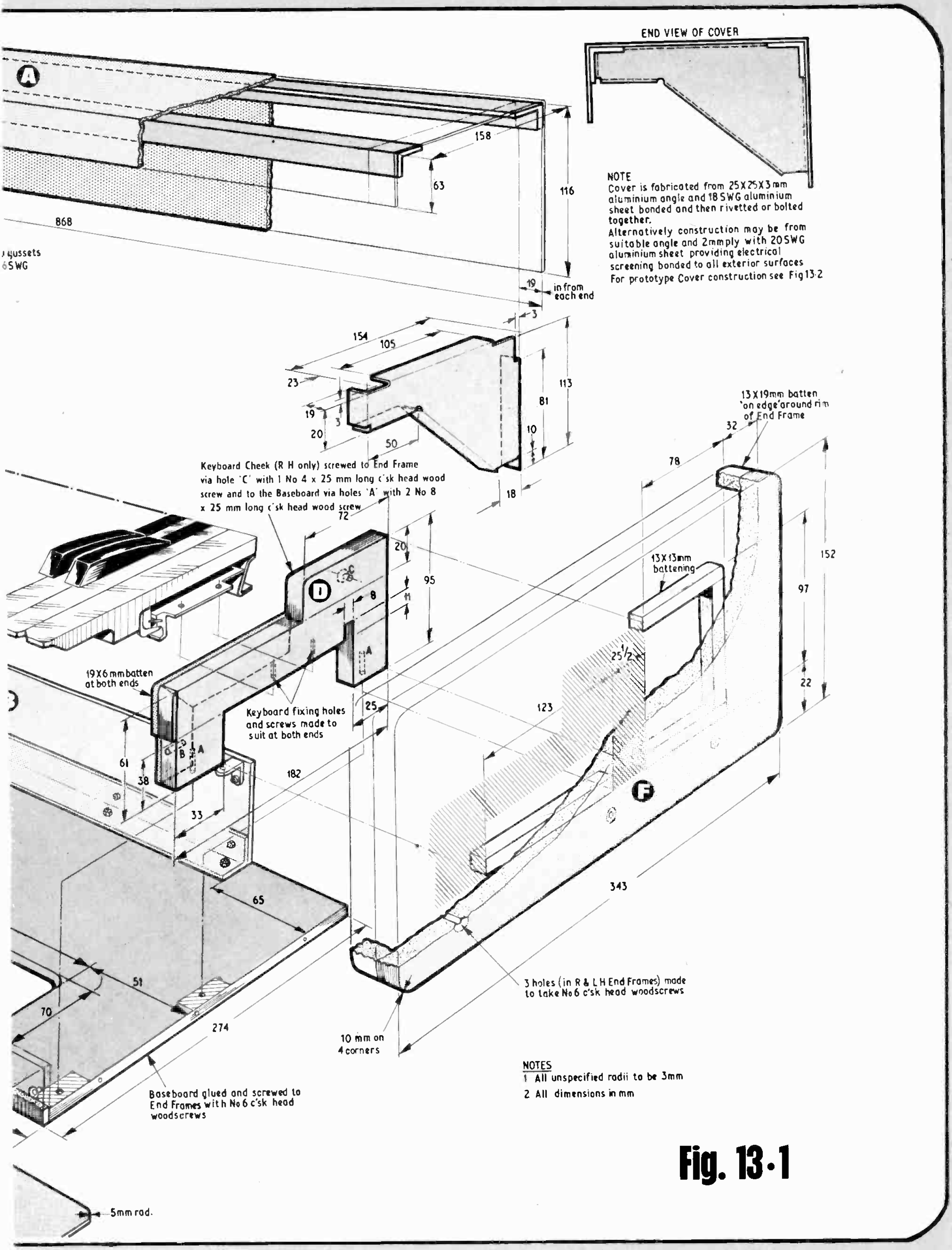


KEYBOARD FRAME



PART MATERIALS SPECN

- **A** As Note adjacent to End View of Cover
- **B** As Note adjacent to Panel
- **C**, **D** From 11 ply and battening
- **E**, **F** From 11 ply and battening
- **G** From 5 ply and 1/8 Hardboard or similar
- **H** Baseboard 7ply Lip 1/8 Hardboard or similar



END VIEW OF COVER
NOTE
Cover is fabricated from 25X25X3mm aluminium angle and 18SWG aluminium sheet bonded and then rivetted or bolted together.
Alternatively construction may be from suitable angle and 2mm ply with 20SWG aluminium sheet providing electrical screening bonded to all exterior surfaces
For prototype Cover construction see Fig 13·2
A
158
63
116
868
gussets
6SWG
19
in from each end
3
154
105
23
113
81
19
3
20
10
50
18
13X19mm batten 'on edge' around rim of End Frame
32
78
152
Keyboard Cheek (R H only) screwed to End Frame via hole 'C' with 1 No 4 x 25 mm long c'sk head wood screw and to the Baseboard via holes 'A' with 2 No 8 x 25 mm long c'sk head wood screw
72
20
95
D
8
11
13X13mm battening
97
25½
22
19X6mm batten at both ends
Keyboard fixing holes and screws made to suit at both ends
25
123
61
38
B
A
182
33
F
65
343
51
70
274
3 holes (in R & L H End Frames) made to take No 6 c'sk head woodscrews
10 mm on 4 corners
Baseboard glued and screwed to End Frames with No 6 c'sk head woodscrews
NOTES
1 All unspecified radii to be 3mm
2 All dimensions in mm
5mm rad.

Fig. 13·1

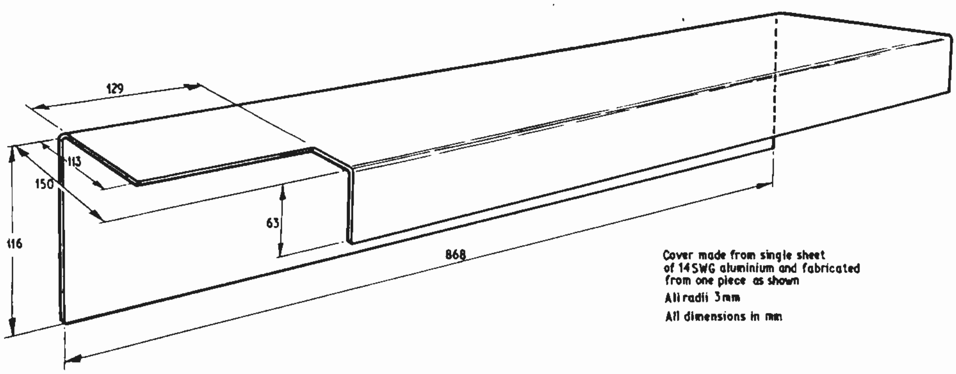


Fig. 13.2. Prototype bending and cutting detail of keyboard cover plate

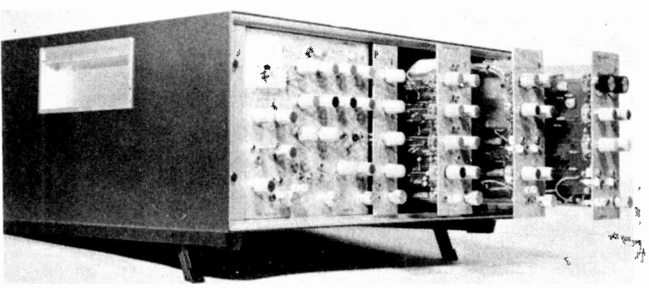
After allowing the baseboard to settle overnight the excess lengths of vinyl may be trimmed off with a sharp knife.

The baseboard may now be glued and screwed to the endframes of the keyboard housing using round head screws, with washers, to prevent wrinkling of the vinyl. Set aside for the glue to set, ensuring the endframes are square with the baseboard.

ASSEMBLING THE KEYBOARD

Attention may now be given to the keyboard itself. Drill two holes 10mm in from each end of the aluminium extrusion which forms the main frame of the keyboard together with coincident sighting holes in each of the cheekplates. Secure the cheeks to the frame with No. 8 round-head woodscrews. Make sure that the aluminium frame is barely flush with but does not protrude beyond the cheeks. The keyboard may now be turned upside down resting on the left cheek and with a suitable block of wood placed beneath the right cheek. Trim the length of the contact strip so that it fits easily into the space to the rear of the actuators.

Place a contact assembly at each end of the strip such that the front of the assembly is flush with the leading edge of the strip, and then manœuvre the strip so that the plain wires on the contact assemblies slightly protrude above and beyond the actuators. When satisfied with the positioning carefully remove the contact assemblies and mark the position of the strip relative to the actuators. The contact strip may now be removed and prepared for permanent fixing.



The contact assemblies themselves will be secured to the strip by means of adhesive and thus the upper surface of the strip has to be prepared by thoroughly roughening the surface by means of coarse grade emery or glass paper.

The contact strip may be secured to the keyboard frame by means of adhesive or by means of screws. In the former case the lower surface of the strip must also be thoroughly roughened together with its mating face on the mainframe of the keyboard. In the latter case a minimum of three screws will be required (each end and centre) and the appropriate drillings made through the contact strip and frame. Note that if the latter method is employed keys will have to be removed in line with each drilling. The contact actuators can be removed by a straight upwards pull after which the key spring will have to be disconnected before the key can be removed.

The contact assemblies may now be fixed into position with the front face of the assembly flush with the edge of the strip and with the long, plain wires centred squarely over their respective actuators.

WIRING THE KEYBOARD

The first stage in wiring up the contact assemblies is to fan out, in a vertical plane, the lead out wires common to each unit. With the keyboard inverted and, facing the rear of the assembly, key 1 at the left end is the lowest C while key 49 at the extreme right is the highest C. Starting with the lead-out wire nearest to the contact strip wire all these together from key 1 to 49 inclusive. 24 s.w.g. tinned copper wire is suitable for this purpose. This row will form the −15V busbar and an insulated wire should be connected to row 1 key 1 for subsequent coupling to the −15V rail. Although not absolutely essential it is a good idea to use short lengths of insulated sleeving on the bare sections of connecting wire between contact assemblies.

Row No. 2 forms the envelope shaper triggering busbars. Link together all No. 2 wires from key 1 to key 18 inclusive and attach an insulated wire to key 1 row 2 for subsequent attachment to the link switch (S2b). A similar procedure is adopted for key 19 to 49 inclusive with an insulated wire attached to key 19 row 2.

Row No. 3 is wired in an identical manner to Row No. 2 except that the busbars so formed will be carrying V.C.O. control voltages and the insulated lead-out wires will be connected to S2a.

CODED KEY WIRES

The contact assembly wires in row No. 4 are individually hard wired direct to the keyboard divider circuit board. It is best to ensure that each key in any octave has its own distinctive wire colour.

Loosely bunch tie the octave wire groups together so that there is less likelihood of confusion when wiring into the divider board.

When the contact wiring has been completed the keyboard assembly may be mounted into the main housing and secured. Fit the circuit board supporting panel and mount the two large circuit boards into the positions shown in the sketch. In the prototype Vero brackets were used for this purpose and secured to the circuit boards by means of nylon screws and nuts. The wiring to the divider should be led through the gap between the panel and circuit board, trimmed to length and soldered to their respective pins.

Place the control panel temporarily in place on the keyboard housing and slide the envelope shaper sub-chassis into position making sure that the control shafts protrude through their respective holes in the control panel. Secure the sub-chassis to the baseboard by means of suitable woodscrews.

FINAL TUNING

With the installation of the power supply unit or connection of the umbilical cable the final tuning of the keyboard unit may be accomplished.

Having already matched the performance of the v.c.o.s the final tuning consists quite simply of matching the setting of the fixed span control (VR3) to suit the requirements of the oscillators. Constructor/musicians will find this to be a relatively easy matter since it is only necessary to play, consecutively, two notes an octave apart and adjust VR3 until the required pitch difference is achieved. For those constructors who do not possess the keen "pitch ear" of the practised musician it will be necessary to revert to the use of the oscilloscope.

Using one oscillator only and monitoring the output signal, adjust the tune control so that, with middle C depressed, the frequency is exactly 250Hz. Next depress the C above middle C and note the frequency, adjusting VR3 until it stabilises at 500Hz. The adjustment to VR3 will have caused the lower frequency to move so it will now be necessary to go back to middle C again and re-adjust the tune control so that it is once again 250Hz. Further adjustment to VR3 and the tune control are made until such time as the frequency ratio between middle C and its octave is exactly 1 : 2.

Very close octave spans may be achieved by taking the lowest and highest C's on the keyboard for the purpose of tuning. If the lowest C is set at 50Hz by means of the tune control then the upper C will require to be set to 800Hz corresponding to a frequency ratio of 1 : 16.

Once VR3 has been set, the tune control may be adjusted over quite a wide range without disturbing the octave frequency span. This feature presents a number of advantages because it allows the four octave register of the keyboard to be positioned almost anywhere within the audio frequency spectrum without the necessity of retuning. Similarly it allows the natural notes, normally the key of C, to play in any other key designation.

The variable span control may be switched in as required in order that the keyboard may be matched with acoustic instruments which may be slightly out of tune. At extreme settings the variable span control can reduce the frequency span of the keyboard to a semitone or less or extend the frequency such that one octave on the keyboard covers about three octaves of frequency. These latter possibilities will perhaps be of greatest interest to those musicians wishing to explore the realms of micro and macro tone compositions.

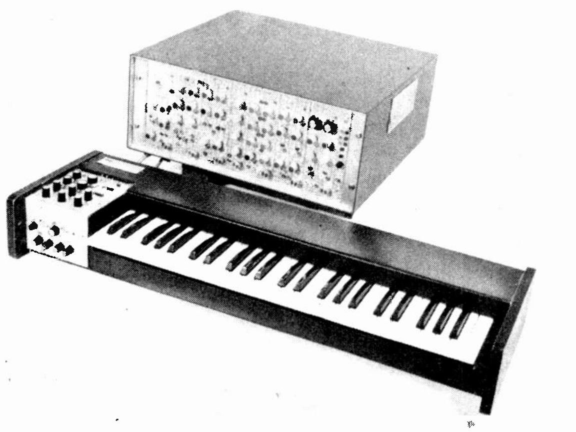
MODULATION AMPLIFIERS

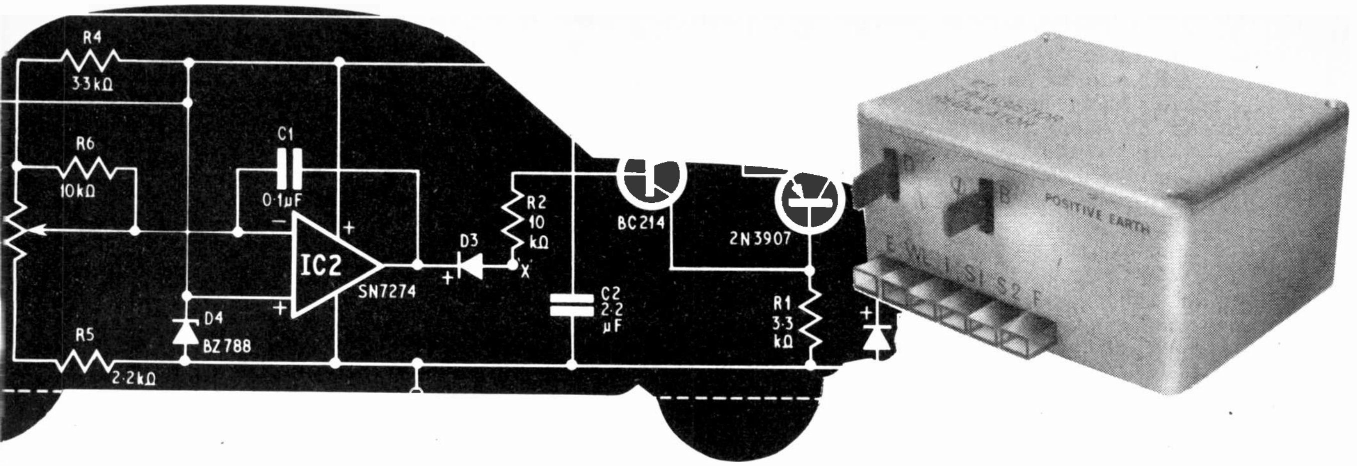
Modulation amplifiers are provided to enable the setting up of relatively complex relationships between oscillators without the necessity for complex circuitry. The simplest use for the modulation amplifiers lies in the provision of vibrato modulation. In this case V.C.O.2 is switched off and its frequency adjusted to about 7Hz by means of its manual control. S6(1) is then closed and the depth control VR7(1) adjusted until the desired degree of vibrato is achieved. The characteristics of sine, triangular and square wave induced vibrato are quite different and many interesting effects are possible by simply varying waveform and modulation depth.

Some of the most interesting effects however occur when both the v.c.o.s are cross modulating one another, and it is possible to simulate a number of conventional acoustic instruments even to providing very realistic bell tones when the appropriate envelope characteristics are combined with a degree of reverberation. In this latter mode of operation extreme settings of the depth controls can provide a series of very bizarre effects in which key positions appear to be juxtaposed and with a number of keys providing grunting, warbling or twittering sounds.

The synthesiser is still a relatively young instrument, having been available to the public for about five or six years. As a creative tool it is without equal but there is still a great deal of development to be done and constructors who have followed the project so far will not only be amongst the first synthesiser owners but will find themselves in the unique and exciting position of perhaps being able to make some contribution towards the further growth of the instrument. ★

An Invitation to a Lecture . . . see page 178





AUTO-CHARGER REGULATOR

By J.R. WATKINSON B.Sc.

In common with many other vehicle components, the voltage regulator which controls the car d.c. generator or dynamo appears to have been passed by as far as electronics is concerned. Thus regulators fitted to new vehicles today retain the same electromechanical form as when they were first devised.

VEHICLE POWER SYSTEM

The electrical devices in a vehicle which is moving are driven by power from the dynamo which in turn is driven by the engine. When the engine is not running power is still needed to operate the starter motor and ignition as well as parking lights, etc. and thus the battery is required.

Basically, when the engine is not running, the battery provides power, and when the engine is started the dynamo takes over, and recharges the battery.

REGULATOR FUNCTION

In order to charge the battery, current must be passed through it in the opposite direction to that in which it flows with the battery in use. Also in the case of a 12V battery the voltage applied must be more than 12V.

Referring to Fig. 1a, assume that the dynamo is producing a charging voltage then a current I_1 will flow, and the battery will charge.

If the generator stops the battery voltage can cause a heavy reverse current I_2 to flow as in Fig. 1b. The presence of the diode in Fig. 1c prevents this current flowing.

One of the jobs performed by the regulator is to prevent this reverse current, using a cut-out.

As the dynamo is directly coupled to the engine its speed will vary from a few hundred to several thousand rev/min, so that its output will vary accordingly. Again, the regulator must control the dynamo voltage so it does not rise too much at high speeds and cause damage.

SOLID STATE REGULATOR

The present solid state regulator has no moving parts. The circuit is shown in Fig. 2 with a table of negative earth changes in Table 1.

Operation is as follows. Diode D1 replaces the cut-out as it will only allow current to flow one way from the generator. The ignition light is connected across the diode *via* the ignition switch so that when the engine is not running it will light and when the generator voltage rises it will go out as is normal.

Transistors TR1 and TR2 switch the field current to the generator, and diode D2 suppresses the inductive spike which would otherwise occur when TR1 switches off.

The Zener diode D4 is a 5·1V device selected for low temperature coefficient. In conjunction with R3 it forms a reference voltage. R4, VR1 and R5 form a potential divider across the battery, and the integrated circuit operational amplifier IC1 compares the potential at the wiper of the preset with that across the Zener diode.

Should the voltage at the wiper of VR1 exceed 5·1V, caused by the battery voltage being driven high by the generator, then the output of IC1 will

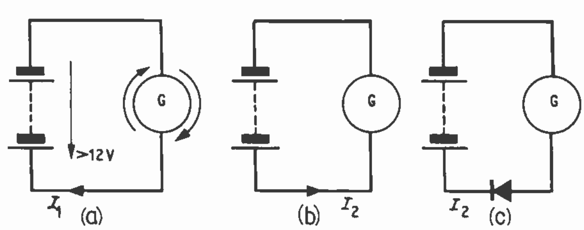


Fig. 1. Car dynamo current conditions for charge (a), incorrect discharge (b) and prevention of the latter (c)

swing towards earth, causing current to pass through D3 and R2, turning on TR3, and reducing the base current to TR2 and hence TR1.

Should the supply voltage fall below the correct amount, the output of IC1 swings away from earth, reducing the current through TR3, and allowing more base current into TR2, hence increasing the field current.

OPERATION

Operation is very similar to that of a stabilised power supply and since the battery acts as a very large capacitor and the gain of the circuit is high, regulation is very good. In practice, the needle of a voltmeter connected to the battery cannot be seen to move when the engine is rapidly speeded up from about 500 to 4,000 r.p.m.

The remaining components are C1, which limits the slewing rate of IC1 and prevents instability, C2, which shorts out any r.f. interference or spikes from the ignition and R6, which switches off the field current, should the wiper of VR1 go open circuit for any reason causing charging to cease, and the ignition light to come on).

To convert the regulator to combined current/voltage regulation, the circuit of Fig 3 is added. The generator current is monitored by detecting the voltage drop across the wire from the generator to the cut-out diode, and when it exceeds an amount pre-set by VR2, the output of IC2 will swing towards earth, cutting off the field current as before.

ADVANTAGES

As all of the active components are semiconductors, the regulator should last indefinitely, and can easily be transferred from car to car.

The precise voltage regulation obtained means that the vehicle's headlamp, and other bulbs should last longer, as filaments are very sensitive to even marginal overvoltage which can occur with conventional regulators. The unit, once adjusted, need never be touched, whereas the relay springs in vibrating regulators fatigue and require readjustment periodically for optimum performance.

The generator voltage must rise appreciably above battery voltage before a mechanical cut-out will pull in, whereas the cut-out diode conducts as soon as its forward bias voltage is exceeded. Thus in traffic, the generator can operate for a slightly larger percentage of the time, easing the load on the battery.

With a little shopping around, the unit can be built for less than a new conventional regulator.

TABLE 1
For NEGATIVE Earth vehicles alterations to Fig. 2 are

ITEM	ACTION
Battery	Reversed
D1 to D4	,,
ICI	Reverse Pins 4 and 7
TR1	Substitute OC28 or *pnp* 2N3055
TR2	,, 2N2907
TR3	,, BC214

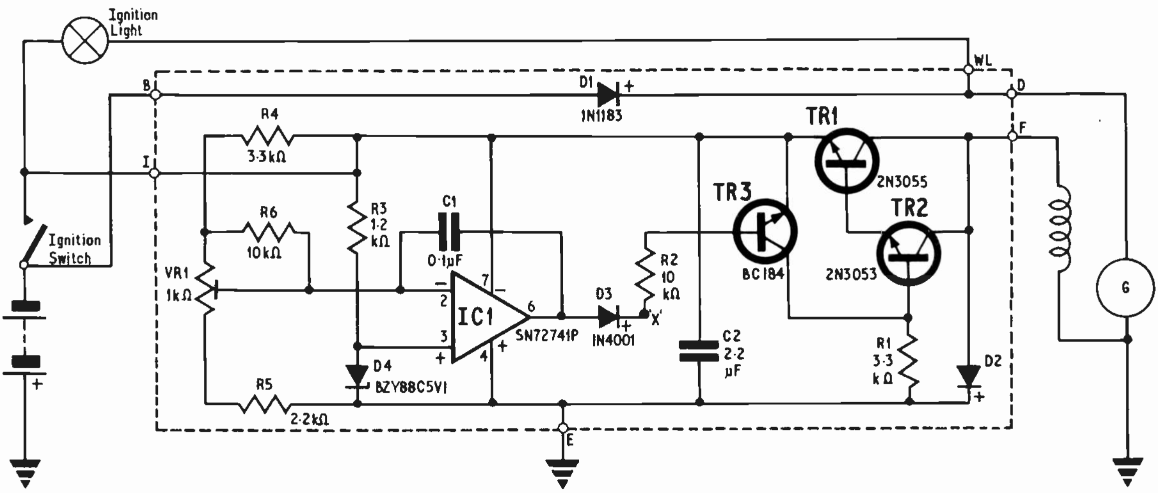


Fig. 2. Solid state voltage regulator for positive earth vehicles

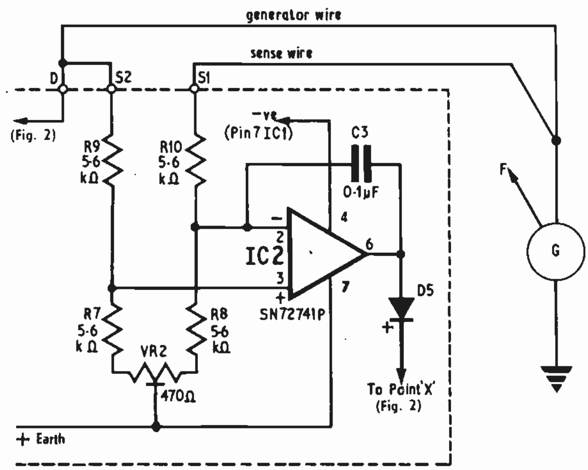


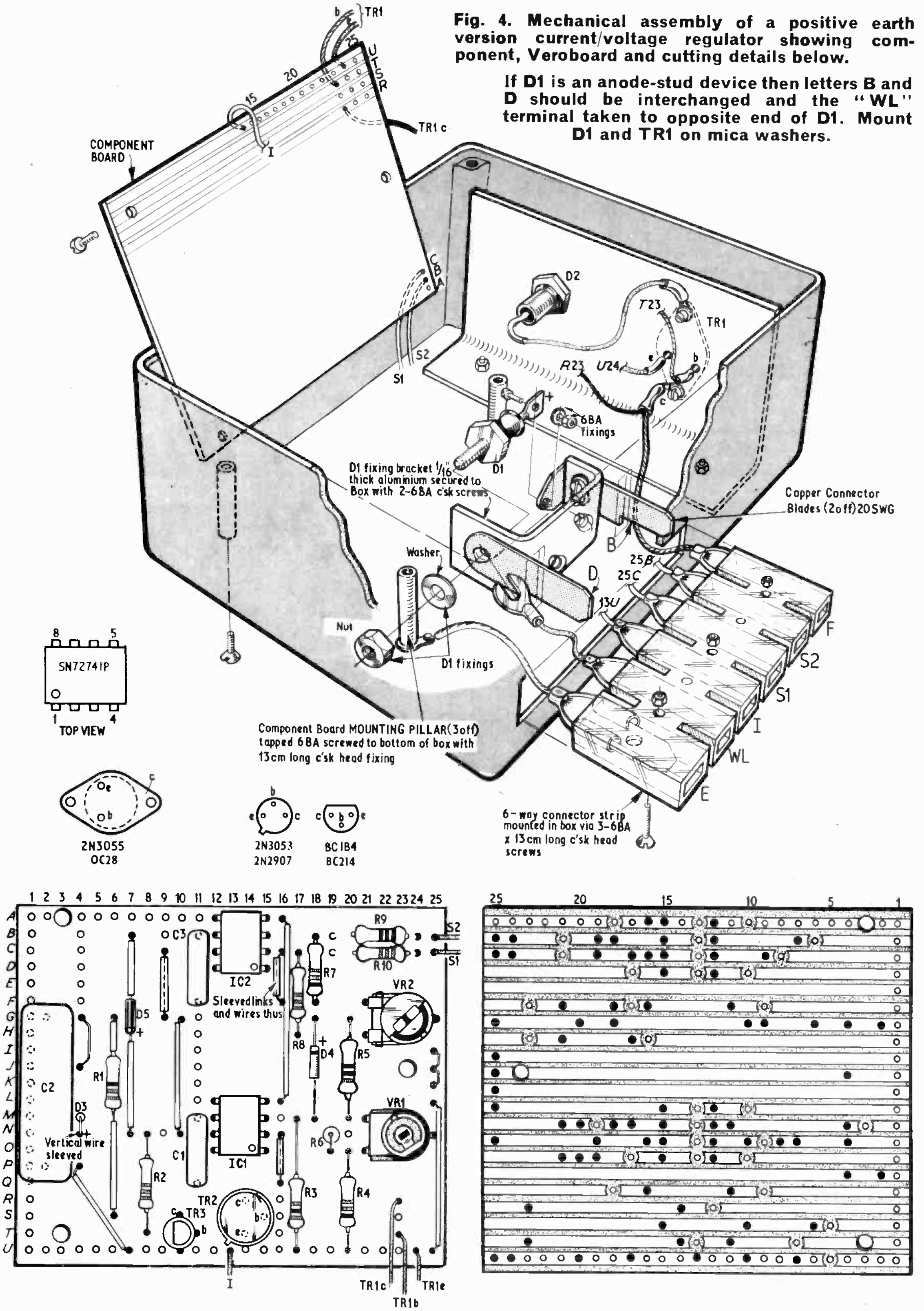
Fig. 3. (Right) Added circuit to give current regulation as well as voltage regulation

TABLE 2
For NEGATIVE Earth vehicles the following alterations apply

ITEM	ACTION
ICI	Reverse pins 4 and 7
Earth	Becomes −Ve
−Ve	,, +Ve
D5	Reverse

Fig. 4. Mechanical assembly of a positive earth version current/voltage regulator showing component, Veroboard and cutting details below.

If D1 is an anode-stud device then letters B and D should be interchanged and the "WL" terminal taken to opposite end of D1. Mount D1 and TR1 on mica washers.



CONSTRUCTION

The unit is housed in a die-cast box, as it is important to prevent ingress of moisture or oil.

The positive earth version is slightly easier to build as the generator flywheel diode D2 can be fitted direct to chassis.

Almost any car can be instantly converted from one polarity to the other, simply by removing the existing regulator, turning round the battery, and fitting the appropriate solid state regulator. Any car radio or other devices must also be adjusted for the correct polarity to prevent damage.

To make the unit physically compatible with a vehicle wiring system, it is fitted with blade connectors, ⅜in wide for the high current connections to the diode D1 and ¼in wide for the rest. The ¼in blade connectors are available in strips of 12 blades from auto electric dealers and resemble barrier strips.

The voltage regulator unit requires a four blade block to be cut from a strip, and the current/voltage regulator requires six blades. This connector block is mounted in the base of the box so as to project through a slot drilled and filed in the side.

The diode D1 should be fitted next, and as it passes a heavy current, should be well coupled thermally to the box. It must, however, be very carefully insulated from the box, as any short circuit between the two could cause severe damage to the wiring of the car.

Thus the diode is bolted directly to a 16 s.w.g. aluminium bracket, and the nut also holds the copper connector blade for the cathode (+ earth only and a tag washer). The ⅜in connector blades are made from ⅜in wide copper conduit clips, available from an electrical dealer. These clips can easily be straightened, cut and filed to size. See Fig. 4.

INSULATION

The anode connection to the diode is similarly made, and should be fastened to the diode bracket with nylon screws, and with a piece of mica for insulation. A 6BA tag washer should be included on the screw connecting the anode terminal to the blade (negative earth only).

The diode assembly should now be used to mark out two slots for the blades, and the mounting holes. Remember that the lid of the box has a flange which comes below the top of the box sides. This must not be allowed to touch the diode bracket.

The diode bracket should be fitted with nylon screws and a thin mica sheet between it and the box. Silicone grease must be used on both sides of the mica. If mica is not available, the diode bracket can be spaced off with TO3 transistor bushes, and the gap filled with silicone grease.

The assembly should be thoroughly tested, preferably with a battery and light bulb, to show that the diode is functioning, and that both its terminals are insulated from the box side.

If an ohmmeter is available, the insulation between the body of the diode and the box should be at least 1MΩ.

When tested, the space around the blades can be filled with silicone rubber to make the box watertight again.

Next, the heat sink for D2 and TR1 should be made, and these components fitted. TR1 should be fitted with a mica washer and a tag washer under both collector bolts. Check the insulation. D2 may be bolted direct to the heat sink for the positive earth version, but for the negative earth version it must be insulated, and a tag washer fitted for connection purposes, or an anode stud diode must be used.

CIRCUITRY

Having tested the insulation if necessary of the diode the appropriate end should be connected to the adjacent collector tag of the power transistor. The heat sink should now be fitted to the box.

The rest of the circuitry may be built on a small piece of 0·1in matrix Veroboard and mounted in the box with 6BA standoff screws and nuts. Because of the vibration environment, the transistors should be fitted with mounting pads. Do not use i.c. sockets.

The wiring should be completed as per the diagram and checked. The connections to the rear of the blade connector block are made with ¼in push connectors crimped or soldered to the wires.

In the positive earth version, the ignition warning light terminal WL is connected to the cathode tag washer of D1, and in the negative earth version, to the anode tag.

TESTING AND ADJUSTMENT

Only the voltage regulator can be tested out of the vehicle. If the current regulator is to be added, leave out the diode D5 until the voltage regulator has been tested.

COMPONENTS . . .

Resistors

R1	3·3kΩ ¼W 5%		R4	3·3kΩ ¼W 5%
R2	10kΩ ¼W 5%		R5	2·2kΩ ¼W 5%
R3	1·2kΩ ¼W 5%		R6	10kΩ ¼W 5%
R7–R10	5·6kΩ ¼W 2% (4 off)			

Potentiometers

VR1 1kΩ miniature preset
VR2 470Ω miniature preset

Capacitors

C1 0·1μF 250V
C2 2·2μF 50V (NOT electrolytic)
C3 0·1μF 250V Polyester

Integrated Circuits

IC1 SN72741 P. 8-pin DIL version
1C2 SN72741 P. 8-pin DIL version
Both IC1 and 2 may be replaced with one unit, the SN72747 N which is a dual 741 but cost will increase.

Transistors

TR1 2N3055 (pos earth). 2N3614 (neg earth)
TR2 2N3053 (pos earth). 2N2907 (neg earth)
TR3 BC184 (pos earth). BC214 (neg earth)

Diodes

D1 35A, 50V p.i.v. silicon diode
D2 10A, 50V p.i.v. silicon diode
D3 General purpose silicon diode
D4 BZY88, C5V1. 5·1V 400mW Zener
D5 General purpose silicon diode

Miscellaneous

Case, Eddystone diecast box 3½in × 4½in × 2in. Veroboard, 0·1in Matrix, 2½in × 1¾in. 1 × 12 way, ¼in blade connector strip and connectors. Assorted aluminium sheet, washers, mica, nuts and screws to suit

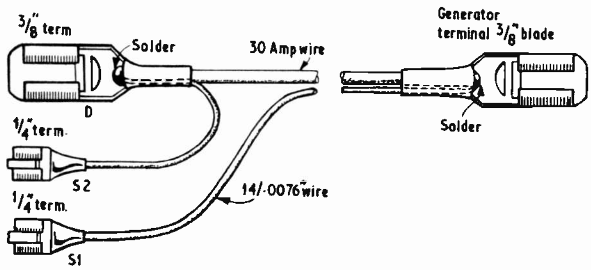


Fig. 5. Current sensing generator cable

Connect a 24W (or similar) bulb (12V) from terminal F to earth and earth the box. Turn VR1 until the wiper is at the R6 and R4 end of the track. Connect the live battery wire, in series with a 5A fuse to the I terminal. (The fuse is to protect you and the car if a short exists.) The bulb should not light.

If the wiper of VR1 is now advanced along the track, the bulb should light about ⅓-way along. This simulates a fall in battery voltage turning on the field current. Now take an ordinary 1·5V U2 battery, and connect it in series with the car battery lead to I so that the voltages add. Turn the wiper so that the bulb is *just* extinguished with the two batteries in series. If the U2 is removed and the car battery reconnected the bulb should now light again. If this procedure has been followed correctly the preset VR1 should be approximately adjusted.

The box should now be temporarily installed. Locate the old regulator and record the positions of the wires connected to it. Disconnect the live end of the car battery, and remove the wires from the old regulator, and re-connect them, terminal by terminal, to the blades on the box. Take a new wire from terminal I to any point which is switched by the ignition switch, e.g. the live side of the ignition coil, or the wiper switch.

Reconnect the battery. If there are any large sparks when attempting this, recheck the insulation of D1, and ensure it is reverse biased when the engine is stationary! If all is well, connect an accurate voltmeter across the battery and start the engine. The red ignition light should go out, and as revs increase, the voltage should rise to a little over 13V and stay there for any higher revs. The ammeter should show a charging current, which will reduce as the battery recharges after starting.

VR1 should now be accurately adjusted, with the engine revving, to set the voltage to the makers' recommended value. This can be found from a workshop manual, or from your garage, but will not be far from 15V.

CURRENT REGULATOR

If the voltage regulator only has been built, it is now complete. Disconnect the battery, remove the box, make sure all the screws are tight, then re-fit it permanently and fit the lid. After another quick check, the unit can be virtually forgotten if it has been built correctly.

For the current regulator version, now fit D5 (make sure you refer to the correct diagram, and get the polarity right), and make up a special current sensing generator cable Fig. 5.

The generator cable in most cars has a connector block in it and the contact resistance of this will spoil the accuracy of the current regulator or could prevent any charging!

The new cable must be in one piece and of adequate rating (30A). At the generator end, the sense wire and the current carrying wire should be soldered together into the same ⅜in blade connector, and pushed on to the generator in place of the old cable which should be tied back and insulated, for re-use, should you wish to dispose of the car and retain the regulator.

Both wires should be taken to the regulator, where a separate wire should be taken from the end of the current cable to blade S2. This again is to eliminate the contact resistance of the ⅜in generator blade connection. The sense wire from the generator end of the cable should go to blade S1. The sense wire need not be very thick, as it is in series with 5·6kΩ resistors, which serve to swamp the contact resistance of S1 and S2 connections, and little current flows. Use 14/0076 wire or equivalent for robustness.

The next step is to measure the resistance of the current carrying conductor. As a guide, 6ft of 30A cable has approximately one hundredth (0·01Ω) of an ohm resistance.

Measure the current taken by, say, a headlamp, and call it I. Now connect the generator cable firmly in the same current path, and with a voltmeter on a range of approximately 0·25V f.s.d. measure the voltage across the S1 and S2 connections, and call it V.

The maximum safe current for the average generator is 20A and the object of this exercise is to find out what potential will exist across the sensing cable when 20A is flowing. This voltage will be given by

$$V_{20A} = 20 \times \frac{V}{I},$$

where $\frac{V}{I}$ is the resistance of the wire calculated from the noted values.

INSTALLATION

Now install the regulator as before, and fit the current sensing leads. The regulator should now have no blade without a connection to the car.

Set the wiper of VR2 to the R7 end of the track, reconnect the battery and start up. The ignition light should stay on, even when revving up. Now connect the voltmeter across S1 and S2 and slowly advance VR2 until a reading is obtained, again with the engine revving. If the full headlights and windscreen wipers are switched on, to load the generator, then VR2 can be advanced, so that the voltage across S1 and S2 is the value V_{20A} that you calculated beforehand but not more. VR2 is now adjusted, and final installation can take place as before.

Finally, a word of warning. A car battery has a very low output resistance, and if it is shorted out, several hundred amps may flow. If a spanner is dropped across the terminals, it may be melted, or if you short out a wire you are holding, you could be burned. Before making any modification to a car's wiring, if you are inexperienced, disconnect the battery first. The battery should also be disconnected if you use a charger, with this regulator, to protect the semiconductors from transients. ★

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PRACTICAL
ELECTRONICS

MARCH ISSUE ON SALE FEBRUARY 8, 1974

Subject to the current National industrial situation at the time of going to press

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* Keys react with positive click when pressed.
* Clear-last-entry feature.
* Automatic ('implied') constant – no need for separate operating button.
* Common-sense ('algebraic') logic – enter calculations just as you write them.
* Calculates to 8 significant digits; fully floating decimal point positions itself automatically.
* Clear, bright 8-digit display.
* Unwanted zeros are suppressed.
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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.

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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.
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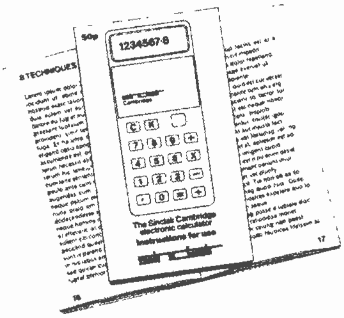

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PLEASE PRINT

Audio/Visual THERMOMETER

By M. PLANT

ONE of the great advantages of using a thermistor sensor in an electronic thermometer is the rapidity with which temperature measurements can be made. If you combine this facet with audio and visual indication when a preset temperature is reached, one can see the versatility of the unit to be described.

The unit can be calibrated for 0°C if it is intended for use as a frost alarm for an orchard, hatchery or greenhouse. At this setting it is a useful car accessory, warning of icy roads.

CIRCUIT OPERATION

It is best to regard the circuit of Fig. 1 as consisting of two parts divided by the dotted line. The part to the left of the line is a sensitive electronic switch producing a positive voltage at the collector of TR3 when the thermistor temperature has fallen to a value which is predetermined by the setting of the potentiometer VR3. That part to the right is a two transistor (complementary pair) astable oscillator which is d.c. coupled to the preceding circuit by R9 and is switched on by the rising voltage across R8 when TR3 begins to conduct. The oscillator produces a note, the frequency of which is to some extent determined by the value of C1.

A light emitting diode provides the load in the emitter of TR4 and lights up, actually pulsing at the frequency of the note which is heard from the loudspeaker.

TR1 and TR2 are connected as a long-tailed pair since they share a common emitter resistor R3. The base of TR1 is connected to the voltage divider made up of the temperature sensitive combination TH1, VR1 and VR2. The base of TR2 is connected to the voltage divider consisting of the series combination VR3, R4, R5 and R6.

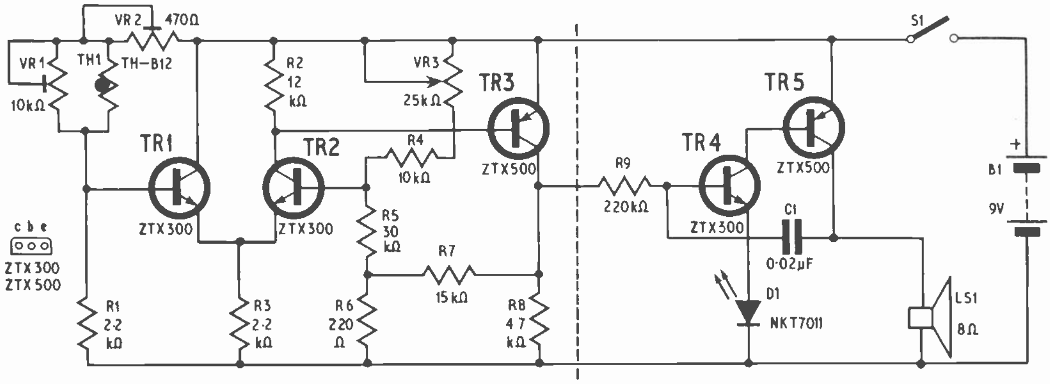


Fig. 1. Circuit diagram of thermometer

TEMPERATURE SETTING

Suppose that the base of TR2 is arranged at 3V by the temperature setting control VR3 and TR1 is at 2V. Since the emitters of these two transistors will take up the higher of these two voltages, the base/emitter junction of TR1 will be reverse-biased and that of TR2 will be forward biased. Hence TR3 will be switched on in turn switching on the oscillator due to the voltage drop across R8.

As the temperature of the thermistor increases its resistance falls since it is a negative temperature coefficient type. Thus the voltage drop across TH1 falls and the base voltage of TR1 rises. As it reaches 3V, the base voltage of TR2, both transistors are on and the speaker remains sounding a note. But as the base voltage of TR1 rises the base/emitter of TR2 become reverse biased, so that TR3 switches off hence switching off the oscillator.

TR1 and TR2 actually form a differential amplifier the on/off states of which are immune to changes of battery voltage and circuit temperature. It is both sensitive and stable giving reliable readings during the life of the battery and under different environmental temperatures.

FEEDBACK

In order that the switching on and off of TR3 is precise, positive feedback is provided by R7 between the collector of TR3 and the base of TR2.

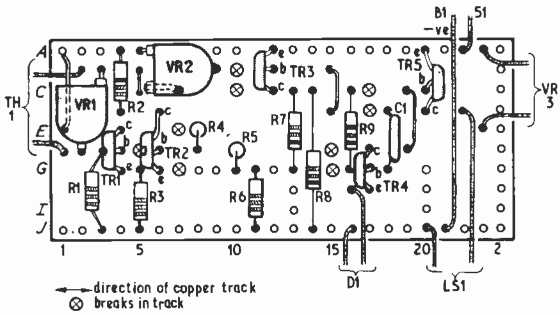


Fig. 2. Component layout and wiring

A fraction of the rising voltage across R8, as TR3 begins to switch on, is fed back to the junction of R5 and R6 which enhances the rising base voltage of TR2 so encouraging this transistor to switch hard on and hence TR3.

ASSEMBLY DETAILS

A $2\frac{1}{2} \times 1$in, 0·1in matrix Veroboard is used for mounting the majority of small components as in Fig. 2. The cuts to be made in the copper tracks are marked with an X.

The housing for the prototype unit was a Kodachrome transparency box which provided enough space for the board assembly, speaker, switch, temperature potentiometer and battery and kept the whole unit to pocket sized proportions.

Two types of thermistor are recommended for the thermometer. The cheaper one, VA1098, has a resistance of about 4·7 kilohms at 25°C and although its disc like structure enables connecting leads to

COMPONENTS . . .

Resistors

R1 2·2kΩ	R6 220Ω
R2 12kΩ	R7 15kΩ
R3 2·2kΩ	R8 4·7kΩ
R4 10kΩ	R9 220kΩ
R5 30kΩ	

All ¼W 5% carbon

Capacitor
C1 0·02μF

Transistors
TR1, TR2, TR4 ZTX300 (3 off)
TR3, TR5 ZTX500 (2 off)

Diode
D1 NKT 7011 l.e.d.

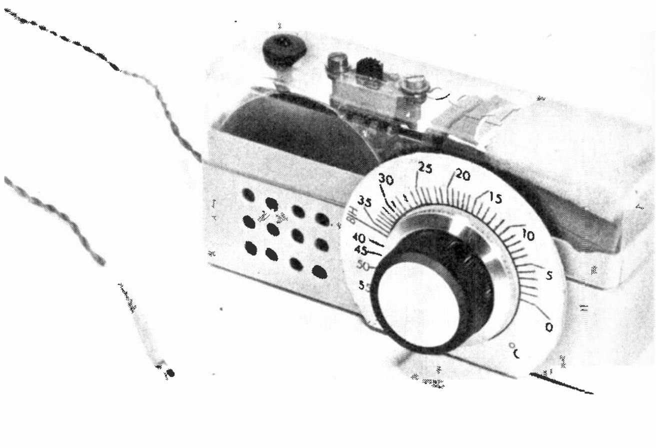
Thermistor
TH1 TH-B12 *or* VA1098 (see text)

Potentiometers
VR1 10kΩ cermet preset
VR2 470Ω cermet preset
VR3 25kΩ min. carbon, linear

Miscellaneous
B1—9V PP3, S1—on/off switch, LS1—2in, 8Ω miniature loudspeaker

be attached to it easily, there is the problem of insulating the semiconducting disc against the action of conducting liquids in which it might be immersed. For this reason the glass encapsulated bead type TH-B12 is to be preferred.

In order that the leads can be insulated from contact with liquids, heat-shrinkable sleeving of 3mm diameter was used extending half way up the stem of the glass encapsulation.



The finished thermometer. Note the clearly delineated temperature scale

CALIBRATION

To calibrate the thermometer a cardboard disc of about 2in diameter should be arranged to go under the fixing nut of VR3. A pointer knob is next attached to the spindle. First crush a few cubes of ice and place them in a container with some cold water. Strap the thermistor to the bulb of a 0–100°C thermometer and use the whole to stir the ice/water admixture.

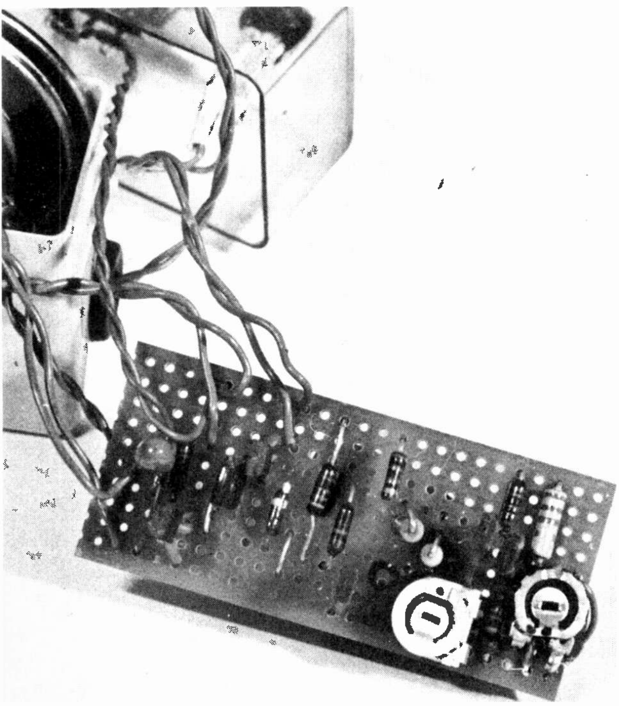
When the temperature has reached 0°C rotate the knob of VR3 until the l.e.d. comes on and the speaker sounds. Use the marker on the knob to pencil a line on the cardboard disc indicating 0°C.

Heat the ice-water gently until the ice has melted and at degree intervals mark the cardboard disc with the appropriate temperature. When the dial has been calibrated in this way, remove it and ink in the marks and the temperatures. When replacing the disc behind the nut ensure that it is placed in the original position and check by using the melting ice again that the disc, in relation to the angular position of the potentiometer, has not changed.

RESOLUTION

To ensure a resolution of 1°C between 0 and 65°C and of 3°C between 65 and 80°C the presets VR1 and VR2 are included in the circuit. Prior to the calibration process these should be adjusted to about 7 kilohms and 400 ohms respectively to achieve this. ★

Layout of components on the small piece of Veroboard



INGENUITY UNLIMITED

ELECTRONIC DOORBELL

The circuit is basically one multivibrator running at a chosen audio frequency and switched on and off by another running at a few hertz. The pulsed signal is then amplified and fed to a loudspeaker.

The circuit diagram is shown in Fig. 1, and it operates in a similar manner to the conventional multivibrator. When power is applied circuit imbalances will favour one gate, assuming that they operate such that pin 6 goes towards the positive supply rail then C1 will charge up through R1. At first the voltage across R1 will be large but as C1 charges the voltage will fall until logic state 0 is reached at about 1·5V.

Since an unused input to a gate is at logic state 1 the output of the gate connected to R1 will be controlled by the input on pin 2, and will be in the opposite state.

Therefore when pin 2 falls to a 0 pin 3 will go to 1, causing C2 to charge up through R2 in a similar manner to C1/R1. When the voltage on pin 4 falls to logic state 0 the output on pin 6 will go to 1 and the cycle will begin again with C1 charging.

C1 will have discharged during the time when C2 was charging as at that time pin 6 will have been at 0 due to the 1 on pin 4. Similarly C2 discharges while C1 is charging.

The abrupt change of state as the logic thresholds are reached produces a square wave output. The output of the low frequency (switching) multivibrator is applied to an input of one of the gates in the tone multivibrator, and since the output of a gate will not change if an input is held at 0 the tone oscillator only runs when the output of the low frequency oscillator puts a 1 on pin 1.

A. Piper,
Teddington, Middx.

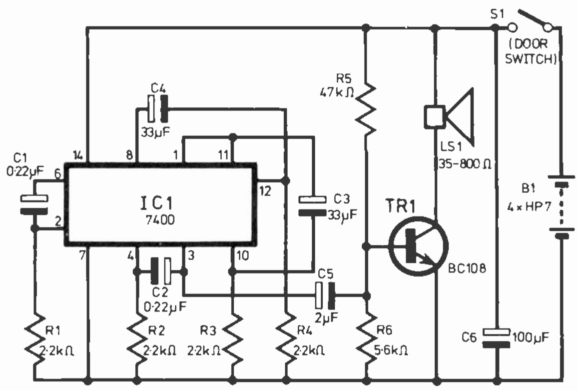
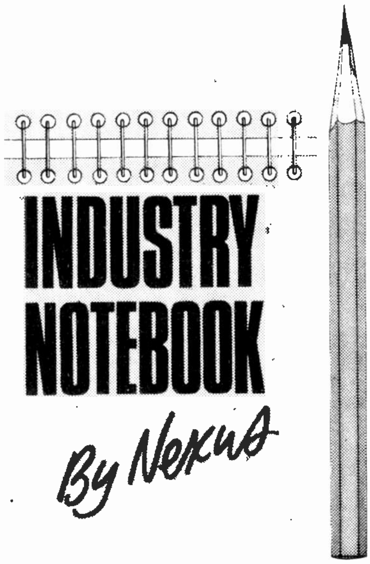


Fig. 1. Circuit diagram of the doorbell



TEST GEAR PERKS UP

After four dreary years of stagnation the UK instrument industry has come into a long-awaited growth phase in 1973, and 1974 looks even better with more investment capital about.

Britain's largest and strongest indigenous instrument specialist, Marconi Instruments, is expecting to top £10 million turnover in 1974. The USA is still MI's best individual country but in total volume Europe is the biggest market and getting better all the time. But they are also strong in Eastern Europe, including the Soviet Union, and have healthy and improving business in Australasia and the Middle and Near East. The Far East market is patchy although 1973 showed a lot of improvement following participation in the British exhibition in Peking.

With an engineering department of 230 people, 90 of them design engineers, the level of innovation is high and with three BCS-approved calibration laboratories MI's technical capability is beyond question. Large investment in development is now beginning to surface and no less than 14 new products are in process of being brought to the market.

Some equipment I have seen in their labs are more systems than instruments, for example the fully automated TV test equipment which monitors picture quality, provides a printout of performance at pre-arranged intervals and sounds the alarm for deterioration of quality before the viewer would even notice it.

Scheduled for early 1974 is a new spectrum analyser which is definitely in the world class, and a white noise equipment with a number of technical advances. MI's Autotest automatic testing systems are now doing well.

The upturn in instrument business was confirmed by Peter Finch, managing director of Labhire, the rental company. Having got the company well established in the UK, Finch is now branching out in Europe. His French operation, based in Paris, is headed by Guy Goulet, formerly head of Schlumberger's sales network in France. A Dusseldorf office has been opened under Rainer Mader and a second base in Germany is soon to be set up in Munich under Kuno Vinbruck, formerly Schlumberger's sales co-ordinator in Germany.

Nothing if not ambitious, Finch is busily planning expansion of the Labhire service into Scandinavia, Italy and Spain. Europe, he believes, has fantastic potential for instrument hire. The belief is clearly shared by the top Schlumberger executives who have joined him in the enterprise.

NEW ARRIVAL

A market revival always attracts new entrants. Look out for a miniature oscilloscope from Lawtronics, better known as a semiconductor distributor in Kent. Bernard Lawson has one on the stocks, battery-operated and weighing but 3lbs. Specification is said to include 10MHz bandwith and 10mV sensitivity at 1MHz and 500mV at 10MHz. Price not yet fixed but I understand it will be less than £100.

Initially Lawson plans to put manufacture out to sub-contract but hopes to set up his own plant, in which case the Pocket Scope will be supplemented by a whole range of tiny instruments.

COMPONENT HEADACHES

Component supply is still a headache. Because big users have been ordering here, there and everywhere in the hope of getting what they can, the manufacturers have only the slightest idea of what the demand really is. All they know with certainty is that business has never been better.

Harlow-based B & R Relays tell me that their problem as a manufacturer is now materials supply. Some types of plastics as well as steel are getting difficult. And a sign of the times is that Siemens' flat-pack relays which B & R import as a factored line are selling better than ever despite a price rise (from devaluation of the Pound in relation to the DM) of what at one time would have been a crippling 30 per cent in a single year. Price, says B & R managing director Brian Austin, is no barrier if the product is really needed.

A change in marketing policy for 1974 is also announced by B & R. A decision has been made to sell small quantities (typically 200-off or less) through distributor stockists while the big orders, such as one for 20,000-off recently won, will be handled direct.

HUGE MLS MARKET

A £1,000 million market is not to be sneezed at. This is the estimate for Microwave Landing Systems (MLS) to replace the present Instrument Landing Systems (ILS) at the world's airports. ILS is at the limit of technical "stretch", the best examples being seen at London Airport, Heathrow, and at Dulles, USA, and Orly, France, all of which have Category III installations for fully automatic landing.

There are several problems with ILS, the most important being siting constraints which introduce difficulty at many airports, and the heavy operational constraints because aircraft have to follow a precisely defined centre-line and glide-slope approach.

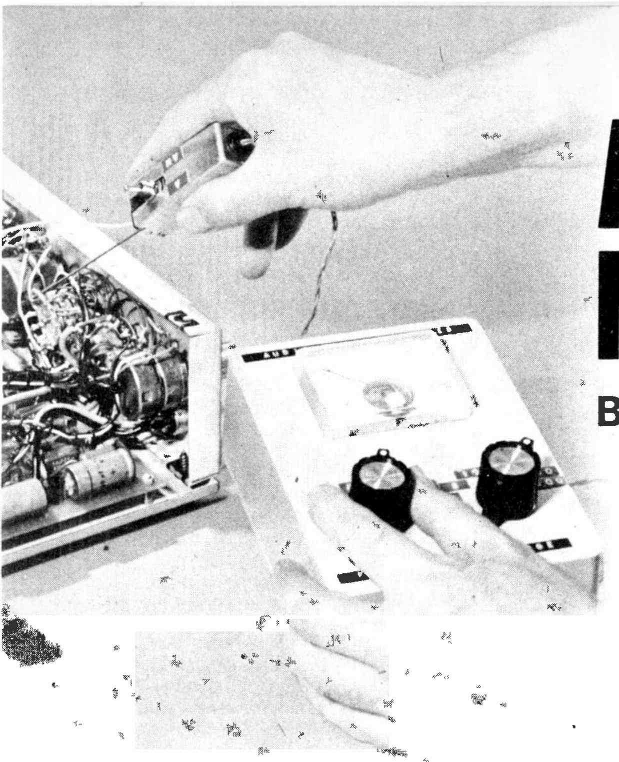
With MLS, which will operate at 5GHz, it is much simpler to install and aircraft can make their approaches on a curved path and at what angle of descent is most appropriate — a big plus-feature with new generations of STOL and VTOL aircraft on the drawing board.

Technical proposals for MLS are currently being submitted to a Working Group of the International Civil Aviation Organisation (ICAO) All Weather Operations Panel. The two basic proposals under consideration are a microwave scanning beam system and a commutated Doppler technique. The British proposal is for the latter and Plessey Radar is involved in a £1 million development programme in co-operation with the Ministry of Defence Procurement Executive and the Department of Trade and Industry.

The commutated Doppler principle is due to the British navaids pioneer Charles Earp who is a consultant to Plessey Radar. First hardware for the proposed system will be delivered to the Royal Aircraft Establishment for evaluation trials by mid-74.

Meantime, it will be up to ICAO to decide on the best system from technical proposals put forward by the UK, USA, Germany, France and Australia. Decision will be purely on technical merit and whatever the system finally decided upon there will be plenty of work for all the "contestants".

Safety of passengers is an essential so MLS will have a long evaluation period and first operational systems are not expected to be in service before 1980.



AUDIO MILLIVOLTMETER

By J. N. WATT

SPECIFICATION

Ranges	1mV to 100V r.m.s. f.s.d. in 11 ranges
Frequency response	30Hz to >50kHz
Input impedance	1M Ω
Accuracy	3% f.s.d.
Amplifier output	0·5V r.m.s.
Power supply	Two nine volt batteries

MOST of the multi-range testmeters used by home experimenters have a.c. ranges that do not extend down to as low levels as the d.c. ranges. This is a pity, for such testmeters often have a frequency response up to at least a few kilohertz, and meaningful measurements on audio amplifiers would frequently be useful if they could be made at the lower levels commonly encountered.

This lack of sensitivity makes it impossible to trace signals through a multi-stage amplifier or through a filter, for example. The measurement of hum levels on supply lines, via a d.c. blocking capacitor, is another field where a highly sensitive meter would be an advantage.

It was with these factors in mind that the unit described here was put together. It has a full scale deflection, on the most sensitive range, of 1mV, a frequency range of 30Hz to at least 50kHz, and an input impedance of 1MΩ.

An additional feature is the capability of the unit being used as an amplifier with a voltage gain of up to 500, and for this purpose an output socket is provided, with the internal meter switched out.

Thus a useful pre-amplifier stage for oscilloscopes and amplifiers is available.

SEPARATE PROBE

The instrument described here consists of two principal parts, namely the main unit, containing the meter, fine range and function switching and the meter amplifier, and a small probe, which contains an f.e.t. pre-amplifier and a divide-by-1,000 switch for coarse range switching.

Why is it necessary to have this separate probe? Consider the situation where a pair of test leads, say 1ft long, are used to connect a test instrument to an amplifier or other equipment under test. It is quite likely that the capacity existing between this pair of leads could be 30pF or so, which corresponds to a reactance of 1MΩ at only 4kHz.

Since this millivoltmeter has been arranged to have an input impedance of 1MΩ (so that no undue loading of the circuit under test should occur), it follows that at a frequency of 4kHz an error in measurement by a factor of about two would be present; at higher frequencies these errors would become worse, so that at 20kHz the reading registered on the millivoltmeter would be about 17 per cent of the correct value.

An external probe improves matters in the following manner. Connections from the small, readily handled probe to the test circuit are easily kept very short and can in fact be no more than an inch or two if required.

The circuit contained in the probe has a high input impedance and a low output impedance, and thus the impedance level at which signals are conveyed to the main unit is very much lower than 1MΩ (in point of fact it is of the order of 1kΩ), so that although the probe is used on a lead of about one foot in length and of perhaps 30pF self capacitance, no error due to that capacitance arises.

FREQUENCY RESPONSE

Theoretically, this particular layout would introduce no error until a frequency of about 6MHz is reached—a frequency well beyond the upper limit of the main instrument.

This raises the question of frequency response. The lower limit of 30Hz should cover most audio requirements and ensure that measurements can be made of 50Hz mains ripple on supply lines, etc.

The upper limit is quoted at 50kHz simply because it was found that the unit was linear up to that point and 50kHz was the upper limit of the author's audio test gear! Investigation with an r.f. generator was unfruitful, since the millivoltmeter had been designed to have an upper limit of about 100kHz.

The upper limit was set at this point for two reasons. Firstly, with the readily available integrated circuit employed, attempts to obtain reliable amplification at much higher frequencies would most likely lead to instability problems, unless stringent precautions in respect of layout were taken. This could have created difficulties in a home construction design.

Secondly, with such an upper limit, spurious pick-up of high power broadcasting stations such as Radio 2 on 200kHz will not cause difficulties.

At the same time, the quoted upper limit of 50kHz is so far above the audio spectrum that no doubt about the instrument's fidelity could be levelled at it on that score.

CIRCUIT OPERATION

Consider now the overall circuit diagram of Fig. 1. Input to the probe is *via* S1 (used to select either volts or millivolts range) which, in the "mV" position passes the signal, via C3 and R4, to TR1. Capacitor C3 is a d.c. blocking capacitor, R3 is the gate resistor of TR1 and sets the input impedance on the "mV" setting of S1, while R4 limits any gate current to a safe value. Excessive gate current could otherwise flow, due, for instance, to charging and discharging of C3 whenever the probe input was connected to a point at a high d.c. potential.

With S1 in the "V" position, division of the input voltage by a factor of 1,000 takes place by means of R1 and R2, with C1 and C2 providing frequency compensation.

Without these two capacitors, stray capacitance across R1, R2 and S1 would give unequal voltage division at different frequencies. Details of how C1 is adjusted for best performance are given later.

The transistors TR1 and TR2 are used in a very stable configuration in which a voltage gain of about six times is obtained. Only TR1 however is in the probe itself, TR2 and its associated collector load resistors being housed in the main unit, thus allowing the probe to be built in as small a volume as possible.

The signal paths from the probe to the main unit are in fact the source lead of TR1 which is at low impedance, and the connection to the base of TR2, similarly at low impedance.

Variable resistor VR1, decoupled by C4, is required so that the correct d.c. working voltage can be set at TR2 collector, thus allowing for the rather wide spread of characteristics usually found in the low cost f.e.t. used for TR1.

The amplified signal appearing at TR2 collector is passed to the high accuracy attenuator R8 to R13, the appropriate range then being selected by S2 for further signal amplification by IC1.

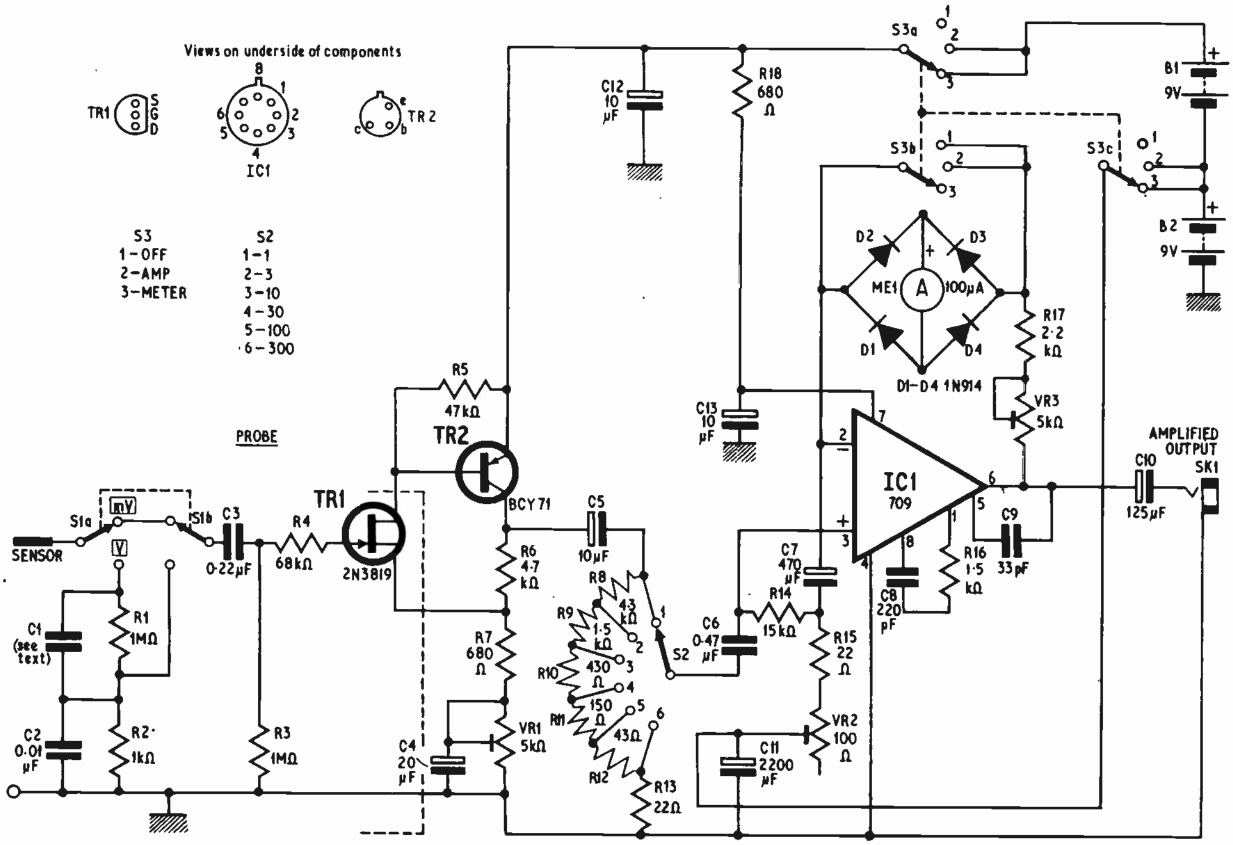


Fig. 1. Circuit diagram of the Audio Millivoltmeter. The circuit to the left of the dotted line is that contained within the separate probe

This particular integrated circuit is probably the most readily available linear i.c. on the market and is advertised under various type numbers, all of which include the figures "709". We require the TO99 (similar to TO5) version.

INTEGRATED CIRCUIT AMPLIFIER

Integrated circuit IC1 is arranged as a non-inverting amplifier, i.e. the output is in phase with the input. The output is fed back, via the bridge rectifier D1 to D4 and the meter, to the inverting input, and, due to the very high gain available in IC1, the signal at the inverting input terminal closely follows that at the non-inverting input.

Since C7 has a negligible reactance, current through R15 and VR2, and hence through the meter, depends only on the input voltage. This is the case even with the diodes included in the circuit and hence linearity is assured even at small signal levels.

It is this effect that enables the instrument to respond accurately to signals as small as 1mV.

Signals fed back from the output of IC1 appear in phase with the input signal at the lower end of R14, thus R14 has signals of almost equal amplitude and of the same phase at each end, so that its apparent value is thereby very much greater than its actual value, so increasing the input impedance of the i.c. stage. This effect is known as "bootstrapping".

This bootstrapping method of increasing input impedance prevents loading of the attenuator R8 to R13, while at the same time it allows the use of a resistor of fairly low value for R14.

A greater value resistor in this position could cause d.c. offset at the input to IC1 due to the unavoidable current flowing in R14 from the i.c. non-inverting input terminal, caused by base current in the i.c.'s input stage.

Keeping R14 down to the value employed here ensures that this effect gives rise to no inaccuracy in meter deflection.

The capacitor C7 has been chosen to be 470μF to ensure that little phase shift occurs in the signal fed back to the lower end of R14 even at low frequencies, so preserving the bootstrap effect.

VOLTAGE LINES

The sensitivity of the millivoltmeter is set by adjustment of VR2 by a method to be described later. This resistor is returned to the +9V line, so ensuring that the non-inverting input of the i.c. (and hence, by the negative feedback action already described, the inverting input also) is maintained at about half way between the positive supply rail (in this case +18V) and the negative supply rail (in this case ground).

Often, it is arranged that these supply rails lie either side of zero potential, e.g. +15V and −15V, but in this case it was thought best to earth one side of the supply and use a centre-tapped battery to produce the same effect in the manner described.

The very large value of capacitor employed for C11 ensures that the source impedance of the +9V rail is maintained at a sufficiently low value even at the lowest frequency at which the millivoltmeter is to be used. Unwanted impedance here would have the effect of increasing the apparent value of R15 plus VR2; this unwanted increase would have led to incorrect meter deflection at the lower frequencies.

DECOUPLING AND FREQUENCY COMPENSATION

Since both the pre-amplifier stage (TR1 and TR2) and the main amplifier (IC1) are both arranged as non-inverting amplifiers, there is a danger that via the +18V supply rail, thereby leading to errors. coupling could take place between the two stages Accordingly, R18 and C13 are incorporated to decouple the supply to IC1.

Components C8, R16 and C9 have the values recommended by the i.c. manufacturer for stable operation under the gain/frequency conditions used here, and serve to limit the frequency response to the desired value, as mentioned earlier.

Variable resisitor VR3 and fixed resistor R17 set the overall gain of the main amplifier stage to give a convenient level at the output when the instrument is used in the "amplifier" mode. In that condition, the diode bridge D1 to D4 is shorted out by the pole of S3b; if these diodes were to remain in circuit, distortion of the output waveform would result, due to their almost constant voltage drop.

Before going on to constructional details, it is worth noting that the gain of the pre-amplifier is determined by the ratio of the value of two resistors, namely R6 and R7, while in the main amplifier, meter deflection is set by the value of the combination of R15 and VR2.

These methods of stabilising gain mean that any alterations in transistor or i.c. parameters have no deleterious effect on the meter reading. Further, the additional complexity of a stabilised power supply, together with the resultant power consumption, is thereby rendered unnecessary.

CONSTRUCTION

Practical construction can be arranged to suit individual requirements, but that shown in Figs. 2 and 3 is recommended.

A robust die-cast box gives both excellent mechanical protection and electrical screening and the size chosen is small enough to make the instrument light and readily handled.

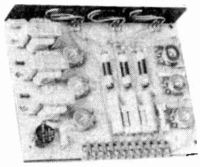
Construction of the probe (Fig. 2) will depend to some extent on what is available to the particular constructor. In the author's case, a screening can from a valve type i.f. transformer was employed (an old TV set is one good source of supply), but provided the general layout is followed, almost any metal container of the appropriate size can be used.

The switch S1 is held down to the strip of 0·1in Veroboard by thin tinned copper wires threaded through its terminals. A slot cut in the can side takes the switch bush and this is retained by the fixing nut.

The coil former was cut away from its base and then discarded, and the Veroboard joined to the base by means of wire soldered into three of the six terminal holes; one of these wires is continued through on the outside as an earth connector to the equipment under test, while the centre one is brought out using 18 s.w.g. tinned copper wire to form a probe, for signal input.

Three wires are passed through the centre hole at the top of the can to connect the probe to the main unit, while the Veroboard holding the components is wrapped in a piece of polythene sheet to guard against inadvertent contact with the case.

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 × 7in × 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.

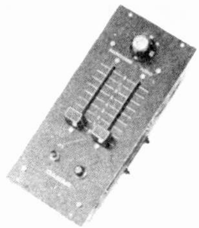
As optional extras, an attractive ready-punched facia panel and control knobs are available. The unit is available as a ready built mixer with facia.

Size: 9.5in × 4·8in × 1·5in (with facia).

Construction manual available separately at 25p.

Kit Price £11.

STL/1 Single Channel Sound to Light Unit

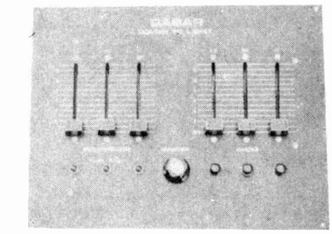


Single channel "Sound to Light" unit with 60mm slider fader controls for audio trigger level and background load dimmer.
This unit is switchable for response to High, Mid. and Low frequency audio signals, selected by facia control. A D.J. "pulse-flash" push button is fitted for manual flashing of the lamp load together with neon load indicator.
Maximum Load: 1kW at 240V a.c.
Size: 8in × 3·6in × 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 × 4·5in × 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 facia 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 × 8·5in × 4in. **Price £42·35.**

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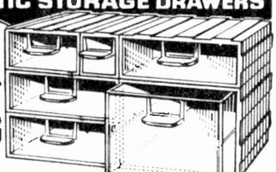

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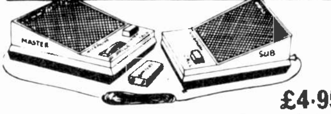

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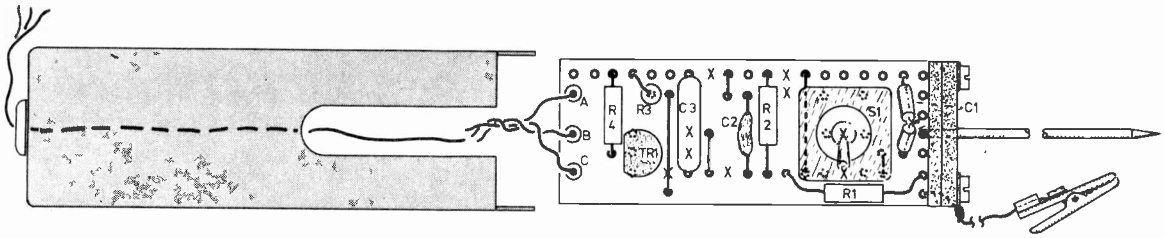


Fig. 2. Construction of the probe which forms a separate hand-held unit. The circuit on the Veroboard must be screened; an old coil screening can was used in the prototype

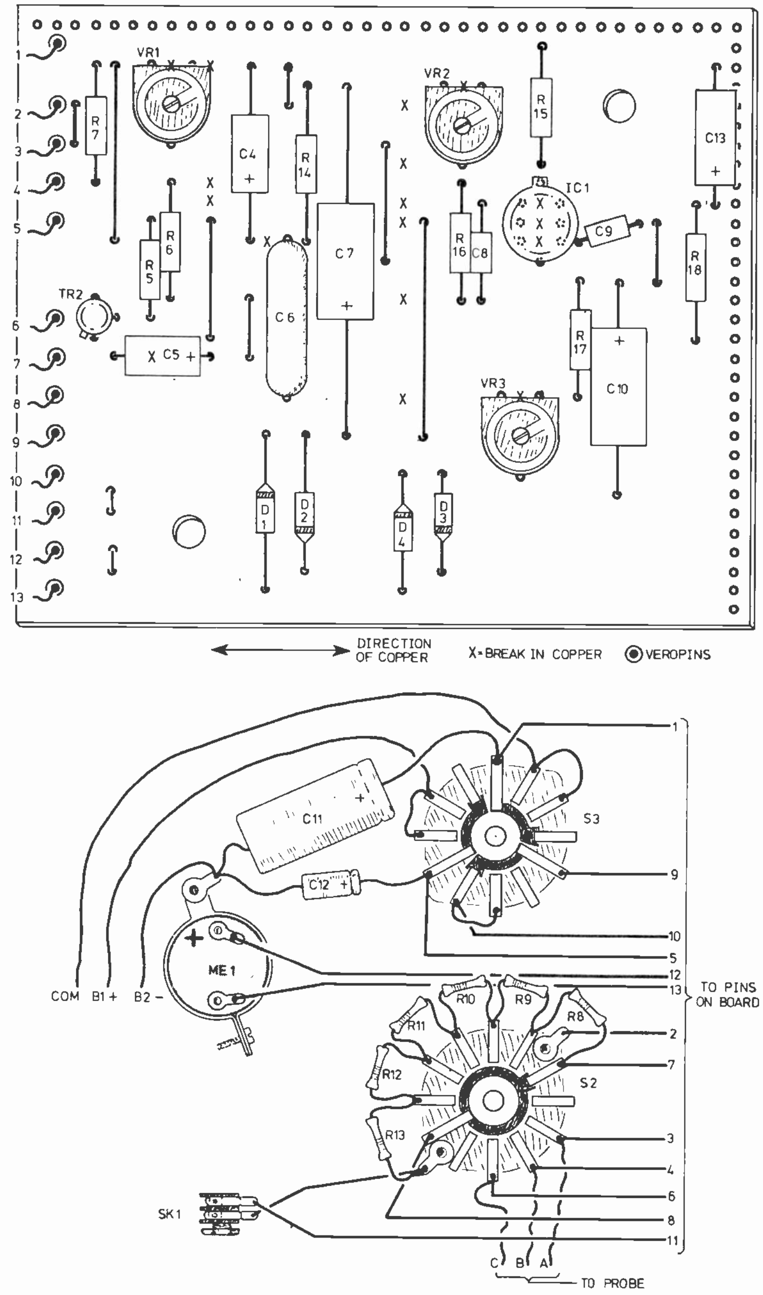


Fig. 3. Construction of the main unit of the Audio Millivoltmeter. The Veroboard is mounted in the lid of the box and the other components in the base (see photograph)

COMPONENTS . . .

Resistors

R1	1M Ω 2%	R10	430 Ω 2%
R2	1k Ω 2%	R11	150 Ω 2%
R3	1M Ω	R12	43 Ω 2%
R4	68k Ω	R13	22 Ω 2%
R5	47k Ω	R14	15k Ω
R6	4·7k Ω	R15	22 Ω
R7	680 Ω	R16	1·5k Ω
R8	4·3k Ω 2%	R17	2·2k Ω
R9	1·5k Ω 2%	R18	680 Ω

All ±5% ⅛W carbon unless otherwise stated

Potentiometers

VR1 5k Ω
VR2 100 Ω
VR3 5k Ω
} horizontal skeleton presets

Capacitors

C1 see text
C2 0·01μF ceramic
C3 0·22μF polyester
C4 20μF 10V elect.
C5 10μF 16V elect.
C6 0·47μF polyester
C7 470μF 3V elect.
C8 220pF
C9 33pF
C10 125μF 10V elect.
C11 2,200μF 16V elect.
C12 10μF 25V elect.
C13 10μF 25V elect.

Semiconductors

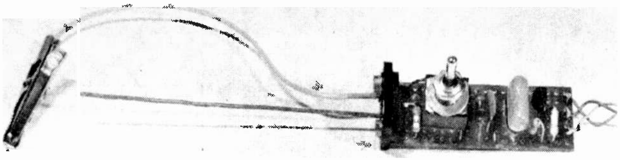
D1–D4 1N914 or similar small signal silicon (4 off)
TR1 2N3819
TR2 BCY71
IC1 709 TO5 can

Switches

S1 Miniature d.p.d.t. toggle
S2 2-pole 6-way make-before-break wafer (only 1 pole used)
S3 4-pole 3-way make-before-break wafer (only 3 poles used)

Miscellaneous

ME1 100μA f.s.d.
SK1 3·5mm jack socket
Diecast box 6¾in × 4¾in × 2in
0·1in matrix Veroboard 3¾in × 3¼in and 2in × ⅝in
Screening can for probe, knobs, nuts and bolts, grommets, etc.



Photograph showing the internal construction of the hand-held probe. The screening consists of a coil screening can. It is bolted to the tag holding the lead to the earth clip

MAIN UNIT CONSTRUCTION

The construction of the main unit (Fig. 3) follows a conventional pattern, with the two switches and meter on the front panel, and the 0·1in pitch Veroboard mounted on the rear (or lid) of the box. For insulation, two thicknesses of 2mm polystyrene wall insulation are interposed between board and box lid, with the board held in place by means of two 6BA screws and nuts.

Two PP3 batteries are used. Held together with rubber bands, they are clamped in place, when the box lid is tightened down, by a piece of foam plastic glued to the lid, and prevented from sideways movement by means of a scrap of ¼in hardwood, glued to the box itself.

Resistors R8 to R13 are best mounted on the wafer of switch S2, which must be of make-before-break action. Should a break-before-make switch be employed, when S2 is operated, the i.c. will have only R14 at its non-inverting input between positions, and since this latter resistor appears to the i.c. to be very much larger than its actual value due to the bootstrap action described earlier, sufficient random noise would be generated to give a large unwanted meter deflection.

Switch S3 should also be of make-before-break action, to preserve continuity of battery supply when switching.

The three leads from the probe enter through a hole close to S2 and, for convenience, are terminated on three unused tags on S2.

SETTING UP

After careful checking of the wiring—it is often a good idea to get somebody else to give a final check—move switch S3 to "amplifier". Monitor the potential at IC1 output, i.e. its connection to C10; it should lie close to +9V.

Next, transfer the meter to TR2 collector (the metal can makes a convenient anchor point for a clip) and adjust VR1 to give a reading of about 10V. This setting of the quiescent voltage at this point has been found to give the best dynamic range, so allowing stable amplification without clipping.

Now provide a signal of suitable frequency (say 400Hz) and amplitude. If no audio generator with accurate output level indication is to hand, then a mains transformer with a secondary of around 10V will suffice (see Fig. 4).

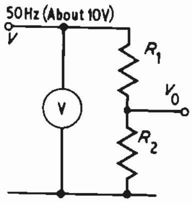


Fig. 4. Set-up for generation of 50Hz test signal

$$V_0 = \frac{R_2}{R_1 + R_2} \times V$$

$$R_1 + R_2 = 10 \text{ to } 15\text{k}\Omega$$

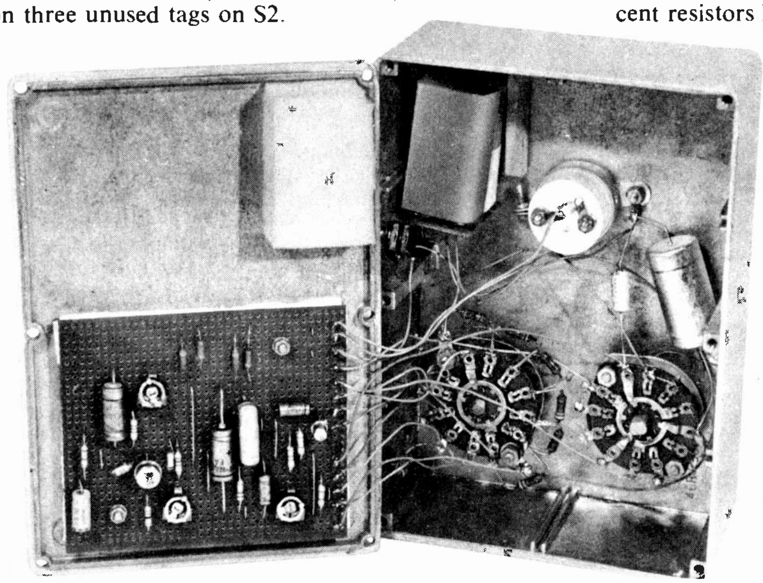
$$V_0 = 300\text{mV or less}$$

Measure the actual voltage available with an a.c. meter of known accuracy, and then arrange resistors to give a voltage of 300mV or slightly less; use resistors of 2 per cent tolerance or better, if possible, and of total value of about 10kΩ to 15kΩ.

Set the millivoltmeter to "300" and "mV". Inject the test signal and adjust VR2 to give the required meter deflection, i.e. that corresponding to the level decided upon.

Now change the test signal to 1V or slightly less, and, switching the millivoltmeter to "1" and "V", check the reading. All should be well if R1 and R2 and R8 to R13 are correct.

This method of setting up makes use of an external a.c. meter used on a range where its accuracy can be expected to be at its best. Subsequently, the millivoltmeter will be able to read 1mV f.s.d. with the same accuracy, provided that 2 per cent resistors have been used where suggested.



Photograph of the internal layout of the components within the die-cast box

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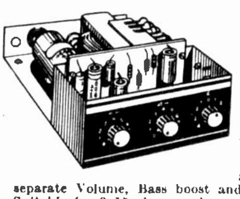
SUPERSOUND 13 HI-FI MONO AMPLIFIER



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

PRICE £11·60 P. & P. 40p.

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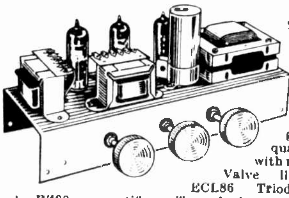

A.c. mains 200-240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w × 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. **Price £9·90.** P. & P. 50p.

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Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case, overall size 6" × 3½" × 2½". Suitable for Transistor Radios, Tape Recorders, Amplifiers, etc., etc. Ready built and tested.

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Also available specification as above but size 10" × 6" **£2·70** and size 8" round **£2·60** P. & P. 35p.
LIMITED NUMBER EMI 2½" 8 ohm Tweeters. Mounted on flat bracket, size 2½" wide × 7½" long. **70p** per pair plus 15p P. & P. Ex equipment but new and tested. **70p** per pair plus 15p P. & P.

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10 watts peak handling. 3, 8 or 15 ohm. **£2·45.** P. & P. 36p.
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Size 11⅞in × 14⅜in × 1⅛in deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz-20kHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details. Only **£6·55** each. P. & P. 34p.

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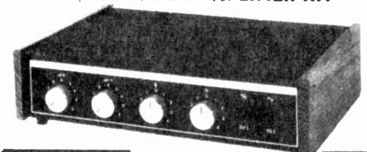
Adjustable headband with comfortable flexifoam ear-muffs. Wired and fitted with standard stereo ¼in jack plug. Frequency response 30-15,000Hz. Matching impedance 8-16 ohms. Easily converted for mono. PRICE **£3·30.** P. & P. 25p.

HAVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



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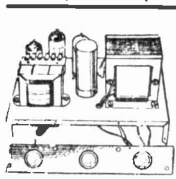
A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. (Very simple to modify to suit magnetic cartridge—instructions included). Output stage for any speakers from 5 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Power output 14W r.m.s. per channel into 5 ohms. Frequency response ± 3dB 12-30,000Hz. Sensitivity better than 80mV into 1MΩ. Full power bandwidth ± 3dB 12-15,000Hz. Bass boost approx. to ± 12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 35V at 1·0 amp. Overall size—12" wide × 8" deep × 2½" high.
Fully detailed 7-page construction manual and parts list free with kit or send 18p plus large S.A.E.

PRICES	AMPLIFIER KIT,	**£11·55**	P. & P. 25p.
	(Magnetic input components 33p extra)		
	POWER PACK KIT,	**£3.30**	P. & P. 35p.
	CABINET,	**£3·30**	P. & P. 35p.

(Post Free if all units purchased at same time). Full after sales service. Also available ready built and tested, **£23·10.** Post Free.
Note: The above amplifier is suitable for feeding two mono sources into inputs (e g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

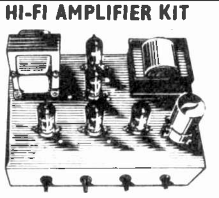
3-VALVE AUDIO AMP. HA34 MK II



Designed for Hi-Fi reproduction of records. A.C. Mains operation Ready built on plated heavy gauge metal chassis, size 7¼in w. × 4in. d. × 4½in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£5·50.** P. & P. 45p.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **£4·50.** P. & P. 45p.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet **15p** plus S.A.E. (Free with parts). **All parts sold separately.** ONLY **£8·80.** P. & P. 60p. Also available ready built and tested **£12·10.** P. & P. 70p.

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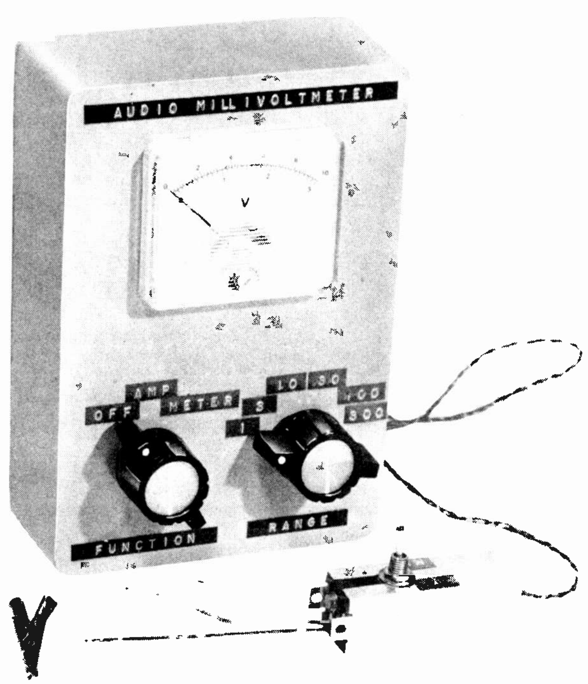

Photograph of the completed Audio Millivoltmeter showing disposition of controls on the front panel

ADJUSTMENT OF PROBE CAPACITOR

Adjustment of C1 comes next. Inject a 400Hz signal with the instrument on the 300mV range, and set the input level for full scale deflection on the meter. Switch to the 1V range; the meter should indicate 0·3 of f.s.d.

Now repeat with a signal in the range 20kHz to 50kHz. If C1 has the correct value, identical results will be obtained; if C1 is too small, then, on the 1V range the meter will read low.

As a guide, the author used a value of 6·7pF, obtained by means of a series combination of 10pF and a 22pF polystyrene capacitors.

The setting of VR3 can be done to suit individual requirements; in the author's instrument it was found convenient to have 0·5V r.m.s. output available, on the "amplifier" position of S3 when meter f.s.d. was indicated on the "meter" position.

THE INSTRUMENT IN USE

In use, put S3 to the "amplifier" position for a few seconds before switching to "meter", so that the large value electrolytic capacitors employed in various positions can charge up to their working voltages without causing damage to the meter movement.

Remember that C3 has a working voltage of 250V; should the millivoltmeter be used to measure the hum level on the h.t. line of a valve amplifier for example, then a suitable capacitor must be connected in series with the input to the probe. A 1μF 500V component should suffice.

Probe construction is such that the instrument should not really be used to measure a.c. voltages of greater than 100V (see specification), although the controls can be set to "300" and "V". An ordinary moving coil meter plus rectifiers combination (as used in most multi-purpose testers) would be more appropriate for voltages of that level and above, the millivoltmeter being intended for use at much lower levels.

FREQUENCY RESPONSE CURVES

One typical application of the millivoltmeter is in the plotting of the response curves of audio amplifiers, and utilises the set-up shown in Fig. 5. The millivoltmeter is used firstly to check that as the audio generator output frequency is varied, its output level remains constant. If this is not so (and few audio generators have an output level that is constant in that way) then the level should be re-adjusted at each frequency as it is brought into use. With the millivoltmeter then placed across the amplifier output, the level of voltage present there is easily read. In this way a frequency response curve can be plotted.

The term "amplifier" can, of course, be any power amplifier or pre-amplifier and further curves can be plotted for different settings of the tone controls, etc.

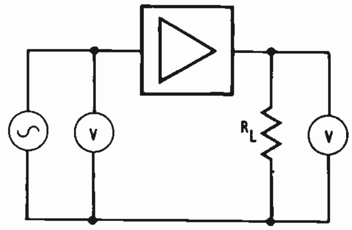

Fig. 5. A typical set up for using the Audio Millivoltmeter to measure frequency response curves of audio amplifiers or overload points

The load resistor RL must be included to simulate the actual load for the amplifier under test, although naturally it can be the load normally employed, e.g. a loudspeaker.

As a safety measure, it is a good rule to always set the audio millivoltmeter to a higher range than that expected. For example, if a level of 1V is thought to be present, set the instrument to the 10V range, subsequently reducing the setting when the actual level is confirmed.

This simple precaution (which applies to the use of all test instruments) will vastly reduce the chance of damage to expensive moving coil meters.

AMPLIFIER OVERLOAD

A further use for the audio millivoltmeter is in determining the overload point of an amplifier. This can be done with the set up of Fig. 5, as follows.

Increase the input to the amplifier in convenient steps, say by a doubling of the level from the audio oscillator, while monitoring the output of the test amplifier. The millivoltmeter will need to be changed from amplifier input to amplifier output alternately to do this. Eventually, an increase in input voltage will not be matched by a corresponding increase in output voltage, and this is the point at which overload begins at the frequency in use.

A plot of output against input voltage will readily enable the exact point of overload to be found. ★

Readout—
A SELECTION FROM OUR POSTBAG

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

Quad-wrangle

Sir—Regarding Mr. Wadsworth's letter (*Viewpoint*, December 1973) when he questions whether or not quadraphonic sound is a "con": of course it's a con! So for that matter is recorded music. But we seem to have adapted to eating food out of tin cans and deep freeze packets, why not listening to orchestral music out of loudspeakers? Only electronic music was designed specifically to be heard through loudspeakers.

On that basis, one might as well make one's canned music as palatable as possible and quadraphonic reproduction definitely enhances such music to no small degree. On the face of it, quadraphonics may seem an expensive luxury, but thanks to P.E. Rondo, this is not the case. The four 20W amplifiers, pre-amplifiers, SQ decoder, power supply unit, and all hardware have been built for just on £50. Could the system be obtained off-the-peg for this price? I doubt it.

Having now got the basic system operational, I can confirm the quality to be of a very high standard for the price.

So I've been conned and am thoroughly enjoying it: in this quarter quadraphonic sound has definitely caught on.

One plea, however: Two good "music system" projects in one year (P.E. Synthesiser and now P.E. Rondo) have proved expensive in total. Could you keep your hands off that super-con Octaphonic for at least another year, please?

I. Stuart-Colwill,
London, S.W.16.

More lifelike

Sir—I read with interest E. Wadsworth's letter in P.E. November 1973, and I must disagree with what he says.

The whole point of a hi-fi system, be it mono, stereo or quadraphonic is that it tries to reproduce as faithfully as possible the sounds one would hear in a concert hall. As Mr. Wadsworth points out, a musical group has a definite width, and to members of the audience, different sounds will appear to come from different directions. The great advantage of polyphonic as opposed to monophonic systems is that they reproduce, as far as is possible within the limits of the listening area, this effect can add therefore, to the realism of the music. How lifeless some music feels when it appears to come from only one source.

Stereo and quadraphonic systems are surely not a "con" therefore. They make the music sound more lifelike, and this is what hi-fi is all about.

I disagree with Mr. Wadsworth's comparison of colour television with amateur slides. I suggest he looks at a correctly adjusted television, which, as he will find, is capable of giving quality equal to the very best 35mm slides.

I would query on what authority Mr. Wadsworth makes such a brash statement. Also, he seems to be equaling "amateur" with "incompetent" which is not true by any means, as the large number of excellent articles in P.E. proves.

M. Norton,
Hailsham.

You are not alone

Sir—In reply to Mr. E. Wadsworth of Huddersfield:—You are not alone. You are simply one of the 90 per cent of the population who does not appreciate good music correctly presented, and you have not got a colour T.V. or, if you have, dump it and get a good Japanese one and get someone who knows the job to set it up for you.

I reckon you will be just about line of sight to Holme Moss and Emley Moor transmitters so you have no excuse for poor reception.

You appear to believe that stereo just gives a wider sound picture. That can be achieved by putting a mono sound source into two loudspeakers set well apart but it won't be stereo. Correct stereo reproduction will bring the orchestra or artists, or whatever the sound source is, into your living room so you can close your eyes and feel the presentation is live.

Each artist or instrument will sound to left or right, or some place between just as they were positioned at the time. That is no "con" trick. It actually takes place.

I've never thought the industry pushed stereo at all, it sells itself to those who know what sounds right. I think we are lucky that stereo and the transistor grew up together so we are able to have good quality sound at good power from the compact equipment at a reasonable price.

I should think that your group of musicians stood close together in order to get each one's sound into the single microphone which was practice before stereo, whereas now each artist has his own microphone. You have admitted that "a group of musicians constitutes a certain size" and that size is much larger than a single loudspeaker.

Concerning "quad." I am sure this adds even more realism to stereo, but I feel this requires a good sized room to be really effective but it is a step forward.

You must have listened to some rubbish stereo set-ups and watched some delapidated colour T.V.'s.

If you still think its a con trick—come over and look and listen. My set-up didn't cost the earth and I'm not rich, but I use my eyes and ears. I've not been conned.

C. A. King,
Nr. Sheffield.

Good advert

Sir—I would like to commend (through your columns) the following advertisers for prompt and efficient postal service:

R.T.V.C. (Acton) Ltd.,
Unisound amplifier—6 days.

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All include day of posting, which is excellent service and also proves that our postal system is not always as bad as it is often claimed.

D. L. Baxter,
Newbury.

AN INVITATION

UNIVERSITY OF ESSEX

A lecture THE P.E. SOUND SYNTHESISER will be given by Douglas Shaw on Wednesday, January 23, 1974, at 7 p.m. Readers in the Colchester area who would like to attend will be most welcome. Write to P. Noakes, Department of Electrical Engineering Science, University of Essex, Colchester.

Exciting...the Stereo 21!

Can you really get sound quality like this FOR LESS THAN £19? YES, YOU CAN! WITH THE NEW

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Top-quality amplifier, BSR turntable, matching speakers. Deck and speaker cabinets you simply wrap round and glue to build. Screw in the amplifier and connect up (all push fit no soldering whatsoever), so simple literally anyone can do it. Except for glue and panel pins all parts supplied including full instructions—all for £18·45 (plus the cost of post and packing if you buy by mail), and—to round it all off—a money refund if not satisfied if your pleasure in STEREO 21 is not complete!

Just think—in only a few days you could be giving your ears the treat of a lifetime—AND introducing your envious friends to STEREO 21!

Power Output 2 7 watts per channel and headphone socket with automatic cut-out. Provision for auxiliary inputs—radio tape, etc., and output for taping discs Overall dimensions Speakers approx $15\frac{1}{2} \times 8 \times 4$ in Complete deck and cover enclose position approx $15\frac{1}{2} \times 12 \times 6$ in

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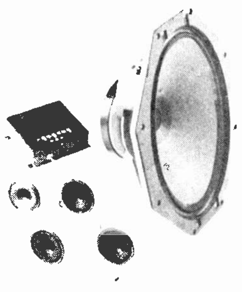
OUR PRICE £25·00 + £1·50 p. & p.



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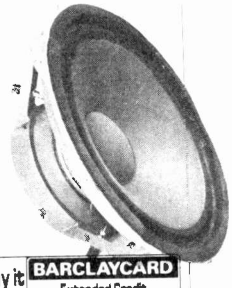

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The unique VISCOUNT III amplifier, plus the Garrard SP25 Mk III deck, plus the magnificent Duo Type III matched speakers (or Duo Type II for a small room) give you an audio installation that will prove unbeatable for listening pleasure! On the brushed aluminium front panel of the amplifier you'll find all the facilities you need—volume, bass, treble and balance controls, plus switches for mono/stereo, on/off function and bass and treble filters. Plus headphone socket on the back. And the teak finish will harmonise and enhance virtually any style of interior decor!
The heart-stopping timbre of Tom Jones at his most virile . . . the last lingering harmonics of a solo performance by Heifetz or Menuhin . . . the pathos and the panache of Liza Minelli . . . the majestic sonorities of the brass band and the elfin subtleties of the virtuoso clavichordist—hear every nuance with a fidelity that you have *never* experienced before!
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PRICES: SYSTEM 1

Viscount III R 102 amplifier	£24 20	+ £1 p & p
2 Duo Type II speakers	£14 00	+ £2·20 p & p
Garrard SP25 Mk III with MAG. cartridge plinth & cover	£18·00	+ £1 75 p & p
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PRICES: SYSTEM 2

Viscount R 102 amplifier	£24 20	+ £1 p & p
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Garrard SP25 Mk III with MAG cartridge plinth & cover	£18 00	+ £1·75 p & p
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The Tourist PB is suitable for 12 volt working on both negative and positive earth vehicles it covers the full medium and long wave bands. It is permeability tuned and sturdily constructed. Output is a full 2·5 watts into an 8 ohms speaker. But the Tourist PB will operate into any loudspeaker from 8 to 15 ohms.
Apart from the output stage, which is an integrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modulised IF stages which are pre-aligned before despatch. As well as electronic components this kit also contains 2 diamond-spun aluminium knobs, elegant matching front panel, dial, washers, screws and wire.
The Tourist PB can be mounted in any standard size dash panel and it has an illuminated tuning scale. Chassis size is: 7in wide, 2in high and 4¹¹⁄₁₆in deep.

* Circuit diagram and comprehensive instructions 55p free with parts.
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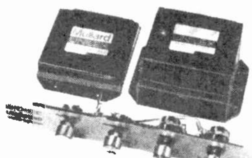

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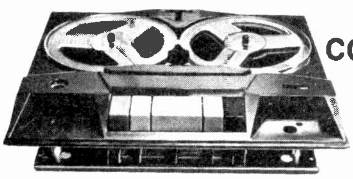

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The Viscount III, the fabulous Stereo 21 and the Unisound Modules will all accept this unit, simply connect up. **£10·60** p. & p. 90p.

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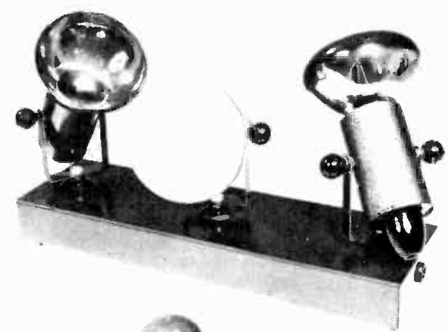

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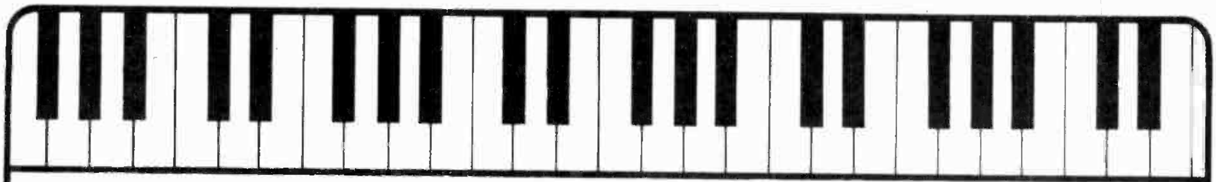

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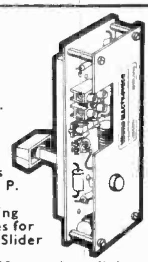

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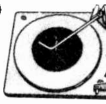
STEREO AND MONO



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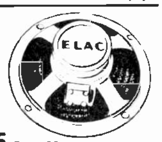

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100/25V	10p	32 + 32/350V	40p		

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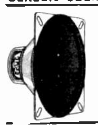

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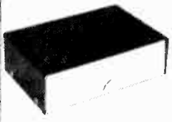

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741C 8-pin DIL	36p
MFC 6040 electronic attenuator	£0·95
SG 3402N for Ring Modulator	£1·69
CA 3046	69p

CAPACITORS

Sub-miniature Axial lead electrolytic

Mfd	V	Price	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			
3·3	63	6p	100	4	6p			
4·7	63	6p	100	10	6p	470	6·3	6p
6·8	40	6p	100	25	6p	470	10	10p
6·8	63	6p	100	40	6p	470	25	12p
10	25	6p	100	63	12p	470	40	18p
10	63	6p	150	6·3	6p	680	6·3	10p
15	16	6p	150	16	6p	680	16	12p
15	40	6p	150	25	6p	680	25	18p
15	63	6p	150	40	10p	680	40	22p
22	10	6p	150	63	12p	1000	4	10p
22	25	6p	220	4	6p	1000	10	12p
22	63	6p	220	10	6p	1000	16	18p
33	6·3	6p	220	16	6p	1000	25	22p
33	16	6p	220	25	10p	1500	6·3	12p
33	40	6p	220	40	12p	1500	10	18p
47	4	6p	220	63	18p	1500	16	22p
47	10	6p	330	4	6p	2200	6·3	18p
47	25	6p	330	10	6p	2200	10	22p
47	40	6p	330	16	10p	3300	6·3	22p
47	63	6p	330	63	22p	4700	4	22p

OMNIUM GATHERUM

PP3. 6 etc. battery clip dual min. **9p.**
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 **43p.**
Red neon 240V panel mounting **25p.**
Lacing Cord Strong rayon cored PVC 25m **43p.**
Panel fuse holders 20mm **20p**; 1¼in **30p.**

Transformers
LT700 min. output transformer Pri. 1·2kΩ Sec. 5Ω 200mW **35p.**

Sub-min. Mains Transformer
6–0–6V 100mA **95p.** 12–0–12V 50mA **95p.**
Size: Both approx. 30 × 27 × 25mm

Min. Mains Transformer
Size: 46 × 31 × 38mm.
0–12V 250mA. 0–12V 250mA **£1·36.**

Mains Transformer MT3AT
Pri 200–220–240V. Sec. 12–15–20–24–30V 1A **£2·48.**

Mains Transformer MT206AT
Pri. 200–220–240V. Sec. 0–15–20V 1A. 0–15–20V 1A **£3·10.**

Hook-up wire, 7 strand 0·2mm. PVC covered tinned copper wire for light general connexions up to 1·4A. 11 colours: black, blue, brown, green, grey, orange, pink, red, violet, white, yellow. 10 metres of any one colour **17p.** Pack of 11 (1 of each colour) 10m. coils **£1·75.**

Single core screened 6p per metre.
Twin individually screened **9p** per metre.
High quality single screened 50Ω 100pF per metre, ideal for high grade audio connexions **12p** per metre.

Mains 3-core sub-miniature 1A black PVC covered 19 strand 0·1mm per conductor. **6½p** per metre.

PLUGS AND SOCKETS

DIN PLUGS
2 pin (1 flat) 8p
3 pin 9p
4 pin, 5 pin A (180°), 5 pin B (240°), 6 pin 10p

DIN Sockets
2 pin 6p
3 pin, 4 pin, 5 pin A (180°), 5 pin B (240°), 6 pin 7p

MAINS
P360 3 pin 1·5A chassis plug with line socket. Per pair 24p
SA 2190 3 pin 5A chassis plug 17p
SA 1862 Line socket for above 19p

McMURDO
RP8 8 way chassis plug 36p

RS8 8 way chassis socket 52p

PHONO
Plug plastic 5p
Plug screened 9p
Chassis socket 4p

JACK
Std. ¼" mono plug
Plastic 13p
Screened 17p

Std. ¼" stereo plug
Plastic 16p
Screened 25p
Open mono socket ¼" 10p; Moulded mono socket ¼" with 2 break contacts 13p; Moulded stereo socket ¼" with 3 break contacts 18p; 3·5mm. plug plastic 8p; screened 11p; open socket 8p.

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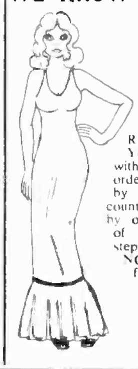

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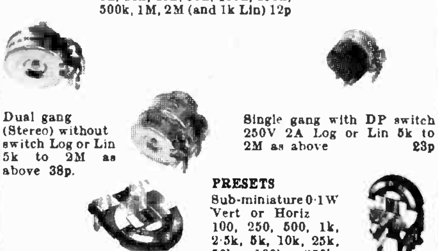
POTENTIOMETERS

Rotary miniature carbon track ¼" 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.

Single gang with DP switch 250V 2A Log or Lin 5k to 2M as above 23p

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 ¼" spindle 10, 50, 100R **34p**; 250, 500, 1k, 5k **33p**; 10k, **37p**; 25k **40p**; 50k **44p**.

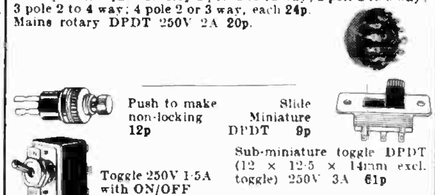
TRANSISTORS, DIODES & I.C's.

AC127	25p	MPF102	36p	2N3053	18p
AC128	20p	OC25	49p	2N3054	55p
AC176	17p	OC28	49p	2N3055	49p
AD149	47p	OC35	49p	2N3819	24p
AD161/2	69p	OC44	20p	OA90	7p
BC107	10p	OC71	20p	OA91	6p
BC108	10p	TIS43	28p	1N914	4p
BC109	10p	2N706	10p	1N4148	4p
BC147	10p	2N1304	30p	1N4001	6p
BC148	10p	2N1711	24p	1N4002	6½p
BC149	12p	2N2219	25p	1N4003	7p
BC168	13p	2N2646	45p	1N4004	7½p
BC169C	12p	2N2905	33p	1N4005	8p
BC182L	12p	2N2907	25p	1N4006	8½p
BC204	14p	2N2926O	10p	1N4007	9p
BC209C	14p	2N2926Y	10p	WO05	30p
BD131	45p	2N2926G	10p	WO4	34p
BD132	54p	741C 8-pin DIL 36p			
BD131/2	£1·20	741C 14-pin DIL 45p			
BF194	15p	DIL Sockets 8-pin 20p			
BFY51	16p	14-pin 15p			

See our catalogue for our full range of transistors, 74 series I.C's bridges, etc.

SWITCHES

Rotary with adjustable stop 1 pole 2 to 12 way; 2 pole 2 to 6 way; 3 pole 2 to 4 way; 4 pole 2 or 3 way, each **24p**.
Mains rotary DPDT 250V 2A **20p**.



Push to make non-locking 12p

Slide Miniature DPDT 9p

Toggle 250V 1·5A with ON/OFF plate 25p.

Sub-miniature toggle DPDT (12 × 12·5 × 14mm excl. toggle) 250V 3A 61p

RESISTORS

Carbon Film ½W 5%	1Ω to 1M; 10% 1·2M to 10M		E12	1p
Carbon Film ¼W 5%	1Ω to 10Ω; 10% 1·2M to 10M		E12	1p
Carbon Film ⅛W 5%	11Ω to 910k	E12 & E24		1p
Carbon Film 1W 5%	10Ω to 10M		E12	3p
Metal Oxide ½W 2%	10Ω to 1M	E12 & E24		4p
Wirewound 2½W 10%	0·22ohms to 0·47ohms		E12	10p
Wirewound 2½W 5%	1ohm to 270ohms		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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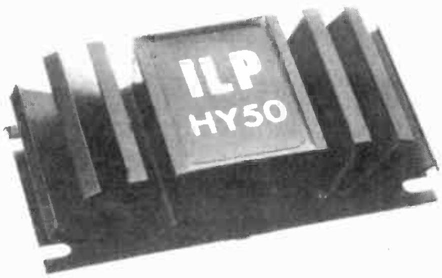
SECOND GENERATION 25 WATT HYBRID



A brand new hybrid fabrication technique, recently perfected in our laboratories, has enabled us to achieve our latest range of completely integrated devices.
We have now finally reduced the modular audio amplifier to a simple input/output device requiring only the addition of a basic unstabilized (split line) power supply.
The HY50 takes medium power modules to their logical conclusion by incorporating with it a heatsink, which is designed in special high conductivity alloy sufficient for normal audio use without additional chassis sinking. All this without significantly increasing the size of the module comparable in size to a packet of "King-size" cigarettes.
Consistent with modern thinking a triple rated output circuit with a load fuse allows for peak transient response without distortion but ensures the necessary protection.

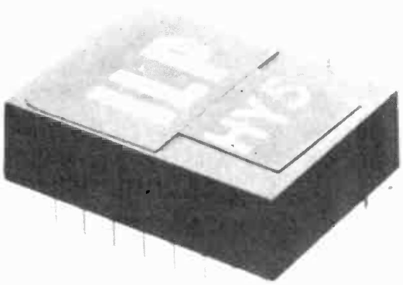
SPEC.

OUTPUT POWER:	25W RMS, 50W peak music power.
LOAD IMPEDANCE:	4–16Ω into 8Ω
INPUT SENSITIVITY:	0dB (0·775V RMS).
INPUT IMPEDANCE:	47kΩ.
TOTAL HARMONIC DISTORTION:	Less than 0·1% at 25W typically 0·05.
SIGNAL/NOISE RATIO:	better than 75dB.
FREQUENCY RESPONSE:	10Hz–50kHz ± 1dB.
SUPPLY VOLTAGE:	±25V.
SIZE:	105 × 50 × 25mm.

Price £5·40 mono £10·80 stereo. Price inclusive of VAT & P. & P.

NEW HY5 PREAMPLIFIER

Unchallenged for two years, the HY5, our unique multifunction preamplifier/tone hybrid, has been brought into line with the advancements in our power hybrids.
Like the HY50, the new HY5 has no external components and has been redesigned to run off a split power line with improvements in signal/noise, overload capability and reduced distortion. The output has been increased to match the power module (0dB), and share the same power supply.
Overall size is reduced by the use of a new thin film circuitry while the device still retains all the functions of the earlier device.
When combined with the HY50 and power supply only potentiometers are required to complete a simple mono amplifier with input and output facilities expected to be found on Hi-Fi amplifiers.
The combination of two HY5's two HY50's sharing a common power supply (PSU50) are linked by a balance control to form a complete stereo system.



SPEC.

INPUTS
Magnetic Pick-up 3mV (within 1dB RIAA curve)
Ceramic Pick-up up to 3mV.
Microphone 10mV.
Tuner 250mV.
Auxiliary 3–100mV.
Input impedance 47kΩ 1 kHz

OUTPUTS
Tape 100mV.
Main output. 0dB (0·775V).

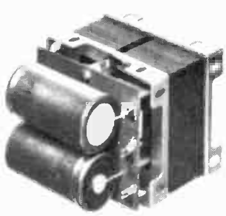
ACTIVE TONE CONTROLS
Treble ± 12dB at 10kHz
Bass ± 12dB at 100Hz

OVERLOAD CAPABILITY
(equalization stage) 40dB on most sensitive input.

OUTPUT NOISE LEVEL
(below 10mV magnetic input) 68dB.

DISTORTION 0·05% at 1kHz.
SUPPLY VOLTAGE ± 16–25V.
SUPPLY CURRENT 15mA.

Price £4·51 mono £9·02 stereo. Price inclusive of VAT & P. & P.



POWER SUPPLY PSU50

The new PSU50 has a low profile look being only 2¼in high and can be used for either mono or stereo systems.

SPEC.
OUTPUT VOLTAGE ± 25V.
INPUT VOLTAGE 210–240V.
SIZE: L. 70 D. 90 H. 60mm.
Price £5·23. Price inclusive of VAT & P. & P.

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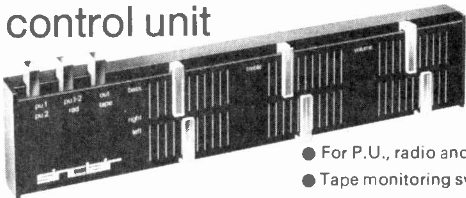
new thinking in modular hi-fi

Stereo 80 pre-amplifier and control unit



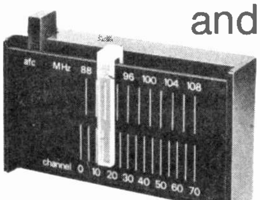
- For P.U., radio and tape
- Tape monitoring switch
- Simplest ever fixing

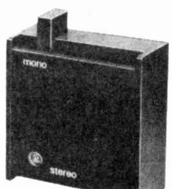
Each channel has its own separate tone and volume controls operated by sliders, enabling ideal environmental matching to be obtained. A virtual earth input stage forms part of the up-dated circuitry that ensures the finest possible quality from all signal sources. Generous overload margins are allowed on all inputs. Clear instructions with template are supplied.

TECHNICAL SPECIFICATIONS
Size – 260 × 50 × 20mm (10¼ × 2 × ¾ins)
Finish – Black with white indicators and transparent Sliders
Inputs – Magnetic pick-up 3mV RIAA corrected. Ceramic pick-up 300mV
Radio 300mV; Tape 30mV
Signal/noise ratio – 60dB
Frequency range – 20Hz to 15KHz ± 1dB: 10Hz to 25KHz ± 3dB
Power requirements – 20 to 35 volts
Outputs – 100mV + AB monitoring for tape
Controls – Press button for tape radio and P U. Sliders for volume, bass (+ 12dB to – 14dB at 100Hz) treble (+ 11dB to – 12dB at 10KHz)

R.R.P. £11.95 +£1·19 V.A.T.

Project 80 FM tuner and stereo decoder





- Twin dual varicap tuning: 4 pole ceramic filter: switchable A.F.C.
- On the decoder, solid state stereo indicating beacon.

Making the Project 80 F.M. tuner and decoder available separately gives a wider choice of systems and saves money where stereo reception may not be required. The tuner is a triumph of electronic design and assures excellent performance. The decoder gives a 40dB channel separation with 150mV output per channel. Both units may be used with other than Project 80 systems.

TECHNICAL SPECIFICATIONS OF TUNER
Size – 85 × 50 × 20mm (3½ × 2 × ¾ins)
Tuning range – 87·5 to 108 MHz
Detector – I.C. balanced coincidence for good A.M. rejection
One I.C. equal to 26 transistors
Distortion – 0·2% at 1 KHz for 30% modulation
4 pole ceramic filter in I.F. section
Aerial impedance – 75 Ω or 240-300 Ω
Sensitivity – 4 microvolts for 30dB quieting
Output – 300 mV for 30% modulation
Power requirements – 23 to 33 volts

R.R.P. £11.95 +£1·19 V.A.T.

DECODER
Size – 47 × 50 × 20mm (1⅞ × 2 × ¾ins)
One 19 transistor I.C.

R.R.P. £7.45 +0·74 V.A.T.

Guarantee

If, within 3 months of purchasing any product direct from us, you are dissatisfied with it, your money will be refunded on production of receipt of payment. Many Sinclair appointed stockists also offer this guarantee. Should any defect arise in normal use, we will service it without charge. For damage arising from mis-use a charge (typically £1·00) will be made.

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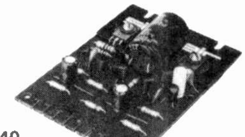
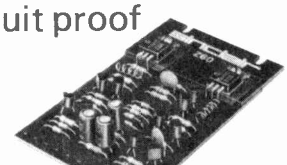
totally short-circuit proof



Z.40



Z.60

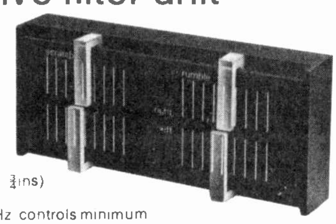
Intended for use in Project 80 installations, these modules readily adapt to an even wider range of applications. Both incorporate built-in protection against short circuiting and risk of damage from mis-use is greatly reduced.

Z.40 TECHNICAL SPECIFICATIONS
Size – 55 × 80 × 20mm (2¼ × 3¼ × ¾ins) 9 transistors
Input sensitivity – 100mV
Output – 15 watts RMS continuous into 8 Ω (35v)
Frequency response – 10Hz – 100KHz ± 1dB
Signal/noise ratio – 64dB
Distortion – at 10 watts into 8 Ω less than 0 1%
Power requirements – 12 to 35 volts

Z.60 TECHNICAL SPECIFICATIONS
Size – 55 × 98 × 15mm (2¼ × 3¾ × ¾ins) 12 transistors
Input sensitivity – 100-250mV
Output – 25 watts RMS continuous into 8 Ω (45V)
Distortion – typically 0·03%
Frequency response – 10Hz to more than 200KHz ± 1dB
Signal/noise ratio – better than 70dB
Built-in protection against transient overload and short circuiting
Load impedance – 4 Ω min, max safe on open circuit

Z.40 R R.P. **£5.45** + 0·54 V.A.T., **Z.60** R R.P. **£6.95** + 0·69p V.A.T.

Project 80 active filter 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 applied to each channel make it easier to obtain ideal stereo balance.

TECHNICAL SPECIFICATIONS
Size – 108 × 50 × 20mm (4¼ × 2 × ¾ins)
Voltage gain – minus 0·2dB
Frequency response – 36Hz to 22KHz controls minimum
Distortion – at 1 KHz – 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

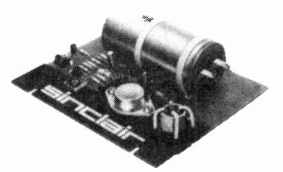
- For scratch and rumble control
- Transistorised active circuitry

R.R.P. £6.95 +0·69 V.A.T.

Power supply units

PZ.8

Stabilised. Re-entrant current limiting makes damage from overload or even direct shorting impossible. Normal working voltage (adjustable) 45V.



R.R.P. £7·98 + 0·79p V.A.T.
Without mains transformer

PZ.5 30V unstabilised
R.R.P. £4·98 + 0·49p V.A.T.

PZ.6 35V. stabilised
R.R.P. £7·98 + 0·79p V.A.T.

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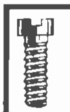

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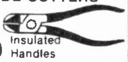

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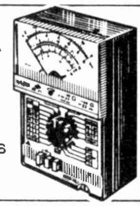

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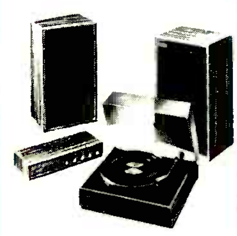

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